FHL
Eliminator High Speed CoCo Hard Drive Kit Instructions

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Before you start

Congratulations on your decision to buy a FHL *Eliminator* Hard Drive Kit. We at FHL try to make all of our products easy to use and this kit is no exception. If you have any trouble during construction please give us a call, we'll be glad to help.

You'll need to prepare a place to build your system, the kitchen table, a desk top, etc will do just fine. You'll need some tools: a phillips screwdriver and maybe a pair of cutters is all you'll need.

Unpack the boxes being VERY careful with the hard drive itself.

ALWAYS KEEP THE HARD DRIVE ON FOAM UNTIL MOUNTED!!!

The hard drive is **VERY** sensitive to shock when it is not mounted via its shock mounting. Dropping it just 1/2 inch on a hard surface could damage it. After it is mounted you don't have to be so careful with it.

If you ever have to ship your system, make sure that it is packed in at least 2 inches of SOFT foam all around. Your goal is to have the system 'float' in the shipping box. Look at the way the hard drive is packed.

Keep the shipping boxes for at least a month. If you have problems with the system they will probably occur in the first month. Once you get past that you've got it made. However, remember that whatever is not backed up is lost if you have a failure. I speak from experience.

Here is a list of what you should find in the boxes:

Hard Drive Case:
Packaged inside is a bag with the:
__power cord
__1 or 2 metal cover plates
__a plastic drive plate cover
__another small bag of screws

Hard Drive Box:
Inside this box besides the hard drive is:
__the WD1002-05 controller for the hard drive
__1 20 pin ribbon cable for the controller to hard drive
__1 34 pin ribbon cable for the controller to hard drive
__1 40 pin ribbon cable for the interface to controller
__1 34 pin ribbon cable for the controller to floppy (optional)
__the *Eliminator* interface and its instructions.
__a information sheet on your hard drive.

Let's build this thang!

√ Check off the things as you do them.

__Take the hard drive case and turn it upside down on the bench.

__Remove the four screws that holds the top.

__Remove the top. Carefully unplug the LED wire as you do.

__Tighten all the remaining screws in the case including the ones that hold the power supply in the case.

__Install the WD1002-05 controller in the bottom of the case. Install the power connector to the board before tightening the mounting screws. **Make sure the screws that mount the brackets do not touch the bottom of the board!** Install washers if they do.

__ Thread the 40 pin ribbon cable thru the back panel and connect to the WD1002-05 board. Observe pin one.

__Connect the 34 pin floppy cable to the board. It connects on the right side near the 40 pin cable. Route the end out the rear with the 40 pin cable. Observe pin 1.

__Connect the 20 pin and the 34 pin hard drive cables to the board. This 34 pin cable connects near the 20 pin cable. Refer to the Isted interface manual.

__Note which is pin 1 on the hard drive connectors.

__Install the hard drive with the circuit board down in the top position of the case. Use the bottom position if you plan to install a floppy drive. ***Make sure that the screws you use only go into the mounting bracket of the hard drive without touching the hard drive case itself. This is so you will not defeat the shock mounting of the hard drive or distort the hard drive case.***

__Connect the 34 and 20 pin cables to the hard drive. Observe pin 1.

__Connect one of the power connectors to the hard drive.

__Tie the remaining power plug and these power wires together with a wire tie to prevent their flapping around and hitting something.

__Install the plastic drive blank panel below the drive.

__Leaving about 1 inch of slack, wrap the two cables with 4 or 5 turns of electricians tape. Lightly clamp the two cables in the case with the metal plate and two 6MM screws over the area with the tape. Be careful not to clamp so tight that the cables insulation is cut. Make sure the connectors are tight to the hard drive.

__Install the case top, remembering to connect the LED power connector.

Fire her up.

Now comes the crucial test. Plug the FHL *Eliminator* interface in to your CoCo's Multi-Pak and power it up. I power both the CoCo and the hard drive from a switched power plug so both go on at the same time.

Refer to the documentation from Bruce Isted and the enclosed sheet about your drive for set up and format information.

Well, that's it. After you've formatted your drive and moved everything over to it you will really appreciate the speed and capacity that you now have. You will be tempted to put everything you own on the hard drive, however I advise against it. It is very easy to get so much junk on the darn thing that finding anything on it is tougher than finding a grade school kid that doesn't know more that you about computers!

One final reminder. Hard drives do break, and when they do ALL your data will be lost, gone, finished, etc etc. The key word is BACKUP! Backup anything and everything you want to keep. You should consider anything not backed up as lost. I speak from experience, I KNOW 'caus I learned the hard way.

FHL has a backup utility called 'fbu' that makes it easier to backup your hard disk.

Enjoy your hard drive.

From all of us at FHL

The Eliminator®

PREFACE

The "Eliminator" name is Frank Hogg's brainchild, and the card is so-called because we feel it is the only card most OS-9 only users will need. Together on this card are collected a WD 1002-05 Host Computer Adapter (HCA), an EPROM socket, two RS-232C serial ports, a parallel printer port, and a Real Time Clock (RTC).

The HCA is designed to interface a Tandy Color Computer 3 (COCO3) to a Western Digital WD 1002-05 hard/floppy disk controller. It is possible to boot directly into OS-9 from a hard or floppy drive attached to the WD 1002-05. The initial set up requires the use of a standard floppy controller, but after this set up the standard floppy controller is no longer necessary. A standard floppy controller and the HCA may be used together with a Multi-Pak Interface.

When used with the DACIA driver provided, the two serial ports are as compatible as possible with the standard Tandy RS-232 Pak's ACIAPAK driver, while making use of the 65C52's extra capabilities and adding a few useful enhancements.

The parallel printer port is a minimal configuration, but will still allow the full use of your parallel printer's capabilities. It is faster than the standard "bit banger" serial port, and requires much less CPU power per character transmitted.

The RTC is a fast full calendar type, with automatic handling of leap years. The Clock module provided updates the system time from the RTC time once per minute, or when the system time is set.

Bruce Isted

ELIMINATOR HARDWARE INSTALLATION

The Eliminator may be plugged directly into the COCO's cartridge port (see the WDDisk manual for information on making a WDDisk boot disk) or into a Multi-Pak Interface (MPI). If used in an MPI the Eliminator should be plugged into slot one, or into any slot if the MPI "IRQ jumper" installation has been done.

MULTI-PAK INTERFACE IRQ JUMPER INSTALLATION

In order to use more than one CART* IRQ driven device in an MPI, or when the Eliminator card is plugged into an MPI slot other than slot one, an "IRQ jumper" must be installed on the MPI. This IRQ jumper connects all of the MPI's CART* pins together, which allows a CART* IRQ to be passed from any slot, no matter which slot is selected. This modification alters the manner in which your MPI operates. After the MPI IRQ jumper installation you will no longer be able to switch between game-paks (or other auto-start cartridges) and other cartridges since the auto-start pak's CART* IRQ is always passed no matter which slot is selected. However, under OS-9 this modification will allow you to use several CART* IRQ driven devices reliably.

As always, note that opening the case of your COCO or Multi-Pak Interface (MPI) will void your warranty. Tandy may refuse to service any equipment that has been modified. It is a good idea to plan things out and choose your solder points carefully. Keep in mind that you may wish to restore the MPI back to original some day. Please do not attempt any modifications unless you are confident of your hardware-hacking abilities, and are willing to take the chance of damaging your equipment. I assume no responsibility for any damage that may occur. However, a number of people have used this type of MPI IRQ jumper successfully. So if you're still willing...

On the MPI circuit board, solder a wire jumper to connect pin 8 (CART*) of all the female card edge "slot" connectors together. If you wish you can remove three of the the four CART* pull-up resistors, although this is not required. It doesn't matter which three pull-up resistors are removed, because all four are connected by the wire jumper you just installed. On the older (larger) MPI the CART* pull-up resistors are R11, R12, R13, and R14. On the newer (smaller) MPI the CART* pull-up resistors are R3, R4, R5, and R6. That's all there is to this MPI IRQ jumper installation. Reassemble the MPI and you're done.

