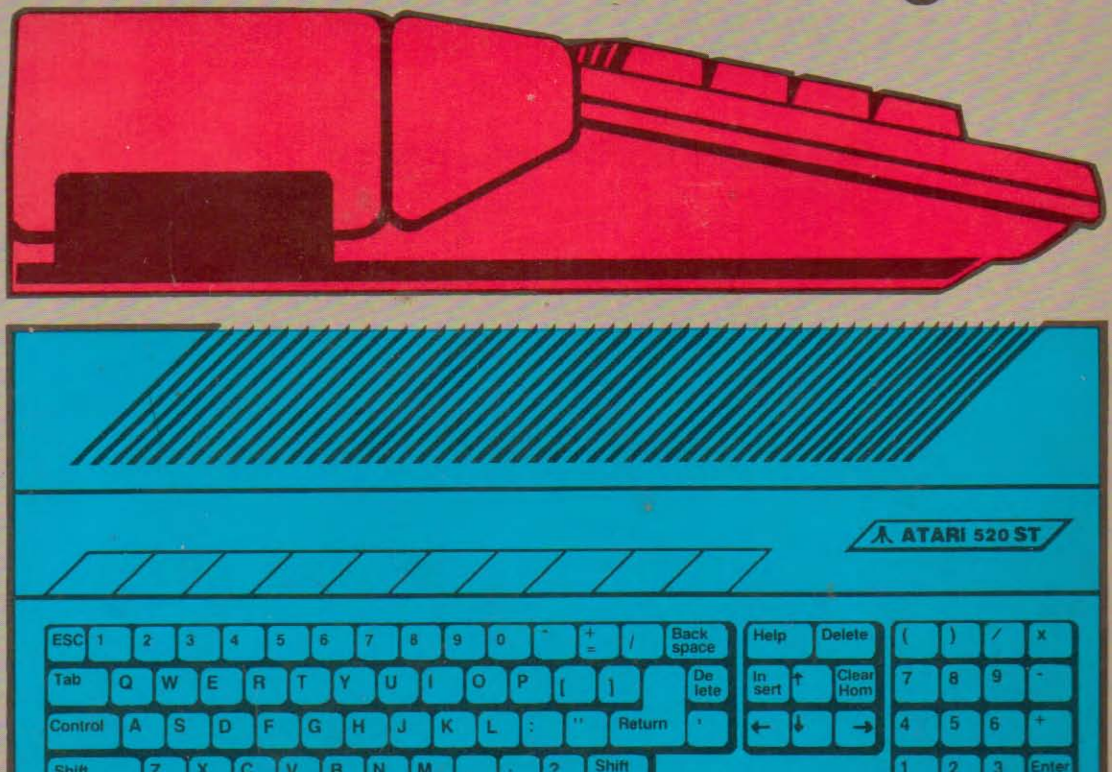
Third Revision—Includes blitter chip information

ATARI® ST™ INTERNALS

The authoritative insider's guide



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ATARI ST INTERNALS

The authoritative insider's guide

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Table of Contents

List of Figures

Chapter One

The Integrated Circuits

The Integrated Circuits

1.1 The 68000 Processor

The 68000 microprocessor is the heart of the entire Atari ST system. This 16-bit chip is in a class by itself; programmers and hardware designers alike find the chip very easy to handle. From its initial development by Motorola in 1977 to its appearance on the market in 1979, the chip was to be a competitor to the INTEL 8086/8088 (the processor used in the IBM-PC and its many clones). Before the Atari ST's arrival on the marketplace, there were no affordable 68000 machines available to the home user. Now, though, with 16-bit computers becoming more affordable to the *common* man, the 8-bit machines won't be around much longer.

What does the 68000 have that's so special? Here's a very incomplete list of features:

16 data bits
24 address bits (16-megabyte address range!!)
all signals directly accessible without multiplexer
hassle-free operation of "old" 8-bit peripherals
powerful machine language commands
easy-to-learn assembler syntax
14 different types of addressing
17 registers each having 32-bit widths

These specifications (and many yet to be mentioned here) make the 68000 an incredibly good microprocessor for home and personal computers. In fact, as the price of memory drops, you'll soon be seeing 68000-based 64K machines for the same price as present-day 8-bit computers with the same amount of memory.

1.1.1 The 68000 Registers

Let's take a look at 68000 design. Figure 1.1-1 shows the 17 onboard 32-bit registers, the program counter and the status register.

The eight data registers can store and perform calculations, as well as the normal addressing tasks. Eight-bit systems use the accumulators for this, which limits the programmer to a total of 8 accumulators. Our 68000 data registers are quite flexible; data can be handled in 1-, 8-, 16- and 32- bit sizes. Even four-bit operations are possible (within the limits of Binary Coded Decimal counting). When working with 32-bit data, all 32 bits can be handled with a single operation. With 8- and 16-bit data, only the 8th or 16th bit of the data register can be accessed.

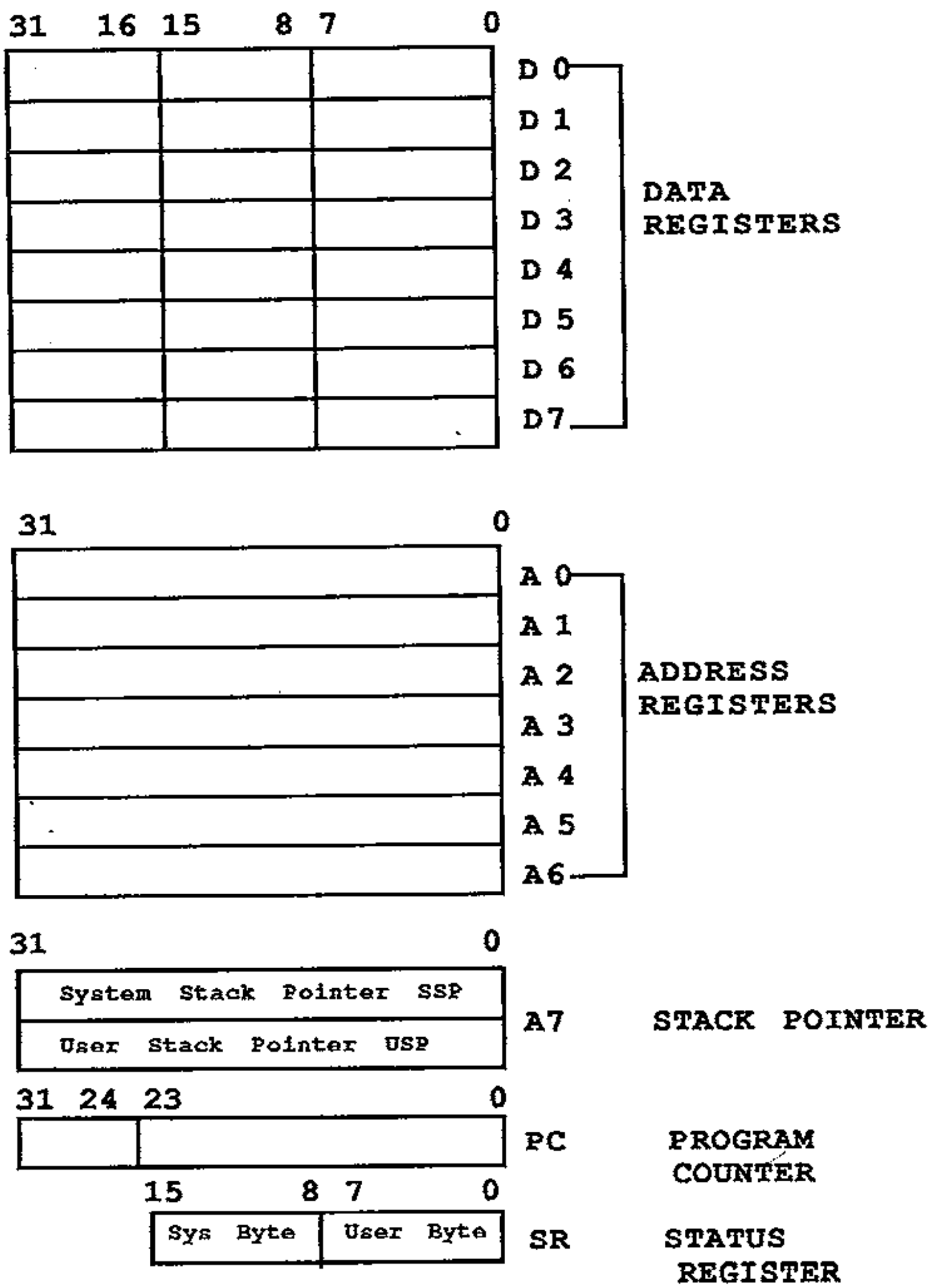
The address registers aren't as flexible for data access as are the data registers. These registers are for addressing, not calculation. Processing data is possible only with word (16-bit) and longword (32-bit) operations. The address registers must be looked at as two distinct groups, the most versatile being the registers A0-A6. Registers A7 and A7' fulfill a special need. These registers are used as the stack pointer by the processor. Two stack pointers are needed to allow the 68000 to run in USER MODE and SUPERVISOR MODE. Register A7 declares whether the system is in USER or SUPERVISOR mode. Note that the two registers work "under" A7, but the register contents are only available to the respective operating mode. We'll discuss these operating modes later.

The program counter is also considered a 32-bit register. It is theoretically possible to handle an address range of over 4 gigabytes. But the address bits A24-A31 aren't used, which "limits" us to 16 megabytes.

The 68000 status register comprises 16 bits, of which only 10 bits are used. This status register is divided into two halves: The lower eight bits (bits 0 to 4 proper) is the "user byte". These bits, which act as flags most of the time, show the results of arithmetical and comparative operations, and can be used for program branches hinging on those results. We'll look at the user byte in more detail later; for now, here is a brief list:

```
BIT 0 = Carry flag       BIT 1 = Overflow flag
BIT 2 = Zero flag        BIT 3 = Negative flag
BIT 4 = eXtend flag
```

Figure 1.1-1 68000 Registers



Bits 8-10, 13 and 15 make up the status register's system byte. The remaining bits are unused. Bit 15 works as a trace bit, which lets you do a software controlled single-step execution of any program. Bit 13 is the supervisor bit. When this bit is set, the 68000 is in supervisor mode. This is the normal operating mode; all commands are executed in this mode. In user mode, in which programs normally run, privileged instructions are inoperative. A special hardware design allows access into the other memory range while in user mode (e.g., important system variables, I/O registers). The system byte of the status register can only be manipulated in supervisor mode; but there's a simple method of switching between modes.

Bits 8 and 10 show the interrupt mask, and run in connection with pins IPL0-IPL2.

The 68000 has great potential for handling interrupts. Seven different interrupt priorities exist, the highest being the "non-maskable interrupt"; NMI. This interrupt recognizes when all three IPL pins simultaneously read low (0). If, however, all three IPL pins read high, there is no interrupt, and the system operates normally. The other six priorities can be masked by appropriate setting of the system byte of the status register. For example, if bit I2 of the interrupt mask is set, while I0 and I1 are off, only levels 7, 6 and 5 (000, 001 and 010) are recognized. All other combinations from IPL0-IPL2 are ignored by the processor.

1.1.2 Exceptions on the 68000

We've spoken of interrupts as if the 68000 behaves like other microprocessors. Interrupts, according to Motorola nomenclature, are an external form of an **exception** (the machine can interrupt what it's doing, do something else, and return to the interrupted task if needed). The 68000 distinguishes between normal operation and exception handling, rather than between user and supervisor mode. One such set of exceptions is the interrupts. Other things which cause exceptions are undefined opcodes, and word or longword access to a prohibited address.

To make exception handling quicker and easier, the 68000 reserves the first 1K of memory (1024 bytes, $000000-$0003FF). The exception table is located here. Exceptions are all coded as one of four bytes of a longword. Encountering an exception triggers the 68000, and the address of the corresponding table entry is output.

A special exception occurs on reset, which requires 8 bytes (two longwords); the first longword contains the standard initial value of the supervisor stack pointer, while the second longword contains the address of the reset routine itself. See Chapter 3.3 for the design and layout of the exception table.

1.1.3 The 68000 Connections

The connections on the 68000 are divided into eight groups (see Figure 1.1-3 on page 11).

The first group combines data and address busses. The data bus consists of pins D0-D15, and the address bus A1-A23. Address bit A0 is not available to the 68000. Memory can be communicated with words rather than bytes (1 word=2 bytes=16 bits, as opposed to 1 byte=8 bits). Also, the 68000 can access data located on odd addresses as well as even addresses. The signals will be dealt with later.

It's important to remember in connection with this, that by word access to memory, the byte of the odd address is treated as the low byte, and the even address is the high byte. Word access shouldn't stray from even addresses. That means that opcodes (whether all words or a single word) must always be located at an even addresses.

When the data and address bus are in "tri-state" condition, a third condition (in addition to high and low) exists, in which the pins offer high resistance, and thus are inactive on the bus. This is important in connection with Direct Memory Access (DMA).

The second group of connections comprise the signals for asynchronous bus control. This group has five signals, which we'll now look at individually:

1) R/W (READ/WRITE)

The R/W signal is a familiar one to all microprocessors. This indicates to memory and peripherals whether the processor is writing to or reading data from the address on the bus.

2) AS (ADDRESS STROBE)

Every processor has a signal which it sends along the data lines signaling whether the address is ready to be used. On the 68000, this is known as the ADDRESS STROBE (low active).

3) UDS (UPPER DATA STROBE)
4) LDS (LOWER DATA STROBE)

If the 68000 could only process an entire memory word (two bytes) simultanesouly, this signal wouldn't be necessary. However, for individual access to the low-byte and high-byte of a word, the processor must be able to distinguish between the two bytes. This is the task performed by UDS and LDS. When a word is accessed, both strobes are activated simultaneously (active=low). Accessing the data at an odd address activates the Lower Data Strobe only, while accessing data atan even address activates the Upper Data Strobe.

Bit A0 from the address bus is used in this case. After every access when the system must distinguish between three conditions (word, even byte, odd byte), A0 determines how to complete the access.

LDS and UDS are tri-state outputs.

5) DTACK

The above signals (with the exception of UDS and LDS) are needed by an 8-bit processor. DTACK takes a different path; DTACK must be low for any write or read access to take place. If the signal is not low within a bus cycle, the address and data lines "freeze up" until DTACK turns low. This can also occur in a WAIT loop. This way, the processor can slow down memory and peripheral chips while performing other tasks. If no wait cycles are used on the ST, the processor moves "at full tilt".

The third group of connections, the signals VMA, VPA and E are for synchronous bus control. A computer is more than memory and a microprocessor; interfaces to keyboard, screen, printer, etc. must be available for communication. In most cases, interfacing is handled by special ICs, but the 68000 has a huge selection of interfaces chips onboard. For hardware designers we'll take a little time explaining these synchronous bus signals.

The signal E (also known as Φ2 or phi 2) represents the reference count for peripherals. Users of 6800 and 6502 machines know this signal as the system counter. Whereas most peripheral chips have a maximum frequency of only 1 or 2 mHz, the 68000 has a working speed of 8 mHz, which can increased to 10 by the E signal. The frequency of E in the ST is 800 kHz. The E output is always active; it is not capable of a TRI- STATE condition.

The signal **VPA** (Valid Peripheral Address) sends data over the synchronous bus, and delegates this transfer to specific sections of the chip. Without this signal, data transfer is performed by the asynchronous bus. VPA also plays a role in generating interrupts, as we'll soon see.

VMA (Valid Memory Address) works in conjunction with the VPA to produce the CHIP-select signal for the synchronous bus.

The fourth group of 68000 signals allows simple DMA operation in the 68000 system. DMA (Direct Memory Access) directly accesses the DMA controllers, which control computer memory, and which is the fastest method of data transfer within a computer system.

To execute the DMA, the processor must be in an inactive state. But for the processor to be signaled, it must be in a "sleep" state; the low BR signal

(Bus Request) accomplishes this. On recognizing the BR signal, the 68000's read/write cycle ends, and the BG signal (Bus Grant) is activated. Now the DMA-requested chip waits until the signals AS, DTACK and (when possible) BGACK are rendered inactive. As soon as this occurs, the BGACK (Bus Grant Acknowledge) is activated by the requested chip , and takes over the bus. All essential signals on the processor are made high; in particular, the data, address and control busses are no longer influenced by the processor. The DMA controller can then place the desired address on the bus, and read or write data. When the DMA chip is finished with its task, the BGACK signal returns to its inactive state, and the processor again takes over the bus.

The fifth group of signals on the 68000 control interrupt generation. The 68000's "user's choice" interrupt concept is one of its most extraordinary performing qualities; you have 199 (!) interrupt vectors from which to choose. These interrupt vectors are divided into 7 non-auto-vectors and 192 auto-vectors, plus 7 different priority lines.

Interrupts are triggered by signals from the three lines IPL0 to IPL2; these three lines give you eight possible combinations. The combination determines the priority of the interrupt. That is, if IPL0, IPL1 and IPL2 are all set high, then the lowest priority is set ("no interrupt"). However, if all three lines are low, then highest priority takes over, to execute a non-maskable interrupt. All the combinations in between affect special bits in the 68000's status register; these, in turn, affect program control, regardless of whether or not a chosen interrupt is allowable.

Wait -- what are auto-vectors and non-auto-vectors? What do these terms mean?

If requesting an interrupt on IPL0-IPL2 while VPA is active (low), the desired code is directly converted from the IPL pins into a vector number. All seven interrupt codes on the IPL pins have their own vectors, though. The auto-vector concept automatically gives the vector number of the IPL interrupt code needed.

When DTACK, instead of VPA, is active on an interrupt request, the interrupt is handled as a non-auto-vector. In this case, the vector number from the triggered chip is produced by DTACK on the 8 lowest bits of the data bus. Usually (though not important here), the vector number is placed into the user-vector range ($40--$FF).

The sixth set of connections are the three "function code" outputs FC0 to FC2. These lines handle the status display of the processor. With the help of these lines, the 68000 can expand to four times 16 megabytes (64 megabytes). This extension requires the MMU (Memory Management Unit). This MMU does more than handle memory expansion on the ST; it also recognizes whether access is made to memory in user or supervisor mode. This information is conveyed to a memory range only accessible in supervisor mode. Also, the interrupt verification uses this information on the FC line. The figure below shows the possible combinations of functions.

Figure 1.1-3

FC2	FC1	FC0	Status
0	0	0	unused
0	0	1	User-mode data access
0	1	0	User-mode program
0	1	1	unused
1	0	0	unused
1	0	1	Supervisor data access
1	1	0	Supervisor program
1	1	1	Interrupt verification

The seventh group contains system control signals. This group applies to the input CLK and BERR, as well as the bidirectional lines RESET and HALT.

The input CLK will generate the working frequency of the processor. The 68000 can operate at different speeds; but the operating frequency must be specified (4, 6, 8, 10, or even 12.5 mHz). The ST has 8 mHz built in, while the minimum operating frequency is 2 mHz. The ST's 8 mHz was chosen as a "middle of the road" frequency to avoid losing data at higher frequencies.

The RESET line is necessary to check for system power-up. The 68000's data page distinguishes between two different reset conditions. On power-up, RESET and HALT are switched low for at least 100 milliseconds, to set up a proper initialization. Every other initialization requires a low impulse of at least 4 "beats" on the 68K.

Here is what RESET does in detail. The system byte of the status register is loaded with the value $27. Once the processor is brought into supervisor status, the Trace flag in the status register is cleared, and the interrupt level is set to 7 (lowest priority, all lines allowable). Additionally, the supervisor stack pointer and program counter are loaded with the contents of the first 8 bytes of memory, whereby the value of the program counter is set to the beginning of the reset routine.

However, since the RESET line is bi-directional, the processor can also have RESET under program control during the time the line is low. The RESET instruction serves this purpose, when the connection is low for 124 "beats". It's possible to re-initialize the peripheral ICs at any time, without resetting the computer itself. RESET time puts the 68000 into a NOP state -- a reset is unstoppable once it occurs.

The HALT pin is important to the RESET line's existence (as we mentioned above), in order to initialize things properly. This pin has still more functions: when the pin is low while RESET is high, the processor goes into a halt state. This state causes the DMA pin to set the processor into the tri-state condition. The HALT condition ends when HALT is high again. This signal can be used in the design of single-step control.

HALT is also bi-directional. When the processor signals this line to become low, it means that a major error has occurred (e.g., doubled bus and address errors).

A low state on the BERR pin will call up exception handling, which runs basically like an external interrupt. In an orderly system, every access to the asynchronous bus quits with the DTACK signal. When DTACK is outputting, however, the hardware can produce a BERR, which informs the processor of any errors found. A further use for BERR is in connection with the MMU, to test for proper memory access of a specific range; this access is signaled by the FC pins. If protected memory is tried for in user mode, a BERR will turn up.

When both BERR and HALT are low, the processor will "re-execute" the instruction at which it stopped. If it doesn't run properly on the second "go-round", then it's called a *doubled* bus error, and the processor halts.

The eighth group of connections are for voltage and ground.

1.2 The Custom Chips

The Atari ST has four specially developed ICs. These chips (GLUE, MMU, DMA and SHIFTER) play a major role in the low price of the ST, since each chip performs several hundred overlapping functions. The first prototype of the ST was 5 X 50 X 30 cm. in size, mostly to handle all those TTL ICs. Once multiple functions could be crammed into four ICs, the ST became a saleable item. Then again, the present ST hasn't quite reached the ultimate goal -- it still has eight TTLs.

Naturally, since these chips were specifically designed by Atari for the ST, they haven't been publishing any spec sheets. Even without any data specs, we can give you quite a bit of information on the workings of the ICs.

An interesting fact about these ICs is that they're designed to work in concert with one another. For example, the DMA chip can't operate alone. It hasn't an address counter, and is incapable of addressing memory on its own (functions which are taken care of by the MMU). It's the same with SHIFTER -- it controls video screen and color, but it can't address video RAM. Again, MMU handles the addressing.

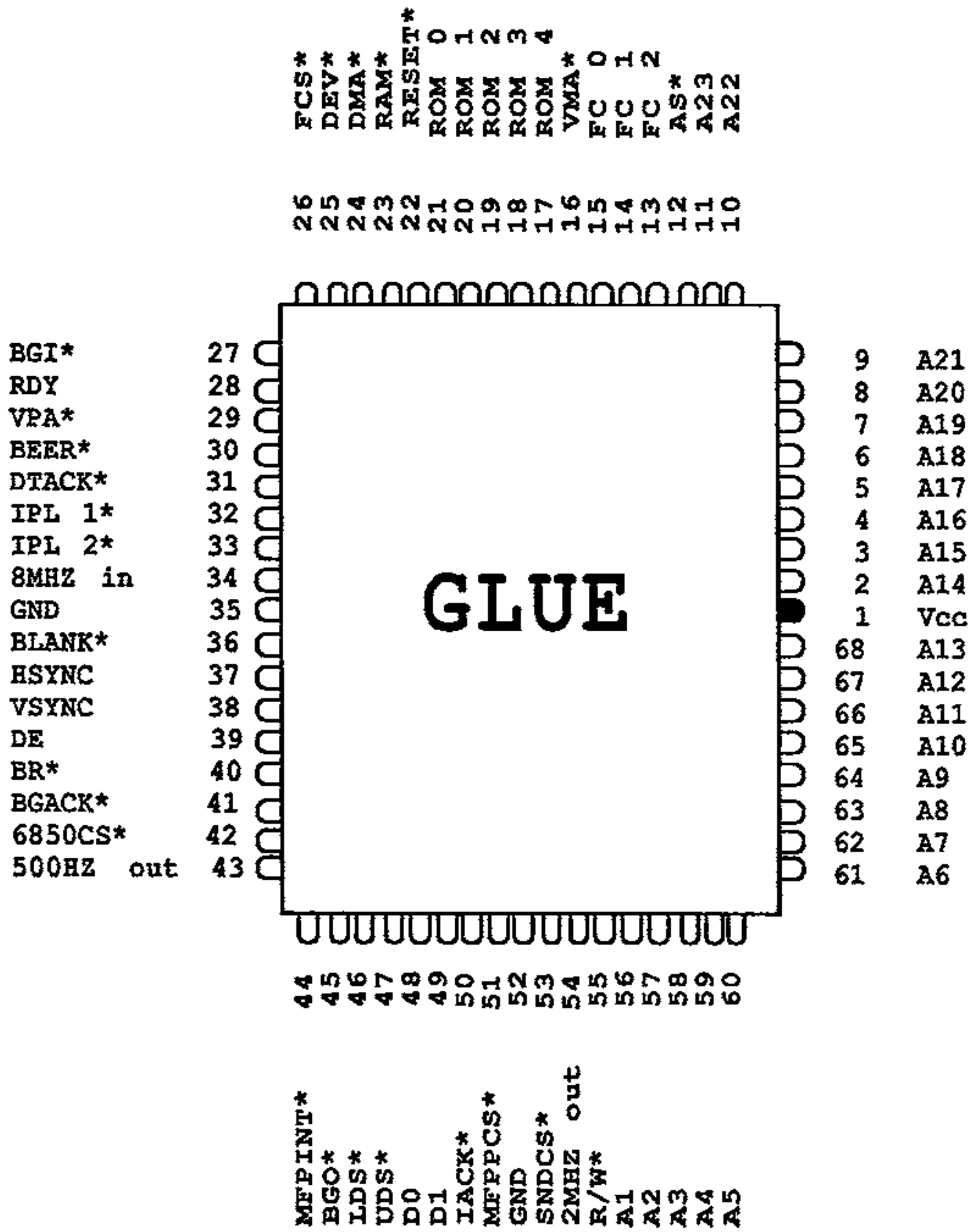
The system programmer can easily figure out which IC has which register. It is only essential to be able to recognize the address of the register, and how to control it. We're going to spend some time in this chapter exploring the pins of the individual ICs.

The most important IC of the "foursome" is GLUE. Its title speaks for the function -- a glue or paste. This IC, with its 68 pins, literally holds the entire system together, including decoding the address range and working the peripheral ICs.

Furthermore, the DMA handshake signals BR, BG and BGACK are produced/output by GLUE. The time point for DMA request is dictated by GLUE by the signal from the DMA controller. GLUE also has a BG (Bus Grant) input, as well as a BGO (Bus Grant Out).

The interrupt signal is produced by GLUE; in the ST, only IPL1 and IPL2 are used for this. Without other hardware, you can't use NMI (interrupt level 7). The pins MFPINT and IACK are used for interrupt control.

Figure 1.2-1 GLUE



The function code pins are guided by GLUE, where memory access tasks are performed (range testing and access authorization). Needless to say, the BERR signal is also handled by this chip. VPA is particularly important to the peripheral ICs and the appropriate select signals.

GLUE generates a timing frequency of 8 mHz. Frequencies between 2 mHz (sound chip's operating frequency) and 500 kHz (timing for keyboard and MIDI interface) can be produced.

HSYNC, VSYNC, BLANK and DE (Display Enable) are generated by GLUE for monitor operation. The synchronous timing can be switched on and off, and external sync-signals sent to the monitor. This will allow you to synchronize the ST's screen with a video camera.

The MMU also has a total of 68 pins. This IC performs three vital tasks. The most important task is coupling the multiplexed address bus of dynamic RAM with the processor's bus (handled by address lines A1 to A21). This gives us an address range totaling 4 megabytes. Dynamic RAM is controlled by RAS0, RAS1, CAS0L, CAS0H, CAS1L and CAS1H, as well as the multiplexed address bus on the MMU. DTACK, R/W, AS, LDS and UDS are also controlled by MMU.

We've already mentioned another important function of the MMU: it works with the SHIFTER to produce the video signal (the screen information is addressed in RAM, and SHIFTER conveys the information). Counters are incorporated in the MMU for this; a starting value is loaded, and within 500 nanoseconds, a word is addressed in memory and the information is sent over DCYC. The starting value of the video counter (and the screen memory position) can be shifted in 256-byte increments.

Another integrated counter in MMU, as mentioned earlier, is for addressing memory using the DMA. This counter begins with every DMA access (disk or hard disk), loading the address of the data being transferred. Every transfer automatically increments the counter.

The SHIFTER converts the information in video RAM into impulses readable on a monitor. Whether the ST is in 640 X 200 or 320 X 200 resolution, SHIFTER is involved.

Figure 1.2-2 MMU

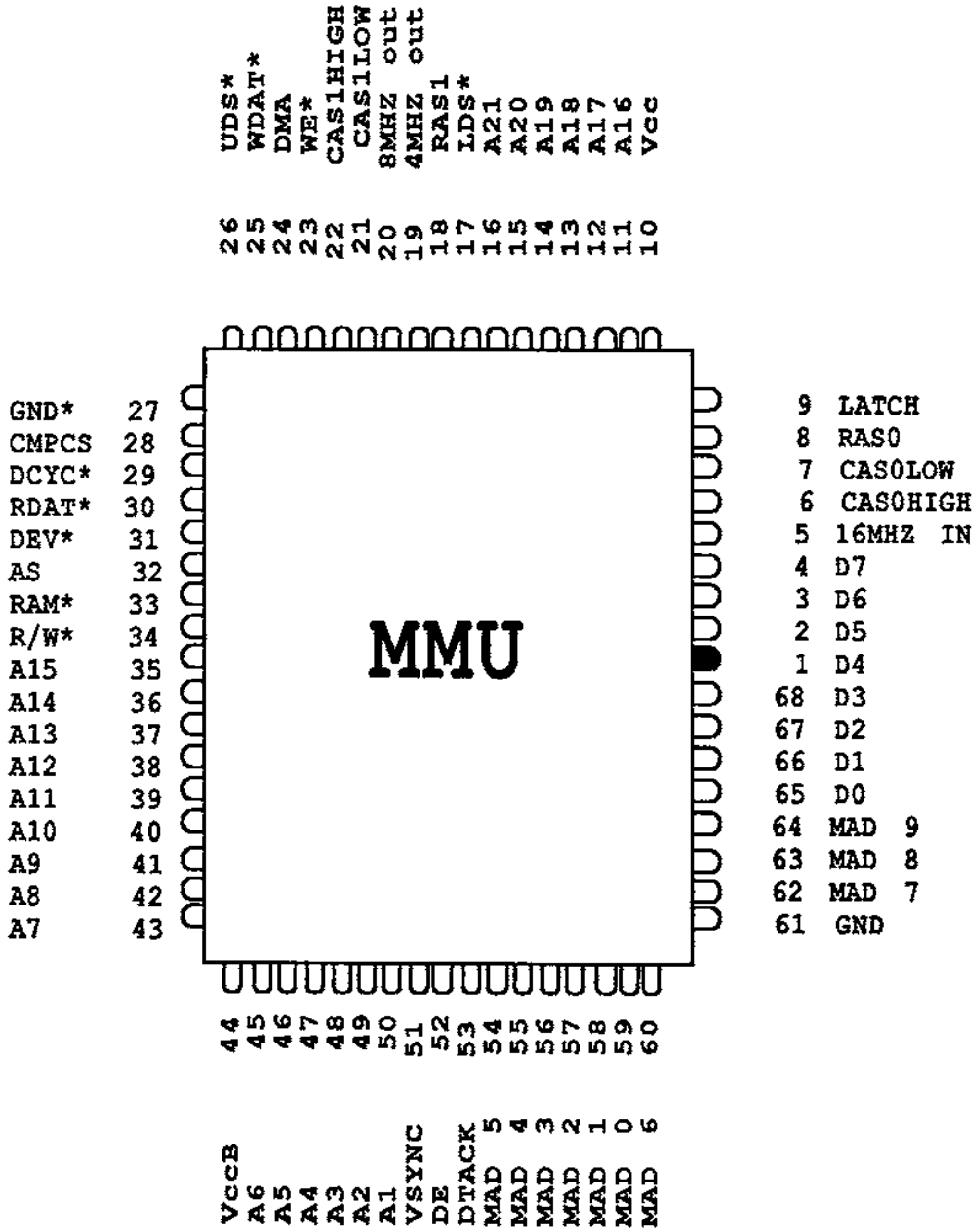
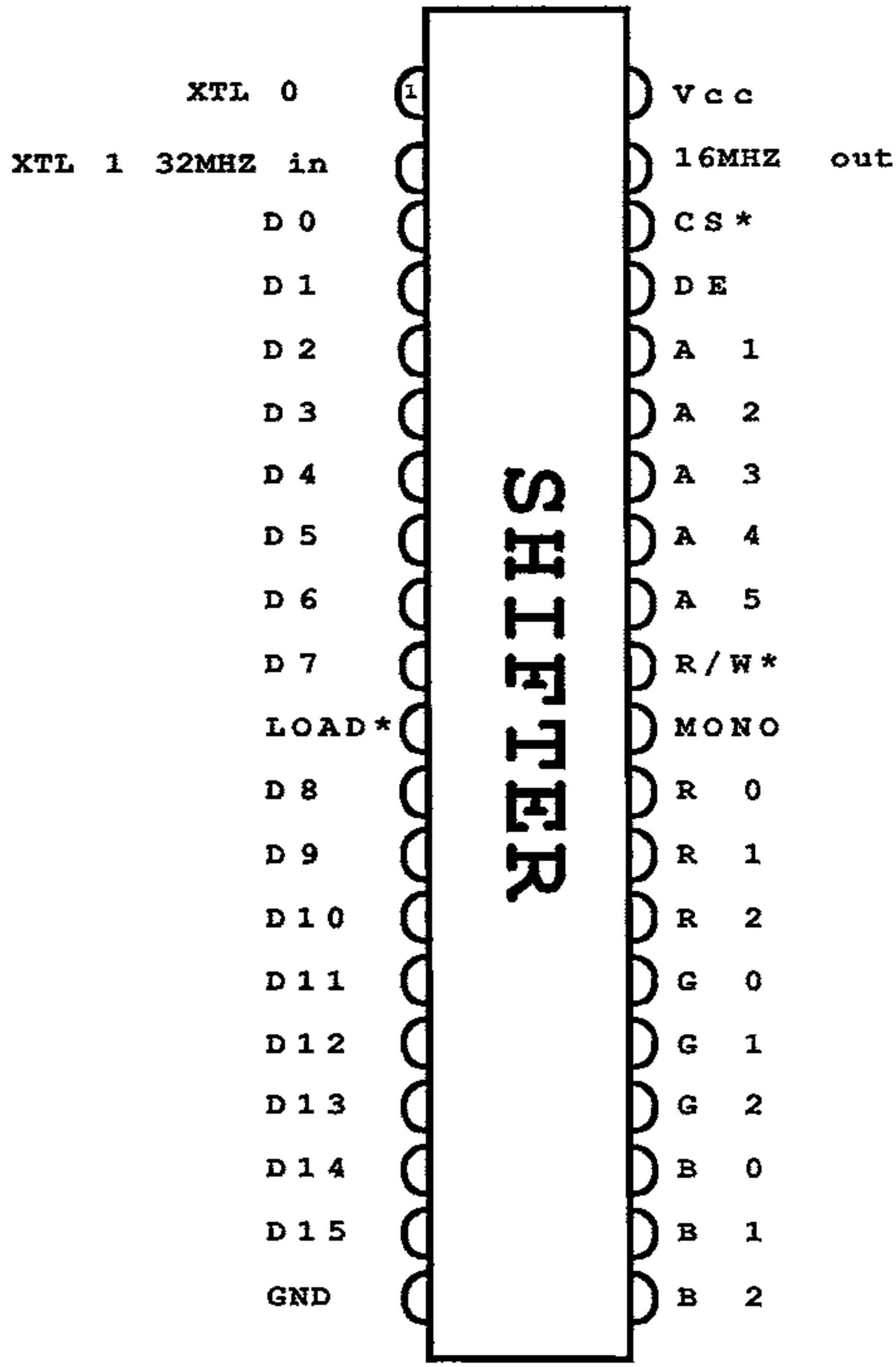


Figure 1.2-3 SHIFTER



The information from RAM is transferred to SHIFTER on the signal LOAD. A resolution of 640 X 400 points sends the video signal over the MONO connector. Since color is impossible in that mode, the RGB connection is rendered inactive. The other two resolutions set MONO output to inactive, since all screen information is being sent out the RGB connection in those cases.

The third color connection works together with external equipment as a digital/analog converter. Individual colors are sent out over different pins, to give us color on our monitor. Pins R1- R5 on the address bus make up the "palette registers". These registers contain the color values, which are placed in individual bit patterns. The 16 palette registers hold a total of 16 colors for 320 X 200 mode. Note, however, that since these are based on the "primary" colors red, green and blue, these colors can be adjusted in 8 steps of brightness, bringing the color total to 512.

The DMA controller is like SHIFTER, only in a 40-pin housing; it is used to oversee the floppy disk controller, the hard disk, and any other peripherals that are likely to appear.

The speed of data transfer using the floppy disk drive offers no problems to the processor. It's different with hard disks; data moves at such high speed that the 68000 has to send a "pause" over the 8 mHz frequency. This pace is made possible by the DMA.

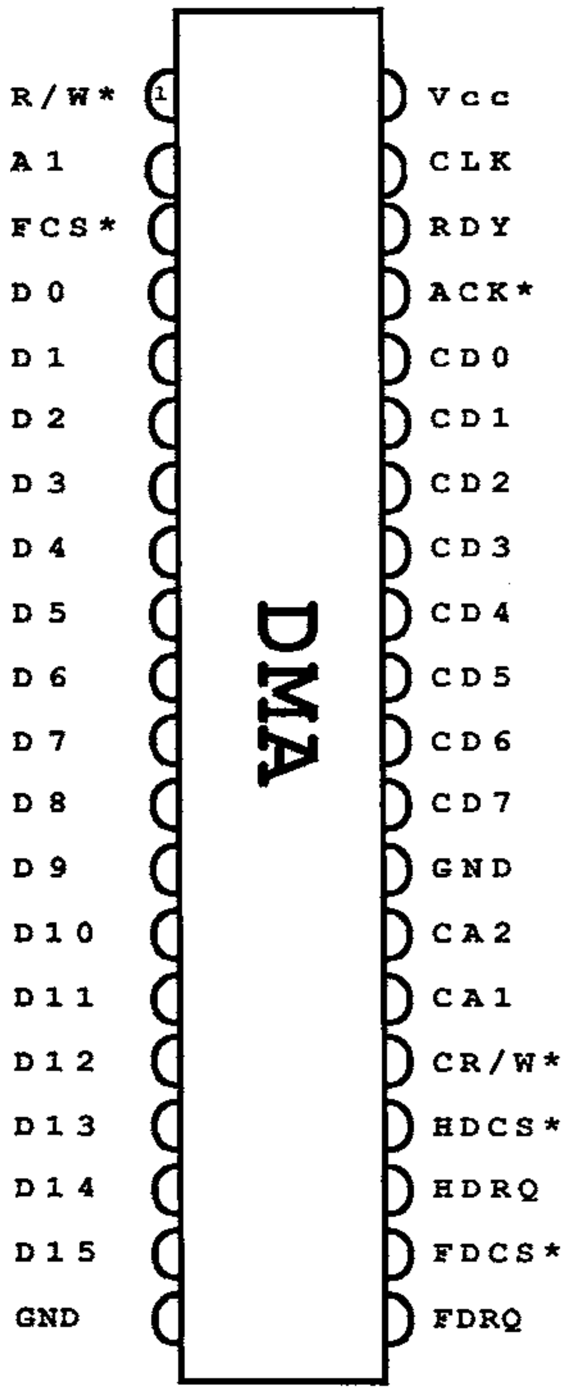
The DMA is joined to the processor's data bus to help transfer data. Two registers within the machine act as a bi-directional buffer for data through the DMA port; we'll discuss these registers later. One interesting point: The processor's 16-bit data bus is reduced to 8 bits for floppy/hard disk work. Data transfer automatically transfers two bytes per word.

The signals CA1, CA2, CR/W, FDCS and FDRQ manage the floppy disk controller. CA1 and CA2 are signals which the floppy disk controller (FDC) uses to select registers. CR/W determine the direction of data transfer from/to the FDC, and other peripherals connected to the DMA port.

The RDY signal communicated with GLUE (DMA-request) and MMU (address counter). This signal tells the DMA to transfer a word.

As you can see, these ICs work in close harmony with one another, and each would be almost useless on its own.

Figure 1.2-4 DMA



1.3 The WD 1772 Floppy Disk Controller

Although the 1772 from Western Digital has only 28 pins, this chip contains a complete floppy disk controller (FDC) with capabilities matching 40-pin controllers. This IC is software-compatible with the 1790/2790 series. Here are some of the 1772's features:

Simple 5-volt current
Built-in data separator
Built-in copy compensation logic
Single and double density
Built-in motor controls

Although the user has his/her choice of disk format, e.g. sector length, number of sectors per track and number of tracks per diskette, the "normal" format is the optimum one for data transfer. So, Apple or Commodore diskettes can't be used.

Before going on to details of the FDC, let's take a moment to look at the 28 pins of this IC.

1.3.1 1772 Pins

These pins can be placed in three categories. The first group consists of the power connections.

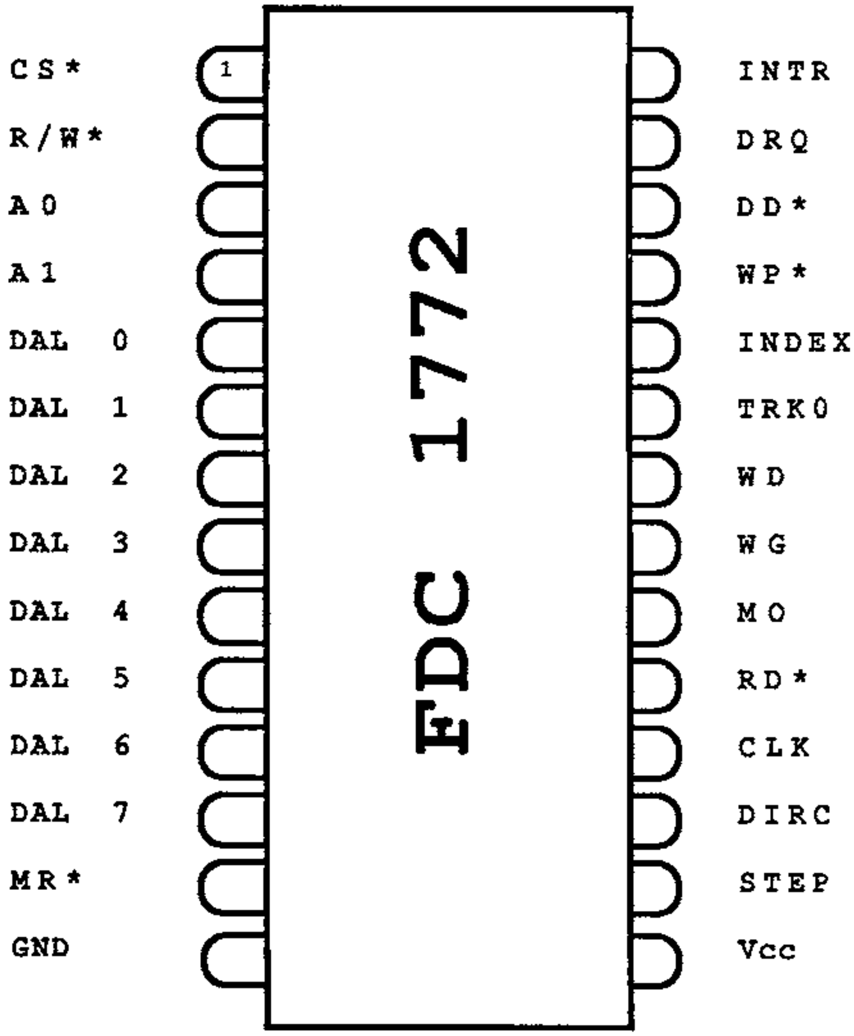
Vcc:
+5 volts current.

GND:
Ground connection.

MR:
Master reset. FDC reinitializes when this is low.

The second set are processor interface pins. These pins carry data between the processor and the FDC.

Figure 1.3-1 FDC 1772



D0-D7:

Eight-bit bi-directional bus; data, commands and status information go between FDC and system.

CS:

FDC can only access registers when this line is low.

R/W:

Read/Write. This pin states data direction. HIGH= read by FDC, LOW=write from FDC.

A0,A1:

These bits determine which register is accessed (in conjunction with R/W). The 1772 has a total of five registers which can both read and write to some degree. Other registers can only read OR write. Here is a table to show how the manufacturer designed them:

A1	A0	R/W=1	R/W=0
0	0	Status Reg.	Command Reg.
0	1	Track Reg.	Track Reg.
1	0	Sector Reg.	Sector Reg.
1	1	Data Reg.	Data Reg.

DRQ:

Data Request. When this output is high, either the data register is full (from reading), and must be "dumped", or the data register is empty (writing), and can be refilled. This connection aids the DMA operation of the FDC.

CLK:

Clock. The clock signal counts only to the processor bus. An input frequency of 8 mHz must be on, for the FDC's internal timing to work.

The third group of signals make up the floppy interface.

STEP:

Sends an impulse for every step of the head motor.

DIRC:

Direction. This connection decides the direction of the head; high moves the head towards center of the diskette.

RD:

Read Data. Reads data from the diskette. This information contains both timing and data impulses -- it is sent to the internal data separator for division.

MO:

Motor On. Controls the disk drive motor, which is automatically started during read/write/whatever operations.

WG:

Write Gate. WG will be low before writing to diskette. Write logic would be impossible without this line.

WD:

Write Data. Sends serial data flow as data and timing impulses.

TR00:

Track 00. This moves read/write head to track 00. TR00 would be low in this case.

IP:

Index Pulse. The index pulses mark the physical beginnings of every track on a diskette. When formatting a disk, the FDC marks the start of each track before formatting the disk.

WPRT:

Write Protect. If the diskette is write-protected, this input will react.

DDEN:

Double Density Enable. This signal is confined to floppy disk control; it allows you to switch between single-density and double-density formats.

1.3.2 1772 Registers

CR (Command Register):

Commands are written in this 8-bit register. Commands should only be written in CR when no other command is under execution. Although the FDC only understands 11 commands, we actually have a large number of possibilities for these commands (we'll talk about those later).

STR (Status Register):

Gives different conditions of the FDC, coded into individual bits. Command writing depends on the meaning of each bit. The status register can only be read.

TR (Track Register):

Contains the current position of the read/write head. Every movement of the head raises or lowers the value of TR appropriately. Some commands will read the contents of TR, along with information read from the disk. The result affects the Status Register. TR can be read/written.

SR (Sector Register):

SR contains the number of sectors desired from read/write operations. Like TR, it can be used for either operation.

DR (Data Register):

DR is used for writing data to/ reading data from diskette.

1.3.3 Programming the FDC

Programming this chip is no big deal for a system programmer. Direct (and in most cases, unnecessary) programming is made somewhat harder AND drastically simpler by the DMA chip. The 11 FDC commands are divided into four types.

Type	Function
1	Restore, look for track 00
1	Seek, look for a track
1	Step, a track in previous direction
1	Step In, move head one track in (toward disk hub)
1	Step Out, move head one track out (toward edge of disk)
2	Read Sector
2	Write Sector
3	Read Address, read ID
3	Read Track, read entire track
3	Write Track, write entire track (format)
4	Force Interrupt

Type 1 Commands

These commands position the read/write head. The bit patterns of these five commands look like this:

```
                    BIT
           7  6  5  4  3  2  1  0
Restore    0  0  0  0  H  V  R1 R0
Seek       0  0  0  1  H  V  R1 R0
Step       0  0  1  U  H  V  R1 R0
Step In    0  1  0  U  H  V  R1 R0
Step Out   0  1  1  U  H  V  R1 R0
```

All five commands have several variable bits; bits R0 and R1 give the time between two step impulses. The possible combinations are:

R1	R0	STEP RATE
0	0	2 milliseconds
0	1	3 milliseconds
1	0	5 milliseconds
1	1	6 milliseconds

These bits must be set by the command bytes to the disk drive. The V-bit is the so-called "verify flag". When set, the drive performs an automatic verify after every head movement. The H-bit contains the spin-up sequence. The system delays disk access until the disk motor has reached 300 rpm. If the H-bit is cleared, the FDC checks for activation of the motor-on pins. When the motor is off, this pin will be set high (motor on), and the FDC waits for 6 index impulses before executing the command. If the motor is already running, then there will be no waiting time.

The three different step commands have bit 4 designated a U- bit. Every step and change of the head appears here.

Type 2 Commands

These commands deal with reading and writing sectors. They also have individual bits with special meanings.

BIT	7	6	5	4	3	2	1	0
Read Sector	1	0	0	M	H	E	0	0
Write Sector	1	0	1	M	H	E	P	A0

The H-bit is the previously described start-up bit. When the E-bit is set, the FDC waits 30 milliseconds before starting the command. This delay is important for some disk drives, since it takes time for the head to change tracks. When the E-bit reads null, the command will run immediately.

The M-bit determines whether one or several sectors are read one after another. On a null reading, only one sector will be read from/written to. Multi-sector reading sets the bit, and the FDC increments the counter at each new sector read.

Bits 0 and 1 must be cleared for sector reading. Writing has its own special meaning: the A0 bit conveys to bit 0 whether a cleared or normal data address mark is to be written. Most operating systems don't use this option (a normal data address mark is written).

The P-bit (bit 1) dictates whether pre-compensation for writing data is turned on or off. Pre-compensation is normally set on; it supplies a higher degree of protection to the inner tracks of a diskette.

Type 3 Commands

Read Address gives program information about the next ID field on the diskette. This ID field describes track, sector, disk side and sector length. Read Track gives all bytes written to a formatted diskette, and the data "between sectors". Write Track formats a track for data storage. Here are the bit patterns for these commands:

```
BIT             7 6 5 4 3 2 1 0
Read Address    1 1 0 0 H E 0 0
Read Track      1 1 1 0 H E 0 0
Write Track     1 1 1 1 H E P 0
```

The H- and E-bits also belong to the Type 2 command set (spin-up and head-settle time). The P-bit has the same function as in writing sectors.

Type 4 Commands

There's only one command in this set: Force Interrupt. This command can work with individual bits during another FDC command. When this command comes into play, whatever command was currently running is ended.

```
BIT             7  6  5  4  3  2  1  0
Force Interrupt 1  1  0  1  I3 I2 I1 I0
```

Bits I0-I3 present the conditions under which the interrupt is pressed. I0 and I1 have no meaning to the 1772, and remain low. If I2 is set, an interrupt will be produced with every index impulse. This allows for software controlled disk rotation. If I3 is set, an interrupt is forced immediately, and the currently-running command ends. When all bits are null, the command ends without interruption.

1.4 The MFP 68901

MFP is the abbreviation for Multi-Function Peripheral. This name is no exaggeration; wait until you see what it can do! Here's a brief list of the most noteworthy features:

8-bit parallel port
Data direction of every port bit is individually programmable
Port bits usable as interrupt input
16 possible interrupt sources
Four universal timers
Built-in serial interface

1.4.1 The 68901 Connections

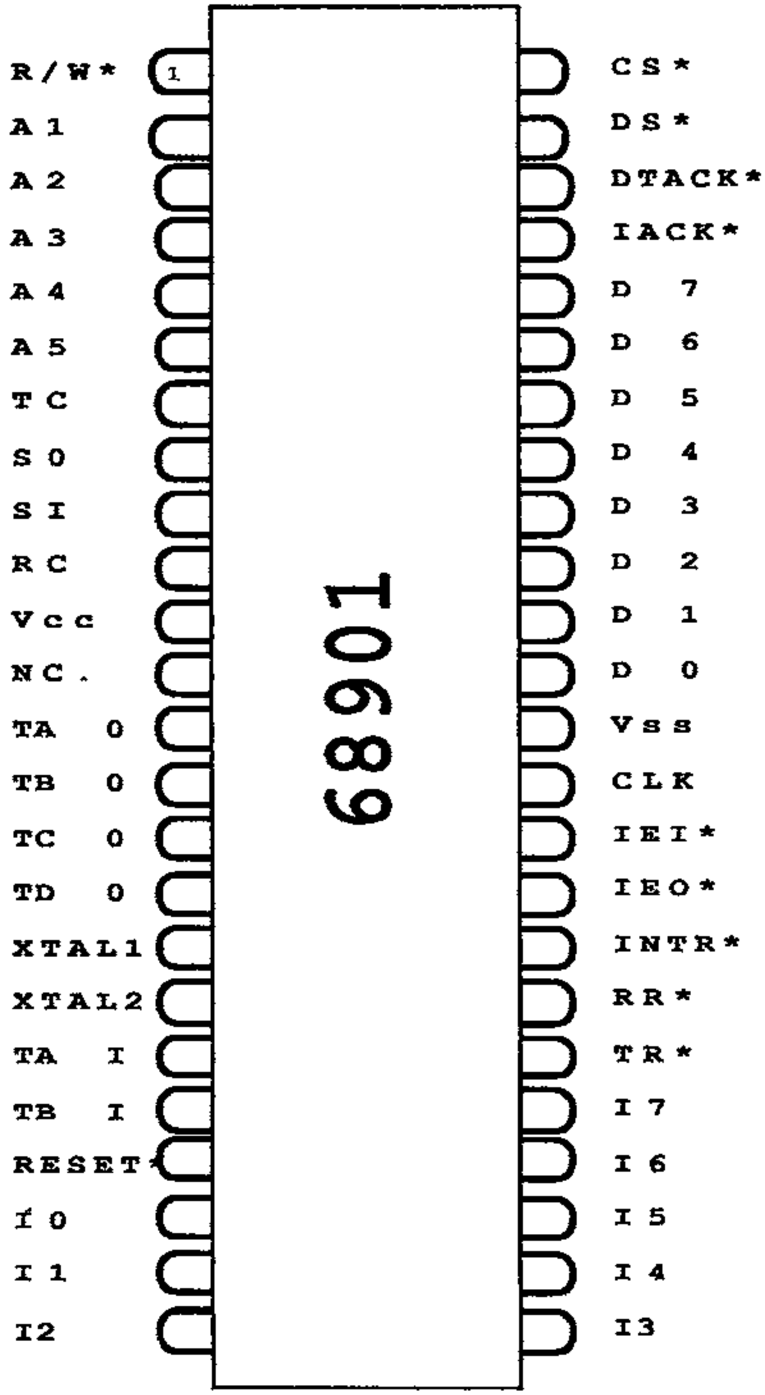
The 48 pins of the MFP are set apart in function groups. The first function group is the power connection set:

GND, Vcc, CLK:
Vcc and GND carry voltage to and from the MFP. CLK is the clock input; this clock signal must not interfere with the system timer of the processor. The ST's MFP operates at a frequency of 4 mHz.

Communication with the data bus of the processor is maintained with D0-D7, DTACK, RS1-RS5 and RESET.

D0-D7:
These bi-directional pins normally work with the 8 lowest data bits of the 68000. It is also possible to connect with D8 through D15, but it's impossible to produce non-auto interrupts. Thus, interrupt vectors travel along the low order 8 data bits.

Figure 1.4-1 MFP 68901



CS (Chip Select):
This line is necessary to communication with the MFP. CS is active when low.

DS (Data Strobe):
This pin works with either LDS or UDS on the processor. Depending on the signal, MFP will operate either the lower or upper half of the data bus.

DTACK (Data Transfer ACKnoledge):
This signal shows the status of the bus cycle of the processor (read or write).

RS1-RS5 (Register Select):
These pins normally connect with to the bottom five address lines of the processor, and serve to choose from the 24 internal registers.

RESET:
If this pin is low for at least 2 microseconds, the MFP initializes. This occurs on power-up and a system reset.

The next group of signals cover interrupt connections (IRQ, IACK, IEI and IEO).

IRQ (Interrupt ReQuest):
IRQ will be low when an interrupt is triggered in the MFP. This informs the processor of interrupts.

IACK (Interrupt ACKnowledge):
On an interrupt (IRQ and IEI), the MFP sends a low signal over IACK and DS on the data lines. Since 16 different interrupt sources are available, this makes handling interrupts much simpler.

IEI, IEO (Interrupt Enable In/ Out):
These two lines permit daisy-chaining of several MFPs, and determine MFP priority by their positioning in this chain. IEI would work through the MFP with the highest priority. IEO of the second MFP would remain unswitched. On an interrupt, a signal is sent over IACK, and the first MFP in the chain will acknowledge with a high IEO.

Next, we'll look at the eight I/O lines.

IO0-7 (Input/Output):
These pins use one or all normal I/O lines. The data direction of each port bit is set up in a data direction register of its own. In addition, though, every port bit can be programmed to be an interrupt input.

The timer pins make up yet another group of connections:

XTAL1,2 (Timer Clock Crystal):
A quartz crystal can be connected to these lines to deliver a working frequency for the four timers.

TAI,TBI (Timer Input):
Timers A and B can not only be used as real counters differently from timers C and D with the frequency from XTAL1 and 2, but can also be set up for event counting and impulse width measurement. In both these cases, an external signal (Timer Input) must be used.

TAO,TBO,TCO,TDO (Timer Output):
Every timer can send out its status on each peg (from 01 to 00). Each impulse is equal to 01.

The second-to-last set of signals are the connections to the universal serial interface. The built-in full duplex of the MFP can be run synchronously or asynchronously, and in different sending and receiving baud rates.

SI (Serial Input):
An incoming bit current will go up the SI input.

SO (Serial Output):
Outgoing bit voltage (reverse of SI).

RC (Receiver Clock):
Transfer speed of incoming data is determined by the frequency of this input; the source of this signal can, for example, be one of the four timers.

TC (Transmitter Clock):
Similar to RC, but for adjusting the baud-rate of data being transmitted.

The final group of signals aren't used in the Atari ST. They are necessary when the serial interface is operated by the DMA.

RR (Receiver Ready):
This pin gives the status of the receiving data registers. If a character is completely received, this pin sends current.

TR (Transmitter Ready):
This line performs a similar function for the sender section of the serial interface. Low tells the DMA controller that a new character in the MFP must be sent.

1.4.2 The MFP Registers

As we've already mentioned, the 68901 has a total of 24 different registers. This large number, together with the logical arrangement, makes programming the MFP much easier.

Reg 1 GPIP, General Purpose I/O Interrupt Port
This is the data register for the 8-bit ports, where data from the port bits is sent and read.

Reg 2 AER, Active Edge Register
When port bits are used for input, this register dictates whether the interrupt will be a low-high- or high-low conversion. Zero is used in the high-low change, one for low-high.

Reg 3 DDR, Data Direction Register
We've already said that the data direction of individual port bits can be fixed by the user. When a DDR bit equals 0, the corresponding pin becomes an input, and 1 makes it an output. Port bit positions are influenced by AER and DDR bits.

Reg 4,5 IERA,IERB, Interrupt Enable Register

Every interrupt source of the MFP can be separately switched on and off. With a total of 16 sources, two 8-bit registers are needed to control them. If a 1 has been written to IERA or IERB, the corresponding channel is enabled (turned on). Conversely, a zero disables the channel. If it comes upon a closed channel caused by an interrupt, the MFP will completely ignore it. The following table shows which bit is coordinated with which interrupt occurrence:

```
IERA
Bit 7: I/O port bit 7 (highest priority)
Bit 6: I/O port bit 6
Bit 5: Timer A
Bit 4: Receive buffer full
Bit 3: Receive error
Bit 2: Sender buffer empty
Bit 1: Sender error
Bit 0: Timer B

IERB
Bit 7: I/O port bit 5
Bit 6: I/O port bit 4
Bit 5: Timer C
Bit 4: Timer D
Bit 3: I/O port bit 3
Bit 2: I/O port bit 2
Bit 1: I/O port bit 1
Bit 0: I/O port bit 0, lowest priority
```

This arrangement applies to the IP-, IM- and IS-registers discussed below.

Reg 6,7 IPRA,IPRB, Interrupt Pending Register

When an interrupt occurs on an open channel, the appropriate bit in the Interrupt Pending Register is set to 1. When working with a system that allows vector creation, this bit will be automatically cleared when the MFP puts the vector number on the data bus. If this possibility doesn't exist, the IPR must be cleared using software. To clear a bit, a byte in the MFP will show the location of the specific bit.

The bit arrangement of the IPR is shown in the table for registers 4 and 5 (see above).

Reg 8,9 ISRA,ISRB,Interrupt In-Service Register

The function of these registers is somewhat complicated, and depends upon bit 3 of register 12. This bit is an S-bit, which determines whether the 68901 is working in "Software End-of-Interrupt" mode (SEI) or in "Automatic End-of-Interrupt" mode (AEI). AEI mode clears the IPR (Interrupt Pending Bit), when the processor gets the vector number from the MFP during an IACK cycle. The appropriate In-Service bit is cleared at the same time. Now a new interrupt can occur, even when the previous interrupt hasn't finished its work.

SEI mode sets the corresponding ISR-bit when the vector number of the interrupt is requested by the processor. At the interrupt routine's end, the bit designated within the MFP must be cleared. As long as the Interrupt In-Service bit is set, all interrupts of lower priority are masked out by the MFP. Once the Pending-bit of the active channel is cleared, the same sort of interrupt can occur a second time, and interrupts of lesser priority can occur as well.

Reg 10,11 IMRA,IMRB Interrupt Mask Register

Individual interrupt sources switched on by IER can be masked with the help of this register. That means that the interrupt is recognized from within and is signalled in the IPR, even if the IRQ line remains high.

Reg 12 VR Vector Register

In the cases of interrupts, the 68901 can generate a vector number corresponding to the interrupt source requested by the processor during an Interrupt Acknowledge Cycle. All 16 interrupt channels have their own vectors, with their priorities coded into the bottom four bits of the vector number (the upper four bits of the vector are copied from the vector register). These bits must be set into VR, therefore.

Bit 3 of VR is the previously mentioned S-bit. If this bit is set (like in the ST), then the MFP operates in "Software End-of-Interrupt" mode; a cleared bit puts the system into "Automatic End-of-Interrupt" mode.

Reg 13,14 TACR,TBCR Timer A/B Control Register

Before proceeding with these registers, we should talk for a moment about the timer. Timers A and B are both identical. Every timer consists of a data register, a programmable feature and an 8-bit count-down counter. Contents of the counters will decrease by one every impulse. When the counter stands at 01, the next impulse changes the corresponding timer to the output of its pins. At the same time, the value of the timer data register is loaded into the timer. If this channel is set by the IER bit, the interrupt will be requested. The source of the timer beats will usually be those quartz frequencies from XTAL1 and 2. This operating mode is called delay mode, and is available to timers C and D.

Timers A and B can also be fed external impulses using timer inputs TAI and TBI (in event count mode). The maximum frequency on timer inputs should not surpass 1/4 of the MFP's operating frequency (that is, 1 mHz).

Another peculiarity of this operating mode is the fact that the timer inputs for the interrupts are I/O pins 13 and 14. By programming the corresponding bits in the AER, a pin-jump can be used by the timer inputs to request an interrupt. TAI is joined with pin 13, TBI by pin 14. Pins 13 and 14 can also be used as I/O lines without interrupt capability.

Timers A and B have yet a third operating mode (pulse-length measurement). This is similar to Delay Mode, with the difference that the timer can be turned on and off with TAI and TBI. Also, when pins 13 and 14 are used, the AER-bits can determine whether the timer inputs are high or low. If, say, AER-bit 4 is set, the counter works when TAI is high. When TAI changes to low, an interrupt is created.

Now we come to TACR and TBCR. Both registers only use the fifth through eighth bits. Bits 0 to 3 determine the operating mode of each timer:

BIT 3 2 1 0	Function
0 0 0 0	Timer stop, no function executed
0 0 0 1	Delay mode, subdivider divides by 4
0 0 1 0	Delay mode, subdivider divides by 10
0 0 1 1	Delay mode, subdivider divides by 16
0 0 1 1	Delay mode, subdivider divides by 16
0 1 0 0	Delay mode, subdivider divides by 50
0 1 0 1	Delay mode, subdivider divides by 64
0 1 1 0	Delay mode, subdivider divides by 100
0 1 1 1	Delay mode, subdivider divides by 200
1 0 0 0	Event Count Mode
1 0 0 1	Pulse extension mode,subdivider divides by 4
1 0 1 0	Pulse extension mode,subdivider divides by 10
1 0 1 1	Pulse extension mode,subdivider divides by 16
1 1 0 0	Pulse extension mode,subdivider divides by 50
1 1 0 1	Pulse extension mode,subdivider divides by 64
1 1 1 0	Pulse extension mode,subdivider divides by 100
1 1 1 1	Pulse extension mode,subdivider divides by 200

Bit 4 of the Timer Control Register has a particular function. This bit can produce a low reading for the timer being used with it at any time. However, it will immediately go high when the timer runs.

Reg 15 TCDCR Timers C and D Control Register

Timers C and D are available only in delay mode; thus, one byte controls both timers. The control information is programmed into the lower three bits of the nibbles (four- bit halves). Bits 0 and 2 arrange Timer D, Timer C is influenced by bits 4 and 6. Bits 3 and 7 in this register have no function.

Bit 2 1 0 Bit 6 5 4	Function - Timer D Function - Timer C
0 0 0	Timer Stop
0 0 1	Delay Mode, division by 4
0 1 0	Delay Mode, division by 10
0 1 1	Delay Mode, division by 16
1 0 0	Delay Mode, division by 50
1 0 1	Delay Mode, division by 64
1 1 0	Delay Mode, division by 100
1 1 1	Delay Mode, division by 200

Reg 16-19 TADR,TBDR,TCDR,TDDR Timer Data Registers

The four Timer Data Registers are loaded with a value from the counter. When a condition of 01 is reached, an impulse occurs. A continuous countdown will stem from this value.

Reg 20 SCR Synchronous Character Register

A value will be written to this register by synchronous data transfer, so that the receiver of the data will be alerted. When synchronous mode is chosen, all characters received will be stored in the SCR, after first being put into the receive buffer.

Reg 21 UCR,USART Control Register

USART is short for Universal Synchronous/Asynchronous Receiver/Transmitter. The UCR allows you to set all the operating parameters for the interfaces. Parameters can also be coded in with the timers.

```
Bit 0      : unused
Bit 1      : 0=Odd parity
             1=Even parity

Bit 2      : 0=No parity (bit 1 is ignored)
             1=Parity according to bit 1

Bits 3,4   : These bis control the number of
             start- and stopbits and the
             format desired.
   Bit  4 3 Start Stop Format
        0 0   0     0   Synchronous
        0 1   1     1   Asynchronous
        1 0   1     1,5 Asynchronous
        1 1   1     2   Asynchronous

Bits 5,6   :  These bits give the
              "wordlength" of the data bits
              to be transferred.
   Bits 6 5 Word length
        0 0 8 bits
        0 1 7 bits
        1 0 6 bits
        1 1 5 bits
```

```
Bit 7      :  0=Frequency from TC and RC
                    directly used as transfer
                    frequency (used only for
                    synchronous transfer)
                    1=Frequency in TC and RC
                    internally divided by 16.
```

Reg 22 RSR Receiver Status Register

The RSR gives information concerning the conditions of all receivers. Again, the different conditions are coded into individual bits.

Bit 0 Receiver Enable Bit

When this bit is cleared, receipt is immediately turned off. All flags in RSR are automatically cleared. A set bit means that the receiver is behaving normally.

Bit 1 Synchronous Strip Enable

This bit allows synchronous data transfer to determine whether or not a character in the SCR is identical to a character in the receive buffer.

Bit 2 Match/Character in Progress

When in synchronous transfer format, this bit signals that a character identical with the SCR byte would be received. In asynchronous mode, this bit is set as soon as the startbit is recognized. A stopbit automatically clears this bit.

Bit 3 Found - Search/Break Detected

This bit is set in synchronous transfer format, when a character received coincides with one stored in the SCR. This condition can be treated as an interrupt over the receiver's error channel. Asynchronous mode will cause the bit to set when a BREAK is received. The break condition is fulfilled when only zeroes are received following a startbit. To distinguish between a BREAK from a "real" null, this line should be low.

Bit 4 Frame Error

A frame error occurs when a byte received is not a null, but the stopbit of the byte IS a null.

Bit 5 Parity Error

The condition of this bit gives information as to whether parity on the last received character was correct. If the parity test is off, the PE bit is untouched.

Bit 6 Overrun Error

This bit will be set when a complete character is in the receiver floating range but not read into the receive buffer. This error can be operated as an interrupt.

Bit 7 Buffer Full

This bit is set when a character is transferred from the floating register to the receive buffer. As soon as the processor reads the byte, the bit is cleared.

Reg 23 TSR Transmitter Status Register

Whereas the RSR sends receiver information, the TSR handles transmission information.

Bit 0 Transmitter Enable

The sending section is completely shut off when this bit is cleared. At the same time the End-bit is cleared and the UE-bit is set (see below). The output to the receiver is set in the corresponding H- and L-bits.

Bits 1,2 High- and Low-bit

These bits let the programmer decide which mode of output the switched-off transmitter will take on. If both bits are cleared,the output is high. High-bit only will create high output; low-bit, low output. Both bits on will switch on loop-back-mode. This state loops the output from the transmitter with receiver input. The output itself is on the high-pin.

Bit 3 Break

The break-bit has no function in synchronous data transfer. In asynchronous mode, though, a break condition is sent when the bit is set.

Bit 4 End of Transmission

If the sender is switched off during running transmission, the end-bit will be set as soon as the current character has been sent in its entirety. When no character is sent, the bit is immediately set.

Bit 5 Auto Turnaround

When this bit is set, the receiver is automatically switched on when the transmitter is off, and a character will eventually be sent.

Bit 6 Underrun Error

This bit is switched on when a character in the sender floating register will be sent, before a new character is written into the send buffer.

Bit 7 Buffer Empty

This bit will be set when a character from the send buffer will be transferred to the floating register. The bit is cleared when new data is written to the send buffer.

Reg 24 UDR, USART Data Register

Send/receive data is sent over this register. Writing sends data in the send buffer, reading gives you the contents of the receive buffer.

1.5 The 6850 ACIAs

ACIA is short for "Asynchronous Communications Interface Adapter". This 24-pin IC has all the components necessary for operating a serial interface, as well as error-recognizing and data-formatting capabilities. Originally for 6800-based computers, this chip can be easily tailored for 6502 and 68000 systems. The ST has two of these chips. One of them communicates with the keyboard, mouse, joystick ports, and runs the clock. Keyboard data travels over a serial interface to the 68000 chip. The second ACIA is used for operating the MIDI interface.

Parameter changes in the keyboard ACIA are not recommended: The connection between keyboard and ST can be easily disrupted. The MIDI interface is another story, though -- we can create all sorts of practical applications. Incidentally, nowhere else has it been mentioned that the MIDI connections can be used for other purposes. One idea would be to use the MIDI interfaces of several STs to link them together (for schools or offices, for example).

1.5.1 The Pins of the 6850

For those of you readers who aren't very well-acquainted with the principles of serial data transfer, we've included some fairly detailed descriptions in the pin layout which follows.

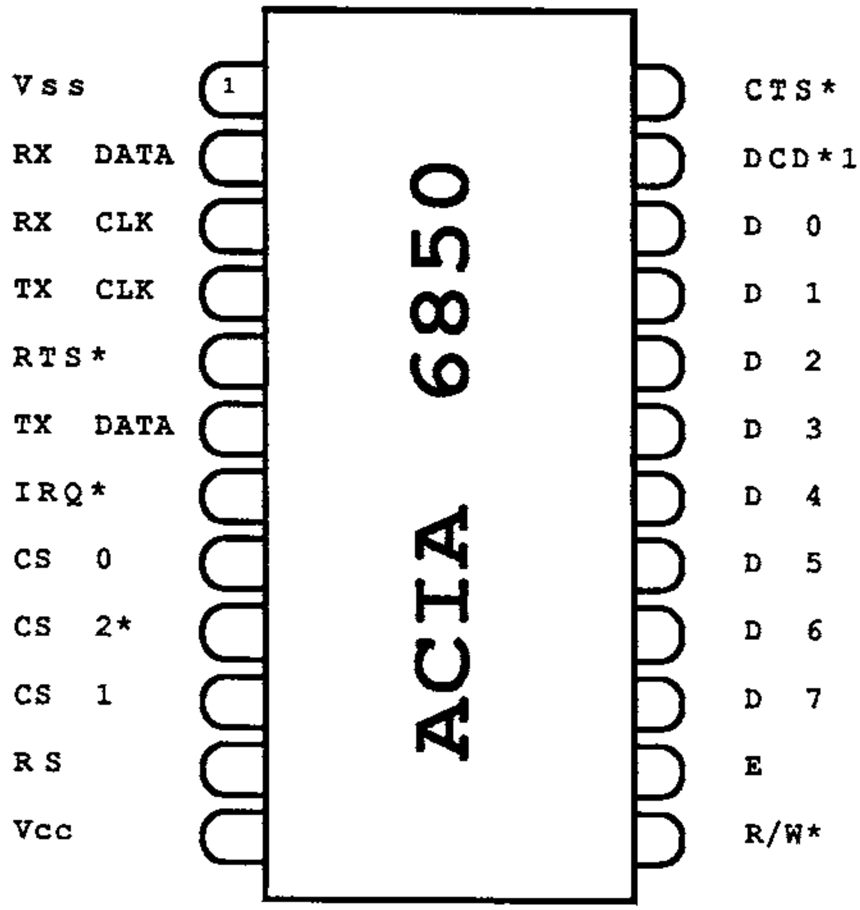
Vss

This connection is the "ground wire" of the IC.

RX DATA Receive Data

This pin receives data; a start-bit must precede the least significant data-bit before receipt.

Figure 1.5-1 ACIA 6850



RX CLK Receive Clock

This pin signal determines baud-rate (speed at which the data is received), and is synchronize to the incoming data. The frequency of RX CLK is patterned after the desired transfer speed and after the internally programmed division rate.

TX CLK Transmitter Clock

Like RX CLK, only used for transmission speed.

RTS Request To Send

This output signals the processor whether the 6850 is low or high; mostly used for controlling data transfer. A low output will, for example, signal a modem that the computer is ready to transmit.

TX DATA Transmitter Data

This pin sends data bit-wise (serially) from the computer.

IRQ Interrupt Request

Different circumstances set this pin low, signaling the 68000 processor. Possible conditions include completed transmission or receipt of a character.

CS 0,1,2 Chip Select

These three lines are needed for ACIA selection. The relatively high number of CS signals help minimize the amount of hardware needed for address decoding, particularly in smaller computer systems.

RS Register Select

This signal communicates with internal registers, and works closely with the R/W signal. We shall talk about these registers later.

Vcc Voltage

This pin is required of all ICs -- this pin gets an operating voltage of 5V.

R/W Read/Write

This tells the processor the "direction" of data traveling through the ACIA. A high signal tells the processor to read data, and low writes data in the 6850.

E Enable

The E-signal determines the time of reading/writing. All read/write processes with this signal must be synchronous.

D0 - D7 Data

These data lines are connected to those of the 68000. Until the ACIA is accessed, these bidirectional lines are all high.

DCD Data Carrier Detect

A modem control signal, which detects incoming data. When DCD is high, serial data cannot be received.

CTS Clear To Send

CTS answers the computer on the signal RTS. Data transmission is possible only when this pin is low.

1.5.2 The Registers of the 6850

The 6850 has four different registers. Two of these are read only. Two of them are write only. These registers are distinguished by R/W and RS, after the table below:

R/W	RS	Register	Access
0	0	Control Register	write
0	1	Sender Register	write
1	0	Status Register	read
1	1	Receive Register	read

The sender/receiver registers (also known as the RX- and TX- buffers) are for data transfer. When receiving is possible, the incoming bits are put in a shift register. Once the specified number of bits has arrived, the contents of the shift register are transferred to the TX buffer. The sender works in much the same way, only in the reverse direction (RX buffer to sender shift register).

The Control Register

The eight-bit control register determines internal operations. To solve the problem of controlling diverse functions with one byte, single bits are set up as below:

CR 0,1

These bits determine by which factor the transmitter and receiver clock will be divided. These bits also are joined with a master reset function. The 6850 has no separate reset line, so it must be accomplished through software.

CR1	CR0	
0	0	RXCLK/TXCLK without division
0	1	RXCLK/TXCLK by 16 (for MIDI)
1	0	RXCLK/TXCLK by 64 (for keyboard)
1	1	Master RESET

CR 2,3,4

These so-called Word Select bits tell whether 7 or 8 data-bits are involved; whether 1 or 2 stop-bits are transferred; and the type of parity.

CR4	CR3	CR2	
0	0	0	7 databits, 2 stopbits, even parity
0	0	1	7 databits, 2 stopbits, odd parity
0	1	0	7 databits, 1 stopbit, even parity
0	1	1	7 databits, 1 stopbit, odd parity
1	0	0	8 databits, 2 stopbit, no parity
1	0	1	8 databits, 1 stopbit, no parity
1	1	0	8 databits, 1 stopbit, even parity
1	1	1	8 databits, 1 stopbit, odd parity

CR 6,5

These Transmitter Control bits set the RTS output pin, and allow or prevent an interrupt through the ACIA when the send register is emptied. Also, BREAK signals can be sent over the serial output by this line. A BREAK signal is nothing more than a long sequence of null bits.

CR6	CR5	
0	0	RTS low, transmitter IRQ disabled
0	1	RTS low, transmitter IRQ enabled
1	0	RTS high, transmitter IRQ disabled
1	1	RTS low, transmitter IRQ disabled, BREAK sent

CR 7

The Receiver Interrupt Enable bit determines whether the receiver interrupt will be on. An interrupt can be caused by the DCD line changing from low to high, or by the receiver data buffer filling. Besides that, an interrupt can occur from an OVERRUN (a received character isn't properly read from the processor).

CR7	
0	Interrupt disabled
1	Interrupt enabled

The Status Register

The Status Register gives information about the status of the chip. It also has its information coded into individual bytes.

SR0

When this bit is high, the RX data register is full. The byte must be read before a new character can be received (otherwise an OVERRUN happens).

SR1

This bit reflects the status of the TX data buffer. An empty register sets the bit.

SR2

A low-high change on pin DCD sets SR2. If the receiver interrupt is allowable, the IRQ will be cancelled. The bit is cleared when the status register and the receiver register are read. This also cancels the IRQ. SR2 register remains high if the signal on the DCD pin is still high; SR2 registers low if DCD becomes low.

SR3

This line shows the status of CTS. This signal cannot be altered by a master reset, or by ACIA programming.

SR4

Shows "Frame errors". Frame errors are when no stop-bit is recognized in receiver switching. It can be set with every new character.

SR5

This bit displays the previously mentioned OVERRUN condition. SR5 is reset when the RX buffer is read.

SR6

This bit recognizes whether the parity of a received character is correct. The bit is set on an error.

SR 7

This signals the state of the IRQ pins; this bit makes it possible to switch several IRQ lines on one interrupt input. In cases where an interrupt is program-generated, SR7 can tell which IC cut off the interrupt.

The ACIAs in the ST

The ACIAs have lots of extras unnecessary to the ST. In fact, CTS, DCD and RTS are not connected.

The keyboard ACIA lies at the addresses $FFFC00 and $FFFC02. Built-in parameters are: 8-bit word, 1 stopbit, no parity, 7812.5 baud (500 kHz/64).

The parameters are the same for the MIDI chip, EXCEPT for the baud rate, which runs at 31250 baud (500 kHz/16).

1.6 The YM-2149 Sound Generator

The Yamaha YM-2149, a PSG (programmable sound generator) in the same family as the General Instruments AY-3-8190, is a first-class sound synthesis chip. It was developed to produce sound for arcade games. The PSG also has remarkable capabilities for generating/altering sounds. Additionally, the PSG can be easily controlled by joysticks, the computer keyboard, or external keyboard switching. The PSG has two bidirectional 8-bit parallel ports. Here's some general data on the YM-2149:

- three independently programmable tone generators
- a programmable noise generator
- complete software-controlled analog output
- programmable mixer for tone/noise
- 15 logarithmically raised volume levels
- programmable envelopes (ASDR)
- two bidirectional 8-bit data ports
- TTL-compatible
- simple 5-volt power

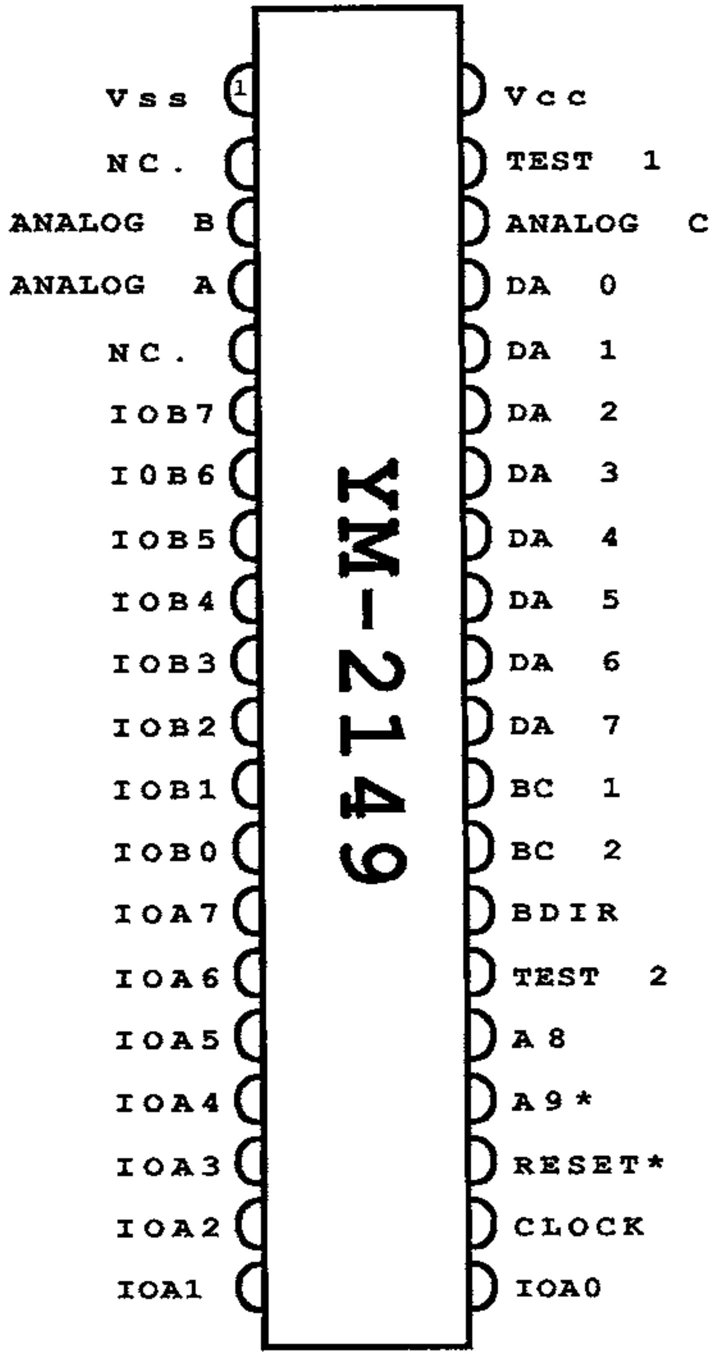
The YM-2149 has a total of 16 registers. All sound capabilities are controlled by these registers.

The PSG has several "functional blocks" each with its own job. The tone generator block produces a square-wave sound by means of a time signal. The noise generator block produces a frequency-modulated square-wave signal, whose pulse-width simulates a noise generator. The mixer couples the three tone generators' output with the noise signal. The channels may be coupled by programming.

The amplitude control block controls the output volume of the three channels with the volume registers; or creates envelopes (Attack, Decay, Sustain, Release, or ADSR), which controls the volume and alters the sound quality.

The D/A converter translates the volume and envelope information into digital form, for external use. Finally one function block controls the two I/O ports.

Figure 1.6-1 Sound chip YM-2149



1.6.1 Sound Chip Pins

Vss:

This is the PSG ground connection.

NC.:

Not used.

ANALOG B:

This is the channel B output. Maximum output voltage is 1 vss.

ANALOG A:

Works like pin 3, but for channel A.

NC.:

Not used.

IOB7 - 0:

The IOB connections make up one of the two 8-bit ports on the chip. These pins can be used for either input or output. Mixed operation (input and output combined) is impossible within one port, however both ports are independent of one another.

IOA7 - 0:

Like IOB, but for port A.

CLOCK:

All tone frequencies are divided by this signal. This signal operates at a frequency between 1 and 2 mHz.

RESET:

A low signal from this pin resets all internal registers. Without a reset, random numbers exist in all registers, the result being a rather unmusical "racket".

A9:

This pin acts as a chip select-signal. When it is low, the PSG registers are ready for communication.

A8:

Similar to A9, only it is active when high.

TEST2:

Test2 is used for testing in the factory, and is unused in normal operation.

BDIR & BC1,2:

The BDIR (Bus DIRection), BC1 and BC2 (Bus Control) pins control the PSG's register access.

BDIR	BC2	BC1	PSG function
0	0	0	Inactive
0	0	1	Latch address
0	1	0	Inactive
0	1	1	Read from PSG
1	0	0	Latch address
1	0	1	Inactive
1	1	0	Write to PSG
1	1	1	Latch address

Only four of these combinations are of any use to us; those with a 5+ voltage running over BC2. So, here's what we have left:

BDIR	BC1	Function
0	0	Inactive, PSG data bus high
0	1	Read PSG registers
1	0	Write PSG registers
1	1	Latch, write register number(s)

DA0 - 7:

These pins connect the sound chip to the processor, through the data bus. The identifier DA means that both data and (register) addresses can be sent over these lines.

ANALOG C:

Works with channel C (see ANALOG B, above).

TEST1:

See TEST2.

Vcc:

+5 volt pin.

1.6.2 The 2149 Registers and their Functions

Now let's look at the functions of the individual registers. One point of interest: the contents of the address register remain unaltered until reprogrammed. You can use the same data over and over, without having to send that data again.

Reg 0,1:

These register determine the period length, and the pitch of ANALOG A. Not all 16 bits are used here; the eight bits of register 0 (set frequency) and the four lowest bits of register 1 (control step size). The lower the 12-bit value in the register, the higher the tone.

Reg 2,3:

Same as registers 0 and 1, only for channel B.

Reg 4,5:

Same as registers 0 and 1, only for channel C.

