Acromag®

Series PMC-DX503/DX2003
Reconfigurable 16 Digital / 24 Differential I/O

USER'S MANUAL

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IMPORTANT SAFETY CONSIDERATIONS

You must consider the possible negative effects of power, wiring, component, sensor, or software failure in the design of any type of control or monitoring system. This is very important where property loss or human life is involved. It is important that you perform satisfactory overall system design and it is agreed between you and Acromag, that this is your responsibility.

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RELATED PUBLICATIONS

The following manuals and part specifications provide the necessary information for in depth understanding of the DX board.

Virtex II Data Book	**http://www.xilinx.com**
PCI 9056 Data Book	**http://www.plxtech.com**
IDT71V65603 Specification	**http://www.idt.com**
CY2305 Specification	**http://www.cypress.com**

1.0 GENERAL INFORMATION

The re-configurable DX503/DX2003 board has 16 digital input/output channels and 24 differential input/output channels. Re-configuration of a 500K system gates FPGA is possible via a direct download into the Xilinx FPGA over the PCI bus. In addition, on board flash memory can be loaded with FPGA configuration data for automatic Xilinx configuration on power-up. Flash programming is also implemented over the PCI bus.

All digital input/output channels can be programmed as input or output in two channel groups. The data direction, input/output, for each differential channel can be independently controlled. Eight change-of-state interrupt channels are provided on the least significant eight digital channels. Also, the example design includes an interface to the 256K x 36-bit SRAM.

Table 1.1: *The DX503 boards are available in standard and extended temperature ranges*

MODEL	Board Form Factor	I/O Type	OPERATING TEMPERATURE RANGE
PMC DX503 PMC DX503R	PCI Mezzanine Card	16 TTL / 24 Differential	0°C to +70°C
PMC DX2003 PMC DX2003R	PCI Mezzanine Card	16 TTL / 24 Differential	0°C to +70°C
PMC DX503E PMC DX503RE	PCI Mezzanine Card	16 TTL / 24 Differential	-40°C to +85°C
PMC DX2003E PMC DX2003RE	PCI Mezzanine Card	16 TTL / 24 Differential	-40°C to +85°C

Note: The "R" in the model number indicates rear field I/O only. All other models have front I/O.

KEY DX503 FEATURES

- **Reconfigurable Xilinx FPGA** – In system configuration of a 500K (DX503) or 2Meg (DX2003) system gate FPGA is implemented through a flash configuration device or via the PCI bus. This provides a means for implementation of custom user defined digital designs.

- **16 Digital Input/Output Channels** – Interface with up to 16 input/output TTL channels which can be configured as input or output in two channel groups.

- **24 Differential Input/Output Channels** – 24 channels of differential RS422 can be configured for input or output with independent direction control. Rear I/O models only provide 23 differential I/O channels.

- **Programmable Change of State/Level Interrupts –** Interrupts are software programmable for any bit Change-Of-State or level on 8 channels.

- **256K x 36 SRAM –** A 256K x 36-bit static random access memory (SRAM) is directly accessed by the Xilinx device. Custom user defined design logic for the Xilinx FPGA will permit use of the SRAM as FIFO memory, or single port memory as required by the application.

- **Example Design Provided –** The example VHDL design includes implementation of the PCI9056 Local bus interface, control of digital I/O, eight Change-Of-State interrupts, and SRAM read/write interface logic.

- **Programmable Clock Generation –** Clock generation logic is provided by the Xilinx FPGA for applications requiring a custom user specified

clock frequency. Clock generation can be programmed to any desired frequency between 10MHz and 100MHz.

PCI INTERFACE FEATURES

- **Power Up and System Reset is Failsafe –** For safety, the digital and differential channels are configured for input upon power-up.
- **PCI Bus Master –** The PCI9056 PCI interface chip becomes the bus master to perform DMA transfers.
- **Write Disable Jumper –** User configurable flash and EEPROM board memory can be hardware write disabled by removal of on board resistor network jumper.
- **DMA Operation –** The PCI9056 supports two independent DMA channels capable of transferring data from the PCI to Local bus and Local to PCI bus. The example design implements DMA block and demand modes of operation.
- **Field Connections –** All digital I/O, and power connections are made through a single 68-pin SCSI front panel I/O connector. Models PMCDX503R, PMCDX503RE, PMCDX2003R, and PMCDX2003RE only use a 64 pin rear I/O connector.
- **32, 16, 8-bit I/O** - Register Read/Write is performed through data transfer cycles in the PCI memory space. All registers can be accessed via 32, 16, or 8-bit data transfers.
- **Compatibility** – Complies with PCI Local Bus Specification Revision 2.2. Provides one multifunction interrupt. Board is 5V or 3.3V signaling compliant. The voltage provided on PCI connector VIO pins determines the operating voltage of the PCI bus.
- **Supply Voltage Requirement –** The board requires 3.3 volts external power be provided on the 3.3 volt signal lines of the PCI bus connector.