ELIMINATOR CONNECTOR AND JUMPER INFORMATION

J1 - DUAL ACIA AND HCA/PRINTER/RTC BASE ADDRESS SELECT JUMPERS

J1 is used to select the base address of the dual ACIA serial ports and of the WD 1002-05 Host Computer Adapter (HCA), parallel printer port, and real time clock. The Dual ACIA serial ports are 4 bytes each, combined into an 8 byte block. The HCA, printer, and clock are also combined into an 8 byte block. These address blocks are independent of each other, except that they can't be set to the same address. Only one shorting plug can be used for the dual ACIA serial ports address selection, and only one shorting plug can be used for the HCA/printer/clock address selection. The user must ensure that the addresses chosen for the Eliminator do not conflict with other hardware. See the "Eliminator Multifunction Board Connector Layout" for connector and pin references.

Shorting Plug Between Pins	Serial Port 1 Base Address	Serial Port 2 Base Address	
1 and 2	$FF40	$FF44	
4 and 5	$FF48	$FF4C	
7 and 8	$FF50	$FF54	
10 and 11	$FF58	$FF5C	
13 and 14	$FF60	$FF64	<-standard
16 and 17	$FF68	$FF6C	
19 and 20	$FF70	$FF74	
22 and 23	$FF78	$FF7C	

Shorting Plug Between Pins	HCA Base Address	RTC Base Address	Printer Port Base Address	
2 and 3	$FF40	$FF42	$FF46	
5 and 6	$FF48	$FF4A	$FF4E — P	
8 and 9	$FF50	$FF52	$FF56	
11 and 12	$FF58	$FF5A	$FF5E	
14 and 15	$FF60	$FF62	64 $FF66 — P3, P4	
17 and 18	$FF68	$FF6A	6C $FF6E — P5, P6	
20 and 21	$FF70	$FF72	74 $FF76 — P1, P2	<-standard
23 and 24	$FF78	$FF7A	$FF7E	

J2 - AUTOBOOT DRIVE AND ADDRESS BLOCK SELECT JUMPERS

J2 is used to select the default auto-boot drive and appropriate address block code for the auto-boot EPROM. The auto-boot may be disabled by leaving all shorting plugs unconnected or by mismatching the selected HCA address and address block code. A shorting plug connected between pins is referred to as "closed", and no shorting plug connected between pins is "open".

Default Auto-Boot Drive	Pins 1 And 2	Pins 3 And 4	Pins 5 And 6	
hard drive 0	closed	closed	closed	<-standard
hard drive 1	open	closed	closed	
hard drive 2	closed	open	closed	
floppy drive 0	open	open	closed	
floppy drive 1	closed	closed	open	
floppy drive 2	open	closed	open	
floppy drive 3	closed	open	open	
disable auto-boot	open	open	open	

HCA Base Address	Pins 7 And 8	Pins 9 And 10	Pins 11 And 12	
$FF40	closed	closed	closed	
$FF48	open	closed	closed	
$FF50	closed	open	closed	
$FF58	open	open	closed	
$FF60	closed	closed	open	
$FF68	open	closed	open	
$FF70	closed	open	open	<-standard
$FF78	open	open	open	

J3 - PARALLEL PRINTER PORT CONNECTOR

J3 is a male 26 pin IDC (header) connector for the parallel printer port. This connector is a direct match for the first 26 pins of a standard 36 pin parallel printer connector. Alternately the first 25 pins of this connector are a direct match for a "PC" type DB-25 printer connector. If used with a "PC" type connector then pin 2 is the auto-linefeed (autolf*) output. Between connectors J2 and J3 can be found a pair of pads. If these pads are shorted together (default when shipped) then autolf* is pulled low and a "PC" type printer will automatically add a line feed to every carriage return it receives. If the pads are disconnected (requires a trace cut on the component side of the board) then autolf* is pulled high by the "PC" type printer and line feeds won't be automatically added to carriage returns. Please note that not all printers work properly with a "PC" type printer connector. The maximum recommended cable length is 10 feet (3 metres).

Pin Number	Signal Description	Pin Number	Signal Description
1	strobe* out	2	gnd/autolf*
3	data 0 i/o	4	no connect
5	data 1 i/o	6	no connect
7	data 2 i/o	8	no connect
9	data 3 i/o	10	ground
11	data 4 i/o	12	ground
13	data 5 i/o	14	ground
15	data 6 i/o	16	ground
17	data 7 i/o	18	ground
19	no connect	20	ground
21	busy in	22	ground
23	no connect	24	ground
25	no connect	26	no connect

J4 - WD 1002-05 HCA CONNECTOR

J4 is a male 40 pin IDC (header) connector for the WD 1002-05 hard/floppy disk controller. The recommended cable length is between 3 feet (1 metre) and 5 feet (1.5 metres) for best operation.

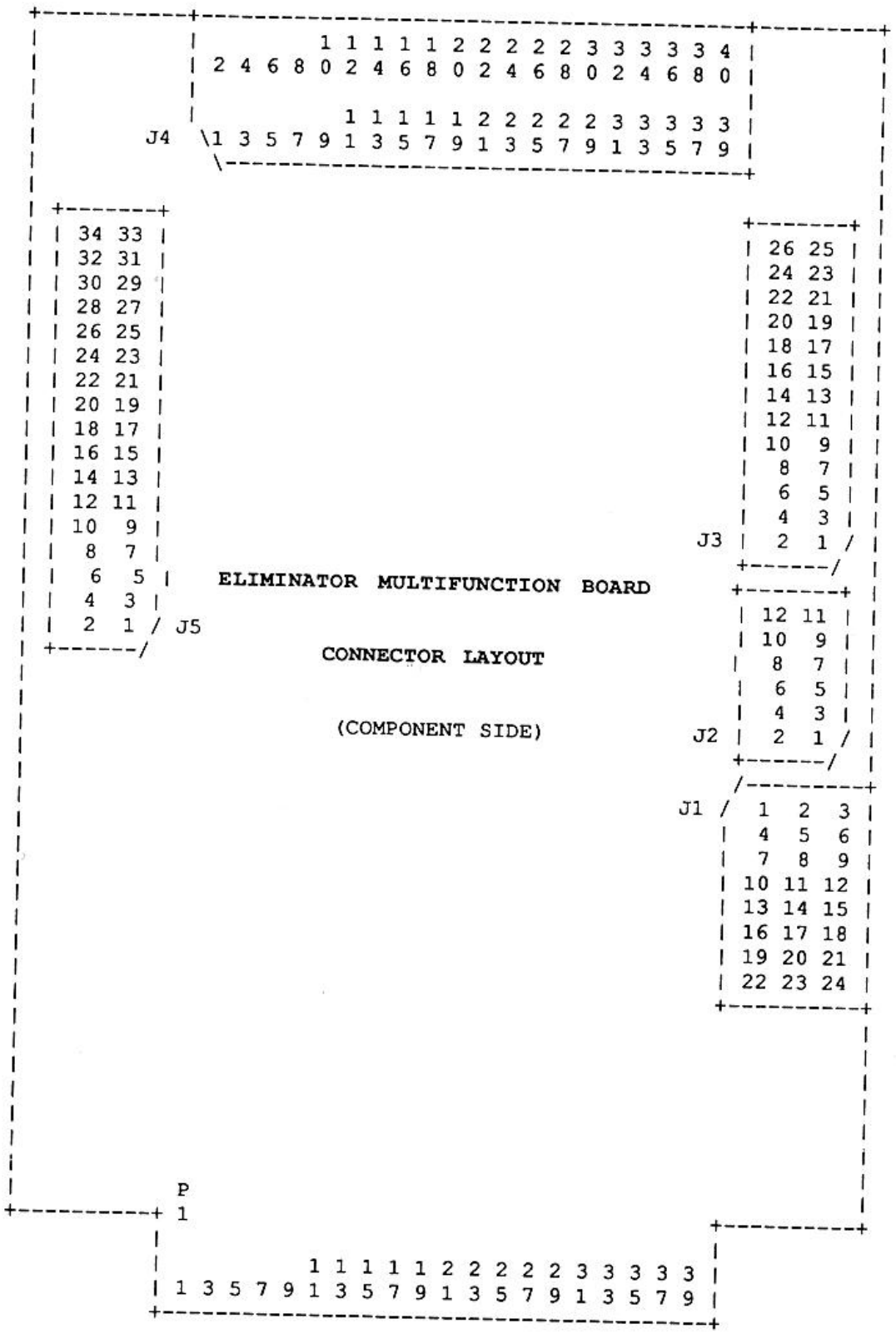
Pin Number	Signal Description	Pin Number	Signal Description
1	data 0 i/o	2	ground
3	data 1 i/o	4	ground
5	data 2 i/o	6	ground
7	data 3 i/o	8	ground
9	data 4 i/o	10	ground
11	data 5 i/o	12	ground
13	data 6 i/o	14	ground
15	data 7 i/o	16	ground
17	addr 0 out	18	ground
19	addr 1 out	20	ground
21	addr 2 out	22	ground
23	select* out	24	ground
25	write* out	26	ground
27	read* out	28	ground
29	no connect	30	ground
31	mfm*/fm out	32	ground
33	5"*/8" out	34	ground
35	intrq in	36	ground
37	no connect	38	ground
39	reset* out	40	ground

