



# NON-VOLATILE SOLID STATE RECORDING

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# Mountain Optech Designs, Manufactures and Markets Rugged Mass Memory Solutions



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# COMPANY BACKGROUND

- Founded in 1985
- Located: Boulder, Colorado
- Products: Mass Memory Systems
- Specialty: Rugged COTS Products
  - Optical MO & CD-ROM
  - Magnetic Hard Drives
  - Solid State
- Subsidiary of Phillips Service Industries, Inc.
- General Manager: Dennis Sauerbrey



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# DEVELOPMENT

- **MOUNTAIN OPTECH INC., MID 1994**
- **“WE NEED A HIGH CAPACITY NON-VOLATILE SOLID STATE DATA STORAGE PRODUCT”**



# WHY FLASH SOLID STATE

- Extremely Durable Under Harsh Conditions
  - Wide Temperature Range - 40 to +75 C
  - No Rotating Media / No Moving Parts
- Fast Data Accesses
  - Microseconds Instead of Milliseconds
  - No Latency
- Secure Data
  - Non-Volatile



# WHAT IS MASS STORAGE FLASH

- Custom Boards With Captive Memory Chips
  - EEPROM, NOR, DINOR
  - New Design Required For Upgrade
- Socketed Flash ( Intel, AMD, Micron)
  - Bulk/Sectored/Boot Block (64K Blocks)
  - Requires Driver or FTL (Flash Translation Layer)
- Hard Disk Emulation FLASH Modules - 512 Byte Sectors With IDE/ATA Interface
  - SanDisk, Hitachi, Mitsubishi, Smart Modular



# SOLID STATE MINIMUM REQUIREMENTS

- SCSI II, 1553, RS-422, RS-232 Inputs
  - Special Bus Alternatives
- 8 Megabytes DRAM Cache Memory
- 16 Megabytes to 1 Gigabyte Non-Volatile Flash Memory
- Multi-Processing Operating System
- 1 Megabyte Sustained Write Rate (Channel Speed Burst)
- 2 Megabyte + Sustained Read Rate
- 810 D Environmental Performance
  - 6 Grms Vibration
  - 30 G Shock
  - -40 to 75 Degrees C Temperatures



# DEVELOPMENT OBJECTIVE

- Non-Volatile Solid State Read/Write Data Storage Product
  - Requirements
    - Fast Write/Read Data Rate
    - High Capacity
    - Reliable
    - Long Product/Technology Life
    - Reasonable Cost
    - Versatile
    - Easily Upgradable
    - Growth Path - Building Block Design





# SOLID STATE PRODUCT DEVELOPMENT

- Review of Existing Technology - 1995
  - Technology was not yet ready for High Capacity
    - Write Rate too Slow
    - Too Costly
- How Can We Be Ready With the Technology ?
  - We Needed a Standard Bus Interface Controller
  - We Need a Device Interface to the Solid State Device



# INTERFACE CONTROLLER

- Fall 1994 MOI Awarded Phase II SBIR for Development of an Optical Recorder for Use on V22
- Development Requirement:
  - Intelligent Interface Controller

# FIRST BUILDING BLOCK

- Intelligent Interface Controller
  - Multiple Input Interfaces - SCSI, 1553, RS 232, RS422
  - Booch Object Oriented C++ Software
  - CPU Power for the Future - Intel 80CF960
  - Multi Processing Real Time OS - pSOS
  - Expandable and Up-dateable ROM - Captive FLASH
  - Data Buffering - 8 MB EDO RAM
  - Standard Device Output - SCSI, PCMCIA-ATA



# HARDWARE COMPONENTS

- CPU Intel 80CF960 -33
- SCSI Host Interface NCR 53C720
- FLASH Module Intel 28F016
- DRAM Micron 50ns EDO
- DRAM Controller Xilinx 4005E
- Serial Interfaces RS422 National VL16C550
- Device Controller Xilinx 4005E
- Device Interface Mod PCMCIA-ATA



# SECOND BUILDING BLOCK

- Industrial Standard PCMCIA-ATA Interface
  - PCMCIA-ATA Compatible
  - Replaceable Module Design
    - Easy Maintenance
    - Easily Upgradeable
  - Customized for Maximum Multi-Operating OS Usage
  - Each Device Addressable Simultaneously
    - Each Device a Master
  - Variable and Expandable Number of Devices
    - 4 to 20 SS Modules



