M-Systems
Flash Disk Pioneers

Series 2000

DiskOnChip®2000
MD-2200 Data Sheet

Features

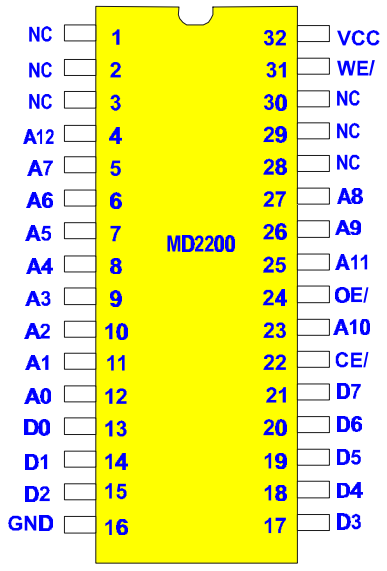
- **Single chip plug-and-play FTL FlashDisk**
- **2 - 12MB capacity (24-72MB in 2H97)**
- **Simple, easy to integrate interface**
- **32-pin DIP JEDEC standard EEPROM compatible pinout**
- **Embedded *TrueFFS*Ò software provides:**
  - **Full hard disk read/write capability**
  - **Third generation wear leveling**
  - **Automatic management of bad blocks**
- **Operates with FLite™ (FAT - FTL/Lite) in O/S-less environments**
- **EDC/ECC for high data reliability**
- **Full boot capability**
- **Low power consumption**
- **Broad O/S support: DOS, Windows, Windows95, WindowsCE; Additional support offered: pSOS+, QNX, VxWorks and others**
- **Single 5V supply**
- **Window size – 8KB**
- **Best cost performance solution**

1. General Description

The DiskOnChip 2000 family of products provides a single chip, solid-state flash disk in a standard 32-pin DIP package. The DiskOnChip 2000 is intended for use in embedded and portable PC-compatible computers that have limited space and minimal power consumption requirements. By placing the DiskOnChip 2000 into a standard socket, physical space requirements are reduced. Unlike standard IDE drives, no cables or extra space is required. The DiskOnChip 2000 is a solid-state disk with no moving parts, resulting in a significant reduction in power consumption and an increase in reliability. The DiskOnChip is a small, plug-and-play Flash disk. It is easy to use and saves integration overhead.

The DiskOnChip 2000 family of products is available in capacities ranging from 2MB up to 12 MB, unformatted. While in future versions the capacity will be dramatically increased (up to 72MB in 2nd half of 1997), the same pin-out will be retained. This way, the socket on the target platform will not have to be changed, when accommodating future larger capacities.. In order to manage the disk, the DiskOnChip 2000 includes the TrueFFS, M-Systems' Flash File System. The DiskOnChip 2000 package is pin-to-pin compatible with standard 32-pin EPROM device.

The DiskOnChip 2000 is shipped as a plug-and-play device, meaning that it was programmed and formatted during production. Future software upgrades and formatting can be done on the target platform. There is no need to remove the DiskOnChip 2000 from its socket in order to modify its contents or to reformat it.



Pin Name	Description	Pin Number	Direction
A0 - A12	Address bus	4-12,23,25-27	Inputs
D0 - D7	Data bus	13-15,17-21	I/O
CE/	Chip Enable	22	Input
OE/	Output Enable	24	Input
WE/	Write Enable	31	Input
NC	Not Connected	1,2,3,28,29,30	
VCC	Power	32	
GND	Ground	16	

Figure 1 - MD2200 Pin-out

2. Operation In PC Architecture

2.1 Functional

In standard PC architecture, the DiskOnChip is mounted in a 32-pin DIP socket, which is compatible with a standard EEPROM. The DiskOnChip should be mapped into the expansion BIOS area of the PC. During the boot process, the DiskOnChip loads its software into the PC's memory and installs itself as an additional disk drive in the system. After that, the PC's operating system is loaded and the DiskOnChip is recognized as a standard disk. No external software is required. The DiskOnChip can be used as the only disk in the system, allowing the system to boot from it. The DiskOnChip can also work with other hard disks or floppies as the boot device or as a secondary disk.

Figure 2 shows DiskOnChip memory location relative to the PC memory map.

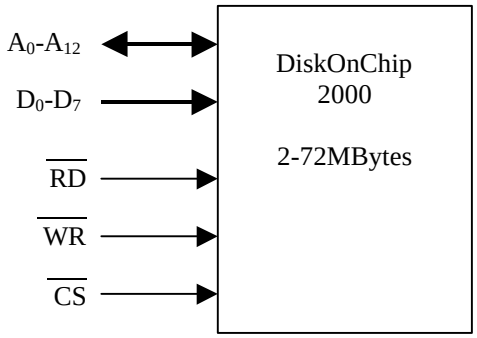


Figure 2 – DiskOnChip Interface

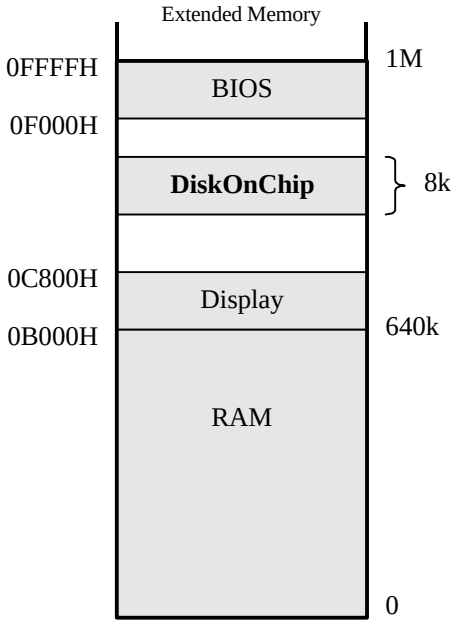


Figure 3 - PC memory map

The DiskOnChip should be mapped to occupy an 8 KB window of expansion BIOS space, which is usually located between 0C0000H to 0EFFFFH.

After executing the POST (Power on Self-Test), and as part of the PC BIOS standard operation, the BIOS searches for ROM expansion code. When found, the BIOS executes the initialization code located in the DiskOnChip. This code loads the TrueFFS drivers into memory, installs the DiskOnChip as a disk in the system, and then transfers control back to the BIOS code. At this stage, when

the operating system is attempting to identify which disks are available to the system, the DiskOnChip software emulates a hard disk and responds as such.

From this point on, the DiskOnChip appears as a standard disk drive, i.e. it is assigned a drive letter and it can be used by any software applications. No BIOS set-up modifications or autoexec.bat/config.sys modifications are required.

The flash memory within the DiskOnChip is accessed by the TrueFFS through an 8KB window in the PC's upper memory. The TrueFFS handles the paging of this window in the flash array, as well as the Flash Disk emulation which includes flash table management, wear levelling and background space reclamation on unused flash blocks. The same window will be used with larger capacities in future versions of the DiskOnChip 2000. No redesign of the socket or larger memory resources will be required.

The DiskOnChip with TrueFFS provides true sector-based disk emulation, which is compatible with conventional hard disks. The DiskOnChip provides a bootable drive that is compatible with DOS and Windows disk utilities. All the users' applications and utilities can be used the same way they are handled on the desktop.

2.2 System Requirements

In a standard PC architecture there are only two requirements on the socket into which DiskOnChip is inserted:

1. The socket should be mapped to the ROM expansion space of the PC (0C8000H to 0E0000H).
2. The socket memory window must occupy at least 8KB-memory space in the PC's memory addresses.

The first requirement allows the DiskOnChip to load its software to memory automatically during the boot process.

The second requirement defines the minimum window size required by the DiskOnChip. The window size can be larger than 8KB, since the DiskOnChip 2000is equipped with an internal anti-alias algorithm.

2.3 TrueFFS

TrueFFS is M-Systems' FTL Flash File System management technology which allows common flash components to fully emulate a hard disk. This capability simplifies the usage of flash, as no special or complicated algorithms are needed to work with it - just read and write to it like any disk drive.

TrueFFS acts as a block device driver, working under the native O/S and file system. In this way it maintains full compatibility with other disks in the system and all disk utilities and drivers which accompany them.

The TrueFFS is designed to be loaded at start-up. This allows the flash disk to be the boot device. No other system disk is required.

TrueFFS enables enhanced performance which nearly matches the maximum read/write limit of the flash components. Background erasure of used flash blocks eliminates the long delays commonly encountered when writing to flash. Due to direct access to the flash, which has no moving parts, read speeds are exceptionally fast. Additionally, there are no access, seek or spin-up delays which are typically encountered with mechanical disk drives.

2.4 Boot

As described above, the DiskOnChip 2000 is recognized by the system like any hard disk. The DiskOnChip can be used as the only disk in the system, in which case it will be referred to as drive C. The DiskOnChip can work together with or without a floppy drive, or with another hard disk. When working with another hard disk, the DiskOnChip can be configured as the last drive, where the hard disk will be C: and the DiskOnChip will be D:, or as the first drive, where the hard disk will be D: and the DiskOnChip will be C:.

The DiskOnChip can be used as the boot device when configured as C. In this configuration, the user is required to format the DiskOnChip as a bootable device (i.e. copy the OS files into the disk, which can be done with the DOS SYS command).

2.5 Integrating the DiskOnChip 2000

The DiskOnChip is fully plug-and-play, making it very easy to integrate:

1. Plug the DiskOnChip into the DIP socket.
2. Power up the system.
3. Access the DiskOnChip as a regular drive, and copy your application files into the DiskOnChip.
4. If the DiskOnChip is to be the bootable drive, format it as a bootable disk and re-boot the system.

The DiskOnChip is shipped formatted and pre-programmed to be fully plug-and-play. In addition, M-Systems provides utilities for testing and formatting the DiskOnChip 2000. These utilities operate on the DiskOnChip that is plugged into the host system. The provided utilities also allow on-board updating of the internal DiskOnChip firmware. This eliminates the need to physically remove the DiskOnChip from the socket in order to modify its software or firmware.

3. Operation In non-PC architecture

The DiskOnChip 2000 can work with any other CPU or operating system besides DOS or Windows. The following sections describe how to operate the DiskOnChip in these environments.

3.1 Operation with standard operating systems

The DiskOnChip 2000 is compatible with many operating systems in addition to DOS. This includes QNX, pSOS, VxWorks, WindowsCE, and many others.