SIGNAL INTERFACE PRODUCTS

The board I/O is accessed via a 68 pin SCSI front panel connector.

Cables and a termination panel are available to interface with this board.

See the Appendix for further information on these products.

Cable:

Model 5028-432: A 2-meter, round 68 conductor shielded cable with a male SCSI-3 connector at both ends and 34 twisted pairs. The cable is used for connecting the board to Model 5025-288 termination panels. For optimum performance, use the shortest possible length of shielded cable.

Termination Panel:

Model 5025-288: DIN-rail mountable panel provides 68 screw terminals for universal field I/O termination. Connects to Acromag board, via SCSI-3 to twisted pair cable described above.

ENGINEERING DESIGN KIT

Acromag provides an engineering design kit for the DX boards (sold separately), a "must buy" for first time DX module purchasers. The design kit (model PMC-DX-EDK) provides the user with the basic information required to develop a custom FPGA program for download to the Xilinx FPGA. The design kit includes a CD containing: schematics, parts list, part location drawing, example VHDL source, and other utility files. The DX module are intended for users fluent in the use of Xilinx FPGA design tools.

BOARD DLL CONTROL SOFTWARE

Acromag provides a software product (sold separately) to facilitate the development of Windows (98/Me/2000/XP®) applications accessing Acromag PMC I/O board products, PCI I/O Cards, and CompactPCI I/O Cards. This software (Model PCISW-API-WIN) consists of low-level drivers and Windows 32 Dynamic Link Libraries (DLLs) that are compatible with a number of programming environments including Visual C++™, Visual Basic®, Borland C++ Builder® and others. The DLL functions provide a high-level interface to boards eliminating the need to perform low-level reads/writes of registers, and the writing of interrupt handlers.

BOARD VxWORKS SOFTWARE

Acromag provides a software product (sold separately) consisting of board VxWorks® software. This software (Model PMCSW-API-VXW) is composed of VxWorks® (real time operating system) libraries for all Acromag PMC I/O board products, PCI I/O cards, and CompactPCI I/O cards. The software is implemented as a library of "C" functions which link with existing user code to make possible simple control of all Acromag PCI boards.

BOARD QNX SOFTWARE

Acromag provides a software product (sold separately) consisting of board QNX® software. This software (Model PMCSW-API-QNX) is composed of QNX® (real time operating system) libraries for all Acromag PMC I/O board products, PCI I/O cards, and CompactPCI I/O cards. The software supports X86 PCI bus only and is implemented as library of "C" functions which link with existing user code to make possible simple control of all Acromag PCI boards.

2.0 PREPARATION FOR USE

UNPACKING AND INSPECTION

Upon receipt of this product, inspect the shipping carton for evidence of mishandling during transit. If the shipping carton is badly damaged or water stained, request that the carrier's agent be present when the carton is opened. If the carrier's agent is absent when the carton is opened and the contents of the carton are damaged, keep the carton and packing material for the agent's inspection.

For repairs to a product damaged in shipment, refer to the Acromag Service Policy to obtain return instructions. It is suggested that salvageable shipping cartons and packing material be saved for future use in the event the product must be shipped.

This board is physically protected with packing material and electrically protected with an anti-static bag during shipment. However, it is recommended that the board be visually inspected for evidence of mishandling prior to applying power.

WARNING: **This board utilizes static sensitive components and should only be handled at a static-safe workstation.**

CARD CAGE CONSIDERATIONS

Refer to the specifications for loading and power requirements. Be sure that the system power supplies are able to accommodate the power requirements of the system boards, plus the installed Acromag board, within the voltage tolerances specified.

Adequate air circulation must be provided to prevent a temperature rise above the maximum operating temperature and to prolong the life of the electronics. If the installation is in an industrial environment and the board is exposed to environmental air, careful consideration should be given to air-filtering.

