

The information in this article has been collected from Burke & Burke application notes 1-4, and has been revised for use with our current products.

Section 1 provides general information on setting up a hard disk system based on the Burke & Burke CoCo XT and CoCo XT-RTC hard disk interfaces.

Section 2 describes Burke & Burke's hard disk related software products.

Please refer to Burke & Burke Application Note #6 for help with common BASIC and OS9 hard disk setup problems.

1.0 Setting Up a Hard Disk System

1.1 About the CoCo XT

The CoCo XT interfaces a standard PC compatible hard disk drive and controller to any model of Color Computer. Burke & Burke chose this type of hard disk system because it offers a combination of high quality, high performance and low price.

We also offer the CoCo XT-RTC, which provides a battery-powered real-time clock / calendar in addition to all of the features of the CoCo XT. The battery provides several years of reliable clock operation, and can be easily replaced by the user.

In this article, the name CoCo XT will be used to refer to both the CoCo XT itself, and the CoCo XT-RTC.

The CoCo XT uses the same type of hard disk controller that is used in many "clone" personal computers. The controller includes a 2048 character disk buffer, which eliminates the need to halt the computer while accessing the hard disk (this feature is sometimes referred to as "no halt" operation).

The CoCo XT is a hard disk interface. The metal housing of the CoCo XT holds both the Burke & Burke interface board and a hard disk controller board that you supply.

1.2 Equipment Requirements

In order to use the CoCo XT, you must have the following equipment and software (not included with the CoCo XT):

- CoCo, Multi-PAK Interface, and Floppy Disk System
- 1 or 2 suitable hard disk drives

- Suitable hard disk controller and cables
- Hard disk cabinet and power supply
- Burke & Burke XT-ROM (optional -- boots OS9 from hard disk)
- Burke & Burke HYPER-I/O software package (optional -- allows you to use hard drive with RS-DOS Disk BASIC)
- OS9 Level I or Level II operating system (optional)

Typically, 20 Meg hard drives are available mail-order for about \$250 including the controller and cables (10 meg systems are about \$150). If you purchase the controller and cables seperately, they will cost about \$75. Hard disk cabinets with built-in power supplies are available for around \$80.

The best place to look for mail-order equipment deals is in a monthly magazine called COMPUTER SHOPPER. This magazine costs about \$3.00 per issue, but the 400+ pages of ads are well worth the money.

Several hardware vendors that we and our customers have dealt with successfully are:

HARD DRIVES INT'L	(Tempe, Az)	-- Drives and Controllers
TIMELINE INC.	(Gardena, CA)	-- Drives and Controllers
HARDTIMES	(San Jose, CA)	-- Drives and Cabinets
WALKER ELECTRONICS	(Dallas, TX)	-- Cabinets and cables
WETEX	(Montebello, CA)	-- Cabinets
JM SYSTEM INC.	(Montebello, CA)	-- Drives

1.3 Computer and Multi-PAK Information

The CoCo XT works with the CoCo 1, CoCo 2, or CoCo 3. You will need at least 64K of memory to use the interface from either BASIC or OS9.

The hard disk can be shared between OS9 and BASIC if desired, and individual files can be transferred between OS9 and BASIC using the HCOPY, HDIR, and HDEL utilities supplied with HYPER-I/O.

It is easiest to use the CoCo XT with a Multi-PAK or compatible expansion interface. The CoCo XT installs in any slot of the Multi-PAK. You can also use a "Y-cable" and an external 12 volt power supply if a Multi-PAK is not available. A simple modification to the CoCo XT is required when using a "Y-cable", and you must be careful that no other devices in your system are addressed in the CoCo XT's reserved range of \$FF50-\$FF53.

Although a configured hard disk system can run without any floppy drives, you will need a floppy disk controller and at least one floppy drive in order to set up your system. The floppy disk controller may use any version of Disk Extended Color BASIC (RS-DOS). Other disk operating systems (JDOS, CDOS, ADOS) are not currently

supported.

1.4 Hard Disk Drive Information

Most hard disk drives used in personal computers provide either an ST-412/ST-506 interface or an on-board SCSI/SASI controller. Neither of these interfaces is directly compatible with either a Color Computer (or with a PC, for that matter). The ST-412/ST-506 interface requires a suitable hard disk controller; the SCSI/SASI interface requires a SCSI/SASI controller in order to communicate with the host computer.

The Burke & Burke interface is designed to work with hard drives that provide an ST-506/ST-412 interface. This type of drive is both more common and less expensive than a SCSI/SASI drive, and controllers for this type of drive are both abundant and economical (about \$65 mail-order).