# SANDISK PCMCIA-ATA FLASH DISK MODULES

- SanDisk Is The Leader In FLASH Disk Technology - Worlds Largest Manufacturer of Data Storage FLASH Products
- SanDisk Is The Leader In Disk Emulation
  - IDE/ATA Interface
  - 512 Byte Sectors ( Just Like A Hard Drive)
  - Intelligent Controller Handles
    - ECC/Defect Management
    - Retirement of defects At The Bit Level
    - Power Conversion
    - Wear Leveling

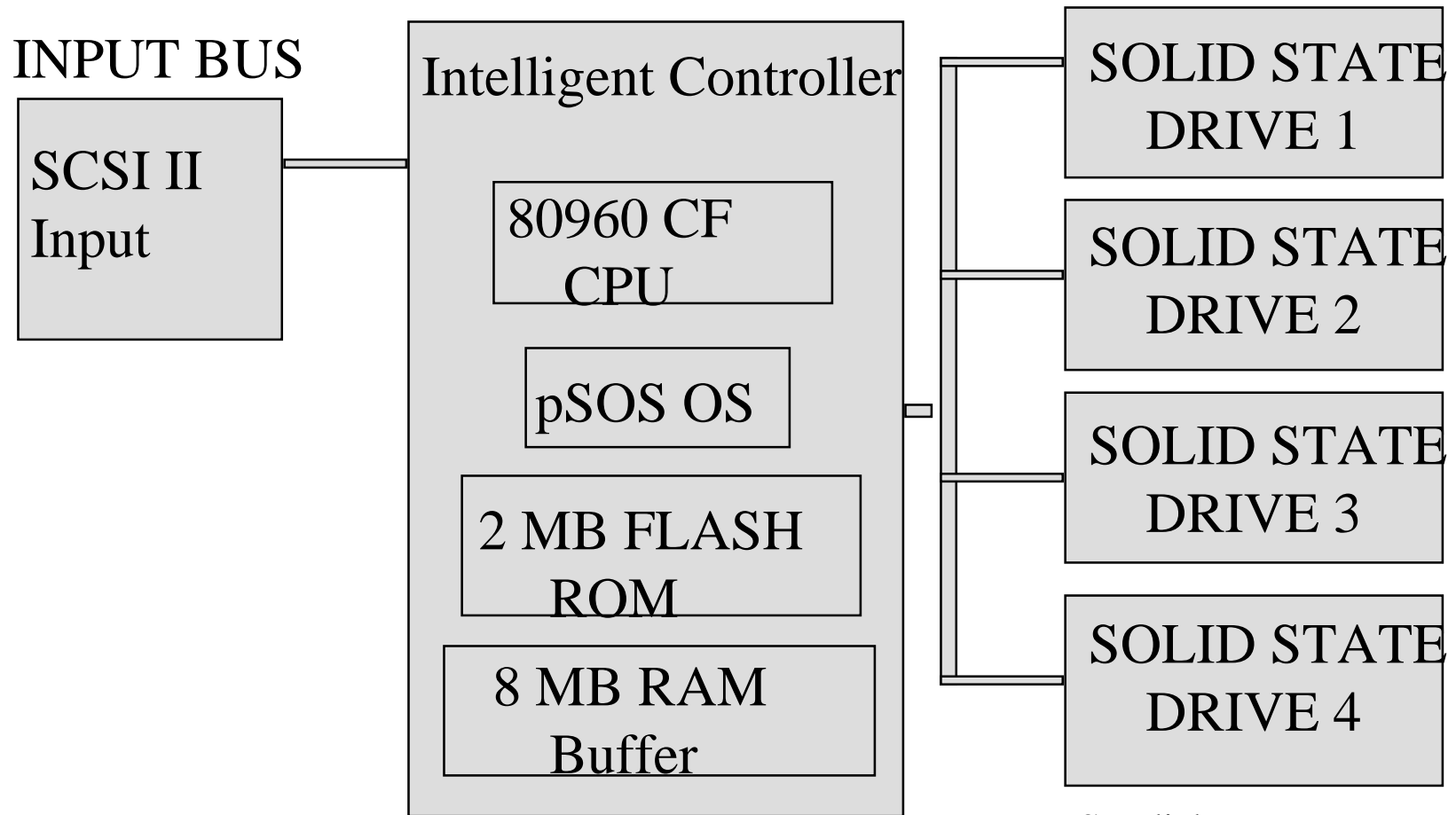


# FIRST SOLID STATE PRODUCT

- Delivered July 1996
- Performance
  - SCSI II Input
  - 8 MB DRAM Cache Memory
  - 440 Megabytes Capacity
  - 1 Megabyte Sustained Write Rate with 5 Megabyte/Sec
  - 3 Megabytes/Sec Sustained Read Rate
  - Removable 5 1/4” form Factor