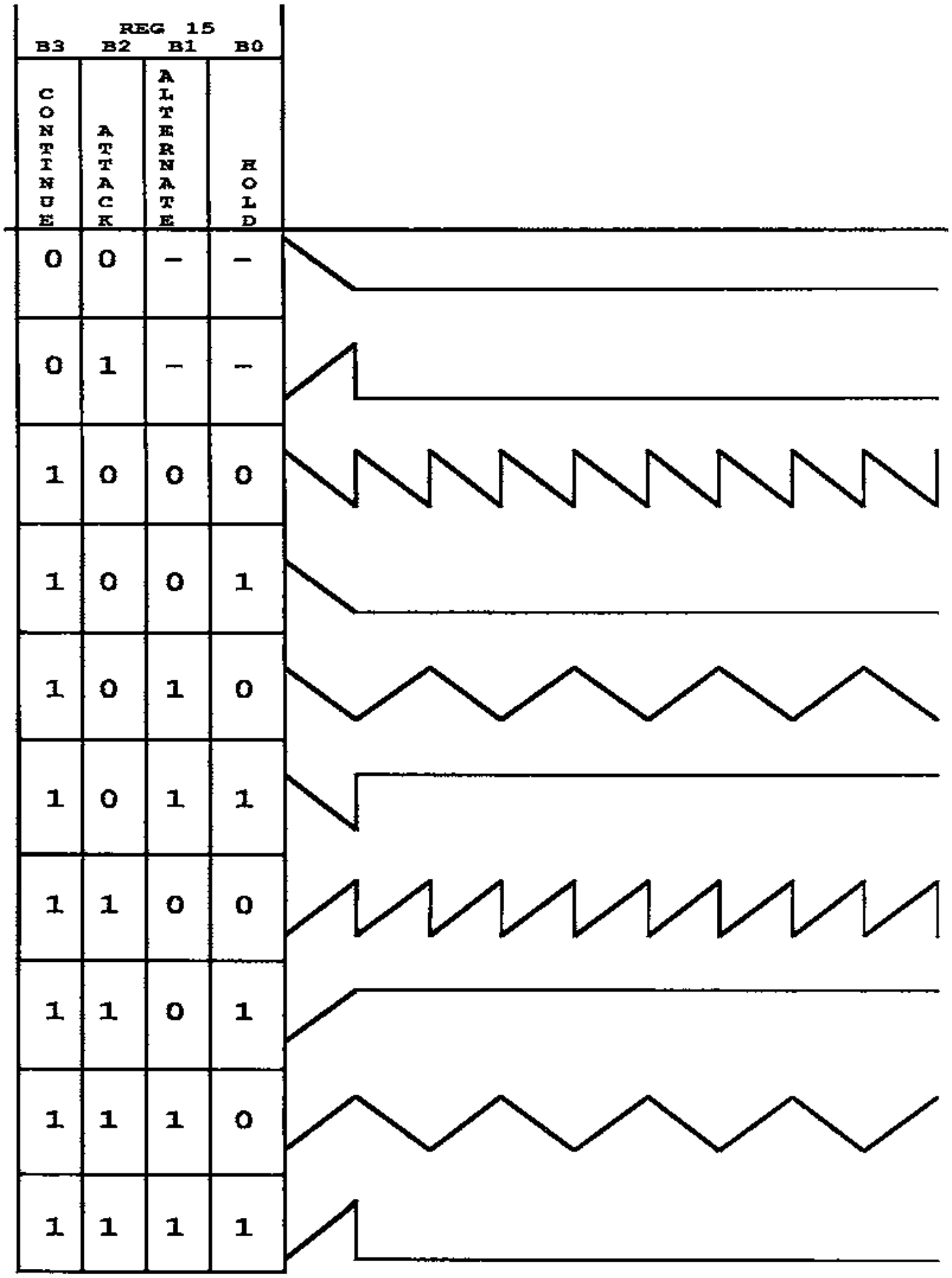
Reg 6:

The five lowest bits of this register control the noise generator. Again, the smaller the value, the higher the noise "pitch".

Reg 7:

```
Bit 0:Channel A tone on/off       0=on /1=off
Bit 1:Channel B tone on/off       0=on /1=off
Bit 2:Channel C tone on/off       0=on /1=off
Bit 3:Channel A noise on/off      0=on /1=off
Bit 4:Channel B noise on/off      0=on /1=off
Bit 5:Channel C noise on/off      0=on /1=off
Bit 6:Port A in/output            0=in /1=out
Bit 7:Port B in/output            0=in /1=out
```

Figure 1.6-2 Envelopes of the PSG



Reg 8:

Bits 0-3 of this register control the signal volume of channel A. When bit 4 is set, the envelope register is being used and the contents of bits 0-3 are ignored

Reg 9:

Same as register 8, but for channel B.

Reg 10:

Same as register 8, but for channel C.

Reg 11,12:

The contents of register 11 are the low-byte and the contents of register 12 are the high-byte of the sustain.

Reg 13:

Bits 0-3 determine the waveform of the envelope generator. The possible envelopes are pictured in Figure 1.6-2.

Reg 14,15:

These registers comprise the two 8-bit ports. Register 14 is connected to Port A and register 15 is connected to Port B. If these ports are programmed as output (bits 7 and 8 of register 7) then values may be sent through these registers.

1.7 I/O Register Layout in the ST

The entire I/O range (all peripheral ICs and other registers) is controlled by a 32K address register -- $FF8000 - $FFFFFF. Below is a complete table of the different registers. CAUTION: The I/O section can be accessed only in supervisor mode. Any access in user mode results in a bus-error.

```
$FF8000   Memory configuration
$FF8200   Video display register
$FF8400   Reserved
$FF8600   DMA/disk controller
$FF8800   Sound chip
$FFFA00   MFP 68901
$FFFC00   ACIAs for MIDI and keyboard
```

The addresses given refer only to the start of each register, and supply no hint as to the size of each. More detailed information follows.

$FF8000 Memory Configuration

There is a single 8-bit register at $FF8001 in which the memory configuration is set up (four lowest bits). The MMU-IC is designed for maximum versatility within the ST. It lets you use three different types of memory expansion chips: 64K, 256K, and the 1M chips. Since all of these ICs are bit-oriented instead of byte-oriented, 16 memory chips of each type are required for memory expansion. The identifier for 16 such chips (regardless of memory capacity) is BANK. So, expansion is possible to 128 Kbyte, 512 Kbyte or even 2 Megabytes.

MMU can control two banks at once, using the RAS- and CAS- signals. The table on the next page shows the possible combinations:

$FF8001	Bit	Memory configuration	
	3-0	Bank 0	Bank 1
	0000	128K	128K
	0001	128K	512K
	0010	128K	2 M
	0011	reserved	
	0100	512K	128K
	0101	512K	512K
	0100	512K	2 M,normally reserved
	0100	reserved	
	1000	2M	128K
	1001	2M	512K
	1010	2M	2M
	1011	reserved	
	11XX	reserved	

The memory configuration can be read from or written to.

$FF8200 Video Display Register

This register is the storage area that determines the resolution and the color palette of the video display.

```
$FF8201   8-bit  Screen memory position (high-byte)
$FF8203   8-bit  Screen memory position (low-byte)
```

These two read/write registers are located at the beginning of the 32K video RAM.

In order to relocate video RAM, another register is used. This register is three bytes long and is located at $FF8205. Video RAM can be relocated in 256-byte incremeents. Normally the starting address of video RAM is $78000.

```
$FF8205   8-bit  Video address pointer (high-byte)
$FF8207   8-bit  Video address pointer (mid-byte)
$FF8209   8-bit  Video address pointer (low-byte)
```

These three registers are read ONLY. Every three microseconds, the contents of these registers are incremented by 2.

```
$FF820A BIT        Synchronization mode
        1 0
        : :-- 0=internal,1=external synchronization
        :---- 0=60 Hz, 1=50Hz screen frequency
```

The bottom two bits of this register control synchronization mode; the remaining bits are unused. If bit 0 is set, the HSync and VSync impulses are shut off, which allows for screen synchronization from external sources (monitor jack). This offers new realm of possibilities in video, synchronization of your ST and a video camera, for example.

Bit 1 of the sync-mode register handles the screen frequency. This bit is useful only in the two "lowest" resolutions. High-res operation puts the ST at a 70 Hz screen frequency.

Sync mode can be read/written.

```
$FF8240   16-bit   Color palette register 0
$FF8242   16-bit   Color palette register 1
   :        :                 :
   :        :      Color palette registers 2-13
   :        :                 :
$FF825C   16-bit   Color palette register 14
$FF825E   16-bit   Color palette register 15
```

Although the ST has a total of 512 colors, only 16 different colors can be displayed on the screen at one time. The reason for this is that the user has 16 color pens on screen, and each can be one of 512 colors. The color palette registers represent these pens. All 16 registers contain 9 bits which affect the color:

```
FEDCBA9876543210
.....XXX.XXX.XXX
```

The bits marked X control the registers. Bits 0-2 adjust the shade of blue desired; 4-6, green hue; and 8-A, red. The higher the value in these three bits, the more intense the resulting color.

Middle resolution (640 X 200 points) offers four different colors; colors 4 through 15 are ignored by the palette registers.

When you want the maximum of 16 colors, it's best to zero-out the contents of the palette registers.

High-res (640 X 400 points) gives you a choice on only one "color"; bit 0 of palette register 0 is set to the background color. If the bit is cleared, then the text is black on a light background. A set bit reverses the screen (light characters, black background). The color register is a read/write register.

```
$FF8260    Bit  Resolution
           1 0
           0 0  320 X 200 points, four focal planes
           0 1  640 X 200 points, two focal planes
           1 0  640 X 400 points, one focal planes
```

This register sets up the appropriate hardware for the graphic resolution desired.

$FF8600 DMA/Disk Controller

```
$FF8600              reserved
$FF8602              reserved

$FF8604    16-bit    FDC access/sector count
```

The lowest 8 bits access the FDC registers. The upper 8 bits contain no information, and consistently read 1. Which register of the FDC is used depends upon the information in the DMA mode control register at $FF8606. The FDC can also be accessed indirectly.

The sector count-register under $FF8604 can be accessed when the appropriate bit in the DMA control register is set. The contents of these addresses are both read/write.

```
$FF8606    16-bit    DMA mode/status
```

When this register is read, the DMA status is found in the lower three bits of the register.

```
 Bit 0  0=no error, 1=DMA error
 Bit 1  0=sector count = null, 1=sector count<>null
 Bit 2  Condition of FDC DATA REQUEST signal
```

Write access to this address controls the DMA mode register.

```
  Bit 0     unused
  Bit 1     0=pin A0 is low
            1=pin A0 is high
  Bit 2     0=pin A1 is low
            1=pin A1 is high
  Bit 3     0=FDC access
            1=HDC access
  Bit 4     0=access to FDC register
            1=access to sector count register
  Bit 5     0, reserved
  Bit 6     0=DMA on
            1=no DMA
  Bit 7     0=hard disk controller access (HDC)
            1=FDC access
  Bit 8     0=read FDC/HDC registers
            1=write to FDC/HDC registers

$FF8609   8-bit      DMA basis and counter high-byte
$FF860B   8-bit      DMA basis and counter mid-byte
$FF860D   8-bit      DMA basis and counter low-byte
```

DMA transfer will tell the hardware at which address the data is to be moved. The initialization of the three registers must begin with the low-byte of the address, then mid-byte, then high-byte.

$FF8800 Sound Chip

The YM-2149 has 16 internal registers which can't be directly addressed. Instead, the number for the desired register is loaded into the select register. The chosen registers can be read/write, until a new register number is written to the PSG.

```
$FF8800   8-bit      Read data/Register select
```

Reading this address gives you the last register used (normally port A), by which disk drive is selected. This can be accomplished with write-protect signals, although these protected contents can be accessed by another register. Port A is used for multiple control functions, while port B is the printer data port.

```
PORT A
  Bit 0      Page-choice signal for double-sided
             floppy drive
  Bit 1      Drive select signal -- floppy drive 0
  Bit 2      Drive select signal -- floppy drive 1
  Bit 3      RS-232 RTS-output
  Bit 4      RS-232 DTR output
  Bit 5      Centronics strobe
  Bit 6      Freely usable output (monitor jack)
  Bit 7      reserved
```

When $FF8800 is written to, the select register of the PSG is alerted. The information in the bottom four bits are then considered as register numbers. The necessary four-bit number serves for writing to the PSG.

```
$FF8802   8-bit     Write data
```

Attempting to read this address after writing to it will give you $FF only, while BDIR and BC1 are nulls.

Writing register numbers and data can be performed with a single MOVEP instruction.

$FFFA00 MFP 68901

The MFP's 24 registers are found at uneven addresses from $FFFA01-$FFFA2F:

```
$FFFA01   8-bit     Parallel port
$FFFA03   8-bit     Active Edge register
$FFFA05   8-bit     Data direction
$FFFA07   8-bit     Interrupt enable A
$FFFA09   8-bit     Interrupt enable B
$FFFA0B   8-bit     Interrupt pending A
$FFFA0D   8-bit     Interrupt pending B
$FFFA0F   8-bit     Interrupt in-service A
$FFFA11   8-bit     Interrupt in-service B
$FFFA13   8-bit     Interrupt mask A
$FFFA15   8-bit     Interrupt mask B
$FFFA17   8-bit     Vector register
$FFFA19   8-bit     Timer A control
$FFFA1B   8-bit     Timer B control
```

$FFFA1D	8-bit	Timer C & D control
$FFFA1F	8-bit	Timer A data
$FFFA21	8-bit	Timer B data
$FFFA23	8-bit	Timer C data
$FFFA25	8-bit	Timer D data
$FFFA27	8-bit	Sync character
$FFFA29	8-bit	USART control
$FFFA2B	8-bit	Receiver status
$FFFA2D	8-bit	Transmitter status
$FFFA2F	8-bit	USART data

See the chapter on the MFP for details on the individual registers.

I/O Port

Bit 0	Centronics busy
Bit 1	RS-232 data carrier detect - input
Bit 2	RS-232 clear to send - input
Bit 3	reserved
Bit 4	keyboard and MIDI interrupt
Bit 5	FDC and HDC interrupt
Bit 6	RS-232 ring indicator
Bit 7	Monochrome monitor detect

Timers A and B each have an input which can be used by external timer control, or send a time impulse from an external source. Timer A is unused in the ST, which means that the input is always available, but it isn't connected to the user port, so the Centronics busy pin is connected instead. You can use it for your own purposes.

Timer B is used for counting screen lines in conjunction with DE (Display Enable).

The timer outputs in A-C are unused. Timer D, on the other hand, sends the timing signal for the MFP's built-in serial interface.

$FFFC00 Keyboard and MIDI ACIAs

The communications between the ST, the keyboard, and musical instruments are handled by two registers in the ACIAs.

$FFFC00	8-bit	Keyboard ACIA control
$FFFC02	8-bit	Keyboard ACIA data
$FFFC04	8-bit	MIDI ACIA control
$FFFC06	8-bit	MIDI ACIA data

Figure 1.7-1 I/O Assignments

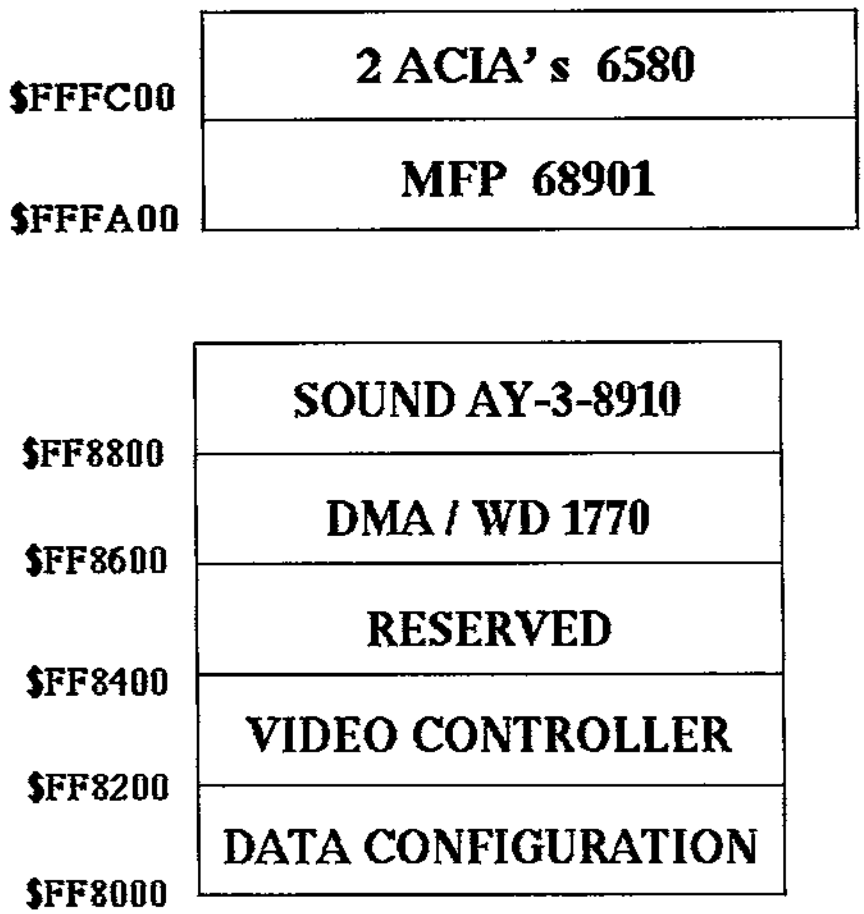
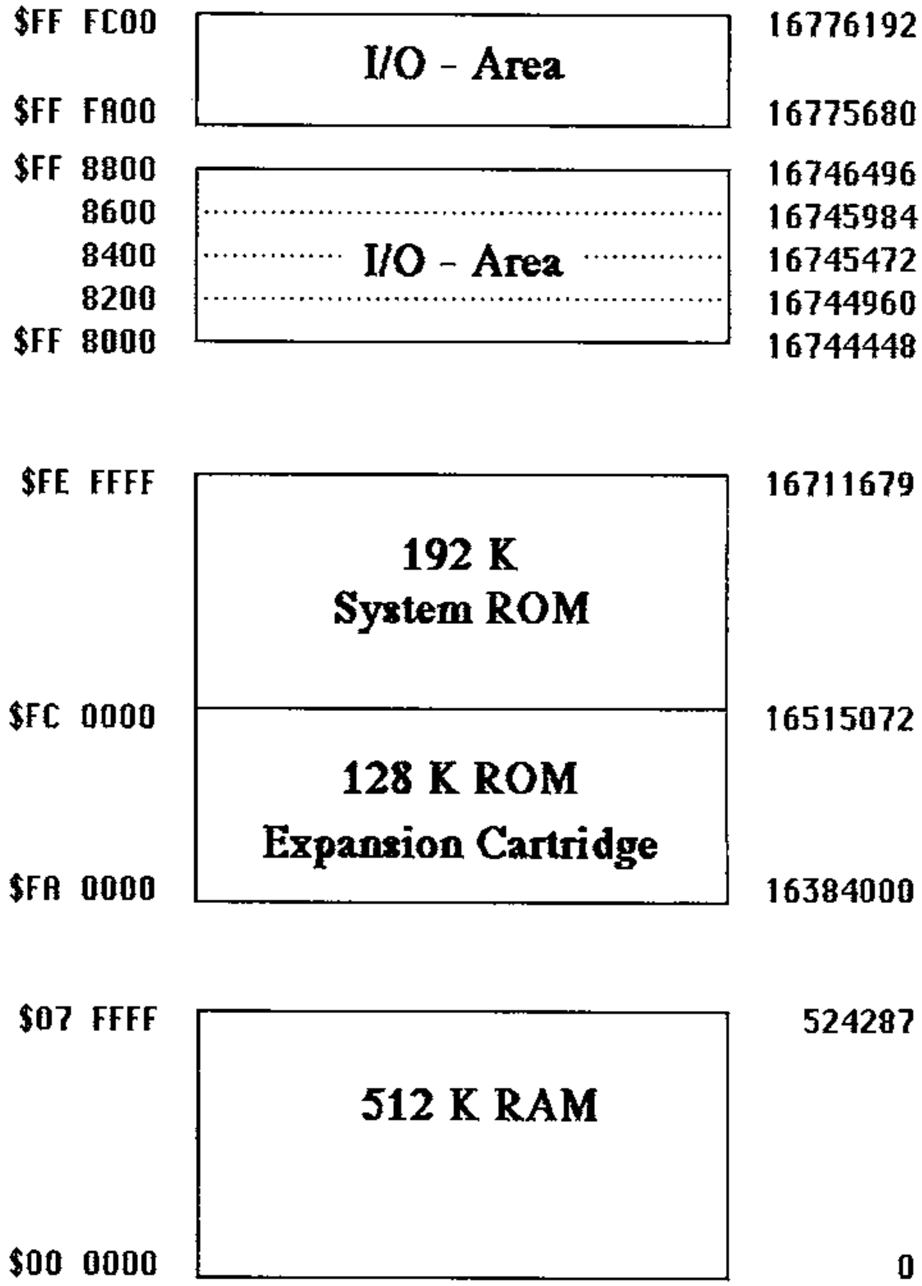


Figure 1.7-2 Memory Map of the ATARI ST



Chapter Two

The Interfaces

The Interfaces

2.1 The Keyboard

Do you think it's really necessary to give a detailed report on something as trivial as the keyboard, since keyboards all function the same way? Actually the title should read "Keyboard Systems" or something similar. The keyboard is controlled by its own processor. You will soon see how this affects the assembly language programmer.

The keyboard processor is single-chip computer (controller) from the 6800 family, the 6301. Single chip means that everything needed for operation is found on a single IC. In actuality, there are some passive components in the keyboard circuit along with the 6301.

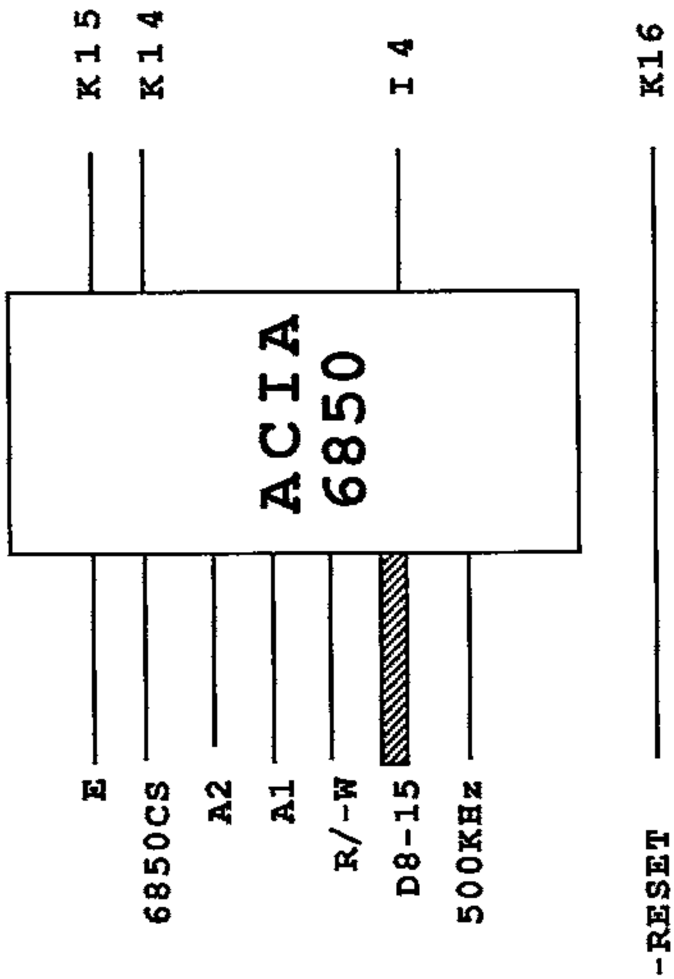
The 6301 has ROM, RAM, some I/O lines, and even a serial interface on the chip. The serial interface handles the traffic to and from the main board.

The advantage of this design is easy to see. The main computer is not burdened by having to continually poll the keyboard. Instead it can dedicate itself completely to processing your programs. The keyboard processor notifies the system if an event occurs that the operating system should be aware of.

The 6301 is not only responsible for the relatively boring task of reading the keyboard, however. It also takes care of the rather complicated tasks required in connection with the mouse. The main processor is then fed simply the new X and Y coordinates when the mouse is moved. Naturally, anything to do with the joysticks is also taken care of by the keyboard controller.

In addition, this controller contains a real-time clock which counts in one-second increments.

Figure 2.1-1 6850 Interface to 68000



In Figure 2.1-1 is an overview of the interface to the 68000. As you see, the main processors is burdened as little as possible. The ACIA 6850 ensures that it is disturbed only when a byte has actually been completely received from the keyboard. The ACIA, by the way, can be accessed at addresses $FFFC00 (control register) and $FFFC02 (data register). The individual connection to the keyboard takes place over lines K14 and K15. K indicates the plug connection by which the keyboard is connected to the main board.

The signal that the ACIA has received a byte is first sent over line 14 to the MFP 68901 which then generates an interrupt to the 68000. The clock frequency of 500KHz comes from GLUE. From this results the "odd" transfer rate of 7812.5 baud.

In case you were surprised that data can also be sent *to* the keyboard processor, you will find the solution to the puzzle in Chapter 2.1.2.

The block diagram of the keyboard circuit is found in Figure 2.1-2. The function is as simple as the figure is easy to read. The processor has 4K of ROM available. The 128 bytes of RAM is comparitively small, but it is used only as a buffer and for storing pointers and counters.

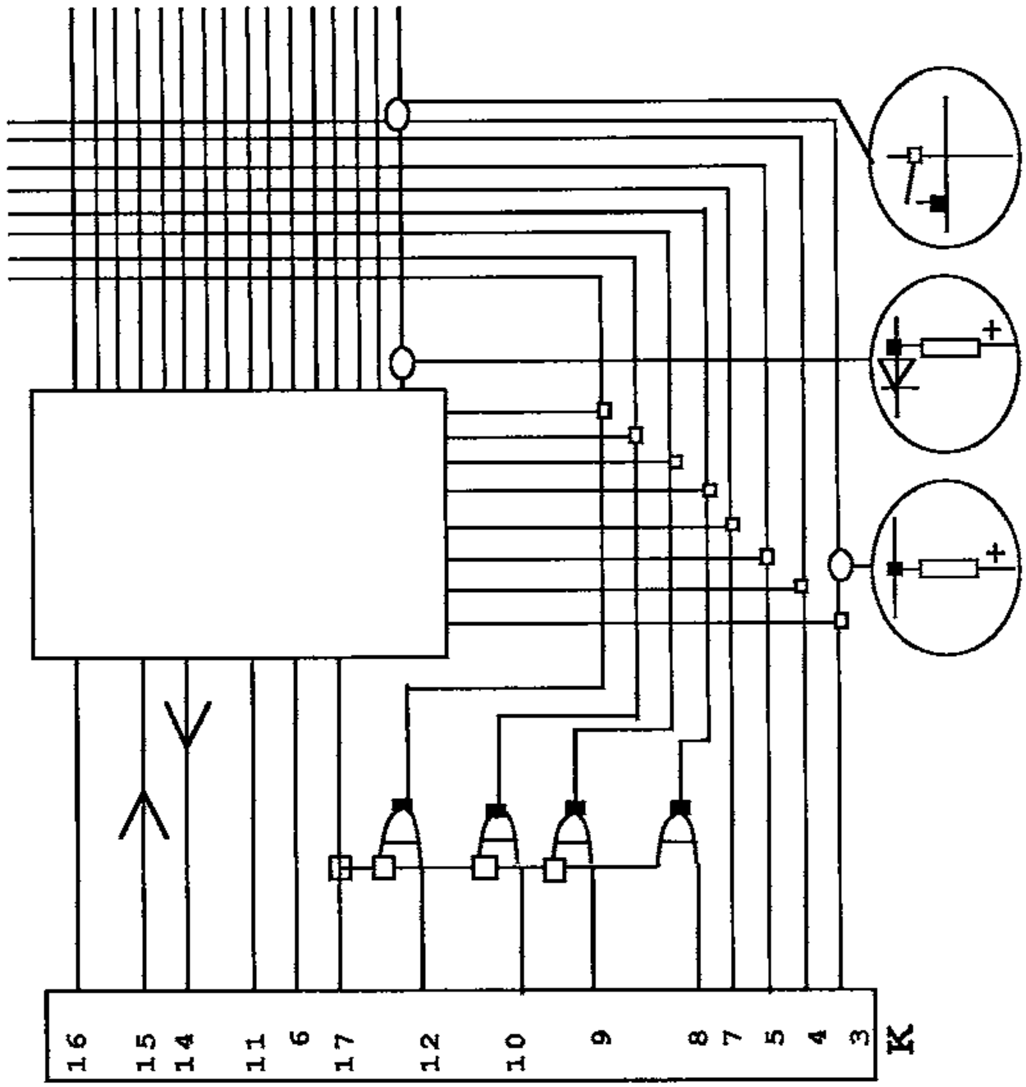
The lines designated with K are again the plug connections assigned to the main board. With few exceptions, the connections for the joystick and mouse are also put through. K16 is the reset line from the 68000. K15 carries the send data from the 6850, K14 the send data from the 6301.

The I/O ports 1(0-7), 3(1-7), and 4(0-7) are responsible for reading the keyboard matrix. One line from ports 3 and 4 is pulled low in a cycle. The state of port 1 is the checked. If a key is pressed, the low signal comes through on port 1.

Each key can be identified from the combination of value placed on ports 3 and 4 and the value read from port 1.

If none of the lines of Port 3 and 4 are placed low and a bit of port 1 still equals zero, a joystick is active on the outer connecter 1. The data from outer connector 0, to which a mouse or a joystick can be connected, does not come through by chance since it must first be switched through the NAND gate with port 2 (bit 0). The buttons on the mouse or the joystick then arrive at port 2 (1 and 2).

Figure 2.1-2 Block Diagram of Keyboard Circuit



The assignments of the K lines to the signal names on the outer connecter are found in the next section.

The processor 6301 is completely independent, but it can also be configured so that it works with an external ROM. Some of the port lines are then reconfigured to act as address lines. The configuration the processor assumes (one of eight possibilities) depends on the logical signal placed on port 2 (bits 0-2) during the reset cycle. All three lines high puts the processor in mode 7, the right one for the task intended here. But bits 1 and 2 depend on the buttons on the mouse. If you leave the mouse alone while powering-up, everything will be in order. If you hold the two buttons down, however, the processors enters mode 1 and makes a magnificent belly-flop, since the hardware for this operating mode is not provided. You notice this by the fact that the mouse cursor does not move on the screen if you move the mouse. Only the reset button will restore the processor.

2.1.1 The Mouse

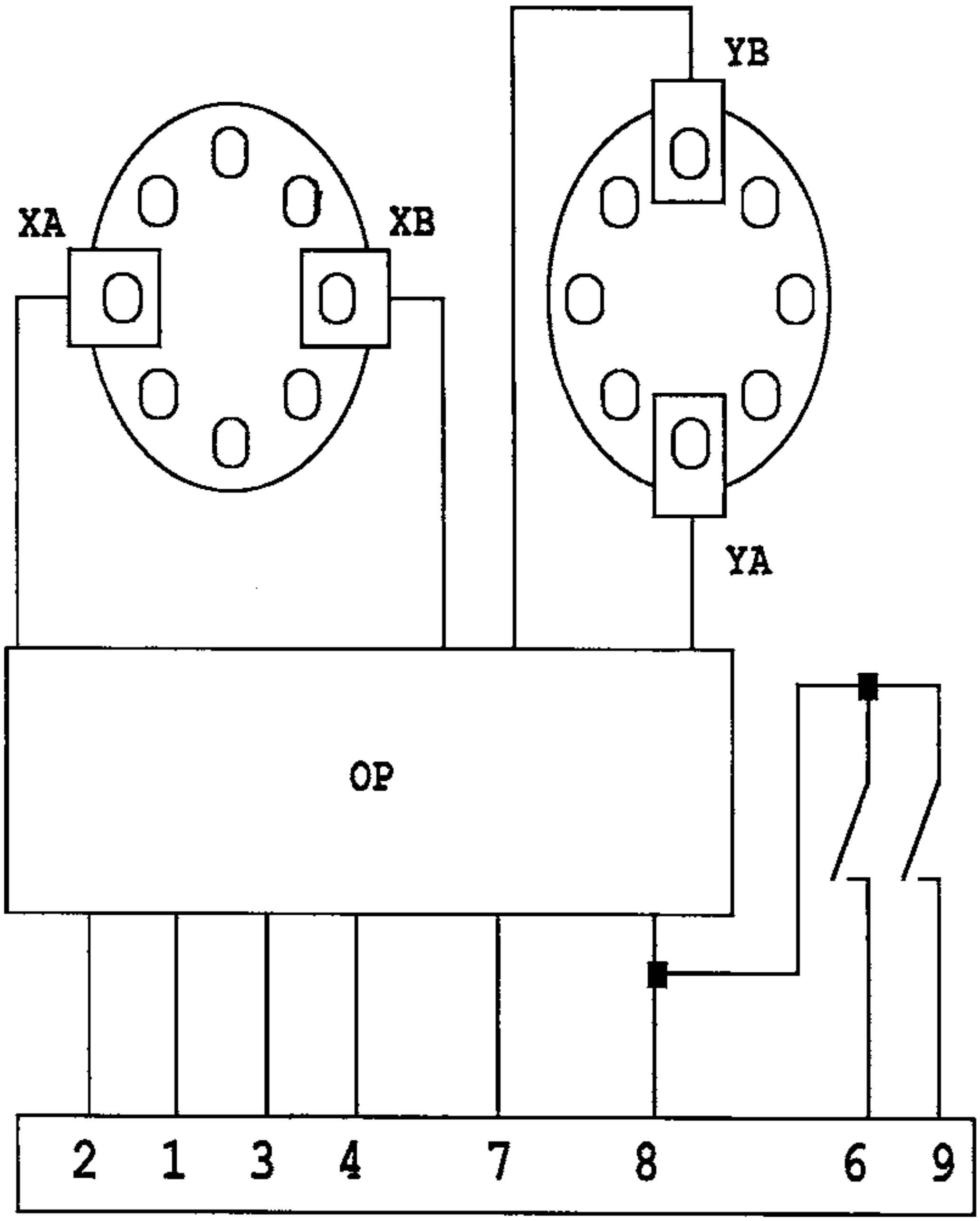
The construction of this little device is quite simple, but effective. Essentially, it consists of four light barriers, two encoder wheels, and a drive mechanism.

The task of the mouse is to give the computer information about its movements. This information consists of the components: direction on the X-axis, direction on the Y-axis, and the path traveled on each axis.

In order to do this, the rubber-covered ball visible from the outside drives two encoder wheels whose drive axes are at angle of 90 degrees to each other. The one or the other axis rotates more or less, forwards or backwards, depending on the direction the mouse is moved.

It is no problem to determine the absolute movement on each axis. The encoder wheels alternately interrupt the light barriers. One need only count the pulses from each wheel to be informed about the path traveled on each axis.

Figure 2.1.1-1 The Mouse



It is more difficult when the direction of movement is also required. The designers of the mouse used a convenient trick for this. There are not one, but two light barriers on each encoder wheel. They are arranged such that they are not shielded by the wheel at precisely the same time, but one shortly after the other. This arrangement may not be so clear in Figure 2.1.1-1, so we'll explain it in more detail The direction can be determined by noticing which of the two light barriers is interrupted first. This is why the pulses from both light barriers are sent out, making a total of four. Corresponding to their significance they carry the names XA, XB, YA, YB.

The two contacts which you see on the picture represent the two buttons.

The large box on the picture is a quad operational amplifier which converts the rather rough light-barrier pulses into square wave signals.

In Figure 2.1.1-2 is the layout of the control port on the computer, as you see it when you look at it from the outside. The designation behind the slash applies when a joystick is connected and the number in parentheses is the pin number of the keyboard connector.

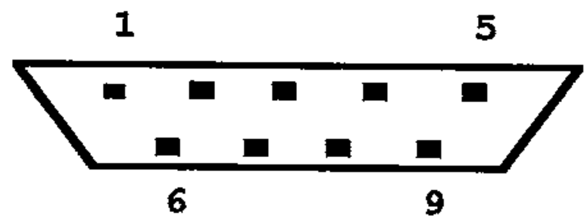
Port 0

1	XB/UP	(K12)
2	XA/DOWN	(K10)
3	YA/LEFT	(K9)
4	YB/RIGHT	(K8)
6	LEFT BUTTON/FIRE	(K11)
7	+5V	(K13)
8	GND	(K1)
9	RIGHT BUTTON	(K6)

Port 1

1	UP	(K7)
2	DOWN	(K5)
3	LEFT	(K4)
4	RIGHT	(K3)
5	Port 0 enable	(K17)
6	FIRE	(K6)
7	+5V	(K13)
8	GND	(K1)

Figure 2.1.1-2 Mouse control port



2.1.2 Keyboard commands

The keyboard processor "understands" some commands pertaining to such things as how the mouse is to be handled, etc. You can set the clock time, read the internal memory, and so on. You can find an application example in the assembly language listing on page 80 (after command $21).

The "normal" action of the processor consists of keeping an eye on the keyboard and announcing each keypress. This is done by outputting the number of the key when the key is pressed. When the key is released the number is set again, but with bit 7 set. The result of this is that no key numbers greater than 127 are possible. You can find the assignment of the key numbers to the keys at the end of this section in figure 2.1.2-1. In reality these numbers only go up to 117 because values from $F6 up are reserved for other purposes. There must be a way to pass more information than just key numbers to the main processor, information such as the clock time or the current position of the mouse. This cannot be handled in a single byte but only in something called a package, so the bytes at $F6 signal the start of a package. Which header comes before which package is explained along with the individual commands.

A command to the keyboard processor consists of the command code (a byte) and any parameters required. The following description is sorted according to command bytes.

$07
Returns the result of pressing one of the two mouse buttons. A parameter byte with the following format is required:

```
Bit 0  =1: The absolute position is returned when a
           mouse button is pressed. Bit 2 must =0.
Bit 1  =1: The absolute position is returned when a
           mouse button is released. Bit 2 must =0.
Bit 2  =1: The mouse buttons are treated like
           normal keys. The left button is key
           number $74, the right is $75.
Bits 3-7   must always be zero.
```

$08

Returns the relative mouse position from now on. This command tells the keyboard processor to automatically return the relative position (the distance from the previous position) whenever the mouse is moved. A movement is given when the number of encoder wheel pulses has reached a given threshold. See also $0B. A relative mouse package looks like this:

```
1 byte   Header in range $F8-$FB. The two lowest
         bits of the header indicate the condition
         of the two mouse buttons.
1 byte   Relative X-position (signed!)
1 byte   Relative Y-position (signed!)
```

If the relative position changes substantially between two packages so that the distance can no longer be expressed in one byte, another package is automatically created which makes up for the remainder.

$09

Returns the absolute mouse position from now on. This command also sets the coordinate maximums. The internal coordinate pointers are at the same time set to zero. The following parameters are required:

```
1 word   Maximum X-coordinate
1 word   Maximum Y-coordinate
```

Mouse movements under the zero point or over the maximums are not returned.

$0A

With this command it is possible to get the key numbers of the cursor keys instead of the coordinates. A mouse movement then appears to the operating system as if the corresponding cursor keys had been pressed. These parameters are necessary:

```
1 byte Number of pulses (X) after which the key
       number for cursor left (or right) will be
       sent.
1 byte Number of pulses (Y) after which the key
       number for cursor up (or down) will be sent.
```

$0B

This command sets the trigger threshold, above which movements will be announced. A certain number of encoder pulses elapse before a package is sent. This functions only in the relative operating mode. The following are the parameters:

```
1 byte    Threshold in X-direction
1 byte    Threshold in Y-direction
```

$0C

Scale mouse. Here is determined how many encoder pulses will go by before the coordinate counter is changed by 1. This command is valid only in the absolute. The following parameters are required:

```
1 byte    X scaling
1 byte    Y scaling
```

$0D

Read absolute mouse position. No parameters are required, but a package of the following form is sent:

```
1 byte    Header = $F7
1 byte    Button status
      Bit 0 = 1: Right button was pressed since the
                 last read
      Bit 1 = 1: Right button was not pressed
      Bit 2 = 1: Left button was pressed since the
                 last read
      Bit 3 = 1: Left button was not pressed
```

From this strange arrangement you can determine that the state of a button has changed since the last read if the two bits pertaining to it are zero.

```
1 word Absolute X-coordinate
1 word Absolute Y-coordinate
```

$0E
Set the internal coordinate counter. The following parameters are required:

```
1 byte    =0 as fill byte
1 word    X-coordinate
1 word    Y-coordinate
```

$0F
Set the origin for the Y-axis is down (next to the user).

$10
Set the origin for the Y-axis is up.

$11
The data transfer to the main processor is permitted again (see $13).
Any command other than $13 will also restart the transfer.

$12
Turn mouse off. Any mouse-mode command ($08, $09, $0A) turns the mouse back on. If the mouse is in mode $0A, this command has no effect.

$13
Stop data transfer to main processor.
NOTE: Mouse movements and key presses will be stored as long as the small buffer of the 6301 allows. Actions beyond the capacity of the buffer will be lost.

$14
Every joystick movement is automatically returned. The packages sent have the following format:

```
1 byte    Header = $FE or $FF for joystick 0/1
1 byte    Bits 0-3 for the position (a bit for each
          direction), bit 7 for the button
```

$15
End the automatic-return mode for the joystick. When needed, a package must be requested with $16.

$16
Read joystick. After this command the keyboard sends a package as described above.

$17

Joystick duration message. One parameter is required.

```
1 byte    Time between two messages in 1/100 sec.
```

From this point on, packages of the following form are sent continuously (as long as no other mode is selected):

```
1 byte    Bit 0 for the button on joystick 1, bit 1
          for that of joystick 0
1 byte    Bits 0-3 for the position of joystick 1,
          bits 4-7 for the position of joystick 0
```

NOTE: The read interval should not be shorter than the transfer channel needs to send the two bytes of the package.

$18

Fire button duration message. The condition of the button in joystick 1 (!) is continually tested and the result packed into a byte. This means that a message byte contains 8 such tests, whereby bit 7 is the most recent. The keyboard controller determines the time between byte fetches by the main processor. This time is divided into eight equal intervals in which the button is polled. The polling then takes place as regularly as possible. This mode remains active until another command is received.

$19

Cursor key simulation mode for joystick 0 (!). The current position of the joystick is sent to the main processor as if the corresponding cursor keys had been pressed (as often as necessary). To avoid having to explain the same things for the following parameters, here are the most important: All times are assumed to be in tenths of seconds. R indicates the time, when reached, cursor clicks will be sent in intervals of T. After this the interval is V. If R=0, only V is responsible for the interval. Naturally, this mechanism comes into play only when the joystick is held in the same position for longer than T or R.

```
1 byte    RX
1 byte    RY
1 byte    TX
1 byte    TY
1 byte    VX
1 byte    VY
```

$1A
Turn off joysticks. Any other joystick command turns them on again.

$1B
Set clock time. This command sets the internal real-time clock in the keyboard processor. The values are passed in packed BCD, meaning a digit 0-9 for each half byte, yielding a two-digit decimal number per byte. The following parameters are necessary:

```
1 byte    Year, two digit (85, 86, etc.)
1 byte    Month, two digit (12, 01, etc.)
1 byte    Day, two digit (31,01,02, etc.)
1 byte    Hours, two digit
1 byte    Minutes, two digit
1 byte    Seconds, two digit
```

Any half byte which does not contain a valid BCD digit (such as F) is ignored. This makes it possible to change just part of the date or clock time.

$1C
Read clock time. After receiving this command the keyboard processor returns a package having the same format as the one described above. A header is added to the package, however, having the value $FC.

$20
Load memory. The internal memory of the keyboard processor (naturally only the RAM in the range $80 to $FF makes sense) can be written with this command. It is not clear to us of what use this is since according to our investigations (we have disassembled the operating system of the 6301), no RAM is available to be used as desired. Perhaps certain parameters can be changed in this manner which are not accessible through "legal" means. Here are the parameters:

```
1 word    Start address
1 byte    Number of bytes (max. 128)
Data bytes (corresponding to the number)
```

The interval at which the data bytes will be sent must be less than 20 msec.

$21

Read memory. This command is the opposite of $20. These parameters are required:

```
1 word    Address at which to read
```

A package having the following format is returned:

```
1 byte   Header 1 =$F6. This is the status header
         which precedes all packages containing any
         operating conditions of the keyboard
         processor. We will come to the general
         status messages shortly.
1 byte   Header 2 =$20 as indicator that this
         package carries the memory contents.
6 bytes  Memory contents starting with the address
         given in the command.
```

Here is a small program which we used to read the ROM in the 6301 and output it to a printer. Here you also see how the status packages arrive from the keyboard. These are normally thrown away by the 68000 operating system. Section 3.1 contains information about the GEMDOS and XBIOS calls used.

```
                                   prt     equ     0
                                   chout   equ     3
                                   gemdos  equ     1
                                   bios    equ     13
                                   xbios   equ     14
                                   stvec   equ     12
                                   rdm     equ     $21
                                   wrkbd   equ     25
                                   kbdvec  equ     34
                                   term    equ     0
                                   start:
00000000 3F3C0022                          move.w  #kbdvec,-(a7)
00000004 4E4E                              trap    #xbios
00000006 548F                              addq.l  #2,a7
00000008 41F900000000                      lea     0,a0
0000000E 43F9000000D6                      lea     keyin,a1
00000014 23C000000104                      move.l  d0,savea
0000001A 23F0000C00000100                  move.l  stvec(a0,d0),save
00000022 2189000C                          move.l  a1,stvec(a0,d0)
```

```
00000026 383CF000                    move.w  #$f000,d4
                              loop:
0000002A 33C40000010A                move.w  d4,tbuf+1
00000030 61000084                    bsr     keyout
                              wait:
00000034 0C39000000000F8             cmpi.b  #0,rbuf
0000003C 67F6                        beq     wait
0000003E 3C3C0006                    move.w  #6,d6
00000042 610A                        bsr     bufout
00000044 5C44                        addq.w  #6,d4
00000046 0C44FFFF                    cmpi.w  #$ffff,d4
0000004A 6DDE                        blt     loop
0000004C 6052                        bra     exit
                              bufout:
0000004E 49F9000000F9                lea     rbuf+1,a4
                              bytout:
00000054 101C                        move.b (a4)+,d0
00000056 6106                        bsr     hexout
00000058 5306                        subq.b  #1,d6
0000005A 66F8                        bne     bytout
0000005C 4E75                        rts
                              hexout:
0000005E 3240                        movea.w d0,a1
00000060 E808                        lsr.b   #4,d0
00000062 02800000000F                andi.l  #15,d0
00000068 47F9000000E8                lea     table,a3
0000006E 14330000                    move.b  0(a3,d0),d2
00000072 E14A                        lsl.w   #8,d2
00000074 3009                        move.w  a1,d0
00000076 02800000000F                andi.l  #15,d0
0000007C 14330000                    move.b  0(a3,d0),d2
00000080 3002                        move.w  d2,d0
00000082 3F02                        move.w  d2,-(a7)
00000084 E048                        lsr.w   #8,d0
00000086 6108                        bsr     chrout
00000088 301F                        move.w  (a7)+,d0
0000008A 6104                        bsr     chrout
0000008C 103C0020                    move.b  #" ",d0
                              chrout:
00000090 3F00                        move.w  d0,-(a7)
00000092 3F3C0000                    move.w  #prt,-(a7)
00000096 3F3C0003                    move.w  #chout,-(a7)
0000009A 4E4D                        trap    #bios
0000009C 5C8F                        addq.l  #6,a7
0000009E 4E75                        rts
                              exit:
000000A0 307900000104                movea   savea,a0
```

```
000000A6 203900000100             move.l  save,d0
000000AC 2140000C                 move.l  d0,stvec(a0)
000000B0 3F3C0000                 move.w  #term,-(a7)
000000B4 4E41                     trap    #gemdos
                          keyout:
000000B6 13FC0000000000F8         move.b  #0,rbuf
000000BE 487900000109             pea     tbuf
000000C4 3F3C0002                 move.w  #2,-(a7)
000000C8 3F3C0019                 move.w  #wrkbd,-(a7)
000000CC 4E4E                     trap    #xbios
000000CE DFFC00000008             adda.l  #8,a7
000000D4 4E75                     rts
                          keyin:
000000D6 103C0008                 move.b  #8,d0
000000DA 43F9000000F8             lea     rbuf,a1
                          repin:
000000E0 12D8                     move.b  (a0)+,(a1)+
000000E2 5300                     subq.b  #1,d0
000000E4 66FA                     bne     repin
000000E6 4E75                     rts
                          table:
000000E8 3031323334353637         dc.b    "0123456789ABCDEF"
000000F0 3839414243444546
000000F8                  rbuf:   ds.b    8
00000100                  save    ds.l    1
00000104                  savea   ds.l    1
00000108                  dummy   ds.b    1
00000109 21               tbuf    dc.b    rdm
0000010A                          ds.b    2
0000010C                          .end
```

$22
Execute routine. With this command you can execute a subroutine in the 6301. Naturally, you must know exactly what it does and where it is located, so long as you have not transferred it yourself to RAM with $20 (assuming you found some free space). The only required parameters are:

```
1 word  Start address
```

Status messages
You can at any time read the operating parameters of the keyboard by simply adding $80 to the command byte with which you would to set the operating mode (whose parameters you want to know). You then get a status package back (header=$F6), whose format corresponds exactly to those which would be necessary for setting the operating mode.

An example makes it clearer: you want to know how the mouse is scaled. So you send as the command the value $8C (since $0C sets the scaling). You get the following back:

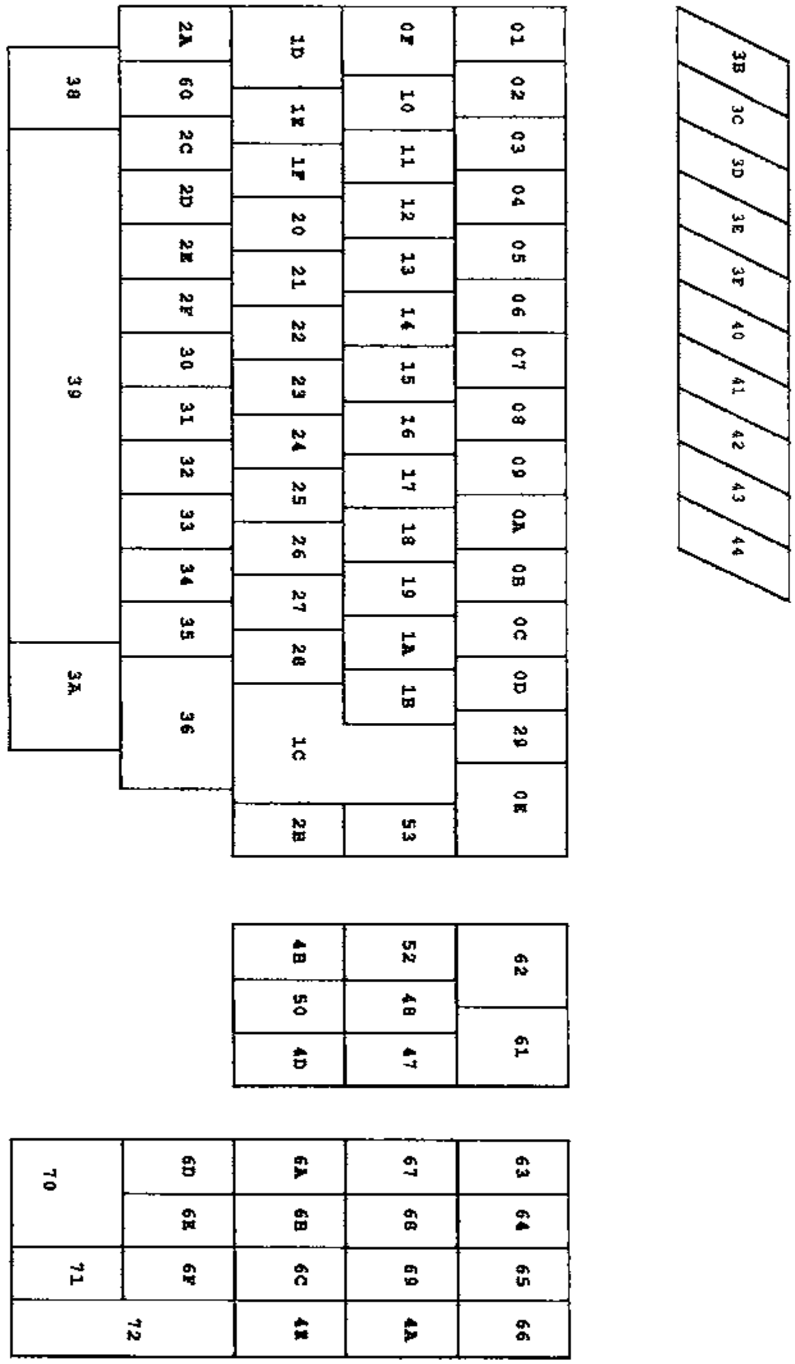
```
1 byte Status header =$F6
1 byte X-scaling
1 byte Y-scaling
```

This is the same format which would be necessary for the command $0C. For commands which do not require parameters, you get the evoked command back as such. For example, say you want to know what operating mode the joystick is in ($14 or $15). You send the value $94 (or $95, it makes no difference). As status package you receive, in addition to the header, either $14 or $15 depending on the operating mode of the joystick handler.

Allowed status checks are: $87, $88, $89, $8A, $8B, $8C, $8F, $90, $92, $94, $99, and $9A.

In conclusion we have a tip for those for whom the functions of the keyboard are too meager and who want to give it more "intelligence". The processor 6301 is also available in "piggy-back" version, the 63P01 (Hitachi). This model does not have ROM built in, but has a socket on the top for an EPROM of type 2732 or 2764 (8K!). You can then realize your own ideas and, for example, use the two joystick connections as universal 4-bit I/O ports, for which you can also extend the command set in order to access the new functions from the XBIOS as well.

Figure 2.1.2-1 ATARI ST Key Assignments



2.2 The Video Connection

Without this, nothing would be displayed. You would be tapping in the dark in the truest sense of the word. Conspicuous are the many pins on the connection. Naturally more lines are required for hooking up an RGB monitor than for a monochrome screen, but seven would be enough. There is also something special about the remaining lines. In Figure 2.2-1 you find a block diagram in which you can see how the video connection is tied to the system. The numbering of the pins is given on the figure on the next page, as you can see, when you look at the connector from the outside. Here is the pin layout:

1 AUDIO OUT. This connection comes from the amplifier connected to the output of the sound chip. A high-impedance earphone can be attached here if you do not use the original monitor.

2 Not used

3 GPO, General Purpose Output. This connection is available for your use. The line has TTL levels and comes from I/O port A bit 6 of the sound chip.

4 MONOCHROME DETECT. If this line, which leads to the I7 input of the MFP 68901, is low, the computer enters the high-resolution monochrome mode. If the state of the line changes during operation, a cold start is generated.

5 AUDIO IN leads to the input of the amplifier described in 1 and is there mixed with the output of the sound chip.

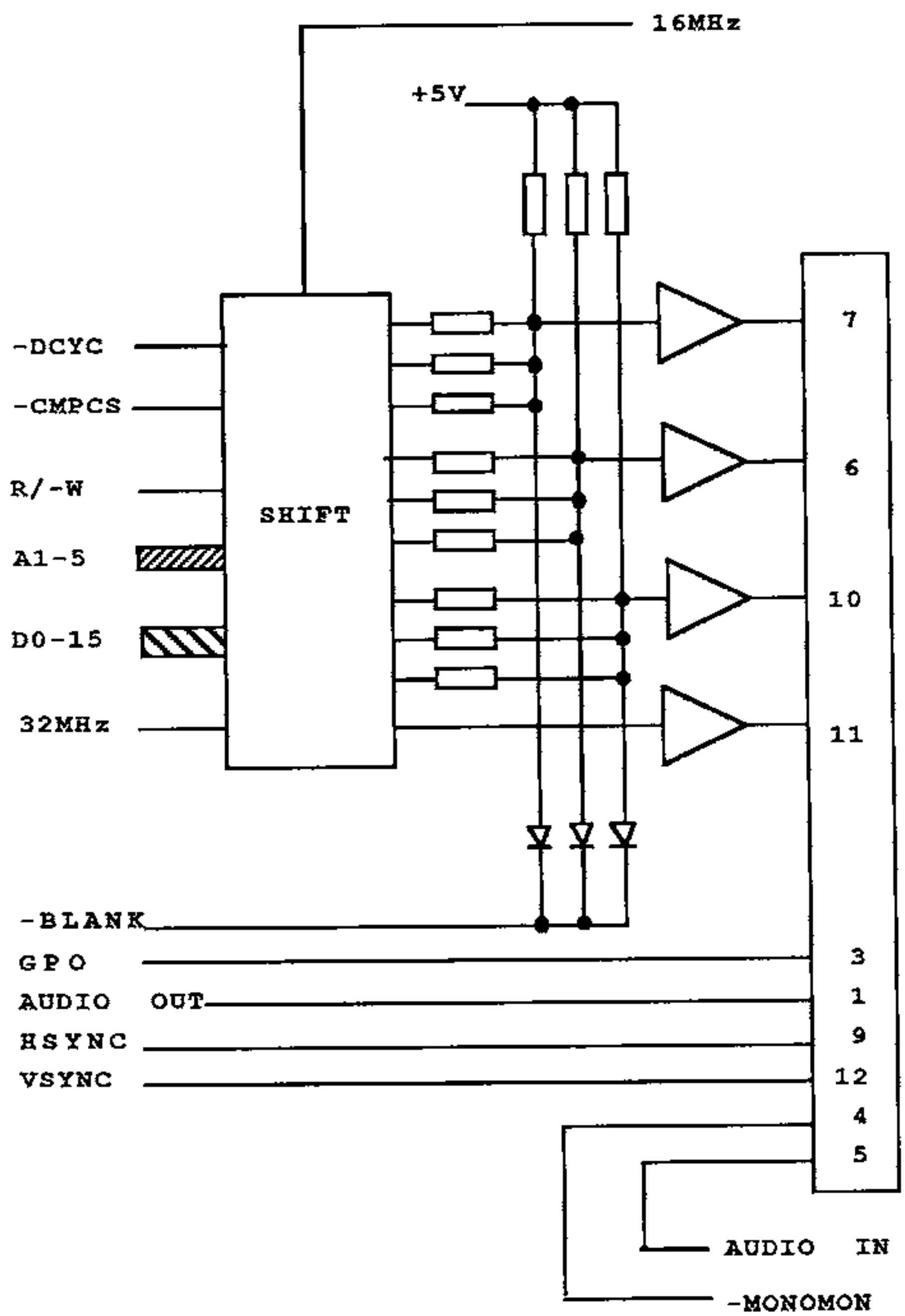
6 GREEN is the analog green output of the video shifter.

7 RED. Red output.

8 GROUND.

9 HORIZONTAL SYNC is responsible for the horizontal beam return of the monitor.

Figure 2.2-1 Diagram of Video Interface



10 BLUE is the analog blue output of the video shifter.

11 MONOCHROME provides a monochrome monitor with the intensity signal.

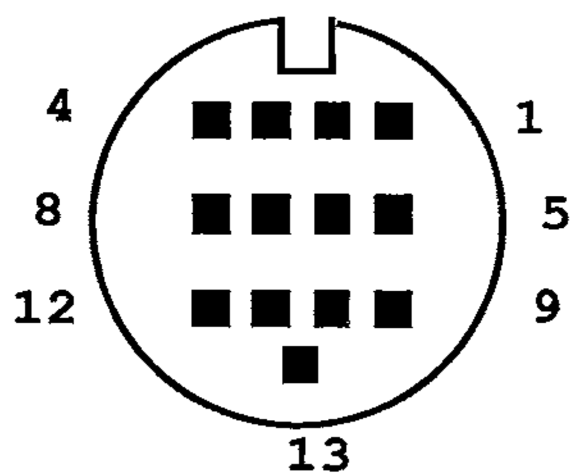
12 VERTICAL SYNC takes care of the beam return at the end of the screen.

13 GROUND.

A tip for the hardware hobbyist:

A plug to fit this connector is not available. If you want to make a plug for connecting other monitors, simply use a piece of perf board in which you have soldered pins, since the pins are fortunately organized in a 1/10" array. Pin 13 is out of order, but it is not needed since pin 8 is also available for ground.

Figure 2.2-2 Monitor Connector



2.3 The Centronics Interface

A standard Centronics parallel printer can be connected to this interface, provided that you have the proper cable. As you can see in Figure 2.3-2, the connection to the system is somewhat unusual. The data lines and the strobe of the universal port of the sound chip are used. So you find these too on the picture, in which the other lines, which will not be described in the section, will not disturb you. They belong to the disk drive and RS-232 interface and are handled there.

Here is the pin description:

1 -STROBE indicates the validity of the byte on the data lines to the connected device by a low pulse.

2-9 DATA

11 BUSY is always placed high by the printer when it is not able to receive additional data. This can have various causes. Usually the buffer is full or the device is off line.

18-15 GROUND.

All other pins are unused.

A tip for making a cable. Get flat-cable solderless connectors. You need a type D25-subminiature, a Cinch 36-pin (3M,AMP) and the appropriate length of 25-conductor flat ribbon cable. You squeeze the connectors on the cable so that pins 1 match up on both sides (they are connected together). The other connections then match automatically. Note that there will naturally be some pins free on the printer side.

Figure 2.3-1 Printer Port Pins

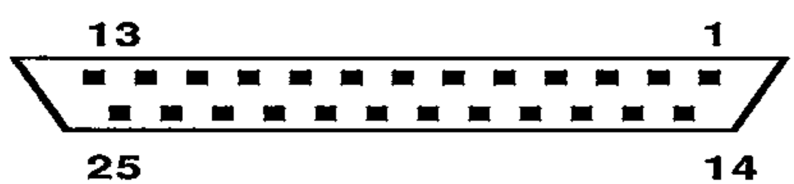
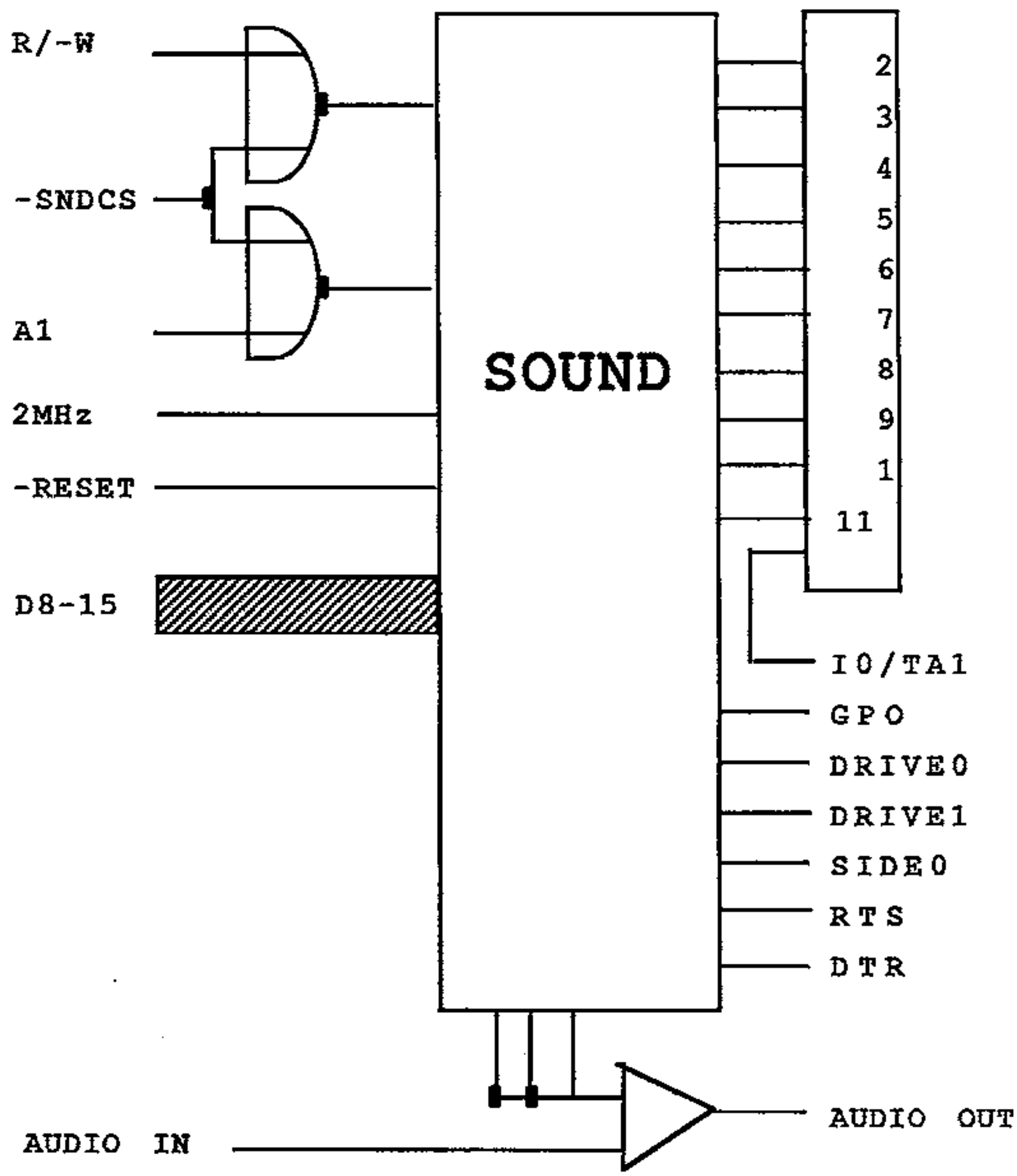


Figure 2.3-2 Centronics Connection



2.4 The RS-232 Interface

This interface usually serves for communication with other computers and modems. You can also connect a printer here. Note the description of pin 5!

Figure 2.4-1 shows the connection to the system. Normally you don't have to do any special programming to use this interface. It is taken care of by the operating system. Here the control of the interface is not controlled by a special IC (UART) as is usually the case, but the lines are serviced more or less "by hand." The shift register in the MFP is used for this purpose. The handshake lines however come from a wide variety of sources. Note this in the following pin description:

1 CHASSIS GROUND (shield)
This is seldom used.

2 TxD
Send data

3 RxD
Receive data

4 RTS
Ready to send comes from I/O port A bit 3 of the sound chip and is always high when the computer is ready to receive a byte. On the Atari, this signal is first placed low after receiving a byte and is kept low until the byte has been processed.

5 CTS
Clear to send of a connected device is read at interrupt input I2 of the MFP. At the present time this signal is handled improperly by the operating system. Therefore it is possible to connect only devices which "rattle" the line after every received byte (like the 520ST with RTS). The signal goes to input I2 of the MFP, but unfortunately is tested only for the signal edge. You will not have any luck connecting a printer because they usually hold the CTS signal high as long as the buffer is not full. There is no signal edge after each byte, which means that only the first byte of a text is transmitted, and then nothing.

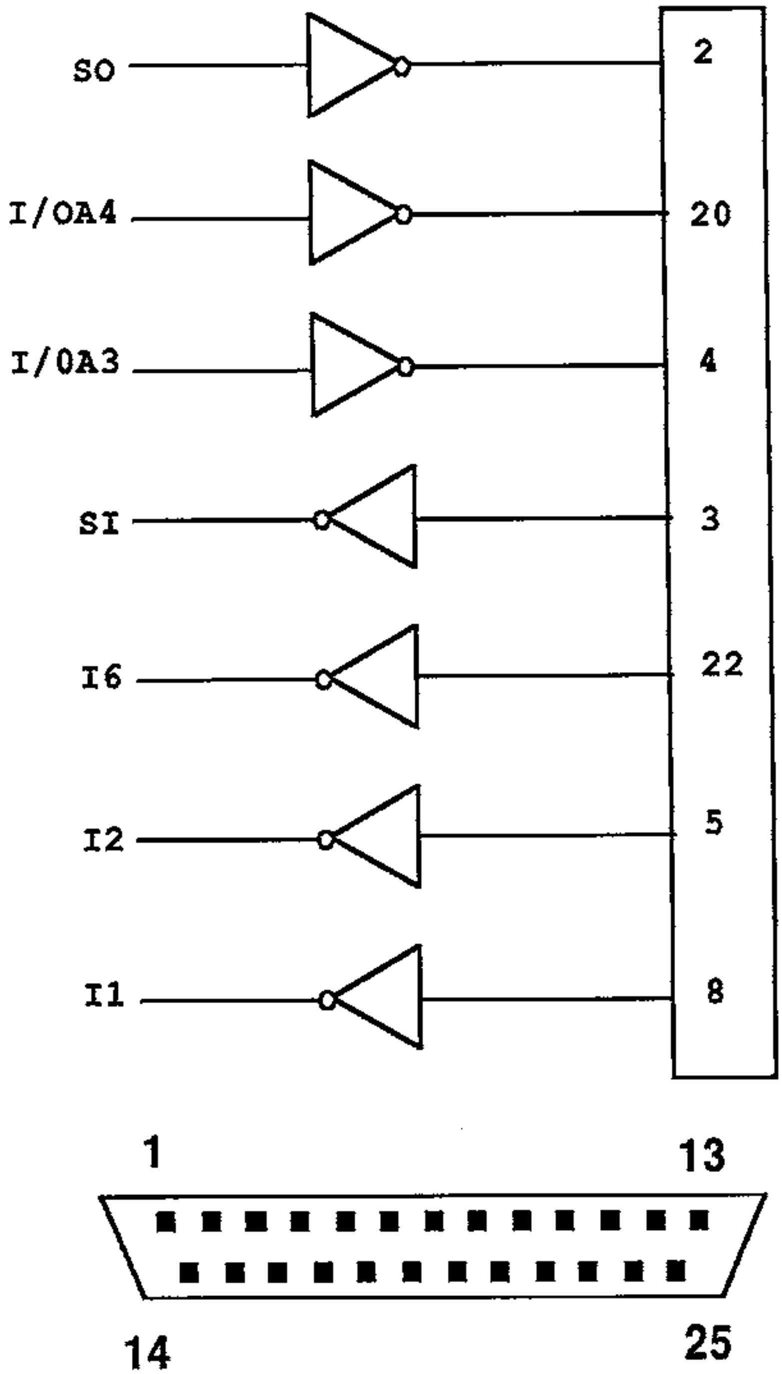
7 GND
Signal ground.

8 DCD
Carrier signal detected. This line, which goes to interrupt input I1 of the MFP, is normally serviced by a modem, which tells the computer that connection has been made with the other party.

20 DTR
Device ready. This line signals to a device that the computer is turned on and the interface will be serviced as required. It comes from I/O port A bit 4 of the sound chip.

22 RI
Ring indicator is a rather important interrupt on I6 of the MFP and is used by a modem to tell the computer that another party wishes connection, that is, someone called.

Figure 2.4-1 RS-232 Connection



2.5 The MIDI Connections

The term MIDI is probably unknown to many of you. It is an abbreviation and stands for Musical Instrument Digital Interface, an interface for musical instruments.

It is certainly clear that we can't simply hook up a flute to this port. So first a little history. Music professionals (more precisely: keyboardists, musicians who play the synthesizer) demanded agreement between the various manufacturers to interface computers to musical instruments. They found it absurd to connect complicated set-ups with masses of wire. The idea was to service several synthesizers from one keyboard.

The tone created was basically analog (and still is, to a degree), so that the manafacturers agreed that a control voltage difference of 1V corresponded to a difference in tone of 1 octave. This way one could play several devices under "remote control," but not service them.

This changed substantially when the change was made to digital tone creation. Here one didn't have to turn a bunch of knobs, there were buttons to press, whereby the basis for digital control was created.

Some manufacturers got together and designed a digital interface, the basic commands of which would be the same throughout, but which would still support the additional features of a given device.

The device is based on the teletype, the current-loop principle, which is not very susceptible to noise, but significantly faster. The transfer rate is 31250 baud (bits per second). The data format is set at one start bit, eight data bits, and one stop bit.

An IC can therefore be used for control which would otherwise be used for RS-232 purposes. You see the connection to the system in figure 2.5-1.

Logically, MIDI is multi-channel system, meaning that 16 devices can be serviced by one master, or a device with 16 voices. These devices are all connected to the same line (bus principle). To identify which device or which voice is intended, each data packet is preceded by the channel number. The device which recognizes this number as its own then executes the desired action.

You may wonder what such an interface is doing in a computer. A computer can provide an entire arsenal of synthesizers with settings or complete melodies (sequencer) because of its high speed and memory capacity. It can also be used to record and store input from a synthesizer keyboard.

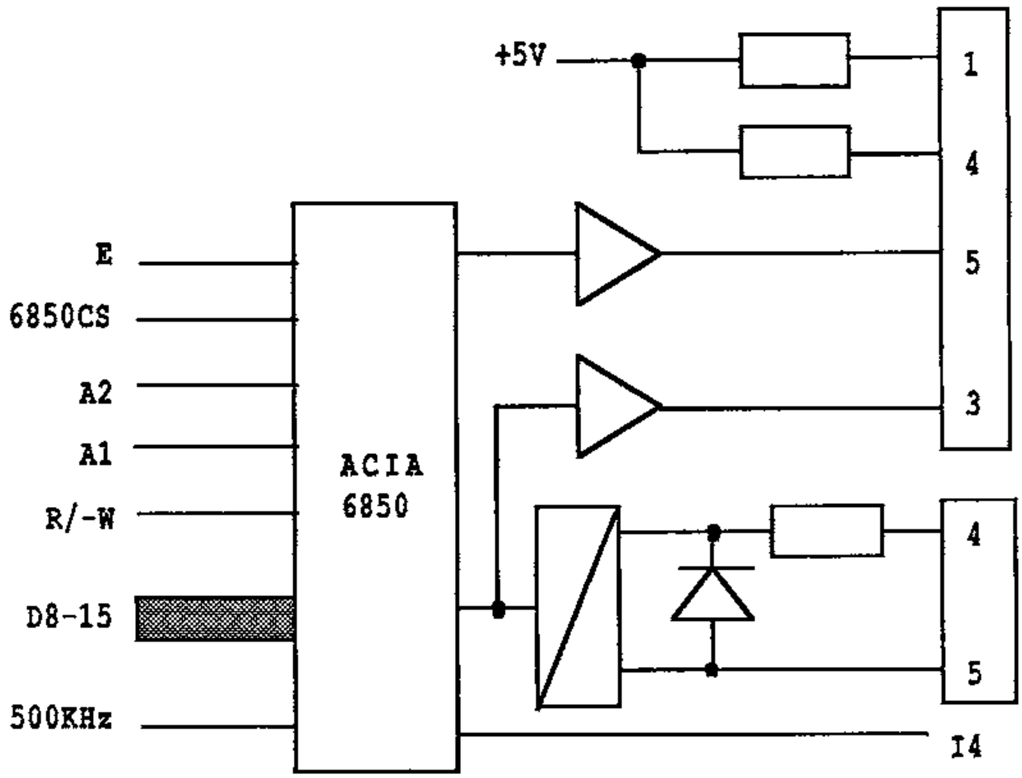
For this purpose the ST has the interfaces MIDI-IN and MIDI-OUT. The interfaces are even supported by the XBIOS so you don't have to worry about their actual operation.

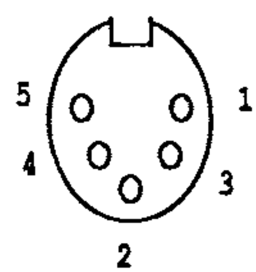
The current loop travels on pins 4 and 5, out through pin 4 (+) of MIDI-OUT and in at 5, when a device is connected.

For MIDI-IN the situation is reversed because the current flows in through pin 4 and back out through pin 5. It goes though something called an optocoupler which electrically isolates the computer from the sender.

The receive data are looped back to MIDI-OUT (pins 1 and 3), which implements the MIDI-THRU function, although not entirely according to the standard.

Figure 2.5-1 MIDI System Connection





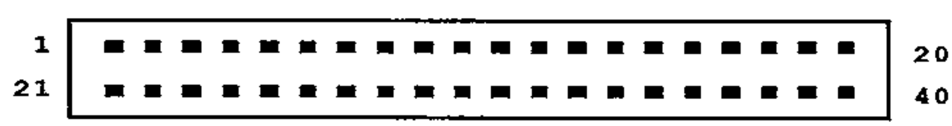
2.6 The Cartridge Slot

The cartridge slot can be used *exclusively* for inserting ROM cartridges. Up to 128K in the address space $FA0000 to $FBFFFF can be addressed. The reason we stressed the exclusivity of the read access is the following. We thought it would be practical to outfit a cartridge with RAM and then load programs into it after the system start which would still remain after a reset. In order to try this we brought the R/-W signal to the outside. The experience taught us, however, that a write access to these addresses creates a bus error. The GLUE takes care of this. As you see, nothing is left to chance in the Atari.

Figure 2.6-1 The Cartridge Slot

+5V	1	21	A8
+5V	2	22	A14
D14	3	23	A7
D15	4	24	A9
D12	5	25	A6
D13	6	26	A10
D10	7	27	A5
D11	8	28	A12
D8	9	29	A11
D9	10	30	A4
D6	11	31	-ROM3
D7	12	32	A3
D4	13	33	-ROM4
D5	14	34	A2
D2	15	35	-UDS
D3	16	36	A1
D0	17	37	-LDS
D1	18	38	GND
A13	19	39	GND
A16	20	40	GND

Position:



2.7 The Floppy Disk Interface

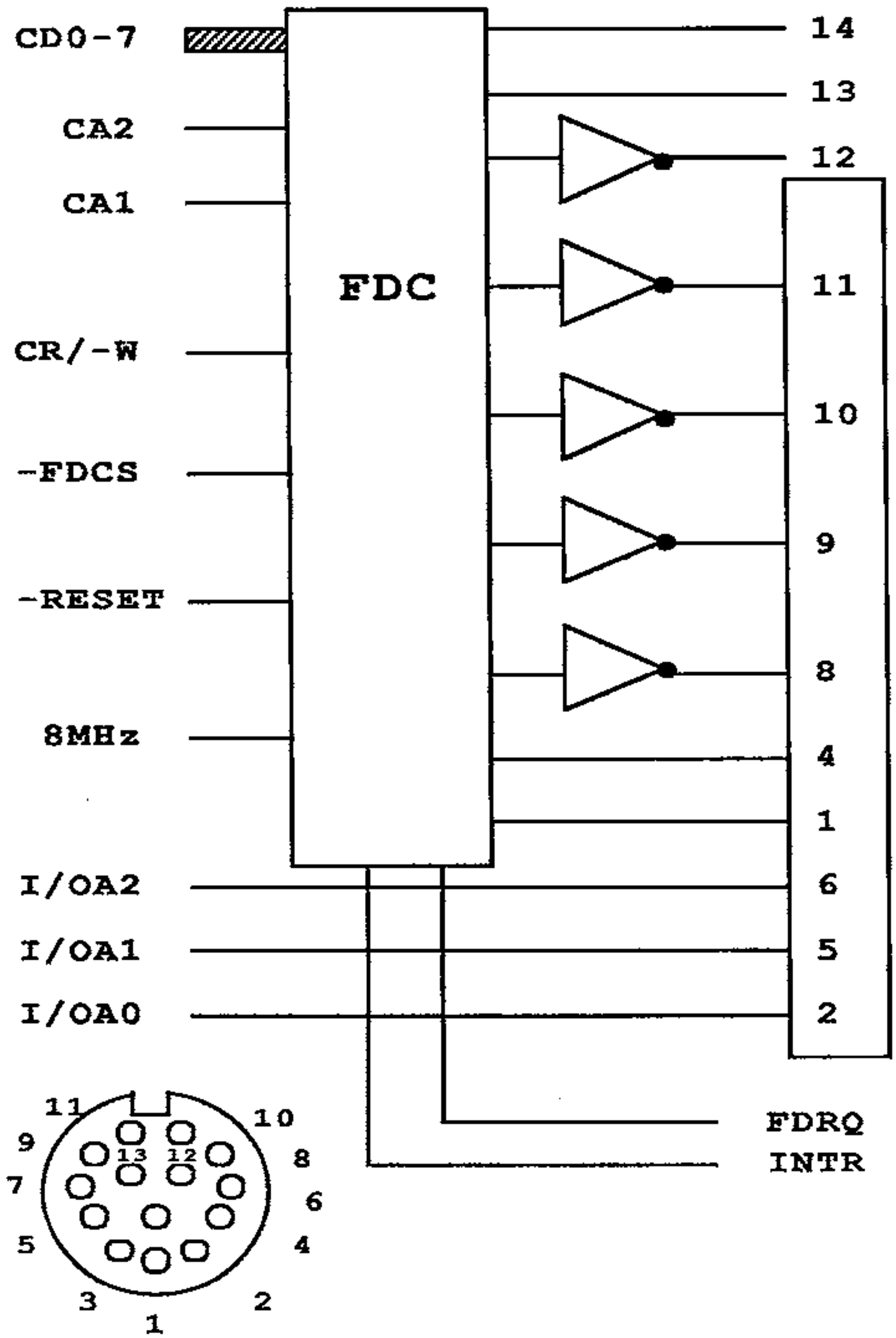
The interface for floppy disk drives is conspicuous because of the unusual connector, a 14-pin DIN connector. All of the signals required for the operation of two disk drives are available on it.

You know most of the signals from the description of the disk controller 1772, since nine of the available connections are directly or via a buffer connected to the controller. Only the drive select 1 and drive select 2 signals and the side 0 select are not derived from the disk controller. These signals come from port A of the sound chip.

Pinout of the disk connector:

```
1 READ DATA            8 MOTOR ON
2 SIDE 0 SELECT        9 DIRECTION IN
3 GND                 10 STEP
4 INDEX               11 WRITE DATA
5 DRIVE 0 SELECT      12 WRITE GATE
6 DRIVE 1 SELECT      13 TRACK 00
7 GND                 14 WRITE PROTECT
```

Figure 2.7-1 Disk Connection



2.8 The DMA Interface

Up to 8 external devices can be connected to this 19-pin subminiature D connector. Such devices include hard disks, networks, and also coprocessors. The communication between the external devices and the ST runs at speeds up to 1 million bytes per second. Unfortunately, no experiments with DMA devices could be performed at the time this was printed. For this reason we cannot make the following statements with one hundred percent certainty.

The RESET line on pin 12 permits devices to be reset by the Atari. If this pin is low, as is the case when the Atari is turned on or when executing a RESET command, external devices are placed in a defined power-up state, without having to individually turn each device off and then on again.

Since most of the external devices will use a controller IC, the signal CS, Chip Select on pin 9, must also be available. The signal A1 is also to be seen in connection with this, because it is then important if the controller has more than just one register. This signal can distinguish between two registers.

The data transfer takes place over the bidirectional data bus on pins 1 to 8. The R/W line on the DMA bus determines the direction of the data transfer. The DMA chip can either write data to the bus (R/W is high), or read data from the bus (R/W is low). Data can be read or written only on the request of the external device. The release of a transfer is signaled by the signal DRQ (pin 19).

The ACK signal on pin 14 appears to be a purely hardware-dependent confirmation of the DRQ signal. The actual significance could not be checked however.

The last signal on the DMA port is the INT input. A low on this connection can generate an interrupt. The hard disk, for example, signals the end of the command through a low. The interrupt uses the same interrupt input on the MFP as the disk controller. This is input I/O 5. This means the at the floppy disk drive and the hard disk cannot transfer data together. The DMA is also not in such a position since it has only one DMA channel available.

The interrupt of this input is disabled in the MFP internally because the floppy as well as the hard disk routines check the port bit in a loop in order to determine the end of the command. This simplifies the implementation of the time out, which is always generated when the floppy or hard disk has not reacted to the command within a certain length of time.

Figure 2.8-1 DMA Port

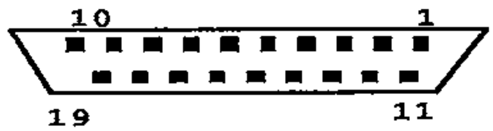
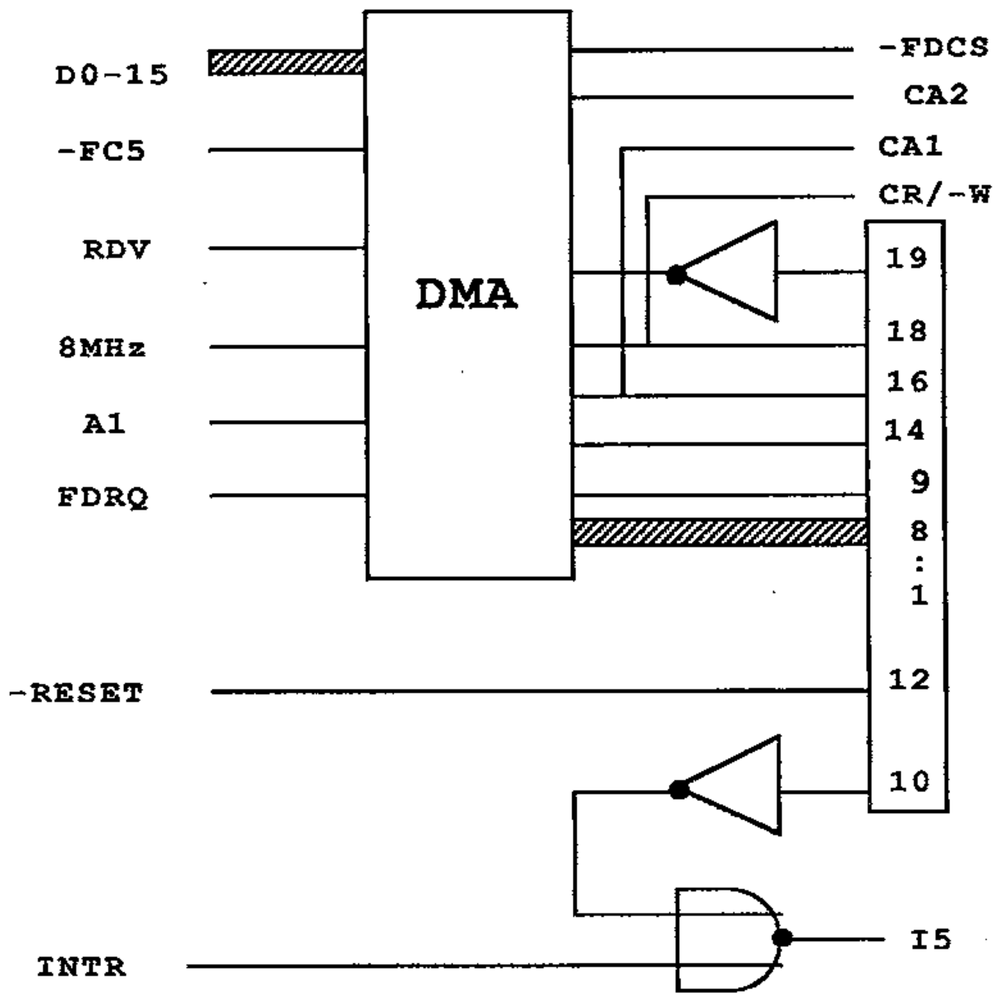


Figure 2.8-2 DMA Connections



Chapter 3

The ST Operating System

The ST Operating System

GEMDOS--what is it? Is it in the ST? The operating system is supposed to be TOS, though. Or CP/M 68K? Or what?