The storage capacity of a hard drive is often described in "mega-bytes". A megabyte is simply a million characters, so a 20 Meg hard disk holds about 20,000,000 characters. That's equivalent to over 1,000 pages of text!

The hard drive is organized into a number of "heads", each of which is further divided into "tracks". The tracks are divided into 256 or 512 character "sectors", much like a floppy disk.

The number of heads on a hard drive normally ranges from 2-16. The number of tracks is usually between 150 and 1024. The maximum number of sectors per track depends how many characters there are per sector, and also on something called the "encoding method".

There are 2 commonly used encoding methods: MFM and RLL. The first method, MFM, is used on both floppy disks and hard disks. This method provides 32 or more (256 byte) sectors per track. The RLL method is a newer technique that requires a special disk drive -- it squeezes 48 or more sectors into every track.

Some hard disk controllers only support a maximum of 8 heads. If you are buying a drive with more than 8 heads, you must be sure to get a suitable controller.

1.5 Hard Disk Controller Information

1.5.1 Mechanical Considerations

Hard disk controllers used with the Burke & Burke system must have both a 62-contact edge connector and the ST-412/ST-506 interface. The edge connector plugs directly into the 62 position socket on the CoCo XT interface card; the combined interface card and controller then plug directly into the Multi-PAK's 40 position socket. The height of the combined interface card and hard disk controller is almost exactly the same as the height of the original Tandy floppy

disk controller.

Not all PC-compatible hard disk controllers are alike, and some will not work with the CoCo XT. The mounting screws in the interface housing, and the hard disk support software, are optimized for use with particular hard disk controllers. Several controllers that work well with the CoCo XT hard disk interface are:

- Western Digital WD1002-WX1 (MFM)
- Western Digital WD1002A-WX1 (see below; MFM)
- DTC 5150CRH (MFM)
- Western Digital WD1002-27X (RLL)
- Western Digital WD1002A-27X (see below; RLL)
- Adaptec 2072 (RLL)
- DTC 5160CRH (RLL)

Western Digital has recently changed the mechanical design of their hard disk controllers, moving the mounting holes and eliminating jumper bank S1. There are three such controllers on the market at this time: the WD1002A-WX1, the WD1002A-27X and the WDXT-GEN.

The WD1002A-xxx controllers may be used if a slight change is made to the CoCo XT housing: one of the mounting screws must be removed, and the threaded insert must be snapped off of the board with a pliers. You must also file a small notch in the controller board, which does not effect its operation in any way. Contact Burke & Burke for further information if you need to use this type of controller.

The WDXT-GEN controller does not fit into the CoCo XT housing. It can be used if you don't mind about 1/4" of controller board hanging out the end of the housing. Many vendors who normally sell the WDXT-GEN will replace it with a WD1002-WX1 for about \$10.

1.5.2 The ST-412/ST-506 Interface

The ST-412/ST-506 interface consists of a 34 contact connector and one or more 20 contact connectors. The 34 contact connector mates with a cable that is "daisy chained" to all hard drives in your system -- much like the 34 conductor cable used with floppy drives. The 20 contact connector mates with a cable that is unique for each drive. A hard disk controller that supports 2 hard drives will have one 34 contact connector and two 20 contact connectors.

1.5.3 "No Halt" Operation

All of the CoCo XT compatible hard disk controllers include a

2K disk buffer. The hard disk controller reads from or writes to this buffer independent of what the CoCo is doing. Your CoCo does not need to slow down or "HALT" during hard disk I/O, because the hard disk controller takes care of all critical timing.

All of the CoCo XT compatible hard disk controllers also include a "BIOS ROM". This ROM or EPROM normally contains software that tells a PC "clone" computer how to access the hard disk. Since this software is not needed in CoCo hard disk systems, the CoCo XT allows your Color Computer to execute instructions out of a custom EPROM that you install in the BIOS ROM socket (one such EPROM is Burke & Burke's XT-ROM, which automatically boots OS9 from your hard disk at power-up).

The hard disk controller stores and retrieves information from the hard disk 512 bytes at a time. Burke & Burke's interface software automatically translates between this 512 byte sector size and the 256 byte sectors used by OS9 and Disk BASIC.

Although most hard disk controllers are capable of operating in an interrupt driven mode, Burke & Burke have maximized both the performance and ease of installation of the CoCo XT by not using interrupts in our interface. This allows you to use the CoCo XT in conjunction with other interrupt driven devices, such as an RS-232 PAK or a modem PAK, without having to make hardware modifications to your equipment.