J5 - DUAL ACIA PORTS CONNECTOR

J5 is a male 34 pin IDC (header) connector for the dual ACIA serial ports. It is split into two sections, where pins 1 through 16 make up serial port 1 and pins 19 through 34 make up serial port 2. Pins 17 and 18 are not connected. Note that pins 1 through 16 and pins 19 through 34 are direct matches for a standard DB-25 serial port connector. The maximum recommended unshielded cable length is 10 feet (3 metres), although shielded cable may work at up to 50 feet (15 metres) in length.

Pin Number	Signal Description	Pin Number	Signal Description
1	no connect	2	no connect
3	tx data 1	4	no connect
5	rx data 1	6	no connect
7	rts 1	8	no connect
9	cts 1	10	no connect
11	dsr 1	12	no connect
13	ground	14	dtr 1
15	dcd 1	16	no connect
17	no connect	18	no connect
19	no connect	20	no connect
21	tx data 2	22	no connect
23	rx data 2	24	no connect
25	rts 2	26	no connect
27	cts 2	28	no connect
29	dsr 2	30	no connect
31	ground	32	dtr 2
33	dcd 2	34	no connect

The Eliminator®



ELIMINATOR SOFTWARE INSTALLATION

On the Eliminator software disk you will find four directories: CMDS, DEFS, MODULES, and SRC. The CMDS directory contains utilities whose description follows shortly. The DEFS and SRC directories contain definition and source files for most of the software on the Eliminator software disk. The MODULES directory contains a number of drivers, descriptors, and other system files.

UTILITIES

CLKADDR

CLKADDR is used to inspect or change the hardware base address of the real time clock module provided for the RTC. The RTC clock module may be either in memory or in a single module disk file. See the Eliminator connector and jumper information section for details on what this hardware base address should be.

Usage: `ClkAddr [/<module> || -<pathlist>] [option] [option] [...]`

Purpose: To report or alter the current option settings of real time clock modules in memory or on disk in single module files.

```
Options:   nam = Real time clock module name.Can't be altered.
           hpa = Base hardware port address in fake M$Mem
                 requirement.
```

Examples:

```
clkaddr /clock
```

Prints the current option settings of the Clock module in memory.

```
clkaddr -modules/clock.rtc hpa=ff6c
```

Sets the base hardware address of the real time clock module in the MODULES/Clock.rtc file to $FF6C.

XMODE

XMODE is used to inspect or change the options in any SCF device descriptor. The SCF device descriptor module may be either in memory or in a single module disk file. The XMode utility provided here is intended as a replacement for the standard XMode. While the operation differs from the standard XMode's operation, a lot more power is provided and operation is more consistent throughout. All options require either a hexadecimal (0 through FFFF) number or a legal OS-9 name-string as an argument. XMode is based on Kevin Darling's DMode utility, which is a similar utility for RBF (disk) devices.

Usage: `XMode [/<device> || -<pathlist> || -?] [option] [option] [...]`

Purpose: To report or alter current option settings of SCF device descriptors in memory or on disk in single module files.

Options: nam, mgr, ddr, hpn, hpa, upc, bso, dlo, eko, alf, nul, pau, pag, bsp, del, eor, eof, rpr, dup, psc, int, qut, bse, ovf, par, bau, xon, xof, col, row, xtp, wnd, val, sty, cpx, cpy, fgc, bgc, bdc

Examples: `xmode /t2`

Prints the current option settings of the /T2 descriptor in memory.

```
xmode -modules/t4.dd nam=T2 bau=6 hpa=ff6c eof=1B
```

Changes the module name in the MODULES/T4.dd file to T2, sets the baud rate code to 6, the hardware port address to $FF6C, and the end of file character to $1B.

```
xmode -?
```

Prints more complete information on all of the options.

The NAM option accepts only a legal OS-9 module name with a maximum of 4 characters. It is up to the user to ensure that there is adequate room for the module name, and if required to rename the disk file to suit the new module name. The MGR and DDR options can't be changed. All other options require hexadecimal numbers (0 through FFFF). XTP is for certain ACIA descriptors only. WND, VAL, STY, CPX, CPY, FGC, BGC, and BDC are for window descriptors only.

```
nam Device Name
mgr File Manager Name
ddr Device Driver Name
hpn H'ware Page Number
hpa H'ware Port Address
upc Case Lock Flag
bso Backspace Method
dlo Delete Line Method
eko Screen Echo Flag
alf Auto Linefeed Flag
nul End Of Line Nulls
pau Page Pause Flag
pag Page Length
bsp Backspace Character
del Delete Line Char
eor End Of Record Char
eof End Of File Char
rpr Reprint Line Char
dup Duplicate Line Char
psc Pause Character
int Interrupt Character
qut Quit Character
bse Backspace Echo Char
ovf Overflow Character
par Type (Parity) Code
bau Baud Rate Code
xon XON Character
xof XOFF Character
col Display Columns
row Display Rows
xtp Extended Type Code
wnd Window Number
val Valid Window Flag
sty Window Screen Type
cpx X Corner Position
cpy Y Corner Position
fgc Foreground Colour
bgc Background Colour
bdc Border Colour
```

MODULES DOCUMENTATION

ACIAPAK.DR is a replacement for the standard RS-232 Pak driver. It is "friendlier" to other CART* IRQ driven devices, and handles GIME CART* IRQs more reliably than the standard RS-232 Pak driver.

CLOCK.50HZ and **CLOCK.60HZ** are replacements for the standard software clock modules. They handle GIME CART* IRQs more reliably than the standard software clock modules. They are intended to be used in the OS9Boot file in the absence of the RTC which is available for the Eliminator.

CLOCK.50RTC and **CLOCK.60RTC** are 50 and 60 Hz (respectively) real time clock modules intended for use with the RTC which is available for the Eliminator. One or the other (not both) should replace the software clock modules in the OS9Boot file when the RTC is to be used.