IMPORTANT: *Adequate air circulation must be provided to prevent a temperature rise above the maximum operating temperature.*

BOARD CONFIGURATION

Remove power from the system before installing board, cables, termination panels, and field wiring.

The board may be configured differently, depending on the application. When the board is shipped from the factory, it is configured as follows:

- The default configuration of the programmable software control register bits at power-up are described in section 3.
- The control registers must be programmed to the desired configuration before starting data input or output operation.
- The on board flash and EEPROM memory devices are read/write enabled.

Default Hardware Configuration

Front Panel Field I/O Connector

The front panel connector provides the field I/O interface connections. It is a SCSI-3 68-pin female connector (AMP 787082-7 or equivalent) employing latch blocks and 30 micron gold in the mating area (per MIL-G-45204, Type II, Grade C). Connects to Acromag termination panel 5025-288 from the front panel via round shielded cable (Model 5028-432).

Data direction of digital channels 0 to 15 is controlled as two channel groups. For example, digital channels 0 and 1 are set together as input or output. In addition channels 2 and 3, 4 and 5, up to channels 14 and 15 are set in pairs as input or output. The data direction of differential channels 16 to 39 are independently controlled.

***Table 2.1**: Board Field I/O Pin Connections*

Pin Description	Pin	Pin Description	Pin
Digital CH0	1	COMMON	35
Digital CH1	2	COMMON	36
Digital CH2	3	Differential Ch24+	37
Digital CH3	4	Differential Ch24-	38
Digital CH4	5	Differential Ch25+	39
Digital CH5	6	Differential Ch25-	40
Digital CH6	7	Differential Ch26+	41
Digital CH7	8	Differential Ch26-	42
Digital CH8	9	Differential Ch27+	43
Digital CH9	10	Differential Ch27-	44
Digital CH10	11	Differential Ch28+	45
Digital CH11	12	Differential Ch28-	46
Digital CH12	13	Differential Ch29+	47
Digital CH13	14	Differential Ch29-	48
Digital CH14	15	Differential Ch30+	49
Digital CH15	16	Differential Ch30-	50
COMMON	17	Differential Ch31+	51
COMMON	18	Differential Ch31-	52
Differential Ch16+	19	Differential Ch32+	53
Differential Ch16-	20	Differential Ch32-	54
Differential Ch17+	21	Differential Ch33+	55
Differential Ch17-	22	Differential Ch33-	56
Differential Ch18+	23	Differential Ch34+	57
Differential Ch18-	24	Differential Ch34-	58
Differential Ch19+	25	Differential Ch35+	59
Differential Ch19-	26	Differential Ch35-	60
Differential Ch20+	27	Differential Ch36+	61
Differential Ch20-	28	Differential Ch36-	62
Differential Ch21+	29	Differential Ch37+	63
Differential Ch21-	30	Differential Ch37-	64
Differential Ch22+	31	Differential Ch38+	65
Differential Ch22-	32	Differential Ch38-	66
Differential Ch23+	33	Differential Ch39+	67
Differential Ch23-	34	Differential Ch39-	68

Rear J4 Field I/O Connector

On models with rear I/O, the J4 PMC connector provides the field I/O interface connections. This connector is a 64-pin female receptacle header (AMP 120527-1 or equivalent) which mates to the male connector on the carrier/CPU board (AMP 120521-1 or equivalent).

Table 2.2: *Board Rear Field I/O Pin Connections*

Pin Description	Pin	Pin Description	Pin
Digital CH0	1	Differential Ch24+	2
Digital CH1	3	Differential Ch24-	4
Digital CH2	5	Differential Ch25+	6
Digital CH3	7	Differential Ch25-	8
Digital CH4	9	Differential Ch26+	10
Digital CH5	11	Differential Ch26-	12
Digital CH6	13	Differential Ch27+	14
Digital CH7	15	Differential Ch27-	16
Digital CH8	17	Differential Ch28+	18
Digital CH9	19	Differential Ch28-	20
Digital CH10	21	Differential Ch29+	22
Digital CH11	23	Differential Ch29-	24
Digital CH12	25	Differential Ch30+	26
Digital CH13	27	Differential Ch30-	28
Digital CH14	29	Differential Ch31+	30
Digital CH15	31	Differential Ch31-	32
Differential Ch16+	33	Differential Ch32+	34
Differential Ch16-	35	Differential Ch32-	36
Differential Ch17+	37	Differential Ch33+	38
Differential Ch17-	39	Differential Ch33-	40
Differential Ch18+	41	Differential Ch34+	42
Differential Ch18-	43	Differential Ch34-	44
Differential Ch19+	45	Differential Ch35+	46
Differential Ch19-	47	Differential Ch35-	48
Differential Ch20+	49	Differential Ch36+	50
Differential Ch20-	51	Differential Ch36-	52
Differential Ch21+	53	Differential Ch37+	54
Differential Ch21-	55	Differential Ch37-	56
Differential Ch22+	57	Differential Ch38+	58
Differential Ch22-	59	Differential Ch38-	60
Differential Ch23+	61	COMMON	62
Differential Ch23-	63	COMMON	64