  - 810 D Environmental Performance
  - Uses Industry Std PCMCIA-ATA FLASH Modules



# BLOCK DIAGRAM



RAID 0  
SCSI SOLID STATE DISK

Sandisk  
PCMCIA-ATA  
Modules  
4 to 220 MB



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# SECTOR STRIPPED RAID 0

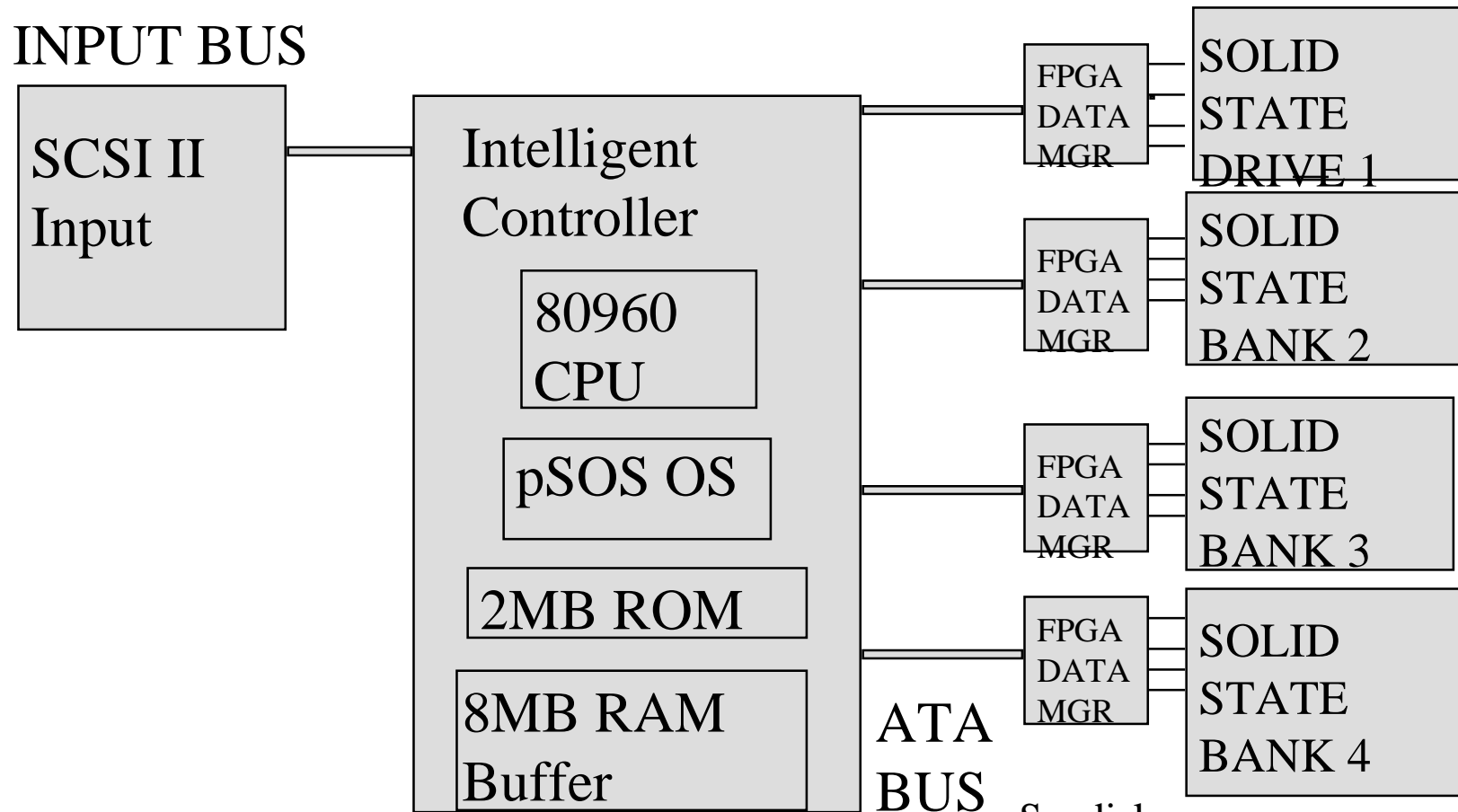
- PCMCIA-ATA FLASH Memory Modules
- 4 Modules in Bank / 300KB/Sec per Module
- Write Sequence
  - Interpret SCSI Starting Sector ( Simple Modula 4 )
  - Issue 512 Byte Write to Drive 0
    - Drive 0 Starts to Write
  - Issue 512 Byte Write to Drive 1 - Burst Buffer Full
    - Drive 1 Starts to Write
  - ETC Drives 3 and 4
  - Repeat Cycle
- Results: 1 Megabyte/Sec Average Write Rate