In order to use the DiskOnChip with these Operating Systems, the appropriate DiskOnChip 2000 device driver should be installed. The DiskOnChip 2000 device driver can either be included with the operating system, or supplied by M-Systems.

When operating under one of these Operating Systems in a PC compatible host system (i.e. x86 CPU and standard BIOS), the boot process is performed in the same way as described above for DOS.

3.2 FLite

For using the DiskOnChip 2000 in other environments with either a non-supported operating system, or without an operating system at all, M-Systems provides the FLite software. FLite stands for FAT/FTL-Lite.

FLite is a portable solution for integrating the DiskOnChip 2000 into non-standard environments or operating systems. Figure 5 shows a block diagram of FLite.

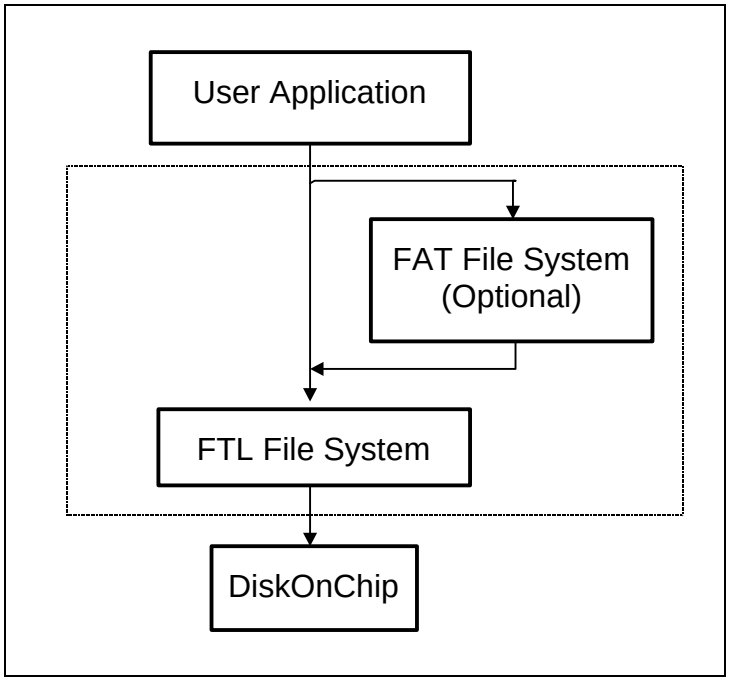


Figure 4 - FLite Block Diagram

FLite is a file system and flash media manager targeted for applications that require file handling capabilities and the need to transfer files and data to a desktop computer.

The DOS FAT file component provides a PC compatible file system, allowing the application to read and write files in the same way that it is done on the PC.

The DOS FAT component provides full implementation of a DOS FAT file system, including support for subdirectories. Following are some of the supported services of the DOS FAT component: Open, Close, Read, Write, Seek, Delete, Mkdir, Rmdir, Join file and Split file.

FLite uses the industry standard FTL (Flash Translation Layer) format, which provides the full hard disk emulation at the sector level.

FLite includes portable source code with a simple API for ease of use in micro-controllers, even those without a native operating system. FLite is designed to support a wide range of environments including 8 bit CPUs such as 8051 and RISC CPUs such as SH3 and PowerPC.

4. Theory Of Operation

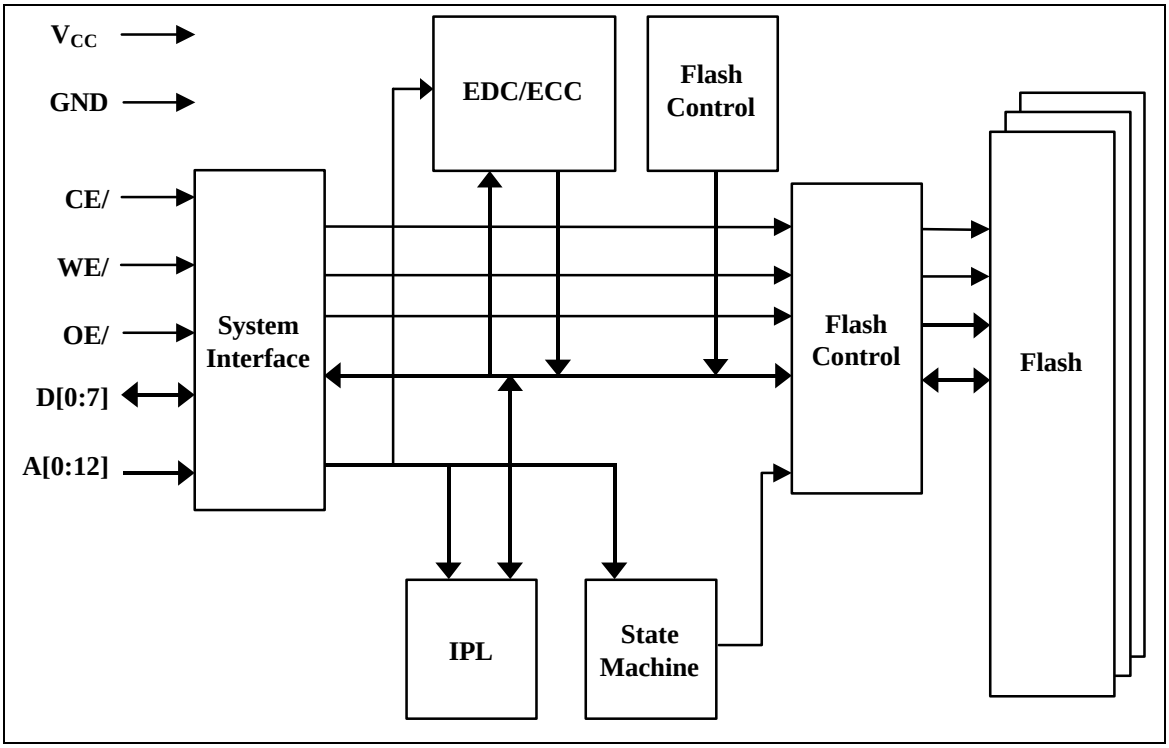


Figure 5 - MD2200 Block Diagram

The DiskOnChip 2000 looks to the system as a standard EEPROM. The system interface is controlled by the host bus signals (read, write, addresses and chip select), which generate the appropriate control signals to the internal blocks.

The internal ROM provides an IPL code which loads the TrueFFS software from the Flash device into the PC memory during boot (after power up or reset). This code is necessary since NAND-type flash devices have no linear address, and therefore cannot be used as boot code storage devices. After the IPL code is loaded, the driver initializes the internal registers and the state machine. It then loads the TrueFFS software drivers from the NAND flash devices.

The Flash Control block interfaces with the NAND flash devices using M-Systems' CDSN protocol. The Flash blocks include the Flash devices, which are mounted inside the DiskOnChip. There may be more than one Flash device. The software automatically detects the number of Flash devices and their capacity by reading their ID code, and calculates the total capacity of the DiskOnChip 2000.

5. Disk Capacities

Each DiskOnChip device is fully tested and formatted when shipped from M-Systems. The exact capacity of each model is detailed in the following table:

Model	Formatted Capacity (bytes)	Sectors	Formatted Capacity under DOS 6.22 (bytes)	Sectors under DOS 6.22 (bytes)
MD2200-02MB	1,998,848	3904	1,986,560	3880
MD2200-04MB	4,038,656	7888	4,022,272	7856
MD2200-08MB	8,151,040	15920	8,128,512	15876
MD2200-12MB	12,263,424	23952	12,228,608	23884
MD2200-24MB	24,592,384	48032	24,516,608	47884

6. Electrical Specifications

6.1 Absolute Maximum Ratings

Parameter	Symbol	Rating[1]	Units	Notes
DC supply voltage	V_{CCS}	-0.3 to 6.0	V	
Input pin voltage[2]	V_{IN}	-0.3 to V_{CC}	V	
Input pin current	I_{IN}	-10 to 10	mA	25°C
Storage temperature	T_{STG}	-45 to 100	°C	

Notes:

1. Permanent device damage may occur if Absolute Maximum ratings are exceeded. Exposure to absolute maximum rating conditions for extended periods of time may affect device reliability.
2. The voltage at any pin may undershoot to -2.0V or overshoot to Vcc+2.0V for periods <20ns.

6.2 Capacitance

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_{I/O}$	Input/Output Capacitance	V_{IL} =0V			15	pF

Note: Capacitance is not 100% tested.

6.3 Operating Temperature Ranges

Regular operating temperature ..... 0°C to +70°C

Enhanced operating temperature..... -25°C to +75°C

Extended operating temperature..... -45°C to +85°C

6.4 Humidity

10%-90% relative, non condensing

6.5 EDC/ECC

Enhanced Reed-Solomon ECC:

- Corrects up to two 10-bit symbols including two random bit errors.
- Corrects single bursts up to 11 bits.
- Detects single bursts up to 31 bits and double bursts up to 11 bits.
- Detects up to 4 random bit errors.

6.6 DC Electrical Characteristics Over Operating Range

Symbol	Parameter	Conditions	Min (nS)	Typ (nS)	Max (nS)	Unit
V_{CCS}	System Supply Voltage		4.5	5.0	5.5	V
V_{IH}	High Level Input Voltage		2.0			V
V_{IL}	Low Level Input Voltage				0.8	V
V_{OH}	High Level Output Voltage		2.4			V
V_{OL}	Low Level Output Voltage				0.4	V
I_{IL}	Input Leakage Current				±1	µA
I_{OZ}	Output Leakage Current				±10	µA
I_{VCC}	Supply Current	Cycle Time = 100 nS, Outputs open		40	50	mA
I_{STDBY}		Standby		60	100	µA
I_{RD}		Read cycle		25	40	mA
I_{WR}		Write cycle		30	40	mA

6.7 AC Operating Conditions

Timing specifications are based on the following conditions:

Parameter	Value
Supply Voltage	V_{CC} = 5V ± 0.5V
Input Pulse Levels	0.4V to 2.6V
Input Rise and Fall Times	5 ns
Input and Output Timing Levels	0.8V and 2.0V
Output Load	50 pF

6.8 Timing Specifications

6.8.1 Read Cycle Timing

Symbol	Description	Min (ns)	Max (ns)	Notes
T_{SU}(A)	Address to OE# asserted setup time	10		
T_{HO}(A)	OE# asserted to Address hold time	10		
T_{SU}(CE0)	CE# asserted to OE# asserted setup time	0		1
T_{HO}(CE0)	OE# negated to CE#=0 hold time	0		2
T_{HO}CE1)	OE# or WE# negated to CE#=1 hold time	10		
T_{SU}(CE1)	CE# negated to WE# or OE# asserted setup time	10		
T_{REC}	OE# negated to start of next cycle	15		
T_{ACC}	Read access time		45	3
T_{EN}(D)	OE# asserted to D active delay		45	
T_{DIS}(D)	OE# negated to D Hi-Z delay		6	

Notes:

1. CE# may be asserted any time before or after OE# is asserted. If CE# is asserted after OE#, all timing relative to OE# asserted will be referenced instead to the time of CE# asserted.
2. CE# may be negated any time before or after OE# is negated. If CE# is negated before OE#, all timing relative to OE# negated will be referenced instead to the time of CE# negated.
3 IPL and Register reads only.