DACIA.DR and **DACIA.MPI** are drivers for the Eliminator's dual ACIA serial ports. The Dacia.dr driver is intended for use when the Eliminator is plugged directly into the COCO's cartridge port, or plugged into any MPI slot when the MPI IRQ jumper installation has been done. The Dacia.mpi driver is intended for use when the Eliminator is plugged into slot 1 of an MPI without an IRQ jumper. One or the other (not both) is intended to be installed in the OS9Boot file when the dual serial ports are to be used. It's general operation is similar to that of the Aciapak driver, with the following enhancements per Bill Dickhaus' modifications:
SS.CDSta ($99) get status call. Current DCD (bit 5) and DSR (bit 6) status is returned in register [A]. The respective signals are enabled when their bit is clear (0), and disabled when their bit is set (1).
SS.CDSig ($9A) set status call. The signal code in the LSB of register [X] is sent to the caller's process ID when DCD or DSR signal status changes. The signal is released (removed) when the signal is sent, so this call must be made once for every signal sent.
SS.CDRel ($9B) set status call. Releases (removes) a pending SS.CDSig signal for the caller's process ID. The signal can only be released by the same process ID that installed it.
IT.PAR (offset $26 in device descriptors) has bits defined as follows: bit 7 sets stop bits where %0XXXXXXX is 1 and %1XXXXXXX is 2; bits 6 and 5 set word length bits where %X00XXXXX is 8, %X01XXXXX is 7, %X10XXXXX is 6, and %X11XXXXX is 5; bit 4 sets "modem kill" where %XXX0XXXX causes no action when DCD is lost and %XXX1XXXX returns an E$HangUp error and kills all processes related to the device when DCD is lost; bit 3 sets receive software flow control where %XXXX0XXX is disabled and %XXXX1XXX is enabled; bit 2 sets transmit software flow control where %XXXXX0XX is disabled and %XXXXX1XX is enabled; bit 1 sets CTS/RTS hardware flow control where %XXXXXX0X is disabled and %XXXXXX1X is enabled; bit 0 sets DSR/DTR hardware flow control where %XXXXXXX0 is disabled and %XXXXXXX1 is enabled (forced DTR in IT.XTYP overrides this bit).
IT.BAU (offset $27 in device descriptors) has bits defined as follows: bits 7 and 6 set parity where %00XXXXXX is odd, %01XXXXXX is even, %10XXXXXX is mark, and %11XXXXXX is space; bit 5 sets parity enable where %XX0XXXXX disables (no parity) and %XX1XXXXX enables; bit 4 is unused; bits 3, 2, 1, and 0 set baud rate where %XXXX0000 is 110, %XXXX0001 is 300, %XXXX0010 is 600, %XXXX0011 is 1200, %XXXX0100 is 2400, %XXXX0101 is 4800, %XXXX0110 is 9600, %XXXX0111 is 19200, %XXXX1000 is 38400, and other codes are illegal.
IT.XTYP (offset $2E in device descriptors) is an additional byte in the device descriptor's option table that is checked only when the device is initialized. It's bits are defined as follows: bit 7 is unused; bit 6 sets DTR where %X0XXXXXX causes DTR to be enabled when a path is opened to the device and disabled when the device is terminated, and %X1XXXXXX causes DTR to be enabled immediately upon initialization and never disabled (even when the device is terminated); bits 5 and 4 are unused; bits 3, 2, 1, and 0 may be used to allocate from 0 to 15 pages (256 bytes each) of receive data buffer memory where %XXXX0000 is 0 pages (default receive data buffer is used) and %XXXX1111 is 15 pages.

P.DD is the device descriptor for the Eliminator's parallel printer port. It is intended to be installed in the OS9Boot file as a replacement for the standard "bit-banger" printer port's P.dd descriptor. The XMode utility can be used to change the device name (EG: P1), which would allow using both the bit-banger and parallel printer ports in the same OS9Boot file.

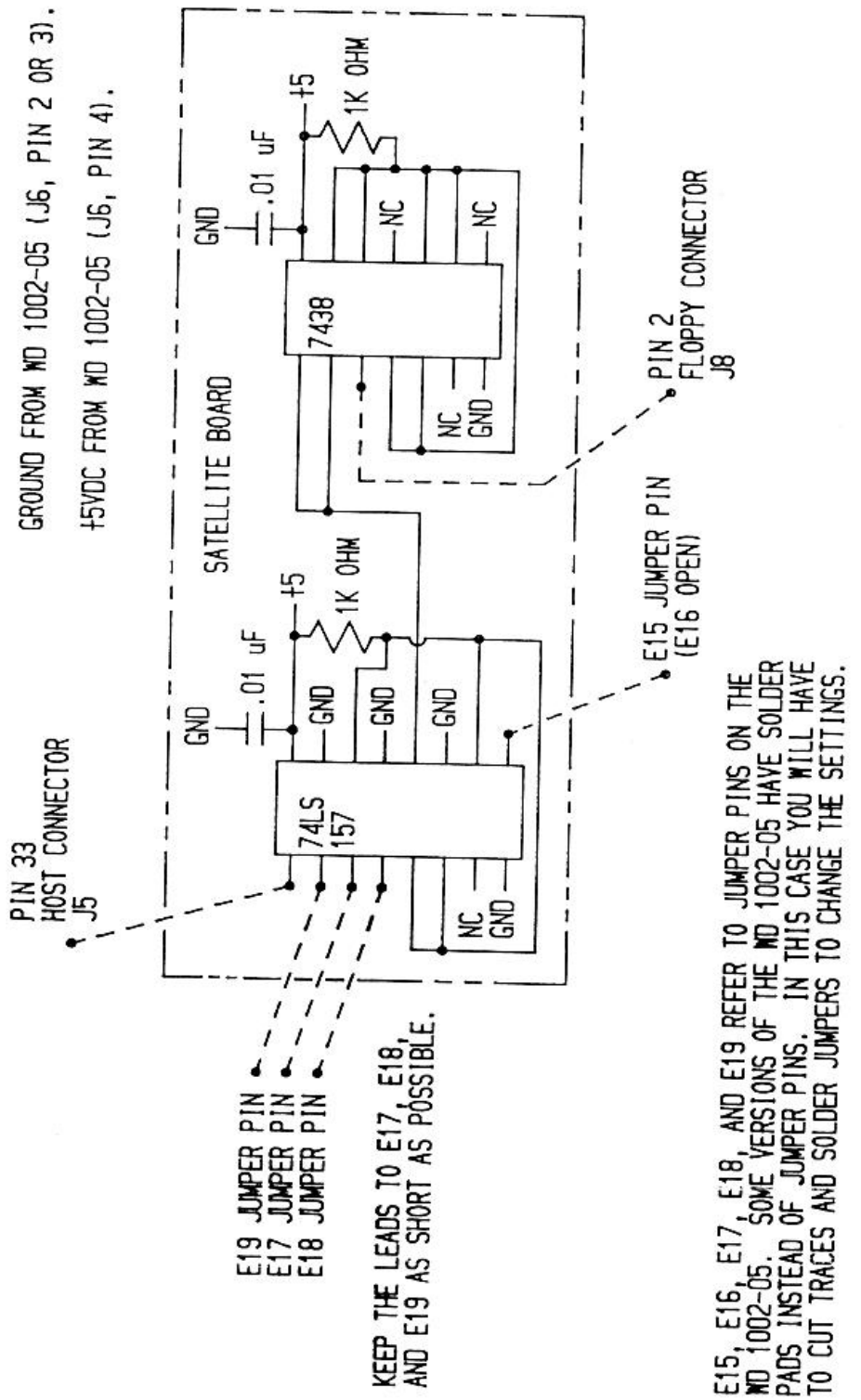
PPIA.DR is the device driver for the Eliminator's parallel printer port. It is intended to be installed in the OS9Boot file when the parallel printer port is to be used.