Note: On rear I/O models, Differential CH39 is not connected to J4.

Non-Isolation Considerations

The board is non-isolated, since there is electrical continuity between the logic and field I/O grounds. As such, the field I/O connections are not isolated from the system. Care should be taken in designing installations without isolation to avoid noise pickup and ground loops caused by multiple ground connections.

3.0 PROGRAMMING INFORMATION

This Section provides the specific information necessary to program and operate the board.

This board is a PCI Specification version 2.2 compliant PCI bus master/target board.

The PCI bus is defined to address three distinct address spaces: I/O, memory, and configuration space. This board can be accessed via the PCI bus I/O, memory, and configuration spaces.

The card's configuration registers are initialized by system software at power-up to configure the card. The board is a Plug-and-Play PCI card. As a Plug-and-Play card the board's base address and system interrupt request line are not selected via jumpers but are assigned by system software upon power-up via the configuration registers. A PCI bus configuration access is used to read/write the PCI card's configuration registers.

PCI Configuration Address Space

When the computer is first powered-up, the computer's system configuration software scans the PCI bus to determine what PCI devices are present. The software also determines the configuration requirements of the PCI card.

The system software accesses the configuration registers to determine how many blocks of memory space the module requires. It then programs the board's configuration registers with the unique memory base address.

The configuration registers are also used to indicate that the board requires an interrupt request line. The system software then programs the configuration registers with the interrupt request line assigned to the board.

Since this board is relocatable and not fixed in address space, its device driver must use the mapping information stored in the board's Configuration Space registers to determine where the board is mapped in memory space and which interrupt line will be used.

CONFIGURATION REGISTERS

The PCI specification requires software driven initialization and configuration via the Configuration Address space. This board provides 512 bytes of configuration registers for this purpose. It contains the configuration registers, shown in Table 3.1, to facilitate Plug-and-Play compatibility.

The Configuration Registers are accessed via the Configuration Address and Data Ports. The most important Configuration Registers are the Base Address Registers and the Interrupt Line Register which must be read to determine the base address assigned to the board and the interrupt request line that goes active on a board interrupt request.

Table 3.1 Configuration Registers

Reg. Num.	D31 D24	D23 D16	D15 D8	D7 D0
0	Device ID = 4253(DX503) 4353 (DX2003)		Vendor ID= 16D5	
1	Status		Command	
2	Class Code=118000			Rev ID=00
3	BIST	Header	Latency	Cache
4	32-bit Memory Base Address for Memory Accesses to Local, Runtime, DMA, and Messaging Queue Registers (PCIBAR0)			
5	PCI Base Address for I/O Accesses to Local, Runtime, DMA, and Messaging Queue Registers (PCIBAR1)			
6	32-bit Memory Base Address for Memory Accesses to Local Address Space 0, 2M Space, FPGA Space (PCIBAR2)			
7 : 10	Not Used			
11	Subsystem ID= 4253 (DX503) 4353 (DX2003)		Subsystem Vendor ID=16D5	
12	Not Used			
13,14	Reserved			
15	Max_Lat	Min_Gnt	Inter. Pin	Inter. Line

This board is allocated memory space address (PCIBAR0) to access the PCI9056 runtime, DMA, and messaging queue registers. The PCI9056 decodes 512 bytes for these memory space registers. These registers can also be accessed by an I/O cycle, with the PCI bus address matching the I/O Base Address (PCIBAR1).

By default this EEPROM memory is read/write enabled. Removal of 6-pin resistor network R1 disables writes to the PCI bus configuration EEPROM memory. Refer to Resistor Location Drawing 4502-039 to identify the board location of R1. Note removal of resistor R1 also disables writing the flash configuration device.

In addition, this board is allocated a 2M byte block of memory (PCIBAR2) that is addressable in the PCI bus memory space to control the board's multiple functions included in the virtex II FPGA.