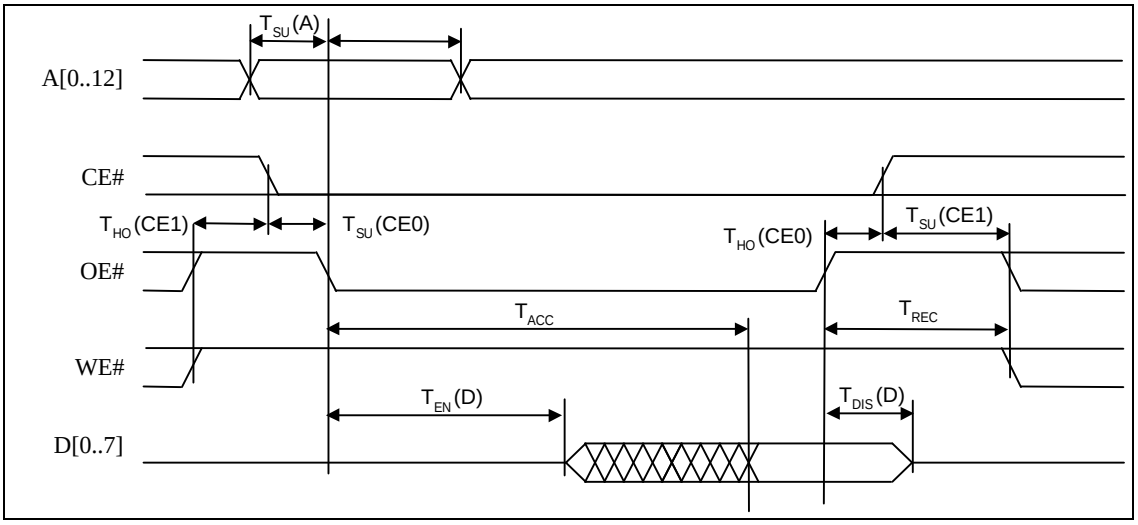


Figure 7 – Read Cycle

6.8.2 Write Cycle Timing

Symbol	Description	Min (nS)	Max (nS)	Notes
$T_{SU}(A)$	Address to WE# asserted setup time	10		
$T_{HO}(A)$	WE# asserted to Address hold time	10		
$T_{W}(WE)$	WE# asserted width	30		
$T_{SU}(CE0)$	CE# asserted to WE# asserted setup time	0		1
$T_{HO}(CE0)$	WE# negated to CE#=0 hold time	0		2
$T_{HO}(CE1)$	OE# or WE# negated to CE#=1 hold time	10		
$T_{SU}(CE1)$	CE# negated to WE# or OE# asserted setup time	10		
T_{REC}	WE# negated to start of next cycle	15		
$T_{SU}(D)$	D to WE# negated setup time	25		
$T_{HO}(D)$	WE# negated to D hold time	4		

Notes:

1. CE# may be asserted any time before or after WE# is asserted. If CE# is asserted after WE#, all timing relative to WE# asserted will be referenced instead to the time of CE# asserted.
2. CE# may be negated any time before or after WE# is negated. If CE# is negated before WE#, all timing relative to WE# negated will be referenced instead to the time of CE# negated.

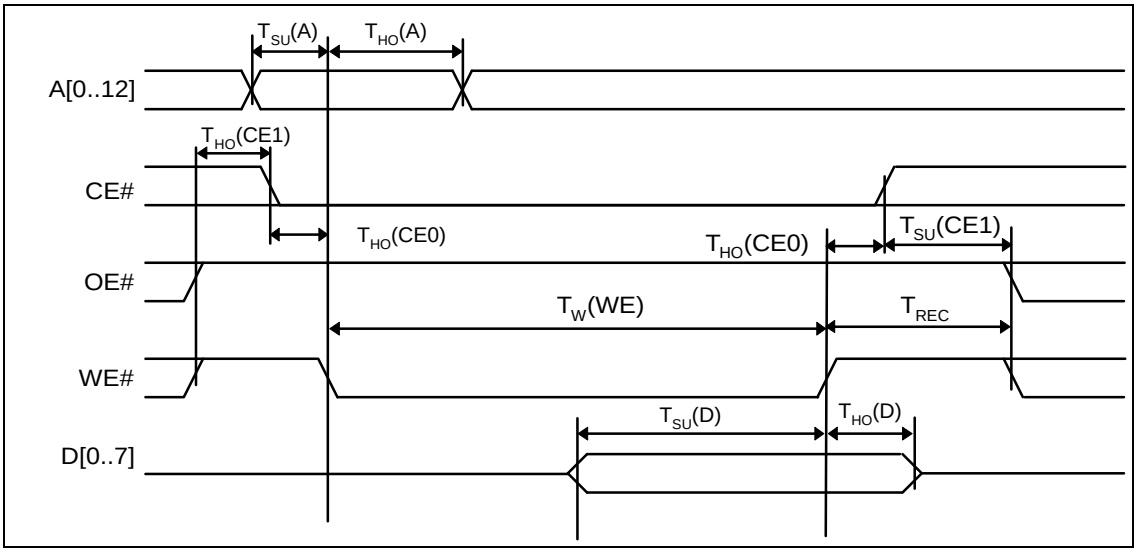
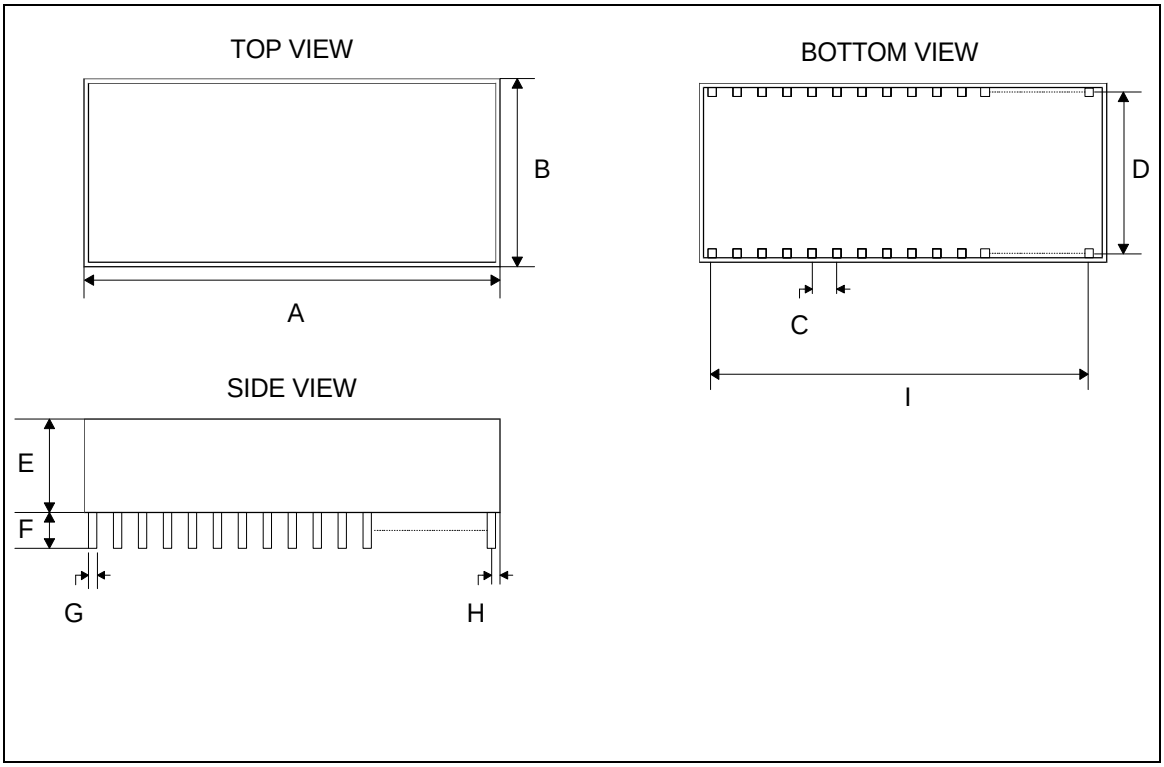


Figure 8 – Write Cycle

6.9 Mechanical Dimensions



	MD-2200-Dxx	
	Millimetres	**Inches**
A	41.65 ± 0.1	1.64 ± 0.004
B	17.90 ± 0.1	0.704 ± 0.004
C	2.54	0.100
D	15.24	0.600
E	5.50 ± 0.2	0.216 ± 0.008
F	3.70 ± 0.2	0.145 ± 0.008
G	0.46 + 0.04	0.018 + 0.001
H	1.80 ± 0.1	0.071 ± 0.004
I	38.10 ± 0.1	1.5 ± 0.004

6.10 Ordering Information

MD-2200-DCC-T-PI

CC:	Capacity (2,4,8,12,24 MB)		
T:	Temperature Range	Blank -	Regular 0°C to +70°C
		N -	Enhanced -25°C to +75°C
		X -	Extended -45°C to +85°C
PI:	Packaging	Blank	Bulk
		PI	Individual (incl. manual and utilities diskette)

6.11 Additional Information

Document/ Tool	Description
DiskOnChip 2000 Data Sheet	DiskOnChip 2000 Data Sheet
DiskOnChip 2000 Utilities	DiskOnChip 2000 Utilities User Manual
DiskOnChip 2000 quick installation guide	DiskOnChip 2000 quick installation guide (provided with the individual package)
AP-DOC-10	Application note - Designing with DiskOnChip 2000
DiskOnChip2000-EVB	DiskOnChip Evaluation Board
DiskOnChip2000-PIK	DiskOnChip Programmer and Integrator's Kit
DiskOnChip2000-GANG	8 Socket Gang Programmer[1]

M-Systems
Flash Disk Pioneers

Series 2000

Questions and Answers about DiskOnChip2000

1. I am designing my next board right now, and am considering the DiskOnChip2000 as the storage media. What should I do?

   M-Systems has a full set of application notes to describe the necessary details. The main requirement is to add a 32 pin DIP socket to your board, connect it as a standard EEPROM, and map it into an 8KByte window in the Expansion BIOS area of the PC. The DiskOnChip is a self-contained, bootable disk drive, and it doesn't require any software integration. Please refer to AP-DOC-010 "Designing with the DiskOnChip2000" for further information

2. My systems require flexible storage solutions; sometimes I need a hard disk and sometimes a Flash Disk. Can DiskOnChip work in this type of environment?