T3.DD and **T4.DD** are device descriptors for the Eliminator's dual serial ports. They may be used in addition to or instead of the standard T1 and T2 descriptors. The XMode utility can be used to change the device names (EG: T1 and T2 respectively) if desired. These device descriptors contain the additional IT.XTYP byte described in the DACIA section above.

%XXX1XXXX
- illegal

FIGURE 1

5"/8" FLOPPY CONTROL



WDDisk Manual

PREFACE

WDDisk is an OS-9 driver for the Tandy Color Computer and Western Digital WD 1002-05 floppy/hard disk controller using either the original FHL/Isted or the Eliminator's Host Computer Adapter (HCA).

It is possible to boot directly into OS-9 from a hard or floppy drive attached to the WD 1002-05. The initial set up requires the use of a standard floppy controller, several utilities provided with this package, and the installation of a custom "auto-boot" EPROM into the HCA. After this set up the standard floppy controller is no longer necessary, but it can be used together with the HCA and a Multi-Pak Interface if desired.

Bruce Isted

HCA HARDWARE SETUP

See the FHL/Isted or Eliminator hardware manual for most setup information. Users of the original FHL/Isted HCA will find additional information here that is not included in their hardware manual.

HCA WDBoot EPROM

Both the original FHL/Isted HCA and the Eliminator have an EPROM socket. The original FHL/Isted EPROM socket supports either a 2764 or 27128, while the Eliminator EPROM socket supports any one of a 2764, 27128, or 27256.

The WDBoot auto-boot routine in the supplied 2764 EPROM is also available on the WDDisk Driver disk in the MODULES directory in the wdboot.bin file. It is not an OS-9 module, but rather a Disk BASIC "LOADM-able" binary file.

The WDBoot EPROM in combination with the new HCA Boot module can automatically boot OS-9 from any drive attached to the WD 1002-05. The WDBoot auto-boot routine will locate the HCA anywhere in device memory ($FF40 through $FF7F), providing the base hardware address and the address block select jumpers match. See the Isted/FHL HCA or Eliminator hardware manual for information on setting the HCA's base hardware address and the default auto-boot drive jumpers.

The WDBoot auto-boot routine first attempts to boot from floppy drive 0 attached to the WD 1002-05 controller, then from either the default jumper selected or keyboard override selected auto-boot drive. This process is repeated until OS-9 boots, to a maximum of ten times.

Keyboard override occurs when a key is pressed and held for about 3 seconds. If the key is "0", "1", or "2" then hard drive 0, 1, or 2 is the auto-boot drive, respectively. If the key is "3", "4", "5", or "6" the floppy drive 0, 1, 2, or 3 is the auto-boot drive, respectively. Any other key will cause the WDBoot auto-boot routine to abort and fall through to the highest level BASIC ROM.

If the auto-boot fails after 10 attempts the screen will be filled with a number from one to three, which indicates the reason for failure. Ones indicate the HCA cannot be located, or no auto-boot drive jumper selection. Twos indicate a physical disk or controller error. Threes indicate that the selected auto-boot disk was not bootable. After the screen has been filled with the error code typing any key will drop you through to the highest level BASIC ROM.

SPECIAL NOTE: Users of Bob Puppo's PC keyboard adapter who have the startup menu may find that they must quickly and repeatedly tap the "3" key for several seconds to get the WDBoot routine's attention before they press and hold the desired keyboard override key.

WDDisk Manual

Note that the auto-boot drive select jumpers are the first six pins and the address block select jumpers are the last six pins in the 12 pin block beside the PIA. Pins 1 and 2 correspond to bit 0, pins 3 and 4 correspond to bit 1, and pins 5 and 6 correspond to bit 2 of the auto-boot drive select jumpers in the original FHL/Isted HCA manual. Pins 7 through 12 were previously undefined and reserved, but are now used as the address block select jumpers. See the Eliminator hardware manual for information on the address block select jumpers, or for users of the original FHL/Isted HCA this information is repeated here:

J2 is used to select the default auto-boot drive and appropriate address block code for the auto-boot EPROM. The auto-boot may be disabled by leaving all shorting plugs unconnected or by mismatching the selected HCA address and address block code. A shorting plug connected between pins is referred to as "closed", and no shorting plug connected between pins is "open".

Default Auto-Boot Drive	Pins 1 And 2	Pins 3 And 4	Pins 5 And 6	
hard drive 0	closed	closed	closed	<-standard
hard drive 1	open	closed	closed	
hard drive 2	closed	open	closed	
floppy drive 0	open	open	closed	
floppy drive 1	closed	closed	open	
floppy drive 2	open	closed	open	
floppy drive 3	closed	open	open	
disable auto-boot	open	open	open	

HCA Base Address	Pins 7 And 8	Pins 9 And 10	Pins 11 And 12	
$FF40	closed	closed	closed	
$FF48	open	closed	closed	
$FF50	closed	open	closed	
$FF58	open	open	closed	
$FF60	closed	closed	open	
$FF68	open	closed	open	
$FF70	closed	open	open	<-standard
$FF78	open	open	open	

Drive Setup

You must ensure that the drive selects are set properly for all drives connected to the WD 1002-05, and that no two hard drives and no two floppy drives have the same drive select.

One (and only one) hard drive and floppy drive in each chain should have a terminator resistor installed in it. The terminator resistor is normally installed in the drive that is farthest from the WD 1002-05 controller in each chain.

Cable Connections

The HCA is connected to the WD 1002-05 by a 40 conductor ribbon cable (J5 on the WD 1002-05). This cable should have IDC (straight pin "header") connectors at each end in the case of the Eliminator HCA, or an IDC connector at the WD 1002-05 end and a card edge connector at the HCA end in the case of the original FHL/Isted HCA. For best results use a cable between 3 feet (1 metre) and 5 feet (1.5 metres) in length.

The hard drive(s) are connected to the WD 1002-05 by two cables. One cable is a 34 pin ribbon cable (J7 on the WD 1002-05) which is connected in daisy-chain fashion to all hard drives. This cable should have an IDC connector on the WD 1002-05 end and a connector to suit the drive at the other end. Each of the hard drives has its own 20 pin ribbon cable. These cables should have an IDC connector on the WD 1002-05 end and a connector to suit the drive at the other end. J1 should be connected to /H0, J2 to /H1, and J3 to /H2. Some versions of the WD 1002-05 have the J1 and J3 connectors mislabelled, so if the recommended connection doesn't work try the J3 connector for /H0 and the J1 connector for /H2. The maximum length for these cables is 10 feet (3 metres).

The floppy floppy drive(s) are connected to the WD 1002-05 by a 34 pin ribbon cable. The cable (J8 on the WD 1002-05) is connected in daisy-chain fashion to all floppy drives. This cable should have an IDC connector on the WD 1002-05 end and a connector to suit the drive at the other end. The maximum length for this cable is 10 feet (3 metres).

The power leads are connected to the WD 1002-05 and most drives by the usual 4 pin polarized plug (J6 on the WD 1002-05), where pin 1 is +12VDC (not required by the WD 1002-05), pins 2 and 3 are GROUND, and pin 4 is +5VDC. Some (especially the 3.5") drives have a different power connector, so be sure before you power up!

WD 1002-05 Jumpers

The following table contains the WD 1002-05's recommended jumper placement. There are a few places where exact placement of the jumpers is subject to your preference, and/or the capabilities (or limitations) of your hardware.

JUMPER MARK	JUMPER PLACEMENT	DESCRIPTION
E1,E2	E1-E2 closed	see note 1
E3,E4	E3 E4 open	test-open
E5,E6,E7	E5-E6 closed,E7 open	see note 2
E8,E9,E10	E8-E9 closed,E10 open	see note 3
E11,E12	E11 E12 open	see note 4
E13,E14	E13 E14 open	test-open
E15,E16	E15-E16 closed	see note 5
E17,E18,E19	E18-E19 closed,E17 open	see note 6
E20,E21	E20-E21 closed	master clock-closed
E22,E23	E22-E23 closed	VCO-closed

NOTE 1: E1-E2 closed = MFM (floppy double density). E1 E2 open = FM (floppy single density). I recommend you use 'E1-E2 closed' unless you make use of the HCA's FM/MFM control output.