This question can be answered with few words. The operating system in the ST is named TOS--Tramiel Operating System--after the head of Atari. This TOS, in contrast to earlier information has nothing to do with CP/M 68K from Digital Research. At the start of development of the ST, CP/M 68K was implemented on it, but this was later changed because CP/M 68K is not exactly a model of speed and efficiency. A 68000 running at 8MHz and provided with DMA would be slowed considerably by the operating system.

At the beginning of 1985, Digital Research began developing a new operating system for 68000 computers, which would include a user-level interface. This operating system was named GEMDOS. It is exactly this GEMDOS which makes up the hardware-independent part of TOS. Like CP/M, TOS consists of a hardware-dependent and a hardware-independent part. The hardware-dependent part is the BIOS and the XBIOS, while the hardware-independent part is called GEMDOS. A large number of functions are built into GEMDOS, through which the programmer can control the actual input/output functions of the computer. Functions for keyboard input, text output on the screen or printer, and the operation of the various other interfaces are all present. Another quite important group contains the functions for file handling and for logical file and disk management.

3.1 The GEMDOS

When you look at the functions available under GEMDOS, you will eventually come to the conclusion that the whole thing is not really new. All the functions in GEMDOS are very similar to the functions of the MS-DOS operating system. Even the functions numbers used correspond to those of MS-DOS. But not all MS-DOS functions are implemented in GEMDOS. Especially in the area of file management, only the UNIX compatible functions are implemented in GEMDOS. The "old" block-oriented functions which are included in MS-DOS to maintain compatibility with CP/M are missing from GEMDOS. Also, special functions relating to the hardware of MS-DOS computers (8088 processor) are missing.

Another essential difference between MS-DOS and GEMDOS is that for GEMDOS calls as well as for the BIOS and XBIOS, the function number, the number of the desired GEMDOS routine, and the required parameters are placed on the stack and are not passed in the registers. The 68000 is particularly suited to this type of parameters passing. GEMDOS is called with `TRAP #1` and the function is executed according to the contents of the parameter list. After the call, the programmer must put the stack back in order himself, by clearing the parameters from memory.

The basic call of GEMDOS functions differs from the BIOS and XBIOS calls only in the trap number.

In regard to all GEMDOS calls, it must be noted that registers D0 and A0 are changed in all cases. If a value is returned, it is returned in D0, or D0 may contain an error number, and after the call A0 (usually) points to the stack address of the function number. Any parameters required in D0 or A0 must be placed there before GEMDOS is called.

The remainder of this section describes the individual GEMDOS functions.

$00 TERM

Calling GEMDOS with function number 0 ends the running program and returns to the program from which it was started. For applications, programs started from the desktop, program control is returned to the desktop. If the program was called from a different program, execution is passed back to the calling program. This point is important for chaining program segments.

```
CLR.W  -(SP)
TRAP
```

$01 CONIN

CONIN fetches a single character from the keyboard. The routine waits until a character is available. The result, the character read from the keyboard, is returned in the D0 register. The ASCII code of the pressed key is returned in the low byte of the low word, while the low byte of the high word of the register contains the scan code returned from the keyboard. This is important when reading keys which have no ASCII code. This applies to the 10 function keys or the keys of the cursor block, for example. These keys return the ASCII value zero when pressed.

If needed, the scan code can be used to determine if the digits on the keypad or the main keyboard were pressed, since these keys have identical ASCII codes, but return different scan codes.

```
 .
MOVE.W #1,-(SP)    * Function number on the stack
TRAP   #1          * Call GEMDOS
ADDQ.L #2,SP       * Correct stack
 .
```

$02 CONOUT

CONOUT represents the simplest and most primitive character output of GEMDOS. With this function only one character is printed on the screen. The character to be displayed is placed on the stack as the first word. The ASCII value of the character to be printed must be in the low byte of the word and the high byte should be zero.

The character printed by CONOUT is outputted to device number 2, the normal console output. Control characters and escape sequences are interpreted normally.

```
MOVE.W #'A',-(SP)   * Output an A
MOVE.W #2,-(SP)     * CONOUT
TRAP   #1           * Call GEMDOS
ADDQ.L #4,SP        * Correct stack
```

$03 AUXILLIARY INPUT

Under the designation "auxilliary port" is the RS-232 interface of the ST. A character can be read from the interface with the function CAUXIN. The function returns when a character has been completely received. The character is returned in the lower eight bits of register D0.

$04 AUXILLIARY OUTPUT

Similar to the input of characters via the serial interface, a character can be sent with this function. With this function the programmer should clear the upper eight bits of the word and pass the character to be sent in the lower eight bits.

$05 PRINTER OUTPUT

PRINTER OUTPUT is the simplest method of operating a printer connected to the Centronics interface. One character is printed with each call.

An important part of PRINTER OUTPUT is the return value in D0. If the character was sent to the printer, the value -1 ($FFFFFFFF) is returned in D0. If, after 30 seconds, the printer was unable to accept the character (not turned on, OFF LINE, no paper, etc.), GEMDOS returns a time out to the program. D0 then contains a zero.

```
MOVE.W #'A',-(SP)   * Output an A
MOVE.W #5,-(SP)     * Function number
TRAP   #1           * Call GEMDOS, output character
ADDQ.L #4,SP        * Correct stack
TST.W  D0           * Affect flags
BEQ    printererror
```

$06 RAWCONIO

RAWCONIO is a somewhat unusual mixture of keyboard input and screen output and receives a parameter on the stack.

With a function value of $FF the keyboard is tested. If a character is present, the ASCII code and scan code are passed in D0 as described for CONIN. But if no key value is present, the value zero is passed as both the ASCII code and the scan code in D0. The call to RAWCONIO with parameter $FF is comparable to the BASIC INKEY$ function.

If a value other than $FF is passed to the function, the value is interpreted as a character to be printed and it is output at the current cursor position. This output also interprets the control characters and escape sequences properly.

```
START:

MOVE.W #$FF,-(SP)  * Function value test keyboard
MOVE.W #6,-(SP)    * Function number
TRAP   #1          * Call GEMDOS, test keyboard
ADDQ.L #4,SP       * Correct stack
TST.W  D0          * Character arrived?
BEQ    START       * Not yet
CMP.B  #3,D0       * ^C selected as the end marker
BEQ    END
MOVE   D0,-(SP)    * Character for output on the stack
MOVE   #6,-(SP)    * Function number
TRAP   #1          * Call GEMDOS, test keyboard
ADDQ.L #4,SP       * Correct stack
BRA    START       * Get new character
```

$07 DIRECT CONIN WITHOUT ECHO

The function $07 differs from $01 only in that the character received from the keyboard is not displayed on the screen. It waits for a key just as does CONIN.

$08 CONIN WITHOUT ECHO

Function $08 does not differ from function $07. Both function calls have exactly the same effect. The reason for this seemingly nonsensical behavior lies in the mentioned compatibility to MS-DOS. Under MS-DOS the two functions are different in that with $08, certain keys not present on the ATARI are evaluated correctly, while this evaluation does not take place with function $07.

$09 PRINT LINE

You have already become familiar with functions to output individual characters on the screen with CONOUT and RAWCONIO. PRINT LINE offers you an easy way to output text. An entire string can be printed at the current cursor position with this function. To do this, the address of the string is placed on the stack as a parameter. The string itself is concluded with a zero byte. Escape sequences and control characters can also be evaluated with this function.

After the call, D0 contains the number of characters which were printed. The length of the string is not limited.

```
MOVE.L  #text,-(SP)   * Address of the string on the stack
MOVE    #$09,-(SP)    * Function number PRT LINE
TRAP    #1            * Call GEMDOS
ADDQ.L  #6,SP         * "Clean up" the stack
.
.
text    .DC.B 'This is the string to be printed',$0D,$0A,0
```

$0A READLINE

READLINE is a very easy-to-use function for reading characters from the keyboard. In contrast to the "simpler" character-oriented input functions, an entire input line can be fetched from the keyboard with READLINE. The characters entered are displayed on the screen at the same time.

The address of an input buffer is passed to the function as the parameter. The value of the first byte of the input buffer determines the maximum length of the input line and must be initialized before the call. At the end of the routine, the second byte of the buffer contains the number of characters entered. The characters themselves start with the third byte.

The routine used by READLINE for keyboard input is quite different from the character-oriented console inputs. Escape sequences are not interpreted during the output. Only control characters like control-H (backspace) and control-I (TAB) are recognized and handled appropriately. The following control characters are possible:

```
^C   Ends input AND program (!)
^H   Backspace one position
^I   TAB
^J   Linefeed, end input
^M   CR, end input
^R   Entered line is printed in new line
^U   Don't count line, start new line
^X   Clear line, cursor at start of line
```

A function like ^H, deleting a character entered, is useful, but for large programs you should write your own input routine because ^C is very "dangerous." Unlike CP/M, the program will be ended even if the cursor is not at the very start of the input line.

If more characters are entered than were indicated in the first byte of the buffer at the initialization, the input is automatically terminated. If the input is terminated by ENTER, ^J, or ^M, the terminating character will not be put in the buffer.

After the input, D0 contains the number of characters entered, excluding ENTER, which can be found at buffer+1.

$0B CONSTAT

All key presses are first stored in a buffer in the operating system. This buffer is 64 bytes in length. The key values stored there are taken from the buffer when a call to a GEMDOS output routine is made.

CONSTAT can be used to check if characters are stored in the keyboard buffer. After the call, D0 contains the value zero or $FFFF. A zero in D0 indicates that no characters are available.

$0E SETDRV

The current drive can be determined with the function SETDRV. A 16-bit parameter containing the drive specification is pased to the routine. Drive A is addressed with the number 0 and drive B with the number 1.

After the call, D0 contains the number of the drive active before the call.

$10 CONOUT STAT

CONOUT STAT returns the status of the console in D0. If the value $FFFF is returned, a character can be displayed on the screen. If the returned value is zero, however, no character output is possible on the screen at that time. Incidently, all attempts to create a not-ready status at the console failed. The only imaginable possibility for the not-ready status would be if the output of the individual bit pattern of a character was interrupted and the interrupt routine itself tried to output a character. This case could not, however, be created.

$11 PRTOUT STAT

This function returns the status, the condition of the Centronics interface. If no printer is connected (or turned off, or off line), D0 contains the value zero after the call to indicate "printer not available." If, however, the printer is ready to receive, D0 contains the value $FFFF.

$12 AUXIN STAT

By calling AUXIN STAT you can determine if a character is available from the receiver of the serial interface ($FFFF) or not ($0000). As with all other functions, the value is returned in D0.

$13 AUXOUT STAT

AUXOUT STAT gives information about the state of the serial bus. A value of $FFFF indicates that the serial interface can send a character, while zero indicates that no characters can be sent at this time.

$19 CURRENT DISK

For many applications it is necessary to know which drive is currently active. The current drive can be determined by the function $19. After the call, D0 contains the number of the drive. The significance of the drive numbers is the same as for $0E, SET DRIVE (0=A, 1=B).

$1A SET DISK TRANSFER ADDRESS

The disk transfer address is the address of a 44-byte buffer required for various disk operations (especially directory operations). Along with the GEMDOS functions SEARCH FIRST and SEARCH NEXT are examples for using the DTA.

```
MOVE.L #DTADDRESS,-(SP) * Address of the 44-byte DTA buffer
MOVE.W #$1A,-(SP)       * Function number SET DTA
TRAP   #1               * Set DTA
ADDQ.L #6,SP            * Clean up the stack
```

$20 SUPER

This function is especially interesting for programmers who want to access the peripheral components or system variables available only in the supervisor mode while running a program in the user mode. After calling this function from the user mode, the 68000 is placed in the supervisor mode. In contrast to the XBIOS routine for enabling the supervisor mode, additional GEMDOS, BIOS, and XBIOS calls can be made after a successful SUPER call.

First we will look at the case in which the SUPER function is called from a program in the user mode with a value of zero on the stack. In this case the program finds itself in the supervisor mode after the call. The supervisor stack pointer is set to the value of the user stack pointer and the original value of the supervisor stack pointer is returned in D0. This value should be stored by the program in order to get back into the user mode later.

If a value other than zero is passed to the SUPER function the first time it is called, this value is interpreted as the desired value of the supervisor stack pointer. In this case as well, D0 contains the original value of the supervisor stack pointer, which the program should save.

Before a program ends, the user mode should be reenabled. This change of operating modes requires the address acquired the first time the routine was called in order to set the supervisor stack pointer back to its original value.

The SUPER function differs from all other GEMDOS functions in one very important respect. Under certain circumstances, this call can also change the contents of A1 and D1. If you store important values in these registers, you must save the values somewhere before calling the SUPER function.

```
                          * The 6800 is in the user mode
CLR.L   -(SP)             * User stack becomes supervisor stack
MOVE.W #$20,-(SP)         * Call SUPER
TRAP    #1                * The supervisor mode is active
                          * after the TRAP
ADD.L   $6,SP             * D0 = old supervisor stack
MOVE.L D0,_SAVE_SSP       * Save value
.
.
.
.  Here processing can be done in the supervisor mode
.
.
.
MOVE.L _SAVE_SSP,-(SP) * Old supervisor stack pointer
MOVE.W #$20,-(SP)      * Call SUPER
TRAP    #1             * Now we are back in the user mode
ADD.L   #6,SP
.
.
.
```

$2A GET DATE

You have no doubt experimented with the status field at one time or another. In addition to various other functions, the status field contains a clock with clock time and date. It can be useful for some applications to have the data available. The date can be easily determined by the GET DATE function. This function call requires no parameters and makes the date available in the low word of register D0. It is rather thoroughly encoded, though, so that the result in D0 must be prepared in order to get the correct date.

The day in the range 1 to 31 is coded in the lower five bits. Bits 5 to 8 contain the month in the value range 1 to 12, and the year is contained in bits 9 to 15. The value range in these "year bits" goes from 0 to 119. The value of these bits must be added to the value 1980 in order to get the actual year. The date 12/12/1992, for example, would result in $198C in D0. This can be represented in binary as %0001100.1100.01100. The lengths of the three fields are marked with periods.

$2B SET DATE

The clock time and date can also be set from application programs. This is particularly interesting for programs which use the date and/or clock time. An example of this would be invoice processing in which the current date is inserted in the invoice. Such programs can then ask the user to enter the date. This avoids the problems that occur if the user forgets to set the date and clock time on the status field beforehand.

The date must be passed to the function SET DATE in the same format as it is received from GET DATE, bits 0-4 = day, bits 5-8 = month, bits 9-15 = year-1980.

```
MOVE.W #%101101011001,-(SP)  * Set date to 10/25/1985
MOVE.W #$2B,-(SP)            * Function number of SET DATE
TRAP   #1                    * Set date
ADDQ.L #6,SP                 * Repair stack
```

$2C GET TIME

The function GET TIME returns the current (read: set) time from the GEMDOS clock. Similar to the date, the clock time is coded in a special pattern in individual bits of the register D0 after the call. The seconds are represented in bits 0-4. But since only values from 0 to 31 can be represented in 5 bits, the internal clock runs in two second increments. In order to get the correct seconds-result the contents of these five bits must be multiplied by two. The number of minutes is contained in bits 5 to 10, while the remaining bits 11-15 give information about the hour (in 24-hour format).

$2D SET TIME

It is also possible to set the clock time under GEMDOS. The function SET TIME expects a 16-bit value (word) on the stack, in which the time is coded in the same form as that in which GET TIME returns the clock time.

```
MOVE.W #%1000101010111101,-(SP) * Clock time 17:21:58
MOVE.W #$2D,-(SP)               * Function # of GET TIME
TRAP   #1                       * Set date
ADDQ.L #6,SP                    * Repair stack
```

$2F GET DTA

The function $2F is the counterpart of function $1A, SET DTA. A call to this function returns the address of the current disk transfer buffer in D0. An exact explanation of this buffer is found together with the functions SEARCH FIRST and SEARCH NEXT.

$30 GET VERSION NUMBER

Calling this function returns in D0 the version number of GEMDOS. In the version of GEMDOS currently in release, this question is always answered with $0D00, corresponding to version 13.00. Official Atari documentation claims that a value of $0100 should be returned for this version, though perhaps the value should indicate that the present GEMDOS version is the $D = diskette version.

$31 KEEP PROCESS

This function is comparable to the GEMDOS function TERM $00. The program is also ended after a call to this function. $31 does differ from $00 in several important points.

After processing `TRAP #1`, like TERM, control is passed back to the program which started the program just ended. In contrast to TERM, a termination condition can be communicated to the caller. While TERM returns the termination value zero (no error), zero or one may be selected as the termination value for $31. A value other than zero means that an error occurred during program processing.

Another essential point lies in the memory management of GEMDOS. When a program is started, the entire available memory space is made available to it. If the program is ended with TERM, the memory space is released and made available to GEMDOS. The entire area of memory released is also cleared, filled with zeros. The program actually physically disappears from the memory. With function $31, however, an area of memory can be protected at the start address of the program. This memory area is not released when the program is ended and it is also not cleared. The program could be restarted without having to load it in again.

KEPP PROCESS is called with two parameters. The example programs shows the parameter passing.

```
MOVE.W #0,-(SP)         * Error code no error, else 1
MOVE.L #$1000,-(SP)     * Protect $1000 bytes at program start
MOVE.W #$31,-(SP)       * Function number, end program
TRAP   #1               *                                now
```

$36 GET DISK FREE SPACE

It can be very important for disk-oriented programs to determine the amount of free space on the diskette. Then you have the ability to request that the user change disks at the appropriate time. "Disk full" messages or even data loss can then be avoided.

Function $36 returns exactly this information. The number of the desired disk drive and the address of a 16-byte buffer must be passed to the function. If the value 0 is passed as the drive number, the information is fetched from the active drive, a 1 takes the information from drive A, and a 2 from drive B.

The information passed in the buffer is divided into four long words. The first long word contains the number of free allocation units. Each file, even if it is only eight bytes long, requires at least one such allocation unit.

The second long word gives information about the number of allocation units present on the disk, regardless of whether they are already used or are still free. For the "small," single-sided diskettes this value is $15C or 351, while the double-sided disks have $2C7 = 711 allocation units. The third long word contains the size of a disk sector in bytes. For the Atari this is always 512 bytes ($200 bytes).

In the last word is the number physical sectors belonging to an allocation unit. This is normally 2. Two sectors form one allocation unit.

The number of available bytes of disk space can easily be calculated from this information.

```
MOVE.W #0,-(SP)         * Information from the active drive
MOVE.L #BUFFER,-(SP)    * Address of the 16-byte buffer
MOVE   #$36,-(SP)       * Function number
TRAP   #1
ADDQ.L #8,SP            * Clean up stack
.
.
.
.bss
BUFFER:
freal: .ds.l   1        * Free allocation units
total: .ds.l   1        * Total allocation units
bps:   .ds.l   1        * Bytes/physical sector
pspal: .ds.l   1        * Phys. sectors/alloc. unit
```

$39 MKDIR

A subdirectory can be created from the desktop with the menu option "NEW FOLDER". Such a subdirectory can also be created from an application program with a call to $39.

In order to create a new folder, the function $39 is given the address of the folder name, also called the pathname. This name may consist of 8 characters and a three-character extension. The same limitations apply to pathnames as do to filenames. The pathname must be terminated with a zero byte when calling MKDIR.

After the call, D0 indicates whether the operation was performed successfully. If D0 contains a zero, the call was successful. Errors are indicated through a negative number in D0. At the end of this chapter you will find an overview of all of the error messages occurring on connection with GEMDOS functions.

```
MOVE.L #pathname        * Address of the pathname
MOVE   #$39,-(SP)       * Function number
TRAP   #1
ADDQ.L #6,SP            * Repair stack
TST.W  D0               * Error occurred?
BNE    error            * Apparently
.
.
.
pathname:
       .dc.b  'private.dat',0
```

$3A RMDIR

A subdirectory created with MKDIR can be removed again with $3A. As before, the pathname, terminated with a zero, is passed to RMDIR. The error messages also correspond to those for MKDIR, with zero for success or a negative value for errors. An important error message should be mentioned at this point. It is the message -36 ($FFFFFFCA). This is the error message you get when the subdirectory you are trying to remove contains files.

Only empty subdirectories can be removed with RMDIR. In the event of the described error message, one must first erase all of the files in the directory with UNLINK ($41) and then call RMDIR again.

$3B CHDIR

The system of subdirectories available under GEMDOS is exactly the same form available under UNIX. This system is now running on systems with diskette drives, but its advantages become noticeable first when a large mass storage device such as a hard disk with several megabytes of storage capacity is connected to the system. After a while, most of the time would probably be spent looking for files in the directory.

To better organize the data, subdirectories can be placed within subdirectories. It can therefore become necessary to specify several subdirectories until one has the directory in which the desired file is stored. An example might be:

```
/hugos.dat/cfiles.s/csorts.s/cqsort.s
```

Translated this would mean: load the file `cqsort.s` from the subdirectory `csorts.s`. This subdirectory `csorts.s` is found in the subdirectory `cfiles.s`, which in turn is a subdirectory of `hugos.dat`. If the whole expression is given as a filename, the desired file will actually be loaded (assuming that the file and all of the subdirectories are present). If you want to access another file via the same path (do you understand the term pathname?), the entire path must be entered again. But you can also make the subdirectory specified in the path into the current directory, by calling CHDIR with the specification of the desired path. After this, all of the files in the selected subdirectory can be accessed just by the filenames. The path is set by the function.

```
MOVE.L #path,-(SP)      * Address of the path
MOVE.W #$3B,-(SP)       * Function number
TRAP   #1
ADDQ.L #6,SP            * Repair stack
TST.W  D0               * Error occurred?
BNE    error            * Apparently
.
.
.
path:
       .dc.b  '/hugos.dat/private.dat/',0
```

$3C CREATE

In all operating systems, the files are accessed through the sequence of opening the file, accessing the data, (reading or writing), and then closing the file. This "trinity" also exists under GEMDOS, although there is an exception. Under CP/M, for example, a non-existing file can also be opened. When a file which does not exist is opened, it is created. Under GEMDOS, the file must first be created. The call $3C, CREATE, is used for this purpose. Two parameters are passed to this GEMDOS function: the address of the desired filename, and an attribute word.

If a zero is passed as the attribute word, a normal file is created, a file which can be written to as well as read from. If the value 1 is passed as the attribute, the file will only be able to be read after it is closed. This is a type of software write-protect (which naturally cannot prevent the file from disappearing if the disk is formatted).

Other possible attributes are $02, $04, and $08. Attribute $02 creates a "hidden" file and attribute $02 a "hidden" system file. Attribute $08 creates a file with a "volume label." The volume label is the (optional) name which a disk can be given when it is formatted. The disk name is then created from the maximum of 11 characters in the name and the extension. Files with one of the last three attributes are excluded from the normal directory search. On the ST, however, they do appear in the directory.

When the function CREATE is ended, a file descriptor, also called a file handle, is returned in D0. All additional accesses to the file take place over this file handle (a numerical value bewteen 6 and 45). The handle must be given when reading, writing, or closing files. A total of $28 = 40 files can be opened at the same time.

If CREATE is called and a file with this name already exists, it is cut off at zero length. This is equivalent to the sequence delete the old file and create a new file with the same name, but it goes much faster.

If after calling CREATE you get a handle number back in D0, the file need not be opened again with $3D OPEN.

```
MOVE.W #$0,-(SP)          * File should have R/W status
MOVE.L #filename,-(SP)    * Address of the filename on stack
MOVE.W #$3C,-(SP)         * Function number
TRAP   #1                 * Call GEMDOS
ADDQ.L #8,SP              * Clean up stack
TST    D0                 * Error occurred?
BMI    error              * It appears so
MOVE   D0,handle          * Save file handle
.
.
.
filename:                 * Don't forget zero byte
       .dc.b  'myfile.dat',0
.
handle:
       .ds.w  1
```

$3D OPEN

You can create only new files with CREATE, or shorten existing files to length zero. But you must be able to process existing files further as well. To do this, such files must be opened with the OPEN function.

The first parameter of the OPEN function is the mode word. With a zero in the mode word, the opened file can only be read, with one it can only be written. With a value of 2, the file can be read as well as written. The filename, terminated with zero byte in the usual manner, is passed as the second parameter.

The OPEN function returns the handle number in D0 as the result if the file is present and the desired access mode is possible. Otherwise D0 contains an error number. See the end of the chapter for a list of the error numbers.

```
MOVE.W #$2,-(SP)       * File read and write
MOVE.L #filename       * Address of the filename on the stack
MOVE.W #$3D,-(SP)      * Function number
TRAP   #1              * Call GEMDOS
ADDQ.L #8,SP           * Clean up the stack
TST.W  D0              * Error occurred?
BMI    error           * Apparently
MOVE   D0,handle       * Save file handle for later accesses
.
.
.
filename:              * Don't forget zero byte!
       .dc.b   'myfile.dat',0
.
handle:
       .ds.w   1
```

$3E CLOSE

Every opened file should be closed when it will no longer be accessed within a program, or when the program itself is ended. Especially when writing, files must absolutely be closed before the program ends or data may be lost.

Files are closed by a call to CLOSE, to which the handle number is passed as a parameter. The return value will be zero if the file was closed correctly.

```
MOVE.W handle,-(SP)    * Handle number
MOVE.W #$3E,-(SP)      * Function number
TRAP   #1              * Call GEMDOS
ADDQ.L #4,SP           * Error occurred?
BMI    error           * Apparently
.
.
handle:
       .ds.w   1
```

$3F READ

Opening and closing files is naturally only half of the matter. Data must be stored and the retrieved later. Reading such files can be done in a very elegant manner with the function READ. READ expects three parameters: first the address of a buffer in which the data is to be read, then the number of bytes to be read from the file, and finally the handle number of the file. This number you have (hopefully) saved from the previous OPEN.

We mentioned the possible handle numbers in conjunction with CREATE. What we didn't mention, however, is why the first handle number is six. The cause of this is that things called devices, like the keyboard, the screen, the printer, and the serial interface, are also accessed via handle numbers for READ and WRITE operations. The device assignments are:

```
0 = Console input
1 = Console output
2 = RS-232
3 = Printer
```

Numbers 4 and 5 also function as console input and output. When using these handle numbers, the system sometimes returns "invalid handle number". The correct programming and the exact purpose of these two numbers is not known.

As return value, D0 contains either an error number (hopefully not) or the number of bytes read without error. No message regarding the end of the file is returned. This is not necessary, however, since the size of the file is contained in the directory entry (see SEARCH FIRST/SEARCH NEXT). If the file is read past the logical end, no message is given. The reading will be interrupted at the end of the last occupied allocation unit of the file. The number of bytes read in this case is always divisible by $400.

```
MOVE.L #buffer,-(SP)    * Address of the data buffer
MOVE.L #$100,-(SP)      * Read 256 bytes
MOVE.W handle,-(SP)     * Space for the handle number
MOVE.W #$3F,-(SP)       * Function number
TRAP   #1
ADD.L  #12,SP
TST.L  D0               * Did an error occur
BMI    error            * Apparently
.
.
handle:
       .ds.w  1         * Space for the handle number
.
buffer:
       .ds.b  $100      * Suffices in our example
```

$40 WRITE

Writing to a file is just as simple as reading from it. The parameters required are also the same as those required for reading. The file descriptors from OPEN and CREATE calls can be used as the handle, but the device numbers listed for READ can also be used. The output of a program can be sent to the screen, the printer, or in a file just by changing the handle number.

$41 UNLINK

Files which are no longer needed can be deleted with UNLINK. To do this, the address of the filename or, if necessary, the complete pathname must be passed to the function. If the D0 register contains a zero after the call, the file has been deleted. Otherwise D0 will contain an error number.

```
MOVE.L pathname,-(SP)  * Address of the data buffer
MOVE.W #$41,-(SP)      * Function number
TRAP   #1
ADD.L  #6,SP
TST.W  D0              * Did an error occur?
BMI    error           * Apparently
.
.
.
pathname:
       .dc.b   '/rolli/private/pacman.prg',0
```

$42 LSEEK

Up to now we have become acquainted only with sequential data accesses. We can read through any file from the beginning until we come the desired information. An internal file pointer which points to the next byte to be read goes along with each read. We can only move this pointer continuously in the direction of the end of file by reading. A few bytes forward or backward, setting the pointer as desired, is not something we can do. This is required for many applications, however.

LSEEK offers an extraordinarily easy-to-use method of setting the file pointer to any desired byte within the file and to read or write at this point.This UNIX-compatible option of GEMDOS is much easier to use that the methods available under CP/M for relative file management, for instance.

A total of three parameters are passed to the LSEEK function. The first parameter specifies the number of bytes by which the pointer should be moved. An additional parameter is the handle number of the file. The last parameter is a mode word which describes how the file is to be moved. A zero as the mode moves the pointer to the start of the file and from there the given number of bytes toward the end of the file. Only positive values may be used as the number. With a mode value of 1, the pointer is moved the desired positive or negative amount from the current position, and a 2 as the mode value means the distance specified is from the end of the file. Only negative values are allowed in this mode.

After the call, D0 contains the absolute position of the pointer from the start of the file, or an error message.

```
MOVE.W #1,-(SP)       * Relative from the current file ptr
MOVE.W handle,-(SP)   * File handle
MOVE.L #$-20,-(SP)    * 32 bytes back
MOVE.W #$42,-(SP)     * Function number
TRAP   #1
ADD.L  #10,SP
TST.W  D0             * Did an error occur?
BMI    error          * Apparently
.
.
handle:
       .ds.w  1       * Space for the handle number
```

$43 CHANGE MODE (CHMOD)

With the CREATE function a file can be assigned a specific attribute. This attribute can be determined and subsequently changed only with the function CHANGE MODE. The name of the file must be known because the address of the name or the complete pathname must be passed to CHMOD. Another parameter word specifies whether the file attribute is to be read or set. Moreover, a word must be passed which contains the new attribute. When reading the attribute of a file this word is not necessary, but should be passed to the routine as a dummy value. We indicated the possible file attributes in our discussion of the function CREATE, but here they are again in a table:

```
$00 = normal file status, read/write possible
$01 = File is READ ONLY
$02 = "hidden" file
$04 = system file
$08 = file is a volume label, contains disk name
$10 = file is a subdirectory
$20 = file is written and closed correctly
```

Attributes $10 and $20 cannot be specified when the file is created. Attribute $20 is granted by the operating system, while the GEMDOS function

MKDIR is used to create a subdirectory. The MKDIR function creates not only the directory entry with the appropriate attribute, it also arranges the subdirectory on the disk physically.

After the call, D0 will contain the current attribute value, which will be the new value after setting the attribute, or, as with all other function calls, a negative error number.

First example:

```
MOVE.W #1,-(SP)         * Give file READ ONLY attribute
MOVE.W #1,-(SP)         * Set attribute
MOVE.L #pathname,-(SP)  * We also need the pathname
MOVE.W #$43,-(SP)       * Function number
TRAP   #1
ADD.L  #10,SP
TST.W  D0               * Did an error occur?
BMI    error            * Apparently
.
.
.
pathname:               * Don't forget zero byte at end!
       .dc.b  'killme.not',0
```

Second example:

```
MOVE.W #0,-(SP)         * Dummy value, not actually required
MOVE.W #0,-(SP)         * Read attribute
MOVE.L #pathname,-(SP)  * and the pathname
MOVE.W #$43,-(SP)       * Function number
TRAP   #1
ADD.L  #10,SP
TST.W  D0               * Did an error occur?
BMI    error            * Apparently
.
.
.
pathname:               * Don't forget zero byte at the end!
       .dc.b  'what-am.i',0
```

$45 DUP

As mentioned in connection with the functions READ and WRITE, the devices console, line printer, and RS-232 are also available to the programmer. This permits input and output to be redirected to these devices. One of the devices can be assigned a file handle number with the DUP function. After the call the next free handle number is returned.

$46 FORCE

The FORCE function allows further manipulation of the handle numbers. If in a program the console input and output are used exclusively via the READ and WRITE functions with the handle numbers 0 and 1, the input or output can be redirected with a call to this function. Screen outputs are written to a file, inputs are not taken from the keyboard, but from a previously-opened file.

$47 GETDIR

A given subdirectory can be made into the current directory with the function $37. All file accesses with a pathname then run only in the set subdirectory. Under certain presumptions it can be possible to determine the pathname to the current subdirectory. This is accomplished by the function call GETDIR, $47. This call requires the designation of the desired disk drive (0=current drive, 1=drive A, 2=drive B, etc.) and a pointer to a 64-byte buffer. The complete pathname to the current directory will be placed in this buffer. The pathname will be terminated by a zero byte. If the function is called when the main directory is active, no pathname will be returned. In this case, the first byte in the buffer will contain zero. After the call, D0 must contain the value zero. If the value is negative, an error occurred, for example if an incorrect drive number was passed.

```
MOVE.W #0,-(SP)       * Get pathname of the current drive
MOVE.L #buffer,-(SP)  * Address of the 64-byte buffer
MOVE.W #$47,-(SP)     * Function number
TRAP   #1
ADDQ.L #8,SP
TST.L  D0             * Error?
BNE    error          * D0<>0 if error
.
.
.
buffer:
       .ds.b   64     * Buffer for pathname
```

$48 MALLOC

The MALLOC function and the two that follow it, MFREE and SETBLOCK, are concerned with the memory organization of GEMDOS. As already mentioned in conjunction with function $31, KEEP PROCESS, a program is assigned all of the entire memory space available after it is loaded. This is uncritical in many cases, because only a single program is running. But there are applications under GEMDOS in which such organization is not sensible. An accessory such as the VT-52 emulator may be called from within a program, for example. Such a program also requires memory space, but the memory might not be available. No further program modules can be loaded if the entire memory is occupied. For this reason, each program should reserve only the space which it actually needs for the program and data. The memory not required can be given back to GEMDOS.

If the program should need some of the memory it gave back, it can request memory from GEMDOS via the function MALLOC (memory allocate). The number of bytes required is passed to MALLOC. After the call, D0 contains the starting address of the memory area reserved by the call or an error message if an attempt is made to reserve more memory than is actually available.

If -1L is passed as the number of bytes to be allocated, the number of bytes available is returned in D0.

First example:

```
MOVE.L #-1,-(SP)      * Determine number of free bytes
MOVE.W #$48,-(SP)     * Function number
TRAP   #1
ADDQ.L #6,SP          * Number of free bytes in D0
 .
 .
```

Second example:

```
MOVE.L #$1000,-(SP)  * Get hex 1000 bytes for the program
MOVE.W #$48,-(SP)    * Function number
TRAP   #1
ADDQ.L #6,SP
TST.W  D0            * Error or address of memory?
BMI    error         * Negative long word = error!
MOVE.L D0,mstart     * Else start addr of the reserved area
 .
 .
mstart:
       .ds.l   1
```

$49 MFREE

An area of memory reserved with MALLOC can be released at any time with MFREE. To do this, GEMDOS is passed the address of the memory to be released. The value will usually be the address returned by MALLOC.

If a value of zero is returned in D0, the memory was released by GEMDOS without error. A negative values indicates errors.

```
MOVE.L mstart,-(SP)  * Addr of a previously allocated area
MOVE.W #$49,-(SP)     * Function number
TRAP   #1
ADDQ.L #6,SP          * Number of free bytes in D0
TST.L  D0             * Error?
BNE    error          * D0<>0 is error!
.
.
mstart:
       .ds.l  1
```

$4A SETBLOCK

In contrast to the MALLOC function, a specific area of memory can be reserved with the function SETBLOCK. The memory beginning at the specified address is returned to GEMDOS, even if it was reserved before. This function can be used to reserve the actual memory requirements of a program and release the remaining memory.

The parameters the function requires are the starting address and the length of the area to be reserved. The area specified with these parameters is then reserved by GEMDOS and is not released again until the end of the program or after calling the MFREE function.

Usually programs will begin with the following command sequence or something similar. After the call, D0 must contain zero, otherwise an error occurred.

```
MOVE.L A7,A5          * Save stack pointer in A5
MOVE.L #USTCK,A7      * Set up stack for the program
MOVE.L 4(A5),A5       * A5 now points to the base-page start
                      * exactly $100 bytes below the prg start
MOVE.L $C(A5),D0      * $C(A5) contains length of the prg area
ADD.L  $14(A5),D0     * $14(A5) containg the length of the
                      * initialized data area
ADD.L  $1C(A5),D0     * $1C(A5) contains length of the
                      * uninitialized data area
ADD.L  #$100,D0       * Reserve $100 bytes base page
MOVE.L D0,-(SP)       * D0 contains the length of the area
                      * to be reserved
MOVE.L A5,-(SP)       * A5 contains the start of the area
                      * to be reserved
MOVE.W #0,-(SP)       * Meaningless word, but still necessary!
MOVE.W #$4A,-(SP)     * Function number
TRAP   #1
ADD.L  #12,SP         * Clean up the stack as usual
TST.L  D0             * Did an error occur?
BNE    error          * Stop
.                     * Here the program continues...
.
```

$4B EXEC

The EXEC function permits loading and chaining programs. If desired, the program loaded can be automatically started. In addition to the function number, the addresses of three strings and a mode word are expected on the stack.

The first address is a pointer to something called an "environment" string, a string which describes the "environment." If the environment is not set, the address of a null string, the address of a zero byte, will suffice.

The second pointer contains a command line for the program being called. A command line is comparable to the line which may be entered from the command mode when you have selected the point "TOS -takes parameters" from the option "Options".

The third pointer points to the filename or pathname of the file. All three strings must be terminated with a zero byte or consist of only a zero byte.

The mode word can be either zero or three. The standard value zero starts the loaded program automatically, while a three loads the program without automatically executing it. In this last case, either the address of the base page or an error message is returned in D0.

```
MOVE.L #env,-(SP)      * Environment
MOVE.L #com,-(SP)      * Command line
MOVE.L #fil,-(SP)      * Filename
MOVE.W #0,-(SP)        * Load and start, please
MOVE.W #$4B,-(SP)      * Function number
TRAP   #1
ADD.L  #14,SP          * Here we come to the end of the
.                      * chained program or postloaded module
.
fil:                   * Load sort routine
       .dc.b  'qsort.prg',0
com:                   * Sort the file in ascending order
       .dc.b  'up data.asc',0
env:                   * No environment
       .dc.b  0
.
```

$4C TERM

TERM $4C represents the third method, after TERM $00 and TERM $31, of ending a program. TERM $4C automatically makes the memory used by the program available to GEMDOS again. Different from TERM $00, however, a programmer-defined return value other than zero can be returned to the caller. This allows a short message to be passed back to the calling program.

```
MOVE.W #37,-(SP)      * Any 2-byte value
MOVE.W #$4C,-(SP)     * End program
TRAP   #1             *            now
.                     * We never get here
```

$ 4E SFIRST

The SFIRST function can be used to check to see if a file with the given name is present in the directory. If a file with the same name is found, the filename, the file attribute, data and time of creation, and the size of the file in bytes is returned. This information is placed in the DTA buffer, whose address is set with the SETDTA function, by GEMDOS.

One feature of this function is that the filename need not be specified in its entirety. Individual characters in the filename can be exchanged for a question mark "?", but entire groups of letters can also be replaced by a "*". In the extreme form a filename would be reduced to the string "*.*". In this case the first file in the directory would satisfy the conditions and the filename would appear in the DTA buffer along with the other information.

In addition to the filename, the SFIRST function must also be given a search attribute. The possible parameters of the search attribute correspond to the attributes which can be specified in CHMOD function:

```
$00 = Normal access, read/write possible
$01 = Normal access, write protected
$02 = Hidden entry (ignored by the ST desktop)
$04 = Hidden system file (ignored like $02)
$08 = Volume label, diskette name
$10 = Subdirectory
$20 = File will be written and closed
```

The following rules apply when searching for files:

> If the attribute word is zero, only normal files are recognized. System files or subdirectories are not recognized.
> System files, hidden files, and subdirectories are found when the corresponding attribute bits are set. Volume labels are not recognized, however.

In order to get the volume label, this option must be expressly set in the attribute word. All other files are then ignored.
After the call, D0 contains the value zero if a corresponding file has been found. In this case the 44-byte DTA buffer is constructed as follows:

```
Bytes  0-20     Reserved for GEMDOS
Byte   21       File attribute
Bytes  22-23    Clock time of file creation
Bytes  24-25    Date of file creation
Bytes  26-29    File size in bytes (long)
Bytes  30-43    Name and extension of the file
```

If, however, no file is found which corresponds to the specified search string, the error message -33, file not found, is returned.

```
MOVE.L #dta,-(SP)       * Set up DTA buffer
MOVE.W #1A,-(SP)        * Function number SETDTA
TRAP   #1
ADDQ.L #6,SP
MOVE.W #attrib,-(SP)    * Attribute value
MOVE.L #filnam,-(SP)    * Name of file to search for
MOVE.W #$4E,-(SP)       * Function number
TRAP   #1
ADDQ.L #8,SP
TST    D0               * File found?
BNE    notfound         * Apparently not
.
.
attrib:
       .dc.b  0         * Search for normal files only
filnam:
       .dc.b  '*.*',0   * Search for the 1st possible file
.
.
dta:
       .ds.b  44         * Space for the DTA buffer
```

$4F SNEXT

The SNEXT function (Search next) can be used to see if there are other files on the disk which match the filename given. To do this, only the function number need be passed; SNEXT does not require any parameters. All of the parameters are set from the SFIRST call.

If the search string is very global, as in the previous example, all of the files on a diskette can be determined and displayed one after the other with SFIRST and SNEXT. This makes it rather easy to display a directory within a program. The SNEXT function is called repeatedly and the contents of D0 are check afterwards. If D0 contains a value other than zero, either an error occurred, or all of the directory entries have been searched.

$56 RENAME

A RENAME function is found in almost every disk-oriented operating system in one form or another, since renaming files is required fairly often . Under GEMDOS, files are renamed with the RENAME function, which requires two pointer to file or pathnames. The first pointer points to the new name, with the specification of the pathname of the file if necessary, and the second pointer points to the previous name. A 2-byte parameter is required in addition to the two pointers. We were not able to determine the significance of the additional word parameter. Different values had no (recognizable) effect.

As a return value, D0 contains either zero, meaning that the name was changed correctly, or an error code.

```
MOVE.L #newnam,-(SP)    * New filename
MOVE.L #oldname,-(SP)   * File to rename
MOVE.W #0,-(SP)         * Dummy?
MOVE.W #$56,-(SP)       * Function number
TRAP   #1
ADD.L  #12,SP
TST.L  D0               * Test for error
.
.
oldnam:                 * Don't forget zero byte at end!
       .dc.b  'oldfile.dat',0
newnam:
       .dc.b  'newname.dat',0
.
.
```

$57 GSDTOF

If the directory is displayed as text rather than icons on the desktop, the date and time of file creation as well as the size of the file in bytes is shown. The time and date can either be set or read with function $57. To do this it is necessary that the file be already opened with OPEN or CREATE. The handle number obtained at the opening must be passed to the function. Additional parameters are a word which acts as a flag as to whether the time and data are to be set (0) or read (1), and a pointer to a 4-byte buffer which either contains the result data or will be provided with the required data before the call.

This date buffer contains the time in the first two byes and the date in the last two. The format of the data is identical to that of the functions for setting/reading the time and date.

Example 1:

```
MOVE.W #1,-(SP)       * Read time and date
MOVE.W #handle,-(SP)  * File must first be opened
MOVE.L #buff,-(SP)    * 4 byte buffer
MOVE.W #$57,-(SP)     * Function number
TRAP   #1
ADD.L  #10,SP
.
.
handle:
       .ds.b  2
buff:
       .ds.b  4
.
.
```

Example 2:

```
MOVE.W #0,-(SP)       * Set time and date
MOVE.W #handle,-(SP)  * File must first be opened
MOVE.L #buff,-(SP)    * 4 byte buffer
MOVE.W #$57,-(SP)     * Function number
TRAP   #1
ADD.L  #10,SP
.
.
handle:
       .ds.b  2
buff:
       .ds.b  4
.
.
```

3.1.1 GEMDOS error codes and their meaning

The GEMDOS functions return a value giving information about whether or not an error occurred during the execution of the function. A value of zero means no error; negative values have the following meanings:

```
-32  Invalid function number
-33  File not found
-34  Pathname not found
-35  Too many files open (no more handles left)
-36  Access not possible
-37  Invalid handle number
-39  Not enough memory
-40  Invalid memory block address
-46  Invalid drive specification
-49  No more files
```

In addition to these error messages, the BIOS error messages may occur. These error messages have numbers -1 to -31 and are described in section 3.3

3.2 The BIOS Functions

The software interface between the GEMDOS and the hardware of the computer is the BIOS (Basic Input Output System). The BIOS, as the name suggests, is concerned with the fundamental input/output functions. This includes screen output, keyboard input, printer output, as well as the RS-232 interface and, of course, input/output to the disk.

The BIOS functions are also available to user programs. The `TRAP` instruction of the 68000 processor is used to call them. Any data required is passed through the stack and the result of the function is returned in the D0 register. The machine language programmer should be aware that the contents of D0-D2 and A0-A2 are changed when calling BIOS functions; the remaining registers remain unchanged.

BIOS function calls are even simpler if you program in C. Here you can use simple function calls with the corresponding parameter lists. The function calls are stored as macros in an include file. In the examples, the definition of the function and its parameters in C will be shown. For assembly language programmers, the use is described in an example.

`TRAP #13` is reserved for the BIOS functions.

0 getmpb *get memory parameter block*

```
C: void getmpb(pointer)
   long pointer;
```

Assembler:

```
move.l  pointer,-(SP)
move.w  #0,-(SP)
trap    #13
addq.l  #6,sp
```

This function fills a 12-byte block whose address is contained in `pointer` with the memory parameter block. This block contains three pointers itself:

```
long   mfl           Memory free list
long   mal           Memory allocated list
long   rover         Roving pointer
```

The structures to which each pointer points are constructed as follows:

```
long   link          Pointer to next block
long   start         Start address of the block
long   length        Length of the block in bytes
long   own           Process descriptor
```

Example:

```
move.l #buffer,-(sp)  Buffer for MPB
move.w #0,-(sp)       getmpb
trap   #13            Call BIOS
addq.l #6,sp          Stack correction
```

We get the values \$48E, 0, and \$48E. The following data are at address \$48E:

```
link   0              No additional block
start  $3B900         Start address of the free memory
length $3C700         Length of the free memory
own    0              No process descriptor
```

1 bconstat *return input device status*

```
C: int bconstat(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #1,-(sp)
trap   #13
addq.l #4,sp
```

This function returns the status of an input device which is defined as follows:

```
Status 0       No characters ready
Status -1      (at least) one character ready
```

The parameter `dev` specifies the input device:

```
dev     Input device
 0      PRT:, Centronics interface
 1      AUX:, RS-232 interface
 2      CON:, Keyboard and screen
 3      MIDI, MIDI interface
 4      IKBD, Keyboard port
```

The following table lists the allowed accesses to these devices:

Operation	PRT:	AUX:	CON:	MIDI	IKBD
Input status	no	yes	yes	yes	no
Input	yes	yes	yes	yes	yes
Output status	yes	yes	yes	yes	yes
Output	yes	yes	yes	yes	yes

This example waits until a character from the RS-232 interface is ready.

```
wait move.w #1,-(sp)       RS-232
     move.w #1,-(sp)       bconstat
     trap   #13
     addq.l #4,sp
     tst    d0             character available?
     beq    wait           no, wait
```

2 conin *read character from device*

```
C: long conin(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #2,-(sp)
trap   #13
addq.l #4,sp
```

This function fetches a character from an input device. The parameter `dev` has the same meaning as in the previous function. The function does not return until a character is ready.

The character received is in the lowest byte of the result. If the input device was the keyboard (`con`, 2), the key scan code is also returned in the lower byte of the upper word (see description of the keyboard processor).

Example:

```
move.w  #2,-(sp)      con
move.w  #2,-(sp)      bconin
trap    #13
addq.l  #4,sp
```

3 bconout *write character to device*

```
C: void bconout(dev, c)
   int dev, c;
```

Assembler:

```
move.w c,-(sp)
move.w dev,-(sp)
move.w #3,-(sp)
trap   #13
addq.l #6,sp
```

This function serves to output a character "c" to the output device dev (meaning is the same as for the previous function). The function returns when the character has been outputted.

Example:

```
move.w #'A',-(sp)
move.w #0,-(sp)       PRT:
move.w #3,-(sp)       bconout
trap   #13
addq.l #6,sp
```

The example outputs the letter "A" to the printer.

4 rwabs *read and write disk sector*

```
C: long rwabs(rwflag, buffer, number, recno,dev)
   long buffer;
   int rwflag, number, recno, dev;
```

Assembler:

```
   move.w dev,-(sp)
   move.w recno,-(sp)
   move.w number,-(sp)
   move.l buffer,-(sp)
   move.w rwflag,-(sp)
   move.w #4,-(sp)
   trap   #13
   add.l  #14,sp
```

This function serves to read and write sectors on the disk. The parameters have the following meaning:

rwflag	Meaning
0	Read sector
1	Write sector
2	Read sector, ignore disk change
3	Write sector, ignore disk change

The parameter `buffer` is the address of a buffer into which the data will be read from the disk or from which the data will be written to the disk. The buffer should begin at an even address, or the transfer will run very slowly.

The parameter `number` specifies how many sectors should be read or written during the call. The parameter `recno` specifies which logical sector the process will start with.

The parameter `dev` determines which disk drive will be used:

dev	Drive
0	Drive A
1	Drive B
2	Hard disk

The function returns an error code as the result. If this value is zero, the operation was performed without error. The returned value will be negative if an error occurred. The error code has the following meaning:

```
  0  OK, no error
 -1  General error
 -2  Drive not ready
 -3  Unknown command
 -4  CRC error
 -5  Bad request, invalid command
 -6  Seek error, track not found
 -7  Unknown media (invalid boot sector)
 -8  Sector not found
 -9  (No paper)
-10 Write error
-11 Read error
-12 General error
-13 Diskette write protected
-14 Diskette was changed
-15 Unknown device
-16 Bad sector (during verify)
-17 Insert diskette (for connected drive)
```

Example:

```
      move.w #0,-(sp)        Drive A
      move.w #10,-(sp)       Start at logical sector 10
      move.w #2,-(sp)        Read 2 sectors
      move.l #buffer,-(sp)   Buffer address
      move.w #0,-(sp)        Read sectors
      move.w #4,-(sp)        rwabs
      trap   #13
      add.l  #14,sp
      ...
buffer     ds.b  2*512
```

5 setexec *set exception vectors*

```
C: long setexec(number, vector)
   int  number;
   long vector;
```

Assembler:

```
   move.l vector,-(sp)
   move.w number,-(sp)
   move.w #5,-(sp)
   trap   #13
   addq.l #8,sp
```

The function `setexec` allows one of the exception vectors of the 68000 processor to be changed. The number of the vector must be passed in `number` and the address of the routine pertaining to it in `vector`. The function returns the old vector as the result. If you just want to read the vector, pass the value -1 as the new address. The 256 processor vectors as well as 8 vectors for GEM, which numbers $100 to $107 (address $400 to $41C) can be changed with this function.

Example:

```
   move.l #buserror,-(sp)
   move.w #2,-(sp)
   move.w #5,-(sp)
   trap   #13
   addq.l #8,sp
   ...
buserror  ...
```

6 tickcal *return millisecond per tick*

```
C: long tickcal()
```

Assembler:

```
move.w #6,-(sp)
trap   #13
addq.l #2,sp
```

This function returns the number of milliseconds between two system timer calls.

Example:

```
move.w #6,-(sp)
trap   #13
addq.l #2,sp
```

Result: 20 ms

7 getbpb *get BIOS parameter block*

```
C: long getbpb(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #7,-(sp)
trap   #13
addq.l #4,sp
```

This function returns a pointer to the BIOS Parameter Block of the drive `dev` (0=drive A, 1=drive B).

The BPB (BIOS Parameter Block) is constructed as follows:

```
int  recsiz   Sector size in bytes
int  clsiz    Cluster size in sectors
int  clsizb   Cluster size in bytes
int  rdlen    Directory length in sectors
int  fsiz     FAT size in sectors
int  fatrec   Sector number of the second FAT
int  datrec   Sector number of the first data cluster
int  numcl    Number of data clusters on the disk
int  bflags   Misc. flags
```

The function returns the address $3E3E for drive A and the address $3E5E for drive B. An address of zero indicates an error.

Example:

```
move.w #0,-(sp)      Drive A
move.w #7,-(sp)      getbpb
trap   #13
addq.l #4,sp
```

Here are the BPB data for 80 track single and double-sided disk drives:

Parameter	80 track SS	80 track DS
recsiz	512	512
clsiz	2	2
clsizb	1024	1024
rdlen	7	7
fsiz	5	5
fatrec	6	6
datrec	18	18
numcl	351	711

8 bcostat *return output device status*

```
C: long bcostat(dev)
   int  dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #8,-(sp)
trap   #13
addq.l #4,sp
```

This function tests to see if the output device specified by `dev` is ready to output the next character. `dev` can accept the values which are described in function one. The result of this function is either -1 if the output device is ready, or zero if it must wait.

Example:

```
move.w #0,-(sp)        Printer ready?
move.w #8,-(sp)        bcostat
trap   #13
addq.l #4,sp
```

9 mediach *inquire media change*

```
C: long mediach(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #9,-(sp)
trap   #13
addq.l #4,sp
```

This function determined if the disk was changed in the meantime. The parameter `dev`, the drive number (0=drive A, 1=drive B), must be passed to the routine. One of three values can occur as the result:

```
0     Diskette was definitely not changed
1     Diskette may have been changed
2     Diskette was definitely changed
```

Example:

```
move.w #1,-(sp)       Drive B
move.w #9,-(sp)       mediach
trap   #13
addq.l #4,sp
```

10 drvmap *inquire drive status*

```
C: long drvmap()
```

Assembler:

```
move.w #10,-(sp)
trap   #13
addq.l #2,sp
```

This function returns a bit vector which contains the connected drives. The bit number n is set if drive n is available (0 means A, etc.). Even if only one drive is connected, %11 is still returned, since two logical drives are assumed.

Example:

```
move.w #10,-(sp)        drvmap
trap   #13
addq.l #2,sp
```

11 kbshift *inquire/change keyboard status*

```
C: long kbshift(mode)
   int mode;
```

Assembler:

```
move.w mode,-(sp)
mode.w #11,-(sp)
trap   #13
addq.l #4,sp
```

With this function you can change or determine the status of the special keys on the keyboard. If `mode` is -1, you get the status, a positive value is accepted as the status. The status is a bit vector which is constructed as follows:

```
Bit    Meaning
 0     Right shift key
 1     Left shift key
 2     Control key
 3     ALT key
 4     Caps Lock on
 5     Right mouse button (CLR/HOME)
 6     Left mouse button (INSERT)
 7     Unused
```

Example:

```
move.w #-1,-(sp)      Read shift status
move.w #11,-(sp)      kbshift
trap   #13
addq.l #4,sp
```

3.3 The XBIOS

To support the special hardware features of the Atari ST, there are extended BIOS functions, which are called via a `TRAP #14` instruction. The functions, like the normal BIOS functions, can be called from assembly language as well as from C. When calling from C, a small TRAP handler in machine language is again necessary, which can look like this:

```
trap14:
      move.l  (sp)+,retsave  Save return address
      trap    #14            Call XBIOS
      move.l  retsave,-(sp)  Restore return address
      rts

      .bss
retsave  ds.l  1             Space for the return address
```

Macro functions can be used in C which allow the extended BIOS functions (eXtended BIOS, XBIOS) to be called by name. The appropriate function number and TRAP call will be created when the macro is expanded.

When working in assembly language, the function number of the XBIOS routine need simply be passed on the stack. The XBIOS has 40 different functions whose signficance and use are described on the following pages.

0 initmous *initialize mouse*

```
C: void initmous(type, parameter, vector)
   int type;
   long parameter, vector;
```

Assembler:

```
move.l vector,-(sp)
move.l parameter,-(sp)
move.w type,-(sp)
move.w #0,(-sp)
trap   #14
add.l  #12,sp
```

This XBIOS function initializes the routines for mouse processing. The parameter `vector` is the address of a routine which will be executed following a mouse-report from the keyboard processor. The parameter `type` selects from among the following alternatives:

```
type
 0      Disable mouse
 1      Enable mouse, relative mode
 2      Enable mouse, absolute mode
 3      unused
 4      Enable mouse, keyboard mode
```

This allows you to select if mouse movements are to be reported and in what manner this will occur.

The parameter `parameter` points to a parameter block, which is constructed as follows:

```
char topmode
char buttons
char xparam
char yparam
```

The parameter `topmode` determines the layout of the coordinate system. A 0 means that Y=0 lies in the lower corner, 1 means that Y=0 lies in the upper corner.

The parameter `buttons` is a parameter for the command "set mouse buttons" of the keyboard processor (see description of the IKBD, intelligent keyboard).

The parameters `xparam` and `yparam` are scaling factors for the mouse movement. If you have selected 2 as the `type`, the absolute mode, the parameter block determines four more parameters:

```
int  xmax
int  ymax
int  xstart
int  ystart
```

These are the X and Y-coordinates of the maximal value which the mouse position can assume, as well as the start value to which the mouse will be set.

Example:

```
   move.l #vector,-(sp)      Address of the mouse position
   move.l #parameter,-(sp)   Address of the parameter block
   move.w #1,-(sp)           Enable relative mouse mode
   move.w #0,-(sp)           Init mouse
   trap   #14
   add.l  #12,sp
   ...
parameter dc.b ......
   ...
vector    ...                Mouse interrupt routine
```

1 ssbrk *save memory space*

```
C: long ssbrk(number)
   int number;
```

Assembler:

```
move.w number,-(sp)
move.w #1,-(sp)
trap   #14
addq.l #4,sp
```

This function reserves memory space. The number of bytes must be passed in `number`. The memory space is prepared at the upper end of memory. The function returns the address of the reserved memory area as the result. This function must be called before initializing the operating system, meaning that is must be called from the boot ROM, before the operating system is loaded.

Example:

```
move.w #$400,-(sp)       Reserve 1K
move.w #1,-(sp)          ssbrk
trap   #14
addq.l #4,sp
```

2 physbase *return screen RAM base address*

```
C: long physbase()
```

Assembler:

```
move    #2,-(sp)
trap    #14
addq.l #2,sp
```

This function returns the base of the physical screen RAM. The physical screen RAM is the area of memory which is displayed by the video shifter. The result is a long word.

Example:

```
$78000, base address of the screen for 512K RAM
```

3 logbase *set logical screen base*

```
C: long logbase()
```

Assembler:

```
move    #3,-(sp)
trap    #14
addq.l  #2,sp
```

The logical screen base is the address which is used for all output functions as the screen base. If the physical and logical screen bases are different, one screen will be displayed while another picture is being constructed in a different area of RAM, which will be displayed later. The result of this function call is again a longword.

Example:

```
$78000, base address of the screen for 512K RAM
```

4 getrez *return screen resolution*

```
C: int getrez()
```

Assembler:

```
move.w #4,-(sp)
trap   #14
addq.l #2,sp
```

This function call returns the screen resolution:

```
0 :=  Low resolution, 320*200 pixels, 16 colors
1 :=  Medium resultion, 640*200 pixels, 4 colors
2 :=  High resolution, 640*400, pixels, monochrome
```

Example:

```
2, monochrome
```

5 setscreen *set screen parameters*

```
C: void setscreen(logadr, physadr, res)
   long logadr, physadr;
   int res;
```

Assembler:

```
move.w res,-(sp)
move.l physadr,-(sp)
move.l logadr,-(sp)
move.w #5,-(sp)
trap   #14
add.l  #12,sp
```

This function changes the screen parameters which can be read with the previous three functions. If a parameter should not be set, a negative value must be passed. The parameters are set in the next VBL routine so that no disturbances appear on the screen.

Example:

Set the physical and the logical screen address to $70000, retain the resolution.

```
move.w #-1,-(sp)          Retain resolution
move.l #$70000,-(sp)      Physical base
move.l #$70000,-(sp)      Logical base
move.w #5,-(sp)           setscreen
trap   #14
add.l  #12,sp
```

6 setpalette *set color palette*

```
C: void setpalette(paletteptr)
   long paletteptr;
```

Assembler:

```
move.l paletteptr,-(sp)
move.w #6,-(sp)
trap   #14
addq.l #6,sp
```

A new color palette can be loaded with this function. The parameter `paletteptr` must be a pointer to a table with 16 colors (each a word). The address of the table must be even. The colors will be loaded at the start of the next VBL. Example:

```
    move.l #palette,-(sp)     Address of the new color palette
    move.w #6,-(sp)           set palette
    trap   #14
    addq.l #6,sp
    ....
palette   dc.w   $777,$700,$070,$007,$111,$222,$333,$444,
                 $555,$000,$001,$010,$100,$200,$020,$002,
                 $123,$456
```

7 setcolor *set color*

```
C: int setcolor(colornum, color)
   int colornum, color
```

Assembler:

```
move.w color,-(sp)
move.w colornum,-(sp)
move.w #7,-(sp)
trap   #14
addq.l #6,sp
```

This function allows just one color to be changed. The color number (0-15) and the color belonging to it (0-$777) must be specified. If -1 is given as the color, the color is not set but the previous color is returned.

Example:

```
move.w #$777,-(sp)        Color white
move.w #1,-(sp)           As color number 1
move.w #7,-(sp)
trap   #14
addq.l #6,sp
```

8 floprd *read diskette sector*

```
C: int floprd(buffer, filler, dev, sector, track, side,
count)
   long buffer, filler;
   int  dev, sector, track, side, count;
```

Assembler:

```
   move.w count,-(sp)
   move.w side,-(sp)
   move.w track,-(sp)
   move.w sector,-(sp)
   move.w dev,-(sp)
   clr.l  -(sp)
   move.l buffer,-(sp)
   move.w #8,-(sp)
   trap   #14
   add.l  #20,sp
```

This function reads one or more sectors in from the diskette. The parameters have the following meaning:

`count:` Specifies how many sectors are to be read. Values between one and nine (number of sectors per track) are possible.

`side:` Selects the diskette side, zero for single-sided drives and zero or one for double-sided drives.

`track:` Determines the track number (0-79 for 80-track drives or 0-39 for 40-track drives).

`sector:` The sector number of the first sector to be read (0-9).

`dev:` Determine drive number, 0 for drive A and 1 for drive B.

`filler:` Unused long word.

`buffer:` Buffer in which the diskette data should be written. The buffer must begin on a word boundary and be large enough for the data to be read (512 bytes times the number of sectors).

The function returns an error code which has the following meaning:

```
  0 OK, no error
 -1 General error
 -2 Drive not ready
 -3 Unknown command
 -4 CRC error
 -5 Bad request, invalid command
 -6 Seek error, track not found
 -7 Unknown media (invalid boot sector)
 -8 Sector not found
 -9 (No paper)
-10 Write error
-11 Read error
-12 General error
-13 Diskette write protected
-14 Diskette was changed
-15 Unknown device
-16 Bad sector (during verify)
-17 Insert diskette (for connected drive)
```

Example:

```
    move.w #1,-(sp)          Read a sector
    move.w #0,-(sp)          Page zero
    move.w #0,-(sp)          Track zero
    move.w #1,-(sp)          Sector one
    move.w #1,-(sp)          Drive B
    clr.l  -(sp)
    move.l #buffer,-(sp)
    move.w #8,-(sp)          floprd
    trap   #14
    add.l  #20,sp
    tst    d0                Did error occur?
    bmi    error             yes
    ...
buffer  ds.b 512             Buffer for a sector
```

9 flopwr *write diskette sector*

```
C: int floprd(buffer, filler, dev, sector, track, side,
              count)
   long buffer, filler;
   int  dev,sector,track,side,count;
```

Assembler:

```
   move.w count,-(sp)
   move.w side,-(sp)
   move.w track,-(sp)
   move.w sector,-(sp)
   move.w dev,-(sp)
   clr.l  -(sp)
   move.l buffer,-(sp)
   move.w #9,-(sp)
   trap   #14
   add.l  #20,sp
```

One or more sectors can be written to disk with this XBIOS function. The parameters have the same meaning as for the function 8 *floprd*. The function returns an error code which also has the same meaning as for reading sectors. Example:

```
   move.w #3,-(sp)          Write three sectors
   move.w #0,-(sp)          Side zero
   move.w #7,-(sp)          Track seven
   move.w #1,-(sp)          Sector one
   move.w #0,-(sp)          Drive A
   clr.l  -(sp)
   move.l #buffer,-(sp)     Address of the buffer
   move.w #9,-(sp)          flopwr
   trap   #14
   add.l  #20,sp
   tst    d0                Did an error occur?
   bmi    error             yes
   ...
buffer  ds.b 3*512          Buffer for three sectors
```

10 flopfmt *format diskette*

```
C: int flopfmt(buffer, filler, dev, spt, track, side,
               interleave, magic, virgin)
   long buffer, filler, magic;
   int  dev, spt, track, side, interleave, virgin;
```

Assembler:

```
   move.w virgin,-(sp)
   move.l magic,-(sp)
   move.w interleave,-(sp)
   move.w side,-(sp)
   move.w track,-(sp)
   move.w spt,-(sp)
   move.w dev,-(sp)
   clr.l  -(sp)
   move.l buffer,-(sp)
   move.w #10,-(sp)
   trap   #14
   add.l  #26,sp
```

This routine serves to format a track on the diskette. The parameters have the following meanings:

`virgin:`	The sectors are formatted with this value. The standard value is \$E5E5. The high nibble of each byte may not contain the value \$F.
`magic:`	The constant \$87654321 must be used as magic or formatting will be stopped.
`interleave:`	Determines in which order the sectors on the disk will be written, usually one.
`side:`	Selects the disk side (0 or 1).
`track:`	The number of the track to be formatted (0-79).
`spt:`	Sectors per track, normally 9.
`dev:`	The drive, 0 for A and 1 for B.

`filler:` Unused long word.

`buffer:` Buffer for the track data; for 9 sectors per track the buffer mst be at least 8K large.

The function returns an error code as its result. The value -16, bad sectors, means that data in some sectors could not be read back correctly. In this case the buffer contains a list of bad sectors (word data, terminated by zero). You can format these again or mark the sectors as bad.

Example:

```
    move.w #$E5E5,-(sp)       Initial data
    move.l #$87654321,-(sp)   magic
    move.w #1,-(sp)           interleave
    move.w #0,-(sp)           side 0
    move.w #79,-(sp)          track 79
    move.w #9,-(sp)           9 sector per track
    move.w #0,-(sp)           drive A
    clr.l  -(sp)
    move.w #buffer,-(sp)
    move.w #10,-(sp)          flopfmt
    trap   #14
    add.l  #26,sp
    tst    d0
    bmi    error

buffer    ds.b  $2000     8K buffer
```

11 unused

12 midiws *write string to MIDI interface*

```
C: void midiws(count, ptr)
   int  count;
   long ptr;
```

Assembler:

```
   move.l ptr,-(sp)
   move.w count,-(sp)
   move.w #12,-(sp)
   trap   #14
   addq.l #8,sp
```

With this function it is possible to output a string to the MIDI interface (MIDI OUT). The parameter `ptr` must point to a string, count must contain the number of characters to be sent minus 1.

Example:

```
   move.l #string,-(sp)             Address of the string
   move.w #stringend-string-1,-(sp) Length
   move.w #12,-(sp)                 midiws
   trap   #14
   addq.l #8,sp

   ....

string    dc.b 'MIDI data"
stringend equ  *
```

13 mfpint *initialize MFP format*

```
C: void mfpint(number, vector)
   int  number;
   long vector;
```

Assembler:

```
   move.l vector,-(sp)
   move.w number,-(sp)
   move.w #13,-(sp)
   trap   #14
   addq.l #8,sp
```

This function initializes an interrupt routine in the MFP. The number of the MFP interrupt is in `number` while `vector` contains the address of the corresponding interrupt routine. The old interrupt vector is overwritten.

Example:

```
   move.l #busy,-(sp)        Busy interrupt routine
   move.w #0,-(sp)           Vector number 0
   move.w #13,-(sp)          mfpint
   trap   #14
   addq.l #8,sp
   ....
busy:
```

14 iorec *return record buffer*

```
C: long iorec(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #14,-(sp)
trap   #14
addq.l #4,sp
```

This function fetches a pointer to a buffer data record for an input device. The following input devices can be specified:

```
dev    Input device
 0     RS-232
 1     Keyboard
 2     MIDI
```

The buffer record for an input device has the following layout:

```
long  ibuf     Pointer to an input buffer
int   ibufsize Size of the input buffer
int   ibufhd   Head index
int   ibuftl   Tail index
int   ibuflow  Low water mark
int   ibufhi   High water mark
```

The input buffer is a circular buffer; the `head index` specifies the next write position (the buffer is filled by an interrupt routine) and the `tail index` specifies from where the buffer can be read. If the head and tail indices are the same, the buffer is empty. The low and high marks are used in connection with the communications status for the RS-232 (XON/XOFF or RTS/CTS). If the input buffer is filled up to the `high water mark`, the sender is informed via XON or CTS that the computer cannot receive any more data. When data received by the computer can be processed again, so that the buffer contents sink below the `low water mark`, the transfer is resumed.

There is an identically-constructed buffer record for the RS-232 output which is located directly behind the input record.

Example:

```
move.w #1,-(sp)      Buffer record for keyboard
move.w #14,-(sp)     iorec
trap   #14
addq.l #4,sp
...
```

Result: $9F2

The following table contains the data for all devices:

	RS-232 input	RS-232 output	Keyboard	MIDI
Address	$9D0	($9DE)	$942	$A00
Buffer address	$6D0	$7D0	$8D0	$950
Buffer length	$100	$100	$80	$80
Head index	0	0	0	0
Tail index	0	0	0	0
Low water mark	$40	$40	$20	$20
High water mark	$C0	$C0	$20	$20

Head and tail indices are naturally dependent on the current operating mode. High and low water marks are set at 3/4 and 1/4 of the buffer size. They have significance only for XON/XOFF or RTS/CTS in connection with RS-232.

15 rsconf *set RS-232 configuration*

```
C: void rsconf(baud, ctrl, ucr, rsr, tsr, scr)
   int baud, ctrl, ucr, rsr, tsr, scr;
```

Assembler:

```
move.w scr,-(sp)
move.w tsr,-(sp)
move.w rsr,-(sp)
move.w ucr,-(sp)
move.w ctrl,-(sp)
move.w baud,-(sp)
move.w #15,-(sp)
trap   #14
add.l  #14,sp
```

This XBIOS function serves to configure the RS-232 interface. The parameters have the following signifcance:

```
scr:  Synchronous Character Register in the MFP
tsr:  Transmitter Status Register in the MFP
rsr:  Receiver Status Register in the MFP
ucr:  USART Control Register in the MFP
ctrl: Communications parameters
baud: Baud rate
```

See the section on the MFP 68901 for information on the MFP registers. If one of the parameters is -1, the previous value is retained. The handshake mode can be selected with the `ctrl` parameter:

```
ctrl  Meaning
  0   No handshake, default after power-up
  1   XON/XOFF
  2   RTS/CTS
  3   XON/XOFF and RTS/CTS (not useful)
```

The `baud` parameter contains an indicator for the baud rate:

baud	Baud rate
0	19200
1	9600
2	4800
3	3600
4	2400
5	2000
6	1800
7	1200
8	600
9	300
10	200
11	150
12	134
13	110
14	75
15	50

Example:

```
move.w #-1,-(sp)
move.w #-1,-(sp)        Don't change MFP registers
move.w #-1,-(sp)
move.w #-1,-(sp)
move.w #1,-(sp)         XON/XOFF
move.w #9,-(sp)         300 baud
move.w #15,-(sp)        rsconf
trap   #14
add.l  #14,sp
```

16 keytbl *set keyboard table*

```
C: long keytbl(unshift, shift, capslock)
   long unshift, shift, capslock;
```

Assembler:

```
   move.l capslock,-(sp)
   move.l shift,-(sp)
   move.l unshift,-(sp)
   move.w #16,-(sp)
   trap   #14
   addi.l #14,sp
```

With this function it is possible to create a new keyboard layout. To do this you must pass the address of the new tables which contain the key codes for normal keys (without shift), shifted keys, and keys with caps lock. The function returns the address of the vector table in which the three keyboard table pointers are located. If a table should remain unchanged, -1 must be passed as the address. A keyboard table must be 128 bytes long. It is addressed via the key scan code and returns the ASCII code of the given key.

Example:

```
   move.l #-1,-(sp)       Don't change caps lock
   move.l #shift,-(sp)    Shift table
   move.l #unshift,-(sp) Table without shift
   move.w #16,-(sp)
   trap   #14
   addi.l #14,sp

   ....
shift:   ...
unshift: ...
```

17 random *return random number*

```
C: long random()
```

Assembler:

```
move.w #17,-(sp)
trap   #14
addq.l #2,sp
```

This function returns a 24-bit random number. Bits 24-31 are zero. With each call you receive a different result. After turning on the computer a different seed is created.

Example:

```
move.w #17,-(sp)       random
trap   #14
addq.l #2,sp
```

18 protobt *produce boot sector*

```
C: void protobt(buffer, serialno,disktype, execflag)
   long buffer, serialno;
   int  disktype, execflag;
```

Assembler:

```
   move.w execflag,-(sp)
   move.w disktype,-(sp)
   move.l serialno,-(sp)
   move.l buffer,-(sp)
   move.w #18,-(sp)
   trap   #14
   add.l  #14,sp
```

This function serves to create a boot sector. A boot setor is located on track 0, sector 1 on side 0 of a diskette and gives the DOS information about the disk type. If the boot sector is executable, it can be be used to load the operating system. With this function you can create a new boot sector, for a different disk format or to change an existing boot sector. The parameters:

`execflag`: determines if the boot sector is executable.

```
 0 not executable
 1 executable
-1 boot sector remains as it was
```

The disk type can assume the following values:

```
 0  40 track, single sided (180 K)
 1  40 track, double sided (360 K)
 2  80 track, single sided (360 K)
 3  80 track, double sided (720 K)
-1  Disk type remains unchanged
```

The parameter `serialno` is a 24-bit serial number which is written in the boot sector. If the serial number is greater than 24 bits ($01000000), a random serial number is created (with the above function). A value of -1 means that the serial number will not be changed.

The parameter `buffer` is the address of a 512-byte buffer which contains the boot sector or in which the boot sector will be created.

A boot sector has the following construction:

Address		40 track SS	40 track DS	80 track SS	80 track DS
0- 1	Branch instruction to boot program if executable				
2- 7	'Loader'				
8-10	24-bit serial number				
11-12	BPS	512	512	512	512
13	SPC	1	2	2	2
14-15	RES	1	1	1	1
16	FAT	2	2	2	2
17-18	DIR	64	112	112	112
19-20	SEC	360	720	720	1440
21	MEDIA	252	253	248	249
22-23	SPF	2	2	5	5
24-25	SPT	9	9	9	9
26-27	SIDE	1	2	1	2
28-29	HID	0	0	0	0
510-511	CHECKSUM				

The abbreviations have the following meanings:

EPS: Bytes per sector. The sector size is 512 bytes for all formats

SPC: Sectors per cluster. The number of sectors which are combined into one block by the DOS, 2 sectors equals 1K.

RES: Number of reserved sectors at the start of the disk including the boot sector.

FAT: The number of file allocation tables on the disk.

DIR: The maximum number of directory entries.

SEC: The total number of sectors on the disk.

MEDIA: Media descriptor byte, not used by the ST-BIOS.

SPF: Number of sectors in each FAT.

SPT: Number of sectors per track.

`SIDE:` Number of sides of the diskette.

`HID:` Number of hidden sectors on the disk.

The boot sector is compatible with MS-DOS 2.x. This is why all 16-bit words are stored in 8086 format (first low byte, then high byte).

If the checksum of the whole boot sector is $1234, the sector is executable. In this case the boot program is located at address 30. Example:

```
    move.w #-1,-(sp)       Don't change executability
    move.w #3,-(sp)        80 tracks DS
    move.l #-1,-(sp)       Don't change serial number
    move.l #buffer,-(sp)
    move.w #18,-(sp)       protobt
    trap   #14
    add.l  #14,sp

buffer ds.b 512
```

This example program can be used to adapt an existing boot sector for 80 tracks, double sided.

19 flopver *verify diskette sector*

```
C: int flopver(buffer, filler, dev, sector, track, side,
               count)
   long buffer, filler;
   int  dev, sector, track, side, count;
```

Assembler:

```
   move.w count,-(sp)
   move.w side,-(sp)
   move.w track,-(sp)
   move.w sector,-(sp)
   move.w dev,-(sp)
   clr.l  -(sp)
   move.l buffer,-(sp)
   move.w #19,-(sp)
   trap   #14
   add.l  #16,sp
```

This function serves to verify one or more sectors on the disk. The sectors are read from the disk and compared with the buffer contents in memory. The parameters have the same meaning as for reading and writing sectors. If the sector and buffer contents agree, the result of the function will be zero. If an error occurs, the error number will be returned in D0 that has the following meaning:

```
  0  OK, no error
 -1  General error
 -2  Drive not ready
 -3  Unknown command
 -4  CRC error
 -5  Bad request, invalid command
 -6  Seek error, track not found
 -7  Unknown media (invalid boot sector)
 -8  Sector not found
 -9  (No paper)
-10  Write error
-11  Read error
-12  General error
-13  Diskette write protected
-14  Diskette was changed
-15  Unknown device
```

```
-16 Bad sector (during verify)
-17 Insert diskette (for connected drive)
```

In the case of an error, the buffer will contain a list of erroneous sectors (16-bit values), terminated by a zero word. If the BIOS function 4 *rwabs* was used to write the sectors and if the variable *fverify* ($444) is set, the sectors will automatically be verified after they are written.

Example:

```
move.w #1,-(sp)        A sector
move.w #0,-(sp)        Side zero
move.w #39,-(sp)       Track 39
move.w #1,-(sp)        Sector 1
move.w #0,-(sp)        Drive A
clr.l  -(sp)
move.l #buffer,-(sp)   Buffer address
move.w #19,-(sp)       flopver
trap   #14
add.l  #16,sp
tst    d0              Error?
bmi    error
```

20 scrdmp *output screen dump*

```
C: void scrdmp()
```

Assembler:

```
move.w #20,-(sp)
trap   #14
addq.l #2,sp
```

This function outputs a hardcopy of the screen to a connected printer. The previously-set printer parameters ("desktop Printer setup") are used. You can also perform this function by simultaneously pressing the ALT and HELP keys or from the desktop through "Print Screen" from the "Options" menu.

Example:

```
move.w #20,-(sp)       Hardcopy
trap   #14             Call XBIOS
addq.l #2,sp
```

21 cursconf *set cursor configuration*

```
C: int cursconf(function, rate)
   int function, rate;
```

Assembler:

```
move.w rate,-(sp)
move.w function,-(sp)
move.w #21,-(sp)
trap   #14
addq.l #6,sp
```

This XBIOS function serves to set the cursor function. The parameter `function` can have a value from 0-5, which have the following meanings:

```
function  Meaning
    0     Disable cursor
    1     Enable cursor
    2     Flash cursor
    3     Steady cursor
    4     Set cursor flash rate
    5     Get cursor flash rate
```

You can use this function to set whether the cursor is visible, and whether it is flashing or steady. Thie XBIOS function returns a result only if you fetch the old baud rate. The unit of the flash frequency is dependent on the screen frequency: It is 70 Hz for a monochrome monitor or 50 Hz for a color monitor. You can set a new flash rate with function number 5. You need only use the parameter `rate` if you want to pass a new flash rate.

Example:

```
move.w #20,-(sp)        20/70 seconds
move.w #4,-(sp)         Set flash rate
move.w #21,-(sp)        cursconf
trap   #14
addq.l #6,sp
```

22 settime *set clock time and date*

```
C: void settime(time)
   long time;
```

Assembler:

```
move.l time,-(sp)
move.w #22,-(sp)
trap   #14
add.l  #6,sp
```

This function is used to set the clock time and date. The time is passed in the lower word of `time` and the date in the upper word. The time and date are coded as follows:

```
bits  0- 4  Seconds in two-second increments
bits  5-10  Minutes
bits 11-15  Hours

bits 16-20  Day 1-31
bits 21-24  Month 1-12
bits 25-31  Year (minus offset 1980)
```

Example:

```
move.l #%1011001100000100000000000000,-(sp)
move.w #22,-(sp)      settime
trap   #14
addq.l #6,sp
```

This call sets the date to the 16th of September, 1985, and the clock time to 8 o'clock.

23 gettime *return clock time and date*

```
C: long gettime()
```

Assembler:

```
move.w #23,-(sp)
trap   #14
addq.l #2,sp
```

This function returns the current date and the clock time in the following format:

```
bits  0- 4  Seconds in two-second increments
bits  5-10  Minutes
bits 11-15  Hours

bits 16-20  Day 1-31
bits 21-24  Month 1-12
bits 25-31  Year (minus offset 1980)
```

Example:

```
move.w #23,-(sp)     gettime
trap   #14
addq.l #2,sp
move.l d0,time       Save time and date
```

24 bioskeys *restore keyboard table*

`C: void bioskeys()`

Assembler:

```
move.w #24,-(sp)
trap   #14
addq.l #2,sp
```

If you have selected a new keyboard layout with the XBIOS function 16, *keytbl*, this function will restore the standard BIOS keyboard layout. You can call this function, for example, before exiting a program of your own which changed the keyboard layout.

Example:

```
move.w #24,-(sp)    bioskeys
trap   #14
addq.l #2,sp
```

25 ikbdws *intelligent keyboard send*

```
C: void ikbdws(number, pointer)
   int  number;
   long pointer;
```

Assembler:

```
   move.l pointer,-(sp)
   move.w number,-(sp)
   move.w #25,-(sp)
   trap   #14
   addq.l #8,sp
```

This XBIOS function serves to transmit commands to the keyboard processor (intelligent keyboard). The parameter `pointer` is the address of a string to be sent, `number` is the length of a string minus 1.

Example:

```
   move.l #string,-(sp)             Address of the string
   move.w #strend-string-1,-(sp)    Length minus 1
   move.w #25,-(sp)                 ikbdws
   trap   #14
   addq.l #8,sp
   ...
string     dc.b  $80,1
strend     equ   *
```

26 jdisint *disable interrupts on MFP*

```
C: void jdisint(number)
   int number;
```

Assembler:

```
move.w number,-(sp)
move.w #26,-(sp)
trap   #14
addq.l #4,sp
```

This function makes it possible to selectively disable interrupts on the MFP 68901. The parameter is the MFP interrupt number (0-15). The significance of the individual interrupts is described in the section on interrupts.

Example:

```
move.w #10,-(sp)     Disable RS-232 transmitter interrupt
move.w #26,-(sp)     Disable interrupt
trap   #14
addq.l #4,sp
```

27 jenabint *enable interrupts on MFP*

```
C: void jenabint(number)
   int number;
```

Assembler:

```
move.w number,-(sp)
move.w #27,-(sp)
trap   #14
addq.l #4,sp
```

This function can be used to re-enable an interrupt on the MFP. The parameter is again the number of the interrupt, 0-15.

Example:

```
move.w #12,-(sp)      Enable RS-232 receiver interrupt
move.w #27,-(sp)      Enable interrupt
trap   #14
addq.l #4,sp
```

28 giaccess *access GI sound chip*

```
C: char giaccess(data, register)
   char data;
   int  register;
```

Assembler:

```
   move.w #register,-(sp)
   move.w #data,-(sp)
   move.w #28,-(sp)
   trap   #14
   addq.l #6,sp
```

This function allows access to the registers of the GI sound chip. `register` must contain the register number of the sound chip (0-15). The meaning of the individual registers is given in the hardware description of the sound chip. Bit 7 of the register number determines whether the specified register will be written or read:

```
  Bit 7  0: Read
         1: Write
```

When writing, an 8-bit value is passed in `data;` when reading, the function returns the contents of the corresponding register.

Example:

```
   move.w #$80+3,-(sp)      Write register 3
   move.w #$50,-(sp)        Value to write
   move.w #28,-(sp)
   trap   #14
   addq.l #6,sp
```

29 offgibit *reset Port A GI sound chip*

```
C: void offgibit(bitnumber)
   int bitnumber;
```

Assembler:

```
move.w #bitnumber,-(sp)
move.w #29,-(sp)
trap   #14
addq.l #4,sp
```

A bit of port A of the sound chip can be selectively set with this function call. Port A is an 8-bit output port in which the individual bits have the following funtion:

```
Bit 0:  Select disk side 0/side 1
Bit 1:  Select drive A
Bit 2:  Select drive B
Bit 3:  RS-232 RTS (Request To Send)
Bit 4:  RS-232 DTR (Data Terminal Ready)
Bit 5:  Centronics strobe
Bit 6:  General Purpose Output
Bit 7:  unused
```

Example:

```
move.w #4,-(sp)      DTR bit
move.w #29,-(sp)     offgibit
trap   #14
addq.l #4,sp
```

30 ongibit *clear Port A of GI sound chip*

```
C: void ongibit(bitnumber)
   int bitnumber;
```

Assembler:

```
   move.w #bitnumber,-(sp)
   move.w #30,-(sp)
   trap   #14
   addq.l #4,sp
```

This function is the counterpart of the previous function. With this it is possible to clear a bit of port A in the sound chip.

Example:

```
   move.w #4,-(sp)      DTR bit
   move.w #30,-(sp)     ongibit
   trap   #14
   addq.l #4,sp
```

31 xbtimer *start MFP timer*

```
C: void xbtimer(timer, control, data, vector)
   int  timer, control, data;
   long vector;
```

Assembler:

```
    move.l vector,-(sp)
    move.w data,-(sp)
    move.w control,-(sp)
    move.w timer,-(sp)
    move.w #31,-(sp)
    trap   #14
    add.l  #12,sp
```

This function allows you to start a timer in the MFP 68901 and assign an interrupt routine to it. `timer` is the number of the timer in the MFP:

```
Timer A : 0
Timer B : 1
Timer C : 2
Timer D : 3
```

The parameters `data` and `control` are the values which are placed in the corresponding control and data registers of the timer. We refer you to the hardware description of the MFP 68901.