   For applications requiring disk storage flexibility, DiskOnChip is a perfect solution. For flash disk-only applications, DiskOnChip offers a wide range of capacities to tailor the solution to the lowest price point. If no flash disk is needed, the overhead cost is about 5 cents for the (unused) DiskOnChip socket. For mixed solutions, DiskOnChip can work in conjuction with a hard disk and can be configured as the boot disk or next available drive.

3. What are the advantages of DiskOnChip2000 vs. a Resident Flash Array?

   A Resident Flash Array (RFA) is comprised of flash components soldered to a main or daughter board and integrated with interface logic and a flash file driver such as TrueFFS, to make them work as a flash disk. RFAs may appear to offer slightly lower component cost but they suffer from many restrictions compared to DiskOnChip2000:

   - Board space usage - up to six time reduction in space with DiskOnChip
   - Flexibility - easy to plug-in different capacities
   - Migrate to new technologies - no board redesign required or software updates
   - Ease of integration
   - Can be pre-programmed - lowers manufacturing cost

4. What modifications will I have to make to the AUTOEXEC.BAT and the CONFIG.SYS files in order to use the DiskOnChip2000?

   None.

5. Will I need to place any special files on the DiskOnChip2000 in order for it to work?

   No. The only files required are the customer's application files. The DiskOnChip driver is kept on the flash media, in a safe place, protected from and invisible to the user.

6. How will I upgrade the DiskOnChip firmware when M-Systems releases new software versions? Will I have to open my products and remove the DiskOnChip2000 from its socket?

   The DiskOnChip does not need to be removed from the socket. Running a simple utility program on the target system can perform the upgrade quickly and easily.

7. Is the DiskOnChip2000 Plug & Play?

   Yes, DiskOnChip is self-contained and needs no external drivers or jumper settings. Just plug the DiskOnChip2000 into the socket and power up the system.

8. Is the DiskOnChip2000 suitable for use in ultra-small portable products, such as Personal Digital Assistants running Microsoft CE?

   DiskOnChip is fully compatible with Windows CE. M-Systems has developed TrueFFS drivers for Windows CE although they have not yet been made available for the DiskOnChip. Because DiskOnChip is an ultra small, high capacity drive, it is ideal for storing large databases or applications, which will make it an attractive solution to many OEM's and vertical integrators of such PDAs. Alternatively, for this handheld market, the Series2000 is also available from M-Systems in the thin Type I PC Card (PCMCIA) format, with capacities as high as128 MBytes. These cards include the necessary Windows CE drivers.

9. I have the DiskOnChip 1000 programmer. Can I still use it with the DiskOnChip2000?

   The external programmer is composed of an ISA card and a socket with a flat cable. Both the ISA card and the socket should be upgraded to support the DiskOnChip2000 PIK. M-Systems will replace your old 32 pin socket and ISA Card with a new one free of charge.

10. What are the main improvements of DiskOnChip2000 Series over the previous DiskOnChip 1000 Series?

    The key improvements with DiskOnChip2000 are:
    - The ability to store up to 6 times more data, eventually to become a 36x improvement!
    - More than 5 times improvement in write performance
    - Up to 50% lower in price

    These improvements will become even more significant later this year when the maximum capacity increases to 72MB.

The DiskOnChip is a paradigm shift for the design engineer, who can consider it as a true alternative to hard disk drives.

For DiskOnChip Series 1000 customers, the new Series 2000 can be a drop-in replacement, providing the socket has a write signal, when working in Flash Disk Mode. No changes need to be made in design or configuration. All M-Systems' products provide such an easy migration path. They will grow with the your application, providing forward as well as backward compatibility.

Here are the main differences between DiskOnChip Series 2000 and 1000:

- Increased capacities - 2, 4, 8 or 12MB vs. 1 or 2MB
- Lower cost
- Better performance - write speeds of 250KB/sec vs. 50KB/sec.
- Lower power consumption
- Reduced memory requirement - 8KB memory window vs. 32KB.

11. Is the DiskOnChip dependent on certain Flash technologies or Flash chip vendors?

No. DiskOnChip is implemented with M-Systems' industry standard technology - TrueFFS and FTL, which stands for "Flash Translation Layer," works with any flash technology. Therefore, it can be implemented with any of the common flash technologies available in the market - NOR (Intel, Sharp, AMD, or Fujitsu), NAND (Toshiba or Samsung), and others. M-Systems' future road map will include other additional flash technologies.

- M-Systems' designers can therefore take advantage of the best technologies available to give DiskOnChip the best performance, capacity and price.
- The DiskOnChip is self contained, i.e. once plugged in the socket, it works as a Flash Disk. This is regardless of the flash technology being used inside of the product. The result is more flexibility, broader choices, and easier integration.
- All of M-Systems' Flash data storage solutions guarantee forward and backward compatibility. The underlying flash technology is transparent to the designer and quick migration to versions utilizing new, leading edge components is possible.

12. Is NAND technology mature and is there only a single source for this type of Flash memory component?

- NAND technology is mature. The third generation of product (64Mbit) is now appearing, while current versions have been shipping in volume for several years.
- There is more than one source for NAND: Samsung, and Toshiba Corporation, . Toshiba was the original developer of Flash memory back in the mid-eighties and they invented the NAND flash technology as well. DiskOnChip2000 can use NAND flash from either of these sources!

13. How easily can I upgrade from Series 1000 to DiskOnChip2000?

    DiskOnChip2000 is a drop-in replacement for the DiskOnChip1000 when operating in Flash Disk Mode, providing the write signal is connected to the socket.

    The DiskOnChip2000 does not support BIOS replacement mode.

14. In earlier stages of using the DiskOnChip 1000, I had to use an external programmer in order to modify the firmware or to test the DiskOnChip. Do I have to use the programmer with the DiskOnChip2000 for this purpose?

    No. All the tasks done by the programmer can be done while the DiskOnChip is plugged into your target platform. However, the PIK (Programmer and Integrator Kit) can be a useful tool during the manufacturing stages.

Series 2000

User Manual

DiskOnChip®2000

Utilities

July-97

91-SR-002-02-8L REV. 2.0

M-Systems

Flash Disk Pioneers

1. Introduction

M-Systems' *DiskOnChip2000* is a new generation of high performance single-chip Flash Disk. The DiskOnChip MD2000 provides a Flash Disk in a standard 32-pin DIP package.

This unique data storage solution offers a better, faster, and more cost-effective Flash Disk for Single Board embedded systems, Internet devices and portable applications with limited space and modest disk capacity requirements.

The new DiskOnChip 2000 provides a Flash Disk (as BIOS expansion) which does not require any bus, slot or connector. Simply insert the DiskOnChip2000 into a 32-pin socket on your CPU board, with a minimal installation cost, and you have a bootable Flash Disk.

Various Operating Systems are supported by DiskOnChip 2000 : DOS, Windows, Win95. Additional support offered: pSOS+, QNX, VxWorks and others.

DiskOnChip2000 is the optimal solution for Single Board Computers - it's a small, fully functional, easy to integrate, plug-and-play Flash Disk with a very low power consumption.

This manual describes the software utilities for the DiskOnChip 2000.

2. DFORMAT

Before TrueFFS can access a flash media, the media must be formatted, just as a floppy disk must be formatted. Formatting initializes the media and writes to it a new and empty DOS file system. When formatting is complete, the media contains only a root directory.

The DiskOnChip is fully tested and formatted before the product is shipped, but it can be formatted more than once. Each time it is formatted, naturally all data on the media is destroyed. When reformatting, the boot-image is **retained** by default.

The DFORMAT syntax is:

```
Usage: DFORMAT {drive-letter | /WIN:segment} [/SIZE:size]
[/USE:nnn]
[LABEL:label] [/DOSVER:n] [/SPARE:n] [/Y]
```

The DFORMAT options are:

drive-letter DOS drive letter of the TrueFFS drive.

/WIN:Segment	Memory address in which the DiskOnChip is located. Use either this flag or the ***drive-letter*** flag.
/LABEL:*label*	A string to be used as the DOS label of the formatted media.
/SIZE:*size*	The size of the flash media to be formatted (including the install partition). By default the entire media is formatted by DFORMAT. This option limits the formatted size.
/USE:*nnn*	Percentage of available space on the flash media to be used for file storage. ***nnn*** can be any number from 1 to 100. Default is 99 (99%). The value of this option may affect the write performance of TrueFFS.
/DOSVER:*dos-major-version*	Format for a target system running the specified DOS version. The default is the current DOS version (the one on which DFORMAT is executed). For example, /DOSVER:3 formats for DOS 3.x. Valid values are 1 to 6.
/SPARE:*n*	Number of spare units. Default is 1. A value 0 selects a WORM (Write Once Read Many)
/Y	Do not pause for confirmation before beginning to format.

Note: All sizes specified in DFORMAT options are in bytes if specified as simple numbers, in KBytes if specified with the suffix **K**, or in megabytes if specified with the suffix **M**.

Example 1: DFORMAT C:

Formats the DiskOnChip which is used as drive C.

Example 2: DFORMAT /WIN:D000

Formats the DiskOnChip which is located at memory address hex D000. If any other hard disk is present in the system, the DiskOnChip will be identified as drive D:

2.1 Configuring the DiskOnChip as a Bootable Disk

The DiskOnChip fully supports the BOOT capability. In order for the DiskOnChip to be bootable, it should be DOS formatted as bootable, like any floppy or hard disk that required to be bootable.

Example: SYS D:

Change the disk into bootable (assuming the DiskOnChip is disk D):

3. DUPDATE - Updating DiskOnChip 2000 Firmware

In case a firmware update will be required, M-Systems will deliver a new .EXB file which should be written into the firmware portion of the Flash media within the DiskOnChip, using the DUPDATE utility.