NOTE 2: E5-E6 closed, E7 open = normal floppy READY latch. E6-E7 closed, E5 open = READY signal from floppy drive (if available). I recommend you use 'E5-E6 closed, E7 open', as floppy operation appears to be erratic if the floppy READY signal is used.

NOTE 3: E8-E9 closed, E10 open = no floppy write precomp. E9-E10 closed, E8 open = floppy write precomp above cylinder 43. E8 E9 E10 open = floppy write precomp always. If you have normal (250 Kbit/Sec) floppy drives, use 'E8-E9 closed, E10 open'. If you have high capacity (500 KBit/Sec) floppy drives, you may want to use 'E9-E10 closed, E8 open'.

NOTE 4: E11-E12 closed = 40 mS floppy motor on delay. E11 E12 open = 1 S floppy motor on delay. I recommend you use 'E11 E12 open' unless your floppy drive motors are exceptionally fast starters.

NOTE 5: E15-E16 closed = 5" floppy drive internal VCO selected. E15 E16 open = 8" floppy drive internal VCO selected. If you have normal (250 KBit/Sec) floppy drives, use 'E15-E16 closed'. If you have high capacity (500 KBit/Sec) floppy drives, use 'E15 E16 open'.

NOTE 6: E17-E18 closed, E19 open = 20 MHz input to floppy clock divider. E18-E19 closed, E17 open = 10 MHz input to floppy clock divider. If you have normal (250 KBit/Sec) floppy drives, use 'E18-E19 closed, E17 open'. If you have high capacity (500 KBit/Sec) floppy drives, use 'E17-E18 closed, E19 open'.

FM (Single Density) Floppy Operation

The HCA has an FM/MFM control output on pin 31 of the WD 1002-05 host interface connector (J5 on the WD 1002-05). This is a newly defined line, which was previously not connected to anything. Here are the instructions for using the HCA's FM/MFM control output:

1) Remove the jumper clip connecting 'E1' and 'E2' on the WD 1002-05.

2) Connect a jumper from pin 31 of 'J5' to either jumper pin 'E1' or 'E2' (whichever is connected to pin 37 of the WD2797) on the WD 1002-05.

The WDDisk driver includes full support for the single/double density floppy control output, with the exception of single density formatting. The WD 1002-05 is not capable of single density formatting, but will read and write on a single density disk formatted elsewhere.

High Capacity Floppy Operation

The HCA has a bit rate (500 or 250 KBit/Second) control output on pin 33 of the WD 1002-05 host interface connector (J5 on WD 1002-05). This is a newly defined line, which was previously not connected to anything. Here are the instructions for using the HCA's high/normal density control output:

1) Construct the 5"/8" (high/normal density) floppy control satellite board as detailed in FIGURE 1.

2) Install the satellite board on the WD 1002-05 as outlined in FIGURE 1. Keep the leads that attach to 'E17-E18-E19' as short as possible (under 2 inches), as they carry 10 MHz and 20 MHz clocks to the satellite board and then back to the floppy clock divider circuit on the WD 1002-05.

The WDDisk driver includes full support for the high/normal density floppy control output, with the proviso that the high/normal density control must not be switched within 400 mS of writing to a high/normal density floppy drive. This is because switching between density modes of high/normal density drives requires a 400 mS delay to allow the motor speed to settle at either 300 or 360 RPM.

It would be difficult to allow for this delay in the driver without slowing all floppy writes down by 400 mS. I chose to avoid the problem by not copying between floppies of differing densities if the destination is a high/normal density drive. This may be hard to avoid in certain situations where more than one process is using the floppy drives. I usually leave my high/normal density floppy in the normal density mode (IT.TYP=$20, as opposed to IT.TYP=$21) except when backing up my hard drive. Additionally, I think you'll find that you really don't use your floppy drives much at all... the hard drive gets most of the work!

WD 1002-05 Errata

The E1-E2 jumper controls selection of single or double bit density for the floppy controller chip (WD2797). The schematics from some OEM manuals indicate that E2 is connected to pin 37 on the WD2797, while E1 is ground. This is true on some boards such as the WD 1002-05G, but E1 and E2 are exchanged on others. If you implement the FM/MFM (single/double) density control from the HCA, check E1 and E2 and connect the control line to whichever pin is connected to pin 37 of the WD2797.

The E24-E25 jumper is shown in the schematics in some OEM manuals, but does not exist on all versions of the WD 1002-05. This is not really important, but is mentioned here for the sake of completeness.

The J1, J2, and J3 connectors are mislabelled on some WD 1002-05G boards, where the J1 and J3 connector labels have been exchanged. The easiest method of determining if these connectors are labelled properly is trial and error.

Power Up Considerations

The use of a power bar is recommended to ensure that all of the system is powered up and down simultaneously. In particular, avoid having the WD 1002-05 and hard disk powered up when the HCA is not powered. This may result in garbled data (often cylinder 0 of hard drive 0) depending on the individual hard drive.

WDDISK SOFTWARE SETUP

Driver Options

On the WDDisk Driver disk in the MODULES directory you will find six different versions of the WDDisk driver, distinguished by the file names' suffix. Each file name suffix is made up from the following symbols and their meanings: "2" - the driver works only with Level 2 OS-9; "b" - the driver buffers LSN0 of the last accessed hard disk; "f" - both floppy and hard disk formatting allowed (no "f" means floppy formatting only); "g" - the driver uses GIME CART* IRQ driven I/O (although it will also work with an "IRQ jumper" direct to the COCO's CPU); "m" - the driver sets the Multi-Pak Interface slot select to expect the HCA in slot one, and a "standard" floppy controller in slot four; "p" - the driver uses polled I/O and will work with either Level 1 or Level 2 OS-9.

All versions of the WDDisk driver provide full type-ahead during floppy and hard disk access, as the CPU is not halted at any time. IRQs are masked only when absolutely necessary in the IRQ driven I/O versions only, and for as short a time as possible. There should be no degradation in response to IRQs from other sources.

In a single-user, single-tasking environment there is no noticeable difference between the IRQ driven and the polled I/O versions of the WDDisk driver. In a multi-user and/or multi-tasking situation the IRQ driven I/O version will cause screen and other I/O to appear somewhat smoother in comparison to the polled I/O version.

The polled I/O versions of WDDisk work equally well with Level 1 or Level 2 OS-9. If the HCA is to be used in an MPI it doesn't matter to the polled I/O versions of WDDisk what slot the HCA is plugged into.

It should be noted that the IRQ driven I/O versions of WDDisk provided are for the COCO3 and Level 2 OS-9 only. It is possible to assemble an IRQ driven Level 1 OS-9 version, by simply changing the appropriate conditional assembly flags in the SRC/wdusrset.asm file on the WDDisk Source disk.

The IRQ driven I/O versions of WDDisk must have the HCA's CART* output connected to the COCO3's cartridge port CART* input. This means that these versions of WDDisk may be used only when the HCA is plugged directly into the COCO3's cartridge port, or when the MPI's slot select is switched to the HCA's slot. See the FHL/Isted or Eliminator HCA's hardware manual for more CART* IRQ and MPI slot selection information.

Descriptor Options

On the WDDisk Driver disk in the MODULES directory you will find a number of floppy and hard disk descriptor files. All of these descriptor files have a ".dd" suffix. If required, use the DMode utility supplied with this package to alter the descriptors to suit your drives.

IMPORTANT NOTE: Don't use descriptors from earlier releases of WDDisk with this WDDisk release.

