Designing with the DiskOnChip® Millennium in a PC Environment

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1 Preface

This application note describes how to integrate the DiskOnChip® Millennium with PC compatible systems.

1.1 What is DiskOnChip Millennium

The DiskOnChip Millennium is M-Systems' third generation DiskOnChip series of products. The Millennium series is the world's first monolithic solid state flash disk. It combines a disk controller with flash memory on a single die. The DiskOnChip Millennium is optimized for use in Thin Clients and Internet appliances devices such as: Set-Top Boxes, ITV, Thin client, Web-phones, Hand Held PC (HPC), Car-PC, Thin Server and Hand held terminals. All these require minimal weight, space and power consumption, providing a lower cost alternative to conventional hard and floppy disk drives.

The DiskOnChip Millennium can be designed as the main system storage device providing complete Boot and Hard Disk read/write capabilities, and benefits your design with many other advanced features and possibilities.

The DiskOnChip Millennium is available in two different packages[1]:

- Standard 32-pin DIP Package - This package is functional compatible with DiskOnChip 2000 series and offers modular upgrade from 2 MB up to 144MB flash disk using same socket.

- 32 –pin TSOP-II – SMT package for application that requires small space and/or surface mount assembly technology. The DiskOnChip Millennium can be easily expanded to 16MB, 24MB, 32MB without any glue logic and using the same 8KB memory mapped window.

1.2 Memory Window Allocation

The DiskOnChip Millennium should be mapped into an 8KB window in the BIOS expansion address space of the PC, which is usually located between address 0C0000H to 0EFFFFH.

Note: When designing several TSOP-II devices in parallel, the memory Window should be allocated as if he was using only One Single DiskOnChip Millennium drive (e.g. 8KB memory-mapped window when working in 8-bit data access mode).

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[1] For detailed Technical information regarding the DiskOnChip Millennium refer to the DiskOnChip-Millennium data sheet.

1.3   TrueFFS Driver

The DiskOnChip Millennium contains a built-in copy of the M-Systems industry-standard TrueFFS software driver. This enables the DiskOnChip Millennium to operate as a standard disk drive. The DiskOnChip Millennium can contain the operating system in it to enable systems boot in disk less environment. Additionally, it can be configured as the boot device in systems with a hard disk.

(See below "Configuring the DiskOnChip Millennium as the first drive").

The DiskOnChip Millennium is a self-contained device. The installation of the DiskOnChip Millennium does not require any additional software. The design of the DiskOnChip allows full upward and downward compatibility. DiskOnChip Millennium devices of different densities, are be fully compatible with standard DiskOnChip Millennium.

1.4   Compatibility with DiskOnChip 2000 Series

The DiskOnChip Millennium DIP package is pin compatible with DiskOnChip 2000 series and therefore offers an easy upgrade to DiskOnChip 2000 series for higher capacity using a STD 32 pin DIP socket and. The DiskOnChip Millennium power on reset timing differs from the DiskOnChip 2000 power on reset timing. Please refer to DiskOnChip Millennium data sheet for the detailed reset timing requirements.

The DiskOnChip TSOP package, designed for application that requires SMT technology or limited space, offers the following additional features:
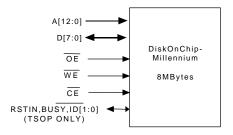
- 5V or 3.3V using (SYS_5V) configuration pin,

- Multiple connection of up to four devices using the ID[1:0] pins and RSTIN#, BUSY# pin for better performance.

TrueFFS driver revision 1.20 and up supports both the DiskOnChip millennium and DiskOnChip 2000 series.