# MultiBanked Solid State Disk

- Up to 5 Banks per Drive
- 4 or 8 Modules Per Bank
- Minimum Configuration
  - 4 Modules at 1.2 Megabytes/Sec Sustained Write
- Maximum Configuration
  - 32 Modules at 4 + Megabytes/Sec Sustained Write
- Compatible with New SanDisk D2 Modules
- Individual LUN Support, Device or Bank

# BLOCK DIAGRAM



RAID 0

SCSI SOLID STATE DISK

Sandisk

PCMCIA-ATA Module

4 to 220 MB Mod

4-8 Modules per BANK



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# Ultra HighSpeed Solid State Disk -Available 1ST QTR 1998

- QuadSpeed SSM MultiBank
  - 1 to 4 Memory Banks per Drive
  - 4 or 8 Modules per Bank
- 1.2 to 1.8 Megabytes/Sec per Bank
  - depending upon # of Modules/bank
- Max Sustained Write Rate = 4 Megabytes/Sec
  - 4 Banks
- Capacities 160 Megabytes to 4.8 Gigabytes

# COST EFFICIENT HIGH CAPACITY SSM

- MultiBank SSM Using SanDisk D2 Modules
  - Multilevel Cell Technology (MLC)
- 200KB to 1 Megabyte/Sec Sustained Write Rate
  - 50 KB Per Module ( ? 100 KB By Mid 1998)
- 1/3 Additional Capacity at Same Cost
- 600 Megabyte to 6 Gigabyte Capacities
- Directly Replaceable with Bi-level Modules

# WHAT DOES THE NEW DESIGN MEAN TO YOU

- You Decide The Requirements
  - High Data Rate, Limited Capacity
    - 20 Modules x 40 MB - 4MB/S, 800MB
  - Lower Data Rate, Higher Capacity
    - 10 Modules x 220 MB - 2 MB/S, 2.2GB
- You Decide The Configuration
  - 2 Devices, 2 MB/S
    - 20 Modules, LUN 0, 1
  - 4 Devices, 1 MB/S
    - 20 Modules, LUN 0, 1, 2, 3



# CUSTOM INTERFACES FOR INTELLIGENT CONTROLLER

- Mountain Optech Designs Special Application Interfaces To Meet Your Needs
- Eliminates the Need to Convert your Data To a Standard Output
- Does Not Require a Computer to Modify the Data
- Interface Modules To Directly Convert Data Streams to SCSI Storage
  - PCM
  - 16 Bit



# CONVENIENCE

- IT'S YOUR DATA,  
YOU DECIDE



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# NEW PRODUCTS FROM MOUNTAIN OPTECH INC.

- VME 6U Solid State Product Line - 4th QTR 1997
  - SCSI Solid State Disk
    - 1, 2, and 3 Slot products Depending upon Capacity
  - 1553 Solid State Disk
  - Multi Input RS 422 Solid State Disk
- VME 6U SCSI Hard Drive Product Line
  - 9 Gigabyte Drive on 3 Slot Board
  - 4 Gigabyte Drive on 2 Slot Board