MEMORY MAP

The memory space address map for the board is shown in Table 3.2. Note that the base address for the board (PCIBAR2) in memory space must be added to the addresses shown to properly access the board registers. Register accesses as 32, 16, and 8-bit in memory space are permitted.

Table 3.2: *Memory Map Configuration Registers*

PCI BAR2+	D31 D08	D07 D00	PCI BAR2+
0003	Not Used[1]	Configuration Status Register	**0000**[2]
0803	Not Used[1]	Configuration Control Register	**0800**
1003	Not Used[1]	Configuration Data	**1000**
2003	Not Used[1]	Flash Status 1 Register	**2000**
2803	Not Used[1]	Flash Status 2 Register	**2800**
3803	Not Used[1]	Flash Read	**3800**
4003	Not Used[1]	Flash Reset	**4000**
4803	Not Used[1]	Flash Start Write	**4800**
5003	Not Used[1]	Flash Erase Sector	**5000**
5803	Not Used[1]	Flash Erase Chip	**5800**
6003	Not Used[1]	Flash Data Register	**6000**
6803	Not Used[1]	Flash Address 7->0	**6800**
7003	Not Used[1]	Flash Address 15->8	**7000**
7803	Not Used[1]	Flash Address 20->16	**7800**

1. *The board will return 0 for all addresses that are "Not Used".*
2. *Address space 0->7FFF is not contiguous because the least significant address lines are not decoded by the CPLD.*

MEMORY MAP

Table 3.2: Memory Map Xilinx Registers

PCI BAR2+	D31 D16	D15 D00	PCI BAR2+
8003	Not Used[1]	Software Reset Register	**8000**
8007	Not Used[1]	Interrupt Status/Clear 7-0 Digital I/O	**8004**
800B	Not Used[1]	15-0 Digital I/O Register	**8008**
800F	Not Used[1]	39-16 Differential I/O Register	**800C**
8013	Direction Register Differential Channels 39-16	Dir. Digital Ch 15-0	**8010**
8017	Not Used[1]	Interrupt Enable Digital Channels 7-0	**8014**
801B	Not Used[1]	Interrupt Type Digital Channels 7-0	**8018**
801F	Not Used[1]	Interrupt Polarity Digital Channels 7-0	**801C**
8023	Not Used[1]		**8020**
8027	Not Used[1]		**8024**
802B	DMA Control Register		**8028**
802F	DMA Transfer Size Channel 0		**802C**
8033	DMA Transfer Size Channel 1		**8030**
8037	Not Used[1]		**8034**
	↓		
FFFFF	Not Used[1]		**FFFFC**
100003	Static RAM Memory		**100000**
	↓		
1FFFFF	Static RAM Memory		**1FFFFC**

1. The board will return 0 for all addresses that are "Not Used".

This memory map reflects byte accesses using the "Little Endian" byte ordering format. Little Endian uses even-byte addresses to store the low-order byte. The Intel x86 family of microprocessors uses "Little Endian" byte ordering. Big Endian is the convention used in the Motorola 68000 microprocessor family and is the VMEbus convention. In Big Endian, the lower-order byte is stored at odd-byte addresses.

Flash Configuration

The DX board uses a flash configuration device to store programming information for the Xilinx FPGA. The flash configuration device and FPGA are hardwired together so that during power-up the contents of the configuration device are downloaded to the FPGA. The flash configuration data can be reprogrammed using the PCI bus interface. The following is the general procedure for reprogramming the flash memory and reconfiguration of the Xilinx FPGA:

1) Disable auto-configuration by setting bit-0 (Stop Configuration) of the Configuration Control register to logic high.
2) Clear the Xilinx of its previous configuration by setting the Configuration Control register bit-2 to logic high. Software must also keep bit-0 set to a logic high.
3) Read INIT as logic high (Bit-1 of Configuration Status register) before programming is initiated. This can take up to 3.7m seconds for the Xilinx XC2V500 FPGA and 5.82m seconds for the Xilinx XC2V2000 FPGA.
4) Verify Flash Chip is not busy by reading bit-7 as logic 0 of the Flash Status 2 register at base address plus 2800H before starting a new Flash operation.
5) Erase the current flash contents by setting bit-0 of the Flash Erase Chip register to logic high. The Flash Erase Chip operation will take 14 seconds to complete.
6) Verify Flash Chip is not busy by reading bit-7 as logic 0 of the Flash Status 2 register at base address plus 2800H before going to the next step.
7) Download the Configuration file to the flash configuration chip via the PCI bus.
   i) Write the byte to be sent to the Flash Data register at base address plus 6000H.
   ii) Write the address of the Flash Chip to receive the new data byte to the Flash Address registers at base address plus 6800H, 7000H, and 7800H. Issue of a Flash Start Write will automatically increment this address after the issued Flash Write has completed. Thus, the address will not need to be set prior to issue of the next Flash Start Write. The first byte of the configuration file should be written to address 0 of the Flash Chip. The Flash Start Write operation will take 9μ seconds to complete.
   iii) Issue a Flash Start Write command to the Flash Chip by writing logic 1 to bit-0 of base address plus 4800H.
   iv) Verify the Flash Chip is not busy by reading bit-7 as logic 0 of the Flash Status 2 register at base address plus 2800H before going back to step i to write the next byte.
8) Enable auto-configuration by setting bit-0 (Stop Configuration) of the Configuration Control register to logic low.
9) Verify configuration complete by reading DONE (bit-0 of Configuration Status Register) as logic high. The auto-configuration process of moving Flash data to the Xilinx FPGA will take 0.16 seconds for the Xilinx XC2V500 and 0.45 seconds for the Xilinx XC2V2000 FPGA.
10) Thereafter, at power-up the configuration file will automatically be loaded into the FPGA.

After the permanent configuration of the Xilinx FPGA is determined, the contents of the flash configuration device can be disabled from future flash reconfiguration. Writing to the flash configuration device is hardware disabled by removal of resistor network R1. Refer to Resistor Location Drawing 4502-039 to identify the board location of R1. Note removal of resistor R1 also disables writes to the PCI bus configuration EEPROM device.

Direct PCI bus to Xilinx Configuration

Configuration of the Xilinx FPGA can be implemented directly from the PCI bus. The following is the general procedure for re-configuration of the Xilinx FPGA via the PCI bus:

1) Disable auto-configuration by setting bit-0 (Stop Configuration) of the Configuration Control register to logic high.
2) Clear the Xilinx of its previous configuration by setting the Configuration Control register bit-2 to logic high. Software must also keep bit-0 set to logic high.
3) Read INIT as logic high (Bit-1 of Configuration Status register) before programming is initiated. This can take up to 3.7m seconds for the Xilinx XC2V500 FPGA and 5.82m seconds for the Xilinx XC2V2000 FPGA.
4) Download the Configuration file directly to the Xilinx FPGA by writing to the Configuration Data register. The entire configuration file must be written to the Xilinx FPGA one byte at a time to the Configuration Data register at base address plus 1000H.
5) Verify configuration complete by reading DONE (bit-0 of Configuration Status Register) as logic high. DONE is expected to be logic high immediately after the last byte of the configuration file is written to the Xilinx FPGA.
6) At power-up the configuration file will need to be reloaded into the FPGA.

Configuration Status Register (Read Only) – (Base + 0000H)

This read only register reflects the status of configuration complete and Xilinx configuration clear. This Configuration Status register is read at base address plus 0H.

Configuration Status Register

Bit(s)	FUNCTION	
0	DONE:	
	0	Xilinx FPGA is not configured
	1	Xilinx FPGA configuration is complete
1	INIT:	
	0	INIT is held low until the Xilinx is clear of its current configuration
	1	INIT transitions high when the clearing of the Xilinx current configuration is complete
2 to 7	Not Used (bits are read as logic "0")	

CONFIGURATION CONTROL REGISTERS

Configuration Control Register (Read/Write Only) – (PCIBAR2 + 0800H)

This read/write register is used to stop Xilinx configuration, clear Xilinx configuration memory, and set Local Bus Hold control. This Configuration Control register is accessed at base address plus 0800H.

Bit(s)	FUNCTION	
0	Stop Xilinx Configuration:	
	0	Enable Xilinx FPGA configuration
	1	Stop Xilinx FPGA configuration
1	Not Used (bit is read as logic "0")	
2	Clear Current Xilinx Configuration:	
	0	Logic low has no effect.
	1	Logic high resets the Xilinx configuration logic. Re-configuration can begin after INIT transitions high.
3 to 6	Not Used (bits are read as logic "0")	
7	Local Bus Hold Control	
	0	CPLD controls generation of Local Hold Acknowledge. The CPLD logic will always grant control of the local bus to the PCI9056 device.
	1	Xilinx FPGA controls generation of the Local Hold Acknowledge signal.