1.5.4 Controller Jumpering

Most hard disk "kits" are shipped with one of several common hard disk controllers. Each of these controllers has slightly different jumpering requirements.

On an RLL controller, the most important jumpering is the mode select jumper. This jumper determines whether you should set up your hard disk device descriptors for 32 sectors per track or 48 sectors per track. When using 32 sectors per track with an RLL controller only, the number of tracks per surface (indicated on the hard disk data sheet) must be multiplied by 1.53. For example, an ST-238 drive normally has 615 tracks but you must specify 940 tracks in order to use 32 sectors per track. If you are using 48 sectors per track, the ST-238 has 615 tracks.

1.5.4.1 WD1002-WX1 Controller

This is the original "short card" MFM hard disk controller for the CoCo XT. Jumpering on this controller is:

W4 -- 2-3
W8 -- 2-3
W6 -- 2-3
W3 -- IN
S1 -- All positions OUT

1.5.4.2 WD1002A-WX1 Controller

Same jumpering as the WD1002A-WX1 controller. There are about 3 different versions of this controller.

Some versions do not have the S1 jumper. S1 is not necessary for operation with the CoCo XT.

The locations of the mounting holes have been changed on some versions. The board can still be mounted in the CoCo XT if you file a small notch in the board and snap off one of the CoCo XT housing's mounting supports.

1.5.4.3 WD1002-27X Controller

This RLL controller is exactly the same shape and size as the WD1002-WX1, and has identical jumpers. There is an additional jumper, W9, on the controller.

W9 -- IN for 32 sectors per track (use with drives having up to 669 tracks per surface -- multiply tracks by 1.53)

W9 -- OUT for 48 sectors per track (use with drives having 670 or more tracks per surface)

1.5.4.4 WD1002A-27X Controller

A newer version of the original WD1002-27X. This RLL controller is the same shape as one of the WD1002A-WX1 versions, and must be modified for mounting in the CoCo XT.

There are only two jumpers on this controller board.

W1,W2 -- IN for 32 sectors per track (use with drives having up to 669 tracks per surface -- multiply tracks by 1.53)

W1,W2 -- OUT for 48 sectors per track (use with drives having 670 or more tracks per surface)

1.5.4.5 Adaptec 2072 Controller

This controller is the same shape and size as the WD1002-WX1. It is an RLL controller that operates only at 48 sectors per track. When using the Adaptec 2072, set up your descriptors for 48 sectors per track regardless of the size of the drive. Do not multiply the number of tracks by 1.53.

The jumpers on this controller should be set as follows:

J5 -- All positions OUT
J8 -- All positions OUT
J9 -- All positions OUT

.5.4.6 DTC Controllers

These are the same shape and size as the WD1002-WX1. Normal jumpering of the DTC-5150CRH is:

W1 -- IN
W2 -- 3-4
W3 -- 2-3
W4 -- 1-2
W5 -- 2-3
W6 -- All positions OUT
W7 -- IN

1.6 Hard Disk Power Supply Information

A hard disk uses much more power than the CoCo can supply. A lot of this power goes to run the motor that spins the disk's platters at 3,600 RPM, especially when the motor is just starting up.

Typical 5.25" hard disks need at about 2.5 Amps at 12 volts and 1 Amp at 5 volts to operate correctly. Some full-height hard disks need as much as 5 Amps at 12 volts when they first start up.

Most floppy disk power supplies provide only about 1.5 Amps at 12 volts. Burke & Burke does not recommend using a floppy disk power supply to run a hard disk, unless you are using a 3.5" drive.

The new 3.5" hard drives are designed for use in battery powered laptop computers. These drives use less than 1 Amp at 12 volts and do not require a cooling fan. A floppy disk power supply will run a 3.5" drive very well. The 3.5" drives cost about \$30-\$50 more than equivalent 5.25" drives, but you could save that much or more on the power supply!

Power supply capabilities are often expressed in Watts. Your hard disk power supply should be rated for at least 38 Watts in order to provide the voltages and currents listed above for 5.25" drives. If you have 2 hard disks, you could need twice this power.

1.7 CoCo XT Interface Board Information

This circuit board is the primary hardware component of the CoCo XT. It converts the CoCo's 40 pin expansion bus into a 62 pin bus suitable for driving PC compatible hard disk controllers.