See the WDDisk Driver disk's INFO/hdparam.txt file for information on a number of different hard drives. The number of cylinders listed in this file is the total on the drive. If the hard drive is partitioned as /H00

boot and /H0 main partitions, the /H00 descriptor's cylinder offset must be zero and the number of cylinders must be one, and the /H0 descriptor's cylinder offset should be one and the number of cylinders one less than the total cylinders for the hard drive.

See the WDDisk Driver disk's INFO/pathdesc.txt file for detailed information on the byte and bit definitions in RBF (Random Block File) device and path descriptors. By manipulating this device or path descriptor information, it is possible to make the WDDisk driver access a wide variety of disk formats.

HCA Boot Module

On the WDDisk Driver disk in the MODULES directory is a Boot.wd file. This is a replacement Boot module tailored to the WD 1002-05 controller and the WDBoot auto-boot EPROM. It replaces the "standard" Boot module in the OS-9 Kernel when the HCA auto-boot is used. See the KUtil utility documentation for more information. Note that this HCA Boot module will not work without the WDBoot auto-boot EPROM.

Clock Options

On the WDDisk Driver disk in the MODULES directory are provided two replacement software clock modules (Clock.50hz and Clock.60hz) for 50 Hz and 60 Hz power, respectively. They are required for reliable operation of the FHL/Isted or Eliminator HCA and other Level 2 OS-9 GIME CART* IRQ driven I/O devices.

These replacement clock modules are compatible with, and should be used instead of, the original Level 2 OS-9 clock modules. Their main difference is that they use a GIME CART* IRQ disable/enable toggle at every clock tick to ensure that there are no "lost" GIME CART* IRQs.

If you have the Eliminator's hardware Real Time Clock (RTC) then you should use the Eliminator's hardware RTC clock module instead of these replacement software clock modules. The Eliminator's hardware RTC module provides the same protection against "lost" IRQs employed in the replacement software clock modules.

Init Replacement

On the WDDisk Driver disk in the MODULES directory is a replacement Init module file. This Init module should be used instead of the standard Init module because it tells OS-9 that the default directory is /DD rather than /D0. This can be important because not all systems will have a /D0 device, but they all should have a /DD device.

Aciapak Replacement

On the WDDisk Driver disk in the MODULES directory is a replacement ACIAPAK driver (Aciapak.dr). It is required for reliable operation of the RS-232 Pak and other Level 2 OS-9 GIME CART* IRQ driven devices.

The replacement ACIAPAK driver is compatible with, and should be used instead of, the original ACIAPAK driver. The main difference is that the replacement ACIAPAK driver uses GIME CART* IRQ disable/enable toggle after every ACIAPAK serial I/O IRQ to ensure that there are no "lost" GIME CART* IRQs.

In addition, the replacement ACIAPAK driver has a larger receive data buffer, which should reduce buffer overflow problems. Finally, GIME CART* IRQs are not disabled when the ACIAPAK driver terminates. This makes it much friendlier towards other GIME CART* IRQ driven devices, who no longer have their IRQs shut off when the ACIAPAK driver is terminated.

WDDisk Manual

Minimum Boot Floppy Disk

Making several copies of a minimum, or emergency, boot floppy disk is strongly recommended. This minimum boot disk should allow you to boot up OS-9 under any circumstances, and the copies should be stored separately to avoid loss. All minimum boot disks will follow the same general guidelines, although specific details will vary depending on the COCO system.

First, never include an H0 descriptor in the boot file. Always use an HD (or any name except H0) and /H00 hard disk descriptors instead. This is because OS-9 attempts to change data and execution directories to the /H0 device, which will cause boot failure if only partially successful. The HD descriptor will give you full access to the main hard drive partition while the H00 descriptor gives you access to the one cylinder hard disk boot partition.

Second, include the Init module supplied with this package in the boot file instead of the standard Init module. The standard Init module tells OS-9 that the default directory is /D0, which may not exist in the boot file. The replacement Init module tells OS-9 that /DD is the default directory, which should always exist in the boot file.

Third, always use a DD descriptor that points to the boot floppy. If booting from a "standard" floppy controller, then /DD and /D0 should be the same floppy drive. If auto-booting from the HCA, then /DD and /F0 should be the same floppy drive.

Fourth, always use a polled I/O version of WDDisk in the boot file. The polled I/O versions will work on either Level 1 or Level 2, plugged directly into the COCO or in any slot of an MPI, and is less likely to be messed up by other hardware or drivers.

Fifth, the minimum boot floppy must have a CMDS directory containing Shell and GrfDrv (Level 2 OS-9 only) files with their executable attributes set.

The minimum boot disk may also contain a startup file and other files and directories.

Information on a number of hard drives is available in the SRC/hdparam.txt file on the WDDisk driver disk. Additional descriptor information is available in the SRC/pathdesc.txt file on the WDDisk driver disk.

"Standard" Boot Floppy Disk

To make a boot floppy disk for the "standard" floppy controller all you need do is add a suitable WDDisk driver and descriptor(s) to your boot file. If the hard drive's main partition is formatted and has a CMDS directory containing Shell and GrfDrv (Level 2 OS-9 only) files with their executable attributes set, then the boot file may contain DD and H0 descriptors for the hard drive. If you booted OS-9 from an HCA auto-boot disk before you made the "standard" boot floppy disk then you must use the KUtil utility supplied with this package to replace the boot disk's HCA Kernel track with a "standard" Kernel track.

HCA Auto-Boot Floppy Disk

To make an HCA auto-boot floppy disk you should add a suitable WDDisk driver and descriptor(s) to your boot file. You may want to remove the "standard" floppy driver and descriptors. If the hard drive's main partition is formatted and has a CMDS directory containing Shell and GrfDrv (Level 2 OS-9 only) files with their executable attributes set, then the boot file may contain DD and H0 descriptors for the hard drive. If you booted OS-9 from a "standard" boot floppy disk before you made the HCA auto-boot floppy disk then you must use the KUtil utility supplied with this package to replace the Boot module in the boot disk's Kernel track with an HCA Boot module.

HCA Auto-Boot Hard Disk

To make an HCA auto-boot hard disk you should add a suitable WDDisk driver and descriptor(s) to your boot file. You may want to remove the "standard" floppy driver and descriptors. If the hard drive's main partition is formatted and has a CMDS directory containing Shell and GrfDrv (Level 2 OS-9 only) files with their executable attributes set, then the boot file may contain DD and H0 descriptors for the hard drive. Do not use OS9gen to create a boot file directly on the hard disk because the Kernel track will be written in the wrong place, which will probably destroy the hard disk's file structure. Use the BtGen and BUtil utilities supplied with this package to create and link the boot file on the hard disk's main partition. If the hard disk's one cylinder boot partition doesn't contain an HCA auto-boot Kernel then you must use the KUtil utility supplied with this package to place one in the boot partition. Note that after using the KUtil utility the hard disk's boot partition no longer has the normal OS-9 file structure. You must also use the BUtil utility on the hard disk's boot partition to set the cylinder offset to the main partition.

Formatting

Assuming the boot file contains a version of the WDDisk driver that allows both floppy and hard disk formatting, the format procedures are very similar to those of the "standard" floppy drives. In fact, formatting a floppy attached to the WD 1002-05 controller is indistinguishable from formatting a "standard" floppy. However, there are some differences when formatting a hard drive. The first thing you'll notice is that the Format utility gives an extra warning when its about to format a hard disk. The second difference is that you are given the choice of a "physical" or "logical" format. If you choose the "physical" format then the hard disk will actually be formatted, and all data on the drive is overwritten. If you choose the "logical" format then the hard drive is not really formatted, but the allocation map and root directories are cleared, which effectively clears out the hard disk's file structure without actually overwriting most of it. The third difference is that you are asked if you want a "physical" verify after formatting. If you choose the "physical" verify then the hard disks sectors are read one at a time and the allocation map is updated to lock out any bad sectors. If you chose not to do the "physical" verify then all sectors are assumed to be good, and the allocation map is cleared.