Configuration Data (Write Only) – (PCIBAR2 + 1000H)

This write only register is used to write Xilinx configuration data directly to the Xilinx FPGA from the PCI bus. This Configuration Data register is accessed at base address plus 1000H. The entire configuration file must be written to the Xilinx FPGA one byte at a time. Configuration complete is verified by reading DONE (bit-0 of Configuration Status Register) as logic high.

A write to this Configuration Data register while auto-configuration from Flash is active will cause the Xilinx configuration to fail. Auto-configuration is stopped by writing logic 1 to bit-0 of the Configuration Control register at base address plus 800H.

The Xilinx FPGA should also be cleared of its current configuration prior to loading of a new configuration file. The FPGA is cleared of its current configuration by writing logic 1 to bit-2 at address plus 800H.

Flash Status 1 (Read Only) – (PCIBAR2 + 2000H)

FLASH CONTROL REGISTERS

This read only register is used to read the DQ5 and DQ3 status of the flash chip. A Flash Status 1 register is at base address plus 2000H.

Flash Status 1 Register

Bit(s)	FUNCTION	
0 to 4	Not Used (bits are read as logic "1 or 0")	
5	DQ5:	
	0	Chip enabled for reading array data.
	1	The system must issue the Flash Reset command to re-enable the device for reading array data if DQ5 goes high. DQ5 can go high during a Flash Start Write, Flash Erase Chip, or Flash Erase Sector operation.
6 and 7	Not Used (bits are read as logic "1 or 0")	

Flash Status 2 (Read Only) – (PCIBAR2 + 2800H)

This read only register is used to read the ready or busy status of the flash chip. A Flash Status 2 register is at base address plus 2800H. The system must first verify that that Flash Chip is not busy before executing a new Flash command. The Flash Chip is busy if bit-7 of this register is set to logic 1. The Flash will always be Busy while bit-0 of the Configuration Control register is set to logic "0".

Flash Status 2 Register

Bit(s)	FUNCTION	
0 to 6	Not Used (bits are read as logic "0")	
7	Busy / Ready~ Set bit-0 of the Configuration Control register to logic "1" before monitoring this busy bit.	
	0	Flash Chip is Ready
	1	Flash Chip is Busy

Flash Read (Read Only) – (PCIBAR2 + 3800H)

A Flash Read command is executed by reading this register at base address plus 3800H. Prior to issue of a Flash Read the Flash Address registers must be set with the desired address to be read. See the Flash Address registers at base address plus 6800H, 7000H, and 7800H.

The system must issue the Flash Reset command to re-enable the device for reading array data if DQ5 goes high. DQ5 can go high during a Flash Start Write, Flash Erase Chip, or Flash Erase Sector operation. DQ5 can be monitored via the Flash Status 1 register at base address plus 2000H.

Flash Reset (Write Only) – (PCIBAR2 + 4000H)

This write only register is used to initiate a reset of the flash chip. A Flash Reset command is executed by writing logic 1 to bit-0 of this register at base address plus 4000H. Writing the flash reset command resets the chip to reading data mode. Once an erase or programming operation begins, the chip ignores reset commands until the operation is complete.

FLASH CONTROL REGISTERS

Flash Start Write (Write Only) – (PCIBAR2 + 4800H)

This write only register is used to initiate the write of a byte to the flash chip. A Flash Start Write command is executed by writing logic 1 to bit-0 of this register at base address plus 4800H. Prior to issue of a Flash Start Write the Flash Data and Address registers must be set with the desired data and address to be written. See the Flash Data and Address registers at base address plus 6000H, 6800H, 7000H, and 7800H.

Flash Erase Sector (Write Only) – (PCIBAR2 + 5000H)

A Flash Erase Sector command is executed by writing logic 1 to bit-0 of this register at base address plus 5000H. Verify that the Flash Chip is not busy from a previous operation before beginning a new operation. This is accomplished by reading bit-0 as logic 1 of the Flash Status 2 register.

There are 32 flash sectors, which are addressed via the most significant five flash address lines. The most significant five flash address lines are set via the Flash Address 23-16 register at base address plus 7800H. Issue of a Flash Erase Sector command will erase the contents of the flash chip only in the sector specified.