DUPDATE requires that the DiskOnChip will be already programmed with previous firmware file programmed into, which is the default Since the DiskOnChip is shipped fully tested and programmed.

The DUPDATE syntax is:

```
DUPDATE [drive-letter | /WIN:Segment] /S:BootImage /FIRST
```

drive-letter DOS drive letter of the TrueFFS drive.

/WIN:Segment Memory address in which the DiskOnChip is located. Use either this parameter or the drive-letter. The segment should be specified in Hex (e.g. /win:d000)

/S:BootImage The boot image file of the new firmware to be written to the DiskOnChip. Usually the file type is .EXB

/FIRST Use this flag to program the DiskOnChip to be the first disk if more disks are installed in the system. This flag has no effect if the DiskOnChip is the only disk in the system. The /S parameter must be supplied when /FIRST flag is used.

Example 1: DUPDATE C: /S:DOC2000.EXB

Program the firmware which is supplied in DOC2000.EXB file into the DiskOnChip located as drive C:

Example 2: DUPDATE /WIN:D000 /S:DOC2000.EXB

Program the firmware which is supplied in DOC2000.EXB file into the DiskOnChip which is located at memory address hex D000.

Example 3: DUPDATE /WIN:D000 /S:DOC2000.EXB /FIRST

Program the firmware which is supplied in DOC2000.EXB file into the DiskOnChip which is located at memory address hex D000. The DiskOnChip will be the first drive (C:) in case a hard disk is available in the system.

Example 4: DUPDATE /WIN:D000 /S:DOC2000.EXB

Program the firmware which is supplied in DOC2000.EXB file into the DiskOnChip which is located at memory address hex D000. The DiskOnChip will be the last drive in the system (e.g. D: if one magnetic hard drive is already configured).

4. DINFO

The DINFO Information utility provides background information regarding the DiskOnChip 2000, and the environment in which it is working. DINFO reports:

- TrueFFS drive letters
- Installed software and its version compliance.
- The size of the Flash media.

The DINFO syntax is:

```
DINFO
```

Example:

DINFO Search the system for DiskOnChip.

Following is the report that was generated in a specific system.

```
DINFO Version 3.3.3 for DiskOnChip 2000 (V1.00)
Copyright (C) M-Systems, 1992-1997
DiskOnChip 2000(R) found at D000:0000
---------------------------------------
Disk statistics:
  Software version: 3.3.03
  Drive letter : D
  Disk size    : 1,992 Kbytes
  Boot size    : 44 Kbytes

Flash media statistics :
  Chip size    : 2,048 Kbytes
  No Of Chips  : 1
  Chip type    : Toshiba TC5816FT
  Total units  : 512
  Free  units  : 494
  Unit size    : 4,096 bytes
  Interleaving : 1
```

These DINFO results show the following:

- A 2MB DiskOnChip
- Programmed with firmware version 3.3.03
- It was assigned a drive letter D:
- The disk size after format is 1,992 KB
- Space allocated for Boot is 44KB
- The Flash media is composed of one Flash device, manufactured by Toshiba
- The Flash media is composed of 512 units
- 494 units are free.
- Each unit is 4.096 bytes

5. Duplicating DiskOnChip 2000

Copying DiskOnChip device is the procedure of copying a “source” DiskOnChip contents into an “image file”, then copying the “image file” contents into as many target DiskOnChip devices as required. All target DiskOnChip devices will have exactly the same contents as the source DiskOnChip, which means they will have exactly the same functionality when plugged into target platform. The only limitation for this process is that all target DiskOnChip devices must have the same capacity of the “source” DiskOnChip. For example: if the “source” DiskOnChip has a 12MB capacity then the “target” DiskOnChip should have 12MB capacity as well.

The duplicating process includes 3 stages:

1. Prepare “source” DiskOnChip.
2. Copy “source” DiskOnChip into an image file.
3. Copy the image file into as many as required “target” DiskOnChip devices.

5.1 Stage 1: Creating the “source” DiskOnChip

The source DiskOnChip includes all target application files. Usually, it will be bootable (see chapter 4.1). The following commands are usually used in order to prepare the “source” DiskOnChip:

1. Format DiskOnChip with DFORMAT utility in target platform, using version 1.04 or above.
2. Copy all target application files onto the DiskOnChip.
3. If required, make the DiskOnChip bootable (this is not a must - but mostly it is required. refer to chapter2.1) - this operation must be done in the target platform (not in PIK).

After the source device was properly prepared, follow the guidelines described below in order to duplicate it as many times as required.

5.2 Stage 2: Copy the “source” DiskOnChip into image file

At this stage, the source DiskOnChip includes all target application files, and it is ready to be duplicated as many times as required. Each duplicated copy will function on the target platform, as the “source” DiskOnChip.

Use GETMIMG utility to copy the “source” DiskOnChip contents into an image file on disk, to be used later as source file for duplications.

1. Run GETMIMG image_file_name.
   (for example: GETMIMG MYDOC.SRC)

5.3 Stage 3: Copy the image file onto “target” DiskOnChip devices

At this stage, the contents of the “source” DiskOnChip is stored in the disk in what we call “image file”. Copying this image file into target DiskOnChip, will result with identical DiskOnChip target device to the one that used as “source”. Use the PUTMIMG utility to perform this task:

1. Power off the system.
2. Insert a target DiskOnChip with the same capacity as the source DiskOnChip into it’s socket.
3. Power on the system
4. Run: PUTMIMG image_file_name.
   (for example: PUTMIMG MYDOC.SRC)
5. The target DiskOnChip will have the exact contents and functionality as the source DiskOnChip when this operation is done. Repeat steps 1 to 3 for each additional target DiskOnChip.

All DiskOnChip devices programmed according to the above procedure are ready to be plugged into the target platforms, and will function exactly the same as the source DiskOnChip.

M-Systems
Flash Disk Pioneers

DiskOnChip®2000
Quick Installation Guide

Dear Customer,

Thank you for purchasing the DiskOnChip 2000. This guide is designed to assist you in a quick and easy installation of the DiskOnChip 2000 in your target platform .

1. DiskOnChip 2000 Installation Instructions

1. **Make sure the target platform is powered OFF**
2. **Plug the DiskOnChip 2000 device into its socket. Verify the direction is correct (pin 1 of the DiskOnChip 2000 is aligned with pin 1 of the socket)**
3. **Power up the system**
4. **During power up you may observe the messages displayed by the DiskOnChip 2000 when its drivers are automatically loaded into system's memory**
5. **At this stage the DiskOnChip 2000 can be accessed as any disk in the system**
6. **If the DiskOnChip 2000 is the only disk in the system, it will appear as the first disk (drive C: in DOS)**
7. **If there are more disks besides the DiskOnChip 2000, the DiskOnChip 2000 will appear by default as the last drive, unless it was programmed as first drive. (please refer to the DiskOnChip 2000 utilities user manual)**
8. **If you want the DiskOnChip 2000 to be bootable:**

   a - copy the operating system files into the DiskOnChip by using the standard DOS command (for example: sys d:)

   b - The DiskOnChip should be the only disk in the systems or should be configured as the first disk in the system (c:) using the DUPDATE utility

2. Additional information and assistance

1. **Visit M-Systems Web site at www.m-sys.com where you can find Utilities Manual, Data Sheet and Application Notes. In addition, you can find the latest DiskOnChip 2000 S/W Utilities**
2. **Contact your dealer for technical support if you need additional assistance, and have the following information ready:**
   - **Product name and serial number**
   - **Description of your computer hardware (manufacturer, model, attached devices, etc.)**
   - **Description of your software (operating system, version, application software, etc.)**
   - **A complete description of the problem**
   - **The exact wording of any error messages**

Series 2000

AP-DOC-010 Application Note

Designing with the DiskOnChip® 2000

Yigal Ben-Zeev

Product Manager

Jul-97

91-SR-002-01-7L REV. 2.0

M-Systems

Flash Disk Pioneers

1. Preface

This application note describes how to integrate the DiskOnChip 2000 with PC compatible systems. The DiskOnChip 2000 is a single chip FlashDisk designed to plug into a standard 32-pin EEPROM socket. The DiskOnChip 2000 should be mapped into an 8KByte window in the BIOS expansion address space of the PC, which is usually located between address 0C0000H to 0EFFFFH.

The DiskOnChip 2000 contains a built-in copy of the M-Systems industry-standard TrueFFS software, which makes the DiskOnChip operate as a standard disk drive. The DiskOnChip 2000 can contain the operating system in it to allow systems to boot without a hard disk. The DiskOnChip 2000 can also be configured as the boot device in systems with a hard disk (see below "Configuring the DiskOnChip 2000 as the first drive").

The DiskOnChip is a self-contained device. The installation of the DiskOnChip does not require any software installation. The design of the DiskOnChip allows for full upward and downward compatibility. While available today in capacities of 2 to 72MBytes, future DiskOnChip devices with higher densities, will be fully compatible with standard DiskOnChip sockets. The basic design of the DiskOnChip actually supports an unlimited capacity.

2. Operating the DiskOnChip

2.1 Installing the DiskOnChip 2000

When installing or removing the DiskOnChip, be sure to first touch a grounded surface to discharge any static electricity from your body. Use the following procedure to install the DiskOnChip:

1. Align pin 1 on the DiskOnChip with pin 1 of socket.
2. Push the DiskOnChip into the socket carefully until it is fully seated.
3. Check to make sure the DiskOnChip is installed securely, and there are no bent pins.

   Caution: The DiskOnChip may be permanently damaged if installed incorrectly!

4. To install the DiskOnChip as drive C on a system without a hard disk, set the CMOS setup of drive C to "not installed" (indicating that no physical magnetic disk is installed), and reboot the computer. The DiskOnChip 2000 will install as drive C. The DiskOnChip needs to be formatted with the System files in order for it to be a bootable drive. See "Configuring the DiskOnChip as the BOOT device" below.
5. To install the DiskOnChip as drive D on a system with a hard disk, just reboot the system, and the DiskOnChip will install as drive D.
6. To install the DiskOnChip as Drive C on a system with a hard disk, see below "Configuring the DiskOnChip as the first drive".