Its a good idea to allow the hard drive to warm up to normal operating temperature before formatting it. Many problems due to thermal expansion can occur if the hard drive is formatted cold, or formatted while it warms up. Most drives reach normal operating temperature within 15 to 30 minutes. Its also a good idea to use the Ecc utility provided with this package to enable corrected data error reporting before formatting the hard drive. Then format the hard drive several times after it has warmed up, starting with the one cylinder boot partition (EG: /H00) followed by the main hard drive partition (EG: /H0) and repeating. To save time, it isn't necessary to do a "physical" verify until the last format pass. If the Ecc utility has been used to enable corrected data error reports then the "physical" verify will catch and lock out bad sectors as well as most of the potentially bad sectors on the hard disk. After formatting is complete the Ecc utility may be used again to turn off corrected data errors, which is the normal state.

WDDisk Manual

Utilities

BTGEN

BTGEN is used to create a file from a list of file names (one per line) from standard input, similar to the standard OS9gen utility. However, BtGen doesn't link the file in LSN0 of the disk, nor does it write a Kernel track to the disk. This makes it suitable for use on hard drives. Finally, BtGen allows you to specify the output file name on the command line.

```
Usage:    btgen [-<option>] <pathlist>

Purpose:  To create an OS-9 boot file without linking it in LSN0
          or placing a kernel on the boot disk.

Options:  s = Single drive operation.

Examples: btgen -s /d0/bootfiles/newboot
               Reads pathlists from standard input (one per line)
               until EOF or a blank line, merges the files in
               memory, prompts for the destination disk, then
               writes the /D0/BOOTFILES/newboot file.
          btgen testboot <bootlist
               Reads pathlists from standard input (one per line
               in the bootlist file) until EOF or a blank line,
               merges the files in memory, then writes the
               testboot file.
```

BUTIL

BUTIL is used to link a boot file in LSN0, to set the cylinder offset in a hard disk boot partition, or to report the current boot file information from LSN0 of the specified disk.

```
Usage:  butil -<options> [<offset>] <pathlist>

Purpose:  To update or report LSN0 boot information.

Options:  b = Link <pathlist> as boot file.
          i = Report boot information from LSN0 of <pathlist>.
          o = Set cylinder <offset> in LSN0 of <pathlist>.

Examples:  butil -b /dd/bootfiles/newboot
               Links BOOTFILES/newboot as the /DD device's boot file.
               This is used whenever you want to link to a new bootfile.
           butil -ib newboot
               Links newboot in the current data directory as the
               boot file, then reports the LSN0 boot information.
           butil -i /h0
               Reports the boot information from LSN0 of the /H0
               device.
           butil -o 1 /h00
               Sets the cylinder offset to (decimal) 1 in LSN0 of
               the /H00 hard drive boot partition.
               This is used whenever /h00 is formatted.
```

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DMODE

DMODE is used to check or change the capabilities of disk device descriptors either in memory or on disk in single module files. All options require either a hexadecimal number (0 through FFFF) or a legal OS-9 namestring as an argument. This utility is similar to XMode in operation. Originally written by, and provided with the permission of, Kevin Darling.

```
Usage:  DMode [/<device> || -<pathlist> || -?] [option] [option] [...]

Purpose:  To report or alter current option settings of RBF device
          descriptors in memory or on disk in single module files.

Options:  nam, mgr, ddr, hpn, hpa, drv, stp, typ, dns, cyl, sid, vfy,
          sct, t0s, ilv, sas, wpc, ofs, rwc.

Examples:  dmode /dd
               Prints the current option settings of the /DD descriptor
               in memory.
           dmode -modules/h0.dd nam=H1 drv=1 cyl=03FF rwc=ffff
               Changes the module name in the MODULES/H0.dd file to H1,
               sets the physical drive number to 1, cylinders to $03FF,
               and the Reduced Write Current cylinder to $FFFF.
           dmode -?
               Prints more complete information on all of the options.
```

The NAM option accepts only a legal OS-9 module name with a maximum of 3 characters. It is up to the user to ensure that there is adequate room for the module name, and if required to rename the disk file to suit the new module name. The MGR and DDR options can't be changed. All other options require hexadecimal numbers (0 through FFFF). The WPC, OFS, and RWC options are for WDDisk descriptors only.

```
nam  Device Descriptor Name
ddr  Device Driver Name
hpa  Hardware Port Address
stp  Step Rate Code
dns  Drive/Disk Density
sid  Drive Sides (Heads)
sct  Sectors Per Track
ilv  Sector Interleave Factor
wpc  Write Precompensation Code
rwc  Reduced Write Current Cylinder

mgr  File Manager Name
hpn  Hardware Page Number
drv  Physical Drive Number
typ  Drive Type
cyl  Drive Cylinders
vfy  Write Verify Flag
t0s  Sectors On Track Zero
sas  Segment Allocation Size
ofs  Partition Offset Cylinder
```

ECC is a utility used to change or check the WD 1002-05 hard disk's corrected data error status. When ECC errors are disabled (normal mode) no error is reported if the WD 1002-05 can successfully correct bad data in a hard disk sector. When ECC errors are enabled then bad data in a hard disk sector will cause an error report even if the WD 1002-05 successfully corrects the data. This is particularly useful during the Format utility's physical verify, when you would normally want bad and marginal sectors to be locked out in the hard disk's allocation map.

```
Usage:  ECC [-<opt>] [/<devname>] [/<devname>] [...]

Purpose:  To enable or disable ECC errors, or check
          current ECC error status (default).

Options:  c = Check current ECC error status.
          d = Disable ECC errors.
          e = Enable ECC errors.
          ? = Print this usage message.
```

WDDisk Manual

KUTIL

KUTIL is used to get a boot disk's Kernel track and put it into a Kernel file, to replace the Boot module in a Kernel file, or to get a Kernel file and put it onto a boot disk's Kernel track.

```
Usage:  kutil -<options> <source> <destination>

Purpose:  To extract/modify/install the OS-9 Kernel.

Options:  g = Get a Kernel track (to Kernel file).
          p = Put a Kernel track (from Kernel file).
          r = Replace the Boot module in a Kernel file.
          s = Single drive operation.

Examples:  kutil -g /d0 /d1/oldkernel
               Reads the /D0 Kernel track and writes it to a
               Kernel file called /D1/oldkernel.
           kutil -rs /d0/modules/boot.wd /d0/oldkernel
               Replaces the Boot module in the Kernel file called
               /D0/oldkernel on one disk with the Boot module
               from the /D0/MODULES/Boot.wd file on another disk.
           kutil -p /d1/oldkernel /h00
               Reads the Kernel file called /D1/oldkernel, and
               writes it to the /H00 Kernel track.
```

PARK

PARK is used to prepare the hard drive(s) for power down by placing the drive's heads beyond the data area on the hard disk, or to restore the hard drive's heads to cylinder zero.

```
Usage:  Park [-<opt>] [/<devname>] [/<devname>] [...]

Purpose:  To park drive heads before power down and/or moving the drive
          (default), or to unpark (restore to track 0) drive heads
          which is occasionally useful after parking drive heads.
Options:  u = Unpark drive heads.
          ? = Print this usage message.
```

Additional Documentation

On The WDDisk Driver disk is a DOCS directory which contains documentation for the PCDOS and RSDOS utilities written by Bob Santy, and the assembly source file for the DMode utility originally written by Kevin Darling. My thanks to both of them for giving their kind permission for these utilities to be included with this package.

WDDisk Source

On the WDDisk Source Disk are DEFS and SRC directories which respectively contain definitions files and source files for most of the utilities and the WDDisk driver and descriptors.