2   Hardware Requirements for the DiskOnChip Millennium

Originally designed for PC systems, the DiskOnChip Millennium can also be used in different hardware environments[2]. The DiskOnChip Millennium uses simple SRAM like interface and therefore can easily be connected to any microprocessor bus. It requires 13 address lines, 8 data lines and basic memory control signals for read, write and chip enable (CE#, WE#, OE#). They are typically found on every hardware platform and can be easily interfaced to. For detailed timing requirements Please refer to "DiskOnChip-Millennium Data sheet". Following is a drawing of the DiskOnChip Millennium and its pins:

Figure 1 - Simplified I/O Diagram

Note: For Detailed DiskOnChip Millennium mechanical dimensions and electrical specifications, please refer to the DiskOnChip Millennium data sheet.

2.1   Expansion of DiskOnChip Capacity

Customers that use the DiskOnChip DIP package can expand their disk capacity by using DiskOnChip2000 series. DiskOnChip2000 series provide up to 144MB of disk capacity using same 32-pin DIP pin out.
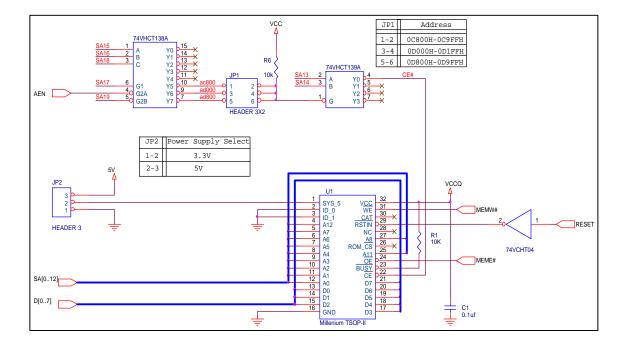
Customers that use the DiskOnChip TSOP-II package can expand their capacity to 16MBytes, 24 MB and 32 MB by connecting up 4 TSOP devices in parallel to the host bus, without any additional circuitry or glue logic. The ID[1:0] configuration inputs determine the identity of each DiskOnChip. Systems that employ only one DiskOnChip must configure the ID[1:0] inputs as {00}. Additional chips may also be configured as {01}, {10} and {11}.
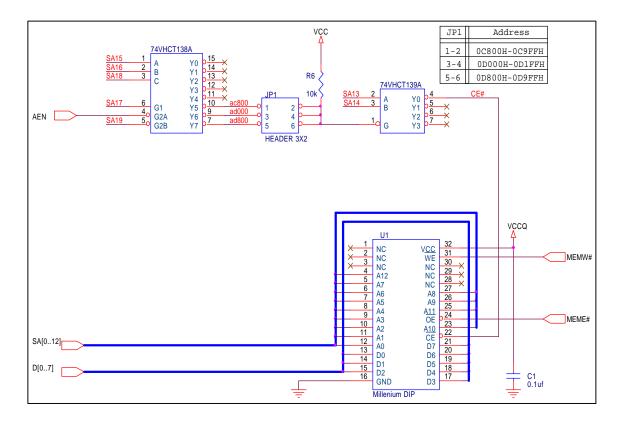
When multiple DiskOnChip devices are connected using the ID[1:0] option, all I/O pins must be wired in common, including the BUSY# output if it is used by the host system.

Note: that in this configuration, user should allocate the same memory Window (same CS signal) - as if he was using only One DiskOnChip.

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[2] For designing the DiskOnChip Millennium in RISC environment refer to AP-DOC-030 "Designing DiskOnChip millennium in RISC environment"

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3   DiskOnChip Millennium on PC-ISA BUS Design Example

4 Implementing "NO WAIT STATE" for Better Performance

DiskOnChip Millennium can be designed to work in ISA BUS with no wait state cycle. The cycle time for accessing the DiskOnChip Millennium can be reduced by shortening the ISA BUS cycles. This could be done by implementing the 'No Wait State' flow scheme.