The parameter `vector` is the address of the interrupt routine which will be executed when the timer runs out. The four timers in the MFP are already partly used by the operating system:

```
Timer A:  Reserved for the end user
Timer B:  Horizontal blank counter
Timer C:  200 Hz system timer
Timer D:  RS-232 baud rate generator
          (the interrupt vector is free)
```

Example:

```
move.l #vector,-(sp)     Interrupt routine
move.w data,-(sp)        Data and
move.w control,-(sp)     Control registers
move.w #0,-(sp)          Timer A
move.w #31,-(sp)         xbtimer
trap   #14
add.l  #12,sp
```

32 dosound *set sound parameters*

```
C: void dosound(pointer)
   long pointer;
```

Assembler:

```
move.l pointer,-(sp)
move.w #32,-(sp)
trap   #14
addq.l #6,sp
```

This function allows for easy sound processing. The parameter `pointer` must point to a string of sound commands. The following commands can be used:

Commands: $00-$0F
: These commands are interpreted as register numbers of the sound chip. A byte following this is loaded into the corresponding register.

Command $80
: An argument follows this command which will be loaded into a temporary register.

Command $81
: Three arguments must follow this command. The first argument is the number of the register in the sound chip in which the contents of the temporary register will be loaded. The second argument is a two's-complement value which will be added to the temporary register. The third argument contains an end criterium. The end is reached when the content of the temporary register is equal to the end criterium.

Commands $82-$FF
: One argument follows each of these commands. If this argument is zero, the sound processing is halted. Otherwise this argument specifies the number of timer ticks (20ms, 50Hz) until the next sound processing.

Example:

```
   move.l #pointer,-(sp)    Pointer to sound command
   move.w #32,-(sp)         dosound
   trap   #14
   addq.l #6,sp
   ....
pointer   dc.b 0,10,1,50,...
```

33 setprt *set printer configuration*

```
C: void setptr(config)
   int config;
```

Assembler:

```
move.w config,-(sp)
move.w #33,-(sp)
trap   #14
addq.l #4,sp
```

This function allows the printer configuration to be read or changed. If `config` contains the value -1, the current value is returned, otherwise the value is accepted as the new printer configuration. The printer configuration is a bit vector with the following meaning:

```
Bit number     0                   1
    0      matrix printer     daisy-wheel
    1      monochrome printer color printer
    2      Atari printer      Epson printer
    3      Test mode          Quality mode
    4      Centronics port    RS-232 port
    5      Continuous paper   Single-sheet
  6-14              reserved
   15               always 0
```

Example:

```
move.w #%000100,-(sp)     Epson printer
move.w #33,-(sp)          setprt
trap   #14
addq.l #4,sp
```

34 kbdvbase *return keyboard vector table*

C: `long kbdvbase()`

Assembler:

```
move.w #34,-(sp)
trap   #14
addq.l #2,sp
```

This XBIOS function returns a pointer to a vector table which contains the address of routines which process the data from the keyboard processor. The table is constructed as follows:

```
long  midivec     MIDI input
long  vkbderr     Keyboard error
long  vmiderr     MIDI error
long  statvec     IKBD status
long  mousevec    Mouse routines
long  clockvec    Clock time routine
long  joyvec      Joystick routines
```

The parameter `midivec` points to a routine which writes data received from the MIDI input (byte in D0) to the MIDI buffer.

The parameters `vkbderr` and `vmiderr` are called when an overflow is signaled by the keyboard or MIDI ACIA.

The remaining four routines `statvec`, `mousevec`, `clockvec`, and `joyvec` process the corresponding data packages which come from the keyboard ACIA. A pointer to the packaged received is passed to these routines in D0. The mouse vector is used by GEM. If you want to use your own routine, you must terminate it with RTS and it may not require more than one millisecond of processing time.

Example:

```
move.w #34,-(sp)    kbdvbase
trap   #14
addq.l #2,sp
```

We get $A0E as the result. The vector field contains the following values:

```
A0E       midivec     $79C6
A12       vkbderr     $759C
A16       vmiderr     $759C
A1A       statvec     $7034
A1E       mousevec    $15296
A22       clockvec    $6A46
A26       joyvec      $7034
A2A       MIDI        $7556
A2E       keyboard    $7568
```

35 kbrate *set keyboard repeat rate*

```
C: int kbrate(delay, repeat)
   int delay, repeat;
```

Assembler:

```
move.w repeat,-(sp)
move.w delay,-(sp)
move.w #35,-(sp)
trap   #14
addq.l #6,sp
```

The keyboard repeat can be controlled with this function. The parameter `delay` specifies the delay time after a key is pressed before the key will automatically be repeated. The parameter `repeat` determines the time span after which the key will be repeated again. These values can be changed from the desktop by means of the two slide controllers on the control panel. The times are based on the 50 Hz system clock. If -1 is specified for one of the parameters, the corresponding value is not set. The function returns the previous values as the result; bits 0-7 contain the `repeat` value and bits 8-15 the value of `delay`.

Example:

```
move.w #-1,-(sp)      Read old values
move.w #-1,-(sp)
move.w #35,-(sp)      kbrate
trap   #14
addq.l #6,sp
```

Result: D0 = $0B03

36 prtblk *output block to printer*

```
C: void prtblk(parameter)
   long parameter;
```

Assembler:

```
move.l parameter,-(sp)
move.w #36,-(sp)
trap   #14
addq.l #6,sp
```

This function resembles the function *scrdmp*(20) and is used by it. The function expects a parameter list, however, whose address is passed to it. This list is constructed as follows:

```
long  blkprt   Address of the screen RAM
int   offset
int   width    Screen width
int   height   Screen height
int   left
int   right
int   scrres   Screen resolution (0, 1, or 2)
int   dstres   Printer resultion (0 or 1)
long  colpal   Address of the color palette
int   type     Printer type (0-3)
int   port     Printer port (0=Centronics, 1=RS232)
long  masks    Pointer to half-tone mask
```

Assembler:

```
   move.l #parameter,-(sp)   Address of the parameter block
   move.w #36,-(sp)          prtblk
   trap   #14
   addq.l #6,sp
   ...
parameter dc.l ...
```

37 wvbl *wait for video*

`C: void wvbl()`

Assembler:

```
move.w #36,-(sp)
trap   #14
addq.l #2,sp
```

This function waits for the next picture return. It can be used to synchronize graphic outputs with the beam return, for example.

Example:

```
move.w #36,-(sp)      wait for wvbl
trap   #14
addq.l #2,sp
```

38 supexec *set supervisor execution*

```
C: void supexec(address)
   long address;
```

Assembler:

```
   move.l address,-(sp)
   move.w #38,-(sp)
   trap   #14
   addq.l #6,sp
```

If a routine is to be executed in the supervisor mode of the 68000 processor, you can accomplish this with this function. Simply pass the address of the routine to the function. Example:

```
   move.l #address,-(sp)
   move.w #38,-(sp)
   trap   #14
   addq.l #6,sp
   ...
address   move.l $400,00
   ...
```

39 puntaes *disable AES*

```
C: void puntaes()
```

Assembler:

```
move.w #39,-(sp)
trap   #14
addq.l #2,sp
```

The AES can be disabled with this function, provided it is not in ROM.

Example:

```
move.w #39,-(sp)
trap   #14
addq.l #2,sp
```

3.4 The Graphics

Next to the high processing speed and the large memory available, the graphics capability is certainly the most fascinating aspect of the ST. With the standard monochrome monitor and the resolution of 640x400 points, it creates a whole new price/performance class for itself. But also in the color resoultion the ST can display 16 colors with 320x200 screen points.

In this chapter we want to explain how the graphics are organized and how you can create fast and effective graphics without using the GEM graphics package, which is rather complicated for beginners. The ST offers the programmer (assembler and C) very useful routines, with whose help graphics programming isn't quite child's play, but they can take away a good deal of the programming work. Unfortunately, some of these functions are so comprehensive that a detailed description would exceed the scope of this book. We have therefore had to limit ourselves to the simpler, but no less interesting functions.

These graphics routines are called in a very elegant manner. The software developers have made use of the fact that there are two groups of opcodes in the 68000 which the 68000 does not "understand" and which generate a trap, or software interrupt, when they are encountered in a program. These are the two groups of opcodes which begin with $Axxx and $Fxxx. In the ST, the $Axxx opcode trap is used in order to access the graphics routines. The trap handler, the program called by the trap, checks the lowest byte of the "command" to see what value it has. Values between zero and $E are permissable here. This gives a total of 14 graphics routines, which should first be presented in an overview. Later we will talk about the actual commands in detail.

```
$A000 Determine address of required variable range
$A001 Set point on the screen
$A002 Determine color of a screen point
$A003 Draw a line on the screen
$A004 Draw a horizontal line (very fast!)
$A005 Fill rectangle with color
$A006 Fill polygon line by line
$A007 Bit block transfer
$A008 Text block transfer
$A009 Enable mouse cursor
$A00A Disable mouse cursor
```

```
$A00B Change mouse cursor form
$A00C Clear sprite
$A00D Enable sprite
$A00E Copy raster form
```

These routines are the ground work for the hardware-dependent part of GEM. All GEM graphic and text output is performed by the routines of the $Axxx opcodes. The set of A-opcodes are very useful in games. In games windows are needed only in the rarest cases. Another important point is the speed of the A-instructions. Using the graphic routines directly is clearly faster than if the output is handled by GEM. Before we describe the individual commands in detail, we will take a brief look at the construction of graphics in the various graphic modes of the ST.

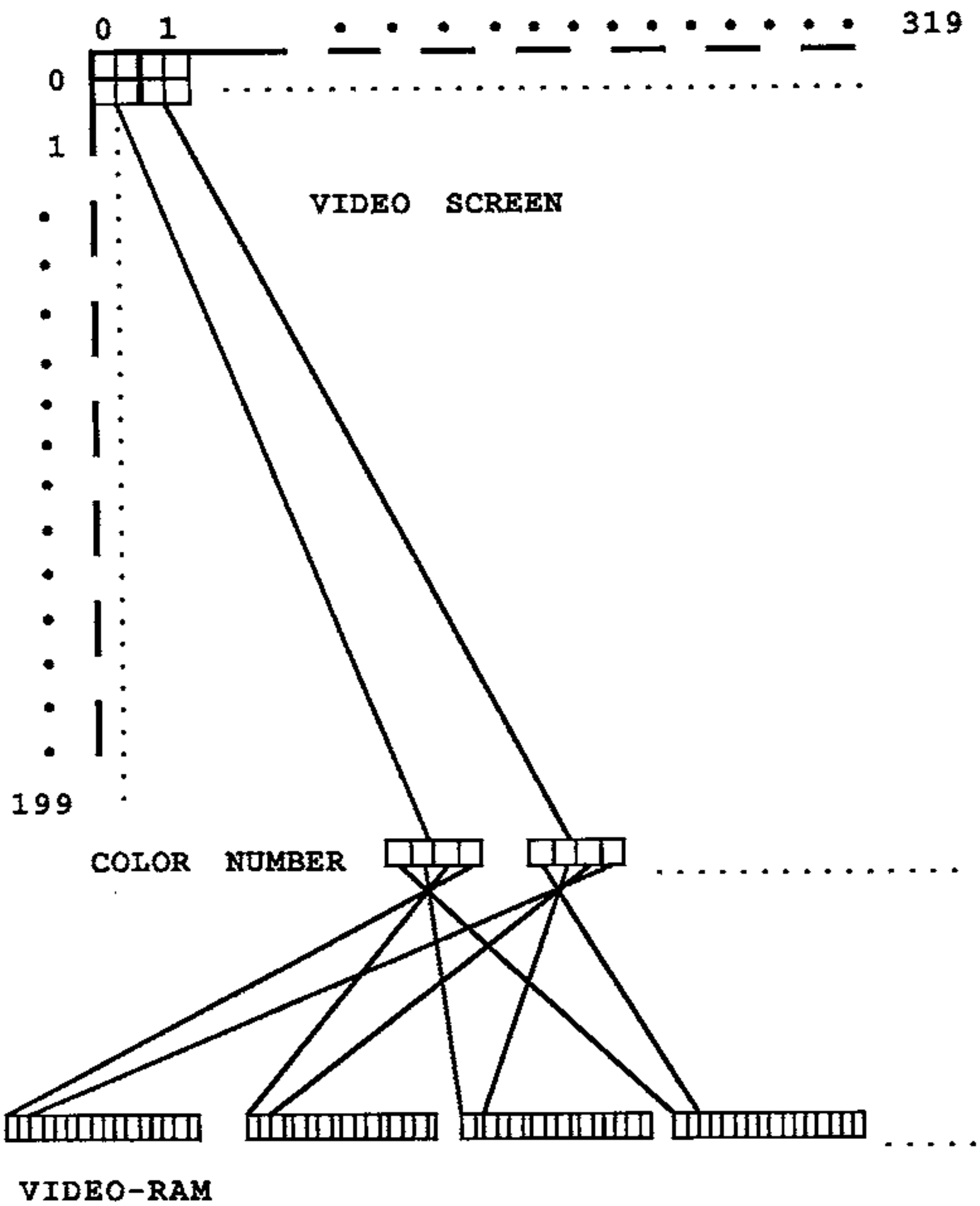
Immediately after turning the ST on, an area of 32K bytes is initialized at the upper memory border as the video RAM. In normal operation this results in addresses $78000 to $7FFFF acting as the screen RAM. This video RAM can be viewed as a window in the ST. We will start with the simplest mode, the 640x400 mode. In this case each 80 bytes, or better, each 40 words forms one screen line. The word with the lowest address is displayed on the left edge of the screen, the additional words are displayed in order from left to right. Within a word, the highest-order bit lies at the left and the lowest-order bit at the right.

With this data, any point on the screen can be easily controlled or read. For example, to set the first screen point, the value $8000 must be written into memory location $78000. Therefore you might store $8000 into memory location $78000. But this isn't recommended.

You might recall that the screen RAM in the ST can be moved quite easily. Then the absolute address of $78000 is no longer correct, of course. For this reason, it is usually more advantageous to set the the point with the "A" function $A001. Function $A001 assumes an X-Y coordinate system with origin in the upper left-hand corner, and determines the position of the video RAM itself in order to set the point at the proper screen location.

In this resolution mode, each screen point is represented by a bit. If the bit is set, the point appears dark, or bright if the the inverse display mode is selected in color palette register 0. The screen consists of only one bit plane. Different colors cannot be represented with just one plane, however. This is why when the resolution increases in the color modes, the number of displayable colors decreases.

Figure 3.4-1 LO-RES-MODE (0)



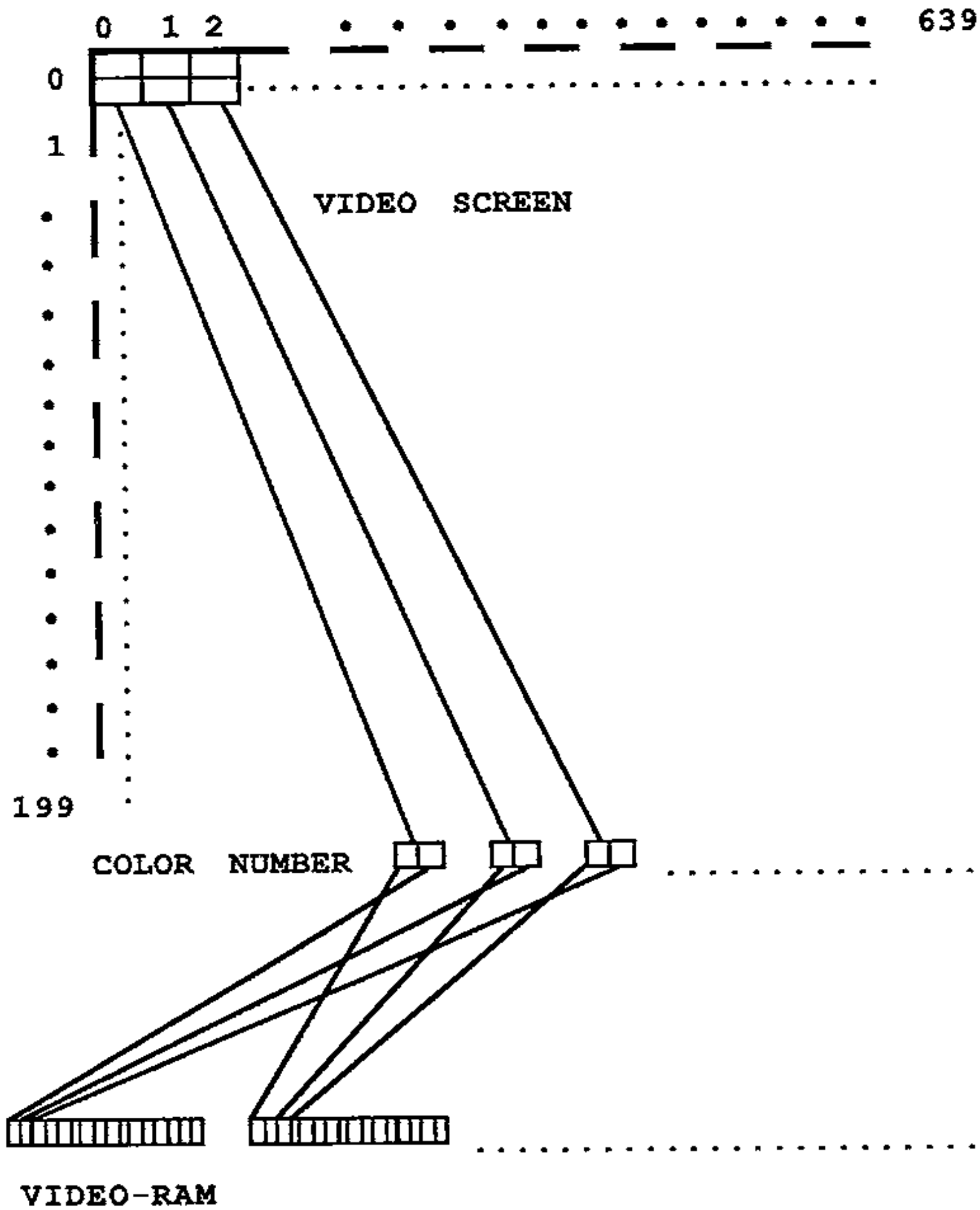
Four colors possible in the 640x200 resolution mode. In this mode, two contiguous memory words form a single logical entity. The color of a point is determined by the value of the two corresponding bits in the two words. If both bits are zero, the background color results. Therefore two sequential words are used together for pixel representation. For the colors, however, all odd words belong to a plane. The second plane is made up of the even words. In this mode, there are two planes available.

Things become quite colorful in the mode with "only" 320x200 points. In this operating mode, 4 contiguous memory words form one entity which detemines the color of the 16 pixels. To stick to the example we used before: in order to set the point in the upper left-hand corner, the topmost bits of words $78000, $78002, $78004, and $78006 must be manipulated. The desired color results from the bit pattern in the words. It naturally requires some computer time to set a point in the desired color, independent of the mode. All of this work is handled by the $A001 routine, however. This routine sets all of the pertaining bits for the desired color in the current resolution. Naturally, all four planes are present in this mode. The first plane, keeping to our example, made up of the words at address $7F000, $7F008, $7F010, ..., and the other planes are composed of the other addresses correspondingly.

Another point to be clarified concerns the fonts or character sets. Since the ST does not have a text mode, only a graphics mode, the text output is created in high-resolution graphics. There are three different fonts built into the ST. You can load additional fonts from disk. Each font has a header which contains important information about the displayable characters. Since the important data are contained in the font header, there are unusually few limits for display. The characters can be arbitrarily high or wide. The age of the 8x8 matrix for character output is over. Genuine proportional type on the screen (!) is even possible.

The three built-in fonts use relatively few of the many possibilities which GEM allows for character generation. All three fonts are mono-spaced fonts, meaning they have a fixed defined size in pixels and a defined pitch. The smallest font has a matrix of 6x6. With a resolution of 640x400 points, 66 lines of 106 characters each can be displayed. This font is only accessible for output under GEM, not for output under TOS, and is used in the output of the directory in the icon form, for example. The next-largest type is composed of 8x8 points. This type is used when a color monitor is connected to the ST, while the third and largest font is used for the normal black-and-white mode. This font uses a matrix of 8x16 points.

Figure 3.4-2 MEDIUM-RES-MODE (1)



The exact layout of the font header is found under command $A008, which represents a very versatile text output which goes far beyond what is possible with the routine of the BIOS and GEMDOS.

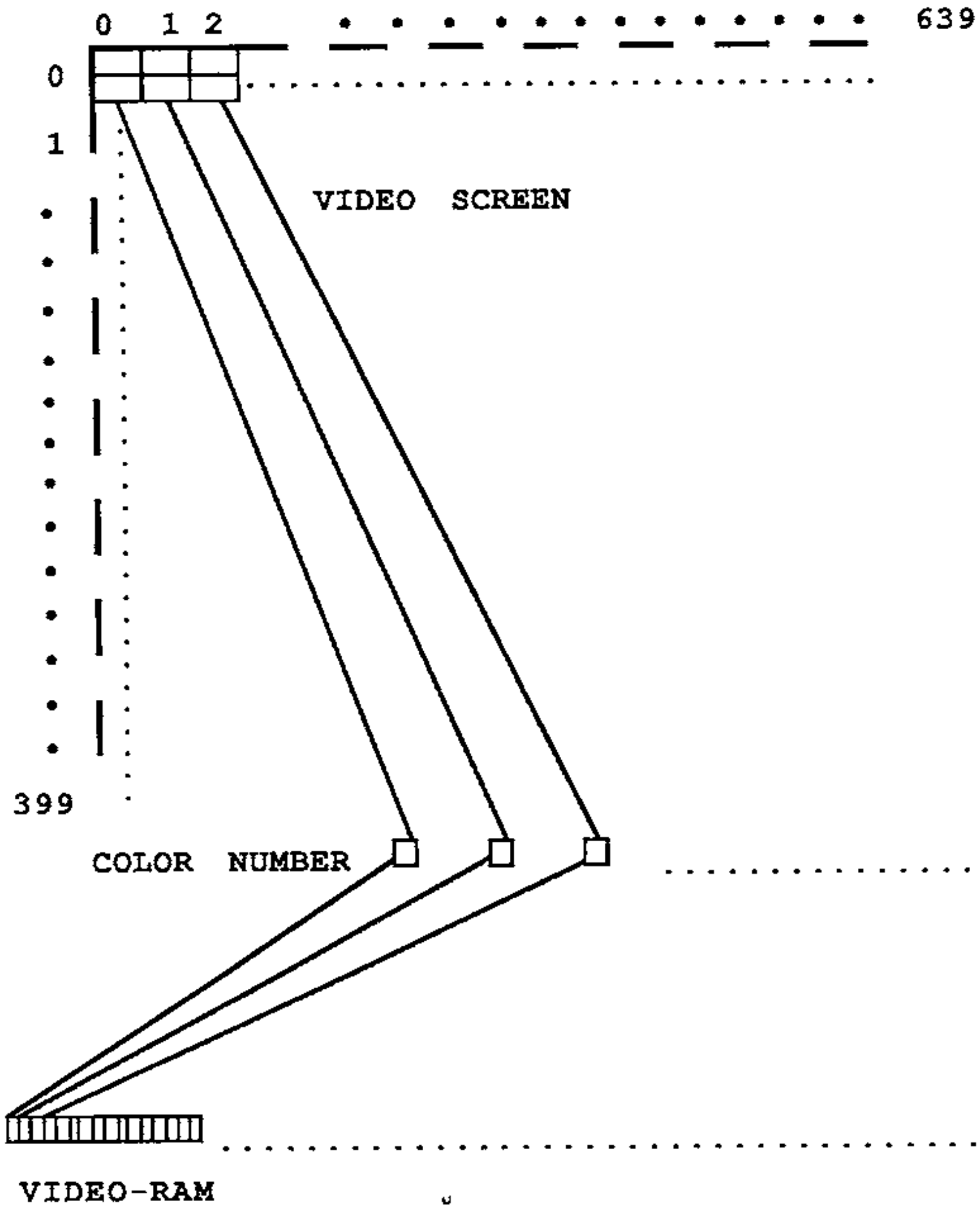
Finally, we must clarify some of the terms which will come up often in the following descriptions, whose meaning may not be so clear. These are the terms CONTRL array, INTIN array, INTOUT array, PTSIN array and PTSOUT array. These arrays are mainly used by GEM to pass parameters to individual GEM functions or to store results from these functions. But line-A functions use parts of these arrays to pass parameters also. The arrays are defined in memory as data areas, whereby each element in the array consists of 2 bytes.

For GEM functions, the CONTRL array always contains the number desired in the first element (CONTRL(0)). This parameter is not used by the line-A commands, however. CONTRL(1) contains the number of XY coordinates required for the function. These coordinates must be placed in the PTSIN array before the call. The element CONTRL(2) is not supplied before the call. After the call it contains the number of XY coordinates in the PTSOUT array. CONTRL(3) specifies how many parameters will be passed to the function in the INTIN array, while CONTRL(4) contains the number of parameters in the INTOUT array after the call. The additional parameters of the CONTRL array are not relevant for users of the line A.

Unfortunately, not all of the parameters for the A opcodes can be in these arrays. For this reason there is another memory area which used as a variable area for (almost) all graphic outputs. The function and use of these over 50 variables is found in a table at the end of this chapter. Important variables are also explained in conjunction with the functions which require them.

By the way, you should be aware that registers D0 to D2 and A0 to A2 are changed by calling the functions. Important values contained in these registers should be saved before a call.

Figure 3.4-3 HI-RES-MODE (2)



$A000 Initialize

Initialize is really the wrong expression for this function. After the call, the addresses of the more important data areas are returned in registers D0 and A0 to A2. This function does not require input parameters.

The program is informed of the starting address of the line-A variables in D0 and A0. After the call, A1 points to a table with three addresses. These three addresses are the starting address of the three system font headers. Register A2 points to a table with the starting addresses of the 15 line-A routines.

This opcode destroys (at least) the contents of registers D0 to D2 and A0 to A2. Important values should be saved before the call.

$A001 PUT PIXEL

This opcode sets a point at the coordinates specified by the coordinates in `PTSIN(0)` and `PTSIN(1)`. The color is passed in `INTIN(0)`. `PTSIN(0)` contains X-coordinate, `PTSIN(1)` the Y-coordinate.

The coordinate system used has its origin in the upper left corner. The possible range of the X and Y coordinates is naturally set according to the graphic mode enabled. Overflows in the X range are not handled as errors. Instead, the Y coordinate is simply incremented by the appropriate amount. No output is made if the Y range is exceeded.

The color in `INTIN(0)` is dependent on the mode used. When driving the monochrome monitor, only bit zero of the value of `INTIN(0)` is evaluated.

$A002 GET PIXEL

The color of a pixel can be determined with this opcode. As with $A001, the XY coordinates are passed in `PTSIN(0)` and `PTSIN(1)`; the color value is returned in the D0 register.

$A003 LINE

With the LINE opcode a line can be drawn bewteen the points with coordinates x1,y1 and x2,y2. The parameters for this function are not passed via the parameter arrays, but must be transferred to the line-A variables before the call. The variables used are:

```
_X1      = x1 coordinate
_Y1      = y1 coordinate
_X2      = x2 coordinate
_Y2      = y1 coordinate
_FG_BP_1 = Plane 1 (all three modes)
_FG_BP_2 = Plane 2 (640x200, 320x200)
_FG_BP_3 = Plane 3 (only 320x200)
_FG_BP_4 = Plane 4 (only 320x200)
_LN_MASK = Bit pattern of the line
           For example: $FFFF = filled
                        $CCCC = broken
_WRT_MOD = Determines the write mode
_LSTLIN  = This variable should be set to -1 ($FFFF)
```

One point to be noted for some applications is the fact that when drawing a line, the highest bit of the line bit pattern is always set on the left screen edge. The line is always drawn from left to right and from top to bottom, not from x1,y1 to x2,y2.

Range overflows are handled as for PUT PIXEL. If an attempt is made to draw a line from 0,0 to 650,50, a line is actually drawn from, 0,0 to 639,48. The "remainder" results in an additional line from 0,49 to 10,50.

A total of four different write modes, with values 0 to 3, are available for drawing lines. With write mode zero, the original bit pattern "under" the line is erased and the bit pattern determined by `_LN_MASK` is put in its place (replace mode). In the transparent mode (`_WRT_MOD=1`), the background, the old bit pattern, is ORed with the new line pattern so only additional points are set. In the XOR mode (`_WRT_MOD=2`), the background and the line pattern are exclusive-ored. The last mode (`_WRT_MOD=3`) is the so-called "inverse transparent mode." As in the transparent mode, it involves an OR combination of the foreground and background data, in which the foreground data, the bit pattern determined by `_LN_MASK`, are inverted before the OR operation.

$A004 HORIZONTAL LINE

This function draws a line from x1,y1 to x2,y1. Drawing a horizontal line is significantly faster than when a line must be drawn diagonally. Diagonal lines are also created with this function, in which the line is divided into multiple horizontal lines segments. The parameters are entered directly into the required variables.

```
_X1       = x1 coordinate
_Y1       = y1 coordinate
_X2       = x2 coordinate
_FG_BP_1 = Plane 1 (all three modes)
_FG_BP_2 = Plane 2 (640x200, 320x200)
_FG_BP_3 = Plane 3 (only 320x200)
_FG_BP_4 = Plane 4 (only 320x200)
_WRT_MOD = Determines the write mode
_patptr  = Pointer to the line pattern to use
_patmsk  = "Mask" for the line pattern
```

The valid values in `_WRT_MOD` also lie between 0 and 3 for this call. The contents of the variable `_patptr` is the address at which the desired line pattern or fill pattern is located. The H-line function is very well-suited to creating filled surfaces. The variable `_patmsk` plays an important role in this. The number of 16-bit values at the address in `_patptr` is dependent on the its value. If, for example, `_patmsk` contains the value 5, six 16-bit values should be located at the address in `_patptr` as the line pattern. If a horizontal line with the Y-coordinate value zero is to be drawn, the first bit pattern is taken as the line pattern. The second word is taken as the pattern for a line drawn at Y-coordinate 1, and so on. The pattern for a line with Y-coordinate 6 is again determined by the first value in the bit table. In this manner, very complex fill patterns can be created with relatively little effort.

$A005 FILLED RECTANGLE

The opcode $A005 represents an extension, or more exactly a special use, of opcode $A004. It is used to created filled rectangles. The essential parameters are the coordinates of the upper left and lower right corners of the of the rectangle.

```
_X1       = x1 coordinate, left upper
_Y1       = y1 coordinate
_X2       = x2 coordinate, right lower
_Y2       = y2 coordinate
_FG_BP_1  = Plane 1 (all three modes)
_FG_BP_2  = Plane 2 (640x200, 320x200)
_FG_BP_3  = Plane 3 (only 320x200)
_FG_BP_3  = Plane 4 (only 320x200)
_WRT_MOD  = Determines the write mode
_patptr   = Pointer to the fill pattern used
_patmsk   = "Mask" for the fill pattern
_CLIP     = Clipping flag
_XMN_CLIP = X minimum for clipping
_XMX_CLIP = X maximum for clipping
_YMN_CLIP = Y minimum for clipping
_YMX_CLIP = Y maximum for clipping
```

We have already explained all of the variables except the "clipping" variables. What is clipping? Clipping creates extracts or clippings of the total picture. If the clipping flag is set to one (or any value not equal to zero), the rectangle, drawn by $A005, is displayed only in the area defined by the clipping-area variables. An example may explain this behavior better: The values 100,100 and 200,200 are specified as the coordinates. The clip flag is 1 and the clip variables contain the values 150,150 for `XMN_CLIP` and `YMN_CLIP` as well as 300,300 for `XMX_CLIP` and `YMX_CLIP`. The value $FFFF will be chosen as the fill value for all of the lines. With these values, the rectangle will have the coordinate 150,150 as the upper left corner and 200,200 as the lower right. The "missing" area is not drawn because of the clip specifications. Clearing the clip flag draws the rectangle in the originally desired size.

$A006 FILLED POLYGON

$A006 is also an extension of $A004. Arbitrary surfaces can be filled with a pattern with this function. The entire surface is not filled with the call: just one raster line is filled, a horizontal line with a width of one point. The result is that there are significantly more options for influencing the fill pattern.

The necessary variables are:

```
PTSIN      = Array with the XY coordinates
CONTRL(1)  = Number of coordinate pairs
_Y1        = y1 coordinate
_FG_BP_1   = Plane 1 (all three modes)
_FG_BP_2   = Plane 2 (640x200, 320x200)
_FG_BP_3   = Plane 3 (only 320x200)
_FG_BP_3   = Plane 4 (only 320x200)
_WRT_MOD   = Determines the write mode
_patptr    = Pointer to the fill pattern used
_patmsk    = "Mask" for the fill pattern
_CLIP      = Clipping flag
_XMN_CLIP  = X minimum for clipping
_XMX_CLIP  = X maximum for clipping
_YMN_CLIP  = Y minimum for clipping
_YMX_CLIP  = Y maximum for clipping
```

Basically, all of the parameters here are to be set exactly as they might be for a call to $A005. Only the first three coordinates are different. The XY coordinates are stored in the `PTSIN` array. It is important you specify the start coordinate again as the last coordinate as well. In order to fill a triangle, you must, for example, enter the coordinates (320,100), (120,300), (520,300), and (320,100). The number of effective coordinate pairs, three in our example, must be placed in `CONTRL(1)`, the second element of the array. With a call to the $A006 function you must also specify the Y-coordinate of the line to be drawn. Naturally you can fill all Y-coordinates from 0 to 399 (0 to 199 in the color modes) in order. But it is faster to find the largest and smallest of the XY values and call the funtion with only these as the range.

$A007 BITBLT

The bit block transfer is used by the text block transfer, $A008, and copy raster form, $A00E. Register A6 must contain a pointer to a parameter table. Unfortunately, the construction of this parameter table could not be determined definitively. Our attempts led to classic system crashes about 70% of the time. For this reason, we cannot say much about the function.

$A008 TEXTBLT

A character from any desired text font can be printed at any graphic position with the TEXT BLock Transfer function. In addition, the form of the character can be changed. The character can be displayed in italics, boldface, outlines, enlarged, or rotated. These things cannot be achieved with the "normal" character outputs via the BIOS or GEMDOS. But to do this, a large number of parameters must be set and controlled. A rather complicated program must be written in order to output text with this function. If the additional options are not absolutely necessary, it is advisable not to use this function. But please decide for yourself.

Before we produce a character on the screen, we must first concern ourselves with the organization of the fonts. We must take an especially close look at the font header because the font is describe in detail by the information contained in it.

Basically, a font consists of four sets of data: font header, font data, character offset table, and horizontal offset table. The font header contains general data about the font, such as its name and size, the number of characters it contains, and various other aspects. This information takes up a total of 88 bytes. The font data contains the bit pattern of the existing, displayable characters. These data are organized so as to save as much space as possible.

In order to be able to better describe the organization, we will imagine a font with only two characters, such as "A" and "B". These characters are to be displayed in a 9x9 matrix. The font data are now in memory so that the bit pattern of the top scan line of the "A" is stored starting at a word boundary.

Since our font is 9 pixels = 9 bits wide, one byte is completely used, but only the top bit of the following byte. 7 bits must be wasted if the top scan line of the "B" is also to begin on a word boundary. This is not so, however, and the first scan line of the "B" starts with bit 6 of the second byte of the font data. Only the data of the second and further scan lines always start on a word boundary. In this manner, almost no bits are wasted in the font. Only the start of the scan lines of the first character actually begin on a word boundary; all other scan lines can begin at any bit position.

Because of this space-saving storage, the position of each character within the font must be calculated. The calculation of the scan-line positions is possible through the character offset table. This table contains one entry for each displayable character. For our example, such a table would contain the entries $0000, $0009, $0012. Through the direction of this table, it is possible to create true proportional type on the screen since the width of each character can be calculated. One subtracts the entry of the character to be displayed from the entry of the next character. The last entry is present so that the width of the last character can also be determined, although it is not assigned to a character.

In addition to the character offset table there is the horizontal offset table. This table is not used by most of the fonts, however. The fonts present in the ST do not use all the possibilities of this table either. If this table were present, it would contain a positive or negative offset value for each character, in order to shift the character to the right or left during output.

At the end of the description of the font construction are the meanings of the variables in the font header.

```
Bytes  0- 1 : Font identifier. A number which describes the
              font.      1=system font
Bytes  2- 3 : Font size in points (point is a measure used
              in type-setting).
Bytes  4-35 : The name of the font as an ASCII string.
Bytes 36-37 : The lowest ASCII value of the displayable
              characters.
Bytes 38-39 : The highest ASCII value of the displayable
              characters.
Bytes 40-49 : Relative distances of top, ascent, half,
              descent, and bottom line from the base line.
Bytes 50-51 : Width of the broadest character in the font.
Bytes 52-53 : Width of the broadest character cell. The cell
              is always at least one pixel wider than the
              actual character so that two characters next
              to each other are separated from each other.
Bytes 54-55 : Linker offset.
```

Bytes 56-57 : Right offset. The two offset values are only used for displaying the font in italics (skewing).

Bytes 58-59 : Thickening. If a character is to be displayed in boldface, the value of this variable is used.

Bytes 60-61 : Underline. Contains the height of the underline in pixels.

Bytes 62-63 : Lightening mask. "Light" characters are found on the desktop when an option on a pull-down menu is not available. This light grey character consists of masking the bits with the lightening mask. Usually the value is $5555.

Bytes 64-65 : Skewing mask. As before, only for displaying characters in italics.

Bytes 66-67 : Flag. Bit 0 is set if the font is a system font.
Bit 1 must be set if the horizontal offset table is present.
Bit 2 is the so-called byte-swap flag. If it is set, the bytes in memory are in 68000 format (low byte-high byte). A cleared swap flag signals that the data is in INTEL format, reversed in memory. With this bit the fonts from the IBM version of GEM can be used on the ST and vice versa.
Bit 3 is set if the width of all characters in the font is equal.

Bytes 68-71 : Pointer to the horizontal offset table or zero.

Bytes 72-75 : Pointer to the character offset table.

Bytes 76-79 : Pointer to the font data.

Bytes 80-81 : Form width. This variable contains the sum of widths of all the characters. The value represents the length of the scan lines of all of the characters and thereby the start of the next line.

Bytes 82-83 : Form height. This variable contains the number of scan lines for this font.

Bytes 84-87 : Contain a pointer to the next font.

After so much talk, we should now list the parameters which must be noted or prepared for the $A008 opcode.

```
_WRT_MODE    = Write mode
_TEXT_FG     = Text foreground color
_TEXT_BG     = Text background color
_FBASE       = Pointer to the start of the font data
_FWIDTH      = Width of the font
_SOURCEX     = X-coordinate of the char in the font
_SOURCEY     = Y-coordinate of the char in the font
_DESTX       = X-coordinate of the char on the screen
_DESTY       = Y-coordinate of the char on the screen
_DELX        = Width of the character in pixels
_DELY        = Height of the character in pixels
_STYLE       = Bit-wise coded flag for special effects
_LITEMASK    = Bit pattern used for "lightening"
_SKEWMASK    = Bit pattern used for skewing
_WEIGHT      = Factor for character enlargement
_R_OFF       = Right offset of the char for skewing
_L_OFF       = Left offste of the char for skewing
_SCALE       = Flag for scaling
_XACC_DDA    = Accumulator for scaling
_DDA_INC     = Scaling factor
_T_SCLSTS    = Scaling direction flag
_CHUP        = Character rotation vector
_MONO_STATUS = Flag for monospaced type
_scrtchp     = Pointer to buffer for effects
_scrpt2      = Offset scaling buffer in _scrtchp
```

The five clip variables are also evaluated.

As you can see, an enormous number of variables are evaluated for the output of graphic text. Here we can go into only the essential (and those we explored) variables.

The write mode allows the output of characters in the four known modes, replace, OR, XOR, and inverse OR. There are 16 other modes available whose effects are not yet known. The variable `_TEXT_FG` is in connection with first four write modes. They form the foreground color used for display. The background color `_TEXT_BG` plays a role only with the 16 additional modes. It is clear that the additional modes are relevant only in connection with a color screen.

The variables _FBASE and _FWIDTH are set according to the desired font. You can find the start of the font data from the header of the desired font (bytes 76-79 in the header). _FWIDTH must be loaded with the contents of the bytes 80 and 81 of the header.

The parameter _SOURCEX determines which character you output. It should contain the ASCII value of the desired character.

The parameter _SOURCEY is usually zero because the character is to be generated from the top to the bottom scan line.

The parameter _DELX can be be calculated as the width of the character in which the entry in the character offset table of the desired character is subtracted from the next entry. The result is the width of the character in pixels. _DELY must be loaded with the value of byte 82-83 of the header.

The _STYLE is something special. Here you can specify if characters should be displayed normally or changed. The possible changes are boldface (thicken, bit 0), shading (lighten, bit 1), italic (bit 2), and outline (bit 4). The given change is enabled by setting the corresponding bit. Another change is scaling. The size of a character can be changed through scaling. Unfortunately, characters can only be enlarged on the ST.

If the scaling flag is cleared (zero), the character is displayed in its original size. The _T_SCLSTS flag determines if the font is to be reduced or enlarged. A value other than zero must be placed here for enlarging. _DDA_INC should contain the value of the enlargement or reduction. An enlargement could be produced only with a value of $FFFF.

Another interesting variable is _CHUP. With the help of this variable, characters can be rotated on the screen. The angle must be given in the range 0 to 360 degrees in tenths of a degree. A restriction must also be made for this function. Usuable results are obtainable only with rotations by 90 degrees. The values are $0000 for normal, $0384 for 90-degree rotation, $0704 (upside-down type), and $0A8C for 270 degrees.

To work with the effects, _scrchp must contain a pointer to a buffer in which TEXTBLT can store temporary values. The exact size of this buffer is not known, but we always found a buffer of 1K to be sufficient. Another buffer must be specified for enlargement (_scrtpt2). An offset is passed as a parameter which refers to the start of the _scrtchp buffer. A value of $40 proved to be sufficient here.

$A009 SHOW MOUSE

Calling this opcode enables the display of the mouse cursor. The cursor follows the mouse when it is moved. If the mouse cursor is disabled, the mouse can be used in programs which abandon the user interface GEM. This option is particularly useful for games.

The parameters required are passed in the `INTIN` and `CONTRL` arrays. `CONTRL(1)` should be cleared before the call and `CONTRL(3)` set to one. `INTIN(0)` has a special significance. The routine for managing the mouse cursor counts the number of calls to remove and enable the cursor. If the cursor is disabled twice, two calls must be made to re-enable it before it will actually appear on the screen. This behavior can be changed by clearing `INTIN(0)`. With this parameter the cursor is immediately set independent of the number of previous HIDE CURSOR calls. If the value in `INTIN(0)` is not equal to zero the actually required number of $A009 calls must be made in order to make the cursor visible.

$A00A HIDE CURSOR

This functions hides the cursor. If this function is called repeatedly, the number is recorded by the operating system and determines the number of calls of SHOW CURSOR before the cursor actually appears.

$A00B TRANSFORM MOUSE

Is the arrow unsuited as a mouse cursor for games? Simply make your own cursor. How would it be if a little car moved across the screen instead of an arrow? The opcode $A00B gives your fantasy free reign, at least as far as it concerns the mouse cursor.

The parameters must be passed in the `INTIN` array. A total of 34 words are necessary. The following table gives information about the use and possible values:

```
INTIN(3) Mask color index, normally 0
INTIN(4) Data color index, normally 1
INTIN(5) to INTIN(20) contain 16 words of the cursor mask
INTIN(21) to INTIN (36) contain 16 words of cursor data
```

The form of the cursor is determined by the cursor data. Each 1 in the data creates a point on the screen. If a cursor is placed over a letter or pattern on the screen, the border between the cursor and the background cannot be determined. The mask enters at this point. Each set bit in the mask clears the background at the given location. This permits a light border to be drawn around the cursor. Take a look at the normal arrow cursor in order to see the operation of the mask.

$A00C UNDRAW SPRITE

This opcode is related to $A00D, DRAW SPRITE. The ST actually has no hardware sprites in sense in which sprite is used on something like the Commodore 64. The ST sprites are organized purely in software. Each sprite is 16x16 pixels large. One example of an ST sprite is the mouse cursor. It is created with this function.

In order to clear a previously-drawn sprite, the address of a buffer in which the background was saved when the sprite was drawn is passed in register A2. The opcode simply transfers the contents of the background buffer to the right spot on the screen. The buffer itself must be 64 bytes large for each plane. Another 10 bytes are used, independent of the number of planes. For monochrome display, the buffer is a total of 74 bytes long, while in the 320x200 pixel resolution (for planes), it is 4x64+10=266 bytes large.

$A00D DRAW SPRITE

This function draws the desired sprite on the screen. Parameters must be passed in the D0, D1, A0, and A2 registers.

D0 and D1 contain the X and Y-coordinates of the position of the sprite on the screen, called the hot spot. A0 is a pointer to the so-called sprite definition block and A2 contains the address of the sprite buffer in which the backgroud will be saved for erasing the sprite later.

The sprite definition block must have the following construction:

```
Word 1 : X offset to hot spot
Word 2 : Y offset to hot spot
Word 3 : Format flag 0=VDI format, 1=XOR format
Word 4 : Background color (bg)
Word 5 : Foreground color (fg)
```

Following this are 32 words which contain the sprite pattern. The pattern must be in memory in the following order:

```
Word 6 : Background pattern of the top line
Word 7 : Foreground pattern of the top line
Word 8 : Background pattern of the second line
Word 9 : Foreground pattern of the second line
etc.
```

The information in the format flag has the following significance:

```
         VDI Format
fg  bg    Result
 0   0    The background appears
 0   1    The color in word 4 appears
 1   0    The color in word 5 appears
 1   1    The color in word 5 appears

         XOR Format
fg  bg    Result
 0   0    The background appears
 0   1    The color in word 4 appears
 1   0    The pixel on the screen is XORed with the fb
          bit
 1   1    The color in word 5 appears
```

$A00E COPY RASTER FORM

Arbitrary areas of the screen can be copied with the $A00E opcode. Not only areas within the screen, but also from the screen into free RAM, and even more important, from the RAM to the screen. Even complete screen pages can be copied very quickly with the COPY RASTER opcode. The name RASTER FORM does express one limitation of the function, however. Each raster form to be copied must begin on a word boundary and must be a set of words.

The parameters are quite numerous and are passed in the `CONTRL`, `PTSIN`, and `INTIN` arrays. In addition, two "memory fom definition" blocks must be in memory for COPY RASTER. We will start with the MFD blocks. Since a copy operation must always have a source and a destination, one block describes the source memory range and the second describes the destination. Each block consists of 10 words. The address of the memory described by the block is contained in the first two words. The third word specifies the height of the form in pixels. Word 4 determines the width of the form in words. Word 6 should be set to 1 and word 7 specifies the number of planes of which the form is composed. The remaining words should be set to zero because they are reserved for future extensions.

3.4.1 An overview of the "line-A" variables

After the initialization $A000, D0 and A0 contain the address of a variable area which contains more than 50 line-A variables. The essential variables have been described along with the various calls, but not the location of the variables within the variable block. We will present this list shortly. When naming the variables we have remained with the names used in the official Atari documentation.

Offset is the value which must be given to access the value register relative. Variables supplied with a question mark could not be definitively explained.

Offset	Name	Size	Function
0	v_planes	word	Number of planes
2	v_lin_wr	word	Bytes per scan line
4	CONTRL	long	Pointer to the CONTRL array
8	INTIN	long	Pointer to the INTIN array
12	PTSIN	long	Pointer to the PTSIN array
16	INTOUT	long	Pointer to the INTOUT array
20	PTSOUT	long	Pointer to the PTSOUT array
24	_FG_BP_1	word	Plane 0 color value
26	_FG_BP_2	word	Plane 1 color value
28	_FG_BP_2	word	Plane 2 color value
28	_FG_BP_2	word	Plane 3 color value
32	_LSTLIN	word	Should be -1 ($FFFF) (?)
34	_LN_MASK	word	Line pattern for $A003
36	_WRT_MODE	word	Write mode (0=write mode 1=transparent 2=XOR mode 3=Inverse trans.)
38	_X1	word	X1-coordinate
40	_Y1	word	Y1-coordinate
42	_X2	word	X2-coordinate
44	_Y2	word	Y2-coordinate

46	_patptr	long	Pointer to the fill pattern (see $A004)
50	_patmsk	word	Fill pattern "mask" (see $A004)
52	_multifill	word	0=fill pattern is only for one plane 1=fill pattern is for multi-plane
54	_CLIP	word	0=no clipping (see $A005) not 0=clipping
56	_XMN_CLIP	word	and
58	_YMN_CLIP	word	define upper left corner of the visible area for clipping
60	_XMX_CLIP	word	and
62	_YMX_CLIP	word	define lower right corner of the visible area for clipping
64	_XACC_DDA	word	Should be set to $8000 before each call to TXTBLT (?)
66	_DDA_INC	word	Enlargement/reduction factor $FFFF for enlargement, reduction doesn't work (?)
68	_T_SCLSTS	word	0=reduction (?) 1=enlargement
70	_MONO_STATUS	word	1=not proportional font 0=proportional type or width of character changed by bold or italics
72	_SOURCEX	word	X-coordinate of char in font
74	_SOURCEY	word	Y-coord of char in font (0)

Note:
SOURCEX is the value of the character from the horizontal offset table (HOT) and can be calculated witht he following formula:
SOURCEX = HOT-element (ASCII value minus FIRST ADE)
The variable FIRST ADE is contained in bytes 36,37 of the font header (see example)

76	_DESTX	word	X-position of char on screen
78	_DESTY	word	Y-position of char on screen
80	_DELX	word	Width of the character
82	_DELY	word	Height of the character

Note:
DELX can be calculated with this formula:
DELX = SOURCEX+1 minus SOURCEX
(see $A008)
DELY is the value FORM height from bytes 82,83 of the font header.

84	_FBASE	long	Pointer to start of font data
88	_FWIDTH	long	Width of font form
90	_STYLE	word	Flags for special effects (see $A008)
92	_LITEMASK	word	Mask for shading
94	_SKEWMASK	word	Mask for italic type
96	_WEIGHT	word	Number of bits by which the character will be expanded
98	_R_OFF	word	Offset for italic type
100	_L_OFF	word	Offset for italic type

Note:
The above five variables should be loaded with the corresponding values from the font header.

102	_SCALE	word	0=no scaling 1=scaling (enlarge/reduce)
104	_CHUP	word	Angle for character rotation 0=normal char representation $384=rotated 90 degrees $708=rotated 180 degrees $A8C=rotated 270 degrees
106	_TEXT_FG	word	Foreground color for text display
108	_scrtchp	long	Address of buffer required for creating special text effects
112	_scrpt2	word	Offset of the enlargement buffer in the scrtchp buffer
114	_TEXT_BG	word	Background color for text rep
116	_COPYTRAN	word	(?)

3.4.2 Examples for using the line-A opcodes

In order to ease your first experiments with the line-A opcodes, we have given a few examples which can serve as a starting-point for you. In the first example, a point is set on the screen with $A001, and then the color of the point is determined with $A002.

```
*******************************************************
*          Demo of the $A000,$A001 and $A002 functions
*
*          rbr 09/28/85
*******************************************************

intin       equ      8
ptsin       equ      12

init        equ      $a000
setpix      equ      $a001
getpix      equ      $a002


start:
            .dc.w    init               * call $A000
            move.l   intin(a0),a3       * address of INTIN-arrays
            move.l   ptsin(a0),a4       * address of PTSIN-arrays

            move     #300,(a4)          * X coordinate
            move     #100,2(a4)         * Y coordinate

            move     #1,(a3)            * color set, pixel set
*                                         0 erase pixel

            .dc.w    setpix             * pixel set

            move     #300,(a4)          * X coordinate
            move     #100,2(a4)         * y coordinate

            .dc.w    getpix             * get color value

*           d0 contains prersent color value
```

Only color values zero and one make sense for a monochrome monitor. Other values can be entered when working in one of the color modes, however.

The next example shows how a triangle can be drawn on the screen with the function FILLED POLYGON.

```
*********************************************
*
*
*           a006 - filled pologyn
*
*
*********************************************

contrl      equ     4
ptsin       equ     12

fg_bp1      equ     24
fg_bp2      equ     26
fg_bp3      equ     28
fg_bp4      equ     30
wrt_mod     equ     36

y1          equ     40

patptr      equ     46
patmsk      equ     50
multifill   equ     52
clip        equ     54
xmn_clip    equ     56
ymn_clip    equ     58
xmx_clip    equ     60
ymx_clip    equ     62


init        equ     $a000
polygon     equ     $a006


            .dc.w   init                * address of variable block
*                                         from A0

            move.w  #1,fg_bp1(a0)       *set colors for monochrome
            clr.w   fg_bp2(a0)
            clr.w   fg_bp3(a0)
            clr.w   fg_bp4(a0)

            move.w  #2,wrt_mod(a0)      * replace mode
```

```
          move.l   #fill,patptr(a0)   * pointer of the fill pattern
          move.w   #4,patmsk(a0)      * four fill patterns
          clr.w    multifill(a0)      * for monochrome
          clr.w    clip(a0)           * no clipping

          move.l   contrl(a0),a6      * adddress of CONTRL array
*                                       from A6
          addq.l   #2,a6              * A6 > CONTRL(1)
          move.w   #3,(a6)            * the XY pair in PTSIN

          move.l   ptsin(a0),a6       * address PTSIN array from A6
          move.l   #tab,a5            * table of coordinates
          move.w   #8,d3              * recieve 8 coordinates
loop      move.w   (a5)+,(a6)+
          dbra     d3,loop

          move.w   #100,d3            * first scanline
loop1     move.w   d3,y1(a0)          * from Y1
          move.l   a0,-(sp)           * restore address variable block

          dc.w     polygon            * fill scanline, A0 destroyed

          move.l   (sp)+,a0           * A0 restored
          addq.w   #1,d3              * calculate next sacanline
          cmp.w    #301,d3            * last scan line?
          bne      loop1              * no, next scanline

          move.w   #1,-(sp)           * Code CONIN wait for keypress
          trap     #1                 * Call GEMDOS
          addq.l   #2,sp              * stack correction

*         rts                         * subroutine all done
          move.w   #0,-(sp)           * terminate to desktop
          trap     #1                 * Call GEMDOS

fill:
          dc.w     %1100110011001100
          dc.w     %0110110110110110
          dc.w     %0011001100110011
          dc.w     %1001100110011001


tab:
          dc.w     320,100
          dc.w     120,320
          dc.w     520,300
          dc.w     320,100
```

The next example shows how the mouse form can be manipulated and how the mouse can be enabled. The example waits for a key press before returning.

```
*****************************************************
*
*
*          show mouse - transform mouse
*
*
*****************************************************


intin       equ       8

init_a      equ       $a000
show_mouse  equ       $a009
transmouse  equ       $a00b


start:
            .dc.w     init_a          * address INIT from A5

            move.l    intin(a0),a5
            move      #0,6(a5)        * INTIN (3) = mask color value
            move      #1,8(a5)        * INTIN (4) = data color value

            add.l     #10,a5          * a5 > INTIN (5)

            lea       maus,a4         * data for new cursor
            move      #16,d0          * 32 words = 16 longs

loop:
            move.l    (a4)+,(a5)+     * transfer INTIN array
            dbra      d0,loop

            .dc.w     transmouse      * and set form

            .dc.w     init_a

            move.l    intin(a0),a0
            clr.w     (a0)            * Number Hide Cursor -ignore call

            .dc.w     show_mouse      * now the new cursor
```

```
               move.w    #1,-(sp)          * Code CONIN wait for keypress
               trap      #1                * Call GEMDOS
               addq.l    #2,sp             * stack correction

*              rts                         * subroutine all done
               move.w    #0,-(sp)          * terminate to desktop
               trap      #1                * Call GEMDOS


maus:
maske:
               .dc.w     %0000000110000000
               .dc.w     %0000011111100000
               .dc.w     %0001111111111000
               .dc.w     %0111111111111110
               .dc.w     %1111111111111111
               .dc.w     %1111001111001111
               .dc.w     %1111001111001111
               .dc.w     %1111001111001111
               .dc.w     %0000001111000000
               .dc.w     %0000001111000000
               .dc.w     %0000001111000000
               .dc.w     %0000001111000000
               .dc.w     %0000001111000000
               .dc.w     %0000001111000000
               .dc.w     %0000000000000000
daten:
               .dc.w     %0000000000000000
               .dc.w     %0000000000000000
               .dc.w     %0000000110000000
               .dc.w     %0000011001100000
               .dc.w     %0110000110000110
               .dc.w     %0110000110000110
               .dc.w     %0000000110000000
               .dc.w     %0000000110000000
               .dc.w     %0000000110000000
               .dc.w     %0000000110000000
               .dc.w     %0000000110000000
               .dc.w     %0000000110000000
               .dc.w     %0000000110000000
               .dc.w     %0000000000000000
               .dc.w     %0000000000000000
```

3.5 The Exception Vectors

The first 1024 bytes of the 68000 processor are reserved for the exception vectors. Routines which use exception handling store the addresses they require in this range of memory.

A condition which leads to an exception can come either from the processor itself or from the peripheral components and controls units connected to it. The interrupts, described in the next section, belong to the class of external events. In addition, a so-called bus error can be created externally.

A bus error can be created by many circumstances. For one, certain memory areas can be protected from unauthorized access by it. As you may already know, the 68000 can run in one of two operating modes. The operating system is driven at the first level, the *supervisor mode*. The *user mode* is intended for user programs. In order that a user program not be able to access important system variables as well as the system components in an uncontrolled fashion, such an access in the user mode leads to a bus error. If such an error occurs, the processor stops execution of the instruction, saves the program counter and status register on the stack, and branches to a routine, the address of which it fetches from the lowest 1024 bytes of memory. In the case of the bus error, the address is at memory location 8 (one long word). What happens in this routine?

First the vector number of the interrupt is determined. In the case of a bus error, this is 2. Mushroom clouds are then displayed on the screen. The user can determine the vector number by counting the number of mushroom pictures. Execution then returns to the GEM desktop.

The following table contains all of the exception vectors.

Vector number	Address	Exception vector meaning
0	$000	Stack pointer after reset
1	$004	Program counter after reset
2	$008	Bus error
3	$00C	Address error
4	$010	Illegal instruction
5	$014	Division by zero
6	$018	CHK instruction
7	$01C	TRAPV instruction
8	$020	Priviledge violation
9	$024	Trace
10	$028	Line A emulator
11	$02C	Line F emulator
12-14	$030-$038	reserved
15	$03C	Uninitialized interrupt
16-23	$040-$05C	reserved
24	$060	Spurious interrupt
25	$064	Level 1 interrupt
26	$068	Level 2 interrupt
27	$06C	Level 3 interrupt
28	$070	Level 4 interrupt
29	$074	Level 5 interrupt
30	$078	Level 6 interrupt
31	$07C	Level 7 interrupt
32	$080	TRAP #0 instruction
33	$084	TRAP #1 instruction
34	$088	TRAP #2 instruction
35	$08C	TRAP #3 instruction
36	$090	TRAP #4 instruction
37	$094	TRAP #5 instruction
38	$098	TRAP #6 instruction
39	$09C	TRAP #7 instruction
40	$0A0	TRAP #8 instruction
41	$0A4	TRAP #9 instruction
42	$0A8	TRAP #10 instruction
43	$0AC	TRAP #11 instruction
44	$0B0	TRAP #12 instruction
45	$0B4	TRAP #13 instruction
46	$0B8	TRAP #14 instruction
47	$0BC	TRAP #15 instruction
48-63	$0C0-$0FC	reserved
64-255	$100-$3FC	User interrupt vectors

The following vectors are used on the ST:

```
Line A emulator      $EB9A
Level 2 interrupt    $543C
Level 4 interrupt    $5452
TRAP #1 GEMDOS       $965E
TRAP #2 GEM          $2A338
TRAP #13 BIOS        $556C
TRAP #14 XBIOS       $5566
```

The vector for division by zero points to `rte` and returns directly to the interrupted program. Vectors 64-79 are reserved for the MFP 68901 interrupts. All other vectors point to $5838 which outputs the vector number and ends the program as described for the bus error.

All of the unused vectors can be used for your own purposes, such as the line F emulator or the 12 unused traps.

3.5.1 The interrupt structure of the ST

The interrupt possibilities which the 6800 microprocessor offers are put to good use in the ST. As you may have already gathered from the hardware description of the processor, the processor has seven interrupt levels with different priorities. The interrupt mask in the system byte of the status register determines which levels can generate an interrupt. An interrupt can only be generated by a level higher than the current contents of the mask in the status register. A interrupt of a certain priority is communicated to the processor by the three interrupt priority level inputs. The following assignment results:

```
Level   IPL 2  1  0
7 (NMI)     0  0  0
6           0  0  1
5           0  1  0
4           0  1  1
3           1  0  0
2           1  0  1
1           1  1  0
0           1  1  1
```

If all three lines are 1 (interrupt level 0), no interrupt is present. Interrupt level 7 is the NMI (non-maskable interrupt), which is executed even if the interrupt mask in the status register contains seven. Which interrupt is assigned which vector (that is, the address of the routine which will process the interrupt) depends on the peripheral component which generates the interrupt. For auto-vectors, the processor itself derives the interrupt number from the interrupt level. The following table is used in this process:

Level	Vector number	Vector address
IPL 1	25	$64
IPL 2	26	$68
IPL 3	27	$6C
IPL 4	28	$70
IPL 5	29	$74
IPL 6	30	$78
IPL 7	31	$7C

Only lines IPL 1 and IPL 2 are used on the Atari ST; Line IPL is permanently set to a 1 level so that only levels 2, 4 and 6 are available. The results in the following assignment:

IPL 2	HBL, horizontal blank, line return
IPL 4	VBL, vertical blank, picture return
IPL 6	MFP 68901

The HPL interrupt is generated on each line return from the video section. It is generated every 50 to 64 μs depending on the monitor connected (monochrome or color). It occurs very often and is normally not permitted by an interrupt mask of three. The standard HBL routine therefore only has the task of setting the interrupt mask to three if it is zero and allows the HBL interrupt so that no more HBL interrupts will occur. One use of the HBL interrupt could be for special screen effects. With the help of this routine, you know exactly which line of the screen has just been displayed. Of much greater importance, however, is the VBL interrupt, which is generated on each picture return. This occurs 50, 60, or 70 times per second depending on the monitor.

The vertical blank interrupt (VBL) routine accomplishes a whole set of a tasks which must be periodically executed or which concern the screen display. When entering the routine, the frame counter `frclock` ($466) is first incremented. Next, a test is made to see if the VBL interrupt is software-disabled. This is the case if `vblsem` ($452) (vertical blank semaphor) is zero or negative. In this case the routine is exited immediately and execution returns to the interrupted program. Otherwise, all of the registers are saved on the stack and the counter `vbclock` ($462), which counts the executed VBL routines, is incremented. Next, a check is made to see if a different monitor has been connected in the meantime. If a change was made from a monochrome to color monitor, the video shifter is reprogrammed accordingly. This is necessary because the high screen frequency of 70 Hz of the monochrome monitor could damage a color monitor. The routine to flash the cursor is called next. If you load a new color palette via the appropriate BIOS functions or want to change the screen address, this happens here in the VBL routine. Since nothing is displayed at this time, a change can be made here without disturbing anything else. If `colorptr` ($45A) is not equal to zero, it is interpreted as a pointer to a new color palette, and this is loaded into the video shifter. The pointer is then cleared again. If `screenptr` is set, this value is used as the new base address of the screen. This takes care of the screen specific portions.

Now the floppy VBL routine is called, which with help the of the write protect status, determines if a diskette was changed. An additional task of this routine is to deselect the drives after the disk controller has turned the drive motor off.

Now comes the most interesting part for the programmer, the processing of the VBL queue. There is a way to tell the operating system to execute your own routines within the VBL interrupt. The maximum number of routines possible is in `nvbls` ($454). This value is normally initialized to 8, but it can be increased if required. Address `vblqueue` ($456) contains a pointer to a vector array which contains the (8) addresses of the VBL routines. Each address is tested within the VBL routine and the corresponding routine executed if the address is not zero.

If you want to install your own VBL routine, check the 8 entries until you find one which contains a zero. At this address you can write a pointer to your routine which from now on will be executed in every VBL interrupt. In all 8 entries are already occupied, you can copy the entries into a free area of memory, append the address of your routine, and redirect `vblqueue` to point to the new vector array. Naturally, you must not forget to increment `vbls`, the number of routines, correspondingly. Your routine may change all registers with the exception of the USP.

As soon as the VBL routine is done, the `dmpflg` ($4EE) is checked. If this memory location is zero, a hardcopy of the screen is outputted. The flag is set in the keyboard interrupt routine if the keys ALT and HELP are pressed at the same time. Finally, the register contents are restored, `vblsem` is released and execution returns to the interrupted routine.

The MFP 68901 occupies interrupt level six in our previous table. This component is in the position to create interrupt vectors on its own. These are referred to non-auto vectors in contrast to the auto vectors used above, because the processor does not generate the vector itself. In the Atari ST, the MFP 68901 works as the interrupt controller. It manages the interrupt requests of all peripheral components including its own.

The MFP can manage sixteen interrupts which are prioritized in reference to each other, similar to the seven levels of the processor. All MFP interrupts appear on level 6 to the 68000, therefore prioritized higher than HBL and VBL interrupts. The following table contains the assignments within the MFP.

Level	Assignment
15	Monochrome monitor detect
14	RS-232 ring indicator
13	System clock timer A
12	RS-232 receive buffer full
11	RS-232 receive error
10	RS-232 transmit buffer empty
9	RS-232 transmit error
8	Line return counter, timer B
7	Floppy controller and DMA
6	Keyboard and MIDI ACIAs
5	Timer C
4	RS-232 baud rate generator, timer D
3	unused
2	RS-232 CTS
1	RS-232 DCD
0	Centronics busy

Not all of these possible interrupt sources are enabled, however. Some signals are processed through polling. The following is a description of the interrupts which are used by the operating system.

Level 2, RS-232 CTS, Address $73C0

This interrupt is generated every time the RS-232 interface is informed via the CTS line that a connected receiver is ready to receive additional data. The routine then sends the next character from the RS-232 transmit buffer.

Level 5, Timer C, Address $7C5C

This timer runs at 200 Hz. The 200 Hz counter at $4BA is first incremented in the interrupt routine. The next actions are performed only every fourth call to the interrupt routine, that is, only every 20ms (50 Hz). First a routine is called which handles the sound processing. Another task of this interrupt is the keyboard repeat when a key is pressed and initial repeat. Finally, the evt timer routine of GEM is called, which is accessed via vector $400.

Level 6, Keyboard and Midi, Address $752A

Two peripheral components are connected to this interrupt level of the MFP, the two ACIAs which receive data from the keyboard and the MIDI interface. In order to decide which of the two components has requested an interrupt, the interrupt request bits in the status registers of the ACIAs are tested and the received byte is fetched if required. If it comes from the keyboard, the scan code is converted to the ASCII code by means of the keyboard table and written into the receive buffer, which happens immediately for MIDI data. Mouse and joystick data also come from the keyboard ACIA and are also prepared accordingly.

Level 9, RS-232 transmit error, Address $7426

If an error occurs while sending RS-232 data, this interrupt routine is activated. Here the transmitter status register is read and the status is saved in the RS-232 parameter block.

Level 10, RS-232 transmit buffer empty, Address $7374

Each time the MFP has completely outputted a data byte via the RS-232 interface, it generates this interrupt. It is then ready to send the next byte. If data is still in the transmit buffer, the next byte is written into the transmit register, which can now be shifted out according to the selected baud rate.

Level 11, RS-232 receive error, Address $7408

If an error occurs when receiving RS-232 data, this interrupt routine is activated. This may involve a parity error or an overflow. The routine only clears the receiver status register and then returns.

Level 12, RS-232 receive buffer full, Address $72C0

If the MFP has received a complete byte, this interrupt occurs. Here the character can be fetched and written into the receive buffer (if there is still room). This routine takes into account the active handshake mode (sending XON/XOFF or RTS/CTS).

The other interrupt possibilities of the MFP are not used, but they can be used for your own routines. For example, interrupt level 0, Centronics strobe, can be used for buffered printer output.

3.6 The Atari ST VT52 Emulator

There are two options for text output on the ST. You can work with the GEMDOS functions by means of `TRAP #1` or a direct BIOS call with `TRAP #13`. The other possibility consists of using the VDI functions.

You have special possibilities for screen control with both variants. We will first take a look at output using the normal DOS or BIOS calls. Here a terminal of type VT52, which offers a wide variety of control functions, is emulated for screen output. These control characters are prefixed with a special character, the escape code. Escape, also shortened to ESC, has ASCII code 27. Following the escape code is a letter which determines the function, as well as additional parameters if required. The following list contains all of the control codes and their significance.

ESC A Cursor up

This function moves the cursor up one line. If the cursor was already on the top line, nothing happens.

ESC B Cursor down

This ESC sequence positions the cursor one line down. If the cursor is already on the bottom line, nothing happens.

ESC C Cursor right

This sequence moves the cursor one column to the right.

ESC D Cursor left

Moves the cursor one position to the left. This function is identical to the control code backspace (BS, ASCII code 8). If the cursor is already in the first column, nothing happens.

ESC E Clear Home

This control sequence clears the entire screen and positions the cursor in the upper left corner of the screen (home position).

ESC H Cursor home

With this function you can place the cursor in the upper left corner of the screen without erasing the contents of the screen.

ESC I Cursor up

This sequence moves the cursor one line towards the top. In contrast to ESC A, however, if the cursor is already in the top line, a blank line is inserted and the remainder of the screen is scrolled down a line correspondingly. The column position of the cursor remains unchanged.

ESC J Clear below cursor

By means of this function, the rest of the screen below the current cursor position is cleared. The cursor position itself is not changed.

ESC K Clear remainder of line

This ESC sequence clears the rest of the line in which the cursor is found. The cursor position itself is also cleared, but the position is not changed.

ESC L Insert line

This makes it possible to insert a blank line at the current cursor position. The remainder of the screen is shifted down; the lowest line is then lost. The cursor is placed at the start of the new line after the insertion.

ESC M Delete line

This function clears the line in which the cursor is found and moves the rest of the screen up one line. The lowest screen line then becomes free. After the deletion, the cursor is located in the first column of the line moved up to take the place of the old one.

ESC Y Position cursor

This is the most important function. It allows the cursor to be positioned at any place on the screen. The function needs the cursor line and column as parameters, which are expected in this order with an offset of 32. If you want to set the cursor to line 7, column 40, you must output the sequence ESC Y CHR$(32+7) CHR$(32+40). Lines and columns are counter starting at zero; for an 80x25 screen the lines are numbered from 0 to 24 and the columns from 0 to 79.

The additional ESC sequences of the VT52 terminal start with a lower case letter.

ESC b Select character color

With this function you can select the character color for further output. With a monochrome monitor you have choice between just 0=white and 1=black. For color display you can select from 4 or 16 colors depending on the mode. Only the lowest four bits of the parameters are evaluated (mod 16). You can use the digit "1" for the color 1 as well as the letters "A" or "a" in addition to binary one.

ESC c Select background color

This function serves to select the background color in a similar manner. If you choose the same color for character and background, you will, of course, not be able to see text output any more.

ESC d Clear screen to cursor position

This sequence causes the screen to be erased starting at the top and going to the current position of the cursor, inclusive. The position of the cursor is not changed.

ESC e Enable cursor

Through this escape sequence the cursor becomes visible. The cursor can, for example, be enabled when waiting for input from the user.

ESC f Disable cursor

Turns the cursor off again.

ESC j Save cursor position

If you want to save the current position of the cursor, you can use this sequence to do so.

ESC k Set cursor to the saved position

This is the counterpart of the above function. It sets the cursor to the position which was previously saved with ESC j.

ESC l Clear line

Clears the line in which the cursor is located. The remaining lines remain unaffected. After the line is cleared, the cursor is located in the first column of the line.

ESC o Clear from start

This clears the current cursor line from the start to the cursor position, inclusive. The position of the cursor remains unchanged.

ESC p Reverse on

The reverse (inverted) output is enabled with this sequence. For all further output, the character and background colors are exchanged. With a monochrome monitor you get white type on a black background.

ESC q Reverse off

This sequence serves to re-enable the normal character display mode.

ESC v Automatic overflow on

After executing this sequence, an attempted output beyond the end of line will automatically start a new line.

ESC w Automatic overflow off

This deactivates the above sequence. An attempt to write beyond the line will result in all following characters being written in the last column.

Similar functions are available to you under VDI. The VDI escape functions (opcode 5) serve this purpose. The appropriate screen function is selected by choosing the proper function number. Note, however, that under VDI the line and column numbering does not begin with zero but with one.

Under VDI there is also a function which outputs a string at specific screen coordinates. If necessary, you can use the ESC functions of the VT52 emulation in addition.

The output of "unprintable" control characters

The three system fonts of the ST have also been supplied with characters for the ASCII codes zero to 31, which are normally interpreted as control codes. On the ST, only codes 7 (BEL), 8 (BS backspace), 9 (TAB), as well as 10, 11, and 12 (LF linefeed, VT vertical tab, and FF form feed all generate a linefeed) plus 13 (CR carriage return) have effect, in addition to ESC. The remaining codes have no effect. How does one access the characters below 32?

To do this, an additional device number is provided in the BIOS function 3 "conout". Normally number 2 "con" serves for output to the screen. If one selects number 5, however, all the codes from, 0 to 255 are outputted as printable characters, control codes are no longer taken into account.

In the appendix you find the three ST system fonts pictured.

3.7 The ST System Variables

The ST uses a set of system variables whose significance and addresses will not change in future versions of the operating system. If you use other variables, such as those from the BIOS listing which are not listed here, you should always remember that these could have a different meaning in a new version of the operating system. The system variables are in the lower RAM area directly above the 68000 exception vectors, at address $400 to 1024. The address range from 0 to $800 (2048) can be accessed only in the supervisor mode. An access in the user mode of the 68000 leads to a bus error.

In the following listing we will use the original names from Atari. In addition to the address of the given variable, typical contents and the significance will be described.

`Address length name    Sample contents`

`$400    L    etv_timer    $F526`

This is the event timer vector of the GEM. It takes care of the periodic tasks of GEM.

`$404    L    etv_critic   $5562`

Critical error handler. Under GEM this pointer points to $2A156. There an attempt is made to correct disk errors, such as if a another disk is requested in a single-drive system.

`$408    L    etv_term     $5328`

This is the GEM vector for ending a program.

`$40C    5L   etv_xtra`

Here is space for 5 additional GEM vectors, which at the time are not yet used.

`$420    L    memvalid     $752019F3`

If the memory location contains the given value, the configuration of the memory controller is valid.

`$424    W    memctrl      $0400`

This is a copy of the configuration value in the memory controller. The value given applies for a 512K machine.

`$426    L    resvalid     $31415926`

If the given value is located here, a jump is made at a reset via the reset vector in address $42A.

`$42A    L    resvector    $FC0008`

See above.

`$42E    L    phystop      $80000`

This is the physical end of the RAM memory; $80000 for a 512K machine.

`$432    L    _membot      $3B900`

The user memory begins here (TPA, transient program area).

`$436    L    _memtop      $78000`

This is the upper end of the user memory.

`$43A    L    memval2      $237698AA`

This "magic" value together with "memvalid" declares the memory configuration valid.

`$43E    W    flock        0`

If this variable contains a value other than zero, a disk access is in progress and the VBL disk routine is disabled.

$440 W seekrate 3

The seek rate (the time it takes to move the read/write head to the next track) is determined according to the following table:

Seek rate	Time
0	6 ms
1	12 ms
2	2 ms
3	3 ms

$442 W _timer_ms $14, 20 ms

The time span between two timer calls, 20 ms corresponds to 50 Hz.

$444 W _fverify $FF

If this memory location contains a value other than zero, a verify is performed after every disk write access.

$446 W _bootdev 0

Contains the device number of the drive from the operating system was loaded.

$448 W palmode 0

If this variable contains a value other than zero, the system is in the PAL mode (50 Hz); if the value is zero, it means the NTSC mode.

$44A W defshiftmod 0

If the Atari is switched from monochrome to color, it gets the new resolution from here (0=low, 1 medium resolution).

$44C W sshiftmod $200

Here is a copy of the register contents for the screen resolution.

```
0   320x200, low resolution
1   640x200, medium resolution
2   640x400, high resolution
```

$44E L _v_bas_ad $78000

This variable contains a pointer to the video RAM (logical screen base). The screen address must always begin on a 256 byte boundary.

$452 W vblsem 1

If this variable is zero, the vertical blank routine is not executed.

$454 W nvbls 8

Number of vertical blank routines.

$456 L _vblqueue $4CE

Pointer to a list of `nvbls` routines which will be executed during the VBL.

$45A L colorptr 0

If this value is not zero, it is interpreted as a pointer to a color palette which will be loaded at the next VBL.

$45E L screenpt 0

This is a pointer to the start of the video RAM, which will be set during the next VBL (zero if no new address is to be set).

$462 L _vbclock $2D26A

Counter for the number of VBL interrupts.

$466 L _frclock $2D267

Number of VBL routines executed (not disabled by vblsem).

$46A L hdv_init $5AE8

Vector for hard disk initialization.

$46E L swv_vec $501E

Vector for changing the screen resolution. A branch is made via this vector with the screen resolution is changed (default is reset).

$472 L hdv_bpb $5B6E

Vector to fetch the BIOS parameter block for a hard disk.

$476 L hdv_rw $5D88

Read/write routine for a hard disk.

$47A L hdv_boot $60B2

Vector to a routine to reboot the hard disk.

$47E L hdv_mediach $5D1E

Media change routine for hard disk.

$482 W _comload 0

If this variable is set to a value other than zero by the boot program, an attempt will be made to load a program called "COMMAND.PRG" after the operating system is loaded.

$484 B conterm 6

Attribute vector for console output

```
Bit  Meaning
 0   Key click on/off
 1   Key repeat on/off
 2   Tone after CTRL G on/off
 3   "kbshift" is retured in bits 24-31 for the
     BIOS function "conin"
```

$485 B unused, reserved

$486 L trp14ret 0

Return address for TRAP #14 call.

`$48A    L     criticret     0`

Return address of the critical error handler

`$48E    4L    themd         0`

Memory descriptor, filled out by the BIOS function `getmpb`.

`$49E    2W    ____md        0`

Space for additional memory descriptors.

`$4A2    L     savptr        $5CE`

Pointer to a save area for the processor registers after a BIOS call.

`$4A6    W     _nflops       2`

Number of connected floppy disk drives.

`$4A8    L     con_state     $8AEE`

Vector for screen output; set by ESC functions to the appropriate routine, for example.

`$4AC    W     save_row      0`

Temporary storage for cursor line when positioning the cursor with ESC Y.

`$4AE    L     sav_context   0`

Pointer to a temporary areas for exception handling.

`$4B2    2L    _bufl         $4F9E, $4FB2`

Pointer to two buffer list headers of GEMDOS. The first header is responsible for data sectors, the second for the FAT (file allocation table) and the directory. Each buffer control block (BCB) is constructed as follows:

```
long  BCB    $4F8A, pointer to next BCB
int   drive  -1,    drive number or -1
int   type   2      buffer type
int   rec    $41C   record number in this buffer
int   dirty  0      dirty flag (buffer changed)
long  DMD    $2854  pointer to drive media descriptor
long  buffer $4292  pointer to the buffer itself
```

$4BA L _hz_200 $71280

Counter for 200 Hz system clock

$4BC 4B the_env 0

Default environment string, four zero bytes.

$4C2 L _drvbits 3

32-bit vector for connected drives. Bit 0 stands for drive A, bit 1 for drive B, and so on.

$4C6 L _dskbufp $12BC

Pointer to a 1024-byte disk buffer. The buffer is used for GSX graphic operations and should not be used by interrupt routines.

$4CA L _autopath 0

Pointer to autoexecute path.

$4CE 8L _vbl_list $15398,0,0...

List of the standard VBL routines.

$4EE W _dumpflg $FFFF

This flag is incremented by one when the ALT and HELP keys are pressed simultaneously. A value of one generates a hardcopy of the screen on the printer. A hardcopy can be interrupted by pressing ALT HELP again.

`$4F0    W    _prtabt       0`

Printer abort flag due to time-out.

`$4F2    L    _sysbase      $5000`

Pointer to start of the operating system.

`$4F6    L    _shell_p      0`

Global shell information.

`$4FA    L    end_os        $3B900`

Pointer to the end of the operating system in RAM, start of the TPA.

`$4FE    L    exec_os       $1EB00`

Pointer to the start of the AES. Normally branched to after the initialization of the BIOS.

3.8 The 68000 Instruction Set

If you are already familiar with the machine language of some 8-bit processor: Forget everything you know. If you do, it will make it easier to understand the following material!

The 68000 processor is fundamentally different in construction and architecture from previous processors (including the 8086!). The essential difference does not lie in the fact that the standard processing width is 16 and not 8 bits (which is sometimes a drawback and can lead to programming errors), but in the fact that, with certain exceptions, the internal registers are not assigned to a specific purpose, but can be viewed as general-purpose registers, with which almost anything is possible.

In eariler processors, the accumulator was always the destination for arithmetic operations, but it is completely absent in the 68000. There are eight data registers (D0-D7) with a width of 32 bits, and as a general rule, at least one of these is involved in an operation. There are also eight address registers (A0-A7), each with 32 bits, which are usually used for generating complex addresses. Register A7 has a set assignment--it serves as the stack pointer. It is also present twice, once as the user stack pointer (USP) and once as the supervisor stack pointer (SSP). The distinction is made because there are also two operating modes, namely the user mode and the supervisor mode.

These two are not only different in that they use different stack pointers, but in that certain instructions are not legal in the user mode. These are the so-called priviledged instructions (see also instruction description), with whose help an unwary programmer can easily "crash" the system rather spectacularly. This is why these instructions create an exception in the user mode. An exception, by the way, is the only way to get from the user mode to the supervisor mode.

In addition there is the status register, the upper half of which is designated as the system byte because it contains such things as the interrupt mask, things which do not concern the "normal" user, making access to this byte also one of the priviledged instructions. The lower byte, the user byte, contains the flags which are set or cleared based on the result of operations, such as the carry flag, zero flag, etc. As a general rule, the programmer works with these flags indirectly, such as when the execution of a branch is made conditional on the state of a flag.

Two things should be mentioned yet: Multi-byte values (addresses or operands) are not stored in memory as they are with 8-bit processors, in the order low byte/high byte, but the other way around. Four-byte expressions (long word) are stored in memory (and the registers of course) with the highest-order byte first.

The second is that unsupported opcodes do not lead to a crash, but cause a special exception, whose standard handling must naturally be performed by the operating system.

3.8.1 Addressing modes

This is probably the most interesting theme of the 68000 because the enormous capability first takes effect through the many various addressing modes.

The effective address (the address which, sometimes composed of several components, finally determines the operand) is fundamentally 32 bits wide, even if one or more the components specified in the instruction is shorter. These are always sign-extended to the full 32-bit width.

The charm of the addressing lies in the fact that almost all instructions (naturally with exceptions), both the source and destination operands, can be specified with one of the addressing modes. This means that even memory operations do not necessarily have to use one of the registers; memory-to-memory operations are possible.

In the assembler syntax, the source operand is given first, followed by the destination operand (behind the comma).

Register Direct

The operand is located in a register. There are two kinds of register direct addressing: data register direct and address register direct.

In the first case, the operand may be bit, byte, word, or long word-oriented; in the second case a word or long word is required, in case the address register is the destination of the operation.

Example: `ADD.B D0,D1` or `ADDA.W D0,A2`

Absolute Data Addressing

The operand is located in the address space of memory. This can also be a peripheral component, naturally (see `MOVEP`). The address is specified in absolute form.

This can have a width of a a long word, whereby the entire address space can be accessed, or it can be only one word wide. In this case is sign-extended (the sign being the highest-order bit) to 32 bits. For example, the word $7FFF becomes the long word $00007FFF, while $FFFF becomes $FFFFFFFF. Only the lower 32K and the upper 32K of the address space can be accessed with the short form. This addressing mode is often used in the operating system of the ST because important system variables are stored low in memory and all peripheral components are decoded at the top.

Example: `MOVE.L $7FFF,$01234567`

Instructions in which both operands are addressed with a long word are the longest instructions in the set, consisting of 10 bytes.

Program Counter Relative Addressing

This addressing mode allows even constants to be addressed in a completely relocatable program, since the base of the address calculation is the current state of the program counter.

The are two variations. In the first, a 16-bit signed offset is added to the program counter, and in the second, the contents of a register (sign-extended if only one word is specified) are also added in, though here the offset may be only 8 bits long.

Example: `MOVE.B $1234(PC),$12(PC,D0.W)`

Register Indirect Addressing

There are several variations of this, and they will be discussed individually.

Register Indirect

Here the operand address is located in an address register.

Example: `CLR.L (A0)`

Postincrement Register Indirect

The operand is addressed as above, but the contents of the address register are then incremented by the length of the operand, by 1 for xxx.B or 4 for xxx.L.

Example: `BSET.B #0,(A0)+` or `BCLR.L #23,(A1)+`

Predecrement Register Indirect

Here the address register is decrement by the length of the operand before the addressing.

Example: `EOR.L D0,$1234(A4)`

Indexed Register Indirect with Offset

As above, but the contents of another register (address or data) are also added in, taking the sign into account. The offset may have a width of 8 bits here, however.

Example: `MOVE.W $12(A5,A6.L),D1`

Immediate Addressing

Here the operand is contained as such in the instruction itself. Naturally, an operand specified in this manner can serve only as a source. The immediate operands can, as a general rule, be any of the allowed widths.

Example: `ADDI.W #$1234,D5`

In the variant QUICK, the constant may be only 3 bits long, therefore having a value from 0-7. An exception is the MOVE command, where the constant may have 8 bits, but in which only a data register is allowed as the destination.

Example: `ADDQ.L #1,A0 or MOVEQ #123,D1`

Implied Register

This addressing mode is mentioned only for the sake of completeness and in it, an operand address is already determined by the instruction itself. The operands are either in the program counter, in the status register, or the system stack pointer.

Example: `MOVE SR,D6`

Regarding the offsets, it should be noted that they are signed numbers in two's complement. Their highest-order bit forms the sign. With an 8-bit value, an offset of +127/-128 is possible, and about ±32K with 16 bits.