2.2 Configuring the DiskOnChip 2000 as the Boot device

In order to configure the DiskOnChip as the boot device, the operating system files need to be copied into it. Copying the operating system files into DiskOnChip should be done like in any other hard disk. The following is an example of a typical initialization process:

1. Set the DiskOnChip as a regular drive in your system (not a boot drive).
2. Install a bootable floppy diskette in drive A and boot the system.
3. At the DOS prompt, type SYS C: to transfer the DOS system files to the DiskOnChip (assuming the DiskOnChip is installed as drive C).
4. Copy any files needed into the DiskOnChip.
5. Remove the floppy diskette and reboot the system. The system will boot from the DiskOnChip, and will allow you to run and access any files that have been copied into the DiskOnChip.

2.3 Configuring the DiskOnChip 2000 as the first drive

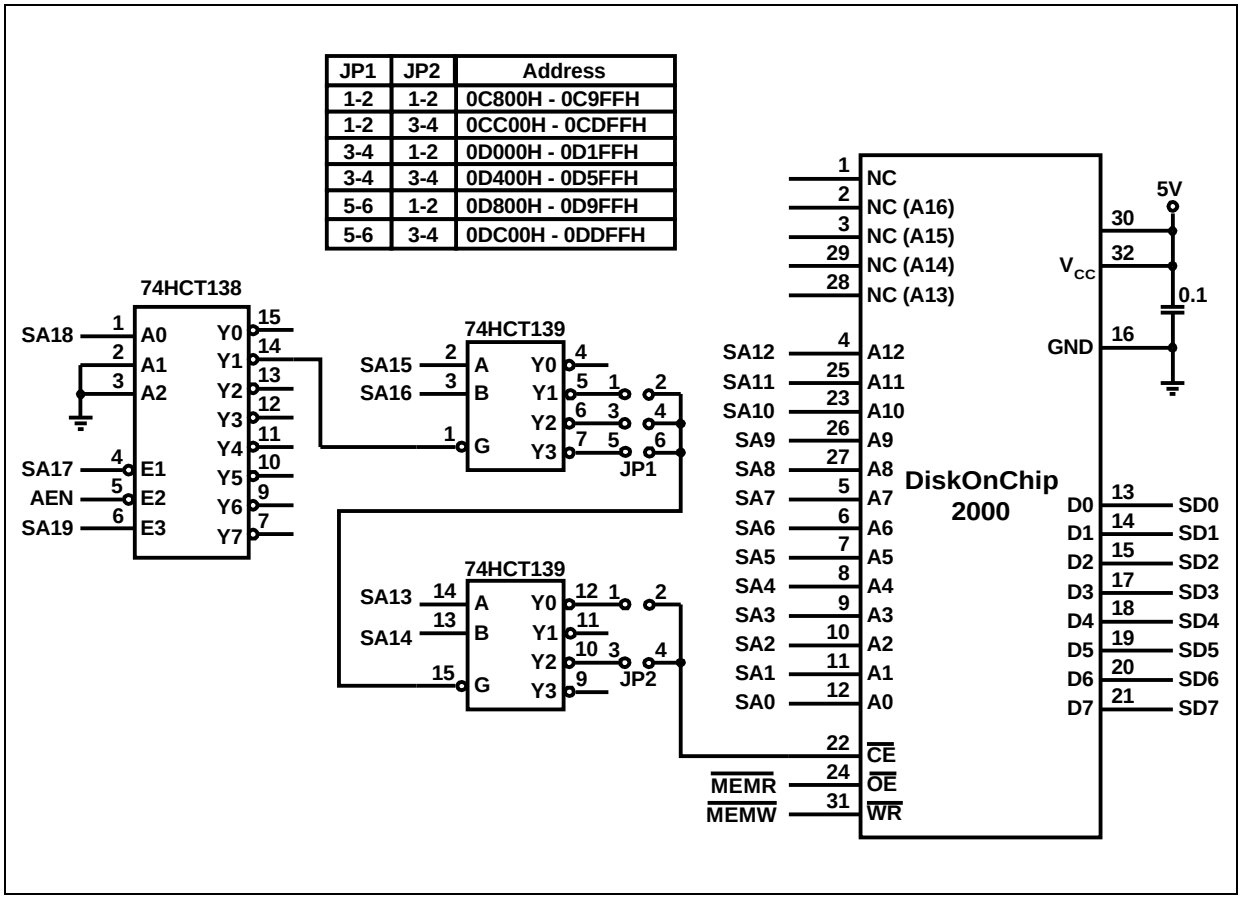
The DiskOnChip can be configured to be installed as the last drive (default), or as the first drive in the system. When configured as the last drive, the DiskOnChip is installed as disk D if there is another hard drive installed, and as drive C if no other hard disk is installed. When configured as the first drive, the DiskOnChip is always installed as drive C. The DiskOnChip is shipped from the factory, configured to install as the last drive. To configure the DiskOnChip to be installed as the first drive, proceed as follows:

1. Boot the system and make sure the DiskOnChip is installed correctly as drive D
2. At the DOS prompt type: DUPDATE D: /FIRST /S:DOC2000.EXB
3. After re-booting the system, the DiskOnChip will appear as drive C:

3. DiskOnChip EVB - An Evaluation Board for the DiskOnChip

The DiskOnChip 2000 Evaluation Board (EVB) is provided by M-Systems as an evaluation tool for the DiskOnChip. The package includes an ISA board with a DiskOnChip socket, software and detailed documentation. The DiskOnChip 2000 EVB enables the evaluation and testing of the DiskOnChip in a standard PC environment.

4. DiskOnChip socket design example



Notes:
1 The above design example shows a DiskOnChip 2000 mapped into an 8KByte window. The DiskOnChip 2000 is compatible with larger windows and will operate and BOOT properly with larger window sizes such as 32KByte and 64KByte windows.
2 Pin 30 connection to VCC is optional - to support 28 pin devices

5. Additional information and Tools

Document/ Tool	Description
DiskOnChip 2000 Data Sheet	DiskOnChip Data Sheet
DiskOnChip 2000 Utilities	DiskOnChip 2000 Utilities User Manual
DiskOnChip2000-EVB	DiskOnChip Evaluation Board
DiskOnChip2000-PIK	DiskOnChip Programmer and Integrators Kit
DiskOnChip-GANG	8 Socket Gang Programmer[1]

1 Contact M-Systems for availability

Series 2000

AP-DOC-011 Application Note

Write Protecting the DiskOnChip® 2000

Dimitry Shmidt

Software Engineer

Aug-97

91-SR-005-00-7L REV. 1.0

M-Systems

Flash Disk Pioneers

1. Preface

The purpose of this application note is to explain how to use the DPROTECT utility to enable the write-protect mechanism in the DiskOnChip2000 Flash Disk. Write protection allows the end user to read data from the Flash Disk, while preventing any modifications to it, thus protecting the media from viruses and unauthorized user modification. The DiskOnChip2000 will retain its write protection even when it is transferred to a different system.

This application note is based on the information provided in Application Note AP-222, *Write Protection for M-Systems' Flash Disks*. AP-222 provides information on the code implementation details and how to call the write protection API from within a program. This application note, AP-DOC-011, provides information on using the write protection utility: DPROTECT.

2. Usage

The DPROTECT syntax is:

DPROTECT drive: /{ON | OFF} [/PASSWORD=*password*]

drive:	Drive letter[1] assigned to the DiskOnChip2000
ON | OFF	/ON - enable write protection /OFF - disable write protection
/PASSWORD=*password*	*password* is an optional eight[2] character[3] password. If a password is not supplied, the default password will be used.

Note:

1. You can run the DINFO utility to determine the drive letter assigned to the DiskOnChip2000.
2. If a longer password is specified it will be truncated to eight characters.
3. Only printable characters can be used.
4. All parameters, except the password, are not case sensitive.

3. Examples

Example 1:

```
DPROTECT D: /ON
```

or

```
dprotect d: /on
```

Assuming that the DiskOnChip2000 is accessed as drive D:, this command will write protect the device with the default password. In order to remove the protection, DPROTECT must be used without a password, as described in example 2.

Example 2:

```
DPROTECT C: /OFF
```

or

```
dprotect c: /off
```

Assuming that the DiskOnChip2000 is accessed as drive C:, this command will remove the write protection only if the device was protected with the default password. If a password was specified when the device was protected, then this command will fail.

Example 3:

```
DPROTECT C: /ON /PASSWORD=mydisk
```

or

```
dprotect c: /on /password=mydisk
```

Assuming that the DiskOnChip2000 is accessed as drive C:, this command will protect the device with the password “mydisk”. In order to remove the protection, DPROTECT must be used with the same password, “mydisk”, as described in example 4.

Example 4:

```
DPROTECT D: /OFF /PASSWORD=mydisk
```

or

```
dprotect d: /off /password=mydisk
```

Assuming that the DiskOnChip2000 is accessed as drive D:, this command will remove the write protection from the device with the password "mydisk". If the password does not match the one used to enable write protection then the operation will fail. If the password is lost, the only way to unprotect the device is to run DFORMAT. This operation will erase the entire contents of the DiskOnChip2000. For further information regarding the DFORMAT utility, please refer to the *DiskOnChip2000 Utilities User Manual*.

4. Additional Documentation and Tools

Document/ Tool	Description
DiskOnChip 2000 Data Sheet	DiskOnChip Data Sheet
DiskOnChip 2000 Utilities	DiskOnChip 2000 Utilities User Manual
DiskOnChip2000-EVB	DiskOnChip Evaluation Board
DiskOnChip2000-PIK	DiskOnChip Programmer and Integrators Kit
DiskOnChip-GANG	8 Socket Gang Programmer*
AP-222	Password-controlled write-protection feature for TFFSBIOS Flash Disks.

* Contact M-Systems for availability

M-Systems' DiskOnChip® 2000 Evaluation Board

DiskOnChip ®2000-EVB

- **ISA card for DiskOnChip 2000 evaluation**
- **Convenient tool for programming the DiskOnChip2000**
- **Enables duplication of DiskOnChip 2000**
- **Shortens integration time**
- **Enables booting from DiskOnChip 2000**
- **Broad O/S support[1]: DOS, Windows, Windows 95, Windows CE, Windows NT**
- **Additional O/S support[1]: pSOS+, QNX, VxWorks and others**
- **Configurable memory window addresses (C8000, D0000, D8000)**
- **Uses 8 KB memory window**

Overview

DiskOnChip 2000 EVB - an ISA card with a socket for DiskOnChip 2000 is a useful tool for designers who need to evaluate, program and test the DiskOnChip 2000, even before the target platform is available.

DiskOnChip2000 overview

M-Systems' *DiskOnChip2000* is a new generation of high performance single-chip Flash Disk. The DiskOnChip MD2000 provides a Flash Disk in a standard 32-pin DIP package.