Both the CoCo XT and CoCo XT-RTC versions of this circuit board include bus conversion logic. The CoCo XT-RTC version of this board also includes a battery holder, clock circuit, and quartz crystal.

The hard disk controller and real-time clock are selected by a low on the SCS* pin and a simultaneous high on the A4 pin. This allows the CoCo to access these devices in the address range \$FF50-\$FF5F when used in conjunction with a Multi-PAK interface.

The controller's BIOS ROM socket is selected by a low on the CTS* pin. This allows the CoCo to access XT-ROM or other custom ROM's in the address range \$C000-\$FFFF. Note, however, that several of the address lines driving this EPROM are inverted by the CoCo XT interface board. Special equipment is needed to create a ROM that is compatible with the CoCo XT, and most "off-the-shelf" DOS EPROMs are incompatible.

When using the CoCo XT with a "Y-cable", the BIOS ROM socket must be disabled. This can be accomplished by a cut and solder jumper on the interface board.

The interface board is about 1.5" high, and plugs into any slot of the Tandy Multi-PAK interface.

1.8 Summary

The CoCo XT hard disk interface from Burke & Burke allows you to put together an inexpensive CoCo hard disk system that works with both Disk BASIC and OS9.

The components that you need to assemble this system are:

- CoCo, Multi-PAK Interface, and Floppy Disk System
- CoCo XT or CoCo XT-RTC hard disk interface
- 1 or 2 suitable hard disk drives
- Suitable hard disk controller and cables
- Hard disk cabinet and power supply
- At least one of the following software packages:

OS9 operating system
Burke & Burke HYPER-I/O

The drives, controller, cables, and power supply are available through a number of vendors that advertise in COMPUTER SHOPPER. For a 20 Meg system, you can obtain these items for about \$350; a 10 Meg system would be about \$230. These prices do not include the CoCo XT or CoCo XT-RTC interface, or the Color Computer, Multi-PAK, and Floppy Disk System.

2.0 Burke & Burke Product Information

Burke & Burke provides several software packages that support the CoCo XT hard disk interface.

The next few sections provide general information on current Burke & Burke products, as well as hints for using these products.

2.1 CoCo XT and CoCo XT-RTC

The CoCo XT package includes all of the software needed to use one or two hard disks under Level I or Level II OS9. The CoCo XT release disk also includes an OS9 hard disk back-up utility, installation utilities, and a hard disk driver routine that can be installed in HYPER-I/O (not included) to allow BASIC programs to access the hard drive.

The CoCo XT-RTC package adds real-time clock support software to the CoCo XT. This software includes OS9 utilities that transfer the correct date and the time of day from the real-time clock to the OS9 system clock automatically at power-up. You can also set the real-time clock from the system clock at any time. A machine language subroutine library is provided for those who wish to access the real-time clock from Disk BASIC or HYPER-I/O.

The Version 2.1 CoCo XT drivers provide several advanced features not present in earlier releases:

- * Improved error reporting
- * Supports hard disk controller in any slot
- * Improved, smaller PARK utility
- * DDMAKER allows user to specify park track and slot number
- * Supports up to 2 hard drives, which may be different sizes
- * Includes EZGen boot configuration utility to simplify installation.

2.2 HYPER-I/O

If you want to use the hard drive with Disk BASIC, you must use Burke & Burke's HYPER-I/O package. HYPER-I/O is **not** a hard disk DOS; it is a "DOS overlay" that allows you to install device drivers and device descriptors in Tandy's Disk BASIC. One such device driver is the XT.DR hard disk driver provided in the CoCo XT release disk, but instructions are provided for writing custom device drivers if you so desire. For example, HYPER-I/O will also support hard drive systems from Tandy, DISTO and other vendors with suitable drivers -- contact Burke & Burke for further information.

Version 2.4 of HYPER-I/O, which normally loads into the upper 32K of the Color Computer's RAM, provides total compatibility with BASIC programs and most 32K machine language programs. For compatibility with 64K software, HYPER-I/O 2.4 can be installed in the 28 pin EPROM socket of your floppy disk controller. Burke & Burke does not provide an EPROM burning service, but most CoCo clubs will burn an EPROM for

a small charge (\$5-\$10).

Popular word processors, assemblers, and graphics design packages are compatible with EPROM-based HYPER-I/O. If a program is incompatible, a simple patch will usually correct the problem.

HYPER-I/O supports any size and combination of floppy disks, and is a prerequisite for HYPER-III, our RAM disk / printer spooler package for the 512K CoCo 3.