3.8.2 The instructions

In the following instruction description, the individual bit patterns are not listed since this would lead to far in this connection. Additonal information can be gathered from books like the *M68000 16/32-Bit Microprocessor Programmer's Reference Manual* (Motorola).

The instructions are also explained only in their base form and variations are mentioned only in name. We will briefly explain what the individual variations can look like here.

The variations are indicated by letter after the operand. This can be one of the following:

A indicates that the destination of the operation is an address register. Word operations are sign-extended to 32 bits.

I indictaes an immediate operand as the source of the operation. I operands may assume all widths as a general width.

Q means quick and represents a special form of immediate addressing. Such an operand is usually three bits wide, corresponding to a value range of 0 to 7. This limited range has the advantage that the operand will fit into the opcode. Since there is no special command for incrementing a register, something like ADDQ.L #1,A0 works well in its place. An exception is MOVEQ. Here the operand may have a value of 0-255.

X indicates arithmetic operations which use the X flag. This flag has a special significance. It is set equal to the carry flag for all arithmetic operations. The carry flag, however, is also affected by transfer operations while the X flag is not so that it remains available for further calculations. This is especially useful for computations with higher precision than the standard 32 bits, where temporary results must first be saved, and where the carry flag can be changed as a result.

All instructions have a suffix after the opcode of the form .B, .W, or .L. This suffix indicates the processing width of the operation. Although a data register, for example, has a width of 32 bits = 4 bytes = 1 long word, the instruction CLR.B D0 clears only the lowest-order byte of the register. For registers, .W specifies the lower word. The higher-order word is not explicitly addressable. If the operand is in memory, it is imporant to know that .W and .L operands must begin on an even address. The same applies for the opcode as such, which also always comprises one word.

If the destination of an operation is an address register, only operands of type .W and .L are allowed, whereby the first is sign-extended to a long word.

Some listings contain instructions of the form MOVE.L #27,D0. The programmer then assumes that the assembler will produce #$0000001B from #27.

Now to the individual instructions:

ABCD Add Decimal with Extend

There is one data format which we have not yet discussed: the BCD format. This means nothing more than "Binary-Coded Decimal" and it uses digits in the range 0-9. Since this information requires only 4 bits, a byte can store a two-digit decimal number. The instruction ABCD can then add two such numbers. The processing width is always 8 bits.

ADD Add Binary

This instruction simply adds two operands.
Variations are *ADDA, ADDQ, ADDI*, and *ADDX*.

AND Logical AND

Two operand are logically combined with each other according the AND function.
Variation: ANDI

ASL Arithmetic Shift Left

The operand is shifted to the left byte by the number of positions given, whereby the highest-order bit is copied into the C and X flags. A 0 is shifted in at the right. If a data register is shifted, the processing width can be any. The number of places to be shifted is either specified as an I operand (3 bits) or is placed in an additional register. If a memory location is shifted, the processing width is always one word. A counter is then not given; it is always =1.

ASR Arithmetic Shift Right

The operand is shifted to the right, whereby the lowest bit is copied to C and X. The sign bit is shifted over from the left. See ASL for information about processing width and counter.

Bcc Branch Conditionally

The branch destination is always a relative address which is either one byte or one word long (signed!). Correspondingly, the branch can jump over a range of +127/-128 bytes or +32K-1/-32K. The point of reference is the address of the following instruction.

Whether or not this instruction is actually executed depends on the required condition, which is verified by means of the flags. Here are the variations and their conditions. A minus sign before a flag indicates that it must be cleared to satisdy the condition. Logical operations are indicated with "*" for AND and "/" for OR.

```
BRA  Branch Always            no condition
BCC  Branch Carry Clear       -C
BCS  Branch Carry Set         C
BEQ  Branch Equal             Z
BGE  Brangh Greater or Equal  N*V/-N*-V
BGT  Branch Greater Than      N*V*-Z/-N*-V*-Z
BHI  Branch Higher            -C*-Z
BLE  Branch Less or Equal     Z/N*-V/-N*V
BLS  Branch Lower or Same     C/Z
BLT  Branch Less Than         N*-V/-N*V
BMI  Branch Minus             N
BNE  Branch Not Equal         -Z
BPL  Branch Plus              -N
BVC  Branch Overflow Clear    -V
BVS  Branch Overflow Set      V
```

BCHG Bit Test and Change

The specified bit of the operand will be inverted. The original state can be determined from the Z flag. The operand is located either in memory (width=.B) or in a data register (width=.L). The bit number is given either as an I operand or is located in a data register.

BCLR Bit Test and Clear

The specified bit is cleared. Everything else is handled as per BCHG.

BSET Bit Test and Set

The specified bit is set. Boundary conditions are per BCHG.

BSR Branch to Subroutine

This is an unconditional branch to a subroutine. Branch distances as for Bcc.

BTST Bit Test

The bit is only checked as to its condition. Everything else as per BCHG.

CHK Check Register Against Boundaries

A data register is checked to see if its contents are less than zero or greater than the operand. Should this be the case, the processor executes an exception. The program is continued at the address in memory location $18 (vector 6). Otherwise no action is taken. The processing width is only word.

CLR Clear Operand

The specified operand is cleared (set to zero).

CMP Compare

The first operand is subtracted from the second without changing either of the two operands. Only the flags are set, according to the result.
Variations: *CMPA* and *CMPI*
Both operands are addresses with the addressing mode (Ax)+ with the variant CMPM.

DBcc Test Condition, Decrement and Branch

A data register is decremented and the flags are checked for the specified condition. A branch is performed if either the condition is fulfilled or the register is -1. Branch conditions and ranges as per Bcc.

DIVS Divide Signed

The second operand is divided by the first operand, taking the sign into account. Afterwards the second operand contains the integer quotient in the lower word and the remainder in the upper word, which has the same sign as the quotient. The data width of the first operand is set at .W and at .L for the second.

DIVU Divide Unsigned

Operation as above, but the sign is ignored.

EOR Exclusive OR

The two operands are logically combined according to the rules of EXOR.
Variations: *EORI*

EXG Exchange Registers

The two registers specified are exchanged with each other.

EXT Sign Extend

The operand is filled to the given processing width with its bit 7 (in the case of .B) or bit 15 (.W).

JMP Jump

Unconditional jump to the specified address. The difference between this and BRA is that here the address is not relative but absolute, that is, the actual jump destination.

JSR Jump to Subroutine

Jump to a subroutine. The difference from BSR is as above.

LEA Load Effective Address

This often-misunderstood instruction loads an address register not with the contents of the specified operand address as is normal for the other instructions, but *with the address as such*!

LINK Link Stack

This instruction first places the given address register on the stack. The contents of the stack pointer (A7) are then placed in this register and the offset specified is added to the stack pointer.

With this practical instruction, data areas can be reserved for a subroutine, without having to make room in the program itself, which would also be impossible in programs which run in ROM. The C-compiler makes extensive use of this capability for local variables.

LSL Logical Shift Left

Function and limitations as per ASL.

LSR Logical Shift Right

Function and limitations as per ASR, except here the sign is not shifted in on the left, but a 0.

MOVE

The first operand is transferred to the second.
Variations: *MOVEA, MOVEQ*

MOVEM Move Mulitple Registers

Here an operand can consist of a list of registers. This can be used to place all of the registers on the stack, for instance.
Example: MOVEM.L A0-A6/D0-D7,-(A7)

MOVEP Move Peripheral Data

This speciality is made expressly for the operation of peripheral components. As a general rule, these work only with an 8-bit data bus, and are are then connected only to the upper or lower 8 bits of the 68000's data bus. If a word or long word is to be transferred, the bytes must be passed over either the upper or lower byte of the data bus, depending on whether the address is even or odd. The address is then always incremented by two so that the transfer always continues on the same half of the data bus on which it was begun. Corresponding to the purpose of this instruction, one operand is always a data register, and the other is always of type register indirect with offset.

MULS Multiply Signed

Signed multiplication of two operands.

MULU Multiply Unsigned

Multiplication of two operands, ignoring the sign.

NBCD Negate Decimal with Extend

A BCD operand is subjected to the operation 0-operand X.

NEG Negate Binary

The operand is subjected to the treatment 0-operand.
Variations: *NEGX*

NOP No Operation

As the name says, this instruction doesn't do anything.

NOT One's Complement

The operand is inverted.

OR Logical OR

The two operands are combined according to the rule for logical OR.

PEA Push Effective Address

The address itself, not its contents, is placed on the stack.

RESET Reset External Devices

The reset line on the 68000 is bidirectional. Not only can the processor be externally reset, but it can also use this instruction to reset all of the peripheral devices connected to the reset line.
This is a priviledged instruction!

ROL Rotate Left

The operand is shifted to the left, whereby the bit shifted out on the left will be shifted back in on the right and the carry flag is affected. Processing widths and shift counter as per ASL.

ROR Rotate Right

As above, but shift from left to right.

ROXL Rotate Left with Extend

As ROL, but the shifted bit is first placed in the X flag, the previous value of which is shifted in on the right.

ROXR Rotate Right with Extend

As above, but reversed shift direction.

RTE Return from Exception

Return from an exception routine to the location at which the exception occurred.

RTS Return from Subroutine

Return froma subroutine to the location at which it was called.

RTR Return and Restore

As above, but the CC register (the one with the flags) is first fetched from the stack (on which it *must* have first been placed, because otherwise execution will not return to the proper address.

SBCD Subtract Decimal with Extend

The first operand is subtracted from the second. Refer to ABCD for information on the data format.

Scc Set Conditionally

The operand (only .B) is set to $FF if the condition is fulfilled. Otherwise it is cleared. Refer to Bcc for the possible condition codes.

STOP

The processor is stopped and can only be called back to life through an external interrupt.

This is a priviledged instruction!

SUB Subtract Binary

The first operand is subtracted from the second.

SWAP Swap Register Halves
The two halves of a data register are exchanged with each other.

TAS Test and Set Operand
The operand (only .B) is checked for sign and 0 (affecting the C and N flags). Bit 7 is then set to 1.

TRAP
The applications programmer uses this instruction when he wants to call functions of the operating systems. This instruction generates an exception, which consists of continuing the program at the address determined by the given vector number. See the chapter on the BIOS and XBIOS for the use of this instruction.

TRAPV Trap on Overflow
If the V flag is set, an exception is generated by this instruction, resulting in program execution continuing at the address in vector 7 ($1C).

TST Test
Action like TAS, but the operand is not changed.

UNLK Unlink
This instruction is the counterpart of LINK. The stack pointer (A7) is loaded with the given address register and this is supplied with the last stack entry. In this manner the area reserved with LINK is released.

Addendum to the condition codes: The conditions listed under Bcc are not complete, because the additional conditions do not make sense at that point. But the instrutions DBcc and Scc have the additional variations T (DBT, ST) and F (DBF, SF). T stands for true and means that the condition is always fulfilled. F stands for false and is the opposite: the condition is never fulfilled.