This unique data storage solution offers a better, faster, and more cost-effective Flash Disk for applications with limited space and modest disk capacity requirements.

DiskOnChip 2000 applications

The DiskOnChip2000 has become the standard Flash Disk module for Embedded Single Board Computers. It is the optimal solution for mother boards used to control a variety of applications: Set-top boxes, Diskless Network Computers, Internet appliances, DVD and CD-Video players and recorders. It can also provide a hard disk O/S back-up for Network Servers.

DiskOnChip2000-EVB

The DiskOnChip 2000 Evaluation Board was developed in M-Systems to provide our customers with a simple, straightforward tool to evaluate, test and program the DiskOnChip 2000 even before the target platform is actually available, since it provides DiskOnChip functionality using standard ISA bus interface.

The DiskOnChip 2000 requires a memory window of only 8KB. It can be plugged into the customers' target board or the EVB , and with a minimal cost can be upgraded to a higher capacity device.

When connecting the DiskOnChip 2000 EVB to a PC, the system works automatically, without need for any software integration. The DiskOnChip is automatically configured as a system disk drive with a full hard disk functionality.

The DiskOnChip 2000 and the EVB enable the system to boot from the DiskOnChip 2000 when the DiskOnChip functions as the primary system disk. The DiskOnChip EVB can also be used as a convenient tool to duplicate, update and test the DiskOnChip 2000, using simple utilities provided with the EVB.

M-Systems
Flash Disk Pioneers

1 Please contact M-Systems for availability

User Manual

DiskOnChip®-EVB

ISA Adaptor for the DiskOnChip

Nov-96

90-SR-001-02-7L REV 1.0

M-Systems
Flash Disk Pioneers

1. Preface

DiskOnChip-EVB card is an ISA card which can accept a DiskOnChip product and be used on a standard ISA bus slot for DiskOnChip demonstration, evaluation, programming and testing.

The DiskOnChip can be plugged on the customer's platform as well as on the DiskOnChip-EVB. Accessing the DiskOnChip on both the customer's platform and the DiskOnChip -EVB board is done by using the DOCPROG utility. Please refer to the *DOCPROG User Manual* for further information.

2. The Board

DiskOnChip -EVB
The DiskOnChip -EVB board is a very simple board, which includes a 32-pin-socket (which works also with 28-pin-socket) and address decoding. The decoding can be done by a single 74LS138 component, but in the DiskOnChip -EVB board we have chosen to use a PAL device in order to allow flexibility to the designer in address space selection. The ABEL equations are described below and can be easily modified to meet any special requirement..

3. DiskOnChip integration on customer's platform

As demonstrated by the DiskOnChip-EVB board, the DiskOnChip flash disks are very easy to integrate into any customer platform. Any platform generates the address decoding anyway, and only the 32-pinDIP socket is required. The only software requirement is that the socket will be mapped to the ROM expansion memory space of the host. Please refer to AP-DOC-002 ("Designing with the DiskOnChip - FlashDisk mode") application note for further details.

4. How to use DiskOnChip-EVB

4.1 Requirements

The requirements are very general:
1. A PC with a free ISA bus slot.
2. 32KB free memory space in the ROM expansion (or 8KB for DiskOnChip2000 products)

4.2 Operating the board, step by step:

1. Make sure the card is not plugged into the target host, and is not connected to power.
2. Plug the DiskOnChip into the socket. Make sure it is the right direction.
3. Make sure the card's setup is correct (usually address hex D0000 is a good selection)
4. Plug the card into the target host's free ISA slot.
5. Power up the host. The DiskOnChip drivers messages should appear on screen. If not, either the DiskOnChip was not programmed or the card's setup is wrong.
6. The DiskOnChip, shipped as plug and play, is available now as any standard disk drive, using any standard software.

5. Programming and testing the DiskOnChip

Use the DOCPROG utility for programming and/or testing. Refer to DOCPROG user manual for further information.

6. The Board's parts description

The DiskOnChip-EVB board includes the following parts:

1. The address decoder, implemented in a 22V10 PAL device (U2)
2. The DiskOnChip (U1)
3. Jumpers (JP1-2)

The PAL is supplied by M-Systems as a part of the card. The source files are included in the DiskOnChip-EVB. The DiskOnChip's socket is a 32 -pin standard DIP socket. Make sure to align pin 14 (GND) of the device to pin 16 (GND) of the socket when placing a 28 pins device into the 32 pins socket.

JP1-2 jumpers determine the address that DiskOnChip-EVB card will occupy on the ISA bus. Set JP1 and JP2 to the desired address according to Table1: Address select.

JP1	JP2	Selected Address space
Open	Open	C000-C7FF
Open	Close	C800-CFFF
Close	Open	D000-D7FF
Close	Close	D800-DFFF

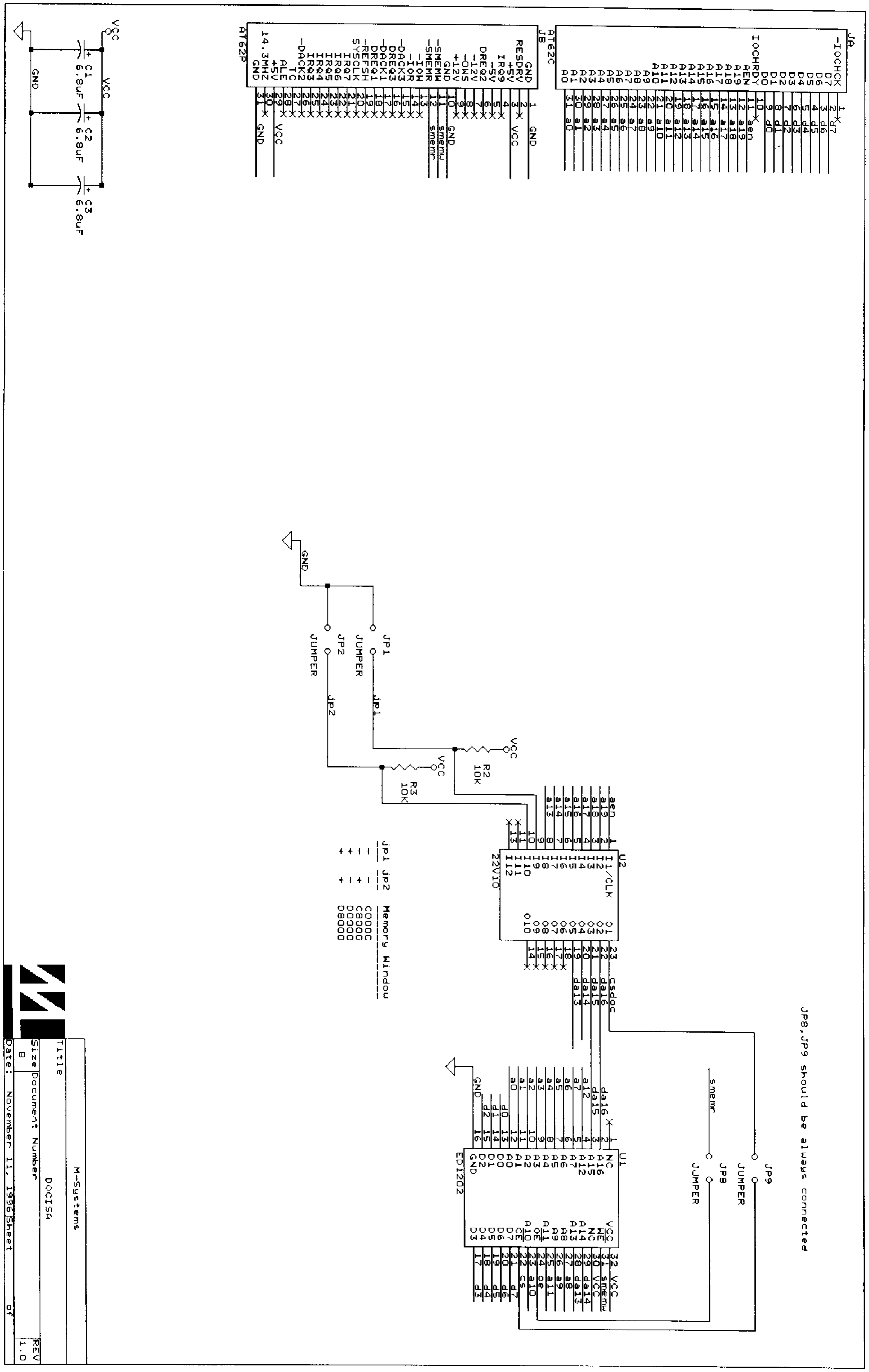
Table A: Address select

7. The ABEl file

The file below is the file that is used to generate the 22V10 PAL. As described above, it is used only to generate the Chip Select signal to the DiskOnChip device according to the desired address.

```
MODULE DISKONCHIP-EVB
title 'DOC ISA card'

U2 device 'p22v10';
" 32KB memory space
" Address space set up by JP1-2

"Inputs
AEN  pin 1;
A19  pin 2;
A18  pin 3;
A17  pin 4;
```

```
A16  pin 5;
A15  pin 6;
A14  pin 7;
A13  pin 8;
JP1  pin 9;
JP2  pin 10;
JP3  pin 11;
JP4  pin 13;

"Outputs
CSDOC pin 23;
DA16  pin 22;
DA15  pin 21;
DA14  pin 20;
DA13  pin 19;

H,L,X = 1,0,.X.;
Addr = [A19,A18,A17,A16,  A15,A14,A13,X,  X,X,X,X,  X,X,X,X];
MemWin = [JP1,JP2];

"MemWin  options: 3: C000 2:C800 1:D000 0:D800

equations

" CSDOC is the CS signal to the DOC. It is generated
" from the address bus, AEN and Window location (32KB size).


!CSDOC =(((Addr >= ^hC000) & (Addr <= ^hc7ff) & !AEN &
(MemWin==3))
      #((Addr >= ^hC800) & (Addr <= ^hcfff) & !AEN & (MemWin==2))
      #((Addr >= ^hd000) & (Addr <= ^hd7ff) & !AEN & (MemWin==1))
      #((Addr >= ^hd800) & (Addr <= ^hdfff) & !AEN & MemWin==0)));
"DA13-16 are the high address signals to the DOC.
DA16 = 0;                       "128KB is never used.
DA15 = 0;                       " 64K: is never used.
DA14 = A14;                       " 32K:  Pass ISA A14.
DA13 = A13;                       " 32K:  Pass ISA A13.
END
```


M-Systems
DOCISA
Date: November 11, 1996
REV 1.0
JP8,JP9 should be always connected

Series 2000

User Manual

DiskOnChip® 2000 PIK

(Programmer and Integrator Kit)

July-97

91-SR-002-04-7L REV. 2.0

M-Systems
Flash Disk Pioneers

1. Introduction

M-Systems' *DiskOnChip2000* is a new generation of high performance single-chip Flash Disk. The DiskOnChip MD2000 provides a Flash Disk in a standard 32-pin DIP package.