When using a hard disk with HYPER-I/O, there is no need to divide the disk into rigid OS9 and BASIC zones. OS9 files and HYPER-I/O files are stored on the hard disk in different formats, but the HYPER-I/O format conforms to OS9 requirements. This means that you can add either HYPER-I/O or OS9, or change the amount of hard disk storage allocated to either, at any time without reformatting your hard disk. HYPER-I/O also allows you to use two hard disks of the same or different sizes if you so desire.

HYPER-I/O stores information on the hard disk in regions called "MSA's" (Mass Storage Areas). To OS9, each MSA looks like a large data file; to HYPER-I/O, an MSA looks like an image of a floppy disk. Many different sizes of MSA are allowed, including standard 35 track floppy disk emulation and emulation of double-sided, 160 track super-floppies. Several different sizes can be mixed on the same hard disk. You can create up to 200 MSA's distributed across one or two hard disks.

Version 2.4 also includes utilities to transfer files between MSA's and the OS9 file system.

New hard disk drivers that allow you to use HYPER-I/O with other vendors' hard disk interfaces (Tandy, LR, Disto) will be available from Burke & Burke as separate packages in the near future.

2.3 XT-ROM

XT-ROM automatically boots OS9 from hard disk whenever the CoCo is turned on or reset. It is a 28 pin EPROM that replaces the BIOS ROM on your Western Digital or Adaptec hard disk controller.

Version 2.2 of XT-ROM provides several advanced features not present in earlier releases:

- * Improved compatibility with RLL hard disk controllers
- * Automatic configuration
- * Allows two different boot files to be stored on the disk
- * An RS-DOS patch is included to make your HYPER-I/O DOS command access XT-ROM instead of the floppy disk.

The alternative boot is selected by holding down the [O] key during power-up. This will load the first 18 sectors of track 129 instead of track 128. The BootPort utility will allow you to store the OS9 kernel on either track. A patch is provided that will use ALTBoot instead of OS9Boot as the boot file when booting from track 129.

XT-ROM automatically senses whether it is running in a CoCo 2 or a CoCo 3.

If you are installing XT-ROM as a "piggy-back" on the BIOS ROM, you may need to add a 4.7K pull-up resistor (or just a wire) between pins 20 and 28 of the *ORIGINAL* BIOS ROM after clipping off pin 20 as shown in the instructions. Note that this resistor connects to pin 20 of the BIOS ROM, and not to pin 20 of XT-ROM. The best solution is to remove the BIOS ROM and install the 28 pin IC socket supplied with XT-ROM.

There is a seven second hard disk power-up delay built into XT-ROM. The memory test provides another 10 seconds of delay. You can bypass these delays by holding down the spacebar during start up.

2.4 WILD

WILD lets you use "wild cards" to tell OS9 to perform an operation on a group of files instead of an individual file.

Version 2.1 of the WILD OS9 wildcard utility has all of the features of previous versions, plus the capability of recursively descending the directory tree. The recursive feature is activated by the new -R command line option.

Typical examples of the use of WILD are:

wild -kp copy *.src /d0/old/*.bak	Copies all files with an extension of ".src" from the current working directory to the directory "/d0/old"
wild del ctmp*	Delete all "C" compiler scratch files from the current working directory.
wild -2p grep -y ABC /d2/???.dat	Search for all occurrences of the string "ABC" in all files with thress character file names and an extension ".txt", located in directory /d2.

Each of these WILD commands performs an operation that would require many OS9 commands if WILD were not used.

2.5 EZGen

EZGen is a module editor that accepts a superset of the ModPatch command set. Rather than modifying memory-resident modules, EZGen accesses the disk file where the modules are stored. This allows EZGen to work with non-sharable modules like CC3Go, and also with special files like the OS9 kernal.

Here is a sample of the EZGen Version 1.02 command set:

C(hange)	Change the value of the byte at a specified module offset
H(eader)	Convert a block of data to an OS9 module
L(ink)	Select a module for editing
M(emorydump)	Display data for a given range of module offsets
P(atch)	Overlay a module from a disk file
R(ename)	Change the name of a module, or any name string in the module
U(pdate)	Replace a module with a version stored in another file
V(erify)	Correct a module CRC
X(extend)	Extend a module by a given number of bytes

If necessary, EZGen will relocate the OS9Boot or AltBoot files to make them contiguous. The new boot location is stored automatically.

Burke & Burke includes EZGen Version 1.02 with the CoCo XT interface. It is also available separately.