3.9 The BIOS Listings - Version 1

```
****************************************************      ATARI ST BIOS
005000 601C                 bra      $501E                 To program start
005002 0100                 dc.b     1,0                   Version 1
005004 0000501E             dc.l     $501E                 Reset address
005008 00005000             dc.l     $5000                 Start of the operating system
00500C 00019C00             dc.l     $19C00                End of the operating system
005010 0000501E             dc.l     $501E                 Reset address
005014 00019BF4             dc.l     $19BF4
005018 06201985             dc.l     $06201985             Creation date 6/20/1985
00501C 0000                 dc.w     0
00501E 46FC2700             move.w   #$2700,SR             Supervisor mode, no interrupts
005022 23F90000501E0000042A move.l   $501E,$42A            Load resvector
00502C 23FC3141592600000426 move.l   #$31415926,$426       Resmagic to resvalid
005036 41F9FFFF8800         lea      $FFFF8800,A0          Address of the sound chip
00503C 10BC0007             move.b   #7,(A0)               Port A and B
005040 117C00C00002         move.b   #$C0,2(A0)            To output
005046 10BC000E             move.b   #$E,(A0)              Select port A
00504A 117C00070002         move.b   #7,2(A0)              Deselect floppies
005050 083A0000FFC8         btst     #0,$501A(PC)
005056 6708                 beq      $5060
005058 13FC0002FFFF820A     move.b   #2,$FFFF820A          Syncmode
005060 43F9FFFF8240         lea      $FFFF8240,A1          Address color0
005066 303C000F             move.w   #$F,D0                16 colors
00506A 41FA03B0             lea      $541C(PC),A0          Address of the color table
00506E 32D8                 move.w   (A0)+,(A1)+           Load color palette
005070 51C8FFFC             dbra     D0,$506E              Next color
005074 9BCD                 sub.l    A5,A5                 Clear A5
005076 307C05FC             move.w   #$5FC,A0              End of the operating system variables
00507A 327C5000             move.w   #$5000,A1             Start of the operating system
00507E 7000                 moveq.l  #0,D0                 Clear D0
005080 30C0                 move.w   D0,(A0)+              Clear memory range
005082 B3C8                 cmp.l    A0,A1                 End reached ?
```

```
005084 66FA                 bne     $5080                   No
005086 206D042E             move.l  $42E(A5),A0             Phystop, end of RAM
00508A 91FC00008000         sub.l   #$8000,A0               Minus 32 K
005090 2B48044E             move.l  A0,$44E(A5)             As video address v bs ad
005094 13ED044FFFFF8201     move.b  $44F(A5),$FFFF8201      Dbaseh, video address for hardware
00509C 13ED0450FFFF8203     move.b  $450(A5),$FFFF8203      Dbasel
0050A4 323C07FF             move.w  #$7FF,D1                ($7FF+1)*16 = 32 K video RAM
0050A8 20C0                 move.l  D0,(A0)+
0050AA 20C0                 move.l  D0,(A0)+
0050AC 20C0                 move.l  D0,(A0)+                Clear screen
0050AE 20C0                 move.l  D0,(A0)+
0050B0 51C9FFF6             dbra    D1,$50A8                Next 16 K bytes
0050B4 207AFF5E             move.l  $5014(PC),A0
0050B8 0C9087654321         cmp.l   #$87654321,(A0)
0050BE 6704                 beq     $50C4
0050C0 41FAFF46             lea     $5008(PC),A0
0050C4 23E80004000004FA     move.l  4(A0),$4FA              End os
0050CC 23E80008000004FE     move.l  8(A0),$4FE              Exec os
0050D4 2B7C00005AE8046A     move.l  #$5AE8,$46A(A5)         Hdv init
0050DC 2B7C00005D880476     move.l  #$5D88,$476(A5)         Hdv rw
0050E4 2B7C00005B6E0472     move.l  #$5B6E,$472(A5)         Hdv bpb
0050EC 2B7C00005D1E047E     move.l  #$5D1E,$47E(A5)         Hdv mediach
0050F4 2B7C000060B2047A     move.l  #$60B2,$47A(A5)         Hdv boot
0050FC 2B6D044E0436         move.l  $44E(A5),$436(A5)       V bs ad as memory top
005102 2B6D04FA0432         move.l  $4FA(A5),$432(A5)       End os as memory bottom
005108 4FF900003E2A         lea     $3E2A,A7                Initialize stack pointer
00510E 3B7C00080454         move.w  #8,$454(A5)             Nvbls, number of VBL routines
005114 50ED0444             st      $444(A5)                Fverify, Floppy Verify after write
005118 3B7C00030440         move.w  #3,$440(A5)             Seekrate for floppy to 3 ms
00511E 2B7C000012BC04C6     move.l  #$12BC,$4C6(A5)         Dskbufp to $12BC, disk buffer
005126 3B7CFFFF04EE         move.w  #$FFFF,$4EE(A5)         Clear dumpflg for hardcopy
00512C 2B7C0000500004F2     move.l  #$5000,$4F2(A5)         Sysbase, start of the operating system
```

```
005134 2B7C000005FC04A2     move.l  #$5FC,$4A2(A5)          Savptr for TRAPs to $5FC
00513C 2B7C00005328046E     move.l  #$5328,$46E(A5)         Hdv dsb auf rts
005144 47FA03FC             lea     $5542(PC),A3            Pointer to rte
005148 49FA01DE             lea     $5328(PC),A4            Pointer to rts
00514C 0CB9FA52235F00FA0000 cmp.l   #$FA52235F,$FA0000      Cartbase, Diagnostic cartrige inserted?
005156 6726                 beq     $517E                   Yes, don't initialize vectors
005158 43FA06DE             lea     $5838(PC),A1            Terminate process
00515C D3FC02000000         add.l   #$2000000,A1            Vector number is in bits 24-31
005162 41F900000008         lea     $8,A0                   Start with bus error
005168 303C003D             move.w  #$3D,D0                 Number of vectors
00516C 20C9                 move.l  A1,(A0)+                Set vector
00516E D3FC01000000         add.l   #$1000000,A1            Increment number in bits 24-31
005174 51C8FFF6             dbra    D0,$516C                Next vector
005178 23CB00000014         move.l  A3,$14                  'Division by zero' to rte
00517E 2B7C000054520070     move.l  #$5452,$70(A5)          Vertical Blank Interrupt, IPL4
005186 2B7C0000543C0068     move.l  #$543C,$68(A5)          Horizontal Blank Interrupt, IPL2
00518E 2B4B0088             move.l  A3,$88(A5)              TRAP #2 to rte
005192 2B7C0000556C00B4     move.l  #$556C,$B4(A5)          TRAP #13 vector
00519A 2B7C0000556600B8     move.l  #$5566,$B8(A5)          TRAP #14 vector
0051A2 2B7C0000EB9A0028     move.l  #$EB9A,$28(A5)          LINE A vector
0051AA 2B4C0400             move.l  A4,$400(A5)             Etv timer to rts
0051AE 2B7C000055620404     move.l  #$5562,$404(A5)         Etv critic vector
0051B6 2B4C0408             move.l  A4,$408(A5)             Etv term to rts
0051BA 41ED04CE             lea     $4CE(A5),A0             Vbl list
0051BE 2B480456             move.l  A0,$456(A5)             As pointer to vblqueue
0051C2 303C0007             move.w  #7,D0                   8 vectors
0051C6 4298                 clr.l   (A0)+                   Clear list
0051C8 51C8FFFC             dbra    D0,$51C6                Next vector
0051CC 61001D14             bsr     $6EE2                   Initialize MFP
0051D0 7002                 moveq.l #2,D0                   Bit number
0051D2 6100012A             bsr     $52FE                   Cart scan, test cartridge
0051D6 9BCD                 sub.l   A5,A5                   Clear A5
```

```
0051D8 6100036A               bsr     $5544                    Wvbl, wait for next picture return
0051DC 61000366               bsr     $5544                    Wvbl, wait for next picture return
0051E0 103C0002               move.b  #2,D0                    Default resolution to monochrome
0051E4 08390007FFFFFA01       btst    #7,$FFFFFA01             Test MFP gpip monochrome detect
0051EC 670C                   beq     $51FA                    No monochrome monitor ?
0051EE 102D044A               move.b  $44A(A5),D0              Get defshiftmd
0051F2 B03C0002               cmp.b   #2,D0                    Color mode ?
0051F6 6D02                   blt     $51FA                    Yes
0051F8 4200                   clr.b   D0                       Otherwise select low resolution
0051FA 1B40044C               move.b  D0,$44C(A5)              Save sshiftmd
0051FE 13C0FFFF8260           move.b  D0,$FFFF8260             Shiftmd, program shifter
005204 B03C0001               cmp.b   #1,D0                    Medium resolution ?
005208 660A                   bne     $5214                    No
00520A 33F9FFFF825EFFFF8246   move.w  $FFFF825E,$FFFF8246      Copy color 15 (black) to color 3
005214 4EB90000F6C4           jsr     $F6C4                    Initialize screen output
00521A 2B7C0000501E046E       move.l  #$501E,$46E(A5)          Hdv dsb
005222 33FC000100000452       move.w  #1,$452                  Vblsem, free VBL
00522A 4240                   clr.w   D0                       Bit number 0
00522C 610000D0               bsr     $52FE                    Cartscan, test cartridge
005230 46FC2300               move.w  #$2300,SR                IPL to 3
005234 7001                   moveq.l #1,D0                    Bit number 1
005236 610000C6               bsr     $52FE                    Cartscan, test cartridge
00523A 61004234               bsr     $9470                    Initialize DOS
00523E 610000B0               bsr     $52F0                    Dskboot
005242 4A7900000482           tst.w   $482                     Cmdload, load shell from disk ?
005248 6718                   beq     $5262                    No
00524A 61003C64               bsr     $8EB0                    Enable cursor
00524E 610006FE               bsr     $594E                    Auto exec
005252 487A0099               pea     $52ED(PC)                Null name
005256 487A0095               pea     $52ED(PC)                Null name
00525A 487A007E               pea     $52DA(PC)                'COMMAND.PRG'
00525E 4267                   clr.w   -(A7)
```

```
005260 605C                 bra     $52BE
005262 610006EA             bsr     $594E
005266 41FA0066             lea     $52CE(PC),A0
00526A 327C0502             move.w  #$502,A1
00526E 0C100023             cmp.b   #35,(A0)           '#' drive indicator ?
005272 6602                 bne     $5276              No
005274 2449                 move.l  A1,A2              Address of the drive indicator
005276 12D8                 move.b  (A0)+,(A1)+        Copy drive number
005278 6AF4                 bpl     $526E              Copy entire string
00527A 103900000446         move.b  $446,D0            Bootdev
005280 D03C0041             add.b   #$41,D0            'A', calculate drive number
005284 1480                 move.b  D0,(A2)            Insert in filename
005286 487900000502         pea     $502               Enviroment string
00528C 4879000052ED         pea     $52ED              Null name
005292 487A0059             pea     $52ED(PC)          Null name
005296 3F3C0005             move.w  #5,-(A7)
00529A 3F3C004B             move.w  #$4B,-(A7)         Exec, load program
00529E 4E41                 trap    #1                 GEMDOS call
0052A0 DEFC000E             add.w   #$E,A7             Correct stack pointer
0052A4 2040                 move.l  D0,A0              Save base page address
0052A6 2179000004FE0008     move.l  $4FE,8(A0)         Exec os
0052AE 487900000502         pea     $502
0052B4 2F08                 move.l  A0,-(A7)
0052B6 487A0035             pea     $52ED(PC)
0052BA 3F3C0004             move.w  #4,-(A7)
0052BE 3F3C004B             move.w  #$4B,-(A7)         Exec, load program
0052C2 4E41                 trap    #1                 GEMDOS call
0052C4 DEFC000E             add.w   #$E,A7             Correct stack
0052C8 4EF90000501E         jmp     $501E              If return, then Reset
0052CE 504154483D00         dc.b    'PATH=',0:1=92
0052D4 233A5C00FF           dc.b    '#:1',0,$FF
0052DA 434F4D4D414E442E5052 dc.b    'COMMAND.PRG',0
```

```
0052E4 4700
0052E6 47454D2E505247      dc.b    'GEM.PRG'

0052ED 000000              dc.b    0,0,0

*************************************************  Dskboot, boot from disk
0052F0 7003                moveq.l #3,D0            Bit number 3
0052F2 610A                bsr     $52FE            Test cartridge
0052F4 20790000047A        move.l  $47A,A0          Hdv boot, load boot vector
0052FA 4E90                jsr     (A0)             And start attempt
0052FC 4E75                rts

*************************************************  Test cartridge
0052FE 41F900FA0000        lea     $FA0000,A0       Cartbase
005304 0C98ABCDEF42        cmp.l   #$ABCDEF42,(A0)+ User cartridge inserted ?
00530A 661A                bne     $5326            No
00530C 01280004            btst    D0,4(A0)         Initialization ?
005310 670E                beq     $5320            No
005312 48E7FFFE            movem.l D0-D7/A0-A6,-(A7) Save registers
005316 20680004            move.l  4(A0),A0         Address of the init routine
00531A 4E90                jsr     (A0)             Perform initialization
00531C 4CDF7FFF            movem.l (A7)+,D0-D7/A0-A6 Restore registers
005320 4A90                tst.l   (A0)             Additional application in cartridge ?
005322 2050                move.l  (A0),A0          Get link address
005324 66E6                bne     $530C            Initialization next application
005326 4E75                rts

*************************************************
005328 4E75                rts                      Default vector

*************************************************  Memory test
00532A D1C1                add.l   D1,A0            Add offset to base address
```

```
00532C 4240                  clr.w   D0                       Clear test pattern
00532E 43E801F8              lea     $1F8(A0),A1              End address of the test
005332 B058                  cmp.w   (A0)+,D0                 Test memory contents
005334 6608                  bne     $533E                    Unequal, terminate
005336 D07CFA54              add.w   #$FA54,D0                Create next test pattern
00533A B3C8                  cmp.l   A0,A1                    End address reached ?
00533C 66F4                  bne     $5332                    No, continue test
00533E 4ED5                  jmp     (A5)                     Back to the calling address

****************************************************
005340 9BCD                  sub.l   A5,A5
005342 0CAD752019F30420      cmp.l   #1965038067,$420(A5)     Memvalid
00534A 6608                  bne     $5354
00534C 0CAD237698AA043A      cmp.l   #594974890,$43A(A5)      Memval2
005354 4ED6                  jmp     (A6)

******************************************************
005356 00000000
00535A 00000000
00535E 00000000
005362 00000000

*******************************************************
005366 1839FFFF8260          move.b  $FFFF8260,D4             Shiftmd, Get video resolution
00536C C87C0003              and.w   #3,D4                    Isolate bits 0 and 1
005370 D844                  add.w   D4,D4                    Double value for word table
005372 B1FC00008000          cmp.l   #$8000,A0
005378 6220                  bhi     $539A
00537A B1FC00000000          cmp.l   #0,A0
005380 6604                  bne     $5386
005382 307B4086              move.w  $530A(PC,D4.w),A0
005386 4280                  clr.l   D0
```

```
005388 1039FFFF8201        move.b  $FFFF8201,D0          Dbaseh
00538E E148                lsl.w   #8,D0
005390 1039FFFF8203        move.b  $FFFF8203,D0          Dbasel
005396 E188                lsl.l   #8,D0
005398 D1C0                add.l   D0,A0
00539A 7E0F                moveq.l #15,D7
00539C 3C3B4078            move.w  $5416(PC,D4.w),D6
0053A0 3605                move.w  D5,D3
0053A2 2448                move.l  A0,A2
0053A4 D4FB406A            add.w   $5410(PC,D4.w),A2
0053A8 1011                move.b  (A1),D0
0053AA 4BFA0004            lea     $53B0(PC),A5
0053AE 6042                bra     $53F2
0053B0 3202                move.w  D2,D1
0053B2 10290001            move.b  1(A1),D0
0053B6 4BFA0004            lea     $53BC(PC),A5
0053BA 6036                bra     $53F2
0053BC 3011                move.w  (A1),D0
0053BE 4EFB4002            jmp     $53C2(PC,D4.w)
0053C2 6004                bra     $53C8                 Low resolution
0053C4 600C                bra     $53D2                 Medium resolution
0053C6 6014                bra     $53DC                 High resolution

****************************************************     Low resolution
0053C8 30C0                move.w  D0,(A0)+
0053CA 30C0                move.w  D0,(A0)+
0053CC 30C0                move.w  D0,(A0)+
0053CE 30C0                move.w  D0,(A0)+
0053D0 600E                bra     $53E0

****************************************************     Medium resolution
0053D2 30C1                move.w  D1,(A0)+
```

```
0053D4 30C1                 move.w  D1,(A0)+
0053D6 30C2                 move.w  D2,(A0)+
0053D8 30C2                 move.w  D2,(A0)+
0053DA 6004                 bra     $53E0

****************************************************     High resolution
0053DC 30C1                 move.w  D1,(A0)+
0053DE 30C2                 move.w  D2,(A0)+
0053E0 51CBFFC6             dbra    D3,$53A8
0053E4 204A                 move.l  A2,A0
0053E6 51CEFFB8             dbra    D6,$53A0
0053EA 5449                 addq.w  #2,A1
0053EC 51CFFFAE             dbra    D7,$539C
0053F0 4ED6                 jmp     (A6)
0053F2 2643                 move.l  D3,A3
0053F4 7400                 moveq.l #0,D2
0053F6 7607                 moveq.l #7,D3
0053F8 E310                 roxl.b  #1,D0
0053FA 40E7                 move.w  SR, -(A7)            Save carry flag
0053FC E352                 roxl.w  #1,D2
0053FE 46DF                 move.w  (A7)+,SR             Restore carry flag
005400 E352                 roxl.w  #1,D2
005402 51CBFFF4             dbra    D3,$53F8
005406 260B                 move.l  A3,D3
005408 4ED5                 jmp     (A5)                 Back to call

****************************************************
00540A 3EC8                 dc.w    16072
00540C 3EC8                 dc.w    16072
00540E 3EA4                 dc.w    16036
005410 00A0                 dc.w    160
005412 00A0                 dc.w    160
```

```
005414 0050                dc.w    80
005416 0000                dc.w    0
005418 0000                dc.w    0
00541A 0001                dc.w    0

*************************************************       Color palatte
00541C 0777                dc.w    $777                 White
00541E 0700                dc.w    $700                 Red
005420 0070                dc.w    $070                 Green
005422 0770                dc.w    $770                 Yellow
005424 0007                dc.w    $007                 Blue
005426 0707                dc.w    $707                 Magenta
005428 0077                dc.w    $077                 Blue-green
00542A 0555                dc.w    $555                 Light grey
00542C 0333                dc.w    $333                 Grey
00542E 0733                dc.w    $733                 Light red
005430 0373                dc.w    $373                 Light green
005432 0773                dc.w    $773                 Light yellow
005434 0337                dc.w    $337                 Light blue
005436 0737                dc.w    $737                 Light magenta
005438 0377                dc.w    $377                 Light blue-gree
00543A 0000                dc.w    $000                 black

*********************************************           HBL interrupt
00543C 3F00                move.w  D0,-(A7)             Save D0
00543E 302F0002            move.w  2(A7),D0             Get status from stack
005442 C07C0700            and.w   #$700,D0             Isolate IPL mask
005446 6606                bne     $544E                Not equal to zero ?
005448 006F03000002        or.w    #$300,2(A7)          Otherwise IPL tp 3
00544E 301F                move.w  (A7)+,D0             Restore D0
005450 4E73                rte
```

```
*************************************************   VBL interrupt
005452 52B900000466        addq.l   #1,$466            Increment frclock
005458 537900000452        subq.w   #1,$452            Vblsem
00545E 6B0000DC            bmi      $553C              VBL interrupt disabled ?
005462 48E7FFFE            movem.l  D0-D7/A0-A6,-(A7)  Save registers
005466 52B900000462        addq.l   #1,$462            Increment vbclock erh\hen
00546C 9BCD                sub.l    A5,A5              Clear A5
00546E 1039FFFF8260        move.b   $FFFF8260,D0       Load shiftmd
005474 C03C0003            and.b    #3,D0
005478 B03C0002            cmp.b    #2,D0              High resolution ?
00547C 6C10                bge      $548E              Yes
00547E 08390007FFFFFA01    btst     #7,$FFFFFA01       Mfp gpip, monochrome detect
005486 662C                bne      $54B4              No color monitor
005488 103C0002            move.b   #2,D0              High resolution
00548C 6016                bra      $54A4
00548E 08390007FFFFFA01    btst     #7,$FFFFFA01       Mfp gpip, monochrome detect
005496 671C                beq      $54B4              Monochrome monitor ?
005498 102D044A            move.b   $44A(A5),D0        Defshiftmd, get color resolution
00549C B03C0002            cmp.b    #2,D0              Monochrome ?
0054A0 6D02                blt      $54A4              No
0054A2 4200                clr.b    D0                 Else low resolution
0054A4 1B40044C            move.b   D0,$44C(A5)        Save sshiftmd
0054A8 13C0FFFF8260        move.b   D0,$FFFF8260       Shiftmd, program shifter
0054AE 206D046E            move.l   $46E(A5),A0        Vector for resolution change
0054B2 4E90                jsr      (A0)               Execute routine
0054B4 61003B42            bsr      $8FF8              Flash cursor
0054B8 9BCD                sub.l    A5,A5              Clear A5
0054BA 4AAD045A            tst.l    $45A(A5)           Colorptr, reload color palette ?
0054BE 6718                beq      $54D8              No
0054C0 206D045A            move.l   $45A(A5),A0        Colorptr, address of the new palette
0054C4 43F9FFFF8240        lea      $FFFF8240,A1       Color0, address in the video shifter
0054CA 303C000F            move.w   #$F,D0             16 colors
```

```
0054CE 32D8               move.w  (A0)+,(A1)+          Copy
0054D0 51C8FFFC           dbra    D0,$54CE             Next color
0054D4 42AD045A           clr.l   $45A(A5)             Clear colorptr again
0054D8 4AAD045E           tst.l   $45E(A5)             Screenpt, new video address ?
0054DC 671A               beq     $54F8                No
0054DE 2B6D045E044E       move.l  $45E(A5),$44E(A5)    Copy screenpt tp v bs ad
0054E4 202D044E           move.l  $44E(A5),D0          V bs ad
0054E8 E048               lsr.w   #8,D0                Bits 8-15
0054EA 13C0FFFF8203       move.b  D0,$FFFF8203         To dbasel
0054F0 E048               lsr.w   #8,D0                Bits 16-24
0054F2 13C0FFFF8201       move.b  D0,$FFFF8201         To dbaseh
0054F8 610011EA           bsr     $66E4                VBL routine for floppies
0054FC 3E3900000454       move.w  $454,D7              Nvbls, number of VBL routines
005502 6720               beq     $5524                No vectors ?
005504 5387               subq.l  #1,D7                Convert to dbra counter
005506 207900000456       move.l  $456,A0              Address of the vblqueue
00550C 2258               move.l  (A0)+,A1             Get vector
00550E B3FC00000000       cmp.l   #$0,A1               Zero ?
005514 670A               beq     $5520                Don't execute routine
005516 48E70180           movem.l D7/A0,-(A7)          Save registers
00551A 4E91               jsr     (A1)                 Execute routine
00551C 4CDF0180           movem.l (A7)+,D7/A0          Restore registers
005520 51CFFFEA           dbra    D7,$550C             Test next vector
005524 9BCD               sub.l   A5,A5                Clear A5
005526 4A6D04EE           tst.w   $4EE(A5)             Dumpflg, hardcopy desired ?
00552A 660C               bne     $5538                No
00552C 61000532           bsr     $5A60                Hardcopy
005530 33FCFFFF000004EE   move.w  #$FFFF,$4EE          Clear dumpflg again
005538 4CDF7FFF           movem.l (A7)+,D0-D7/A0-A6    Restore registers
00553C 527900000452       addq.w  #1,$452              Vblsem, restore VBL again
005542 4E73               rte
```

```
*************************************************     Wvbl, wait for next V-sync
005544 40E7              move.w  SR, -(A7)           Save status
005546 027CF8FF          and.w   #$F8FF,SR           IPL 0, allow interrupts
00554A 203900000466      move.l  $466,D0             Load frclock
005550 B0B900000466      cmp.l   $466,D0             Frclock
005556 67F8              beq     $5550               Still equal ?
005558 46DF              move.w  (A7)+,SR            Restore status
00555A 4E75              rts

*************************************************     Critical error handler
00555C 2F3900000404      move.l  $404,-(A7)          Etv critic
005562 70FF              moveq.l #-1,D0
005564 4E75              rts

*************************************************     TRAP #14
005566 41FA0084          lea     $55EC(PC),A0        Address of the TRAP #14 routines
00556A 6004              bra     $5570

*************************************************     TRAP #13
00556C 41FA004C          lea     $55BA(PC),A0        Address of the TRAP #13 routines
005570 2279000004A2      move.l  $4A2,A1             Savptr, pointer to save area
005576 301F              move.w  (A7)+,D0            Status register to D0
005578 3300              move.w  D0,-(A1)            Save in save area
00557A 231F              move.l  (A7)+,-(A1)         Save PC
00557C 48E11F1F          movem.l D3-D7/A3-A7,-(A1)   And save C register
005580 23C9000004A2      move.l  A1,$4A2             Update savptr
005586 0800000D          btst    #13,D0              Call from supervisor mode ?
00558A 6602              bne     $558E               Yes
00558C 4E6F              move.l  USP,A7              Else use USP
00558E 301F              move.w  (A7)+,D0            Get function number from stack
005590 B058              cmp.w   (A0)+,D0            Compare with maximal number
005592 6C10              bge     $55A4               Too large, stop
```

```
005594 E548                lsl.w    #2,D0                 Convert number ot long counter
005596 20300000            move.l   0(A0,D0.w),D0         Get address of the routine
00559A 2040                move.l   D0,A0                 To A0
00559C 6A02                bpl      $55A0                 Bit 31 cleared ?
00559E 2050                move.l   (A0),A0               Else use address indirectly
0055A0 9BCD                sub.l    A5,A5                 Clear A5
0055A2 4E90                jsr      (A0)                  Execute routine
0055A4 2279000004A2        move.l   $4A2,A1               Get savptr
0055AA 4CD9F8F8            movem.l  (A1)+,D3-D7/A3-A7     Restore registers
0055AE 2F19                move.l   (A1)+,-(A7)           PC on stack
0055B0 3F19                move.w   (A1)+,-(A7)           Status on stack
0055B2 23C9000004A2        move.l   A1,$4A2               Update savptr
0055B8 4E73                rte                            Back to call

**************************************************       Addresses of the TRAP #13 calls
0055BA 000C                dc.w     12                    Number of routines
0055BC 0000572E            dc.l     $572E                 0, getmpb
0055C0 00005694            dc.l     $5694                 1, bconstat
0055C4 0000569A            dc.l     $569A                 2, bconin
0055C8 000056A6            dc.l     $56A6                 3, bconout
0055CC 80000476            dc.l     $476+$80000000        4, (indirect) rwabs
0055D0 0000575A            dc.l     $575A                 5, setexec
0055D4 00005772            dc.l     $5772                 6, tickcal
0055D8 80000472            dc.l     $472+$80000000        7, (indirect) getbpb
0055DC 000056A0            dc.l     $56A0                 8, bcostat
0055E0 8000047E            dc.l     $47E+$80000000        9, (indirect) mediach
0055E4 00005716            dc.l     $5716                 10, drvmap
0055E8 0000571C            dc.l     $571C                 11, shift
```

```
****************************************************  Addresses of the TRAP #14 calls
0055EC 0028             dc.w    40        Number of routines
0055EE 00007AC0         dc.l    $7AC0     0, initmouse
0055F2 00005328         dc.l    $5328     1, rts
0055F6 0000577A         dc.l    $577A     2, physbase
0055FA 0000578E         dc.l    $578E     3, logbase
0055FE 00005794         dc.l    $5794     4, getrez
005602 000057A0         dc.l    $57A0     5, setscreen
005606 000057EE         dc.l    $57EE     6, setpalette
00560A 000057F6         dc.l    $57F6     7, setcolor
00560E 000062D2         dc.l    $62D2     8, floprd
005612 000063B0         dc.l    $63B0     9, flopwr
005616 00006468         dc.l    $6468     10, flopfmt
00561A 00005B64         dc.l    $5B64     11, getdsb
00561E 00006B74         dc.l    $6B74     12, midiws
005622 00007138         dc.l    $7138     13, mfpint
005626 00007440         dc.l    $7440     14, iorec
00562A 00007468         dc.l    $7468     15, rsconf
00562E 00007BC6         dc.l    $7BC6     16, keytrans
005632 00006062         dc.l    $6062     17, rand
005636 0000614A         dc.l    $614A     18, protobt
00563A 00006602         dc.l    $6602     19, flopver
00563E 00005A4E         dc.l    $5A4E     20, dumpit
005642 00009024         dc.l    $9024     21, cursconf
005646 00006AAA         dc.l    $6AAA     22, settime
00564A 00006A90         dc.l    $6A90     23, gettime
00564E 00007BF2         dc.l    $7BF2     24, bioskeys
005652 00006CE6         dc.l    $6CE6     25, ikbdws
005656 00007162         dc.l    $7162     26, jdisint
00565A 0000719C         dc.l    $719C     27, jenabint
00565E 00007A30         dc.l    $7A30     28, giaccess
005662 00007A9A         dc.l    $7A9A     29, offgibit
```

```
005666 00007A74          dc.l    $7A74          30, ongibit
00566A 00007B8A          dc.l    $7B8A          31, xbtimer
00566E 00007C0C          dc.l    $7C0C          32, dosound
005672 00007C20          dc.l    $7C20          33, setprt
005676 00007C54          dc.l    $7C54          34, ikbdvecs
00567A 00007C32          dc.l    $7C32          35, kbrate
00567E 00007D92          dc.l    $7D92          36, prtblk
005682 00005544          dc.l    $5544          37, wvbl
005686 0000568E          dc.l    $568E          38, supexec
00568A 0000581C          dc.l    $581C          39, puntaes

***************************************************  supexec, routine in supervisor mode
00568E 206F0004          move.l  4(A7),A0       Get address from stack
005692 4ED0              jmp     (A0)           Execute routine in supervisor mode

***************************************************  bconstat, get input statis
005694 41FA0020          lea     $56B6(PC),A0   Status table
005698 6010              bra     $56AA

***************************************************  bconin, input
00569A 41FA0032          lea     $56CE(PC),A0   Input table
00569E 600A              bra     $56AA

***************************************************  bcostat, get output status
0056A0 41FA0044          lea     $56E6(PC),A0   Status table
0056A4 6004              bra     $56AA

****************************************************  bconout, output
0056A6 41FA0056          lea     $56FE(PC),A0
```

```
***************************************************  Conout
0056AA 302F0004          move.w  4(A7),D0            Get device number
0056AE E548              lsl.w   #2,D0               Times 4
0056B0 20700000          move.l  0(A0,D0.w),A0       Get address of the routine
0056B4 4ED0              jmp     (A0)                Execute routine

***************************************************  Input statis
0056B6 00005328          dc.l    $5328               Rts
0056BA 00006C70          dc.l    $6C70               RS 232 status
0056BE 00006CFA          dc.l    $6CFA               Console status
0056C2 00006B88          dc.l    $6B88               MIDI status
0056C6 00005328          dc.l    $5328               RTS
0056CA 00005328          dc.l    $5328               RTS

***************************************************  Input
0056CE 00006C3C          dc.l    $6C3C               Parallel port
0056D2 00006C86          dc.l    $6C86               RS 232 input
0056D6 00006D10          dc.l    $6D10               Console input
0056DA 00006BA4          dc.l    $6BA4               MIDI input
0056DE 00005328          dc.l    $5328               RTS
0056E2 00005328          dc.l    $5328               RTS

***************************************************  Output status
0056E6 00006C5C          dc.l    $6C5C               Centronics status
0056EA 00006C96          dc.l    $6C96               RS 232 status
0056EE 00006D46          dc.l    $6D46               Console status
0056F2 00006CBA          dc.l    $6CBA               Keyboard status
0056F6 00006B48          dc.l    $6B48               MIDI status
0056FA 00005328          dc.l    $5328               rts
```

```
*****************************************************   Output
0056FE 00006BD4        dc.l    $6BD4              Centronics output
005702 00006CAE        dc.l    $6CAE              RS 232 output
005706 00008ADE        dc.l    $8ADE              Console output
00570A 00006B5A        dc.l    $6B5A              MIDI output
00570E 00006CCC        dc.l    $6CCC              Keyboard output
005712 00008AD2        dc.l    $8AD2              ASCII outout

*****************************************************   Drvmap, get active floppies
005716 202D04C2        move.l  $4C2(A5),D0        Drvbits, get bit vector
00571A 4E75            rts

*****************************************************   Shift, keyboard status
00571C 7000            moveq.l #0,D0
00571E 102D0A5D        move.b  $A5D(A5),D0        Kshift, get shift status
005722 322F0004        move.w  4(A7),D1           Get parameters from stack
005726 6B04            bmi     $572C              Negative, then set
005728 1B410A5D        move.b  D1,$A5D(A5)        Accept as kbshift
00572C 4E75            rts

*****************************************************   Getmpb, Memory Parameter Block
00572E 206F0004        move.l  4(A7),A0           New MPB
005732 43ED048E        lea     $48E(A5),A1        Themd, Memory descriptor
005736 2089            move.l  A1,(A0)            Mp mfl = address of the MD
005738 42A80004        clr.l   4(A0)              Mp mal = zero
00573C 21490008        move.l  A1,8(A0)           Mp rover = address of the MD
005740 4291            clr.l   (A1)               Clear m link
005742 236D04320004    move.l  $432(A5),4(A1)     Membot as mstart
005748 202D0436        move.l  $436(A5),D0        Memtop
00574C 90AD0432        sub.l   $432(A5),D0        Minus membot
005750 23400008        move.l  D0,8(A1)           Length as m length
005754 42A9000C        clr.l   12(A1)             M own = zero
```

```
005758 4E75                  rts

****************************************************    Setexc, set exception vector
00575A 302F0004              move.w  4(A7),D0          Get vector number
00575E E548                  lsl.w   #2,D0             Times 4 equals address
005760 91C8                  sub.l   A0,A0             Clear A0
005762 41F00000              lea     0(A0,D0.w),A0     Get address of the old vector
005766 2010                  move.l  (A0),D0           Old vector to D0
005768 222F0006              move.l  6(A7),D1          New vector
00576C 6B02                  bmi     $5770             Negative, then don't set
00576E 2081                  move.l  D1,(A0)           Set vector
005770 4E75                  rts

****************************************************    Tickcal, timer value in milliseconds
005772 4280                  clr.l   D0
005774 302D0442              move.w  $442(A5),D0       Get timr ms
005778 4E75                  rts

****************************************************    Physbase, physical video address
00577A 7000                  moveq.l #0,D0
00577C 1039FFFF8201          move.b  $FFFF8201,D0      Dbaseh
005782 E148                  lsl.w   #8,D0
005784 1039FFFF8203          move.b  $FFFF8203,D0      Dbasel
00578A E188                  lsl.l   #8,D0             Video address in D0
00578C 4E75                  rts

****************************************************    Logbase, logical video address
00578E 202D044E              move.l  $44E(A5),D0       Get v bs ad
005792 4E75                  rts

****************************************************    Getrez, get video resolution
005794 7000                  moveq.l #0,D0
```

```
005796 102D8260            move.b  $FFFF8260(A5),D0     Load shiftmd
00579A C03C0003            and.b   #$3,D0               Isolate bits 0 and 1
00579E 4E75                rts

*****************************************************   Setscreen, set screen address
0057A0 4AAF0004            tst.l   4(A7)                Logical address
0057A4 6B06                bmi     $57AC                Negatice, don't set
0057A6 2B6F0004044E        move.l  4(A7),$44E(A5)       Set v bs ad
0057AC 4AAF0008            tst.l   8(A7)                Physical address
0057B0 6B10                bmi     $57C2                Negative, don't set
0057B2 13EF0009FFFF8201    move.b  9(A7),$FFFF8201      Dbaseh
0057BA 13EF000AFFFF8203    move.b  10(A7),$FFFF8203     Dbasel
0057C2 4A6F000C            tst.w   12(A7)               Video resolution
0057C6 6B24                bmi     $57EC                Negative, don't set
0057C8 1B6F000D044C        move.b  13(A7),$44C(A5)      Sshiftmd
0057CE 6100FD74            bsr     $5544                Wvbl, wait for VBL
0057D2 13ED044CFFFF8260    move.b  $44C(A5),$FFFF8260   Sshiftmd to shiftmd
0057DA 426D0452            clr.w   $452(A5)             Vblsem, VBL disabled
0057DE 4EB90000F6C4        jsr     $F6C4                Initialize screen output
0057E4 33FC000100000452    move.w  #1,$452              Vblsem, permit VBL again
0057EC 4E75                rts

*****************************************************   Setpalette, load new color palette
0057EE 2B6F0004045A        move.l  4(A7),$45A(A5)       Set colorptr (execution in VBL)
0057F4 4E75                rts

*****************************************************   Setcolor, set single color
0057F6 322F0004            move.w  4(A7),D1             Color number
0057FA D241                add.w   D1,D1                Times 2
0057FC C27C001F            and.w   #$1F,D1              Limit to valid number
005800 41F9FFFF8240        lea     $FFFF8240,A0         Address color0
005806 30301000            move.w  0(A0,D1.w),D0        Get old color
```

```
00580A C07C0777               and.w    #$777,D0          Clear irrelavant bits
00580E 4A6F0006               tst.w    6(A7)             Test new color value
005812 6B06                   bmi      $581A             Negative, dont set
005814 31AF00061000           move.w   6(A7),0(A0,D1.w)  Set new color
00581A 4E75                   rts

*************************************************** Puntaes, clear AES and restart
00581C 207AF7F6               move.l   $5014(PC),A0      os magic
005820 0C9087654321           cmp.l    #$87654321,(A0)   Already there ?
005826 660E                   bne      $5836             No, done
005828 B1F90000042E           cmp.l    $42E,A0           In ROM ?
00582E 6C06                   bge      $5836             Yes, do nothing
005830 4290                   clr.l    (A0)              Clear magic
005832 6000F7EA               bra      $501E             To reset
005836 4E75                   rts

*************************************************** Term, interrupt running program
005838 6102                   bsr      $583C             PC on stack
00583A 4E71                   nop
00583C 23DF000003C4           move.l   (A7)+,$3C4        Save PC including vector number
005842 48F9FFFF00000384       movem.l  D0-D7/A0-A7,$384  Save registers
00584A 4E68                   move.l   USP,A0            USP
00584C 23C8000003C8           move.l   A0,$3C8           Save
005852 303C000F               move.w   #$F,D0            16 words
005856 41F9000003CC           lea      $3CC,A0           Save area
00585C 224F                   move.l   A7,A1             Get SP to A1
00585E 30D9                   move.w   (A1)+,(A0)+       Save word from stack
005860 51C8FFFC               dbra     D0,$585E          Next word
005864 23FC1234567800000380   move.l   #$12345678,$380   Magic for saved registers
00586E 7200                   moveq.l  #0,D1
005870 1239000003C4           move.b   $3C4,D1           Get vector number to D1
005876 5341                   subq.w   #1,D1             Convert in dbra counter
```

```
005878 6116                   bsr     $5890                Output appropriate # of  'mushrooms'
00587A 23FC000005FC000004A2 move.l  #$5FC,$4A2           Reset savptr for BIOS
005884 3F3C0001               move.w  #1,-(A7)             Return code for error
005888 42A7                   clr.l   -(A7)                Terminate process
00588A 4E41                   trap    #1                   GEMDOS call
00588C 6000F790               bra     $501E                If return, then reset

***************************************************** Write 'mushrooms' on screen
005890 1E39FFFF8260           move.b  $FFFF8260,D7         Shiftmd, get resolution
005896 CE7C0003               and.w   #3,D7                Isolate significant bits
00589A DE47                   add.w   D7,D7                Times 2 for word access
00589C 4280                   clr.l   D0
00589E 1039FFFF8201           move.b  $FFFF8201,D0         Dbaseh
0058A4 E148                   lsl.w   #8,D0
0058A6 1039FFFF8203           move.b  $FFFF8203,D0         Dbasel
0058AC E188                   lsl.l   #8,D0                Screen address
0058AE 2040                   move.l  D0,A0                To A0
0058B0 D0FB702A               add.w   $58DC(PC,D7.w),A0    Plus offset for middle of screen
0058B4 43FA0038               lea     $58EE(PC),A1         Address of bit pattern for "mushroom"
0058B8 3C3C000F               move.w  #$F,D6               16 raster lines
0058BC 3401                   move.w  D1,D2
0058BE 2448                   move.l  A0,A2                Save pointer to start of line
0058C0 3A3B7020               move.w  $58E2(PC,D7.w),D5    Number of words (screen planes)
0058C4                        move.w  (A1),(A0)+           Write a raster line
0058C6 51CDFFFC               dbra    D5,$58C4             A complete mushroom
0058CA 51CAFFF4               dbra    D2,$58C0             The next on the same line
0058CE 5449                   addq.w  #2,A1                Next word of the bit pattern
0058D0 D4FB7016               add.w   $58E8(PC,D7.w),A2    Next destination address
0058D4 204A                   move.l  A2,A0                Restore start of the line
0058D6 51CEFFE4               dbra    D6,$58BC             Next raster line
0058DA 4E75                   rts
```

```
****************************************************    Screen center
0058DC 3E80                 dc.w    100*160             Low resolution
0058DE 3E80                 dc.w    100*160             Mid resolution
0058E0 3E80                 dc.w    200*80              High resolution

****************************************************    Number of screen planes -1
0058E2 0003                 dc.w    3                   Low resolution
0058E4 0001                 dc.w    1                   Mid resolution
0058E6 0000                 dc.w    0                   High resolution

****************************************************    Line length
0058E8 00A0                 dc.w    160                 Low resolution
0058EA 00A0                 dc.w    160                 Mid resolution
0058EC 0050                 dc.w    80                  High resolution

****************************************************    Bit pattern 'mushrooms'
0058EE 07C0                 dc.w    %0000011111000000
0058F0 1FF0                 dc.w    %0001111111110000
0058F2 3BF8                 dc.w    %0011101111111000
0058F4 77F4                 dc.w    %0111011111110100
0058F6 B7FA                 dc.w    %1011011111111010
0058F8 BBFA                 dc.w    %1011101111111010
0058FA DFF6                 dc.w    %1101111111110110
0058FC 66FC                 dc.w    %0110011011111100
0058FE 3288                 dc.w    %0011001010001000
005900 0280                 dc.w    %0000001010000000
005902 0440                 dc.w    %0000010001000000
005904 0440                 dc.w    %0000010001000000
005906 0540                 dc.w    %0000010101000000
005908 0520                 dc.w    %0000010100100000
00590A 0920                 dc.w    %0000100100100000
00590C 0920                 dc.w    %0000100100100000
```

```
00590E 1290               dc.w     %0001001010010000

*****************************************************  Fastcopy, copy disk sector
005910 206F0004           move.l   4(A7),A0            Source address
005914 226F0008           move.l   8(A7),A1            Destination address
005918 303C003F           move.w   #$3F,D0             (63+1)*8 = 512 bytes
00591C 12D8               move.b   (A0)+,(A1)+
00591E 12D8               move.b   (A0)+,(A1)+
005920 12D8               move.b   (A0)+,(A1)+
005922 12D8               move.b   (A0)+,(A1)+         Copy 8 bytes
005924 12D8               move.b   (A0)+,(A1)+
005926 12D8               move.b   (A0)+,(A1)+
005928 12D8               move.b   (A0)+,(A1)+
00592A 12D8               move.b   (A0)+,(A1)+
00592C 51C8FFEE           dbra     D0,$591C            Next 8 bytes
005930 4E75               rts
*****************************************************  Hard disk initialization
005932 2F390000046A       move.l   $46A,-(A7)          Hdv init on stack
005938 4E75               rts                          Jump to routine

*****************************************************
00593A 5C4155544F5C       dc.b     '1AUTO1'
005940 2A2E50524700       dc.b     '*.PRG',0
005946 123456789ABCDEF0   dc.l     $12345678, $9ABCDEF0

*****************************************************  Auto, start and execute a program
00594E 41FAFFEA           lea      $543 (PC),A0        Address of pathname
005952 43FAFFEC           lea      $5940(PC),A1        Address of filename '*.PRG'
005956 23DF000005FC       move.l   (A7)+,$5FC          Return address
00595C 9BCD               sub.l    A5,A5               Clear A5
00595E 2B480600           move.l   A0,$600(A5)         Pathname
005962 2B490604           move.l   A1,$604(A5)         Filename
```

```
005966 202D04C2           move.l  $4C2(A5),D0       Drvbits, vector with active drives
00596A 323900000446       move.w  $446,D1           Bootdev
005970 0300               btst    D1,D0             Drive active ?
005972 6736               beq     $59AA             No, done
005974 41FAF977           lea     $52ED(PC),A0      Pointer to null name
005978 2F08               move.l  A0,-(A7)          Environment
00597A 2F08               move.l  A0,-(A7)          Command tail
00597C 2F08               move.l  A0,-(A7)          Shell name
00597E 3F3C0005           move.w  #5,-(A7)          Create PSP
005982 3F3C004B           move.w  #$4B,-(A7)        Exec, load program
005986 4E41               trap    #1                GEMDOS call
005988 DEFC0010           add.w   #$10,A7           Correct stack
00598C 2040               move.l  D0,A0             PSP
00598E 217C000059AC0008   move.l  #$59AC,8(A0)      PC for auto exec program
005996 2F0B               move.l  A3,-(A7)          Null string
005998 2F00               move.l  D0,-(A7)          PSP
00599A 2F0B               move.l  A3,-(A7)          Shell name
00599C 3F3C0004           move.w  #$4,-(A7)
0059A0 3F3C004B           move.w  #$4B,-(A7)        Exec, load program
0059A4 4E41               trap    #1                GEMDOS call
0059A6 DEFC0010           add.w   #$10,A7           Correct stack pointer
0059AA 4E75               rts

*************************************************   Start auto exec program
0059AC 42A7               clr.l   -(A7)
0059AE 3F3C0020           move.w  #$20,-(A7)        super, enter supervisor mode
0059B2 4E41               trap    #1                GEMDOS call
0059B4 5C4F               addq.w  #6,A7             Correct stack pointer
0059B6 2840               move.l  D0,A4             Saved stack pointer
0059B8 2A6F0004           move.l  4(A7),A5          Base page address
0059BC 4FED0100           lea     $100(A5),A7       Space for base page
0059C0 2F3C00000100       move.l  #$100,-(A7)       $100 bytes
```

```
0059C6 2F0D           move.l   A5,-(A7)       Start of the memory area
0059C8 4267           clr.w    -(A7)
0059CA 3F3C004A       move.w   #$4A,-(A7)     Setblock
0059CE 4E41           trap     #1             GEMDOS call
0059D0 5C4F           addq.w   #6,A7          Correct stack pointer
0059D2 4A40           tst.w    D0             Error ?
0059D4 666A           bne      $5A40          Yes
0059D6 3F3C0007       move.w   #7,-(A7)       R/O, hidden and system files
0059DA 2F3900000600   move.l   $600,-(A7)     Filename
0059E0 3F3C004E       move.w   #$4E,-(A7)     Search first
0059E4 7E08           moveq.l  #8,D7          Bytes for stack correction
0059E6 487900000608   pea      $608           DMA address for DOS
0059EC 3F3C001A       move.w   #$1A,-(A7)     Setdta
0059F0 4E41           trap     #1             GEMDOS call
0059F2 5C4F           addq.w   #6,A7          Correct stack pointer
0059F4 4E41           trap     #1             GEMDOS call
0059F6 DEC7           add.w    D7,A7          Correct stack pointer
0059F8 4A40           tst.w    D0             File found ?
0059FA 6644           bne      $5A40          No
0059FC 207900000600   move.l   $600,A0        Pathname
005A02 247900000604   move.l   $604,A2        Filename
005A08 43F900000634   lea      $634,A1        Auto name
005A0E 12D8           move.b   (A0)+,(A1)+    Copy path part
005A10 B5C8           cmp.l    A0,A2
005A12 66FA           bne      $5A0E
005A14 41F900000626   lea      $626,A0        Name from DMA buffer
005A1A 12D8           move.b   (A0)+,(A1)+    Append to path
005A1C 66FC           bne      $5A1A
005A1E 487AF8CD       pea      $52ED(PC)      Null name
005A22 487AF8C9       pea      $52ED(PC)      Null name
005A26 487900000634   pea      $634           Filename
005A2C 4267           clr.w    -(A7)          Load and start program
```

```
005A2E 3F3C004B          move.w   #$4B,-(A7)         Exec, load program
005A32 4E41              trap     #1                 GEMDOS call
005A34 DEFC0010          add.w    #$10,A7            Correct stack pointer
005A38 7E02              moveq.l  #2,D7              Bytes for stack pointer
005A3A 3F3C004F          move.w   #$4F,-(A7)         Search next
005A3E 60A6              bra      $59E6              Next file
005A40 4FF900003E2A      lea      $3E2A,A7           Stack pointer back to start value
005A46 2F39000005FC      move.l   $5FC,-(A7)         Load return address
005A4C 4E75              rts

**************************************************   Dumpit, screen hardcopy
005A4E 4279000004EE      clr.w    $4EE               Set dumpflg
005A54 610A              bsr      $5A60              Hardcopy
005A56 33FCFFFF000004EE  move.w   #-1,$4EE           Clear dumpflg
005A5E 4E75              rts

**************************************************   Scrdmp, hardcopy
005A60 9BCD              sub.l    A5,A5              Clear A5
005A62 2B6D044E0654      move.l   $44E(A5),$654(A5)  v bs ad, screen output
005A68 426D0658          clr.w    $658(A5)           Offset to Null
005A6C 4240              clr.w    D0
005A6E 102D044C          move.b   $44C(A5),D0        Sshiftmd, screen resolution
005A72 3B400662          move.w   D0,$662(A5)        Save
005A76 D040              add.w    D0,D0              Times 2
005A78 41FA005A          lea      $5AD4(PC),A0       Table for screen resolution
005A7C 3B700000065A      move.w   0(A0,D0.w),$65A(A5) Get screen width
005A82 3B700006065C      move.w   6(A0,D0.w),$65C(A5) Get screen height
005A88 426D065E          clr.w    $65E(A5)           Left
005A8C 426D0660          clr.w    $660(A5)           And right to zero
005A90 2B7C00FF82400666  move.l   #$FF8240,$666(A5)  Address to color palette
005A98 426D066E          clr.w    $66E(A5)           Clear mask pointer
005A9C 322D0A8C          move.w   $A8C(A5),D1        Get printer configuration
```

```
005AA0 E649              lsr.w   #3,D1                Test / quality mode
005AA2 C27C0001          and.w   #1,D1                Isolate bit
005AA6 3B410664          move.w  D1,$664(A5)          And save
005AAA 322D0A8C          move.w  $A8C(A5),D1          Get printer configuration
005AAE 3001              move.w  D1,D0
005AB0 E848              lsr.w   #4,D0                Parallel / Serial
005AB2 C07C0001          and.w   #1,D0                Isolate
005AB6 3B40066C          move.w  D0,$66C(A5)          And save for hardcopy
005ABA C27C0007          and.w   #7,D1                Isolate printer type
005ABE 103B1020          move.b  $5AE0(PC,D1.w),D0    Get assignment from table
005AC2 33C00000066A      move.w  D0,$66A              And save for hardcop
005AC8 486D0654          pea     $654(A5)             Address of the parameter block
005ACC 610022C4          bsr     $7D92                Perform hardcopy
005AD0 584F              addq.w  #4,A7                Correct stack pointer
005AD2 4E75              rts

*******************************************           Parameter table for hardcopy
005AD4 014002800280      dc.w    320,640,640          Screen widths
005AD8 00C800C80190      dc.w    200,200,400          Screen heights

*********************************************         Printer types (-1 = not implemented)
005AE0 00                dc.b    0                    ATARI B/W matrix
005AE1 02                dc.b    2                    ATARI B/W daisy wheel
005AE2 01                dc.b    1                    ATARI color matrix
005AE3 FF                dc.b    -1                   (ATARI color daisy wheel ?)
005AE4 03                dc.b    3                    Epson B/W matrix
005AE5 FF                dc.b    -1                   (Epson B/W daisy wheel)
005AE6 FF                dc.b    -1                   (Epson color matrix)
005AE7 FF                dc.b    -1                   (Epson color daisy wheel)
```

```
********************************************         hdv init
005AE8 4E56FFF0                link    A6,#-16
005AEC 23FC0000012C000025F6 move.l  #300,$25F6       maxacctim to 300*20 ms
005AF6 4240                    clr.w   D0
005AF8 33C0000004A6            move.w  D0,$4A6       nflops
005AFE 33C000004692            move.w  D0,$4692
005B04 3D40FFFE                move.w  D0,-2(A6)     Start with drive A
005B08 604E                    bra     $5B58
005B0A 207C00003E2A            move.l  #$3E2A,A0     Address of the dsb
005B10 326EFFFE                move.w  -2(A6),A1     Drive number
005B14 D1C9                    add.l   A1,A0
005B16 4210                    clr.b   (A0)
005B18 4257                    clr.w   (A7)
005B1A 4267                    clr.w   -(A7)
005B1C 4267                    clr.w   -(A7)
005B1E 3F2EFFFE                move.w  -2(A6),-(A7)  Drive number
005B22 42A7                    clr.l   -(A7)
005B24 42A7                    clr.l   -(A7)
005B26 4EB90000628C            jsr     $628C         flopini
005B2C DFFC0000000E            add.l   #$E,A7        Correct stack pointer
005B32 3F00                    move.w  D0,-(A7)      Save error code
005B34 306EFFFE                move.w  -2(A6),A0     Drive number
005B38 D1C8                    add.l   A0,A0
005B3A D1FC00004910            add.l   #$4910,A0
005B40 309F                    move.w  (A7)+,(A0)    Error code
005B42 6610                    bne     $5B54         Drive not present ?
005B44 5279000004A6            addq.w  #1,$4A6       Increment nflops
005B4A 00B900000003000004C2 or.l    #3,$4C2          drvbits
005B54 526EFFFE                addq.w  #1,-2(A6)     Increment drive number
005B58 0C6E0002FFFE            cmp.w   #2,-2(A6)     Not yet 2
005B5E 6DAA                    blt     $5B0A         Initialize next drive
005B60 4E5E                    unlk    A6
```

```
005B62 4E75                  rts

**************************************************      getdsb
005B64 4E56FFFC              link     A6,#-4
005B68 4280                  clr.l    D0                Zero
005B6A 4E5E                  unlk     A6
005B6C 4E75                  rts

**************************************************      getbpb, get BIOS parameter block
005B6E 4E56FFF4              link     A6,#-12
005B72 48E7070C              movem.l  D5-D7/A4-A5,-(A7) Save registers
005B76 0C6E00020008          cmp.w    #2,8(A6)          Drive number
005B7C 6D06                  blt      $5B84             < 2, ok
005B7E 4280                  clr.l    D0                Else zero
005B80 60000192              bra      $5D14:ln1:fp5
005B84 302E0008              move.w   8(A6),D0          Drive number
005B88 EB40                  asl.w    #5,D0             Timers 32
005B8A 48C0                  ext.l    D0
005B8C 2A40                  move.l   D0,A5
005B8E DBFC00003E3E          add.l    #$3E3E,A5         Plus base address
005B94 284D                  move.l   A5,A4
005B96 3EBC0001              move.w   #1,(A7)           Count, read a sector
005B9A 4267                  clr.w    -(A7)             Side 0
005B9C 4267                  clr.w    -(A7)             Track 0
005B9E 3F3C0001              move.w   #1,-(A7)          Sector 1
005BA2 3F2E0008              move.w   8(A6),-(A7)       Drive number
005BA6 42A7                  clr.l    -(A7)             Filler
005BA8 2F3C000012BC          move.l   #$12BC,-(A7)      Sector buffer
005BAE 4EB9000062D2          jsr      $62D2             Read sector
005BB4 DFFC00000010          add.l    #$10,A7           Correct stack pointer
005BBA 2D40FFF4              move.l   D0,-12(A6)        Save error code
005BBE 4AAEFFF4              tst.l    -12(A6)           And test
```

```
005BC2 6C16          bge     $5BDA           ok ?
005BC4 3EAE0008      move.w  8(A6),(A7)      Drive number
005BC8 202EFFF4      move.l  -12(A6),D0      Error code
005BCC 3F00          move.w  D0,-(A7)
005BCE 4EB90000555C  jsr     $555C           Critical error handler
005BD4 548F          addq.l  #2,A7           Correct stack pointer
005BD6 2D40FFF4      move.l  D0,-12(A6)      Save error code
005BDA 202EFFF4      move.l  -12(A6),D0
005BDE B0BC00010000  cmp.l   #$10000,D0
005BE4 67B0          beq     $5B96           Read boot sector again
005BE6 4AAEFFF4      tst.l   -12(A6)
005BEA 6C06          bge     $5BF2           ok ?
005BEC 4280          clr.l   D0
005BEE 60000124      bra     $5D14

005BF2 2EBC000012C7  move.l  #$12C7,(A7)     Buffer+11, bytes per sector
005BF8 6100066C      bsr     $6266           u2i, convert 8086 integer to 68000 int
005BFC 3E00          move.w  D0,D7           Save bytes per sector
005BFE 670E          beq     $5C0E
005C00 1C39000012C9  move.b  $12C9,D6        Buffer+13, sectors per cluster
005C06 4886          ext.w   D6
005C08 CC7C00FF      and.w   #$FF,D6
005C0C 6606          bne     $5C14
005C0E 4280          clr.l   D0
005C10 60000102      bra     $5D14
005C14 3887          move.w  D7,(A4)         recsize
005C16 39460002      move.w  D6,2(A4)        clsiz
005C1A 2EBC000012D2  move.l  #$12D2,(A7)     Buffer+22, sectors per FAT
005C20 61000644      bsr     $6266           u2i, convert 8086 integer to 68000 int
005C24 39400008      move.w  D0,8(A4)        fsiz
005C28 302C0008      move.w  8(A4),D0
005C2C 5240          addq.w  #1,D0           plus 1
```

```
005C2E 3940000A          move.w  D0,10(A4)       fatrec
005C32 3014              move.w  (A4),D0         recsize
005C34 C1EC0002          muls.w  2(A4),D0        Times clsiz
005C38 39400004          move.w  D0,4(A4)        Yields clsizb
005C3C 2EBC000012CD      move.l  #$12CD,(A7)     Buffer+17, number of directory entries
005C42 61000622          bsr     $6266           u2i, convert 8086 integer to 68000 int
005C46 EB40              asl.w   #5,D0           Times 32
005C48 48C0              ext.l   D0
005C4A 81D4              divs.w  (A4),D0         Divided by recsiz
005C4C 39400006          move.w  D0,6(A4)        Yields rdlen
005C50 302C000A          move.w  10(A4),D0       fatrec
005C54 D06C0006          add.w   6(A4),D0        Plus rdlen
005C58 D06C0008          add.w   8(A4),D0        Plus fsiz
005C5C 3940000C          move.w  D0,12(A4)       Yields datrec
005C60 2EBC000012CF      move.l  #$12CF,(A7)     Buffer+19, number of sectors
005C66 610005FE          bsr     $6266           u2i, convert 8086 integer to 68000 int
005C6A 906C000C          sub.w   12(A4),D0       Minus datrec
005C6E 48C0              ext.l   D0
005C70 81EC0002          divs.w  2(A4),D0        Divided by clsiz
005C74 3940000E          move.w  D0,14(A4)       Yields numcl
005C78 2EBC000012D6      move.l  #$12D6,(A7)     Buffer+26, number of sides
005C7E 610005E6          bsr     $6266           u2i, convert 8086 integer to 68000 int
005C82 3B400014          move.w  D0,20(A5)       dnsides
005C86 2EBC000012D4      move.l  #$12D4,(A7)     Buffer+24, sector per track
005C8C 610005D8          bsr     $6266           u2i, convert 8086 integer to 68000 int
005C90 3B400018          move.w  D0,24(A5)       dspt
005C94 302D0014          move.w  20(A5),D0       dnsides
005C98 C1ED0018          muls.w  24(A5),D0       Times dspt
005C9C 3B400016          move.w  D0,22(A5)       Yields dspc
005CA0 2EBC000012D8      move.l  #$12D8,(A7)     Buffer+28, number of hidden sectors
005CA6 610005BE          bsr     $6266           u2i, convert 8086 integer to 68000 int
005CAA 3B40001A          move.w  D0,26(A5)       dhidden
```

```
005CAE 2EBC000012CF      move.l  #$12CF,(A7)     Buffer+19, number of sectors on disk
005CB4 610005B0          bsr     $6266           u2i, convert 8086 integer to 68000 int
005CB8 48C0              ext.l   D0
005CBA 81ED0016          divs.w  22(A5),D0       Divided by dspc
005CBE 3B400012          move.w  D0,18(A5)       Yields dntracks
005CC2 4247              clr.w   D7              Counter to zero
005CC4 6016              bra     $5CDC           Jump to end of loop
005CC6 204D              move.l  A5,A0           Buffer pointer
005CC8 3247              move.w  D7,A1           Loop counter
005CCA D1C9              add.l   A1,A0           Plus BPB address
005CCC 3247              move.w  D7,A1           Loop counter
005CCE D3FC000012BC      add.l   #$12BC,A1       Plus buffer address
005CD4 11690008001C      move.b  8(A1),28(A0)    Copy byte of the serial number
005CDA 5247              addq.w  #1,D7           Next byte
005CDC BE7C0003          cmp.w   #3,D7           Three bytes already ?
005CE0 6DE4              blt     $5CC6           No
005CE2 207C00000676      move.l  #$676,A0        cdev
005CE8 326E0008          move.w  8(A6),A1
005CEC D1C9              add.l   A1,A0
005CEE 227C00000674      move.l  #$674,A1        wpstatus
005CF4 346E0008          move.w  8(A6),A2
005CF8 D3CA              add.l   A2,A1
005CFA 1091              move.b  (A1),(A0)
005CFC 6704              beq     $5D02
005CFE 7001              moveq.l #1,D0           Disk status uncertain
005D00 6002              bra     $5D04
005D02 4240              clr.w   D0              Status certain
005D04 227C00003E2A      move.l  #$3E2A,A1
005D0A 346E0008          move.w  8(A6),A2
005D0E D3CA              add.l   A2,A1
005D10 1280              move.b  D0,(A1)
005D12 200D              move.l  A5,D0           Address of BPB as result
```

```
005D14 4A9F              tst.l    (A7)+
005D16 4CDF30C0          movem.l  (A7)+,D6-D7/A4-A5    Restore registers
005D1A 4E5E              unlk     A6
005D1C 4E75              rts

*******************************************************  mediach
005D1E 4E560000          link     A6,#0
005D22 48E70304          movem.l  D6-D7/A5,-(A7)       Save registers
005D26 0C6E00020008      cmp.w    #2,8(A6)             Drive number
005D2C 6D04              blt      $5D32                < 2?
005D2E 70F1              moveq.l  #-15,D0              'unknown device'
005D30 604C              bra      $5D7E                Error branch
005D32 3E2E0008          move.w   8(A6),D7             Drive number
005D36 3A47              move.w   D7,A5
005D38 DBFC00003E2A      add.l    #$3E2A,A5
005D3E 0C150002          cmp.b    #2,(A5)
005D42 6604              bne      $5D48
005D44 7002              moveq.l  #2,D0
005D46 6036              bra      $5D7E
005D48 207C00000676      move.l   #$676,A0             wplatch
005D4E 4A307000          tst.b    0(A0,D7.w)
005D52 6704              beq      $5D58
005D54 1ABC0001          move.b   #1,(A5)
005D58 2039000004BA      move.l   $4BA,D0              hz 200
005D5E 3247              move.w   D7,A1
005D60 D3C9              add.l    A1,A1
005D62 D3C9              add.l    A1,A1
005D64 D3FC00000678      add.l    #$678,A1             acctim
005D6A 2211              move.l   (A1),D1
005D6C 9081              sub.l    D1,D0
005D6E B0B9000025F6      cmp.l    $25F6,D0             maxacctim
005D74 6C04              bge      $5D7A
```

```
005D76 4240              clr.w    D0
005D78 6004              bra      $5D7E
005D7A 1015              move.b   (A5),D0
005D7C 4880              ext.w    D0
005D7E 4A9F              tst.l    (A7)+
005D80 4CDF2080          movem.l  (A7)+,D7/A5          Restore registers
005D84 4E5E              unlk     A6
005D86 4E75              rts

**************************************************     rwabs, read/write sector(s)
005D88 4E56FFFC          link     A6,#-4
005D8C 48E70F04          movem.l  D4-D7/A5,-(A7)       Save registers
005D90 0C6E00020012      cmp.w    #2,18(A6)            Drive number
005D96 6D06              blt      $5D9E                < 2 ?
005D98 70F1              moveq.l  #-15,D0              No, unknown device
005D9A 6000010E          bra      $5EAA                Error branch
005D9E 3C2E0012          move.w   18(A6),D6            Save drive number
005DA2 0C6E00020008      cmp.w    #2,8(A6)             rwflag
005DA8 6C0000CE          bge      $5E78
005DAC 3006              move.w   D6,D0
005DAE EB40              asl.w    #5,D0
005DB0 48C0              ext.l    D0
005DB2 2A40              move.l   D0,A5
005DB4 DBFC00003E3E      add.l    #$3E3E,A5
005DBA 3E86              move.w   D6,(A7)
005DBC 6100FF60          bsr      $5D1E                Test media change
005DC0 3E00              move.w   D0,D7                Save status
005DC2 BE7C0002          cmp.w    #2,D7                Disk changed ?
005DC6 660A              bne      $5DD2                No
005DC8 70F2              moveq.l  #-14,D0              Media change error
005DCA 600000DE          bra      $5EAA                Error branch
```

```
005DCE 600000A8        bra     $5E78
005DD2 BE7C0001        cmp.w   #1,D7            Disk possibly changed ?
005DD6 660000A0        bne     $5E78            No
005DDA 3EBC0001        move.w  #1,(A7)          Read a sector (Boot sector)
005DDE 4267            clr.w   -(A7)            Side 0
005DE0 4267            clr.w   -(A7)            Track 0
005DE2 3F3C0001        move.w  #1,-(A7)         Sector 1
005DE6 3F06            move.w  D6,-(A7)         Drive number
005DE8 42A7            clr.l   -(A7)            Filler
005DEA 2F3C000012BC    move.l  #$12BC,-(A7)     Sector buffer
005DF0 4EB9000062D2    jsr     $62D2            floprd
005DF6 DFFC00000010    add.l   #$10,A7          Correct stack pointer
005DFC 2D40FFFC        move.l  D0,-4(A6)        Save error number
005E00 4AAEFFFC        tst.l   -4(A6)           And test
005E04 6C14            bge     $5E1A            Ok ?
005E06 3E86            move.w  D6,(A7)
005E08 202EFFFC        move.l  -4(A6),D0        Error
005E0C 3F00            move.w  D0,-(A7)
005E0E 4EB90000555C    jsr     $555C            Pass an critical error handler
005E14 548F            addq.l  #2,A7            Correct stack pointer
005E16 2D40FFFC        move.l  D0,-4(A6)
005E1A 202EFFFC        move.l  -4(A6),D0
005E1E B0BC00010000    cmp.l   #$10000,D0
005E24 67B4            beq     $5DDA            Read again
005E26 4AAEFFFC        tst.l   -4(A6)           Error number
005E2A 6C08            bge     $5E34            Ok ?
005E2C 202EFFFC        move.l  -4(A6),D0        Error number
005E30 60000078        bra     $5EAA            Error branch

005E34 4247            clr.w   D7               Clear media change status
005E36 601C            bra     $5E54
```

```
005E38 207C000012BC       move.l   #$12BC,A0          Address of the sector buffer
005E3E 10307008           move.b   8(A0,D7.w),D0      Serial number
005E42 4880               ext.w    D0
005E44 1235701C           move.b   28(A5,D7.w),D1     Compare
005E48 4881               ext.w    D1
005E4A B041               cmp.w    D1,D0              With previous value
005E4C 6704               beq      $5E52              Ok ?
005E4E 70F2               moveq.l  #-14,D0            Media change
005E50 6058               bra      $5EAA              Error branch

005E52 5247               addq.w   #1,D7              Next byte of the serial number
005E54 BE7C0003           cmp.w    #3,D7              All 3 bytes tested ?
005E58 6DDE               blt      $5E38              No
005E5A 3046               move.w   D6,A0              Drive number
005E5C D1FC00000676       add.l    #$676,A0           wplatch
005E62 3246               move.w   D6,A1              Drive number
005E64 D3FC00000674       add.l    #$674,A1           wpstatus
005E6A 1091               move.b   (A1),(A0)
005E6C 660A               bne      $5E78
005E6E 3046               move.w   D6,A0
005E70 D1FC00003E2A       add.l    #$3E2A,A0
005E76 4210               clr.b    (A0)
005E78 4A79000004A6       tst.w    $4A6               nflops
005E7E 6604               bne      $5E84
005E80 70FE               moveq.l  #-2,D0             Drive not ready
005E82 6026               bra      $5EAA              Error branch

005E84 0C6E00010008       cmp.w    #1,8(A6)           Drive number
005E8A 6F04               ble      $5E90
005E8C 556E0008           subq.w   #2,8(A6)           Drive number
005E90 3EAE000E           move.w   14(A6),(A7)        count
005E94 3F06               move.w   D6,-(A7)           Drive number
```

```
005E96 3F2E0010          move.w  16(A6),-(A7)          recno
005E9A 2F2E000A          move.l  10(A6),-(A7)          buffer
005E9E 3F2E0008          move.w  8(A6),-(A7)           rwflag
005EA2 6110              bsr     $5EB4                 floprw
005EA4 DFFC0000000A      add.l   #$A,A7                Correct stack pointer
005EAA 4A9F              tst.l   (A7)+
005EAC 4CDF20E0          movem.l (A7)+,D5-D7/A5        Restore registers
005EB0 4E5E              unlk    A6
005EB2 4E75              rts

*****************************************************  floprw, read/write sectors
005EB4 4E56FFFA          link    A6,#-6
005EB8 48E73F04          movem.l D2-D7/A5,-(A7)        Save registers
005EBC 302E0010          move.w  16(A6),D0             Drive number
005EC0 EB40              asl.w   #5,D0                 Times 32
005EC2 48C0              ext.l   D0
005EC4 2A40              move.l  D0,A5
005EC6 DBFC00003E3E      add.l   #$3E3E,A5             Plus base address BPB
005ECC 082E0000000D      btst    #0,13(A6)             Buffer address not even ?
005ED2 6604              bne     $5ED8                 Yes
005ED4 4240              clr.w   D0                    Clear oddflag
005ED6 6002              bra     $5EDA
005ED8 7001              moveq.l #1,D0                 Set oddflag
005EDA 3D40FFFE          move.w  D0,-2(A6)             And save
005EDE 4A6D0016          tst.w   22(A5)                dspc set ?
005EE2 660A              bne     $5EEE                 Yes
005EE4 7009              moveq.l #9,D0                 Else take 9
005EE6 3B400016          move.w  D0,22(A5)             As dspt
005EEA 3B400018          move.w  D0,24(A5)             And dspc
005EEE 6000015E          bra     $604E
```

```
005EF2 4A6EFFFE        tst.w    -2(A6)          oddflag set ?
005EF6 6708            beq      $5F00           No
005EF8 203C000012BC    move.l   #$12BC,D0       Sector buffer
005EFE 6004            bra      $5F04

005F00 202E000A        move.l   10(A6),D0       Get buffer address
005F04 2D40FFFA        move.l   D0,-6(A6)       And save
005F08 3C2E000E        move.w   14(A6),D6       recno, logical sector number
005F0C 48C6            ext.l    D6
005F0E 8DED0016        divs.w   22(A5),D6       Divided by dspc yields track number
005F12 382E000E        move.w   14(A6),D4       recno, logical sector number
005F16 48C4            ext.l    D4
005F18 89ED0016        divs.w   22(A5),D4       Divided by dspc, sector per track
005F1C 4844            swap     D4              Remainder of division as sector number
005F1E B86D0018        cmp.w    24(A5),D4       Compare with dspt
005F22 6C04            bge      $5F28           Greater than or equal ?
005F24 4245            clr.w    D5              Side 0
005F26 6006            bra      $5F2E
005F28 7A01            moveq.l  #1,D5           Side 1
005F2A 986D0018        sub.w    24(A5),D4       Subtract dspt
005F2E 4A6EFFFE        tst.w    -2(A6)          oddflag set ?
005F32 6704            beq      $5F38           No
005F34 7601            moveq.l  #1,D3           Set counter to 1
005F36 6018            bra      $5F50
005F38 302D0018        move.w   24(A5),D0       dspt
005F3C 9044            sub.w    D4,D0           Minus Sector number
005F3E B06E0012        cmp.w    18(A6),D0       Compare with number of sectors
005F42 6C08            bge      $5F4C           Greater or equal ?
005F44 362D0018        move.w   24(A5),D3       dspt
005F48 9644            sub.w    D4,D3           Minus sector number equals counter
005F4A 6004            bra      $5F50
005F4C 362E0012        move.w   18(A6),D3       Number of sectors as counter
```

```
005F50 5244          addq.w  #1,D4           Increment sector # (1st number is 1)
005F52 4A6E0008      tst.w   8(A6)           Test read-write flag
005F56 67000080      beq     $5FD8           Read
005F5A 202EFFFA      move.l  -6(A6),D0       Buffer pointer
005F5E B0AE000A      cmp.l   10(A6),D0       Equals buffer address
005F62 6710          beq     $5F74           Yes
005F64 2EAEFFFA      move.l  -6(A6),(A7)     Source address
005F68 2F2E000A      move.l  10(A6),-(A7)    Destination address
005F6C 4EB900005910  jsr     $5910           fastcpy, copy a sector
005F72 588F          addq.l  #4,A7           Correct stack pointer
005F74 3E83          move.w  D3,(A7)         Number of sectors
005F76 3F05          move.w  D5,-(A7)        Side
005F78 3F06          move.w  D6,-(A7)        Track
005F7A 3F04          move.w  D4,-(A7)        Sector
005F7C 3F2E0010      move.w  16(A6),-(A7)    Drive
005F80 42A7          clr.l   -(A7)           Filler
005F82 2F2EFFFA      move.l  -6(A6),-(A7)    Sector buffer
005F86 4EB9000063B0  jsr     $63B0           flopwr, read sector
005F8C DFFC00000010  add.l   #$10,A7         Correct stack pointer
005F92 2E00          move.l  D0,D7           Error code
005F94 4A87          tst.l   D7              Ok ?
005F96 663E          bne     $5FD6           No
005F98 4A7900000444  tst.w   $444            fverify, verify required ?
005F9E 6736          beq     $5FD6           No
005FA0 3E83          move.w  D3,(A7)         Number of sectors
005FA2 3F05          move.w  D5,-(A7)        Side
005FA4 3F06          move.w  D6,-(A7)        Track
005FA6 3F04          move.w  D4,-(A7)        Sector
005FA8 3F2E0010      move.w  16(A6),-(A7)    Drive
005FAC 42A7          clr.l   -(A7)           Filler
005FAE 2F3C000012BC  move.l  #$12BC,-(A7)    Sector buffer
005FB4 4EB900006602  jsr     $6602           flopver, verify sector
```

```
005FBA DFFC00000010    add.l   #$10,A7        Correct stack pointer
005FC0 2E00            move.l  D0,D7          Error code
005FC2 4A87            tst.l   D7             Ok ?
005FC4 6610            bne     $5FD6          No
005FC6 2EBC000012BC    move.l  #$12BC,(A7)    Sector buffer
005FCC 61000298        bsr     $6266          u2i, convert 8086 integer to 68000 int
005FD0 4A40            tst.w   D0             Bad sector list
005FD2 6702            beq     $5FD6          Sectors OK ?
005FD4 7EF0            moveq.l #-16,D7        Bad sectors
005FD6 603A            bra     $6012

005FD8 3E83            move.w  D3,(A7)        Number of sectors
005FDA 3F05            move.w  D5,-(A7)       Side
005FDC 3F06            move.w  D6,-(A7)       Track
005FDE 3F04            move.w  D4,-(A7)       Sector
005FE0 3F2E0010        move.w  16(A6),-(A7)   Drive
005FE4 42A7            clr.l   -(A7)          Filler
005FE6 2F2EFFFA        move.l  -6(A6),-(A7)   Sector buffer
005FEA 4EB9000062D2    jsr     $62D2          floprd, read sector
005FF0 DFFC00000010    add.l   #$10,A7        Correct stack pointer
005FF6 2E00            move.l  D0,D7          Save error code
005FF8 202EFFFA        move.l  -6(A6),D0      User buffer
005FFC B0AE000A        cmp.l   10(A6),D0      Equals desired buffer ?
006000 6710            beq     $6012          Yes
006002 2EAE000A        move.l  10(A6),(A7)    Source address
006006 2F2EFFFA        move.l  -6(A6),-(A7)   Destination
00600A 4EB900005910    jsr     $5910          fastcpy, copy sector
006010 588F            addq.l  #4,A7          Correct stack pointer
006012 4A87            tst.l   D7             Test error code
006014 6C12            bge     $6028          Ok ?
006016 3EAE0010        move.w  16(A6),(A7)    Drive number
00601A 2007            move.l  D7,D0          Error code
```

```
00601C 3F00                 move.w  D0,-(A7)            On stack
00601E 4EB90000555C         jsr     $555C               Critical error handler
006024 548F                 addq.l  #2,A7               Correct stack pointer
006026 2E00                 move.l  D0,D7               Get error code
006028 BEBC00010000         cmp.l   #$10000,D7          Attempt again ?
00602E 6700FF22             beq     $5F52               Yes
006032 4A87                 tst.l   D7                  Error code
006034 6C04                 bge     $603A               OK
006036 2007                 move.l  D7,D0               Error code as result
006038 601E                 bra     $6058

00603A 3003                 move.w  D3,D0               Sector counter
00603C 48C0                 ext.l   D0
00603E 7209                 moveq.l #9,D1               Times 512
006040 E3A0                 asl.l   D1,D0
006042 D1AE000A             add.l   D0,10(A6)           Increment buffer address
006046 D76E000E             add.w   D3,14(A6)           Logical sector number plus counter
00604A 976E0012             sub.w   D3,18(A6)           Decrement number of sectors to process
00604E 4A6E0012             tst.w   18(A6)              Sectors yet to read/write ?
006052 6600FE9E             bne     $5EF2               Yes
006056 4280                 clr.l   D0                  OK
006058 4A9F                 tst.l   (A7)+
00605A 4CDF20F8             movem.l (A7)+,D3-D7/A5      Restore registers
00605E 4E5E                 unlk    A6
006060 4E75                 rts

*************************************************       random, generate random number
006062 4E56FFFC             link    A6,#-4
006066 4AB9000025FA         tst.l   $25FA               Last random number
00606C 6616                 bne     $6084               Not zero ?
00606E 2039000004BA         move.l  $4BA,D0             200 Hz counter
006074 7210                 moveq.l #16,D1
```

```
006076 E3A0                  asl.l    D1,D0              Bits 0-15 to 16-31
006078 80B9000004BA          or.l     $4BA,D0            Plus 200 Hz counter
00607E 23C0000025FA          move.l   D0,$25FA           Use as start value
006084 2F3CBB40E62D          move.l   #$BB40E62D,-(A7)   3141592621
00608A 2F39000025FA          move.l   $25FA,-(A7)        Last random value
006090 4EB9000094FA          jsr      $94FA              32 * 32 bit multiplication
006096 508F                  addq.l   #8,A7              Correct stack pointer
006098 5280                  addq.l   #1,D0              Result plus 1
00609A 23C0000025FA          move.l   D0,$25FA           As new start value
0060A0 2039000025FA          move.l   $25FA,D0
0060A6 E080                  asr.l    #8,D0              Bits 31-8 to 23-0
0060A8 C0BC00FFFFFF          and.l    #$FFFFFF,D0        24-bit random number as result
0060AE 4E5E                  unlk     A6
0060B0 4E75                  rts

*************************************************    bootload, load boot sector
0060B2 4E560000              link     A6,#0
0060B6 48E70300              movem.l  D6-D7,-(A7)        Save registers
0060BA 4EB900005932          jsr      $5932              hdv init
0060C0 4A79000004A6          tst.w    $4A6               nflops
0060C6 6704                  beq      $60CC              No drive connected ?
0060C8 7001                  moveq.l  #1,D0              'couldn't load'
0060CA 6002                  bra      $60CE
0060CC 7002                  moveq.l  #2,D0              'no drive'
0060CE 3E00                  move.w   D0,D7              Save errors
0060D0 4A79000004A6          tst.w    $4A6               nflops
0060D6 6744                  beq      $611C
0060D8 0C7900020000446       cmp.w    #2,$446            bootdev
0060E0 6C3A                  bge      $611C              No diskette ?
0060E2 3EBC0001              move.w   #1,(A7)            One sector
0060E6 4267                  clr.w    -(A7)              Side 0
0060E8 4267                  clr.w    -(A7)              Track 0
```

```
0060EA 3F3C0001         move.w  #1,-(A7)        Sector 1
0060EE 3F3900000446     move.w  $446,-(A7)      bootdev as drive number
0060F4 42A7             clr.l   -(A7)           Filler
0060F6 2F3C000012BC     move.l  #$12BC,-(A7)    Sector buffer
0060FC 4EB9000062D2     jsr     $62D2           floprd, read sector
006102 DFFC00000010     add.l   #$10,A7         Correct stack pointer
006108 4A80             tst.l   D0              Error ?
00610A 6604             bne     $6110           No
00610C 4247             clr.w   D7
00610E 600C             bra     $611C
006110 4A3900000674     tst.b   $674            wpstatus
006116 6604             bne     $611C
006118 7003             moveq.l #3,D0           'unreadable'
00611A 6024             bra     $6140

00611C 4A47             tst.w   D7
00611E 6704             beq     $6124
006120 3007             move.w  D7,D0           Get old error code
006122 601C             bra     $6140

006124 3EBC0100         move.w  #$100,(A7)      $100 words
006128 2F3C000012BC     move.l  #$12BC,-(A7)    Sector buffer
00612E 61000106         bsr     $6236           Calculate checksum
006132 588F             addq.l  #4,A7           Correct stack pointer
006134 B07C1234         cmp.w   #$1234,D0       Compare with checksum for boot sector
006138 6604             bne     $613E           Not equal ?
00613A 4240             clr.w   D0              OK
00613C 6002             bra     $6140
00613E 7004             moveq.l #4,D0           'not valid boot sector'
006140 4A9F             tst.l   (A7)+
006142 4CDF0080         movem.l (A7)+,D7        Restore registers
```

```
006146 4E5E             unlk    A6
006148 4E75             rts

****************************************************     proto bt, generate boot sector
00614A 4E56FFFA         link    A6,#-6
00614E 48E70704         movem.l D5-D7/A5,-(A7)         Save registers
006152 4A6E0012         tst.w   18(A6)                 Test execflg
006156 6C1E             bge     $6176                  Maintain executability
006158 3EBC0100         move.w  #$100,(A7)             $100 words
00615C 2F2E0008         move.l  8(A6),-(A7)            Address of the sector buffer
006160 610000D4         bsr     $6236                  Calculate checksum
006164 588F             addq.l  #4,A7                  Correct stack pointer
006166 B07C1234         cmp.w   #$1234,D0              Equals checksum for boot sector?
00616A 6704             beq     $6170                  Yes
00616C 4240             clr.w   D0                     Not executable
00616E 6002             bra     $6172
006170 7001             moveq.l #1,D0                  Executable
006172 3D400012         move.w  D0,18(A6)              execflg to 1 = boot sector executable
006176 4AAE000C         tst.l   12(A6)                 Serial number
00617A 6D3E             blt     $61BA                  Negative, don't change
00617C 202E000C         move.l  12(A6),D0              Serial number
006180 B0BC00FFFFFF     cmp.l   #$FFFFFF,D0            > $FFFFFF ?
006186 6F08             ble     $6190                  No
006188 6100FED8         bsr     $6062                  rand, generate random number
00618C 2D40000C         move.l  D0,12(A6)              Save
006190 4247             clr.w   D7                     Clear counter
006192 6020             bra     $61B4

006194 202E000C         move.l  12(A6),D0              Random number
006198 C0BC000000FF     and.l   #$FF,D0                Bits 0-7
00619E 3247             move.w  D7,A1                  Pointer to next byte in buffer
```

```
0061A0 D3EE0008       add.l   8(A6),A1         Plus base address
0061A4 13400008       move.b  D0,8(A1)         Write byte of serial number in buffer
0061A8 202E000C       move.l  12(A6),D0        Random number
0061AC E080           asr.l   #8,D0            In order to shift 8 bits right
0061AE 2D40000C       move.l  D0,12(A6)        And save new value
0061B2 5247           addq.w  #1,D7            Increment counter
0061B4 BE7C0003       cmp.w   #$3,D7           Three bytes copied already ?
0061B8 6DDA           blt     $6194            No
0061BA 4A6E0010       tst.w   16(A6)           Diskette size
0061BE 6D28           blt     $61E8            Negative, don't change
0061C0 3C2E0010       move.w  16(A6),D6        Diskette size
0061C4 CDFC0013       muls.w  #$13,D6          Times 19 equals pointer to prototype BPB
0061C8 4247           clr.w   D7               Clear counter
0061CA 6016           bra     $61E2
0061CC 3047           move.w  D7,A0            Counter
0061CE D1EE0008       add.l   8(A6),A0         Plus address of the buffer
0061D2 3246           move.w  D6,A1
0061D4 D3FC00016D00   add.l   #$16D00,A1       Address of the prototype BPB
0061DA 1151000B       move.b  (A1),11(A0)      Copy BPB
0061DE 5246           addq.w  #1,D6
0061E0 5247           addq.w  #1,D7            Increment counter
0061E2 BE7C0013       cmp.w   #$13,D7          Already 19 ?
0061E6 6DE4           blt     $61CC            No
0061E8 426EFFFA       clr.w   -6(A6)
0061EC 2D6E0008FFFC   move.l  8(A6),-4(A6)     Buffer address
0061F2 600E           bra     $6202
0061F4 206EFFFC       move.l  -4(A6),A0
0061F8 3010           move.w  (A0),D0          Get word from buffer
0061FA D16EFFFA       add.w   D0,-6(A6)        Sum for checksum generation
0061FE 54AEFFFC       addq.l  #2,-4(A6)        Next word
```

```
006202 202E0008          move.l  8(A6),D0          Buffer address
006206 D0BC000001FE      add.l   #$1FE,D0          Plus $1FE
00620C B0AEFFFC          cmp.l   -4(A6),D0         Last word already
006210 62E2              bhi     $61F4
006212 303C1234          move.w  #$1234,D0         Checksum for boot sector
006216 906EFFFA          sub.w   -6(A6),D0         Subtract from previous value
00621A 226EFFFC          move.l  -4(A6),A1
00621E 3280              move.w  D0,(A1)           Checksum in buffer
006220 4A6E0012          tst.w   18(A6)            execflg
006224 6606              bne     $622C             Boot sector executable ?
006226 206EFFFC          move.l  -4(A6),A0
00622A 5250              addq.w  #1,(A0)           Increment checksum, not executable
00622C 4A9F              tst.l   (A7)+
00622E 4CDF20C0          movem.l (A7)+,D6-D7/A5    Restore registers
006232 4E5E              unlk    A6
006234 4E75              rts

*************************************************   Calculate checksum
006236 4E560000          link    A6,#0
00623A 48E70300          movem.l D6-D7,-(A7)       Save registers
00623E 4247              clr.w   D7                Clear sum
006240 600C              bra     $624E
006242 206E0008          move.l  8(A6),A0          Address of the buffer
006246 3010              move.w  (A0),D0           Get word
006248 DE40              add.w   D0,D7             And sum
00624A 54AE0008          addq.l  #2,8(A6)          Pointer to next word
00624E 302E000C          move.w  12(A6),D0         Number of words
006252 536E000C          subq.w  #1,12(A6)         Minus 1
006256 4A40              tst.w   D0                All words added already ?
006258 66E8              bne     $6242             No
00625A 3007              move.w  D7,D0             Result to d0
00625C 4A9F              tst.l   (A7)+
```

```
00625E 4CDF0080          movem.l (A7)+,D7        Restore registers
006262 4E5E              unlk    A6
006264 4E75              rts

***************************************************   u2i, convert 8086 number to 68000 number
006266 4E56FFFC          link    A6,#-4
00626A 206E0008          move.l  8(A6),A0        Address of the number
00626E 10280001          move.b  1(A0),D0        Get high byte
006272 4880              ext.w   D0              Extend to word
006274 C07C00FF          and.w   #$FF,D0         Isolate bits 0-7
006278 E140              asl.w   #8,D0           Shift in position 8-15
00627A 226E0008          move.l  8(A6),A1        Address of the number
00627E 1211              move.b  (A1),D1         Get low byte
006280 4881              ext.w   D1              Extend to word
006282 C27C00FF          and.w   #$FF,D1         Isolate bits 0-7
006286 8041              or.w    D1,D0           Combine with bits 8-15
006288 4E5E              unlk    A6
00628A 4E75              rts

***************************************************   flopini, initialize drive
00628C 43F9000006C8      lea     $6C8,A1         dsb0, pointer to DSB drive A
006292 4A6F000C          tst.w   12(A7)          Drive A ?
006296 6706              beq     $629E           Yes
006298 43F9000006CC      lea     $6CC,A1         dsb1, take DSB from drive B
00629E 337900000440002   move.w  $440,2(A1)      seekrate
0062A6 70FF              moveq.l #-1,D0          Default error number
0062A8 42690000          clr.w   0(A1)           Track number to zero
0062AC 610004BA          bsr     $6768           floplock, set parameters
0062B0 61000696          bsr     $6948           Select drive and side
0062B4 337CFF000000      move.w  #$FF00,0(A1)
0062BA 61000618          bsr     $68D4           restore
0062BE 7E06              moveq.l #6,D7
```

```
0062C0 610005A0          bsr      $6862
0062C4 6608              bne      $62CE
0062C6 6100060C          bsr      $68D4              Restore
0062CA 67000542          beq      $680E              flopok, no error
0062CE 60000530          bra      $6800              flopfail, error

**************************************************** floprd, read sector(s) from disk
0062D2 6100071E          bsr      $69F2              Change, test for disk change
0062D6 70F5              moveq.l  #-11,D0            Error number to read error
0062D8 6100048E          bsr      $6768              floplock, set parameters
0062DC 6100066A          bsr      $6948              Select drive and side
0062E0 610005CC          bsr      $68AE              go2track, search for track
0062E4 66000090          bne      $6376              Try again if error
0062E8 33FCFFFF000006A2  move.w   #-1,$6A2           currerr to default error
0062F0 3CBC0090          move.w   #$90,(A6)          Clear DMA status
0062F4 3CBC0190          move.w   #$190,(A6)
0062F8 3CBC0090          move.w   #$90,(A6)          Data direction to READ
0062FC 33ED068CFFFF8604  move.w   $68C(A5),$FFFF8604 ccount to dskctl, sector counter
006304 3CBC0080          move.w   #$80,(A6)          Read sector command for 1772
006308 3E3C0090          move.w   #$90,D7            Read multiple
00630C 610006B6          bsr      $69C4              wdiskctl, pass D7 to 1772
006310 2E3C00040000      move.l   #$40000,D7         Initialize timeout counter
006316 246D0692          move.l   $692(A5),A2        edma, destination address for DMA
00631A 08390005FFFFFA01  btst     #5,$FFFFFA01       mfp gpip, 1772 done ?
006322 6734              beq      $6358              Yes
006324 5387              subq.l   #1,D7              Decrement timeout counter
006326 6724              beq      $634C              Timed-out ?
006328 1B79FFFF8609069D  move.b   $FFFF8609,$69D(A5) dmahigh
006330 1B79FFFF860B069E  move.b   $FFFF860B,$69E(A5) dmamid
006338 1B79FFFF860D069F  move.b   $FFFF860D,$69F(A5) dmalow
006340 B5ED069C          cmp.l    $69C(A5),A2        Current DMA address equal edma?
006344 6ED4              bgt      $631A              No, continue to wait
```

```
006346 610005E6          bsr      $692E          Reset, end transfer
00634A 600C              bra      $6358
00634C 3B7CFFFE06A2      move.w   #-2,$6A2(A5)   currerr to timeout
006352 610005DA          bsr      $692E          Reset, end transfer
006356 601E              bra      $6376          Start next attempt
006358 3CBC0090          move.w   #$90,(A6)      Select DMA status register
00635C 3016              move.w   (A6),D0        Read status
00635E 08000000          btst     #0,D0          DMA rrror ?
006362 6712              beq      $6376          Yes, try again
006364 3CBC0080          move.w   #$80,(A6)      Select 1772 status register
006368 6100066E          bsr      $69D8          rdiskctl, read register
00636C C03C0018          and.b    #$18,D0        RNF, isolate checksum und lost data
006370 6700049C          beq      $680E          flopok, no error
006374 6118              bsr      $638E          errbits, determine error number
006376 0C6D00010672      cmp.w    #1,$672(A5)    retrycnt to second attempt ?
00637C 6604              bne      $6382          No
00637E 610004FA          bsr      $687A          reseek, home and reseek
006382 536D0672          subq.w   #1,$672(A5)    retrycnt, decrement attempt counter
006386 6A00FF54          bpl      $62DC          Another attempt ?
00638A 60000474          bra      $6800          No, flopfail

*************************************************  errbits, 1772 status in error number
00638E 72F3              moveq.l  #-13,D1        Write protect ?
006390 08000006          btst     #6,D0
006394 6614              bne      $63AA          Yes
006396 72F8              moveq.l  #-8,D1         Record not found ?
006398 08000004          btst     #4,D0
00639C 660C              bne      $63AA          Yes
00639E 72FC              moveq.l  #-4,D1         CRC error ?
0063A0 08000003          btst     #3,D0
0063A4 6704              beq      $63AA          Yes
0063A6 322D06A0          move.w   $6A0(A5),D1    deferror, take default error
```

```
0063AA 3B4106A2          move.w  D1,$6A2(A5)      As currerr
0063AE 4E75              rts

*************************************************  flopwr, write sector(s) on disk
0063B0 61000640          bsr     $69F2            Change, test for disk change
0063B4 70F6              moveq.l #-10,D0          Default error to write wrror
0063B6 610003B0          bsr     $6768            floplock, set parameters
0063BA 302D0688          move.w  $688(A5),D0      csect, sector number 1?
0063BE 5340              subq.w  #1,D0
0063C0 806D0686          or.w    $686(A5),D0      ctrack, track number 0?
0063C4 806D068A          or.w    $68A(A5),D0      cside, side 0?
0063C8 6606              bne     $63D0            No, not boot sector
0063CA 7002              moveq.l #2,D0            Media change
0063CC 6100065C          bsr     $6A2A            Set to 'unsure'
0063D0 61000576          bsr     $6948            select, select drive and seide
0063D4 610004D8          bsr     $68AE            go2track, search for track
0063D8 6600007E          bne     $6458            Error, try again
0063DC 3B7CFFFF06A2      move.w  #-1,$6A2(A5)     currerr to default error
0063E2 3CBC0190          move.w  #$190,(A6)       Clear DMA status
0063E6 3CBC0090          move.w  #$90,(A6)
0063EA 3CBC0190          move.w  #$190,(A6)       Data direction to WRITE
0063EE 3E3C0001          move.w  #1,D7            Sector count register
0063F2 610005D0          bsr     $69C4            wdiskctl, D7 to 1772
0063F6 3CBC0180          move.w  #$180,(A6)       Selects1772
0063FA 3E3C00A0          move.w  #$A0,D7          Write Sector
0063FE 610005C4          bsr     $69C4            wdiskctl, D7 to 1772
006402 2E3C00040000      move.l  #$40000,D7       Timeout counter
006408 08390005FFFFFA01  btst    #5,$FFFFFA01     mfp, gpip, 1772 done ?
006410 670A              beq     $641C            Yes
006412 5387              subq.l  #1,D7            Decrement timeout counter
006414 66F2              bne     $6408            Not timed-out yet ?
006416 61000516          bsr     $692E            reset, end transfer
```

```
00641A 6034                 bra      $6450
00641C 3CBC0180             move.w   #$180,(A6)         Select 1772 status register
006420 610005B6             bsr      $69D8              rdiskctl, read 1772 registers
006424 6100FF68             bsr      $638E              errbits, calculate error number
006428 08000006             btst     #6,D0              Write protect ?
00642C 660003D2             bne      $6800              flopfail, no further attempt
006430 C03C005C             and.b    #$5C,D0            Write protect, RNF, checksum and lost data

006434 661A                 bne      $6450              Error, try again
006436 526D0688             addq.w   #1,$688(A5)        csect, increment sector number
00643A 06AD000000200068E    add.l    #512,$68E(A5)      cdma, DMA address to next sector
006442 536D068C             subq.w   #1,$68C(A5)        ccount, decrement number of sectors
006446 670003C6             beq      $680E              flopok, all sectors, then done
00644A 61000524             bsr      $6970              select1, sector number and DMA pointer
00644E 608C                 bra      $63DC              Write next sector without seek
006450 0C6D00010672         cmp.w    #1,$672(A5)        retrycnt, second attempt ?
006456 6604                 bne      $645C              No
006458 61000420             bsr      $687A              ressek, home and seek
00645C 536D0672             subq.w   #1,$672(A5)        retrycnt, decrement attempt counter
006460 6A00FF6E             bpl      $63D0              Another attempt ?
006464 6000039A             bra      $6800              flopfail, error

*************************************************   flopfmt, format track
006468 0CAF876543210016     cmp.l    #$87654321,22(A7)  Magic number ?
006470 6600038E             bne      $6800              No, flopfail
006474 6100057C             bsr      $69F2              Change, test for disk change
006478 70FF                 moveq.l  #-1,D0             Default error number
00647A 610002EC             bsr      $6768              floplock, set parameters
00647E 610004C8             bsr      $6948              select, select drive and side
006482 3B6F000E0696         move.w   14(A7),$696(A5)    spt, sectors per track
006488 3B6F00140698         move.w   20(A7),$698(A5)    interlv, interleave factor
00648E 3B6F001A069A         move.w   26(A7),$69A(A5)    virgin, sector data for formatting
```

```
006494 7002             moveq.l #2,D0             'changed'
006496 61000592         bsr     $6A2A             Diskette changed
00649A 610003C0         bsr     $685C             hseek, search for track
00649E 66000360         bne     $6800             flopfail, not found
0064A2 336D06860000     move.w  $686(A5),0(A1)    ctrack, write current track in DSB
0064A8 3B7CFFFF06A2     move.w  #-1,$6A2(A5)      currerr to default error
0064AE 6128             bsr     $64D8             Format track
0064B0 6600034E         bne     $6800             flopfail, error
0064B4 3B6D0696068C     move.w  $696(A5),$68C(A5) spt sectors per track as ccount counter
0064BA 3B7C00010688     move.w  #1,$688(A5)       csect, start with sector 1
0064C0 6100015C         bsr     $661E             verify, verify sector
0064C4 246D068E         move.l  $68E(A5),A2       cdma, list with bad sectors
0064C8 4A52             tst.w   (A2)              Bad sector ?
0064CA 67000342         beq     $680E             No
0064CE 3B7CFFF006A2     move.w  #-16,$6A2(A5)     currerr to 'Bad Sector'
0064D4 6000032A         bra     $6800             flopfail, error

*****************************************************  fmtrack, format track
0064D8 3B7CFFF606A0     move.w  #-10,$6A0(A5)     deferror, default error number
0064DE 363C0001         move.w  #1,D3             Start with sector 1
0064E2 246D068E         move.l  $68E(A5),A2       cdma, buffer for track data
0064E6 323C003B         move.w  #$3B,D1           60 times
0064EA 103C004E         move.b  #$4E,D0           $4E, track header
0064EE 6100010A         bsr     $65FA             wmult, write in buffer
0064F2 3803             move.w  D3,D4             Save sector number
0064F4 323C000B         move.w  #$B,D1            12 times
0064F8 4200             clr.b   D0                0
0064FA 610000FE         bsr     $65FA             wmult, write in buffer
0064FE 323C0002         move.w  #2,D1             3 times
006502 103C00F5         move.b  #$F5,D0           $F5
006506 610000F2         bsr     $65FA             wmult, write in buffer
00650A 14FC00FE         move.b  #$FE,(A2)+        $FE, address mark
```

```
00650E 14F900000687      move.b  $687,(A2)+         Track
006514 14F90000068B      move.b  $68B,(A2)+         Side
00651A 14C4              move.b  D4,(A2)+           Sector
00651C 14FC0002          move.b  #2,(A2)+           Sector size (512 bytes)
006520 14FC00F7          move.b  #$F7,(A2)+         Write checksum
006524 323C0015          move.w  #$15,D1            22 times
006528 103C004E          move.b  #$4E,D0            $4E
00652C 610000CC          bsr     $65FA              wmult, write in buffer
006530 323C000B          move.w  #$B,D1             12 times
006534 4200              clr.b   D0                 0
006536 610000C2          bsr     $65FA              wmult, write in buffer
00653A 323C0002          move.w  #2,D1              3 times
00653E 103C00F5          move.b  #$F5,D0            $F5
006542 610000B6          bsr     $65FA              wmult, write in buffer
006546 14FC00FB          move.b  #$FB,(A2)+         $FB, data block mark
00654A 323C00FF          move.w  #$FF,D1            256 times
00654E 14ED069A          move.b  $69A(A5),(A2)+     virgin, initial data in buffer
006552 14ED069B          move.b  $69B(A5),(A2)+
006556 51C9FFF6          dbra    D1,$654E           Next word
00655A 14FC00F7          move.b  #$F7,(A2)+         Write checksum
00655E 323C0027          move.w  #$27,D1            40 times
006562 103C004E          move.b  #$4E,D0            $4E
006566 61000092          bsr     $65FA              wmult, write in buffer
00656A D86D0698          add.w   $698(A5),D4        Add interlv, next sector
00656E B86D0696          cmp.w   $696(A5),D4        spt, largest sector number ?
006572 6F80              ble     $64F4              No, next sector
006574 5243              addq.w  #1,D3              Start sector plus one
006576 B66D0698          cmp.w   $698(A5),D3        interlv
00657A 6F00FF76          ble     $64F2              Next sector
00657E 323C0578          move.w  #$578,D1           1401 times (until track end)
006582 103C004E          move.b  #$4E,D0            $4E
006586 6172              bsr     $65FA              wmult, write in buffer
```

```
006588 13ED0691FFFF860D     move.b  $691(A5),$FFFF860D   dmalow
006590 13ED0690FFFF860B     move.b  $690(A5),$FFFF860B   dmamid
006598 13ED068FFFFF8609     move.b  $68F(A5),$FFFF8609   dmahigh
0065A0 3CBC0190             move.w  #$190,(A6)           Clear DMA status
0065A4 3CBC0090             move.w  #$90,(A6)
0065A8 3CBC0190             move.w  #$190,(A6)           Data direction to WRITE
0065AC 3E3C001F             move.w  #$1F,D7              Sector counter to 31
0065B0 61000412             bsr     $69C4                wdiskctl, D7 to 1772
0065B4 3CBC0180             move.w  #$180,(A6)           Select 1772
0065B8 3E3C00F0             move.w  #$F0,D7              Format track command
0065BC 61000406             bsr     $69C4                wdiskctl, D7 to 1772
0065C0 2E3C00040000         move.l  #$40000,D7           Timeout counter
0065C6 08390005FFFFFA01     btst    #5,$FFFFFA01         mfp gpip, 1772 done ?
0065CE 670C                 beq     $65DC                Yes
0065D0 5387                 subq.l  #1,D7                Decrement timeout counter
0065D2 66F2                 bne     $65C6                Not yet timed-out ?
0065D4 61000358             bsr     $692E                reset, terminate
0065D8 7E01                 moveq.l #1,D7                Clear Z-bit, error
0065DA 4E75                 rts

0065DC 3CBC0190             move.w  #$190,(A6)           Select DMA status
0065E0 3016                 move.w  (A6),D0              Read status
0065E2 08000000             btst    #0,D0                DMA error ?
0065E6 67F0                 beq     $65D8                Yes
0065E8 3CBC0180             move.w  #$180,(A6)           Select 1772 status register
0065EC 610003EA             bsr     $69D8                rdiskctl, read registers
0065F0 6100FD9C             bsr     $638E                errbits, calculate error number
0065F4 C03C0044             and.b   #$44,D0              Test write protect and lost data
0065F8 4E75                 rts

0065FA 14C0                 move.b  D0,(A2)+             Write data in buffer
0065FC 51C9FFFC             dbra    D1,$65FA             Next byte
```

```
006600 4E75               rts

**********************************************         flopver, verfiy sector(s)
006602 610003EE           bsr      $69F2               Change, test for disk change
006606 70F5               moveq.l  #-11,D0             'read error', as default error
006608 6100015E           bsr      $6768               floplock, set parameters
00660C 6100033A           bsr      $6948               Select
006610 6100029C           bsr      $68AE               go2track, search for track
006614 660001EA           bne      $6800               flopfail, error
006618 6104               bsr      $661E               verify1, verify sectors
00661A 600001F2           bra      $680E               flopok, done

***********************************************
00661E 3B7CFFF506A0       move.w   #-11,$6A0(A5)       deferror to 'read error'
006624 246D068E           move.l   $68E(A5),A2         cdma, DMA buffer for bad sector list
006628 06AD00000200068E   add.l    #$200,$68E(A5)      cdma to next sector
006630 3B7C00020672       move.w   #2,$672(A5)         retrycnt, 2 attempts
006636 3CBC0084           move.w   #$84,(A6)           Select sector register
00663A 3E2D0688           move.w   $688(A5),D7         csect, sector number
00663E 61000384           bsr      $69C4               wdiskctl,to disk controller
006642 13ED0691FFFF860D   move.b   $691(A5),$FFFF860D  dmalow
00664A 13ED0690FFFF860B   move.b   $690(A5),$FFFF860B  dmamid
006652 13ED068FFFFF8609   move.b   $68F(A5),$FFFF8609  dmahigh
00665A 3CBC0090           move.w   #$90,(A6)           Clear DMA status
00665E 3CBC0190           move.w   #$190,(A6)
006662 3CBC0090           move.w   #$90,(A6)           Data direction to READ
006666 3E3C0001           move.w   #1,D7               Sector counter to 1
00666A 61000358           bsr      $69C4               wdiskctl
00666E 3CBC0080           move.w   #$80,(A6)           Select 1772 command register
006672 3E3C0080           move.w   #$80,D7             Read sector command
006676 6100034C           bsr      $69C4               wdiskctl
00667A 2E3C00040000       move.l   #$40000,D7          Timeout counter
```

```
006680 08390005FFFFFA01    btst    #5,$FFFFFA01        mfp gpip, 1772 done ?
006688 670A                beq     $6694               Yes
00668A 5387                subq.l  #1,D7               Decrement timeout counter
00668C 66F2                bne     $6680               Timed-out yet ?
00668E 6100029E            bsr     $692E               Reset 1772
006692 6036                bra     $66CA               Next attempt

006694 3CBC0090            move.w  #$90,(A6)           Select DMA status register
006698 3016                move.w  (A6),D0             Reat status
00669A 08000000            btst    #0,D0               DMA error ?
00669E 672A                beq     $66CA               Yes, try again
0066A0 3CBC0080            move.w  #$80,(A6)           Select 1772 status register
0066A4 61000332            bsr     $69D8               rdiskctl, read status
0066A8 6100FCE4            bsr     $638E               errbits, calculate error number
0066AC C03C001C            and.b   #$1C,D0             Test RNF, CRC and lost data
0066B0 6618                bne     $66CA               Error, next attempt
0066B2 526D0688            addq.w  #1,$688(A5)         csect, next sector
0066B6 536D068C            subq.w  #1,$68C(A5)         ccount, decrement sector counter
0066BA 6600FF74            bne     $6630               Another sector ?
0066BE 04AD000002000068E   sub.l   #$200,$68E(A5)      cdma, Reset DMA pointer
0066C6 4252                clr.w   (A2)                bad sector list mit Null abschlie@en
0066C8 4E75                rts

0066CA 0C6D00010672        cmp.w   #1,$672(A5)         retrycnt, 2ns attempt ?
0066D0 6604                bne     $66D6               No
0066D2 610001A6            bsr     $687A               reseek
0066D6 536D0672            subq.w  #1,$672(A5)         Decrement retrycnt
0066DA 6A00FF66            bpl     $6642               Another attempt ?
0066DE 34ED0688            move.w  $688(A5),(A2)+      csect, sector number in bad sector list
0066E2 60CE                bra     $66B2               Next sector
```

```
****************************************************  flopvbl, floppy vertical blank handler
0066E4 9BCD              sub.l    A5,A5             Clear A5
0066E6 4DF9FFFF8606      lea      $FFFF8606,A6      Address of the floppy register
0066EC 50ED0680          st       $680(A5)          Set motoron flag
0066F0 4A6D043E          tst.w    $43E(A5)          flock, disks busy ?
0066F4 6670              bne      $6766             Yes, do nothing
0066F6 203900000466      move.l   $466,D0           frclock
0066FC 1200              move.b   D0,D1
0066FE C23C0007          and.b    #7,D1             Calculate mod 8
006702 6638              bne      $673C             Not yet 8th interrupt ?
006704 3CBC0080          move.w   #$80,(A6)         Select 1772 status register
006708 E608              lsr.b    #3,D0             Use bit 4 as drive number
00670A C07C0001          and.w    #1,D0
00670E 41ED0674          lea      $674(A5),A0       wpstatus, write protect status table
006712 D0C0              add.w    D0,A0             Index with drive number
006714 B07900004A6       cmp.w    $4A6,D0           nflops, number of floppies
00671A 6602              bne      $671E
00671C 4240              clr.w    D0
00671E 5200              addq.b   #1,D0             Drive select bit
006720 E308              lsl.b    #1,D0             Shift in position
006722 0A000007          eor.b    #7,D0             Invert for hardware
006726 6100026C          bsr      $6994             Select drive
00672A 3039FFFF8604      move.w   $FFFF8604,D0      dskctl, read 1772 status
006730 08000006          btst     #6,D0             Test write rpotect bit
006734 56D0              sne      (A0)              And save
006736 1002              move.b   D2,D0             Previous select status
006738 6100025A          bsr      $6994             Recreate
00673C 302D0674          move.w   $674(A5),D0       wpstatus
006740 816D0676          or.w     D0,$676(A5)       Write wplatch
006744 4A6D0682          tst.w    $682(A5)          deslflg, floppies already deselected?
006748 6618              bne      $6762             Yes
00674A 6100028C          bsr      $69D8             Raed 1772 status register
```

```
00674E 08000007          btst     #7,D0               Motor on bit set ?
006752 6612              bne      $6766               Yes, then don't deselect
006754 103C0007          move.b   #7,D0               Both drives
006758 6100023A          bsr      $6994               Deselect
00675C 3B7C00010682      move.w   #1,$682(A5)         Set deslflg
006762 426D0680          clr.w    $680(A5)            Clear motoron flag
006766 4E75              rts

***************************************************   floplock
006768 48F978F8000006A4  movem.l D3-D7/A3-A6,$6A4    regsave
006770 9BCD              sub.l    A5,A5               Clear A5
006772 4DF9FFFF8606      lea      $FFFF8606,A6        Address of the floppy register
006778 50F900000680      st       $680                Set motoron flag
00677E 3B4006A0          move.w   D0,$6A0(A5)         deferror
006782 3B4006A2          move.w   D0,$6A2(A5)         currerr
006786 3B7C0001043E      move.w   #1,$43E(A5)         flock, disable floppy-vbl routine
00678C 2B6F0008068E      move.l   8(A7),$68E(A5)      cdma
006792 3B6F00100684      move.w   16(A7),$684(A5)     cdev
006798 3B6F00120688      move.w   18(A7),$688(A5)     csect
00679E 3B6F00140686      move.w   20(A7),$686(A5)     ctrack
0067A4 3B6F0016068A      move.w   22(A7),$68A(A5)     cside
0067AA 3B6F0018068C      move.w   24(A7),$68C(A5)     ccount
0067B0 3B7C00020672      move.w   #2,$672(A5)         retrycnt
0067B6 43ED06C8          lea      $6C8(A5),A1         dsb0
0067BA 4A6D0684          tst.w    $684(A5)            cdev
0067BE 6704              beq      $67C4               Drive 0 ?
0067C0 43ED06CC          lea      $6CC(A5),A1         dsb1
0067C4 7E00              moveq.l  #0,D7
0067C6 3E2D068C          move.w   $68C(A5),D7         ccount, number of sectors
0067CA E14F              lsl.w    #8,D7               Times 512
0067CC E34F              lsl.w    #1,D7
0067CE 206D068E          move.l   $68E(A5),A0         cdma, start DMA address
```

```
0067D2 D1C7              add.l    D7,A0             Plus length of sector
0067D4 2B480692          move.l   A0,$692(A5)       edma, yields end DMA address
0067D8 4A690000          tst.w    0(A1)             dcurtrack, current track
0067DC 6A20              bpl      $67FE             >= 0 ?
0067DE 61000168          bsr      $6948             No, select
0067E2 42690000          clr.w    0(A1)             Set track to zero
0067E6 610000EC          bsr      $68D4             Restore, head to track zero
0067EA 6712              beq      $67FE             OK ?
0067EC 7E0A              moveq.l  #10,D7
0067EE 6172              bsr      $6862             Seek track 10
0067F0 6606              bne      $67F8             Error ?
0067F2 610000E0          bsr      $68D4             Restore
0067F6 6706              beq      $67FE             OK ?
0067F8 337CFF000000      move.w   #$FF00,0(A1)      Recalibrate, error
0067FE 4E75              rts

**************************************************  flopfail, error in floppy routine
006800 7001              moveq.l  #1,D0             Media change to 'unsure'
006802 61000226          bsr      $6A2A             Set
006806 302D06A2          move.w   $6A2(A5),D0       currerr
00680A 48C0              ext.l    D0
00680C 6002              bra      $6810

**************************************************  flopok, error-free floppy routine
00680E 4280              clr.l    D0
006810 2F00              move.l   D0,-(A7)          ok
006812 3CBC0086          move.w   #$86,(A6)         Select 1772
006816 3E290000          move.w   0(A1),D7          Get track number
00681A 610001A8          bsr      $69C4             wdiskctl, send to disk controller
00681E 3C3C0010          move.w   #$10,D6           seek command
006822 610000C6          bsr      $68EA             flopcms
006826 303900000684      move.w   $684,D0           cdev, drive number
```

```
00682C E548                lsl.w   #2,D0                As index
00682E 41F900000678        lea     $678,A0              acctim
006834 21AD04BA0000        move.l  $4BA(A5),0(A0,D0.w)  200 Hz counter as last access time
00683A 0C790001000004A6    cmp.w   #1,$4A6              nflops
006842 6606                bne     $684A
006844 216D04BA0004        move.l  $4BA(A5),4(A0)       20 Hz counter for other drives
00684A 201F                move.l  (A7)+,D0             Restore error number
00684C 4CF978F8000006A4    movem.l $6A4,D3-D7/A3-A6     regsave
006854 42790000043E        clr.w   $43E                 Clear flock, release vbl routine
00685A 4E75                rts

***************************************************     hseek, head to track
00685C 3E3900000686        move.w  $686,D7              ctrack
006862 33FCFFFA000006A2    move.w  #-10,$6A2            currerr to 'seek error'
00686A 3CBC0086            move.w  #$86,(A6)            Pass track number
00686E 61000154            bsr     $69C4                wdsikctl
006872 3C3C0010            move.w  #$10,D6              Seek command
006876 60000072            bra     $68EA                flopcmds

***************************************************     ressek, home and seek
00687A 33FCFFFA000006A2    move.w  #-10,$6A2            currerr to 'seek error'
006882 6150                bsr     $68D4                Restore
006884 664C                bne     $68D2                Error ?
006886 42690000            clr.w   0(A1)                Current track to zero
00688A 3CBC0082            move.w  #$82,(A6)            Select track register
00688E 4247                clr.w   D7                   Track zero
006890 61000132            bsr     $69C4                wdiskctl
006894 3CBC0086            move.w  #$86,(A6)            Select data register
006898 3E3C0005            move.w  #5,D7                Track 5
00689C 61000126            bsr     $69C4                wdiskctl
0068A0 3C3C0010            move.w  #$10,D6              Seek command
0068A4 6144                bsr     $68EA                flopcmds
```

```
0068A6 662A              bne      $68D2              Error
0068A8 337C00050000      move.w   #5,0(A1)           Track number to 5

************************************************     go2track, search for trak
0068AE 33FCFFFA000006A2  move.w   #-10,$6A2          currerr to 'seek error'
0068B6 3CBC0086          move.w   #$86,(A6)          Select data register
0068BA 3E2D0686          move.w   $686(A5),D7        ctrack, load track number
0068BE 61000104          bsr      $69C4              wdiskctl
0068C2 7C14              moveq.l  #$14,D6            Seek with verify command
0068C4 6124              bsr      $68EA              flopcmds
0068C6 660A              bne      $68D2              Error
0068C8 336D06860000      move.w   $686(A5),0(A1)     ctrack, Save track number
0068CE CE3C0018          and.b    #$18,D7            Test RNF, CRC lost data
0068D2 4E75              rts

************************************************     restore, seek track zero
0068D4 4246              clr.w    D6                 restore command
0068D6 6112              bsr      $68EA              flopcmds
0068D8 660E              bne      $68E8              Error
0068DA 08070002          btst     #2,D7              Test track zero bit
0068DE 0A3C0004          eor.b    #4,SR              Z-Flag invertieren
0068E2 6604              bne      $68E8              nicht Track Null ?
0068E4 42690000          clr.w    0(A1)              current Track auf Null
0068E8 4E75              rts

*************************************************    flopcmds
0068EA 30290002          move.w   2(A1),D0           Seek rate
0068EE C03C0003          and.b    #$3,D0             Bits 0 and 1
0068F2 8C00              or.b     D0,D6              OR in command word
0068F4 2E3C00040000      move.l   #$40000,D7         Timeout counter
0068FA 3CBC0080          move.w   #$80,(A6)          Select 1772 register
0068FE 610000D8          bsr      $69D8              rdiskctl
```

```
006902 08000007          btst     #7,D0            Motor on ?
006906 6606              bne      $690E            Yes
006908 2E3C00060000      move.l   #$60000,D7       Else longer timeout
00690E 610000AA          bsr      $69BA            wdiskctl6, write command in D6
006912 5387              subq.l   #1,D7            Decrement timeout counter
006914 6712              beq      $6928            Timed-out ?
006916 08390005FFFFFA01  btst     #5,$FFFFFA01     mfp gpip, 1772 done ?
00691E 66F2              bne      $6912            No, wait
006920 610000AC          bsr      $69CE            rdiskctl7
006924 4246              clr.w    D6               OK
006926 4E75              rts

006928 6104              bsr      $692E            Reset 1772
00692A 7C01              moveq.l #1,D6             Error
00692C 4E75              rts

**************************************************  Reset 1772, reset floppy controller
00692E 3CBC0080          move.w   #$80,(A6)        Select command register
006932 3E3C00D0          move.w   #$D0,D7          Reset command
006936 6100008C          bsr      $69C4            wdiskctl
00693A 3E3C000F          move.w   #$F,D7           Delay counter
00693E 51CFFFFE          dbra     D7,$693E         Timed-out ? read status
006946 4E75              rts

**************************************************  select, select drive and side
006948 426D0682          clr.w    $682(A5)         Clear deslflg
00694C 302D0684          move.w   $684(A5),D0      cdev, drive number
006950 5200              addq.b   #1,D0
006952 E308              lsl.b    #1,D0            Calculate bit number
006954 806D068A          or.w     $68A(A5),D0      cside, side in bit 0
006958 0A000007          eor.b    #7,D0            Invert bits for hardware
00695C C03C0007          and.b    #7,D0
```

```
006960 6132                  bsr     $6994               Set bits in sound chip
006962 3CBC0082              move.w  #$82,(A6)           Select track register
006966 3E290000              move.w  0(A1),D7            Get track number
00696A 6158                  bsr     $69C4               wdskctl
00696C 422D069C              clr.b   $69C(A5)            tmpdma, clear bits 24-31
006970 3CBC0084              move.w  #$84,(A6)           Select sector register
006974 3E2D0688              move.w  $688(A5),D7         csect, get sector number
006978 614A                  bsr     $69C4               wdiskctl
00697A 13ED0691FFFF860D      move.b  $691(A5),$FFFF860D  dmalow
006982 13ED0690FFFF860B      move.b  $690(A5),$FFFF860B  dmamid
00698A 13ED068FFFFF8609      move.b  $68F(A5),$FFFF8609  dmahigh
006992 4E75                  rts

**************************************************** setporta, set port A in sound chip
006994 40E7                  move.w  SR, -(A7)           Save status
006996 007C0700              or.w    #$700,SR            IPL 7
0069A2 1239FFFF8800          move.b  $FFFF8800,D1        Read port A
0069A8 1401                  move.b  D1,D2               And to D20069AA C23C00F8
0069AA C23C00FA              and.b   #$F8,D1             Clear bits 0-2
0069AE 8200                  or.b    D0,D1               Set new bits
0069B0 13C1FFFF8802          move.b  D1,$FFFF8802        Write result to port A
0069B6 46DF                  move.w  (A7)+,SR            Restore status
0069B8 4E75                  rts

****************************************************** wdiskct6
0069BA 6124                  bsr     $69E0               Delay loop for disk controller
0069BC 33C6FFFF8604          move.w  D6,$FFFF8604        dskctl
0069C2 601C                  bra     $69E0               Delay loop for disk controller

****************************************************** wdiskctl
0069C4 611A                  bsr     $69E0               Delay loop for disk controller
0069C6 33C7FFFF8604          move.w  D7,$FFFF8604        dskctl
```

```
0069CC 6012              bra     $69E0          Delay loop for disk controller

***************************************************  rdiskct7
0069CE 6110              bsr     $69E0          Delay loop for disk controller
0069D0 3E39FFFF8604      move.w  $FFFF8604,D7   dskctl
0069D6 6008              bra     $69E0          Delay loop for disk controller

***************************************************  rdiskctl
0069D8 6106              bsr     $69E0          Delay loop for disk controller
0069DA 3039FFFF8604      move.w  $FFFF8604,D0   dskctl
0069E0 40E7              move.w  SR, -(A7)      Save status
0069E2 3F07              move.w  D7,-(A7)       Save D7
0069E4 3E3C0020          move.w  #$20,D7        Counter
0069E8 51CFFFFE          dbra    D7,$69E8       Delay loop
0069EC 3E1F              move.w  (A7)+,D7       D7 back
0069EE 46DF              move.w  (A7)+,SR       Status back
0069F0 4E75              rts

************************************************  change, tets disk change
0069F2 0C790001000004A6  cmp.w   #1,$4A6        nflops
0069FA 662C              bne     $6A28          None or 2 floppies, done
0069FC 302F0010          move.w  16(A7),D0      Drive number
006A00 B07900004692      cmp.w   $4692,D0       Equals diskette number ?
006A06 671C              beq     $6A24          Yes
006A08 3F00              move.w  D0,-(A7)       Drive number
006A0A 3F3CFFEF          move.w  #-17,-(A7)     'insert disk'
006A0E 6100EB4C          bsr     $555C          Critical error handler
006A12 584F              addq.w  #4,A7          Correct stack pointer
006A14 33FCFFFF00000676  move.w  #$FFFF,$676    wplatch, Status for both drives unsure
006A1C 33EF001000004692  move.w  16(A7),$4692   Save diskette number
006A24 426F0010          clr.w   16(A7)         Drive number to zero
006A28 4E75              rts
```

```
****************************************************    setdmode, set drive change mode
006A2A 41F900003E2A         lea      $3E2A,A0           Disk mode table
006A30 1F00                 move.b   D0,-(A7)           Save mode
006A32 302D0684             move.w   $684(A5),D0        cdev, get drive number
006A36 119F0000             move.b   (A7)+,0(A0,D0.w)   Set drive mode
006A3A 4E75                 rts

**************************************************      dskf, disk flags
006A3C AE                   dc.b     %10101110
006A3D D6                   dc.b     %11010110
006A3E 8C                   dc.b     %10001100
006A3F 17                   dc.b     %00010111
006A40 FB                   dc.b     %11111011
006A41 80                   dc.b     %10000000
006A42 6A                   dc.b     %01101010
006A43 2B                   dc.b     %00101011
006A44 A6                   dc.b     %10100110
006A45 00                   dc.b     0

*************************************************       jdostime, IKBD format in DOS format
006A46 4BF900000000         lea      $0,A5              Clear A5
006A4C 41ED0A43             lea      $A43(A5),A0        Pointer to clock-time buffer
006A50 610000DE             bsr      $6B30              bcdbin
006A54 04000050             sub.b    #80,D0             Subtract offset of 80
006A58 1400                 move.b   D0,D2              Year
006A5A E982                 asl.l    #4,D2              Shift in position
006A5C 610000D2             bsr      $6B30              bcdbin
006A60 D400                 add.b    D0,D2              Add month
006A62 EB82                 asl.l    #5,D2              And shift in position
006A64 610000CA             bsr      $6B30              bcdbin
006A68 D400                 add.b    D0,D2              Add day
```

```
006A6A EB82                 asl.l   #5,D2           And shift in position
006A6C 610000C2             bsr     $6B30           bcdbin
006A70 D400                 add.b   D0,D2           Add hour
006A72 ED82                 asl.l   #6,D2           And shift in position
006A74 610000BA             bsr     $6B30           bcdbin
006A78 D400                 add.b   D0,D2           Add minute
006A7A EB82                 asl.l   #5,D2           And shift in position
006A7C 610000B2             bsr     $6B30           bcdbin
006A80 E208                 lsr.b   #1,D0           2-second resolution
006A82 D400                 add.b   D0,D2           And add seconds
006A84 2B420A4C             move.l  D2,$A4C(A5)     Save new time
006A88 1B7C00000A8E         move.b  #$0,$A8E(A5)    Clear handshake flag
006A8E 4E75                 rts

***********************************************     gettime, get current clock time and date
006A90 1B7CFFFF0A8E         move.b  #-1,$A8E(A5)    Request handshake flag for time
006A96 123C001C             move.b  #$1C,D1         get time of day command
006A9A 61000234             bsr     $6CD0           Send
006A9E 4A2D0A8E             tst.b   $A8E(A5)        New time arrived ?
006AA2 66FA                 bne     $6A9E           No, wait
006AA4 202D0A4C             move.l  $A4C(A5),D0     Get time in D0
006AA8 4E75                 rts

***********************************************     settime, set clock time and date
006AAA 2B6F00040A50         move.l  4(A7),$A50(A5)  Pass time

***********************************************     ikbdtime
006AB0 41F900000A5A         lea     $A5A,A0         Pointer to end of time buffer
006AB6 242D0A50             move.l  $A50(A5),D2     Get time to convert
006ABA 1002                 move.b  D2,D0           To d0
006ABC 0200001F             and.b   #31,D0          Isolate bits 0-4, seconds
006AC0 E300                 asl.b   #1,D0           2-second resolution
```

```
006AC2 6154            bsr      $6B18         Convert
006AC4 EA8A            lsr.l    #5,D2         Minute
006AC6 1002            move.b   D2,D0
006AC8 0200003F        and.b    #63,D0        Isolate bits 0-5
006ACC 614A            bsr      $6B18         Convert
006ACE EC8A            lsr.l    #6,D2         Hours
006AD0 1002            move.b   D2,D0
006AD2 0200001F        and.b    #31,D0        Isolate bits 0-4
006AD6 6140            bsr      $6B18         Convert
006AD8 EA8A            lsr.l    #5,D2         Day
006ADA 1002            move.b   D2,D0
006ADC 0200001F        and.b    #31,D0        Isolate bits 0-4
006AE0 6136            bsr      $6B18         Convert
006AE2 EA8A            lsr.l    #5,D2         Month
006AE4 1002            move.b   D2,D0
006AE6 0200000F        and.b    #15,D0        Isolate bits 0-3
006AEA 612C            bsr      $6B18         Convert
006AEC E88A            lsr.l    #4,D2         Year
006AEE 1002            move.b   D2,D0
006AF0 0200007F        and.b    #$7F,D0       Isolate bits 0-7
006AF4 6122            bsr      $6B18         Convert
006AF6 06100080        add.b    #$80,(A0)     Add offset
006AFA 123C001B        move.b   #$1B,D1       Set Time Of Day command
006AFE 610001D0        bsr      $6CD0         Send to IKBD
006B02 7605            moveq.l  #5,D3         Number of bytes to send
006B04 45F900000A54    lea      $A54,A2       Address of the parameter block
006B0A 610001E4        bsr      $6CF0         Send
006B0E 123C001C        move.b   #$1C,D1       Get Time Of Day command
006B12 610001BC        bsr      $6CD0         Send to IKBD
006B16 4E75            rts
```

```
*************************************************     binbcd, convert byte to BCD
006B18 7200          moveq.l #0,D1                    Ten's counter
006B1A 760A          moveq.l #10,D3                   Load 10
006B1C 9003          sub.b   D3,D0                    Subtract 10
006B1E 6B04          bmi     $6B24
006B20 5201          addq.b  #1,D1                    Increment ten's counter
006B22 60F8          bra     $6B1C
006B24 0600000A      add.b   #10,D0                   Generate one's counter
006B28 E901          asl.b   #4,D1                    Tens in upper nibble
006B2A D001          add.b   D1,D0                    And add ones
006B2C 1100          move.b  D0,-(A0)                 Write result in buffer
006B2E 4E75          rts

*************************************************     bcdbin, convert BCD to binary
006B30 7000          moveq.l #0,D0
006B32 1010          move.b  (A0),D0                  BCD byte
006B34 E808          lsr.b   #4,D0                    Ten's place
006B36 E308          lsl.b   #1,D0
006B38 1200          move.b  D0,D1
006B3A E500          asl.b   #2,D0
006B3C D001          add.b   D1,D0
006B3E 1218          move.b  (A0)+,D1
006B40 0241000F      and.w   #15,D1                   Isolate one's place
006B44 D041          add.w   D1,D0                    Plus ten's place
006B46 4E75          rts

*************************************************     midiost, MIDI output status
006B48 70FF          moveq.l #-1,D0                   Default to OK
006B4A 1439FFFFFC04  move.b  $FFFFFC04,D2             Read MIDI-ACIA status
006B50 08020001      btst    #1,D2                    And test
006B54 6602          bne     $6B58                    OK
006B56 7000          moveq.l #0,D0                    Status not OK
```

```
006B58 4E75              rts

**************************************************  midiwc, output character to MIDI
006B5A 322F0006          move.w  6(A7),D1           Get character
006B5E 43F9FFFFFC04      lea     $FFFFFC04,A1       Pointer to MIDI-ACIA
006B64 14290000          move.b  0(A1),D2           Get MIDI status
006B68 08020001          btst    #1,D2              Test
006B6C 67F6              beq     $6B64              Wait until OK
006B6E 13410002          move.b  D1,2(A1)           Output byte to ACIA
006B72 4E75              rts

**************************************************  midiws, send string to MIDI
006B74 7600              moveq.l #0,D3
006B76 362F0004          move.w  4(A7),D3           Length of string -1
006B7A 246F0006          move.l  6(A7),A2           Address of the string
006B7E 121A              move.b  (A2)+,D1           Get byte from string
006B80 61DC              bsr     $6B5E              Output to MIDI
006B82 51CBFFFA          dbra    D3,$6B7E           Next byte
006B86 4E75              rts

**************************************************  midstat, MIDI receiver status
006B88 41ED0A00          lea     $A00(A5),A0        iorec for MIDI
006B8C 43F9FFFFFC04      lea     $FFFFFC04,A1       Pointer to MIDI-ACIA
006B92 70FF              moveq.l #-1,D0             OK as default
006B94 45E80006          lea     6(A0),A2           Head Index
006B98 47E80008          lea     8(A0),A3           Tail Index
006B9C B54B              cmpm.w  (A3)+,(A2)+        Uninterruptable test
006B9E 6602              bne     $6BA2              Not equal
006BA0 7000              moveq.l #0,D0              Not OK
006BA2 4E75              rts
```

```
**************************************************     midin, get character from MIDI
006BA4 61E2            bsr      $6B88                  midstat
006BA6 4A40            tst.w    D0                     Character ready ?
006BA8 67FA            beq      $6BA4                  No
006BAA 40E7            move.w   SR, -(A7)              Save status
006BAC 007C0700        or.w     #$700,SR               IPL 7, disable interrupts
006BB0 32280006        move.w   6(A0),D1               Head index
006BB4 B2680008        cmp.w    8(A0),D1               Compare with tail index
006BB8 6716            beq      $6BD0
006BBA 5241            addq.w   #1,D1                  Increment head index
006BBC B2680004        cmp.w    4(A0),D1               Greater than buffer size ?
006BC0 6502            bcs      $6BC4                  No
006BC2 7200            moveq.l  #0,D1                  Begin at buffer start again
006BC4 22680000        move.l   0(A0),A1               Pointer to MIDI buffer
006BC8 10311000        move.b   0(A1,D1.w),D0          Get character from buffer
006BCC 31410006        move.w   D1,6(A0)               Save new head index
006BD0 46DF            move.w   (A7)+,SR               Restore status
006BD2 4E75            rts

**************************************************     lstout, output character to Centronics
006BD4 242D04BA        move.l   $4BA(A5),D2            200 Hz counter
006BD8 94AD0A80        sub.l    $A80(A5),D2            Minus printer timeout
006BDC 0C82000003E8    cmp.l    #1000,D2               Waited more than 5 seconds ?
006BE2 6518            bcs      $6BFC                  Yes, time out
006BE4 242D04BA        move.l   $4BA(A5),D2            200 Hz counter, start time for this char
006BE8 6172            bsr      $6C5C                  Get bust status
006BEA 4A40            tst.w    D0                     And test
006BEC 6618            bne      $6C06                  Printer ready ?
006BEE 262D04BA        move.l   $4BA(A5),D3            200 Hz counter
006BF2 9682            sub.l    D2,D3                  Minus start time
006BF4 0C8300001770    cmp.l    #6000,D3               30 seconds ?
006BFA 6DEC            blt      $6BE8                  Not yet reached
```

```
006BFC 7000             moveq.l #0,D0              Flag for time out
006BFE 2B6D04BA0A80     move.l  $4BA(A5),$A80(A5)  200 Hz conter as last time-out time
006C04 4E75             rts
006C06 40C3             move.w  SR, D3             Save status
006C08 007C0700         or.w    #$700,SR           IPL 7, no interrupts
006C0C 7207             moveq.l #7,D1              Mixer
006C0E 61000E28         bsr     $7A38              Select registers
006C12 00000080         or.b    #$80,D0            Port B to output
006C16 7287             moveq.l #$87,D1            Write enable
006C18 61000E1E         bsr     $7A38
006C1C 46C3             move.w  D3,SR              Restore status
006C1E 302F0006         move.w  6(A7),D0           Character to output
006C22 728F             moveq.l #$8F,D1            Write to port B
006C24 61000E12         bsr     $7A38
006C28 610C             bsr     $6C36              Strobe low
006C2A 6104             bsr     $6C30              Strobe high
006C2C 70FF             moveq.l #-1,D0             Flag for OK
006C2E 4E75             rts

**********************************************     Strobe high
006C30 7420             moveq.l #$20,D2            Bit 5
006C32 60000E46         bra     $7A7A              Set

**********************************************     Strobe low
006C36 74DF             moveq.l #$DF,D2            Bit 5
006C38 60000E66         bra     $7AA0              Clear

**********************************************     listin, Get character from parallel port
006C3C 7207             moveq.l #7,D1              Mixer
006C3E 61000DF8         bsr     $7A38              Select register
006C42 0200007F         and.b   #$7F,D0            Port B to input
006C46 7287             moveq.l #$87,D1
```

```
006C48 61000DEE          bsr     $7A38
006C4C 61E2              bsr     $6C30          Strobe high = not busy
006C4E 610C              bsr     $6C5C          Get parallel port status
006C50 4A40              tst.w   D0
006C52 66FA              bne     $6C4E          Wait until character arrives
006C54 61E0              bsr     $6C36          Strobe low = busy
006C56 720F              moveq.l #15,D1         Select port B
006C58 60000DDE          bra     $7A38          Read byte from port

**********************************************  lstostat, parallel port status
006C5C 41F9FFFFFA01      lea     $FFFFFA01,A0   Address of the MFP
006C62 70FF              moveq.l #-1,D0         Default to ok
006C64 082800000000      btst    #0,0(A0)       Test busy
006C6A 6702              beq     $6C6E          OK
006C6C 7000              moveq.l #0,D0          Still busy
006C6E 4E75              rts

**********************************************  auxistat, RS232 input status
006C70 41ED09D0          lea     $9D0(A5),A0    iorec for RS232
006C74 70FF              moveq.l #-1,D0         Default to ok
006C76 45E80006          lea     6(A0),A2       Head index
006C7A 47E80008          lea     8(A0),A3       Tail Index
006C7E B54B              cmpm.w  (A3)+,(A2)+    Buffer leer ?
006C80 6602              bne     $6C84          No
006C82 7000              moveq.l #0,D0          No character there
006C84 4E75              rts

**********************************************  auxin, get character RS-232
006C86 61E8              bsr     $6C70          auxin, character ready ?
006C88 4A40              tst.w   D0
006C8A 67FA              beq     $6C86          No, wait
006C8C 610005D8          bsr     $7266          rs232get, get character
```

```
006C90 024000FF           and.w   #$FF,D0           Isolate bits 0-7
006C94 4E75               rts

************************************************    auxostat, RS232 output status
006C96 41ED09D0           lea     $9D0(A5),A0       iorec for RS232
006C9A 70FF               moveq.l #-1,D0            Default to ok
006C9C 34280016           move.w  22(A0),D2         Tail index
006CA0 6100087C           bsr     $751E             Test for wrap around
006CA4 B4680014           cmp.w   20(A0),D2         Compare with head index
006CA8 6602               bne     $6CAC             Not equal
006CAA 7000               moveq.l #0,D0             No more space in buffer
006CAC 4E75               rts

************************************************    auxout, RS232 output routine
006CAE 322F0006           move.w  6(A7),D1          Get data byte
006CB2 61000556           bsr     $720A             rs232put, and output
006CB6 65F6               bcs     $6CAE             Try again
006CB8 4E75               rts

************************************************    ikbdost, IKBD output status
006CBA 70FF               moveq.l #-1,D0            Default to ok
006CBC 1439FFFFFC00       move.b  $FFFFFC00,D2      IKBD ACIA status
006CC2 08020001           btst    #1,D2             Test
006CC6 6602               bne     $6CCA             OK
006CC8 7000               moveq.l #0,D0             Not ready
006CCA 4E75               rts

************************************************    ikbdwc, send character to IKBD
006CCC 322F0006           move.w  6(A7),D1          Get byte
006CD0 43F9FFFFFC00       lea     $FFFFFC00,A1      Address of the keyboard ACIA
006CD6 14290000           move.b  0(A1),D2          Get status
006CDA 08020001           btst    #1,D2             Ready
```

```
006CDE 67F6              beq      $6CD6          No, wait
006CE0 13410002          move.b   D1,2(A1)       Output character
006CE4 4E75              rts

*************************************************  ikbdws, send string to keyboard
006CE6 7600              moveq.l  #0,D3
006CE8 362F0004          move.w   4(A7),D3       Number of characters -1
006CEC 246F0006          move.l   6(A7),A2       Address of the string
006CF0 121A              move.b   (A2)+,D1       Get byte from string
006CF2 61DC              bsr      $6CD0          And output
006CF4 51CBFFFA          dbra     D3,$6CF0       Next byte
006CF8 4E75              rts

*************************************************  constat, keyboard input status
006CFA 41ED09F2          lea      $9F2(A5),A0    iorec for keyboard
006CFE 70FF              moveq.l  #-1,D0         Default to ok
006D00 45E80006          lea      6(A0),A2       Head index
006D04 47E80008          lea      8(A0),A3       Tail index
006D08 B54B              cmpm.w   (A3)+,(A2)+    Buffer leer ?
006D0A 6602              bne      $6D0E          No
006D0C 7000              moveq.l  #0,D0          No characters there
006D0E 4E75              rts

*************************************************  conin, get character from keyboard
006D10 61E8              bsr      $6CFA          constat, key pressed ?
006D12 4A40              tst.w    D0
006D14 67FA              beq      $6D10          No, wait
006D16 40E7              move.w   SR,-(A7)       Save status
006D18 007C0700          or.w     #$700,SR       IPL 7, disable interrupts
006D1C 32280006          move.w   6(A0),D1       Head index
006D20 B2680008          cmp.w    8(A0),D1       Compare with tail index
006D24 671C              beq      $6D42
```

```
006D26 5441              addq.w   #2,D1             Head index + 2
006D28 B2680004          cmp.w    4(A0),D1          Greater than or equal buffer size ?
006D2C 6502              bcs      $6D30             No
006D2E 7200              moveq.l  #0,D1             Buffer pointer back to start
006D30 22680000          move.l   0(A0),A1          Pointer to keyboard buffer
006D34 7000              moveq.l  #0,D0
006D36 30311000          move.w   0(A1,D1.w),D0     Get character and scan code
006D3A 31410006          move.w   D1,6(A0)          Save new head index
006D3E E188              lsl.l    #8,D0             Scancode to bits 16-23
006D40 E048              lsr.w    #8,D0             ASCII code to bits 0-7
006D42 46DF              move.w   (A7)+,SR          Restore status
006D44 4E75              rts

*************************************************   conoutst, console output status
006D46 70FF              moveq.l  #-1,D0            Always OK
006D48 4E75              rts

*************************************************   ringbel, tone after CTRL G
006D4A 082D00020484      btst     #2,$484(A5)       Tone enabled ?
006D50 670E              beq      $6D60             No
006D52 2B7C00007D5A0A86  move.l   #$7D5A,$A86(A5)   Pointer to sound table for bell
006D5A 1B7C00000A8A      move.b   #$0,$A8A(A5)      Start sound timer
006D60 4E75              rts

***************************************************  Keyboard table, unshifted
006D62 001B313233343536  dc.b     $00,esc,'1','2','3','4','5','6'
006D6A 373839309E270809  dc.b     '7','8','9','0','@',''',bs ,tab
006D72 71776572747A7569  dc.b     'q','w','e','r','t','z','u','i'
006D7A 6F70812B0D006173  dc.b     'o','p','[','+',cr, $00,'a','s'
006D82 646667686A6B6C94  dc.b     'd','f','g','h','j','k','l','\'
006D8A 8423007E79786376  dc.b     ']','#',$00,'1','y','x','c','v'
006D92 626E6D2C2E2D0000  dc.b     'b','n','m',',','.','-',$00,$00
```

```
006D9A 0020000000000000     dc.b    $00,' ',$00,$00,$00,$00,$00,$00
006DA2 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006DAA 00002D0000002B00     dc.b    $00,$00,'-',$00,$00,$00,'+',$00
006DB2 0000007F00000000     dc.b    $00,$00,$00,del,$00,$00,$00,$00
006DBA 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006DC2 3C000028292F2A37     dc.b    '<',$00,$00,'8',')','/','*','7'
006DCA 3839343536313233     dc.b    '8','9','4','5','6','1','2','3'
006DD2 302E0D0000000000     dc.b    '0','.',cr, $00,$00,$00,$00,$00
006DDA 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00

*****************************************************    Keyboard table, shifted
006DE2 001B2122DD242526     dc.b    $00,esc,'!','"','1','$','%','&'
006DEA 2F28293D3F600809     dc.b    '/','(',')','=','?','1',bs, tab
006DF2 51574552545A5549     dc.b    'Q','W','E','R','T','Z','U','I'
006DFA 4F509A2A0D004153     dc.b    'O','P','[','*',cr, $00,'A','S'
006E02 444647484A5B4C99     dc.b    'D','F','G','H','J','K','L','\'
006E0A 8E5E007C59584356     dc.b    ']','^',$00,'1','Y','X','C','V'
006E12 424E4D3B3A5F0000     dc.b    'B','N','M',';',':','1',$00,$00
006E1A 0020000000000000     dc.b    $00,' ',$00,$00,$00,$00,$00,$00
006E22 0000000000000037     dc.b    $00,$00,$00,$00,$00,$00,$00,'7'
006E2A 38002D3400362B00     dc.b    '8',$00,'-','4',$00,'6','+',$00
006E32 3200307F00000000     dc.b    '2',$00,'0',del,$00,$00,$00,$00
006E3A 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006E42 3E000028292F2A37     dc.b    '>',$00,$00,'(',')','/','*','7'
006E4A 3839343536313233     dc.b    '8','9','4','5','6','1','2','3'
006E52 302E0D0000000000     dc.b    '0','.',cr ,$00,$00,$00,$00,$00
006E5A 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00

*****************************************************    Keybaord table, Caps Lock
006E62 001B313233343536     dc.b    $00,esc,'1','2','3','4','5','6'
006E6A 373839309E270809     dc.b    '7','8','9','0','@',''',bs, tab
006E72 51574552545A5549     dc.b    'Q','W','E','R','T','Z','U','I'
```

```
006E7A 4F509A2B0D004153    dc.b    'O','P','[','+',cr, $00,'A','S'
006E82 444647484A4B4C99    dc.b    'D','F','G','H','J','K','L','\'
006E8A 8E23007E59684356    dc.b    ']','#',$00,'1','Y','X','C','V'
006E92 424E4D2C2E2D0000    dc.b    'B','N','M',',','.','-',$00,$00
006E9A 0020000000000000    dc.b    $00,' ',$00,$00,$00,$00,$00,$00
006E9E 0000000000000000    dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006EA2 0000000000000000    dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006EAA 00002D0000002B00    dc.b    $00,$00,'-',$00,$00,$00,'+',$00
006EB2 0000007F00000000    dc.b    $00,$00,$00,del,$00,$00,$00,$00
006EBA 0000000000000000    dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006EC2 3C000028292F2A37    dc.b    '<',$00,$00,'(',')','/','*','7'
006ECA 3839343536313233    dc.b    '8','9','4','5','6','1','2','3'
006ED2 302E0D0000000000    dc.b    '0','.',cr ,$00,$00,$00,$00,$00
006EDA 0000000000000000    dc.b    $00,$00,$00,$00,$00,$00,$00,$00

*************************************************    initnfp, initialize MFP 68901
006EE2 41F9FFFFFA01        lea      $FFFFFA01,A0      Address of the MFP
006EE8 7000                moveq.l  #0,D0             Initialize registers with zero
006EEA 01C80000            movep.l  D0,0(A0)          gpip to iera
006EEE 01C80008            movep.l  D0,8(A0)          ierb to isrb
006EF2 01C80010            movep.l  D0,$10(A0)        isrb to vr
006EF6 117C00480016        move.b   #$48,22(A0)       MFP Non-autovektor # to $48, set S-bit
006EFC 3B7C11110A84        move.w   #$1111,$A84(A5)
006F02 3B7C00140442        move.w   #20,$442(A5)      Timer ms to 20 milliseconds
006F08 7002                moveq.l  #2,D0             Select timer C
006F0A 7250                moveq.l  #80,D1            /64 for 200 Hz
006F0C 343C00C0            move.w   #$C0,D2           192
006F10 6100017E            bsr      $7090             Initialize timer and interrupt vector
006F14 45F900007C5C        lea      $7C5C,A2          Timer C interrupt routine
006F1A 7005                moveq.l  #5,D0             Timer C interrupt number
006F1C 61000228            bsr      $7146             initint, install interrupt
006F20 7003                moveq.l  #3,D0             Select timer D
```

```
006F22 7201                 moveq.l #1,D1               /4 for 9600 Baud
006F24 7402                 moveq.l #2,D2               9600 baud
006F26 61000168             bsr     $7090               Initialize timer and interrupt vector
006F2A 203C00980101         move.l  #$980101,D0         $00, $98, $01, $01
006F30 01C80026             movep.l D0,$26(A0)          To scr, ucr, rsr, tsr
006F34 61000B3A             bsr     $7A70               DTR on
006F38 61000B2E             bsr     $7A68               RTS on
006F3C 41ED09D0             lea     $9D0(A5),A0         Pointer to iorec for RS232
006F40 43F90000705E         lea     $705E,A1            Start data for iorec
006F46 7021                 moveq.l #33,D0              34 bytes
006F48 610000EC             bsr     $7036               Copy into RAM
006F4C 41ED0A00             lea     $A00(A5),A0         Pointer to iorec MIDI
006F50 43F900007050         lea     $7050,A1            Start data for iorec
006F56 700D                 moveq.l #13,D0              14 bytes
006F58 610000DC             bsr     $7036               Copy into RAM
006F5C 203C0000759C         move.l  #$759C,D0           Keyboard and MIDI error vector
006F62 2B400A12             move.l  D0,$A12(A5)         Pointer to error routine keyboard
006F66 2B400A16             move.l  D0,$A16(A5)         Pointer to error routine MIDI
006F6A 2B7C000079C60A0E     move.l  #$79C6,$A0E(A5)     MIDI interrupt vector
006F72 2B7C000075580A2A     move.l  #$7558,$A2A(A5)
006F7A 2B7C000075680A2E     move.l  #$7568,$A2E(A5)
006F82 13FC0003FFFFFC04     move.b  #3,$FFFFFC04        MIDI-ACIA master reset
006F8A 13FC0095FFFFFC04     move.b  #$95,$FFFFFC04      /16, 8 bit, 1 stop bit, no parity
006F92 1B7C00070484         move.b  #7,$484(A5)         Key click, repeat und bell enable
006F98 2B7C00006A460A22     move.l  #$6A46,$A22(A5)     clockvec
006FA0 203C00007034         move.l  #$7034,D0           joyvec & statvec
006FA6 2B400A1A             move.l  D0,$A1A(A5)
006FAA 2B400A1E             move.l  D0,$A1E(A5)
006FAE 2B400A26             move.l  D0,$A26(A5)
006FB2 7000                 moveq.l #0,D0               Clear sound variables
006FB4 2B400A86             move.l  D0,$A86(A5)         Sound pointer
006FB8 1B400A8A             move.b  D0,$A8A(A5)         Delay timer
```

```
006FBC 1B400A8B          move.b  D0,$A8B(A5)      Temp value
006FC0 2B400A80          move.l  D0,$A80(A5)      Printer timeout
006FC4 6100FC6A          bsr     $6C30            Strobe to high
006FC8 1B7C000F0A7E      move.b  #$F,$A7E(A5)
006FCE 1B7C00020A7F      move.b  #2,$A7F(A5)
006FD4 41ED09F2          lea     $9F2(A5),A0      Pointer to iorec to keyboard
006FD8 43F900007042      lea     $7042,A1         Start data for iorec
006FDE 700D              moveq.l #13,D0           14 bytes
006FE0 6154              bsr     $7036            Copy into RAM
006FE2 61000C0E          bsr     $7BF2            Pointer to BIOS keyboard table
006FE6 13FC0003FFFFFC00  move.b  #3,$FFFFFC00     Reset keyboard ACIA
006FEE 13FC0096FFFFFC00  move.b  #$96,$FFFFFC00   /64, 8 bits, 1 top bit, no arity
006FF6 267C00007080      move.l  #$7080,A3        Pointer to MFP Interrupt vectors
006FFC 7203              moveq.l #3,D1            Initialize four vectors
006FFE 2401              move.l  D1,D2
007000 2001              move.l  D1,D0            Interrupt number
007002 06000009          add.b   #9,D0            Plus offset
007006 E582              asl.l   #2,D2
007008 24732000          move.l  0(A3,D2.w),A2    Get vector from table
00700C 61000138          bsr     $7146            initint, install interrupt
007010 51C9FFEC          dbra    D1,$6FFE         Next vector
007014 45ED752A          lea     $752A(A5),A2     MIDI and keyboard vector
007018 7006              moveq.l #6,D0            Vector number 6
00701A 6100012A          bsr     $7146            initint, install interrupt vector
00701E 45ED73C0          lea     $73C0(A5),A2     CTS interrupt routine
007022 7002              moveq.l #2,D0            Vector number 2
007024 61000120          bsr     $7146            initint, install interrupt
007028 247C0000703E      move.l  #$703E,A2        Pointer to init data for IKBD
00702E 7603              moveq.l #3,D3            4 bytes
007030 6100FCBE          bsr     $6CF0            Send string to IKBD
007034 4E75              rts
```

```
007036 10D9              move.b  (A1)+,(A0)+          Block move
007038 51C8FFFC          dbra    D0,$7036             Next byte
00703C 4E75              rts

***********************************************
00703E 8001121A          dc.b    $80,$01,$12,$1A      Reset keyboard, disable mouse und joystick

***********************************************       iorec for keyboard
007042 000008D0          dc.l    $8D0                 Keyboard buffer
007046 0080              dc.w    128                  Length of the keyboard buffer
007048 0000              dc.w    0                    Head index
00704A 0000              dc.w    0                    Tail index
00704C 0020              dc.w    32                   Low water mark, 1/4 buffer length
00704E 0060              dc.w    96                   High water mark, 3/4 buffer length

************************************************      iorec for MIDI
007050 00000950          dc.l    $950                 MIDI buffer
007054 0080              dc.w    128                  Length of the MIDI buffer
007056 0000              dc.w    0                    Head index
007058 0000              dc.w    0                    Tail index
00705A 0020              dc.w    32                   Low water mark, 1/4 buffer length
00705C 0060              dc.w    96                   High water mark, 3/4 buffer length

************************************************      iorec for RS232
00705E 000006D0          dc.l    $6D0                 RS232 input buffer
007062 0100              dc.w    256                  Length of the input buffer
007064 0000              dc.w    0                    Head index
007066 0000              dc.w    0                    Tail index
007068 0040              dc.w    64                   Low water mark, 1/4 buffer length
00706A 00C0              dc.w    192                  High water mark, 3/4 buffer length
00706C 000007D0          dc.l    $7D0                 RS232 output buffer
007070 0100              dc.w    256                  Length of the output buffer
```

```
007072 0000                dc.w    0              Head index
007074 0000                dc.w    0              Tail index
007076 0040                dc.w    64             Low water mark, 1/4 buffer length
007078 00C0                dc.w    192            High water mark, 3/4 buffer length
00707A 00                  dc.b    0              rsrbyte, receiver status
00707B 00                  dc.b    0              tsrbyte, transmitter status
00707C 00                  dc.b    0              rxoff,
00707D 00                  dc.b    0              txoff
00707E 01                  dc.b    1              rsmode, XON/XOFF mode
00707F 00                  dc.b    0              filler

***************************************************         Interrupt vectors for MFP
007080 00007426            dc.l   $7426           #9,  transmitter error
007084 00007374            dc.l   $7374           #10, transmitter interrupt
007088 00007408            dc.l   $7408           #11, receiver error
00708C 000072C0            dc.l   $72C0           #12, receiver interrupt

***************************************************         setimer, initialize timer in MFP
007090 48E7F8F0            movem.l D0-D4/A0-A3,-(A7)   Save registers
007094 207CFFFFFA01        move.l  #$FFFFFA01,A0       Address MFP
00709A 267C00007124        move.l  #$7124,A3
0070A0 247C00007128        move.l  #$7128,A2
0070A6 615A                bsr     $7102
0070A8 267C00007118        move.l  #$7118,A3
0070AE 247C00007128        move.l  #$7128,A2
0070B4 614C                bsr     $7102
0070B6 267C0000711C        move.l  #$711C,A3
0070BC 247C00007128        move.l  #$7128,A2
0070C2 613E                bsr     $7102
0070C4 267C00007120        move.l  #$7120,A3
0070CA 247C00007128        move.l  #$7128,A2
0070D0 6130                bsr     $7102
```

```
0070D2 267C0000712C          move.l  #$712C,A3
0070D8 247C00007130          move.l  #$7130,A2
0070DE 6122                  bsr     $7102
0070E0 C749                  exg     A3,A1
0070E2 47F900007134          lea     $7134,A3
0070E8 7600                  moveq.l #0,D3
0070EA 16330000              move.b  0(A3,D0.w),D3
0070EE 11823000              move.b  D2,0(A0,D3.w)      Write data in MFP
0070F2 B4303000              cmp.b   0(A0,D3.w),D2      And compare
0070F6 66F6                  bne     $70EE              Until match
0070F8 C749                  exg     A3,A1
0070FA 8313                  or.b    D1,(A3)
0070FC 4CDF0F1F              movem.l (A7)+,D0-D4/A0-A3  Restore registers
007100 4E75                  rts

007102 6106                  bsr     $710A
007104 1612                  move.b  (A2),D3
007106 C713                  and.b   D3,(A3)
007108 4E75                  rts

00710A 7600                  moveq.l #0,D3
00710C D6C0                  add.w   D0,A3
00710E 1613                  move.b  (A3),D3
007110 D688                  add.l   A0,D3
007112 2643                  move.l  D3,A3
007114 D4C0                  add.w   D0,A2
007116 4E75                  rts

*************************************************
007118 06060808              dc.b    6,6,8,8
00711C 0A0A0C0C              dc.b    10,10,12,12
```

```
007120 0E0E1010          dc.b     14,14,16,16
007124 12121414          dc.b     18,18,20,20

007128 DFFEDFEF          dc.b     $DF,$FE,$DF,$EF
00712C 181A1C1C          dc.b     $18,$1A,$1C,$1C
007130 00008FF8          dc.b     0,0,$8F,$F8
007134 1E202224          dc.b     $1E,$20,$22,$24

*************************************************   mfpint, set MFP interrupt vector
007138 302F0004          move.w   4(A7),D0           Interrupt number
00713C 246F0006          move.l   6(A7),A2           Interrupt vector
007140 02800000000F      and.l    #15,D0             Number 0-15, long word

**************************************************  initint, Set MFP interrupt vector
007146 48E7E0E0          movem.l  D0-D2/A0-A2,-(A7)  Save registers
00714A 6120              bsr      $716C              Disable interrupts
00714C 2400              move.l   D0,D2              Vector number
00714E E542              asl.w    #2,D2              As index for long word
007150 068200000100      add.l    #$100,D2           Plus base of the MFP vectors
007156 2242              move.l   D2,A1              Vector addres
007158 228A              move.l   A2,(A1)            Set new vector