While the DiskOnChip Millennium is hooked on the ISA BUS, Using the 'No Wait State' mode improves the read and write performance by more than 50% .
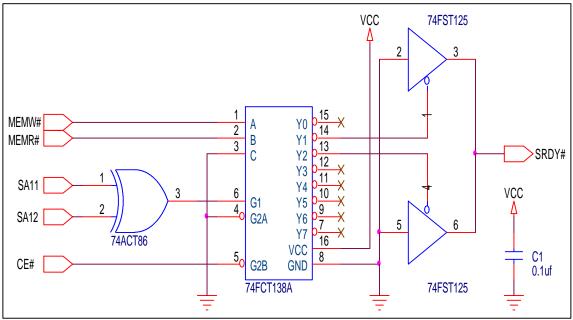
To implement the **'No Wait State'** (open drain) mechanism the SRDY# signal of the ISA BUS should be asserted in response to combination (logic AND) of the following events:

1. Assertion of the Chip Select Control Signal to the DiskOnChip (CE#)
2. Logic XOR of the Write Signal or Read Signal Control Signal (MEMR#, MEMW#)
3. Logic XOR of address signals: SA-11 and SA-12 (e.g. to be '10' or '01')

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SRDY# = ! [!CE# & (MEMR# != MEMW#) & (SA11 != SA12)]

4.1 "NO WAIT STATE" Implementation Example

The following diagram is a design example for "No Wait State" (open drain) circuit implementation. The CE# signal is the Chip enables that is connected to the DiskOnChip. MEMR# and MEMW# are the ISA signal:

Note: Other logic devices may be used.

5   Installing the DiskOnChip Millennium

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

1. Align pin 1 on the DiskOnChip Millennium with pin 1 of socket.

2. Push the DiskOnChip Millennium into the socket carefully until it is fully seated.

3. Check to make sure the DiskOnChip Millennium is installed securely, and there are no bend pins.

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

The DiskOnChip Millennium can be configured to be the first or last drive in a system with or without a Hard Drive and/or as a Boot Device in a system. The DiskOnChip Millennium has a broad and different OS support: DOS, Windows95/95, Windows NT/NT5/NTE, Windows CE and Linux. Additional support offered: pSOS+, QNX, VxWorks, PharLap and others. The DiskOnChip Millennium can be customized to work in O/S-less environments using OSAK (Operating System Adaptation Kit).

Note: For a detailed discussion of Operating and using DOS utilities supplied by M-Systems (to enable the user to format, updated and have a full control over the DiskOnChip Configuration) refer to DiskOnChip Utilities User Manual.

Note: For a detailed discussion of operating and using the DiskOnChip Millennium under different O/S's or in O/S-less environments, refer to the relevant application notes, available from M-Systems' web site (http://www.m-sys.com/).

6   DiskOnChip Millennium EVB - Evaluation Board

The DiskOnChip Millennium Evaluation Board is provided by M-Systems as an evaluation tool for the DiskOnChip Millennium.

The DiskOnChip Millennium EVB enables the evaluation and testing of the DiskOnChip Millennium in a standard PC environment. Two different Evaluation boards are available:

a) ISA board with a DiskOnChip Millennium 32 pin DIP - This board is identical to with DiskOnChip 2000 ISA EVB

b) ISA Board with DiskOnChip Millennium TSOP device

Both boards supplied with software and detailed documentation.

Note: For a detailed discussion of using DiskOnChip Millennium EVB, please refer to the to the DiskOnChip 2000 and DiskOnChip Millennium-EVB User Manual.

7 Additional Information and Tools

Document/ Tool	Description
DiskOnChip Millennium	DiskOnChip Millennium Data Sheet
DiskOnChip Utilities	DiskOnChip Utilities User Manual
AP-DOC-030	Application note - Designing with DiskOnChip Millennium in a RISC Environment
DiskOnChip Millennium-EVB	DiskOnChip Millennium Evaluation Board User Manual
DiskOnChip OSAK	Application note - Operating System Adaptation Kit
DiskOnChip-GANG	8 Socket Gang Programmer[1] User Manual

1 Contact M-Systems for availability