This unique data storage solution offers a better, faster, and more cost-effective Flash Disk for Single Board embedded systems, Internet devices and portable applications with limited space and modest disk capacity requirements.

The new DiskOnChip 2000 provides a Flash Disk (as BIOS expansion) which does not require any bus, slot or connector. Simply insert the DiskOnChip2000 into a 32-pin socket on your CPU board, with a minimal installation cost, and you have a bootable Flash Disk.

Various Operating Systems are supported by DiskOnChip 2000 : DOS, Windows, Win95. Additional support offered: pSOS+, QNX, VxWorks and others.

DiskOnChip2000 is the optimal solution for Single Board Computers - it's a small, fully functional, easy to integrate, plug-and-play Flash Disk with a very low power consumption.

The DiskOnChip 2000 can be accessed directly on the target platform. However, sometimes it is convenient to have an external programmer socket, especially for maintenance purpose. The DiskOnChip 2000 programmer is a very simple and easy to use tool, connecting to a standard desktop PC. Please note that the DiskOnChip 2000 programmer is not a must: all tasks carried by the programmer can be done while the DiskOnChip 2000 is plug onto target platform.

This manual describes the software utilities for the DiskOnChip 2000 programmer. For further details about the DiskOnChip 2000 utilities while it is plugged onto target platform, please refer to DiskOnChip 2000 utilities user manual. For the programmer installation , please refer to DiskOnChip 2000 programmer quick installation guide.

2. DiskOnChip 2000 PIK - a useful programming tool

The DiskOnChip 2000 PIK is a very useful tool for programming and duplicating DiskOnChip 2000 devices before plugging them into the target platform. This applies both to the integration and the testing stage, and in small and medium scale production stages.

During the integration and testing stage, it may be required to format the DiskOnChip using the DPFORMAT utility (since all DiskOnChip 2000 products are shipped fully tested and formatted, DPFORMAT will be rarely used), or to update its firmware without having to place it in the target platform, by using the DPUPDATE utility.

During the production stage, it is often required to duplicate the DiskOnChip which includes the source application files. In most cases, the "source" DiskOnChip will be bootable. The PIK simplifies the operation of copying the "source" DiskOnChip device onto as many as required "target" DiskOnChip devices by using the GETIMAGE utility and PUTIMAGE utilities.

3. Before you start

Make sure you have the all parts listed in the Quick Installation Guide provided with the kit. Install it according to the Quick Installation Guide. It is recommended to pay a visit to M-Systems' web site where you can find additional information and the most updated software version.

4. DPFORMAT

Before TrueFFS can access the flash media, the media must be formatted, just as a floppy disk must be formatted. Formatting initializes the media and writes into it a new and empty DOS file system. When formatting is complete, the media contains only a root directory.

The DiskOnChip is fully tested and formatted before the product is shipped, but it can be formatted more than once. Each time it is formatted, naturally all data on the media is destroyed. When reformatting, the boot-image is **retained** by default.

The DPFORMAT syntax is:

```
DPFORMAT  [/SPARE:n] [/FIRST] [/S:file] [/SIZE:size]
[/USE:nnn] [LABEL:label] [/DOSVER:n] [/Y]
```

The DPFORMAT options are:

/SPARE:*n* Number of spare units. Default is 1. A value 0 selects a WORM (Write Once Read Many).

/FIRST Use this flag to program the DiskOnChip to be the first disk if more disks are installed in the system. This flag has no effect if the DiskOnChip is the only disk in the system. The /S parameter must be supplied when /FIRST flag is used.

/S:file Program the firmware *file* (.EXB) into firmware section of Flash media. This flag is usually used to with /FIRST flag or when firmware version is upgraded.

/SIZE:*size* The size of the flash media to be formatted (including the install partition). By default the entire media is formatted by DPFORMAT. This option limits the formatted size.

/USE:*nnn* Percentage of available space on the flash media to be used for file storage. ***nnn*** can be any number from 1 to 100. Default is 99 (99%).

The value of this option may affect the write performance of TrueFFS.

/LABEL:*label* A string to be used as the DOS label of the formatted media.

/DOSVER:*dos-major-version*

Format for a target system running the specified DOS version. The default is the current DOS version (the one on which DPFORMAT is executed). For example, /DOSVER:3 formats for DOS 3.x. Valid values are 1 to 6.

/Y Do not pause for confirmation before beginning to format.

Note: All sizes specified in DPFORMAT options are in bytes if specified as simple numbers, in KBytes if specified with the suffix **K**, or in megabytes if specified with the suffix **M**.

Example 1: DPFORMAT /S:DOC2000.EXB /FIRST

Formats the DiskOnChip as first drive using the DOC2000.EXB as firmware.

Example 2: DPFORMAT /S:DOC2000.EXB

Formats the DiskOnChip using the DOC2000.EXB as firmware. The DiskOnChip will be the last disk in case more disks are available in the system.

4.1 Configuring the DiskOnChip as a Bootable Disk

When the DiskOnChip 2000 is placed in the programmer socket, which is I/O mapped, it can't be accessed as a disk drive the way it would be if it was placed in a socket which is memory mapped on the target platform. Therefore, it is impossible to run DOS commands to make the DiskOnChip 2000 bootable ("SYS") by using the PIK. However, once a bootable DiskOnChip was generated according to the following instructions, it is possible to duplicate it as many times as required using the PIK, as described in "Duplicating DiskOnChip" (next section)

In order to make the DiskOnChip 2000 bootable, the following steps must be followed:

1. Plug the DiskOnChip into the target platform.
2. Boot from floppy or hard disk.
3. The DiskOnChip should be recognized as a disk drive. (assuming the PC was booted from hard disk which was assigned drive letter C:, the DiskOnChip will be assigned drive letter D:.
4. Run the SYS command (for example, following last assumption, type: SYS D:).

Please refer to DiskOnChip 2000 product manual for further information.

5. DPUPDATE - Updating DiskOnChip 2000 Firmware

In case a firmware update will be required, M-Systems will deliver a new .EXB file which should be written into the firmware portion of the Flash media within the DiskOnChip, using the DPUPDATE utility. (it is always recommended to pay a visit to M-Systems' web site. It may include newer software version, application notes and other useful material)

DPUPDATE requires that the DiskOnChip will be already programmed with previous firmware file programmed into, which is the default Since the DiskOnChip is shipped fully tested and programmed.

The DPUPDATE syntax is:

```
DPUPDATE /S:BootImage /FIRST
```

/S:BootImage The boot image file of the new firmware to be written to the DiskOnChip. Usually the file type is .EXB

/FIRST Use this flag to program the DiskOnChip to be the first disk if more disks are installed in the system. This flag has no effect if the DiskOnChip is the only disk in the system. The /S parameter must be supplied when /FIRST flag is used.

Example 1: DPUPDATE /S:DOC2000.EXB

Program the firmware which is supplied in DOC2000.EXB file into the DiskOnChip located in the programmer socket. The DiskOnChip will be the last disk in case more disks are available in the system.

Example 2: DPUPDATE /S:DOC2000.EXB /FIRST

Program the firmware which is supplied in DOC2000.EXB file into the DiskOnChip which is located at the programmer socket. The DiskOnChip will be the first drive (C:) in case a hard disk is available in the system.

6. Duplicating DiskOnChip 2000

Copying DiskOnChip device is the procedure of copying a “source” DiskOnChip contents into an “image file”, then copying the “image file” contents into as many target DiskOnChip devices as required. All target DiskOnChip devices will have exactly the same contents as the source DiskOnChip, which means they will have exactly the same functionality when plugged into target platform. The only limitation for this process is that all target DiskOnChip devices must have the same capacity of the “source” DiskOnChip. For example: if the “source” DiskOnChip has a 12MB capacity then the “target” DiskOnChip should have 12MB capacity as well.

The duplicating process include 3 stages:

1. Prepare “source” DiskOnChip.
2. Copy “source” DiskOnChip into an image file.
3. Copy the image file into as many as required “target” DiskOnChip devices.

6.1 Stage 1: Creating the “source” DiskOnChip

The source DiskOnChip includes all target application files. Usually, it will be bootable (see chapter 4.1). The following commands are usually used in order to prepare the “source” DiskOnChip:

1. Format DiskOnChip with M-Systems software (DFORMAT in target platform, DPFORMAT in PIK) using version 1.04 or above.
2. Copy all target application files onto the DiskOnChip.
3. If required, make the DiskOnChip bootable (this is not a must - but mostly it is required. refer to chapter 4.1) - this operation must be done in the target platform (not in PIK)

After the source device was properly prepared, follow the guidelines described below in order to duplicate it as many times as required.

6.2 Stage 2: Copy the “source” DiskOnChip into image file

At this stage, the source DiskOnChip includes all target application files, and it is ready to be duplicated as many times as required. Each duplicated copy will function on the target platform, as the “source” DiskOnChip.

Use GETPIMG utility to copy the “source” DiskOnChip contents into an image file on disk, to be used later as source file for duplications.

1. Run GETPIMG image_file_name.
   (for example: GETPIMG MYDOC.SRC)

6.3 Stage 3: Copy the image file onto “target” DiskOnChip devices

At this stage, the contents of the “source” DiskOnChip is stored in the disk in what we call “image file”. Copying this image file into target DiskOnChip, will result with identical DiskOnChip target device to the one that used as “source”. Use the PUTPIMG utility to perform this task:

1. Insert a target DiskOnChip with the same capacity as the source DiskOnChip into the PIK socket.
2. Run: PUTPIMG image_file_name.
   (for example: PUTPIMG MYDOC.SRC)
3. The target DiskOnChip will have the exact contents and functionality as the source DiskOnChip when this operation is done. Repeat last stage for all target DiskOnChip need to be copied.
4. Repeat step 3 with as many target DiskOnChip devices as required.

All DiskOnChip devices programmed according to the above procedure are ready to be plugged into the target platforms, and will function exactly the same as the source DiskOnChip.