00715A 614A              bsr      $71A6              Enable interrupts
00715C 4CDF0707          movem.l  (A7)+,D0-D2/A0-A2  Restore registers
007160 4E75              rts

**************************************************  disint, disable MFP interrupts
007162 302F0004          move.w   4(A7),D0           Get interrupt number
007166 02800000000F      and.l    #15,D0             Convert to long word index
00716C 48E7C0C0          movem.l  D0-D1/A0-A1,-(A7)  Save registers
007170 41F9FFFFFA01      lea      $FFFFFA01,A0       Address the MFP
007176 43E80012          lea      18(A0),A1          Address imra
00717A 614A              bsr      $71C6              Calculate bit number to clear
```

```
00717C 0391              bclr    D1,(A1)             And clear bit
00717E 43E80006          lea     6(A0),A1            Address iera
007182 6142              bsr     $71C6               Calculate bit number to clear
007184 0391              bclr    D1,(A1)             And clear bit
007186 43E8000A          lea     10(A0),A1           Address ipra
00718A 613A              bsr     $71C6               Calculate bit number to clear
00718C 0391              bclr    D1,(A1)             And clear bit
00718E 43E8000E          lea     14(A0),A1           Address isra
007192 6132              bsr     $71C6               Calculate bit number to clear
007194 0391              bclr    D1,(A1)             And clear bit
007196 4CDF0303          movem.l (A7)+,D0-D1/A0-A1   Restore registers
00719A 4E75              rts

**************************************************   jenabint, enable MFP interrupts
00719C 302F0004          move.w  4(A7),D0            Vector number
0071A0 02800000000F      and.l   #15,D0              In long word index
0071A6 48E7C0C0          movem.l D0-D1/A0-A1,-(A7)   Restore registers
0071AA 41F9FFFFFA01      lea     $FFFFFA01,A0        Address MFP
0071B0 43E80006          lea     6(A0),A1            Address iera
0071B4 6110              bsr     $71C6               Calculate bit number to set
0071B6 03D1              bset    D1,(A1)             And set bit
0071B8 43E80012          lea     18(A0),A1           Address imra
0071BC 6108              bsr     $71C6               Calculate bit number to set
0071BE 03D1              bset    D1,(A1)             And set bit
0071C0 4CDF0303          movem.l (A7)+,D0-D1/A0-A1   Restore registers
0071C4 4E75              rts

**************************************************   bselect, calculate bit and register number

0071C6 1200              move.b  D0,D1               Save interrupt number
0071C8 0C000008          cmp.b   #8,D0               Greater than 8 ?
0071CC 6D02              blt     $71D0               No
```

```
0071CE 5141               subq.w  #8,D1             Else subtract offset
0071D0 0C000008           cmp.b   #8,D0             Greater than 8 ?
0071D4 6C02               bge     $71D8             Yes
0071D6 5449               addq.w  #2,A1             Pointer from a to b register
0071D8 4E75               rts

**************************************************  rs232ptr
0071DA 41F9000009D0       lea     $9D0,A0           Pointer to RS232 iorec
0071E0 43F9FFFFFA01       lea     $FFFFFA01,A1      Pointer to MFP
0071E6 4E75               rts

**************************************************  rs232ibuf
0071E8 34280008           move.w  8(A0),D2          Tail index
0071EC 36280006           move.w  6(A0),D3          Head index
0071F0 B443               cmp.w   D3,D2             Head > tail ?
0071F2 6204               bhi     $71F8             No
0071F4 D4680004           add.w   4(A0),D2          Add buffer size
0071F8 9443               sub.w   D3,D2             Tail - head
0071FA 4E75               rts

**************************************************  rtschk
0071FC 082800010020       btst    #1,32(A0)         RTS/CTS mode ?
007202 6704               beq     $7208             No
007204 61000862           bsr     $7A68             rtson
007208 4E75               rts

**************************************************  rs232put, RS232 output
00720A 40E7               move.w  SR, -(A7)         Save status
00720C 007C0700           or.w    #$700,SR          IPL 7, disable interrupts
007210 61C8               bsr     $71DA             rs232ptr, get buffer pointer
007212 082800000020       btst    #0,32(A0)         XON/XOFF mode ?
007218 6706               beq     $7220             No
```

```
00721A 4A28001F          tst.b   31(A0)          XON active ?
00721E 6618              bne     $7238           Yes
007220 08290007002C      btst    #7,44(A1)       Is MFP still sending ?
007226 6710              beq     $7238           Yes
007228 34280014          move.w  20(A0),D2       Head index
00722C B4680016          cmp.w   22(A0),D2       Tail index
007230 6606              bne     $7238           Still characters in buffer?
007232 1341002E          move.b  D1,46(A1)       Pass byte to MFP
007236 601A              bra     $7252

007238 34280016          move.w  22(A0),D2       Tail index
00723C 610002E0          bsr     $751E           Test for wrap around
007240 B4680014          cmp.w   20(A0),D2       Compare with head index
007244 6716              beq     $725C           Same, buffer full
007246 2268000E          move.l  14(A0),A1       Get current buffer address
00724A 13812000          move.b  D1,0(A1,D2.w)   Write character in buffer
00724E 31420016          move.w  D2,22(A0)       Save new tail index
007252 61A8              bsr     $71FC           rtschk, set RTS ?
007254 46DF              move.w  (A7)+,SR        Restore status flag
007256 023C00FE          and.b   #254,SR         Clear carry flag
00725A 4E75              rts

00725C 619E              bsr     $71FC           rtschk, set RTS ?
00725E 46DF              move.w  (A7)+,SR        Restore status
007260 003C0001          or.b    #1,SR           Set carry flag, don't output char
007264 4E75              rts

**************************************************  rs232get, RS232 input
007266 40E7              move.w  SR, -(A7)       Save status
007268 007C0700          or.w    #$700,SR        IPL 7, disable interrupts
00726C 6100FF6C          bsr     $71DA           rs232ptr, get RS232 pointer
007270 32280006          move.w  6(A0),D1        Head index
```

```
007274 B2680008         cmp.w    8(A0),D1        Tail index
007278 671A             beq      $7294           No character in buffer ?
00727A 61000296         bsr      $7512           Test for wrap around
00727E 22680000         move.l   0(A0),A1        Get buffer address
007282 7000             moveq.l  #0,D0
007284 10311000         move.b   0(A1,D1.w),D0   Get character from buffer
007288 31410006         move.w   D1,6(A0)        Set new head index
00728C 46DF             move.w   (A7)+,SR        Restore status
00728E 023C00FE         and.b    #254,SR         Clear carry flag, OK
007292 6006             bra      $729A

007294 46DF             move.w   (A7)+,SR        Restore status
007296 003C0001         or.b     #1,SR           Set carry flag, no character there
00729A 082800000020     btst     #0,32(A0)       XON/XOFF mode ?
0072A0 671C             beq      $72BE           No
0072A2 4A28001E         tst.b    30(A0)          XON active?
0072A6 6716             beq      $72BE           No
0072A8 6100FF3E         bsr      $71E8           Get input biffer length used
0072AC B468000A         cmp.w    10(A0),D2       Equal low water mark ?
0072B0 660C             bne      $72BE           No
0072B2 123C0011         move.b   #$11,D1         XON
0072B6 6100FF52         bsr      $720A           Send
0072BA 4228001E         clr.b    30(A0)          Clear XON flag
0072BE 4E75             rts

**************************************************  rcvint, RS232 receiver interrupt routine
0072C0 48E7F0E0         movem.l D0-D3/A0-A2,-(A7)  Save registers
0072C4 6100FF14         bsr      $71DA           rs232ptr, get RS232 pointer
0072C8 1169002A001C     move.b   42(A1),28(A0)   Read receiver status register
0072CE 08280007001C     btst     #7,28(A0)       Interrupt through receiver buffer full ?
0072D4 67000092         beq      $7368           No
0072D8 082800010020     btst     #1,32(A0)       RTS/CTS mode ?
```

```
0072DE 6704             beq      $72E4          No
0072E0 61000782         bsr      $7A64          rtsoff
0072E4 1029002E         move.b   46(A1),D0      Read data from receiver register
0072E8 082800010020     btst     #1,32(A0)      RTS/CTS mode ?
0072EE 6624             bne      $7314          Yes
0072F0 082800000020     btst     #0,32(A0)      XON/XOFF mode ?
0072F6 671C             beq      $7314          No
0072F8 0C000011         cmp.b    #17,D0         XON received ?
0072FC 6608             bne      $7306          No
0072FE 117C0000001F     move.b   #$0,31(A0)     Clear XOFF flag
007304 6062             bra      $7368          Character not in buffer

007306 0C000013         cmp.b    #19,D0         Receive XOFF ?
00730A 6608             bne      $7314          No
00730C 117C00FF001F     move.b   #$FF,31(A0)    Set XOFF flag
007312 6054             bra      $7368          Character not in buffer

007314 32280008         move.w   8(A0),D1       Tail index
007318 610001F8         bsr      $7512          Test for wrap around
00731C B2680006         cmp.w    6(A0),D1       Head equal tail ?
007320 6746             beq      $7368          Yes
007322 24680000         move.l   0(A0),A2       Get buffer address
007326 15801000         move.b   D0,0(A2,D1.w)  Received byte in buffer
00732A 31410008         move.w   D1,8(A0)       Save new tail index
00732E 6100FEB8         bsr      $71E8          Get input buffer length used
007332 B468000C         cmp.w    12(A0),D2      Equal high water mark ?
007336 6624             bne      $735C          No
007338 082800010020     btst     #1,32(A0)      RTS/CTS mode ?
00733E 6628             bne      $7368          Yes
007340 082800000020     btst     #0,32(A0)      XON/XOFF mode ?
007346 6714             beq      $735C          No
007348 4A28001E         tst.b    30(A0)         XOFF already sent ?
```

```
00734C 660E            bne      $735C              Yes
00734E 117C00FF001E    move.b   #$FF,30(A0)        Set flag for XOFF
007354 123C0013        move.b   #$13,D1            XOFF
007358 6100FEB0        bsr      $720A              Send
00735C 082800010020    btst     #1,32(A0)          RTS/CTS mode ?
007362 6704            beq      $7368              No
007364 61000702        bsr      $7A68              rtson
007368 08A90004000E    bclr     #4,14(A1)          Clear interrupt service bit
00736E 4CDF070F        movem.l  (A7)+,D0-D3/A0-A2  Restore registers
007372 4E73            rte

***************************************************  txrint, tramsmitter buffer empty
007374 48E720E0        movem.l  D2/A0-A2,-(A7)     Save registers ?
007378 6100FE60        bsr      $71DA              rs232ptr, get RS232 pointer
00737C 082800010020    btst     #1,32(A0)          RTS/CTS mode ?
007382 6630            bne      $73B4              Yes, then use this interrupt
007384 082800000020    btst     #0,32(A0)          XON/XOFF mode ?
00738A 6706            beq      $7392              No
00738C 4A28001F        tst.b    31(A0)             XOFF active ?
007390 6622            bne      $73B4              Yes
007392 1169002C001D    move.b   44(A1),29(A0)      Save transmitter status register
007398 34280014        move.w   20(A0),D2          Head index
00739C B4680016        cmp.w    22(A0),D2          Compare with tail index
0073A0 6712            beq      $73B4              Send buffer empty
0073A2 6100017A        bsr      $751E              Test for wrap arround
0073A6 2468000E        move.l   14(A0),A2          Pointer to send buffer
0073AA 13722000002E    move.b   0(A2,D2.w),46(A1)  Pass byte to MFP for sending
0073B0 31420014        move.w   D2,20(A0)          Save new head index
0073B4 08A90002000E    bclr     #2,14(A1)          Clear interrupt service bit
0073BA 4CDF0704        movem.l  (A7)+,D2/A0-A2     Restore registers
0073BE 4E73            rte
```

```
****************************************************    ctsint, CTS interrupt routine
0073C0 48E720E0             movem.l D2/A0-A2,-(A7)      Save registers
0073C4 6100FE14             bsr     $71DA               rs232ptr, get RS232 pointer
0073C8 082800010020         btst    #1,32(A0)           RTS/CTS mode ?
0073CE 672A                 beq     $73FA               No, then ignore interrupt
0073D0 1169002C001D         move.b  44(A1),29(A0)       Save transmitter status
0073D6 08280007001D         btst    #7,29(A0)           Transmitter buffer empty ?
0073DC 67F8                 beq     $73D6               No, wait (must jump to $73D0!)
0073DE 34280014             move.w  20(A0),D2           Head index
0073E2 B4680016             cmp.w   22(A0),D2           Compare with tail index
0073E6 671E                 beq     $7406               Transmit buffer empty
0073E8 61000134             bsr     $751E               Test for wrap arround
0073EC 2468000E             move.l  14(A0),A2           Pointer to transmit buffer
0073F0 13722000002E         move.b  0(A2,D2.w),46(A1)   Pass byte to MFP for sending
0073F6 31420014             move.w  D2,20(A0)           Save new head index
0073FA 08A900020010         bclr    #2,16(A1)           Clear interrupt service bit
007400 4CDF0704             movem.l (A7)+,D2/A0-A2      Restore registers
007404 4E73                 rte

007406 60F2                 bra     $73FA               Transmit buffer empty

****************************************************    rxerror, receive error
007408 48E780C0             movem.l D0/A0-A1,-(A7)      Save registers
00740C 6100FDCC             bsr     $71DA               rs232ptr, get RS232 pointer
007410 1169002A001C         move.b  42(A1),28(A0)       Save receiver status
007416 1029002E             move.b  46(A1),D0           Read data register (clears status)
00741A 08A90003000E         bclr    #3,14(A1)           Clear interrupt service bit
007420 4CDF0301             movem.l (A7)+,D0/A0-A1      Restore registers
007424 4E73                 rte

****************************************************    txerror, transmit error
007426 48E700C0             movem.l A0-A1,-(A7)         Save registers
```

```
00742A 6100FDAE              bsr      $71DA              rs232ptr, get RS232 pointer
00742E 1169002C001D          move.b   44(A1),29(A0)      Save transmitter status
007434 08A90001000E          bclr     #1,14(A1)          Clear interrupt service bit
00743A 4CDF0300              movem.l  (A7)+/A0-A1        Restore registers
00743E 4E73                  rte

*************************************************        iorec, get pointer to table
007440 7200                  moveq.l  #0,D1
007442 322F0004              move.w   4(A7),D1           Get device number
007446 40E7                  move.w   SR, -(A7)          Save status
007448 007C0700              or.w     #$700,SR           IPL 7, disable interrupts
00744C 45F90000745C          lea      $745C,A2           Base address of the table
007452 E581                  asl.l    #2,D1              Times 4 for long word
007454 20321800              move.l   0(A2,D1.l),D0      Get pointer to iorec
007458 46DF                  move.w   (A7)+,SR           Restore status
00745A 4E75                  rts

*************************************************        iorec table
00745C 000009D0              dc.l     $9D0               RS232
007460 000009F2              dc.l     $9F2               IKBD
007464 00000A00              dc.l     $A00               MIDI

*************************************************        rsconf, configure RS232
007468 007C0700              or.w     #$700,SR           IPL 7, disable interrupts
00746C 6100FD6C              bsr      $71DA              rs232ptr, get RS232 pointer
007470 0F490028              movep.l  $28(A1),D7         Save ucr, rsr, tsr, scr
007474 7000                  moveq.l  #0,D0
007476 1340002A              move.b   D0,42(A1)          Disable receiver
00747A 1340002C              move.b   D0,44(A1)          Disable transmitter
00747E 4A6F0006              tst.w    6(A7)              Mode
007482 6B0A                  bmi      $748E              Negative, then don't set
007484 116F00070020          move.b   7(A7),32(A0)       Reset rsmode
```

```
00748A 7000               moveq.l #0,D0
00748C 7400               moveq.l #0,D2
00748E 4A6F0004           tst.w   4(A7)               Baud rate
007492 6B20               bmi     $74B4               Negativce, then don't change
007494 322F0004           move.w  4(A7),D1            Get baud rate number
007498 45F9000074F2       lea     $74F2,A2            Table for baud rate control
00749E 10321000           move.b  0(A2,D1.w),D0       Get value from table
0074A2 45F900007502       lea     $7502,A2            Table for baud rate data
0074A8 14321000           move.b  0(A2,D1.w),D2       Get value from table
0074AC 2200               move.l  D0,D1
0074AE 7003               moveq.l #3,D0               Pointer to timer D
0074B0 6100FBDE           bsr     $7090               Set timer D for new baud rate
0074B4 4A6F0008           tst.w   8(A7)               Set ucr ?
0074B8 6B06               bmi     $74C0               No
0074BA 136F00090028       move.b  9(A7),40(A1)        Set ucr
0074C0 4A6F000A           tst.w   10(A7)              Set rsr ?
0074C4 6B06               bmi     $74CC               No
0074C6 136F000B002A       move.b  11(A7),42(A1)       Set rsr
0074CC 4A6F000C           tst.w   12(A7)              Set tsr ?
0074D0 6B06               bmi     $74D8               No
0074D2 136F000D002C       move.b  13(A7),44(A1)       Set tsr
0074D8 4A6F000E           tst.w   14(A7)              Set scr ?
0074DC 6B06               bmi     $74E4               No
0074DE 136F000F0026       move.b  15(A7),38(A1)       Set scr
0074E4 7001               moveq.l #1,D0
0074E6 1340002A           move.b  D0,42(A1)           Enable receiver
0074EA 1340002C           move.b  D0,44(A1)           Enable transmitter
0074EE 2007               move.l  D7,D0               Old value of the control register
0074F0 4E75               rts

*************************************************     Timer values for RS-232 baud rates
0074F2 0101010101010101   dc.b    1,1,1,1,1,1,1       High byte
```

```
0074FA 0101010101010202     dc.b     1,1,1,1,1,2,2
007502 01020405080A0B10     dc.b     1,2,4,5,8,10,11,16     Low byte
00750B 204060808FAF4060     dc.b     32,64,96,128,143,175,64,96

**********************************************     wrapin, test for wrap arround
007512 5241                 addq.w   #1,D1             Head index + 1
007514 B2680004             cmp.w    4(A0),D1          Equal to buffer size ?
007518 6502                 bcs      $751C             No
00751A 7200                 moveq.l  #0,D1             Else start with zero again
00751C 4E75                 rts

**********************************************     wrapout, test for wrap arround
00751E 5242                 addq.w   #1,D2             Tail index + 1
007520 B4680012             cmp.w    18(A0),D2         Equals buffer size ?
007524 6502                 bcs      $7528             No
007526 7400                 moveq.l  #0,D2             Else start with zero again
007528 4E75                 rts

**********************************************     midikey, keyboard + MIDI interrupt
00752A 48E7FFFE             movem.l  D0-D7/A0-A6,-(A7) Save registers
00752E 4BF900000000         lea      $0,A5             Clear A5
007534 246D0A2A             move.l   $A2A(A5),A2       mbufrec, $7558
007538 4E92                 jsr      (A2)              Interrupt from MIDI-ACIA ?
00753A 246D0A2E             move.l   $A2E(A5),A2       kbufrec, $7568
00753E 4E92                 jsr      (A2)              Interrupt vfromon Keyboard-ACIA ?
007540 08390004FFFFFA01     btst     #4,$FFFFFA01      Still interrupt ?
007548 67EA                 beq      $7534             Yes
00754A 08B90006FFFFFA11     bclr     #6,$FFFFFA11      Clear interrupt service bit
007552 4CDF7FFF             movem.l  (A7)+,D0-D7/A0-A6 Restore registers
007556 4E73                 rte
```

```
**************************************************      MIDI interrupt
007558 41ED0A00             lea      $A00(A5),A0        iorec for MIDI
00755C 43F9FFFFFC04         lea      $FFFFFC04,A1       Address of the MIDI ACIA
007562 246D0A16             move.l   $A16(A5),A2        $759C, MIDI error routine
007566 600E                 bra      $7576

**************************************************      Keyboard interrupt
007568 41ED09F2             lea      $9F2(A5),A0        iorec for keyboard
00756C 43F9FFFFFC00         lea      $FFFFFC00,A1       Address of the keyboard-ACIA
007572 246D0A12             move.l   $A12(A5),A2        $759C, Keyboard error routine
007576 14290000             move.b   0(A1),D2           Get ACIA status
00757A 08020007             btst     #7,D2              Interrupt request ?
00757E 671C                 beq      $759C              No
007580 08020000             btst     #0,D2              Receiver buffer full ?
007584 670A                 beq      $7590              No
007586 48E720E0             movem.l  D2/A0-A2,-(A7)     Save registers
00758A 6112                 bsr      $759E              arcvint, get byte
00758C 4CDF0704             movem.l  (A7)+,D2/A0-A2     Restore registers
007590 02020020             and.b    #$20,D2            Mark bit tested
007594 6706                 beq      $759C              No error
007596 10290002             move.b   2(A1),D0           Read data clear status
00759A 4ED2                 jmp      (A2)               Execute error routine
00759C 4E75                 rts

***********************************************         arcvint, get byte from ACIA
00759E 10290002             move.b   2(A1),D0           Get data from ACIA
0075A2 B1FC000009F2         cmp.l    #$9F2,A0           Keyboard ACIA ?
0075A8 66000416             bne      $79C0              No, MIDI
0075AC 4A2D0A32             tst.b    $A32(A5)           Keyboard state
0075B0 6654                 bne      $7606
0075B2 0C0000F6             cmp.b    #$F6,D0            Keypress ?
0075B6 650000F4             bcs      $76AC              Yes
```

```
0075BA 040000F6             sub.b    #$F6,D0              Subtract offset
0075BE 0280000000FF         and.l    #$FF,D0
0075C4 47F9000075F2         lea      $75F2,A3             Pointer to IKBD code table
0075CA 1B7300000A32         move.b   0(A3,D0.w),$A32(A5)  Save IKBD merken
0075D0 47F9000075FC         lea      $75FC,A3             Pointer to IKBD lengths table
0075D6 1B7300000A33         move.b   0(A3,D0.w),$A33(A5)  IKBD index
0075DC 064000F6             add.w    #$F6,D0              Add offset again
0075E0 0C0000F8             cmp.b    #$F8,D0              Mouse position record ?
0075E4 6D0A                 blt      $75F0                No
0075E6 0C0000FB             cmp.b    #$FB,D0              Mouse position record ?
0075EA 6E04                 bgt      $75F0                No
0075EC 1B400A40             move.b   D0,$A40(A5)          Save mouse position
0075F0 4E75                 rts

****************************************************      IKBD parameter
0075F2 01020303030304050607                               Status codes
0075FC 07050202020206020101                               Lengths

****************************************************
007606 0C2D00060A32         cmp.b    #6,$A32(A5)          Joystick record ?
00760C 64000084             bcc      $7692                Yes
007610 45F900007656         lea      $7656,A2             Pointer to IKBD parameter table
007616 7400                 moveq.l  #0,D2
007618 142D0A32             move.b   $A32(A5),D2          Kstate
00761C 5302                 subq.b   #1,D2                1 - 5 => 0 - 4
00761E E342                 asl.w    #1,D2                Times 2
007620 D42D0A32             add.b    $A32(A5),D2          + 1
007624 5302                 subq.b   #1,D2                1 - 5 => 0 - 4
007626 E542                 asl.w    #2,D2                Times 4
007628 20722000             move.l   0(A2,D2.w),A0        IKBD record pointer
00762C 22722004             move.l   4(A2,D2.w),A1        IKBD index base
007630 24722008             move.l   8(A2,D2.w),A2        IKBD interrupt routine
```

```
007634 2452          move.l  (A2),A2          Get interrupt vector
007636 7400          moveq.l #0,D2
007638 142D0A33      move.b  $A33(A5),D2      Get IKBD index
00763C 93C2          sub.l   D2,A1            Minus base
00763E 1280          move.b  D0,(A1)
007640 532D0A33      subq.b  #1,$A33(A5)      IKBD index minus 1
007644 4A2D0A33      tst.b   $A33(A5)         Test index
007648 660A          bne     $7654
00764A 2F08          move.l  A0,-(A7)         Pass record pointer
00764C 4E92          jsr     (A2)             Execute interrupt routine
00764E 584F          addq.w  #4,A7            Correct stack pointer
007650 422D0A32      clr.b   $A32(A5)         Clear IKBD state
007654 4E75          rts

***********************************************  Parameter table for IKBD
007656 00000A34      dc.l    $A34
00765A 00000A3B      dc.l    $A3B
00765E 00000A1A      dc.l    $A1A
007662 00000A3B      dc.l    $A3B
007666 00000A40      dc.l    $A40
00766A 00000A1E      dc.l    $A1E
00766E 00000A40      dc.l    $A40
007672 00000A43      dc.l    $A43
007676 00000A1E      dc.l    $A1E
00767A 00000A43      dc.l    $A43
00767E 00000A49      dc.l    $A49
007682 00000A22      dc.l    $A22
007686 00000A49      dc.l    $A49
00768A 00000A4B      dc.l    $A4B
00768E 00000A26      dc.l    $A26

*************************************************
```

```
007692 223C00000A4A         move.l  #$A4A,D1
007698 D22D0A32             add.b   $A32(A5),D1
00769C 5D01                 subq.b  #6,D1
00769E 2441                 move.l  D1,A2
0076A0 1480                 move.b  D0,(A2)
0076A2 246D0A26             move.l  $A26(A5),A2     Joystick interrupt routine
0076A6 41ED0A49             lea     $A49(A5),A0     Address of joystick data
0076AA 609E                 bra     $764A

**************************************************  Process received keyboard codes
0076AC 122D0A5D             move.b  $A5D(A5),D1     Load shift status
0076B0 0C00002A             cmp.b   #$2A,D0         Left shift key pressed ?
0076B4 6606                 bne     $76BC           No
0076B6 08C10001             bset    #1,D1           Set bit for left shift key
0076BA 6074                 bra     $7730
0076BC 0C0000AA             cmp.b   #$AA,D0         Left shift key released ?
0076C0 6606                 bne     $76C8           No
0076C2 08810001             bclr    #1,D1           Clear bit for left shift key
0076C6 6068                 bra     $7730
0076C8 0C000036             cmp.b   #$36,D0         Right shift key pressed ?
0076CC 6606                 bne     $76D4           No
0076CE 08C10000             bset    #0,D1           Set bit for right shift key
0076D2 605C                 bra     $7730
0076D4 0C0000B6             cmp.b   #$B6,D0         Right shift key released ?
0076D8 6606                 bne     $76E0           No
0076DA 08810000             bclr    #0,D1           Clear bit for right shift key
0076DE 6050                 bra     $7730
0076E0 0C00001D             cmp.b   #$1D,D0         CTRL key pressed ?
0076E4 6606                 bne     $76EC           No
0076E6 08C10002             bset    #2,D1           Set bit for CTRL key
0076EA 6044                 bra     $7730
0076EC 0C00009D             cmp.b   #$9D,D0         CTRL key released ?
```

```
0076F0 6606              bne     $76F8               No
0076F2 08810002          bclr    #2,D1               Clear bit for CTRL key
0076F6 6038              bra     $7730
0076F8 0C000038          cmp.b   #$38,D0             ALT key pressed ?
0076FC 6606              bne     $7704               No
0076FE 08C10003          bset    #3,D1               Set bit for ALT key
007702 602C              bra     $7730
007704 0C0000B8          cmp.b   #$B8,D0             ALT key released ?
007708 6606              bne     $7710               No
00770A 08810003          bclr    #3,D1               Clear bit for ALT key
00770E 6020              bra     $7730
007710 0C00003A          cmp.b   #$3A,D0             CAPS LOCK key pressed ?
007714 6620              bne     $7736               No
007716 082D00000484      btst    #0,$484(A5)         Get console configuration
00771C 670E              beq     $772C               No key click
00771E 2B7C00007D780A86  move.l  #$7D78,$A86(A5)     Addrss of the key click sound table
007726 1B7C00000A8A      move.b  #$0,$A8A(A5)        Start sound
00772C 08410004          bchg    #4,D1               Invert CAPS LOCK status
007730 1B410A5D          move.b  D1,$A5D(A5)         Save new shift status
007734 4E75              rts

007736 08000007          btst    #7,D0               Was key released ?
00773A 662A              bne     $7766               Yes
00773C 4A2D0A7B          tst.b   $A7B(A5)            Repeat ?
007740 6616              bne     $7758               Yes
007742 1B400A7B          move.b  D0,$A7B(A5)         Save key code for repeat
007746 1B7900000A7E0A7C  move.b  $A7E,$A7C(A5)       Delay 1
00774E 1B7900000A7F0A7D  move.b  $A7F,$A7D(A5)       Delay 2
007756 603A              bra     $7792
007758 1B7C00000A7C      move.b  #$0,$A7C(A5)        Clear delay counter
00775E 1B7C00000A7D      move.b  #$0,$A7D(A5)        Clear delay counter
```

```
007764 602C              bra      $7792
007766 4A2D0A7B          tst.b    $A7B(A5)
00776A 670E              beq      $777A
00776C 7200              moveq.l  #0,D1
00776E 1B410A7B          move.b   D1,$A7B(A5)
007772 1B410A7C          move.b   D1,$A7C(A5)
007776 1B410A7D          move.b   D1,$A7D(A5)
00777A 0C0000C7          cmp.b    #$C7,D0              HOME key released ?
00777E 6708              beq      $7788                Yes
007780 0C0000D2          cmp.b    #$D2,D0              INSERT key released ?
007784 66000238          bne      $79BE                No
007788 082D00030A5D      btst     #3,$A5D(A5)          ALTkey still pressed ?
00778E 6700022E          beq      $79BE                No
007792 082D00000484      btst     #0,$484(A5)          Console status
007798 670E              beq      $77A8                No key click
00779A 2B7C00007D780A86  move.l   #$7D78,$A86(A5)      Address of the sound table for key click
0077A2 1B7C00000A8A      move.b   #$0,$A8A(A5)         Start sound
0077A8 2F08              move.l   A0,-(A7)             Save iorec for keybaord
0077AA 7200              moveq.l  #0,D1
0077AC 1200              move.b   D0,D1                Scan code to D1
0077AE 206D0A5E          move.l   $A5E(A5),A0          Address of the standard keyboard table
0077B2 0240007F          and.w    #$7F,D0
0077B6 082D00040A5D      btst     #4,$A5D(A5)          CAPS LOCK active ?
0077BC 6704              beq      $77C2                No
0077BE 206D0A66          move.l   $A66(A5),A0          Address of the CAPS LOCK keyboard table
0077C2 082D00000A5D      btst     #0,$A5D(A5)          Right shift key pressed ?
0077C8 6608              bne      $77D2                Yes
0077CA 082D00010A5D      btst     #1,$A5D(A5)          Left shift key pressed ?
0077D0 671A              beq      $77EC                No
```

```
0077D2 0C00003B         cmp.b   #59,D0          Function key ?
0077D6 6510             bcs     $77E8           No
0077D8 0C000044         cmp.b   #68,D0          Function key ?
0077DC 620A             bhi     $77E8           No
0077DE 06410019         add.w   #25,D1          Add offset to GSX standard
0077E2 7000             moveq.l #0,D0
0077E4 600001B2         bra     $7998
0077E8 206D0A62         move.l  $A62(A5),A0     Address of the shift keyboard table
0077EC 10300000         move.b  0(A0,D0.w),D0   Get ASCII code from the table
0077F0 082D00020A5D     btst    #2,$A5D(A5)     CTRL key pressed ?
0077F6 6760             beq     $7858           No
0077F8 0C00000D         cmp.b   #13,D0          Carriage return
0077FC 6604             bne     $7802           No
0077FE 700A             moveq.l #10,D0          Convert to linefeed
007800 672A             beq     $782C
007802 0C010047         cmp.b   #$47,D1         CTRL HOME ?
007806 6608             bne     $7810           No
007808 06410030         add.w   #$30,D1         Add $30 to GSX standard
00780C 6000018A         bra     $7998
007810 0C01004B         cmp.b   #$4B,D1         CTRL cursor left ?
007814 6608             bne     $781E
007816 7273             moveq.l #$73,D1         Convert to GSX standard
007818 7000             moveq.l #0,D0
00781A 6000017C         bra     $7998
00781E 0C01004D         cmp.b   #$4D,D1         CTRL cursor right ?
007822 6608             bne     $782C
007824 7274             moveq.l #$74,D1         Convert to GSX standard
007826 7000             moveq.l #0,D0
007828 6000016E         bra     $7998
00782C 0C000032         cmp.b   #$32,D0
007830 6606             bne     $7838
007832 7000             moveq.l #0,D0
```

```
007834 60000162          bra      $7998
007838 0C000036          cmp.b    #$36,D0
00783C 6606              bne      $7844
00783E 701E              moveq.l  #$1E,D0
007840 60000156          bra      $7998
007844 0C00002D          cmp.b    #$2D,D0
007848 6606              bne      $7850
00784A 701F              moveq.l  #$1F,D0
00784C 6000014A          bra      $7998
007850 0240001F          and.w    #$1F,D0
007854 60000142          bra      $7998
007858 082D00030A5D      btst     #3,$A5D(A5)        ALT key pressed ?
00785E 67000138          beq      $7998              No
007862 0C01001A          cmp.b    #$1A,D1            'Ü' ?
007866 6618              bne      $7880              No
007868 103C0040          move.b   #$40,D0            '@'
00786C 142D0A5D          move.b   $A5D(A5),D2        Shift status
007870 02020003          and.b    #3,D2              Left and/or right shift key pressed?
007874 67000122          beq      $7998              No
007878 103C005C          move.b   #$5C,D0            '\'
00787C 6000011A          bra      $7998
007880 0C010027          cmp.b    #$27,D1            'Ö' ?
007884 6618              bne      $789E              No
007886 103C005B          move.b   #$5B,D0            '['
00788A 142D0A5D          move.b   $A5D(A5),D2        Shift status
00788E 02020003          and.b    #3,D2              Left and/or right shift key pressed?
007892 67000104          beq      $7998              No
007896 103C007B          move.b   #$7B,D0            '{'
00789A 600000FC          bra      $7998
00789E 0C010028          cmp.b    #$28,D1            'Ä' ?
0078A2 6618              bne      $78BC
0078A4 103C005D          move.b   #$5D,D0            ''
```

```
0078A8 142D0A5D          move.b  $A5D(A5),D2        Shift status
0078AC 02020003          and.b   #3,D2              Left and/or right shift key pressed?
0078B0 670000E6          beq     $7998              No
0078B4 103C007D          move.b  #$7D,D0            '}'
0078B8 600000DE          bra     $7998
0078BC 0C010062          cmp.b   #$62,D1            ATL HELP ?
0078C0 660A              bne     $78CC              No
0078C2 526D04EE          addq.w  #1,$4EE(A5)        Set dumpflg for hardcopy
0078C6 205F              move.l  (A7)+,A0           Restore keyboard iorec
0078C8 600000F4          bra     $79BE              Done

0078CC 45F900007A2C      lea     $7A2C,A2           Pointer to mouse scancode table
0078D2 7403              moveq.l #3,D2              Test 4 values
0078D4 B2322000          cmp.b   0(A2,D2.w),D1      Value found ?
0078D8 6700010E          beq     $79E8              Yes
0078DC 51CAFFF6          dbra    D2,$78D4           Next value
0078E0 0C010048          cmp.b   #$48,D1            Cursor up ?
0078E4 661C              bne     $7902              No
0078E6 123C0000          move.b  #0,D1              X offset for cursor up
0078EA 143CFFF8          move.b  #-8,D2             Y offset for cursor up
0078EE 102D0A5D          move.b  $A5D(A5),D0        Get shift status
0078F2 02000003          and.b   #3,D0              Left and/or right shift key pressed?
0078F6 6700010E          beq     $7A06              No
0078FA 143CFFFF          move.b  #-1,D2             Only one pixel up with shift
0078FE 60000106          bra     $7A06
007902 0C01004B          cmp.b   #$4B,D1            Cursor left ?
007906 661C              bne     $7924              No
007908 143C0000          move.b  #0,D2              Y offset for cursor left
00790C 123CFFF8          move.b  #-8,D1             X offset for cursor left
007910 102D0A5D          move.b  $A5D(A5),D0        Get shift status
007914 02000003          and.b   #3,D0              Left and/or right shift key pressed?
007918 670000EC          beq     $7A06              No
```

```
00791C 123CFFFF     move.b  #$-1,D1        Only one pixels left with shift
007920 600000E4     bra     $7A06
007924 0C01004D     cmp.b   #$4D,D1        Cursor right ?
007928 661C         bne     $7946          No
00792A 123C0008     move.b  #8,D1          X offset for cursor right
00792E 143C0000     move.b  #0,D2          Y offset for cursor right
007932 102D0A5D     move.b  $A5D(A5),D0    Shift status
007936 02000003     and.b   #3,D0          Left and/or right shift key pressed?
00793A 670000CA     beq     $7A06          No
00793E 123C0001     move.b  #1,D1          Only one pixel right with shift
007942 600000C2     bra     $7A06
007946 0C010050     cmp.b   #$50,D1        Cursor down ?
00794A 661C         bne     $7968          No
00794C 123C0000     move.b  #0,D1          X offset for cursor down
007950 143C0008     move.b  #8,D2          Y offset for cursor down
007954 102D0A5D     move.b  $A5D(A5),D0    Shift status
007958 02000003     and.b   #3,D0          Left and/or right shift key pressed?
00795C 670000A8     beq     $7A06          No
007960 143C0001     move.b  #1,D2          Only one pixel down with shift
007964 600000A0     bra     $7A06
007968 0C010002     cmp.b   #2,D1          '1'
00796C 650C         bcs     $797A          Not greater or equal
00796E 0C01000D     cmp.b   #$D,D1         '='
007972 6206         bhi     $797A          Not less or equal
007974 06010076     add.b   #$76,D1
007978 600C         bra     $7986
00797A 0C000041     cmp.b   #$41,D0        'A'
00797E 650A         bcs     $798A
007980 0C00005A     cmp.b   #$5A,D0        'Z'
007984 6204         bhi     $798A
007986 7000         moveq.l #0,D0
007988 600E         bra     $7998
```

```
00798A 0C000061         cmp.b   #$61,D0          'a'
00798E 6508             bcs     $7998
007990 0C00007A         cmp.b   #$7A,D0          'z'
007994 6202             bhi     $7998
007996 60EE             bra     $7986
007998 E141             asl.w   #8,D1            Scancode to bits 8-15
00799A D041             add.w   D1,D0            ASCII code to bits 0-7
00799C 205F             move.l  (A7)+,A0         Get iorec pointer
00799E 32280008         move.w  8(A0),D1         Tail index
0079A2 5441             addq.w  #2,D1            Plus 2
0079A4 B2680004         cmp.w   4(A0),D1         End of buffer reached ?
0079A8 6502             bcs     $79AC            No
0079AA 7200             moveq.l #0,D1            Buffer pointer back to buffer start
0079AC B2680006         cmp.w   6(A0),D1         Head equal tail ?
0079B0 670C             beq     $79BE            Yes, buffer full
0079B2 24680000         move.l  0(A0),A2         Buffer address
0079B6 35801000         move.w  D0,0(A2,D1.w)    Write data in buffer
0079BA 31410008         move.w  D1,8(A0)         New tail index
0079BE 4E75             rts

*************************************************   midibyte
0079C0 246D0A0E         move.l  $A0E(A5),A2      Pointer to MIDI interrupt handler
0079C4 4ED2             jmp     (A2)             Execute routine

*************************************************   sysmidi
0079C6 32280008         move.w  8(A0),D1         Tail index
0079CA 5241             addq.w  #1,D1            Increment
0079CC B2680004         cmp.w   4(A0),D1         End of buffer reached ?
0079D0 6502             bcs     $79D4            No
0079D2 7200             moveq.l #0,D1            Buffer pointer back to start
0079D4 B2680006         cmp.w   6(A0),D1         Head equal tail ?
0079D8 670C             beq     $79E6            Yes, buffer full
```

```
0079DA 24680000        move.l  0(A0),A2          Buffer address
0079DE 15801000        move.b  D0,0(A2,D1.w)     Write received byte in buffer
0079E2 31410008        move.w  D1,8(A0)          New tail index
0079E6 4E75            rts

*************************************************** keymausl
0079E8 7605            moveq.l #5,D3             Accept right button
0079EA 08010004        btst    #4,D1
0079EE 6702            beq     $79F2             is right button ($47/$C7)
0079F0 7606            moveq.l #6,D3             left button
0079F2 08010007        btst    #7,D1             Pressed or released ?
0079F6 6706            beq     $79FE             Pressed
0079F8 07AD0A5D        bclr    D3,$A5D(A5)       Clear bit for key
0079FC 6004            bra     $7A02
0079FE 07ED0A5D        bset    D3,$A5D(A5)       Set bit for key
007A02 7200            moveq.l #0,D1
007A04 7400            moveq.l #0,D2

*************************************************** keymaus
007A06 41ED0A5A        lea     $A5A(A5),A0       Pointer to mouse-emulator buffer
007A0A 246D0A1E        move.l  $A1E(A5),A2       Mouse interrupt vector
007A0E 4280            clr.l   D0
007A10 102D0A5D        move.b  $A5D(A5),D0       Get status of the "mouse" buttons
007A14 EA08            lsr.b   #5,D0             Bit for right button to bit 0
007A16 060000F8        add.b   #$F8,D0           Plus relative mouse header
007A1A 11400000        move.b  D0,0(A0)          Byte in buffer
007A1E 11410001        move.b  D1,1(A0)          Store X value
007A22 11420002        move.b  D2,2(A0)          Store Y value
007A26 4E92            jsr     (A2)              Call mouse interrupt routine
007A28 205F            move.l  (A7)+,A0          Restore iorec for keyboard
007A2A 4E75            rts
```

```
****************************************************     muskey1
007A2C 47C7            dc.b    $47,$C7,$52,$D2           Scan code mouse substitute

****************************************************     giaccess, read/write sound chip
007A30 302F0004        move.w  4(A7),D0                  Data
007A38 40E7            move.w  SR, -(A7)                 Save status
007A3A 007C0700        or.w    #$700,SR                  IPL 7, disable interrupts
007A3E 48E76080        movem.l D1-D2/A0,-(A7)            Save registers
007A42 41F9FFFF8800    lea     $FFFF8800,A0              Address of the sound chip
007A48 1401            move.b  D1,D2                     Get register number
007A4A 0201000F        and.b   #15,D1                    Registers 0-15
007A4E 1081            move.b  D1,(A0)                   Select register
007A50 E302            asl.b   #1,D2                     Test read/write bit
007A52 6404            bcc     $7A58                     Read
007A54 11400002        move.b  D0,2(A0)                  Write data byte in sound chip register
007A58 7000            moveq.l #0,D0
007A5A 1010            move.b  (A0),D0                   Read byte from sound chip register
007A5C 4CDF0106        movem.l (A7)+,D1-D2/A0            Restore registers
007A60 46DF            move.w  (A7)+,SR                  Restore status
007A62 4E75            rts

****************************************************     rts off, disable RTS
007A64 7408            moveq.l #8,D2
007A66 6012            bra     $7A7A                     Set bit in port A

****************************************************     rts on, enable RTS
007A68 74F7            moveq.l #$F7,D2
007A6A 6034            bra     $7AA0                     Clear bit in port A

****************************************************     dtr off, disable DTR
007A6C 7410            moveq.l #16,D2
007A6E 600A            bra     $7A7A                     Set bit in port A
```

```
****************************************************    dtroff, enable DTR
007A70 74EF             moveq.l #-17,D2
007A72 602C             bra     $7AA0                   Clear bit in port A

****************************************************    ongibit, set bit in sound chip port A
007A74 7400             moveq.l #0,D2
007A76 342F0004         move.w  4(A7),D2                Get bit pattern
007A7A 48E7E000         movem.l D0-D2,-(A7)             Save registers
007A7E 40E7             move.w  SR, -(A7)               Save status
007A80 007C0700         or.w    #$700,SR                IPL 7, disable interrupts
007A84 720E             moveq.l #14,D1                  Port A
007A86 2F02             move.l  D2,-(A7)                Save bit number
007A88 61AE             bsr     $7A38                   Select port A
007A8A 241F             move.l  (A7)+,D2                Bit number back
007A8C 8002             or.b    D2,D0                   Set bit(s)
007A8E 728E             moveq.l #$8E,D1                 Write to port A
007A90 61A6             bsr     $7A38                   Write new value
007A92 46DF             move.w  (A7)+,SR                Restore status
007A94 4CDF0007         movem.l (A7)+,D0-D2             Restore registers
007A98 4E75             rts

****************************************************    offgibit, clear bit in sound chip port A
007A9A 7400             moveq.l #0,D2
007A9C 342F0004         move.w  4(A7),D2                Get bit pattern
007AA0 48E7E000         movem.l D0-D2,-(A7)             Save registers
007AA4 40E7             move.w  SR, -(A7)               Save status
007AA6 007C0700         or.w    #$700,SR                IPL 7, disable interrupts
007AAA 720E             moveq.l #14,D1                  Port A
007AAC 2F02             move.l  D2,-(A7)                Save bit pattern
007AAE 6188             bsr     $7A38                   Select port A
007AB0 241F             move.l  (A7)+,D2                Restore bit pattern
```

```
007AB2 C002                  and.b   D2,D0              Clear bit(s)
007AB4 728E                  moveq.l #$8E,D1            Write to port A
007AB6 6180                  bsr     $7A38              Write new value
007AB8 46DF                  move.w  (A7)+,SR           Restore status
007ABA 4CDF0007              movem.l (A7)+,D0-D2        Restore registers
007ABE 4E75                  rts

***************************************************     initmouse
007AC0 4A6F0004              tst.w   4(A7)              Disable mouse ?
007AC4 6726                  beq     $7AEC              Yes disable mouse
007AC6 2B6F000A0A1E          move.l  10(A7),$A1E(A5)    Mouse interrupt vector
007ACC 266F0006              move.l  6(A7),A3           Address of the paramater block
007AD0 0C6F00010004          cmp.w   #1,4(A7)           Relative mouse ?
007AD6 6724                  beq     $7AFC              Yes
007AD8 0C6F00020004          cmp.w   #2,4(A7)           Absolute mouse ?
007ADE 6736                  beq     $7B16              Yes
007AE0 0C6F00040004          cmp.w   #4,4(A7)           Keycode mouse ?
007AE6 6770                  beq     $7B58              Yes
007AE8 7000                  moveq.l #0,D0              Error, invalid
007AEA 4E75                  rts

***************************************************     Disable mouse
007AEC 7212                  moveq.l #$12,D1            Disable mouse command
007AEE 6100F1E0              bsr     $6CD0              Send to IKBD
007AF2 2B7C00007BC00A1E      move.l  #$7BC0,$A1E(A5)    Mouse interrupt vector to RTS
007AFA 6070                  bra     $7B6C

***************************************************     Relative mouse
007AFC 45ED0A6A              lea     $A6A(A5),A2        Transfer buffer pointer
007B00 14FC0008              move.b  #$8,(A2)+          Relative mouse
007B04 14FC000B              move.b  #$B,(A2)+          Relative mouse threshold x, y
007B08 6166                  bsr     $7B70              Set mouse paramaters
```

```
007B0A 7606             moveq.l #6,D3           Length of the strings - 1
007B0C 45ED0A6A         lea     $A6A(A5),A2     Transfer buffer pointer
007B10 6100F1DE         bsr     $6CF0           Send string to IKBD
007B14 6056             bra     $7B6C

*************************************************** Absolute mouse
007B16 45ED0A6A         lea     $A6A(A5),A2     Transfer buffer pointer
007B1A 14FC0009         move.b  #9,(A2)+        Absolute mouse
007B1E 14EB0004         move.b  4(A3),(A2)+     xmax msb
007B22 14EB0005         move.b  5(A3),(A2)+     xmax lsb
007B26 14EB0006         move.b  6(A3),(A2)+     ymax msb
007B2A 14EB0007         move.b  7(A3),(A2)+     ymax lsb
007B2E 14FC000C         move.b  #$C,(A2)+       Absolute mouse scale
007B32 613C             bsr     $7B70           Set mouse parameters
007B34 14FC000E         move.b  #$E,(A2)+       Initial absolute mouse position
007B38 14FC0000         move.b  #0,(A2)+        Fill byte
007B3C 14EB0008         move.b  8(A3),(A2)+     Start position x msb
007B40 14EB0009         move.b  9(A3),(A2)+     Start position x lsb
007B44 14EB000A         move.b  10(A3),(A2)+    Start position y msb
007B48 14EB000B         move.b  11(A3),(A2)+    Start position y lsb
007B4C 7610             moveq.l #16,D3          String length -1
007B4E 45ED0A6A         lea     $A6A(A5),A2     Transfer buffer pointer
007B52 6100F19C         bsr     $6CF0           Send string to IKBD
007B56 6014             bra     $7B6C
007B58 45ED0A6A         lea     $A6A(A5),A2     Transfer buffer pointer
007B5C 14FC000A         move.b  #$A,(A2)+       Mouse keycode mode
007B60 610E             bsr     $7B70           Set mouse parameters
007B62 7605             moveq.l #5,D3           Length of the string -1
007B64 45ED0A6A         lea     $A6A(A5),A2     Transfer buffer pointer
007B68 6100F186         bsr     $6CF0           Send string to IKBD
007B6C 70FF             moveq.l #-1,D0          Flag for OK
007B6E 4E75             rts
```

```
**************************************************   setmouse, set mouse parameters
007B70 14EB0002           move.b  2(A3),(A2)+        x threshold, scale, delta
007B74 14EB0003           move.b  3(A3),(A2)+        y threshold, scale, delta
007B78 7210               moveq.l #16,D1             Top/bottom ?
007B7A 922B0000           sub.b   0(A3),D1
007B7E 14C1               move.b  D1,(A2)+
007B80 14FC0007           move.b  #7,(A2)+
007B84 14EB0001           move.b  1(A3),(A2)+
007B88 4E75               rts

**************************************************   xbtimer, initialize timer
007B8A 7000               moveq.l #0,D0
007B8C 7200               moveq.l #0,D1
007B8E 7400               moveq.l #0,D2
007B90 302F0004           move.w  4(A7),D0           Timer number (0-3 => A - D)
007B94 322F0006           move.w  6(A7),D1           Value for control register
007B98 342F0008           move.w  8(A7),D2           Value for data register
007B9C 6100F4F2           bsr     $7090              Set timer values
007BA0 4AAF000A           tst.l   10(A7)             Interrupt vector
007BA4 6B1A               bmi     $7BC0              Not used ?
007BA6 246F000A           move.l  10(A7),A2          Interrupt vector
007BAA 7200               moveq.l #0,D1
007BAC 43F900007BC2       lea     $7BC2,A1           Table for determining interrupt number
007BB2 0280000000FF       and.l   #$FF,D0
007BB8 10310000           move.b  0(A1,D0.w),D0      Get interrupt number
007BBC 6100F588           bsr     $7146              initint, set MFP interrupt
007BC0 4E75               rts

**************************************************   Interrupt numbers of the MFP timers
007BC2 0D080504           dc.b    13,8,5,4
```

```
**************************************************    keytrans, set keyboard table
007BC6 4AAF0004           tst.l   4(A7)               Change standard table ?
007BCA 6B06               bmi     $7BD2               No
007BCC 2B6F00040A5E       move.l  4(A7),$A5E(A5)      Address of the standard table
007BD2 4AAF0008           tst.l   8(A7)               Change shift table ?
007BD6 6B06               bmi     $7BDE               No
007BD8 2B6F00080A62       move.l  8(A7),$A62(A5)      Address of the shift table
007BDE 4AAF000C           tst.l   12(A7)              Change CAPS LOCK table ?
007BE2 6B06               bmi     $7BEA               No
007BE4 2B6F000C0A66       move.l  12(A7),$A66(A5)     Address of the CAPS LOCK table
007BEA 203C00000A5E       move.l  #$A5E,D0            Pointer to address of the table
007BF0 4E75               rts

**************************************************    bioskeys, set standard keyboard table
007BF2 2B7C00006D620A5E   move.l  #$6D62,$A5E(A5)     Standard table
007BFA 2B7C00006DE20A62   move.l  #$6DE2,$A62(A5)     Shift table
007C02 2B7C00006E620A66   move.l  #$6E62,$A66(A5)     CAPS LOCK table
007C0A 4E75               rts

**************************************************    dosound, start sound
007C0C 202D0A86           move.l  $A86(A5),D0         Get sound status
007C10 222F0004           move.l  4(A7),D1            Address of the sound table
007C14 6B08               bmi     $7C1E               Negative, don't set
007C16 2B410A86           move.l  D1,$A86(A5)         New sound table
007C1A 422D0A8A           clr.b   $A8A(A5)            Start sound table
007C1E 4E75               rts

**************************************************    setprt, set/get printer configuration
007C20 302D0A8C           move.w  $A8C(A5),D0         Get printer configuration
007C24 4A6F0004           tst.w   4(A7)               New value
007C28 6B06               bmi     $7C30               Negative, don't set
007C2A 3B6F00040A8C       move.w  4(A7),$A8C(A5)      Set printer configuration
```

```
007C30 4E75                 rts

**************************************************   kbrate, set/get keyboard repeat
007C32 302D0A7E             move.w  $A7E(A5),D0      Delay before key repeat
007C36 4A6F0004             tst.w   4(A7)            Test new value
007C3A 6B16                 bmi     $7C52            Negative, don't set
007C3C 322F0004             move.w  4(A7),D1
007C40 1B410A7E             move.b  D1,$A7E(A5)      Set new value
007C44 4A6F0006             tst.w   6(A7)            Repeat rate
007C48 6B08                 bmi     $7C52            Negative, don't set
007C4A 322F0006             move.w  6(A7),D1
007C4E 1B410A7F             move.b  D1,$A7F(A5)      Set new value
007C52 4E75                 rts

**************************************************   ikbdvecs, pointers to IKBD + MIDI vectors
007C54 203C00000A0E         move.l  #$A0E,D0         Address of the vector table
007C5A 4E75                 rts

**************************************************   timercint, timer C interrupt
007C5C 52B9000004BA         addq.l  #1,$4BA          Increment 200 Hz counter
007C62 E7F900000A84         rol.w   $A84             Rotate divisor bit
007C68 6A4E                 bpl     $7CB8            Not fourth interrupt, then done
007C6A 48E7FFFE             movem.l D0-D7/A0-A6,-(A7) Save registers
007C6E 4BF900000000         lea     $0,A5            Clear A5
007C74 614C                 bsr     $7CC2            Process sound
007C76 082D00010484         btst    #1,$484(A5)      Key repeat enabled ?
007C7C 672A                 beq     $7CA8            No
007C7E 4A2D0A7B             tst.b   $A7B(A5)         Key pressed ?
007C82 6724                 beq     $7CA8            No
007C84 4A2D0A7C             tst.b   $A7C(A5)         Counter for start delay
007C88 6706                 beq     $7C90            Not active
007C8A 532D0A7C             subq.b  #1,$A7C(A5)      Decrement counter
```

```
007C8E 6618                bne      $7CA8                 Not run out ?
007C90 532D0A7D            subq.b   #1,$A7D(A5)           Decrement counter for repeat delay
007C94 6612                bne      $7CA8                 Not run out
007C96 1B6D0A7F0A7D        move.b   $A7F(A5),$A7D(A5)     Reload counter
007C9C 102D0A7B            move.b   $A7B(A5),D0           Key to repeat
007CA0 41ED09F2            lea      $9F2(A5),A0           Pointer to iorec keyboard
007CA4 6100FAEC            bsr      $7792                 Key code in keyboard buffer
007CA8 3F2D0442            move.w   $442(A5),-(A7)        20 millseconds per call
007CAC 206D0400            move.l   $400(A5),A0           Get event timer vector
007CB0 4E90                jsr      (A0)                  Execute routine
007CB2 544F                addq.w   #2,A7                 Correct stack pointer
007CB4 4CDF7FFF            movem.l  (A7)+,D0-D7/A0-A6     Restore registers
007CB8 08B90005FFFFFA11    bclr     #5,$FFFFFA11          Clear interrupt service bit
007CC0 4E73                rte

************************************************          sndirq, sound interrupt routine
007CC2 48E7C080            movem.l  D0-D1/A0,-(A7)        Restore registers
007CC6 202D0A86            move.l   $A86(A5),D0           Pointer to sound table
007CCA 67000088            beq      $7D54                 No sound active ?
007CCE 2040                move.l   D0,A0                 Pointer to A0
007CD0 102D0A8A            move.b   $A8A(A5),D0           Load timer value
007CD4 6708                beq      $7CDE                 New sound started ?
007CD6 5300                subq.b   #1,D0                 Else decrement timer
007CD8 1B400A8A            move.b   D0,$A8A(A5)           And save value
007CDC 6076                bra      $7D54                 Done

007CDE 1018                move.b   (A0)+,D0              Get sound command
007CE0 6B2E                bmi      $7D10                 Bit 7 set, then special command
007CE2 13C0FFFF8800        move.b   D0,$FFFF8800          Select register in sound chip
007CE8 0C000007            cmp.b    #7,D0                 Register 7?
007CEC 661A                bne      $7D08                 No
007CEE 1218                move.b   (A0)+,D1              Data for register 7
```

```
007CF0 0201003F          and.b    #$3F,D1              Isolate bits 0 - 5
007CF4 1039FFFF8800      move.b   $FFFF8800,D0         Read mixer
007CFA 020000C0          and.b    #$C0,D0              Isolate bits 6-7
007CFE 8001              or.b     D1,D0                OR data
007D00 13C0FFFF8802      move.b   D0,$FFFF8802         Write byte in sound chip register
007D06 60D6              bra      $7CDE                New sound command
007D08 13D8FFFF8802      move.b   (A0)+,$FFFF8802      Write byte directly in sound chip
007D0E 60CE              bra      $7CDE                Next sound command

007D10 5200              addq.b   #1,D0                Was command $FF ?
007D12 6A32              bpl      $7D46                Yes
007D14 0C000081          cmp.b    #$81,D0              Was command $80 ?
007D18 6606              bne      $7D20                No
007D1A 1B580A8B          move.b   (A0)+,$A8B(A5)       Save byte for later
007D1E 60BE              bra      $7CDE                Next sound command

007D20 0C000082          cmp.b    #$82,D0              Command > $81 ?
007D24 6620              bne      $7D46                Yes, set timer
007D26 13D8FFFF8800      move.b   (A0)+,$FFFF8800      Select register
007D2C 1018              move.b   (A0)+,D0             Add increment-value
007D2E D12D0A8B          add.b    D0,$A8B(A5)
007D32 1018              move.b   (A0)+,D0             End value
007D34 13ED0A8BFFFF8802  move.b   $A8B(A5),$FFFF8802   Write value in sound chip register
007D3C B02D0A8B          cmp.b    $A8B(A5),D0          End value reached ?
007D40 670E              beq      $7D50                Yes
007D42 5948              subq.w   #4,A0                Sound pointer back to same command
007D44 600A              bra      $7D50
007D46 1B580A8A          move.b   (A0)+,$A8A(A5)       Next value as delay timer
007D4A 6604              bne      $7D50
007D4C 307C0000          move.w   #0,A0                Sound pointer to zero
007D50 2B480A86          move.l   A0,$A86(A5)          And save
007D54 4CDF0103          movem.l  (A7)+,D0-D1/A0       Restore registers
```

```
007D58 4E75                 rts

****************************************************  bellsnd, tone after CTRL G
007D5A 0034                 dc.b    0,$34
007D5C 0100                 dc.b    1,0
007D5E 0200                 dc.b    2,0
007D60 0300                 dc.b    3,0
007D62 0400                 dc.b    4,0
007D64 0500                 dc.b    5,0
007D66 0600                 dc.b    6,0
007D68 07FE                 dc.b    7,$FE                Envelope channel A
007D6A 0810                 dc.b    8,$10
007D6C 0900                 dc.b    9,0
007D6E 0A00                 dc.b    10,0
007D70 0B00                 dc.b    11,0
007D72 0C10                 dc.b    12,$10
007D74 0D09                 dc.b    13,9
007D76 FF00                 dc.b    $FF,0

****************************************************  keyclk, key click
007D78 003B                 dc.b    0,$3B
007D7A 0100                 dc.b    1,0
007D7C 0200                 dc.b    2,0
007D7E 0300                 dc.b    3,0
007D80 0400                 dc.b    4,0
007D82 0500                 dc.b    5,0
007D84 0600                 dc.b    6,0
007D86 07FE                 dc.b    7,$FE
007D88 0810                 dc.b    8,$10                Envelope channel A
007D8A 0D03                 dc.b    13,3                 Envelope single attack
007D8C 0B80                 dc.b    11,$80
007D8E 0C01                 dc.b    12,1
```

```
007D90 FF00                 dc.b    $FF,0

*****************************************************    Hardcopy
007D92 4E560000             link    A6,#0
007D96 48E7070C             movem.l D5-D7/A4-A5,-(A7)    Save registers
007D9A 2A6E0008             move.l  8(A6),A5             Address if the parameter block
007D9E 287C00002600         move.l  #$2600,A4            Address of the working memory
007DA4 7E1E                 moveq.l #30,D7               30 bytes
007DA6 6004                 bra     $7DAC
007DA8 18DD                 move.b  (A5)+,(A4)+          Put parameters in working memory
007DAA 5347                 subq.w  #1,D7
007DAC 4A47                 tst.w   D7                   Next byte
007DAE 6EF8                 bgt     $7DA8
007DB0 4AB90000261A         tst.l   $261A                p masks, half-tone mask
007DB6 6708                 beq     $7DC0                Not used ?
007DB8 20390000261A         move.l  $261A,D0             Load mask
007DBE 6006                 bra     $7DC6
007DC0 203C00016D4C         move.l  #$16D4C,D0           Default mask
007DC6 23C00000261A         move.l  D0,$261A             p masks
007DCC 0C79000100002618     cmp.w   #1,$2618             p port
007DD4 6306                 bls     $7DDC
007DD6 70FF                 moveq.l #-1,D0               Set flag
007DD8 60000BC6             bra     $89A0                Error, stop

007DDC 4A7900002618         tst.w   $2618                p port
007DE2 6704                 beq     $7DE8                Centronics ?
007DE4 4240                 clr.w   D0                   0= RS232
007DE6 6002                 bra     $7DEA
007DE8 7001                 moveq.l #1,D0                1= Centronics
007DEA 13C0000025FE         move.b  D0,$25FE             Printer port
007DF0 4A7900002608         tst.w   $2608                Height
007DF6 6642                 bne     $7E3A                Not zero ?
```

```
007DF8 6028                bra     $7E22
007DFA 4A79000004EE        tst.w   $4EE          scrdump flag, ALT HELP pressed again?
007E00 6632                bne     $7E34         Yes, stop
007E02 207900002600        move.l  $2600,A0      blkptr
007E08 1010                move.b  (A0),D0       Get byte from video RAM
007E0A 4880                ext.w   D0
007E0C 3E80                move.w  D0,(A7)       On the stack
007E0E 61000B9A            bsr     $89AA         Output byte
007E12 52B900002600        addq.l  #1,$2600      Increment blkptr
007E18 4A40                tst.w   D0            Output OK ?
007E1A 6706                beq     $7E22         Yes
007E1C 70FF                moveq.l #-1,D0        Set flag
007E1E 60000B80            bra     $89A0         Error, stop

007E22 4240                clr.w   D0
007E24 303900002606        move.w  $2606,D0      width, screen width
007E2A 537900002606        subq.w  #1,$2606      Decrement width
007E30 4A40                tst.w   D0            Already zero ?
007E32 66C6                bne     $7DFA         No, output next byte
007E34 4240                clr.w   D0            Flag for OK
007E36 60000B68            bra     $89A0         Done

007E3A 0C7900030002616     cmp.w   #3,$2616      p type, Epson B/W matrix
007E42 6306                bls     $7E4A
007E44 70FF                moveq.l #-1,D0        Set flag
007E46 60000B58            bra     $89A0         Error, stop

007E4A 0C79000100002610    cmp.w   #1,$2610      dstres, printer resolution
007E52 6306                bls     $7E5A
007E54 70FF                moveq.l #-1,D0        Set flag
007E56 60000B48            bra     $89A0         Error, stop
```

```
007E5A 0C790002000260E    cmp.w    #2,$260E     srcres, screen resolution
007E62 6306               bls      $7E6A
007E64 70FF               moveq.l  #-1,D0       Set flag
007E66 60000B38           bra      $89A0        Error, stop

007E6A 0C79000700002604   cmp.w    #7,$2604     Test offset
007E72 6306               bls      $7E7A
007E74 70FF               moveq.l  #-1,D0       Set flag
007E76 60000B28           bra      $89A0        Error, stop

007E7A 4A790000260E       tst.w    $260E        srcres, screen resolutionm
007E80 6704               beq      $7E86        Low resolution ?
007E82 4240               clr.w    D0
007E84 6002               bra      $7E88
007E86 7001               moveq.l  #1,D0
007E88 13C000004F82       move.b   D0,$4F82     Flag for low resolution
007E8E 0C790001000260E    cmp.w    #1,$260E     srcres
007E96 6704               beq      $7E9C        Medium resolution ?
007E98 4240               clr.w    D0
007E9A 6002               bra      $7E9E
007E9C 7001               moveq.l  #1,D0
007E9E 13C000004ED6       move.b   D0,$4ED6     Flag for medium resolution
007EA4 0C790002000260E    cmp.w    #2,$260E     srcres, screen resolution
007EAC 6704               beq      $7EB2        High resolution ?
007EAE 4240               clr.w    D0
007EB0 6002               bra      $7EB4
007EB2 7001               moveq.l  #1,D0
007EB4 13C000004ED8       move.b   D0,$4ED8     Flag for high resolution
007EBA 4A7900002610       tst.w    $2610        dstres, printer resolution
007EC0 6704               beq      $7EC6        Test mode ?
007EC2 4240               clr.w    D0           Quality mode
007EC4 6002               bra      $7EC8
```

```
007EC6 7001                  moveq.l #1,D0
007EC8 13C000004EE8          move.b  D0,$4EE8       Printer mode
007ECE 0C7900010002616       cmp.w   #1,$2616       p type, ATARI color matrix
007ED6 6704                  beq     $7EDC
007ED8 4240                  clr.w   D0
007EDA 6002                  bra     $7EDE
007EDC 7001                  moveq.l #1,D0
007EDE 13C0000047CE          move.b  D0,$47CE       ATARI color dot-matrix printer
007EE4 0C7900020002616       cmp.w   #2,$2616       p type, ATARI daisy wheel ?
007EEC 6704                  beq     $7EF2          Yes
007EEE 4240                  clr.w   D0
007EF0 6002                  bra     $7EF4
007EF2 7001                  moveq.l #1,D0
007EF4 13C000004F84          move.b  D0,$4F84       Flag for ATARI daisy wheel printer
007EFA 0C7900030002616       cmp.w   #3,$2616       p type, Epson B/W Matrix ?
007F02 6704                  beq     $7F08          Yes
007F04 4240                  clr.w   D0
007F06 6002                  bra     $7F0A
007F08 7001                  moveq.l #1,D0
007F0A 13C0000047D0          move.b  D0,$47D0       Flag for Epson B/W dot matrix
007F10 4A3900004F84          tst.b   $4F84          ATARI daisy wheel printer ?
007F16 6706                  beq     $7F1E          No
007F18 70FF                  moveq.l #-1,D0
007F1A 60000A84              bra     $89A0          Error, stop

007F1E 4A39000047D0          tst.b   $47D0          Epson B/W dot-matrix printer ?
007F24 670C                  beq     $7F32          No
007F26 4A3900004EE8          tst.b   $4EE8          Printer test mode ?
007F2C 6604                  bne     $7F32          No
007F2E 7001                  moveq.l #1,D0
007F30 6008                  bra     $7F3A
007F32 103900004EE8          move.b  $4EE8,D0       Printer resolution
```

```
007F38 4880                 ext.w    D0
007F3A 13C000004EE8         move.b   D0,$4EE8          Printer resolution
007F40 4A3900004F82         tst.b    $4F82             Low resolution ?
007F46 6726                 beq      $7F6E             No
007F48 0C7901400002606      cmp.w    #320,$2606        width, 320 points per line
007F50 631C                 bls      $7F6E
007F52 4240                 clr.w    D0
007F54 303900002606         move.w   $2606,D0          width
007F5A D07CFEC0             add.w    #$FEC0,D0         -320
007F5E D1790000260C         add.w    D0,$260C          Plus right
007F64 33FC014000002606     move.w   #320,$2606        width, 320 points per line
007F6C 6024                 bra      $7F92
007F6E 0C7902800002606      cmp.w    #640,$2606        width, 640 points per line
007F76 631A                 bls      $7F92
007F78 4240                 clr.w    D0
007F7A 303900002606         move.w   $2606,D0          width
007F80 D07CFD80             add.w    #$FD80,D0         -640
007F84 D1790000260C         add.w    D0,$260C          Plus right
007F8A 33FC028000002606     move.w   #640,$2606        Width to 640
007F92 4A3900004ED8         tst.b    $4ED8             High resolution ?
007F98 660001E6             bne      $8180             Yes
007F9C 4247                 clr.w    D7                Clear color counter
007F9E 600001D8             bra      $8178:ln1
007FA2 207900002612         move.l   $2612,A0          colpal
007FA8 4240                 clr.w    D0
007FAA 3010                 move.w   (A0),D0           Get color
007FAC C07C0777             and.w    #$777,D0          Mask irrelavant bits
007FB0 33C0000047BA         move.w   D0,$47BA          Save color
007FB6 54B900002612         addq.l   #2,$2612          colpal pointer to next color
007FBC 0C790777000047BA     cmp.w    #$777,$47BA       Color equal white ?
007FC4 67000194             beq      $815A             Yes
007FC8 3039000047BA         move.w   $47BA,D0          Load color
```

```
007FCE C07C0007        and.w   #7,D0           Isolate blue level
007FD2 33C0000035C2    move.w  D0,$35C2        And save
007FD8 3039000047BA    move.w  $47BA,D0        Load color
007FDE E840            asr.w   #4,D0
007FE0 C07C0007        and.w   #7,D0           Isolate green level
007FE4 33C000004EDA    move.w  D0,$4EDA        And save
007FEA 3039000047BA    move.w  $47BA,D0        Load color
007FF0 E040            asr.w   #8,D0
007FF2 C07C0007        and.w   #7,D0           Isolate red level
007FF6 33C000004694    move.w  D0,$4694        And save
007FFC 4A39000047CE    tst.b   $47CE           ATARI color dot-matrix printer ?
008002 67000114        beq     $8118           No
008006 3047            move.w  D7,A0
008008 D1C8            add.l   A0,A0
00800A D1FC00004EEC    add.l   #$4EEC,A0
008010 30B900004694    move.w  $4694,(A0)      Red level
008016 3047            move.w  D7,A0
008018 D1C8            add.l   A0,A0
00801A 227C00004EEC    move.l  #$4EEC,A1
008020 30309800        move.w  0(A0,A1.l),D0
008024 B07900004EDA    cmp.w   $4EDA,D0        Green level
00802A 6F08            ble     $8034
00802C 303900004EDA    move.w  $4EDA,D0        Green level
008032 600E            bra     $8042
008034 3047            move.w  D7,A0
008036 D1C8            add.l   A0,A0
008038 227C00004EEC    move.l  #$4EEC,A1
00803E 30309800        move.w  0(A0,A1.l),D0
008042 3247            move.w  D7,A1
008044 D3C9            add.l   A1,A1
008046 D3FC00004EEC    add.l   #$4EEC,A1
00804C 3280            move.w  D0,(A1)
```

```
00804E 3047                 move.w  D7,A0
008050 D1C8                 add.l   A0,A0
008052 227C00004EEC         move.l  #$4EEC,A1
008058 30309800             move.w  0(A0,A1.l),D0
00805C B079000035C2         cmp.w   $35C2,D0          Blue level
008062 6F08                 ble     $806C
008064 3039000035C2         move.w  $35C2,D0          Red level
00806A 600E                 bra     $807A
00806C 3047                 move.w  D7,A0
00806E D1C8                 add.l   A0,A0
008070 227C00004EEC         move.l  #$4EEC,A1
008076 30309800             move.w  0(A0,A1.l),D0
00807A 3247                 move.w  D7,A1
00807C D3C9                 add.l   A1,A1
00807E D3FC00004EEC         add.l   #$4EEC,A1
008084 3280                 move.w  D0,(A1)
008086 303900004694         move.w  $4694,D0          Red level
00808C 3247                 move.w  D7,A1
00808E D3C9                 add.l   A1,A1
008090 D3FC00004EEC         add.l   #$4EEC,A1
008096 3211                 move.w  (A1),D1
008098 5241                 addq.w  #1,D1
00809A 9041                 sub.w   D1,D0
00809C 6E04                 bgt     $80A2
00809E 4240                 clr.w   D0
0080A0 6002                 bra     $80A4
0080A2 7001                 moveq.l #1,D0
0080A4 33C000004694         move.w  D0,$4694          Red level
0080AA 303900004EDA         move.w  $4EDA,D0          Green level
0080B0 3247                 move.w  D7,A1
0080B2 D3C9                 add.l   A1,A1
0080B4 D3FC00004EEC         add.l   #$4EEC,A1
```

```
0080BA 3211             move.w  (A1),D1
0080BC 5241             addq.w  #1,D1
0080BE 9041             sub.w   D1,D0
0080C0 6E04             bgt     $80C6
0080C2 4240             clr.w   D0
0080C4 6002             bra     $80C8
0080C6 7001             moveq.l #1,D0
0080C8 33C000004EDA     move.w  D0,$4EDA        Green level
0080CE 3039000035C2     move.w  $35C2,D0        Red level
0080D4 3247             move.w  D7,A1
0080D6 D3C9             add.l   A1,A1
0080D8 D3FC00004EEC     add.l   #$4EEC,A1
0080DE 3211             move.w  (A1),D1
0080E0 5241             addq.w  #1,D1
0080E2 9041             sub.w   D1,D0
0080E4 6E04             bgt     $80EA
0080E6 4240             clr.w   D0
0080E8 6002             bra     $80EC
0080EA 7001             moveq.l #1,D0
0080EC 33C0000035C2     move.w  D0,$35C2        Blue level
0080F2 303900004694     move.w  $4694,D0        Red level
0080F8 E540             asl.w   #2,D0
0080FA 323900004EDA     move.w  $4EDA,D1        Green level
008100 E341             asl.w   #1,D1
008102 D041             add.w   D1,D0
008104 D079000035C2     add.w   $35C2,D0        Blue level
00810A 3247             move.w  D7,A1
00810C D3C9             add.l   A1,A1
00810E D3FC00004698     add.l   #$4698,A1
008114 3280             move.w  D0,(A1)
008116 6040             bra     $8158
008118 303900004694     move.w  $4694,D0        Red level
```

```
00811E C1FC001E           muls.w   #$1E,D0          Times 30, 30% weighting
008122 323900004EDA       move.w   $4EDA,D1         Green level
008128 C3FC003B           muls.w   #$3B,D1          Times 59, 59% weighting
00812C D041               add.w    D1,D0
00812E 3239000035C2       move.w   $35C2,D1         Blue level
008134 C3FC000B           muls.w   #$B,D1           Times 11, 11% weighting
008138 D041               add.w    D1,D0
00813A 48C0               ext.l    D0
00813C 81FC0064           divs.w   #$64,D0          Divide by 100, scaling
008140 3247               move.w   D7,A1
008142 D3C9               add.l    A1,A1
008144 D3FC00004EEC       add.l    #$4EEC,A1
00814A 3280               move.w   D0,(A1)
00814C 3047               move.w   D7,A0
00814E D1C8               add.l    A0,A0
008150 D1FC00004698       add.l    #$4698,A0
008156 4250               clr.w    (A0)
008158 601C               bra      $8176:ln1
00815A 3047               move.w   D7,A0
00815C D1C8               add.l    A0,A0
00815E D1FC00004698       add.l    #$4698,A0
008164 30BC0007           move.w   #7,(A0)
008168 3047               move.w   D7,A0
00816A D1C8               add.l    A0,A0
00816C D1FC00004EEC       add.l    #$4EEC,A0
008172 30BC0008           move.w   #8,(A0)
008176 5247               addq.w   #1,D7            Increment color counter
008178 BE7C0010           cmp.w    #$10,D7          16 colors handled already ?
00817C 6D00FE24           blt      $7FA2            No, next color
008180 4A3900004F82       tst.b    $4F82            Low resolution ?
008186 6716               beq      $819E            No
008188 7004               moveq.l  #4,D0
```

```
00818A 33C000004F0C         move.w  D0,$4F0C
008190 33C000004EE2         move.w  D0,$4EE2
008196 33C000004768         move.w  D0,$4768
00819C 6038                 bra     $81D6
00819E 4A3900004ED6         tst.b   $4ED6           Medium resolution ?
0081A4 6718                 beq     $81BE           No
0081A6 7002                 moveq.l #2,D0
0081A8 33C000004F0C         move.w  D0,$4F0C
0081AE 33C000004768         move.w  D0,$4768
0081B4 33FC000400004EE2     move.w  #4,$4EE2
0081BC 6018                 bra     $81D6:ln1
0081BE 33FC000100004768     move.w  #1,$4768
0081C6 33FC000800004EE2     move.w  #8,$4EE2
0081CE 33FC000200004F0C     move.w  #2,$4F0C
0081D6 4A39000047D0         tst.b   $47D0           Epson B/W dot-matrix printer ?
0081DC 6706                 beq     $81E4           No
0081DE 3F3C0002             move.w  #2,-(A7)
0081E2 6004                 bra     $81E8
0081E4 3F3C0001             move.w  #1,-(A7)
0081E8 303900004F0C         move.w  $4F0C,D0
0081EE 48C0                 ext.l   D0
0081F0 81DF                 divs.w  (A7)+,D0
0081F2 33C000004F0C         move.w  D0,$4F0C
0081F8 4240                 clr.w   D0
0081FA 30390000260A         move.w  $260A,D0        Left
008200 D07900002606         add.w   $2606,D0        Height
008206 D0790000260C         add.w   $260C,D0        Right
00820C C0F900004768         mulu.w  $4768,D0
008212 E848                 lsr.w   #4,D0
008214 33C000004696         move.w  D0,$4696
00821A 303900004696         move.w  $4696,D0
008220 C1F900004EE2         muls.w  $4EE2,D0
```

```
008226 33C000003E80        move.w  D0,$3E80
00822C 203900002600        move.l  $2600,D0        blkptr
008232 C0BCFFFFFFFE        and.l   #$FFFFFFFE,D0   Create even address
008238 23C0000046B8        move.l  D0,$46B8        And save
00823E 203900002600        move.l  $2600,D0        blkptr
008244 B0B9000046B8        cmp.l   $46B8,D0
00824A 660A                bne     $8256
00824C 4240                clr.w   D0
00824E 303900002604        move.w  $2604,D0        Offset
008254 600A                bra     $8260
008256 4240                clr.w   D0
008258 303900002604        move.w  $2604,D0        Offset
00825E 5040                addq.w  #8,D0
008260 33C0000047BC        move.w  D0,$47BC
008266 4279000012EA        clr.w   $12EA
00826C 60000716            bra     $8984
008270 4A79000004EE        tst.w   $4EE            dumpflg, ALT HELP pressed again ?
008276 6600071E            bne     $8996           Yes, terminate
00827A 13FC000100003628    move.b  #1,$3628
008282 4240                clr.w   D0
008284 303900002606        move.w  $2606,D0        width
00828A C0F900004768        mulu.w  $4768,D0
008290 E848                lsr.w   #4,D0
008292 907900004768        sub.w   $4768,D0
008298 E348                lsl.w   #1,D0
00829A 4840                swap    D0
00829C 4240                clr.w   D0
00829E 4840                swap    D0
0082A0 D0B9000046B8        add.l   $46B8,D0        Pointer to video RAM
0082A6 23C000004EDC        move.l  D0,$4EDC
0082AC 700F                moveq.l #15,D0
0082AE 4241                clr.w   D1
```

```
0082B0 323900002606          move.w   $2606,D1          width
0082B6 C27C000F              and.w    #$F,D1
0082BA 9041                  sub.w    D1,D0
0082BC 33C000004F12          move.w   D0,$4F12
0082C2 33F9000026060003E2C   move.w   $2606,$3E2C       width
0082CC 60000124              bra      $83F2
0082D0 4240                  clr.w    D0
0082D2 303900002608          move.w   $2608,D0          height
0082D8 9079000012EA          sub.w    $12EA,D0
0082DE 4840                  swap     D0
0082E0 4240                  clr.w    D0
0082E2 4840                  swap     D0
0082E4 80F900004EE2          divu.w   $4EE2,D0
0082EA 6708                  beq      $82F4
0082EC 303900004EE2          move.w   $4EE2,D0
0082F2 600E                  bra      $8302
0082F4 4240                  clr.w    D0
0082F6 303900002608          move.w   $2608,D0          height
0082FC 9079000012EA          sub.w    $12EA,D0
008302 33C000004ED2          move.w   D0,$4ED2
008308 23F900004EDC0000493C  move.l   $4EDC,$493C
008312 4247                  clr.w    D7
008314 6000009E              bra      $83B4
008318 427900004F1A          clr.w    $4F1A
00831E 33FC000100004F0E      move.w   #1,$4F0E
008326 23F90000493C000047BE  move.l   $493C,$47BE
008330 4246                  clr.w    D6
008332 6030                  bra      $8364
008334 2079000047BE          move.l   $47BE,A0
00833A 3010                  move.w   (A0),D0
00833C 720F                  moveq.l  #15,D1
00833E 927900004F12          sub.w    $4F12,D1
```

```
008344 E260               asr.w    D1,D0
008346 C07C0001           and.w    #1,D0
00834A C1F900004F0E       muls.w   $4F0E,D0
008350 D17900004F1A       add.w    D0,$4F1A
008356 54B9000047BE       addq.l   #2,$47BE
00835C E1F900004F0E       asl.w    $4F0E
008362 5246               addq.w   #1,D6
008364 BC7900004768       cmp.w    $4768,D6
00836A 6DC8               blt      $8334
00836C 4A3900004ED8       tst.b    $4ED8          High resolution ?
008372 6712               beq      $8386          No
008374 4A7900004F1A       tst.w    $4F1A
00837A 6708               beq      $8384
00837C 423900003628       clr.b    $3628
008382 603A               bra      $83BE
008384 601C               bra      $83A2
008386 307900004F1A       move.w   $4F1A,A0
00838C D1C8               add.l    A0,A0
00838E D1FC00004EEC       add.l    #$4EEC,A0
008394 0C500008           cmp.w    #8,(A0)
008398 6708               beq      $83A2
00839A 423900003628       clr.b    $3628
0083A0 601C               bra      $83BE
0083A2 303900004696       move.w   $4696,D0
0083A8 E340               asl.w    #1,D0
0083AA 48C0               ext.l    D0
0083AC D1B90000493C       add.l    D0,$493C
0083B2 5247               addq.w   #1,D7
0083B4 BE7900004ED2       cmp.w    $4ED2,D7
0083BA 6D00FF5C           blt      $8318
0083BE 4A3900003628       tst.b    $3628
0083C4 6736               beq      $83FC
```

```
0083C6 537900004F12          subq.w  #1,$4F12
0083CC 4A7900004F12          tst.w   $4F12
0083D2 6C18                  bge     $83EC
0083D4 303900004768          move.w  $4768,D0
0083DA E340                  asl.w   #1,D0
0083DC 48C0                  ext.l   D0
0083DE 91B900004EDC          sub.l   D0,$4EDC
0083E4 33FC000F00004F12      move.w  #$F,$4F12
0083EC 537900003E2C          subq.w  #1,$3E2C
0083F2 4A7900003E2C          tst.w   $3E2C
0083F8 6E00FED6              bgt     $82D0
0083FC 3E3900003E2C          move.w  $3E2C,D7
008402 CFF900004F0C          muls.w  $4F0C,D7
008408 4A39000047D0          tst.b   $47D0            Epson B/W dot-matrix printer ?
00840E 670A                  beq     $841A            No
008410 3007                  move.w  D7,D0
008412 48C0                  ext.l   D0
008414 81FC0002              divs.w  #2,D0
008418 6002                  bra     $841C
00841A 4240                  clr.w   D0
00841C DE40                  add.w   D0,D7
00841E 3007                  move.w  D7,D0
008420 48C0                  ext.l   D0
008422 81FC0100              divs.w  #$100,D0
008426 4840                  swap    D0
008428 13C000003E86          move.b  D0,$3E86
00842E 3007                  move.w  D7,D0
008430 48C0                  ext.l   D0
008432 81FC0100              divs.w  #$100,D0
008436 13C000003E88          move.b  D0,$3E88
00843C 4279000047D2          clr.w   $47D2
008442 600004A6              bra     $88EA
```

```
008446 427900004F88         clr.w   $4F88
00844C 60000450             bra     $889E
008450 4A39000047CE         tst.b   $47CE             ATARI color dot matrix printer ?
008456 675A                 beq     $84B2             No
008458 4A3900004ED8         tst.b   $4ED8             High resolution ?
00845E 6652                 bne     $84B2             Yes
008460 4A7900004F88         tst.w   $4F88
008466 6616                 bne     $847E
008468 2EBC00016D5E         move.l  #$16D5E,(A7)      ESC 'X' 6
00846E 6100058E             bsr     $89FE             Output string to the printer
008472 4A40                 tst.w   D0                Error ?
008474 6706                 beq     $847C             No
008476 70FF                 moveq.l #-1,D0            Flag for error
008478 60000526             bra     $89A0             Error, terminate

00847C 6034                 bra     $84B2
00847E 0C7900010004F88      cmp.w   #1,$4F88
008486 6616                 bne     $849E
008488 2EBC00016D63         move.l  #$16D63,(A7)      ESC 'X' 5
00848E 6100056E             bsr     $89FE             Output string to printer
008492 4A40                 tst.w   D0                Error ?
008494 6706                 beq     $849C             No
008496 70FF                 moveq.l #-1,D0            Flag for error
008498 60000506             bra     $89A0             Error, terminate

00849C 6014                 bra     $84B2
00849E 2EBC00016D68         move.l  #$16D68,(A7)      ESC 'X' 3
0084A4 61000558             bsr     $89FE             Output string to printer
0084A8 4A40                 tst.w   D0                Error ?
0084AA 6706                 beq     $84B2             No
0084AC 70FF                 moveq.l #-1,D0            Flag for error
```

```
0084AE 600004F0             bra      $89A0            Error, terminate

0084B2 4A39000047D0         tst.b    $47D0            Epson B/W dot-matrix printer?
0084B8 6708                 beq      $84C2            No
0084BA 2EBC00016D6D         move.l   #$16D6D,(A7)     ESC 'L', Bit image 960 points/line
0084C0 6006                 bra      $84C8
0084C2 2EBC00016D71         move.l   #$16D71,(A7)     ESC 'Y', Bit image 960 points/line
0084C8 61000534             bsr      $89FE            Output string to printer
0084CC 4A40                 tst.w    D0               Error ?
0084CE 6706                 beq      $84D6            No
0084D0 70FF                 moveq.l  #-1,D0           Flag for error
0084D2 600004CC             bra      $89A0            Error, terminate

0084D6 103900003E86         move.b   $3E86,D0         Get byte
0084DC 4880                 ext.w    D0               Low byte of the number
0084DE 3E80                 move.w   D0,(A7)          On stack
0084E0 610004C8             bsr      $89AA            Output
0084E4 4A40                 tst.w    D0               Error ?
0084E6 6706                 beq      $84EE            No
0084E8 70FF                 moveq.l  #-1,D0           Flag for error
0084EA 600004B4             bra      $89A0            Error terminate

0084EE 103900003E88         move.b   $3E88,D0         Get byte
0084F4 4880                 ext.w    D0               High byte of the number
0084F6 3E80                 move.w   D0,(A7)          On stack
0084F8 610004B0             bsr      $89AA            Output
0084FC 4A40                 tst.w    D0               Error ?
0084FE 6706                 beq      $8506            No
008500 70FF                 moveq.l  #-1,D0           Flag for error
008502 6000049C             bra      $89A0            Error, terminate

008506 13FC000100004EEA     move.b   #1,$4EEA
```

```
00850E 23F9000046B800004EDC move.l  $46B8,$4EDC
008518 33F9000047BC00004F12 move.w  $47BC,$4F12
008522 4279000012E8         clr.w   $12E8
008528 6000034C             bra     $8876

00852C 4247                 clr.w   D7
00852E 600C                 bra     $853C
008530 3047                 move.w  D7,A0
008532 D1FC000047D4         add.l   #$47D4,A0
008538 4210                 clr.b   (A0)
00853A 5247                 addq.w  #1,D7
00853C BE7C0008             cmp.w   #8,D7
008540 6DEE                 blt     $8530
008542 4247                 clr.w   D7
008544 6010                 bra     $8556
008546 3047                 move.w  D7,A0
008548 D1C8                 add.l   A0,A0
00854A D1FC00003E8A         add.l   #$3E8A,A0
008550 30BC0007             move.w  #7,(A0)
008554 5247                 addq.w  #1,D7
008556 BE7C0004             cmp.w   #4,D7
00855A 6DEA                 blt     $8546
00855C 4240                 clr.w   D0
00855E 303900002608         move.w  $2608,D0            height
008564 9079000012EA         sub.w   $12EA,D0
00856A 4840                 swap    D0
00856C 4240                 clr.w   D0
00856E 4840                 swap    D0
008570 80F900004EE2         divu.w  $4EE2,D0
008576 6708                 beq     $8580
008578 303900004EE2         move.w  $4EE2,D0
00857E 600E                 bra     $858E
```

```
008580 4240                    clr.w   D0
008582 303900002608            move.w  $2608,D0         height
008588 9079000012EA            sub.w   $12EA,D0
00858E 33C000004ED2            move.w  D0,$4ED2
008594 23F900004EDC0000493C move.l  $4EDC,$493C
00859E 4247                    clr.w   D7
0085A0 600000F8                bra     $869A

0085A4 427900004F1A            clr.w   $4F1A
0085AA 33FC000100004F0E        move.w  #1,$4F0E
0085B2 23F90000493C000047BE move.l  $493C,$47BE
0085BC 4246                    clr.w   D6
0085BE 6030                    bra     $85F0
0085C0 2079000047BE            move.l  $47BE,A0
0085C6 3010                    move.w  (A0),D0
0085C8 720F                    moveq.l #15,D1
0085CA 927900004F12            sub.w   $4F12,D1
0085D0 E260                    asr.w   D1,D0
0085D2 C07C0001                and.w   #1,D0
0085D6 C1F900004F0E            muls.w  $4F0E,D0
0085DC D17900004F1A            add.w   D0,$4F1A
0085E2 54B9000047BE            addq.l  #2,$47BE
0085E8 E1F900004F0E            asl.w   $4F0E
0085EE 5246                    addq.w  #1,D6
0085F0 BC7900004768            cmp.w   $4768,D6
0085F6 6DC8                    blt     $85C0
0085F8 4A3900004ED8            tst.b   $4ED8            High resolution ?
0085FE 6722                    beq     $8622            No
008600 4A7900004F1A            tst.w   $4F1A
008606 670C                    beq     $8614
008608 20790000261A            move.l  $261A,A0         p masks
00860E 1010                    move.b  (A0),D0
```

```
008610 4880              ext.w   D0
008612 6002              bra     $8616
008614 4240              clr.w   D0
008616 3247              move.w  D7,A1
008618 D3FC000047D4      add.l   #$47D4,A1
00861E 1280              move.b  D0,(A1)
008620 6066              bra     $8688

008622 3047              move.w  D7,A0
008624 D1C8              add.l   A0,A0
008626 D1FC00003E8A      add.l   #$3E8A,A0
00862C 327900004F1A      move.w  $4F1A,A1
008632 D3C9              add.l   A1,A1
008634 D3FC00004698      add.l   #$4698,A1
00863A 3091              move.w  (A1),(A0)
00863C 3047              move.w  D7,A0
00863E D0C8              add.w   A0,A0
008640 D1FC000047D4      add.l   #$47D4,A0
008646 327900004F1A      move.w  $4F1A,A1
00864C D3C9              add.l   A1,A1
00864E D3FC00004EEC      add.l   #$4EEC,A1
008654 3251              move.w  (A1),A1
008656 D2C9              add.w   A1,A1
008658 D3F90000261A      add.l   $261A,A1          p masks
00865E 1091              move.b  (A1),(A0)
008660 3047              move.w  D7,A0
008662 D0C8              add.w   A0,A0
008664 D1FC000047D4      add.l   #$47D4,A0
00866A 327900004F1A      move.w  $4F1A,A1
008670 D3C9              add.l   A1,A1
008672 D3FC00004EEC      add.l   #$4EEC,A1
008678 3251              move.w  (A1),A1
```

```
00867A D2C9               add.w    A1,A1
00867C D3F90000261A       add.l    $261A,A1           p masks
008682 116900010001       move.b   1(A1),1(A0)
008688 303900004696       move.w   $4696,D0
00868E E340               asl.w    #1,D0
008690 48C0               ext.l    D0
008692 D1B90000493C       add.l    D0,$493C
008698 5247               addq.w   #1,D7
00869A BE7900004ED2       cmp.w    $4ED2,D7
0086A0 6D00FF02           blt      $85A4
0086A4 4A39000047CE       tst.b    $47CE              ATARI color dot-matrix printer ?
0086AA 670000DE           beq      $878A              No
0086AE 4A3900004ED8       tst.b    $4ED8              High resolution ?
0086B4 660000D4           bne      $878A              Yes
0086B8 4247               clr.w    D7
0086BA 600000C4           bra      $8780
0086BE 423900004EE0       clr.b    $4EE0
0086C4 4A7900004F88       tst.w    $4F88
0086CA 6624               bne      $86F0
0086CC 3047               move.w   D7,A0
0086CE D1C8               add.l    A0,A0
0086D0 227C00003E8A       move.l   #$3E8A,A1
0086D6 30309800           move.w   0(A0,A1.l),D0
0086DA 48C0               ext.l    D0
0086DC 81FC0002           divs.w   #$2,D0
0086E0 4840               swap     D0
0086E2 4A40               tst.w    D0
0086E4 6708               beq      $86EE
0086E6 13FC000100004EE0   move.b   #$1,$4EE0
0086EE 606C               bra      $875C
0086F0 0C7900010004F88    cmp.w    #1,$4F88
0086F8 664A               bne      $8744
```

```
0086FA 3047                 move.w  D7,A0
0086FC D1C8                 add.l   A0,A0
0086FE D1FC00003E8A         add.l   #$3E8A,A0
008704 0C500002             cmp.w   #2,(A0)
008708 6730                 beq     $873A
00870A 3047                 move.w  D7,A0
00870C D1C8                 add.l   A0,A0
00870E D1FC00003E8A         add.l   #$3E8A,A0
008714 0C500003             cmp.w   #3,(A0)
008718 6720                 beq     $873A
00871A 3047                 move.w  D7,A0
00871C D1C8                 add.l   A0,A0
00871E D1FC00003E8A         add.l   #$3E8A,A0
008724 0C500006             cmp.w   #6,(A0)
008728 6710                 beq     $873A
00872A 3047                 move.w  D7,A0
00872C D1C8                 add.l   A0,A0
00872E D1FC00003E8A         add.l   #$3E8A,A0
008734 0C500007             cmp.w   #7,(A0)
008738 6608                 bne     $8742
00873A 13FC000100004EE0     move.b  #$1,$4EE0
008742 6018                 bra     $875C
008744 3047                 move.w  D7,A0
008746 D1C8                 add.l   A0,A0
008748 D1FC00003E8A         add.l   #$3E8A,A0
00874E 0C500003             cmp.w   #3,(A0)
008752 6F08                 ble     $875C
008754 13FC000100004EE0     move.b  #$1,$4EE0
00875C 4A3900004EE0         tst.b   $4EE0
008762 671A                 beq     $877E
008764 3047                 move.w  D7,A0
008766 D0C8                 add.w   A0,A0
```

```
008768 D1FC000047D4         add.l   #$47D4,A0
00876E 4210                 clr.b   (A0)
008770 3047                 move.w  D7,A0
008772 D0C8                 add.w   A0,A0
008774 D1FC000047D4         add.l   #$47D4,A0
00877A 42280001             clr.b   1(A0)
00877E 5247                 addq.w  #1,D7
008780 BE7900004ED2         cmp.w   $4ED2,D7
008786 6D00FF36             blt     $86BE
00878A 7E04                 moveq.l #4,D7
00878C 60000086             bra     $8814
008790 4239000035BE         clr.b   $35BE
008796 33FC008000004F10     move.w  #$80,$4F10
00879E 4246                 clr.w   D6
0087A0 603E                 bra     $87E0
0087A2 207C000047D4         move.l  #$47D4,A0
0087A8 10306000             move.b  0(A0,D6.w),D0
0087AC 4880                 ext.w   D0
0087AE 7207                 moveq.l #7,D1
0087B0 9247                 sub.w   D7,D1
0087B2 E260                 asr.w   D1,D0
0087B4 C07C0001             and.w   #$1,D0
0087B8 C1F900004F10         muls.w  $4F10,D0
0087BE 1239000035BE         move.b  $35BE,D1
0087C4 D200                 add.b   D0,D1
0087C6 13C1000035BE         move.b  D1,$35BE
0087CC 303900004F10         move.w  $4F10,D0
0087D2 48C0                 ext.l   D0
0087D4 81FC0002             divs.w  #$2,D0
0087D8 33C000004F10         move.w  D0,$4F10
0087DE 5246                 addq.w  #1,D6
0087E0 BC7C0008             cmp.w   #$8,D6
```

```
0087E4 6DBC             blt      $87A2
0087E6 1039000035BE     move.b   $35BE,D0
0087EC 4880             ext.w    D0
0087EE 3E80             move.w   D0,(A7)
0087F0 610001B8         bsr      $89AA           Output
0087F4 4A40             tst.w    D0
0087F6 6706             beq      $87FE
0087F8 70FF             moveq.l  #-1,D0
0087FA 600001A4         bra      $89A0           Error, terminate

0087FE 4A3900004EEA     tst.b    $4EEA
008804 6704             beq      $880A
008806 4240             clr.w    D0
008808 6002             bra      $880C
00880A 7001             moveq.l  #1,D0
00880C 13C000004EEA     move.b   D0,$4EEA
008812 5247             addq.w   #1,D7
008814 303900004F0C     move.w   $4F0C,D0
00881A 5840             addq.w   #4,D0
00881C BE40             cmp.w    D0,D7
00881E 6D00FF70         blt      $8790
008822 4A39000047D0     tst.b    $47D0           Epson B/W dot-matrix printer ?
008828 6720             beq      $884A           No
00882A 4A3900004EEA     tst.b    $4EEA
008830 6718             beq      $884A
008832 1039000035BE     move.b   $35BE,D0
008838 4880             ext.w    D0
00883A 3E80             move.w   D0,(A7)
00883C 6100016C         bsr      $89AA           Output
008840 4A40             tst.w    D0              OK ?
008842 6706             beq      $884A           Yes
008844 70FF             moveq.l  #-1,D0          Set flag
```

```
008846 60000158             bra      $89A0            Error, terminate

00884A 527900004F12         addq.w   #1,$4F12
008850 0C79000F00004F12     cmp.w    #15,$4F12
008858 6F16                 ble      $8870
00885A 303900004768         move.w   $4768,D0
008860 E340                 asl.w    #1,D0
008862 48C0                 ext.l    D0
008864 D1B900004EDC         add.l    D0,$4EDC
00886A 427900004F12         clr.w    $4F12
008870 5279000012E8         addq.w   #1,$12E8
008876 3039000012E8         move.w   $12E8,D0
00887C B07900003E2C         cmp.w    $3E2C,D0
008882 6D00FCA8             blt      $852C
008886 3EBC000D             move.w   #$D,(A7)         CR
00888A 6100011E             bsr      $89AA            Output
00888E 4A40                 tst.w    D0               OK ?
008890 6706                 beq      $8898            Yes
008892 70FF                 moveq.l  #-1,D0           Set flag
008894 6000010A             bra      $89A0            Error, terminate

008898 527900004F88         addq.w   #1,$4F88
00889E 4A39000047CE         tst.b    $47CE            ATARI color dot-matrix printer ?
0088A4 670C                 beq      $88B2            No
0088A6 4A3900004ED8         tst.b    $4ED8            High resolution ?
0088AC 6604                 bne      $88B2            Yes
0088AE 7003                 moveq.l  #3,D0
0088B0 6002                 bra      $88B4
0088B2 7001                 moveq.l  #1,D0
0088B4 B07900004F88         cmp.w    $4F88,D0
0088BA 6E00FB94             bgt      $8450
0088BE 2EBC00016D75         move.l   #$16D75,(A7)     ESC '3' 1, 1/216" line spacing
```

```
0088C4 61000138          bsr      $89FE          Output string to printer
0088C8 4A40              tst.w    D0
0088CA 6706              beq      $88D2
0088CC 70FF              moveq.l  #-1,D0         Set flag
0088CE 600000D0          bra      $89A0          Error, terminate

0088D2 3EBC000A          move.w   #$A,(A7)       LF
0088D6 610000D2          bsr      $89AA          Output
0088DA 4A40              tst.w    D0             OK ?
0088DC 6706              beq      $88E4          Yes
0088DE 70FF              moveq.l  #-1,D0         Set flag
0088E0 600000BE          bra      $89A0          Error, terminate

0088E4 5279000047D2      addq.w   #1,$47D2
0088EA 4A3900004EE8      tst.b    $4EE8          Printer resolution
0088F0 6704              beq      $88F6
0088F2 7001              moveq.l  #1,D0
0088F4 6002              bra      $88F8
0088F6 7002              moveq.l  #2,D0
0088F8 B079000047D2      cmp.w    $47D2,D0
0088FE 6E00FB46          bgt      $8446
008902 4A3900004EE8      tst.b    $4EE8          Printer resolution
008908 673E              beq      $8948
00890A 4247              clr.w    D7
00890C 6028              bra      $8936
00890E 2EBC00016D7A      move.l   #$16D7A,(A7)   ESC '3' 1, 1/216" line spacing
008914 610000E8          bsr      $89FE          Output string to printer
008918 4A40              tst.w    D0             Error on output ?
00891A 6706              beq      $8922          No
00891C 70FF              moveq.l  #-1,D0         Set flag
00891E 60000080          bra      $89A0          Error, terminate
```

```
008922 3EBC000A         move.w  #$A,(A7)         LF
008926 61000082         bsr     $89AA            Output
00892A 4A40             tst.w   D0               Error during output ?
00892C 6706             beq     $8934            No
00892E 70FF             moveq.l #-1,D0           Set flag
008930 6000006E         bra     $89A0            Error, terminate

008934 5247             addq.w  #1,D7
008936 4A39000047D0     tst.b   $47D0            Epson B/W dot-matrix printer ?
00893C 6704             beq     $8942            No
00893E 7002             moveq.l #2,D0
008940 6002             bra     $8944
008942 7001             moveq.l #1,D0
008944 BE40             cmp.w   D0,D7
008946 6DC6             blt     $890E
008948 2EBC00016D7F     move.l  #$16D7F,(A7)     ESC '1', 7/72" line spacing
00894E 610000AE         bsr     $89FE            Output string to printer
008952 4A40             tst.w   D0               Error during output ?
008954 6704             beq     $895A            No
008956 70FF             moveq.l #-1,D0           Set flag
008958 6046             bra     $89A0            Error, terminate

00895A 3EBC000A         move.w  #$A,(A7)         LF
00895E 614A             bsr     $89AA            Output
008960 4A40             tst.w   D0               Error during output ?
008962 6704             beq     $8968            No
008964 70FF             moveq.l #-1,D0
008966 6038             bra     $89A0            Error, terminate

008968 303900003E80     move.w  $3E80,D0
00896E E340             asl.w   #1,D0
008970 48C0             ext.l   D0
```

```
008972 D1B9000046B8       add.l    D0,$46B8
008978 303900004EE2       move.w   $4EE2,D0
00897E D179000012EA       add.w    D0,$12EA
008984 4240               clr.w    D0
008986 303900002608       move.w   $2608,D0            height
00898C B079000012EA       cmp.w    $12EA,D0
008992 6200F8DC           bhi      $8270
008996 2EBC00016D83       move.l   #$16D83,(A7)        ESC '2', 1/6" line spacing
00899C 6160               bsr      $89FE               Output string to printer
00899E 4240               clr.w    D0                  Flag for OK
0089A0 4A9F               tst.l    (A7)+
0089A2 4CDF30C0           movem.l  (A7)+,D6-D7/A4-A5   Restore registers
0089A6 4E5E               unlk     A6
0089A8 4E75               rts

**********************************************         Output a character
0089AA 4E56FFFC           link     A6,#-4
0089AE 4A39000025FE       tst.b    $25FE               Printer port
0089B4 6722               beq      $89D8               RS232 ?
0089B6 102E0009           move.b   9(A6),D0            Character to output
0089BA 4880               ext.w    D0                  Extend to word
0089BC 3E80               move.w   D0,(A7)             On the stack
0089BE 102E0009           move.b   9(A6),D0            Character to output
0089C2 4880               ext.w    D0                  Extend to word
0089C4 3F00               move.w   D0,-(A7)            And back on stack (?)
0089C6 4EB900008A2C       jsr      $8A2C               Output via Centronics port
0089CC 548F               addq.l   #2,A7               Correct stack pointer
0089CE 4A40               tst.w    D0                  OK ?
0089D0 6604               bne      $89D6               Yes
0089D2 70FF               moveq.l  #-1,D0              Flag for error
0089D4 6024               bra      $89FA               Done
0089D6 6020               bra      $89F8               Error-free termination
```

```
0089D8 102E0009        move.b  9(A6),D0        Character to output
0089DC 4880            ext.w   D0              Extend to word
0089DE 3E80            move.w  D0,(A7)         And on stack
0089E0 102E0009        move.b  9(A6),D0        Character to output
0089E4 4880            ext.w   D0              Extend to word
0089E6 3F00            move.w  D0,-(A7)        And back on stack (?)
0089E8 4EB900008A46    jsr     $8A46           Output via RS-232
0089EE 548F            addq.l  #2,A7           Correct stack pointer
0089F0 4A40            tst.w   D0              OK ?
0089F2 6604            bne     $89F8           Yes
0089F4 70FF            moveq.l #-1,D0          Set error flag
0089F6 6002            bra     $89FA
0089F8 4240            clr.w   D0
0089FA 4E5E            unlk    A6
0089FC 4E75            rts

***********************************************  Output string to printer
0089FE 4E56FFFC        link    A6,#-4
008A02 6018            bra     $8A1C
008A04 206E0008        move.l  8(A6),A0        Get string address
008A08 1010            move.b  (A0),D0         String character
008A0A 4880            ext.w   D0              Extend to word
008A0C 3E80            move.w  D0,(A7)
008A0E 619A            bsr     $89AA           Output character
008A10 52AE0008        addq.l  #1,8(A6)        Pointer to next character
008A14 4A40            tst.w   D0              Error-free output ?
008A16 6704            beq     $8A1C           Yes
008A18 70FF            moveq.l #-1,D0          Error
008A1A 600C            bra     $8A28           Terminate output
008A1C 206E0008        move.l  8(A6),A0        Pointer to string
008A20 0C1000FF        cmp.b   #$FF,(A0)       $FF as end indicator
```

```
008A24 66DE             bne      $8A04              Next character
008A26 4240             clr.w    D0                 OK
008A28 4E5E             unlk     A6
008A2A 4E75             rts

**************************************************  Centronics output
008A2C 302F0006         move.w   6(A7),D0           Character to output
008A30 48E71F1E         movem.l  D3-D7/A3-A6,-(A7)  Save registers
008A34 3F00             move.w   D0,-(A7)           Character to output
008A36 3F00             move.w   D0,-(A7)
008A38 9BCD             sub.l    A5,A5              Clear A5
008A3A 6100E198         bsr      $6BD4              Output character to Centronics port
008A3E 584F             addq.w   #4,A7              Correct stack pointer
008A40 4CDF78F8         movem.l  (A7)+,D3-D7/A3-A6  Restore registers
008A44 4E75             rts

**************************************************  RS232 output
008A46 302F0006         move.w   6(A7),D0           Character to output
008A4A 48E71F1E         movem.l  D3-D7/A3-A6,-(A7)  Save registers
008A4E 3F00             move.w   D0,-(A7)           Character to output
008A50 3F00             move.w   D0,-(A7)
008A52 9BCD             sub.l    A5,A5              Clear A5
008A54 6100E258         bsr      $6CAE              Output character via RS-232
008A58 584F             addq.w   #4,A7              Correct stack pointer
008A5A 4CDF78F8         movem.l  (A7)+,D3-D7/A3-A6  Restore registers
008A5E 4E75             rts

***********************************************     VDI ESCAPE functions
008A60 207900002580     move.l   $2580,A0           Pointer to CONTRL array
008A66 3028000A         move.w   10(A0),D0          Function number
008A6A B07C0013         cmp.w    #$13,D0            Greater than 19 ?
008A6E 6236             bhi      $8AA6
```

```
008A72 307B000A          move.w  $8A7E(PC,D0.w),A0   Get relative address from table
008A76 D1FC00008C7A      add.l   #$8C7A,A0           Add base address
008A7C 4ED0              jmp     (A0)                Execute routine

008A7E 0000              dc.w    $8C7A-$8C7A         0, rts
008A80 FFD8              dc.w    $8C52-$8C7A         1, Inquire addressable alpha character cells
008A82 0012              dc.w    $8C8C-$8C7A         2, Exit alpha mode
008A84 000C              dc.w    $8C86-$8C7A         3, Enter alpha mode
008A86 001A              dc.w    $8C94-$8C7A         4, Alpha cursor up
008A88 002E              dc.w    $8CA8-$8C7A         5, Alpha cursor down
008A8A 0048              dc.w    $8CC2-$8C7A         6, Alpha cursor right
008A8C 0062              dc.w    $8CDC-$8C7A         7, Alpha cursor left
008A8E 0076              dc.w    $8CF0-$8C7A         8, Home alpha cursor
008A90 007E              dc.w    $8CF8-$8C7A         9, Erase to end of alpha screen
008A92 00AA              dc.w    $8D24-$8C7A         10, Erase to end of alpha text line
008A94 0114              dc.w    $8D8E-$8C7A         11, Direct alpha cursor address
008A96 0128              dc.w    $8DA2-$8C7A         12, Output cursor addressable alpha text
008A98 014E              dc.w    $8DC8-$8C7A         13, Reverse video on
008A9A 0158              dc.w    $8DD2-$8C7A         14, Reverse video off
008A9C 0162              dc.w    $8DDC-$8C7A         15, Inquire current alpha cursor address
008A9E 018C              dc.w    $8E06-$8C7A         16, Inquire tablet status
008AA0 0002              dc.w    $8C7C-$8C7A         17, Hardcopy
008AA2 01A4              dc.w    $8E1E-$8C7A         18, Place graphic cursor at location
008AA4 01B4              dc.w    $8E2E-$8C7A         19, Remove last graphic cursor

**************************************************
008AA6 B07C0065          cmp.w   #101,D0             ESC VDI 101 ?
008AAA 670A              beq     $8AB6
008AAC B07C0066          cmp.w   #102,D0             ESC VDI 102 ?
008AB0 6700094E          beq     $9400               Yes, initialize font data
008AB4 4E75              rts
```

```
**************************************************      VDI ESC 101
008AB6 61000448            bsr     $8F00                Cursor off
008ABA 207900002584        move.l  $2584,A0             Pointer to INTIN array
008AC0 3010                move.w  (A0),D0              Get paramaters
008AC2 C0F90000257E        mulu.w  $257E,D0             Times number of bytes per screen line
008AC8 33C00000255E        move.w  D0,$255E
008ACE 6000041E            bra     $8EEE

**************************************************      ascout
008AD2 322F0006            move.w  6(A7),D1             Get character from stack
008AD6 024100FF            and.w   #$FF,D1              Process only low byte
008ADA 600005D2            bra     $90AE                Output character

**************************************************      conout
008ADE 322F0006            move.w  6(A7),D1             Get character from stack
008AE2 024100FF            and.w   #$FF,D1              Process only low byte
008AE6 2079000004A8        move.l  $4A8,A0              Get conout vector
008AEC 4ED0                jmp     (A0)                 And execute routine

**************************************************      Standard conout
008AEE B27C0020            cmp.w   #$20,D1              Control code ?
008AF2 6C0005BA            bge     $90AE                No, output character
008AF6 B23C001B            cmp.b   #$1B,D1              ESC ?
008AFA 660C                bne     $8B08                No, process other CTRL codes
008AFC 23FC00008B4A000004A8 move.l #$8B4A,$4A8          Conout vector to ESC processing
008B06 4E75                rts

**************************************************      Process CTRL codes
008B08 5F41                subq.w  #7,D1                Less than 7 ?
008B0A 6B22                bmi     $8B2E                Ingore, RTS
008B0C B27C0006            cmp.w   #6,D1                Greater than 13 ?
008B10 6E1C                bgt     $8B2E                Ignore, RTS
```

```
008B12 E349                  lsl.w    #1,D1                 Bring to word processing
008B14 307B100A              move.w   $8B20(PC,D1.w),A0     Get relative address from table
008B18 D1FC00008B30          add.l    #$8B30,A0             Add base address to it
008B1E 4ED0                  jmp      (A0)                  And execute corresponding routine

*****************************************************       Jump table for control codes
008B20 0000                  dc.w     $8B30-$8B30           7, BEL
008B22 01AC                  dc.w     $8CDC-$8B30           8, BS
008B24 0004                  dc.w     $8B34-$8B30           9, TAB
008B26 04AA                  dc.w     $8FDA-$8B30           10, LF
008B28 04AA                  dc.w     $8FDA-$8B30           11, VT
008B2A 04AA                  dc.w     $8FDA-$8B30           12, FF
008B2C 049E                  dc.w     $8FCE-$8B30           13, CR

*****************************************************
008B2E 4E75                  rts

*****************************************************       BEL
008B30 6000E218              bra      $6D4A                 Output tone

*****************************************************       TAB
008B34 303900002560          move.w   $2560,D0              Corsor column
008B3A 0240FFF8              and.w    #$FFF8,D0             Convert to number divisable by 8
008B3E 5040                  addq.w   #8,D0                 And add 8
008B40 323900002562          move.w   $2562,D1              Cursor line
008B46 60000764              bra      $92AC                 Reset cursor

*****************************************************       Process character after ESC
008B4A 23FC00008AEE000004A8 move.l   #$8AEE,$4A8           conout vector back to standrad
008B54 927C0041              sub.w    #$41,D1               Minus 'A'
008B58 6BD4                  bmi      $8B2E                 Less, then ignore
008B5A B27C000C              cmp.w    #$C,D1                'M'
```

```
008B5E 6F50                 ble     $8BB0             To ESC table for capital letters
008B60 B27C0018             cmp.w   #$18,D1           'Y' for set cursor ?
008B64 663C                 bne     $8BA2             No,test for lowercase letters
008B66 23FC00008B72000004A8 move.l  #$8B72,$4A8       conout vector for ESC Y
008B70 4E75                 rts

*****************************************************  Process line after ESC Y
008B72 927C0020             sub.w   #$20,D1           Subtract offset
008B76 33C1000004AC         move.w  D1,$4AC           And save line value
008B7C 23FC00008B88000004A8 move.l  #$8B88,$4A8       Process conout vector to column
008B86 4E75                 rts

*****************************************************  Process column after ESC Y
008B88 927C0020             sub.w   #$20,D1           Subtract offset
008B8C 3001                 move.w  D1,D0             Column value
008B8E 3239000004AC         move.w  $4AC,D1           And line
008B94 23FC00008AEE000004A8 move.l  #$8AEE,$4A8       conout vector back to standard
008B9E 6000070C             bra     $92AC             And set cursor

*****************************************************  Test for ESC lowercase
008BA2 927C0021             sub.w   #$21,D1           Subtract offset
008BA6 6B86                 bmi     $8B2E             Ignore lowercase 'b'
008BA8 B27C0015             cmp.w   #$15,D1           'w'
008BAC 6F10                 ble     $8BBE             Less than or equal, process sequence
008BAE 4E75                 rts

*****************************************************  ESC uppercase
008BB0 E349                 lsl.w   #1,D1             Code times 2 for word acces
008BB2 307B1058             move.w  $8C0C(PC,D1.w),A0 Get relative address from table
008BB6 D1FC00008B2E         add.l   #$8B2E,A0         Add base address
008BBC 4ED0                 jmp     (A0)              And execute routine
```

```
*****************************************************    ESC lowercase
008BBE E349                  lsl.w   #1,D1               Code times 2 for word access
008BC0 307B1064              move.w  $8C26(PC,D1.w),A0   Get relative address from table
008BC4 D1FC00008B2E          add.l   #$8B2E,A0           Add base address
008BCA 4ED0                  jmp     (A0)                And execute routine

*****************************************************    ESC b  set character color
008BCC 23FC00008BD8000004A8 move.l   #$8BD8,$4A8         Set conout vector
008BD6 4E75                  rts

*****************************************************
008BD8 23FC00008AEE000004A8 move.l   #$8AEE,$4A8         Set standrad conout vector
008BE2 927C0020              sub.w   #$20,D1             Subtract offset
008BE6 3001                  move.w  D1,D0
008BE8 60000292              bra     $8E7C               Set character color

*****************************************************    ESC c  set background color
008BEC 23FC00008BF8000004A8 move.l   #$8BF8,$4A8         Set conout vector
008BF6 4E75                  rts

*****************************************************
008BF8 23FC00008AEE000004A8 move.l   #$8AEE,$4A8         Standard conout vector
008C02 927C0020              sub.w   #$20,D1             Subtract offset
008C06 3001                  move.w  D1,D0
008C08 6000027E              bra     $8E88               Set background color

*****************************************************    Address table for ESC upper case
008C0C 0166                  dc.w    $8B2E-$8B2E         ESC A
008C0E 017A                  dc.w    $8B2E-$8B2E         ESC B
008C10 0194                  dc.w    $8B2E-$8B2E         ESC C
008C12 01AE                  dc.w    $8B2E-$8B2E         ESC D
008C14 0162                  dc.w    $8B2E-$8B2E         ESC E
```

```
008C16 0000         dc.w    $8B2E-$8B2E       ESC F, rts
008C18 0000         dc.w    $8B2E-$8B2E       ESC G, rts
008C1A 01C2         dc.w    $8B2E-$8B2E       ESC H
008C1C 0306         dc.w    $8B2E-$8B2E       ESC I
008C1E 01CA         dc.w    $8B2E-$8B2E       ESC J
008C20 01F6         dc.w    $8B2E-$8B2E       ESC K
008C22 0320         dc.w    $8B2E-$8B2E       ESC L
008C24 033E         dc.w    $8B2E-$8B2E       ESC M

************************************************  Address table for ESC lowercase
008C26 009E         dc.w    $8B2E-$8B2E       ESC b
008C28 00BE         dc.w    $8B2E-$8B2E       ESC c
008C2A 0366         dc.w    $8B2E-$8B2E       ESC d
008C2C 0382         dc.w    $8B2E-$8B2E       ESC e
008C2E 03D2         dc.w    $8B2E-$8B2E       ESC f
008C30 0000         dc.w    $8B2E-$8B2E       ESC g, rts
008C32 0000         dc.w    $8B2E-$8B2E       ESC h, rts
008C34 0000         dc.w    $8B2E-$8B2E       ESC i, rts
008C36 03F2         dc.w    $8B2E-$8B2E       ESC j
008C38 040E         dc.w    $8B2E-$8B2E       ESC k
008C3A 0428         dc.w    $8B2E-$8B2E       ESC l
008C3C 0000         dc.w    $8B2E-$8B2E       ESC m, rts
008C3E 0000         dc.w    $8B2E-$8B2E       ESC n, rts
008C40 0446         dc.w    $8B2E-$8B2E       ESC o
008C42 029A         dc.w    $8B2E-$8B2E       ESC p
008C44 02A4         dc.w    $8B2E-$8B2E       ESC q
008C46 0000         dc.w    $8B2E-$8B2E       ESC r, rts
008C48 0000         dc.w    $8B2E-$8B2E       ESC s, rts
008C4A 0000         dc.w    $8B2E-$8B2E       ESC t, rts
008C4C 0000         dc.w    $8B2E-$8B2E       ESC u, rts
008C4E 048C         dc.w    $8B2E-$8B2E       ESC v
008C50 0496         dc.w    $8B2E-$8B2E       ESC w
```

```
**************************************************      VDI ESC 1, get screen size
008C52 207900002580        move.l  $2580,A0             Pointer to CONTRL array
008C58 317C00020008        move.w  #2,8(A0)             2 result values
008C5E 20790000258C        move.l  $258C,A0             Pointer to INTOUT array
008C64 303900002550        move.w  $2550,D0             Maximum cursor column (79)
008C6A 5240                addq.w  #1,D0                Plus 1 equals number of columns
008C6C 31400002            move.w  D0,2(A0)             As second result
008C70 303900002552        move.w  $2552,D0             Maximum cursor line (24)
008C76 5240                addq.w  #1,D0                Plus 1 equals number of lines
008C78 3080                move.w  D0,(A0)              As first result
008C7A 4E75                rts

**************************************************      VDI ESC 17
008C7C 3F3C0014            move.w  #$14,-(A7)           Hardcopy
008C80 4E4E                trap    #14
008C82 548F                addq.l  #2,A7                Put stack back in order
008C84 4E75                rts

**************************************************      VDI ESC 3, Enter alpha mode
008C86 6108                bsr     $8C90                ESC E, Clear Home
008C88 60000226            bra     $8EB0                ESC e, Cursor on

**************************************************      VDI ESC 2, Exit alpha mode
008C8C 61000272            bsr     $8F00                ESC f, Cursor off

**************************************************      ESC E, Clear Home
008C90 615E                bsr     $8CF0                ESC H, Cursor Home
008C92 6064                bra     $8CF8                ESC J, Clear rest of screen

**************************************************      ESC A, Cursor up, VDI ESC 4
008C94 323900002562        move.w  $2562,D1             Cursor line
008C9A 67DE                beq     $8C7A                Zero, then done already
```

```
008C9C 5341              subq.w  #1,D1          Subtract one
008C9E 303900002560      move.w  $2560,D0       Get cursor column
008CA4 60000606          bra     $92AC          And set cursor

************************************************* ESC B, Cursor down, VDI ESC 5
008CA8 323900002562      move.w  $2562,D1       Cursor line
008CAE B27900002552      cmp.w   $2552,D1       Compare to maximum cursor line
008CB4 67C4              beq     $8C7A          Already in lowest line, done
008CB6 5241              addq.w  #1,D1          Increment by one
008CB8 303900002560      move.w  $2560,D0       Cursor column
008CBE 600005EC          bra     $92AC          Set cursor

************************************************* ESC C, Cursor right, VDI ESC 6
008CC2 303900002560      move.w  $2560,D0       Cursor column
008CC8 B07900002550      cmp.w   $2550,D0       Compare with maximum value (79)
008CCE 67AA              beq     $8C7A
008CD0 5240              addq.w  #1,D0          Increment by one
008CD2 323900002562      move.w  $2562,D1       Get cursor line
008CD8 600005D2          bra     $92AC          And set cursor

************************************************* ESC D, DEL, Cursor left, VDI ESC 7
008CDC 303900002560      move.w  $2560,D0       Cursor column
008CE2 6796              beq     $8C7A          Already zero ?
008CE4 5340              subq.w  #1,D0          Decrement by one
008CE6 323900002562      move.w  $2562,D1       Cursor line
008CEC 600005BE          bra     $92AC          Set cursor

************************************************* ESC H, Cursor Home, VDI ESC 8
008CF0 7000              moveq.l #0,D0          Column
008CF2 3200              move.w  D0,D1          And line to zero
008CF4 600005B6          bra     $92AC          Set cursor
```

```
*************************************************         ESC J, Clear rest of screen, VDI 9
008CF8 612A                   bsr     $8D24               ESC K, Clear rest of line
008CFA 323900002562           move.w  $2562,D1            Cursor line
008D00 B27900002552           cmp.w   $2552,D1            Compare with maximum cursor line
008D06 6700FF72               beq     $8C7A
008D0A 5241                   addq.w  #1,D1
008D0C 4841                   swap    D1
008D0E 323C0000               move.w  #0,D1
008D12 343900002552           move.w  $2552,D2            Maximum cursor line
008D18 4842                   swap    D2
008D1A 343900002550           move.w  $2550,D2            Maximum cursor column (79)
008D20 60000436               bra     $9158

*************************************************         ESC K, Clear rest of line, VDI ESC 10
008D24 08B9000300002576       bclr    #3,$2576            Clear flag for line overflow
008D2C 40E7                   move.w  SR, -(A7)           Save old value
008D2E 610001D0               bsr     $8F00               ESC f, Cursor off
008D32 610001EC               bsr     $8F20               ESC j, Save cursor position
008D36 323900002560           move.w  $2560,D1            Cursor column
008D3C 08010000               btst    #0,D1
008D40 6716                   beq     $8D58
008D42 B27900002550           cmp.w   $2550,D1            Compare with maximum value (79)
008D48 673A                   beq     $8D84               In last column, then output space
008D4A 323C0020               move.w  #$20,D1             Space
008D4E 6100035E               bsr     $90AE               Output
008D52 323900002560           move.w  $2560,D1            Cursor column
008D58 4841                   swap    D1
008D5A 323900002562           move.w  $2562,D1            Cursor line
008D60 3401                   move.w  D1,D2
008D62 4841                   swap    D1
008D64 4842                   swap    D2
008D66 343900002550           move.w  $2550,D2            Maximum cursor column
```

```
008D6C 610003EA           bsr     $9158
008D70 44DF               move.w  (A7)+,CCR          Restore flag
008D72 6708               beq     $8D7C              Not set ?
008D74 08F9000300002576   bset    #3,$2576           Reset
008D7C 610001BE           bsr     $8F3C              ESC k, Restore cursor position
008D80 6000016C           bra     $8EEE              Re-enable cursor

008D84 323C0020           move.w  #$20,D1            Space
008D88 61000324           bsr     $90AE              Output
008D8C 60E2               bra     $8D70

*************************************************    VDI ESC 11, Set cursor
008D8E 207900002584       move.l  $2584,A0           Pointer to INTIN array
008D94 3210               move.w  (A0),D1            Get line
008D96 5341               subq.w  #1,D1              Minus offset
008D98 30280002           move.w  2(A0),D0           Get column
008D9C 5340               subq.w  #1,D0              Minus offset
008D9E 6000050C           bra     $92AC              Set cursor

*************************************************    VDI ESC 12, Text outout
008DA2 207900002580       move.l  $2580,A0           Pointer to CONTRL array
008DA8 30280006           move.w  6(A0),D0           Number of characters
008DAC 207900002584       move.l  $2584,A0           Pointer to INTIN array
008DB2 600E               bra     $8DC2

008DB4 3218               move.w  (A0)+,D1           Get pointer to D1
008DB6 48E78080           movem.l D0/A0,-(A7)        Restore registers
008DBA 6100FD26           bsr     $8AE2              Output character in D1
008DBE 4CDF0101           movem.l (A7)+,D0/A0        Registers back
008DC2 51C8FFF0           dbra    D0,$8DB4           Output next character
008DC6 4E75               rts
```

```
***********************************************           ESC p, reverse on, VDI ESC 13
008DC8 08F9000400002576      bset    #4,$2576              Set flag for reverse
008DD0 4E75                  rts

***********************************************           ESC q, reverse off, VDI ESC 14
008DD2 08B9000400002576      bclr    #4,$2576              Clear flag for reverse
008DDA 4E75                  rts

***********************************************           VDI ESC 15, Get cursor position
008DDC 207900002580          move.l  $2580,A0              Pointer to CONTRL array
008DE2 317C00020008          move.w  #2,8(A0)              2 result values
008DE8 20790000258C          move.l  $258C,A0              Pointer to INTOUT array
008DEE 303900002562          move.w  $2562,D0              Cursor line
008DF4 5240                  addq.w  #1,D0                 Plus offset
008DF6 3080                  move.w  D0,(A0)               As first result
008DF8 303900002560          move.w  $2560,D0              Cursor column
008DFE 5240                  addq.w  #1,D0                 Plus offset
008E00 31400002              move.w  D0,2(A0)              As second result
008E04 4E75                  rts

***********************************************           VDI ESC 16, Inquire tablet status
008E06 207900002580          move.l  $2580,A0              Pointer to CONTRL array
008E0C 317C00010008          move.w  #1,8(A0)              A result value
008E12 20790000258C          move.l  $258C,A0              Pointer to INTOUT array
008E18 30BC0001              move.w  #1,(A0)               Tablet available
008E1C 4E75                  rts

***********************************************
008E1E 207900002584          move.l  $2584,A0              Pointer to INTIN array
008E24 30BC0000              move.w  #0,(A0)               No result values
008E28 4EF90000FF50          jmp     $FF50                 Set graphic cursor
```

```
*************************************************       VDI ESC 19, Clear graphic cursor
008E2E 4EF90000FF78         jmp      $FF78

****************************************************    ESC I, Cursor up,scroll if needed
008E34 323900002562         move.w   $2562,D1           Cursor line
008E3A 6600FE60             bne      $8C9C              Not in line 0, then cursor up
008E3E 3F3900002560         move.w   $2560,-(A7)        Save cursor column
008E44 6108                 bsr      $8E4E              ESC L, Insert line
008E46 301F                 move.w   (A7)+,D0           Restore cursor column
008E48 7200                 moveq.l  #0,D1              Cursor line to zero
008E4A 60000460             bra      $92AC              Set cursor

****************************************************    ESC L, Insert line
008E4E 610000B0             bsr      $8F00              ESC f, Cursor off
008E52 323900002562         move.w   $2562,D1           Cursor line
008E58 6100056E             bsr      $93C8              Shift remainder of screen down
008E5C 4240                 clr.w    D0                 Cursor in column 0
008E5E 323900002562         move.w   $2562,D1           Cursor line
008E64 61000446             bsr      $92AC              Set cursor
008E68 60000084             bra      $8EEE              Re-enable cursor

****************************************************    ESC M, Clear line
008E6C 61000092             bsr      $8F00              ESC f, Cursor off
008E70 323900002562         move.w   $2562,D1           Cursor line
008E76 61000508             bsr      $9380              Shift remainder of screen up
008E7A 60E0                 bra      $8E5C              See above

****************************************************    Set character color
008E7C C07C000F             and.w    #$F,D0             mod 16, 0..15
008E80 33C000002558         move.w   D0,$2558           Save character color
008E86 4E75                 rts
```

```
**************************************************        Set background color
008E88 C07C000F           and.w    #$F,D0                 mod 16, 0..15
008E8C 33C000002556       move.w   D0,$2556               Save background color
008E92 4E75               rts

**************************************************        ESC d, Clear screen to cursor
008E94 610000DE           bsr      $8F74                  ESC o, Clear line to cursor
008E98 343900002562       move.w   $2562,D2               Cursor line
008E9E 67F2               beq      $8E92                  Already zero, done
008EA0 5342               subq.w   #1,D2
008EA2 4842               swap     D2
008EA4 343900002550       move.w   $2550,D2               Maximum cursor column
008EAA 7200               moveq.l  #0,D1
008EAC 600002AA           bra      $9158

**************************************************        ESC e, Cursor on
008EB0 4A7900002422       tst.w    $2422                  Cursor already on ?
008EB6 67DA               beq      $8E92                  Yes, done
008EB8 427900002422       clr.w    $2422                  Flag for cursor on
008EBE 41F900002576       lea      $2576,A0
008EC4 08100000           btst     #0,(A0)
008EC8 6618               bne      $8EE2
008ECA 08D00002           bset     #2,(A0)
008ECE 303900002560       move.w   $2560,D0               Cursor column
008ED4 323900002562       move.w   $2562,D1               Cursor line
008EDA 6100031C           bsr      $91F8                  Calculate cursor position
008EDE 6000043E           bra      $931E                  Invert character at cursor position

008EE2 61EA               bsr      $8ECE                  Invert character at cursor position
008EE4 08D00001           bset     #1,(A0)
008EE8 08D00002           bset     #2,(A0)
008EEC 4E75               rts
```

```
************************************************
008EEE 4A7900002422         tst.w   $2422          Cursor enabled ?
008EF4 679C                 beq     $8E92          Yes, rts
008EF6 537900002422         subq.w  #1,$2422
008EFC 67C0                 beq     $8EBE          See above
008EFE 4E75                 rts

************************************************   ESC f, Cursor off
008F00 527900002422         addq.w  #1,$2422       Flag for cursor off
008F06 41F900002576         lea     $2576,A0
008F0C 08900002             bclr    #2,(A0)        Clear flag for cursor
008F10 6780                 beq     $8E92          Cursor was already off, rts
008F12 08100000             btst    #0,(A0)
008F16 67B6                 beq     $8ECE
008F18 08900001             bclr    #1,(A0)
008F1C 66B0                 bne     $8ECE
008F1E 4E75                 rts

****************************************************  ESC j, Save cursor position
008F20 08F9000500002576     bset    #5,$2576       Flag for cursor saved
008F28 41F90000242E         lea     $242E,A0       Address of the temp. storage
008F2E 30F900002560         move.w  $2560,(A0)+    Cursor column
008F34 30B900002562         move.w  $2562,(A0)     Cursor line
008F3A 4E75                 rts

****************************************************  ESC k, Cursor to saved position
008F3C 08B9000500002576     bclr    #5,$2576       Was cursor position saved ?
008F44 6700FDAA             beq     $8CF0          No
008F48 41F90000242E         lea     $242E,A0       Address of the temp. stroage
008F4E 3018                 move.w  (A0)+,D0       Cursor column
008F50 3210                 move.w  (A0),D1        Cursor line
008F52 60000358             bra     $92AC          Set cursor
```

```
*************************************************    ESC l, delete line
008F56 61A8           bsr     $8F00                  ESC f, turn cursor off
008F58 323900002562   move.w  $2562,D1               Cursor line
008F5E 3401           move.w  D1,D2
008F60 4841           swap    D1
008F62 4241           clr.w   D1
008F64 4842           swap    D2
008F66 343900002550   move.w  $2550,D2               Maximum cursor column
008F6C 610001EA       bsr     $9158
008F70 6000FEEA       bra     $8E5C                  Cursor in column zero

*************************************************    ESC o, Clear line to cursor
008F74 618A           bsr     $8F00                  ESC f, Turn cursor off
008F76 61A8           bsr     $8F20                  ESC j, Save cursor position
008F78 343900002560   move.w  $2560,D2               Cursor column
008F7E 6730           beq     $8FB0                  Zero, then done
008F80 08020000       btst    #0,D2
008F84 6610           bne     $8F96
008F86 323C0020       move.w  #$20,D1                Space
008F8A 61000122       bsr     $90AE                  Output
008F8E 343900002560   move.w  $2560,D2               Cursor column
008F94 5542           subq.w  #2,D2
008F96 4842           swap    D2
008F98 343900002562   move.w  $2562,D2               Cursor line
008F9E 3202           move.w  D2,D1
008FA0 4842           swap    D2
008FA2 4841           swap    D1
008FA4 4241           clr.w   D1
008FA6 610001B0       bsr     $9158
008FAA 6190           bsr     $8F3C                  ESC k, Restore cursor position
008FAC 6000FF40       bra     $8EEE                  And turn cursor back on
008FB0 323C0020       move.w  #$20,D1                Space
```

```
008FB4 610000F8           bsr     $90AE         Output
008FB8 60F0               bra     $8FAA

************************************************* ESC v, New line at end of line
008FBA 08F9000300002576   bset    #3,$2576      Set flag
008FC2 4E75               rts

************************************************* ESC w, No new line at end of line
008FC4 08B9000300002576   bclr    #3,$2576      Clear flag
008FCC 4E75               rts

************************************************* CR, Cursor in column zero
008FCE 323900002562       move.w  $2562,D1      Cursor line
008FD4 4240               clr.w   D0            Column to zero
008FD6 600002D4           bra     $92AC         Set cursor

************************************************* LF, (VT, FF), Cursor down
008FDA 303900002562       move.w  $2562,D0      Cursor line
008FE0 B07900002552       cmp.w   $2552,D0      Compare with maximum cursor line
008FE6 6600FCC0           bne     $8CA8         Not in lowest linme, just cursor down
008FEA 6100FF14           bsr     $8F00         ESC f, Turn cursor off
008FEE 4241               clr.w   D1
008FF0 6100038E           bsr     $9380         Scroll screen down
008FF4 6000FEF8           bra     $8EEE         And turn cursor back on

************************************************* Flash cursor
008FF8 41F900002576       lea     $2576,A0      Address of the flag word
008FFE 08100002           btst    #2,(A0)       Cursor on ?
009002 671E               beq     $9022         No
009004 08100000           btst    #0,(A0)       Cursor flashing ?
009008 6718               beq     $9022         No
00900A 43F900002565       lea     $2565,A1      Address of the flash counter
```

```
009010 5311             subq.b  #1,(A1)            Decrement counter
009012 660E             bne     $9022              Not yet run down ?
009014 12B900002564     move.b  $2564,(A1)         Reload flash counter
00901A 08500001         bchg    #1,(A0)            Invert cursor phase
00901E 6000FEAE         bra     $8ECE              Turn cursor off

009022 4E75             rts

*************************************************  Cursor configuration, XBIOS No. 21
009024 302F0004         move.w  4(A7),D0           Get number from stack
009028 6BF8             bmi     $9022              Negative, ignore
00902A B07C0005         cmp.w   #5,D0              Greater than 5 ?
00902E 6EF2             bgt     $9022              Yes, ignore
009030 E340             asl.w   #1,D0
009032 41F90000904A     lea     $904A,A0           Base address of the table
009038 D0FB0004         add.w   $903E(PC,D0.w),A0  Plus relative address
00903C 4ED0             jmp     (A0)               Execute function

*************************************************  Address of the routines
00903E 0000             dc.w    $904A-$904A
009040 0004             dc.w    $904E-$904A
009042 0008             dc.w    $9052-$904A
009044 0016             dc.w    $9060-$904A
009046 0024             dc.w    $906E-$904A
009048 002C             dc.w    $9076-$904A

*************************************************  0
00904A 6000FEB4         bra     $8F00              ESC f, Turn cursor off

*************************************************  1
00904E 6000FE60         bra     $8EB0              ESC e, Turn cursor on
```

```
*************************************************    2
009052 6100FEAC           bsr     $8F00             ESC f, Turn cursor off
009056 08ED00002576       bset    #0,$2576(A5)
00905C 6000FE90           bra     $8EEE             Turn cursor back on

*************************************************    3
009060 6100FE9E           bsr     $8F00             ESC f, Turn cursor off
009064 08AD00002576       bclr    #0,$2576(A5)
00906A 6000FE82           bra     $8EEE             Turn cursor back on

*************************************************    4
00906E 1B6F00072564       move.b  7(A7),$2564(A5)   Set cursor flash rate
009074 4E75               rts

*************************************************    5
009076 7000               moveq.l #0,D0
009078 102D2564           move.b  $2564(A5),D0      Load cursor flash rate
00907C 4E75               rts

************************************************    Calculate font data for character in D1
00907E 36390000256C       move.w  $256C,D3          Smallest ASCCI code in font
009084 B243               cmp.w   D3,D1             Compare with character to output
009086 6522               bcs     $90AA             Character not in font
009088 B2790000256A       cmp.w   $256A,D1          Largest ASCII code in font
00908E 621A               bhi     $90AA             Character not in font
009090 207900002572       move.l  $2572,A0          Load font offset pointer
009096 D241               add.w   D1,D1             Code times two
009098 32301000           move.w  (A0,D1.w),D1      Yields bit number in font
00909C E649               lsr.w   #3,D1             Divided by 8 yields byte number
00909E 207900002566       move.l  $2566,A0          Pointer to font data
0090A4 D0C1               add.w   D1,A0             Yields pointer to data for this character
0090A6 4243               clr.w   D3                Flag for character in font
```

```
0090A8 4E75                  rts
0090AA 7601                  moveq.l #1,D3           Character not present in font
0090AC 4E75                  rts

************************************************      ascout, ignore control codes
0090AE 61CE                  bsr     $907E           Character present in font ?
0090B0 6702                  beq     $90B4           Yes
0090B2 4E75                  rts

0090B4 22790000255A          move.l  $255A,A1        Screen address of the character
0090BA 3E3900002556          move.w  $2556,D7        Background color
0090C0 4847                  swap    D7              In upper word
0090C2 3E3900002558          move.w  $2558,D7        Character color in lower word
0090C8 083900040002576       btst    #4,$2576        Reverse turned on ?
0090D0 6702                  beq     $90D4           No
0090D2 4847                  swap    D7              Exchange character and background colors
0090D4 08B9000200002576      bclr    #2,$2576
0090DC 40E7                  move.w  SR, -(A7)       Save status
0090DE 61000160              bsr     $9240           Calculate new position
0090E2 22790000255A          move.l  $255A,A1        Screen address
0090E8 303900002560          move.w  $2560,D0        Cursor column
0090EE 323900002562          move.w  $2562,D1        Cursor line
0090F4 61000252              bsr     $9348           Calculate relative screen address
0090F8 6732                  beq     $912C
0090FA 303900002554          move.w  $2554,D0        Number of bytes per character line
009100 C0C1                  mulu.w  D1,D0
009102 22790000044E          move.l  $44E,A1         Address of the screen RAM
009108 D3C0                  add.l   D0,A1
00910A 4240                  clr.w   D0
00910C B27900002552          cmp.w   $2552,D1        Compare with maximum cursor line
009112 640A                  bcc     $911E
009114 D2F900002554          add.w   $2554,A1        Plus number of bytes per character line
```

```
00911A 5241                 addq.w  #1,D1
00911C 600E                 bra     $912C
00911E 48E7C040             movem.l D0-D1/A1,-(A7)     Save registers
009122 7200                 moveq.l #0,D1
009124 6100025A             bsr     $9380
009128 4CDF0203             movem.l (A7)+,D0-D1/A1     Restore registers
00912C 23C90000255A         move.l  A1,$255A           Screen address
009132 33C000002560         move.w  D0,$2560           Cursor column
009138 33C100002562         move.w  D1,$2562           Cursor line
00913E 44DF                 move.w  (A7)+,CCR          Restore status
009140 6714                 beq     $9156
009142 610001DA             bsr     $931E
009146 08F9000100002576     bset    #1,$2576
00914E 08F9000200002576     bset    #2,$2576
009156 4E75                 rts

009158 9481                 sub.l   D1,D2
00915A 3001                 move.w  D1,D0
00915C 4841                 swap    D1
00915E 61000098             bsr     $91F8              Calculate cursor position
009162 E242                 asr.w   #1,D2
009164 36390000257C         move.w  $257C,D3           Number of screen planes (1,2 or 4)
00916A 0C430004             cmp.w   #4,D3
00916E 6602                 bne     $9172
009170 5343                 subq.w  #1,D3
009172 3202                 move.w  D2,D1
009174 5241                 addq.w  #1,D1
009176 E761                 asl.w   D3,D1
009178 34790000257E         move.w  $257E,A2           Bytes per screen line
00917E 94C1                 sub.w   D1,A2
009180 3202                 move.w  D2,D1
009182 4842                 swap    D2
```

```
009184 5242             addq.w  #1,D2         Times height of a character
009186 C4F90000254E     mulu.w  $254E,D2
00918C 5342             subq.w  #1,D2
00918E 4280             clr.l   D0
009190 3A3900002556     move.w  $2556,D5      Background color
009196 0C790002000257C  cmp.w   #2,$257C      Number of screen levels
00919E 6B44             bmi     $91E4
0091A0 6728             beq     $91CA
0091A2 E245             asr.w   #1,D5
0091A4 4040             negx.w  D0
0091A6 4840             swap    D0
0091A8 E245             asr.w   #1,D5
0091AA 4040             negx.w  D0
0091AC 4283             clr.l   D3
0091AE E245             asr.w   #1,D5
0091B0 4043             negx.w  D3
0091B2 4843             swap    D3
0091B4 E245             asr.w   #1,D5
0091B6 4043             negx.w  D3
0091B8 3A01             move.w  D1,D5
0091BA 22C0             move.l  D0,(A1)+
0091BC 22C3             move.l  D3,(A1)+
0091BE 51CDFFFA         dbra    D5,$91BA
0091C2 D3CA             add.l   A2,A1
0091C4 51CAFFF2         dbra    D2,$91B8
0091C8 4E75             rts

0091CA E245             asr.w   #1,D5
0091CC 4040             negx.w  D0
0091CE 4840             swap    D0
0091D0 E245             asr.w   #1,D5
0091D2 4040             negx.w  D0
```

```
0091D4 3A01              move.w  D1,D5
0091D6 22C0              move.l  D0,(A1)+
0091D8 51CDFFFC          dbra    D5,$91D6
0091DC D3CA              add.l   A2,A1
0091DE 51CAFFF4          dbra    D2,$91D4
0091E2 4E75              rts

0091E4 E245              asr.w   #1,D5
0091E6 4040              negx.w  D0
0091E8 3A01              move.w  D1,D5
0091EA 32C0              move.w  D0,(A1)+
0091EC 51CDFFFC          dbra    D5,$91EA
0091F0 D3CA              add.l   A2,A1
0091F2 51CAFFF4          dbra    D2,$91E8
0091F6 4E75              rts

*************************************************   Calculate cursor position (D0/D1)
0091F8 363900002550      move.w  $2550,D3          Maximum cursor column
0091FE B640              cmp.w   D0,D3
009200 6A02              bpl     $9204             Column value smaller ?
009202 3003              move.w  D3,D0             Else use max value
009204 363900002552      move.w  $2552,D3          Maximum cursor line
00920A B641              cmp.w   D1,D3
00920C 6A02              bpl     $9210             Line value smaller ?
00920E 3203              move.w  D3,D1             Else use maximum value
009210 36390000257C      move.w  $257C,D3          Number of screen planes
009216 3A00              move.w  D0,D5             Column to D5
009218 08850000          bclr    #0,D5
00921C C6C5              mulu.w  D5,D3             Times maximum value
00921E 08000000          btst    #0,D0
009222 6702              beq     $9226
009224 5283              addq.l  #1,D3
```

```
009226 3A3900002554       move.w  $2554,D5      Number of bytes per character line
00922C CAC1               mulu.w  D1,D5         Times line value
00922E 22790000044E       move.l  $44E,A1       Base address of the screen RAM
009234 D3C5               add.l   D5,A1         Plus offset for line
009236 D3C3               add.l   D3,A1         Plus offset for column
009238 D2F90000255E       add.w   $255E,A1      Plus number of bytes per raster line
00923E 4E75               rts

009240 34790000256E       move.w  $256E,A2      formwidth
009246 36790000257E       move.w  $257E,A3      Bytes per screen line
00924C 38390000254E       move.w  $254E,D4      Height of a character
009252 5344               subq.w  #1,D4
009254 3C390000257C       move.w  $257C,D6      Number of screen planes
00925A 5346               subq.w  #1,D6
00925C 3A04               move.w  D4,D5
00925E 2848               move.l  A0,A4
009260 2A49               move.l  A1,A5
009262 E287               asr.l   #1,D7
009264 0807000F           btst    #15,D7
009268 6706               beq     $9270
00926A 642A               bcc     $9296
00926C 76FF               moveq.l #-1,D3
00926E 6004               bra     $9274
009270 6512               bcs     $9284
009272 7600               moveq.l #0,D3
009274 1A83               move.b  D3,(A5)
009276 DACB               add.w   A3,A5
009278 51CDFFFA           dbra    D5,$9274
00927C 5449               addq.w  #2,A1
00927E 51CEFFDC           dbra    D6,$925C
009282 4E75               rts
```

```
009284 1A94            move.b  (A4),(A5)
009286 DACB            add.w   A3,A5
009288 D8CA            add.w   A2,A4
00928A 51CDFFF8        dbra    D5,$9284
00928E 5449            addq.w  #2,A1
009290 51CEFFCA        dbra    D6,$925C
009294 4E75            rts

009296 1614            move.b  (A4),D3
009298 4603            not.b   D3
00929A 1A83            move.b  D3,(A5)
00929C DACB            add.w   A3,A5
00929E D8CA            add.w   A2,A4
0092A0 51CDFFF4        dbra    D5,$9296
0092A4 5449            addq.w  #2,A1
0092A6 51CEFFB4        dbra    D6,$925C
0092AA 4E75            rts

***************************************************     Set cursor
0092AC B07900002550    cmp.w   $2550,D0                 Compare column with maximum value
0092B2 6306            bls     $92BA                    Smaller ?
0092B4 303900002550    move.w  $2550,D0                 Else use maximum value
0092BA B27900002552    cmp.w   $2552,D1                 Compare line with maximum value
0092C0 6306            bls     $92C8                    Smaller ?
0092C2 323900002552    move.w  $2552,D1                 Else use maximum value
0092C8 33C000002560    move.w  D0,$2560                 Save cursor column
0092CE 33C100002562    move.w  D1,$2562                 Save cursor line
0092D4 41F900002576    lea     $2576,A0                 Address of the cursor flag
0092DA 08100002        btst    #2,(A0)
0092DE 6732            beq     $9312
0092E0 08100000        btst    #0,(A0)                  Character inverted at old position?
0092E4 670A            beq     $92F0                    Yes
```

```
0092E6 08900002            bclr    #2,(A0)
0092EA 08100001            btst    #1,(A0)
0092EE 671E                beq     $930E
0092F0 22790000255A        move.l  $255A,A1       Screen address of old cursor
0092F6 6126                bsr     $931E          Invert character at cursor position
0092F8 6100FEFE            bsr     $91F8          Calculate new cursor address
0092FC 23C90000255A        move.l  A1,$255A       Screen address of the cursor
009302 611A                bsr     $931E          Invert character at cursor position
009304 08F9000200002576    bset    #2,$2576       Flag for character is inverted
00930C 4E75                rts

00930E 08D00002            bset    #2,(A0)
009312 6100FEE4            bsr     $91F8          Calculate new cursor position
009316 23C90000255A        move.l  A1,$255A       Screen address of the cursor position
00931C 4E75                rts

*************************************************  Invert character at cursor position
00931E 34790000257E        move.w  $257E,A2       Bytes per screen line
009324 38390000254E        move.w  $254E,D4       Height of a screen line
00932A 5344                subq.w  #1,D4          As dbra counter
00932C 3C390000257C        move.w  $257C,D6       Number of screen planes
009332 5346                subq.w  #1,D6          As dbra counter
009334 3A04                move.w  D4,D5          Counter for raster lines
009336 2849                move.l  A1,A4          Screen address of the character
009338 4614                not.b   (A4)           Invert a raster line of the character
00933A D8CA                add.w   A2,A4          Pointer to next raster line
00933C 51CDFFFA            dbra    D5,$9338       Next raster line
009340 5449                addq.w  #2,A1
009342 51CEFFF0            dbra    D6,$9334       Next screen level
009346 4E75                rts

**************************************************
```

```
009348 B07900002550         cmp.w   $2550,D0         Maximum cursor column
00934E 6612                 bne     $9362
009350 0839000300002576     btst    #3,$2576         Flag for line overflow set ?
009358 6604                 bne     $935E            Yes
00935A 4243                 clr.w   D3
00935C 4E75                 rts

00935E 7601                 moveq.l #1,D3
009360 4E75                 rts

009362 5240                 addq.w  #1,D0
009364 08000000             btst    #0,D0
009368 6706                 beq     $9370
00936A 5249                 addq.w  #1,A1
00936C 4243                 clr.w   D3
00936E 4E75                 rts

009370 36390000257C         move.w  $257C,D3         Number of screen levels
009376 E343                 asl.w   #1,D3
009378 5343                 subq.w  #1,D3
00937A D2C3                 add.w   D3,A1
00937C 4243                 clr.w   D3
00937E 4E75                 rts

*************************************************     Scroll screen down at line D1
009380 26790000044E         move.l  $44E,A3          Address of the screen RAM
009386 363900002554         move.w  $2554,D3         Number of bytes per character line
00938C C6C1                 mulu.w  D1,D3            Multitply by number of lines
00938E 47F33000             lea     0(A3,D3.w),A3    Yields address of the line
009392 4441                 neg.w   D1               Current line
009394 D27900002552         add.w   $2552,D1         Maximum cursor line
00939A 363900002554         move.w  $2554,D3         Number of bytes per character line
```

```
0093A0 45F33000          lea     0(A3,D3.w),A2     Yields address of line 1
0093A4 C6C1              mulu.w  D1,D3             Number of bytes to move
0093A6 E443              asr.w   #2,D3             Number of long words
0093A8 6002              bra     $93AC
0093AA 26DA              move.l  (A2)+,(A3)+       Copy screen lines
0093AC 51CBFFFC          dbra    D3,$93AA
0093B0 323900002552      move.w  $2552,D1          Maximum cursor line
0093B6 3401              move.w  D1,D2
0093B8 4841              swap    D1
0093BA 4842              swap    D2
0093BC 4241              clr.w   D1
0093BE 343900002550      move.w  $2550,D2          Maximum cursor column
0093C4 6000FD92          bra     $9158

*************************************************  Scroll screen at line D1 up
0093C8 26790000044E      move.l  $44E,A3           Address of the screen RAM
0093CE 363900002552      move.w  $2552,D3          Maximum cursor line
0093D4 C6F900002554      mulu.w  $2554,D3          Mult by number of bytes per character line
0093DA 47F33000          lea     (A3,D3.w),A3      Yields address of last character line
0093DE 363900002554      move.w  $2554,D3          Number of bytes per line
0093E4 45F33000          lea     (A3,D3.w),A2      Yields address of line 1
0093E8 3001              move.w  D1,D0             Current line
0093EA 4440              neg.w   D0
0093EC D07900002552      add.w   $2552,D0          Add maximum cursor line
0093F2 C6C0              mulu.w  D0,D3
0093F4 E443              asr.w   #2,D3             Divide by 4 for long word transfer
0093F6 6002              bra     $93FA
0093F8 2523              move.l  -(A3),-(A2)       Copy screen lines
0093FA 51CBFFFC          dbra    D3,$93F8
0093FE 60B6              bra     $93B6
```

```
*************************************************     VDI ESC 102, initialize font parameters
009400 207900002584         move.l  $2584,A0          Pointer to INTIN array
009406 2050                 move.l  (A0),A0           Address of the font header
009408 30280052             move.w  82(A0),D0         formheight, height of a character
00940C 33C00000254E         move.w  D0,$254E          merken
009412 32390000257E         move.w  $257E,D1          Bytes per screen line
009418 C2C0                 mulu.w  D0,D1             Times height of character
00941A 33C100002554         move.w  D1,$2554          Yields bytes per character line
009420 7200                 moveq.l #0,D1
009422 323900002578         move.w  $2578,D1          Number of raster lines on the screen
009428 82C0                 divu.w  D0,D1             Divide by font height
00942A 5341                 subq.w  #1,D1             Minus
00942C 33C100002552         move.w  D1,$2552          Yields maximum cursor line
009432 7200                 moveq.l #0,D1
009434 323900002570         move.w  $2570,D1          Screen width in bits
00943A 82E80034             divu.w  52(A0),D1         Divide by maximum character width
00943E 5341                 subq.w  #1,D1             Minus 1
009440 33C100002550         move.w  D1,$2550          Yields maximum cursor column
009446 33E80050000256E      move.w  80(A0),$256E      formwidth, width of the font
00944E 33E80024000256C      move.w  36(A0),$256C      Smallest ASCII code in font
009456 33E80026000256A      move.w  38(A0),$256A      Largest ASCII code in font
00945E 23E8004C00002566     move.l  76(A0),$2566      Pointer to font data
009466 23E8004800002572     move.l  72(A0),$2572      Pointer to offset table
00946E 4E75                 rts
```

```
***************************************************
00F6C4 10390000044C          move.b  $44C,D0          Initialze screen output
                                                      sshiftmd, screen resolution
00F6CA C07C0003              and.w   #3,D0            Isolate bits 0 and 1
00F6CE B07C0003              cmp.w   #3,D0            3 ?
00F6D2 6604                  bne     $F6D8            No
00F6D4 303C0002              move.w  #2,D0            Replace with 2 (high resolution)
00F6D8 3F00                  move.w  D0,-(A7)         Save resolution
00F6DA 6100007E              bsr     $F75A            Set parameters for scren resolution
00F6DE 301F                  move.w  (A7)+,D0         Restore resolution
00F6E0 41F900017EAA          lea     $17EAA,A0        Address of the 8x8 system font
00F6E6 B07C0002              cmp.w   #2,D0            High resolution ?
00F6EA 6606                  bne     $F6F2            No
00F6EC 41F900018906          lea     $18906,A0        Address of the 8x16 system font
00F6F2 61009D14              bsr     $9408            Initialize font data
00F6F6 33FCFFFF00002558      move.w  #$FFFF,$2558     Character color to black
00F6FE 7000                  moveq.l #0,D0
00F700 33C000002556          move.w  D0,$2556         Background color white
00F706 33C000002560          move.w  D0,$2560         Cursor column zero
00F70C 33C000002562          move.w  D0,$2562         Cursor line zero
00F712 33C00000255E          move.w  D0,$255E
00F718 20790000044E          move.l  $44E,A0          Address of the video RAM
00F71E 23C80000255A          move.l  A0,$255A         As screen address of the cursor
00F724 13FC000100002576      move.b  #1,$2576         Set cursor flag
00F72C 13FC001E00002565      move.b  #$1E,$2565       Cursor flash counter to 30
00F734 13FC001E00002564      move.b  #$1E,$2564       Cursor flash rate to 30
00F73C 33FC000100002422      move.w  #1,$2422         Set flag for cursor on
00F744 323C1F3F              move.w  #$1F3F,D1        8000 long words
00F748 20C0                  move.l  D0,(A0)+         Clear screen
00F74A 51C9FFFC              dbra    D1,$F748
00F74E 23FC00008AEE000004A8  move.l  #$8AEE,$4A8      conout vector to standard
00F758 4E75                  rts
```

```
*********************************************          Initialize screen output
00F75A 7200              moveq.l #0,D1                 D0 contains screen resolution
00F75C 123B0030          move.b  $F78E(PC,D0.w),D1     Get number of screen planes
00F760 33C10000257C      move.w  D1,$257C              And save
00F766 123B0029          move.b  $F791(PC,D0.w),D1     Get bytes per screen line
00F76A 33C10000257E      move.w  D1,$257E              And save
00F770 33C10000257A      move.w  D1,$257A
00F776 E340              asl.w   #1,D0
00F778 323B001A          move.w  $F794(PC,D0.w),D1     Get screen height
00F77C 33C100002578      move.w  D1,$2578              And save
00F782 323B0016          move.w  $F79A(PC,D0.w),D1     Get screen height
00F786 33C100002570      move.w  D1,$2570              And save
00F78C 4E75              rts

*************************************************      Screen parameters
00F78E 040201            dc.b    4,2,1                 Number of screen planes
00F791 A0A050            dc.b    160,160,80            Bytes per screen line
00F794 00C800C80190      dc.w    200,200,400           Screen heights
00F79A 014002800280      dc.w    320,640,640           Screen widths
```

Note: This BIOS listing contains some of the most important sections of TOS Version 1. Later versions of TOS may have some minor differences, but this listing should still prove valuable.

Chapter Four

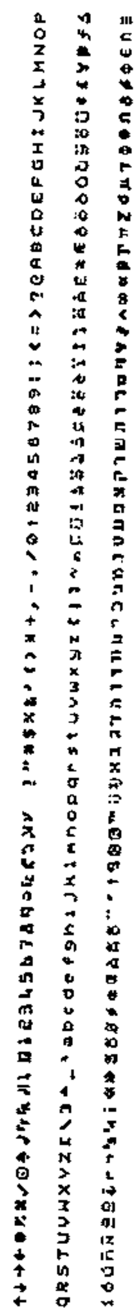
Appendix

4.1 The System Fonts

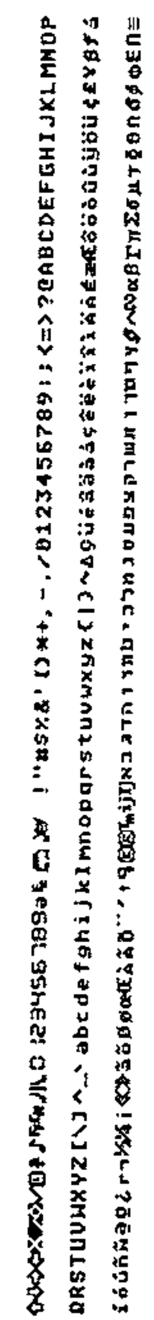
The operating system contains three system fonts for character output.

The 6X6 font is used by the Icons, the 8X8 font is the standard font for output on the color monitor, and the 8X16 font is used for the monochrome monitor output. The chart on the next page includes the characters with the ASCII codes 1 to 255.

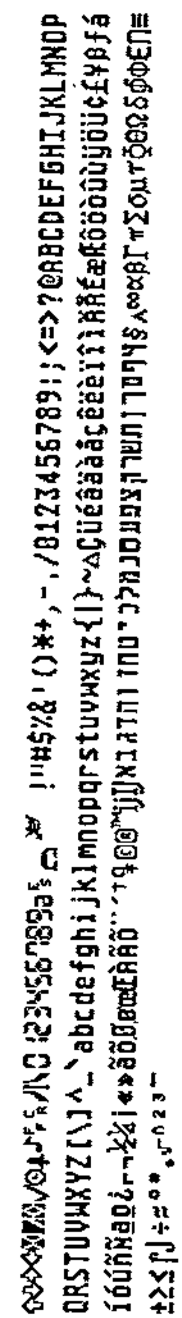
6X6 System Font



8X8 System Font



8X16 System Font



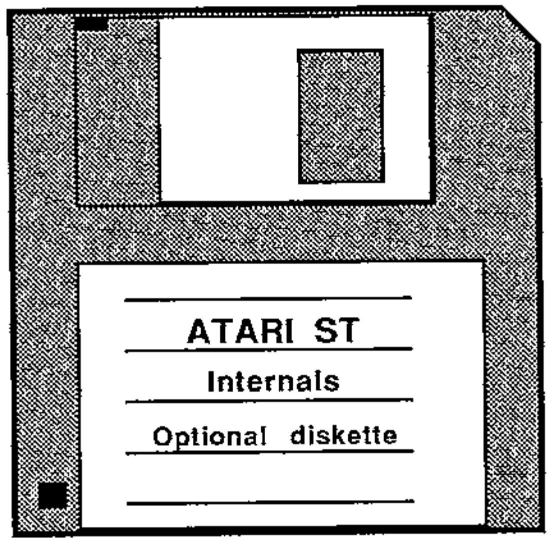
4.2 Alphabetical listing of GEMDOS functions

Name	Opcode (hex)	Page Number
Cauxin	03	106
Cauxis	12	111
Cauxos	13	111
Cauxout	04	106
Cconin	01	105
Cconis	0B	110
Cconos	10	111
Cconout	02	106
Cconrs	0A	109
Cconws	09	109
Cnecin	08	108
Cprnos	11	111
Cprnout	05	107
Crawcin	07	108
Crawio	06	107
Dcreate	39	117
Ddelete	3A	118
Dfree	36	116
Dgetdrv	19	111
Dgetpath	47	128
Dsetdrv	0E	110
Dsetpath	3B	119
Fattrib	43	126
Fclose	3E	122
Fcreate	3C	120
Fdatime	57	137
Fdelete	41	124
Fdup	45	128
Fforce	46	128
Fgetdta	2F	115
Fopen	3D	121
Fread	3F	123
Frename	56	136
Fseek	42	125
Fsetdta	1A	112
Fsfirst	4E	134
Fsnext	4F	136
Fwrite	40	124

Malloc	48	129
Mfree	49	130
Mshrink	4A	131
Pexec	4B	132
Pterm	4C	133
Pterm0	00	105
Ptermres	31	115
Super	20	112
Sversion	30	115
Tgetdate	2A	113
Tgettime	2C	114
Tsetdate	2B	114
Tsettime	2D	115

Index

Optional Diskette



For your convenience, the program listings contained in this book are available on an SF354 formatted floppy disk. You should order the diskette if you want to use the programs, but don't want to type them in from the listings in the book.

All programs on the diskette have been fully tested. You can change the programs for your particular needs. The diskette is available for $14.95 plus $2.00 ($5.00 foreign) for postage and handling.

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Abacus Software
P.O. Box 7219
Grand Rapids, MI 49510

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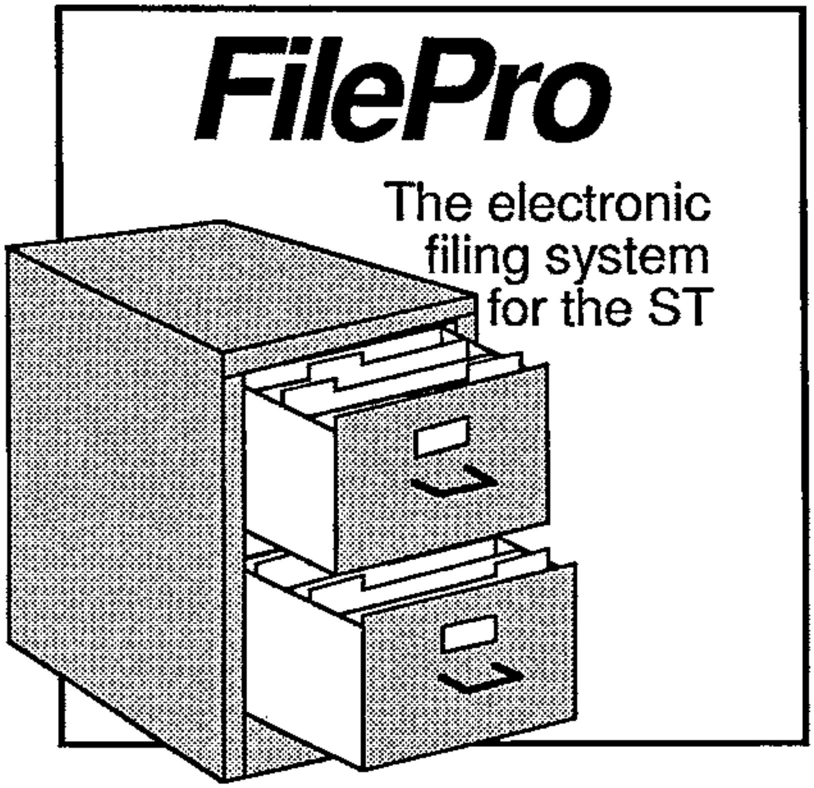
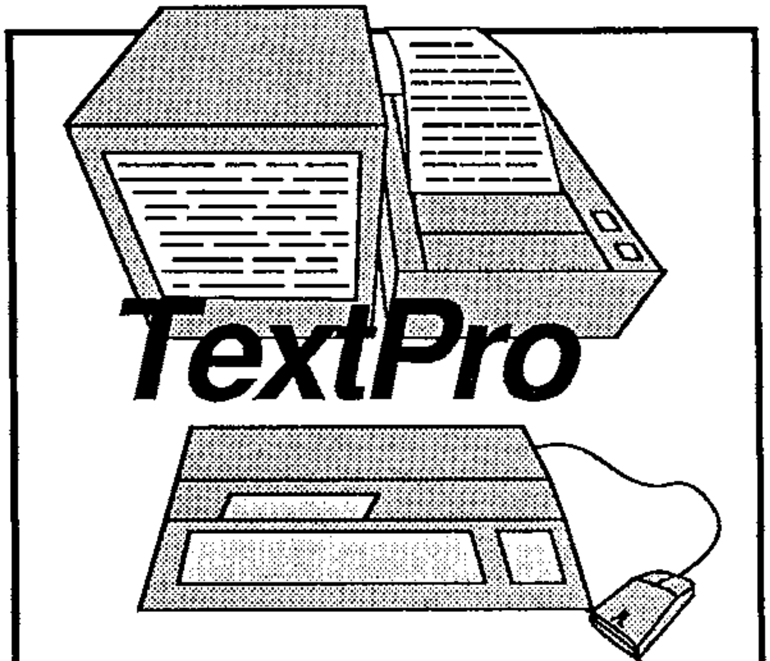
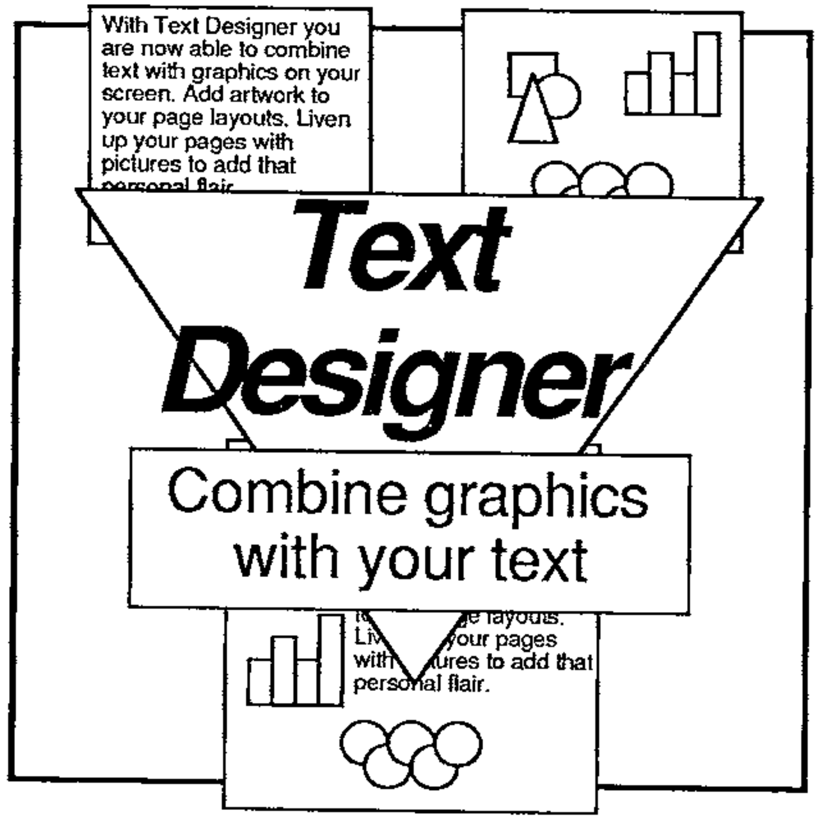


FilePro is a simple to use but flexible data manager. The drop-down menus allow you to quickly define your file and enter your information through screen templates. **FilePro** has many unique features: store data items in different type styles; create subsets of a file; change file definition and format; includes and supports a RAM disk for high speed operation. **FilePro** also has a fast search and sort capabilities, can handle records up to 64,000 characters in length, allows numerical values with up to 15 significant digits, accesses up to 4 files simutaneously, indexes up to 20 different fields per file and has complete, built-in reporting capabilities. $49.95

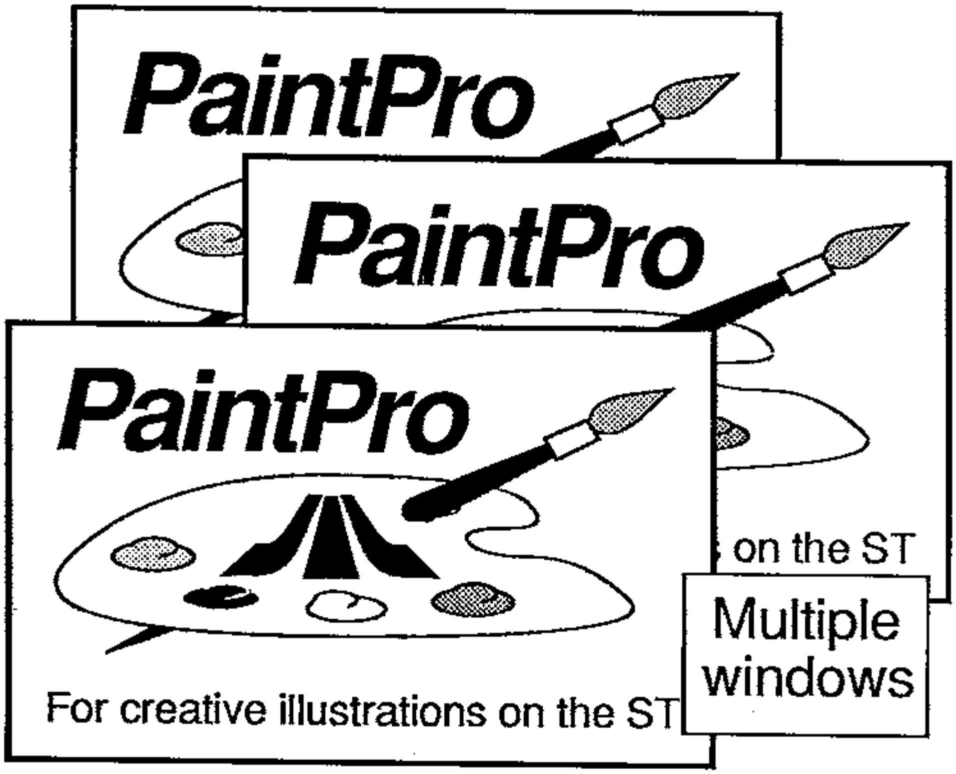


Word processor for the ST

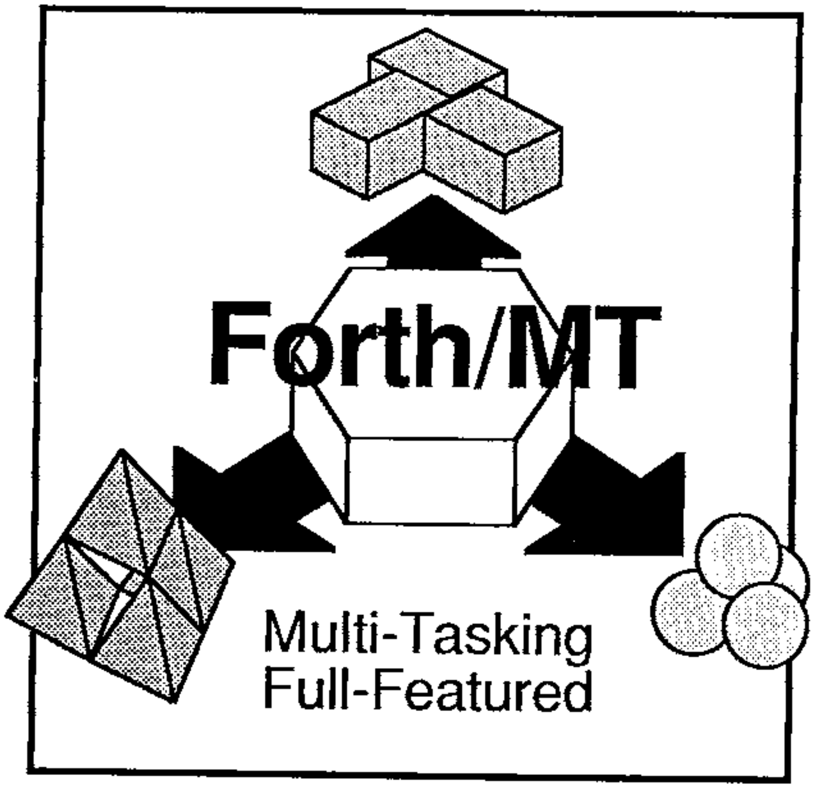
TextPro is a professional quality wordprocessor. In addition to the standard options found in most other word processors, **TextPro** features multi-column output automatic indexing and table of contents, sideways printing (to Epson printers), up to 30 user definable function keys, mode for editing C language source programs and flexible printer driver installation. It is designed with fast entry of text in mind. The advanced **TextPro** user can substitute shortcut keyboard commands for the drop-down menu commands. $49.95



TextDesigner is an ideal package for page layout on the ST allowing you to interlace graphics with text. **TextDesigner** reduces the steps and time involved in preparing professional documents and newsletters. Use the tools provided for borders, lines, text, etc. or cut and paste from **PaintPro**, Doodle, Degas, **TextPro** and other ASCII word processors. **TextDesigner** is a simple to use and versatile package which will give you the professional results you deserve at a reasonable cost. $49.95



PaintPro is a friendly, yet powerful design and painting package for drawing graphic and artistic pictures. This GEM-based package supports up to three active windows and has a complete toolkit of functions: free-form sketching, lines, circles, ellipses, boxes, fill, copy, move, spray, zoom, undo, help and extensive text capabilities. You can also import "foreign" pictures for enhancement using **Paintpro**'s double-sized picture format and send hardcopy to most popular dot-matrix printers. **PaintPro** works with either monochrome or color systems. $49.95



Forth/MT, the multi-tasking, full-featured Forth language for the ST, is for serious programmers. **Forth/MT** is a complete, 32-bit implementation based on Forth '83 standard. Includes many development aids: full screen editor, monitor, macro assembler, over 1500 word library. Includes TOS, LINEA, floating-point and complex arithmetic commands. $49.95

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