A flash bit cannot be programmed from logic 0 back to logic 1. Only an erase chip operation can convert logic 0 back to logic 1. **Prior to reprogramming of the flash chip a Flash Erase Chip or Flash Erase Sector command must be performed.**

The Flash Erase Sector operation will take 0.7 seconds to complete. The system can determine the status of the erase operation by reading the Flash Ready/Busy status. Bit-0 of the Flash Status 2 register, at base address plus 2800H, will read as logic 0 when chip erase is completed.

Any other flash commands written to the flash chip during execution of the flash erase sector operation are ignored. Note that a hardware reset during the erase sector operation will immediately terminate the operation.

Flash Erase Chip (Write Only) – (PCIBAR2 + 5800H)

This write only register is used to erase the entire contents of the flash chip. A flash bit cannot be programmed from logic 0 back to logic 1. Only an erase chip operation can convert logic 0 back to logic 1. **Prior to reprogramming of the flash chip a Flash Erase Chip command must be performed.**

A Flash Erase Chip command is executed by writing logic 1 to bit-0 of this register at base address plus 5800H. Verify that the Flash Chip is not busy from a previous operation before beginning a new operation. This is implemented by reading bit-0 as logic 1 of the Flash Status 2 register.

The Flash Erase Chip operation will take 14 seconds to complete. The system can determine the status of the erase operation by reading the Flash Ready/Busy status. Bit-0 of the Flash Status 2 register, at base address plus 2800H, will read as logic 0 when chip erase is completed.

Any other flash commands written to the flash chip during execution of the flash erase chip operation will be ignored. Note that a hardware reset during the chip erase operation will immediately terminate the operation.

Flash Data Register (Write Only) – (PCIBAR2 + 6000H)

This write only register holds the data byte which is sent to the flash chip upon issue of a Flash Start Write command. Bits 3 to 0 of this register can be read.

Flash Address 7->0 (Write Only) – (PCIBAR2 + 6800H)

This write only register holds the least significant byte of the address to which the flash chip is written upon issue of a Flash Start Write command.

Flash Address 15->8 (Write Only) – (PCIBAR2 + 7000H)

This write only register sets bits 15 to 8 of the address to which the flash chip is written upon issue of a Flash Start Write command.

Flash Address 20->16 (Write Only) – (PCIBAR2 + 7800H)

This write only register sets bits 20 to 16 of the address to which the flash chip is written upon issue of a Flash Start Write command. The most significant 3 bits of this register are not used.

RESET REGISTER

Reset Register (Write Only) – (PCIBAR2 + 8000H)

This write only register is used to issue a software reset. Bit-15 when set to logic "1" will issue a software reset to the Xilinx FPGA.

This register can be read or written with either 8-bit, 16-bit, or 32-bit data transfers.

FPGA INTERRUPT REGISTERS

Interrupt Status/Clear Digital I/O (Read/Write) – (PCIBAR2 + 8004H)

This read/write register is used to determine the pending status of Digital I/O interrupts and release pending Digital I/O interrupts.

The Digital I/O interrupt status/clear registers reflect the status of each of the Digital I/O channels. **Read** of a "1" indicates that an interrupt is pending for the corresponding digital channel. **Write** of a logic "1" to a bit releases the corresponding digital channel's pending interrupt. Writing "0" to a bit location has no effect, a pending interrupt will remain pending.

Digital I/O channel 0 interrupt status is identified via data bit-0 while Digital I/O channel 7 status is identified via data bit-7 at base address plus 8004H.

Table 3.3: *Board Digital Interrupt Status/Clear*

1. *All bits labeled "Not Used" will return logic "0" when read.*

BIT	FUNCTION
0	Digital Channel 0 Interrupt Pending/Clear
1	Digital Channel 1 Interrupt Pending/Clear
2	Digital Channel 2 Interrupt Pending/Clear
3	Digital Channel 3 Interrupt Pending/Clear
4	Digital Channel 4 Interrupt Pending/Clear
5	Digital Channel 5 Interrupt Pending/Clear
6	Digital Channel 6 Interrupt Pending/Clear
7	Digital Channel 7 Interrupt Pending/Clear
8-31	Not Used[1]

DMA INTERRUPT REGISTERS

Interrupts must be enabled via the PCI9056 control registers and the Interrupt Enable register at base address + offset 8014H, in order to generate interrupts. The PCI9056 Interrupt Control/Status register at PCIBAR0 base address + offset 68H must have bits 8 and 11 set to a logic high in order for interrupts to occur.

DMA interrupts must be enabled and controlled through the PCI9056 registers. The PCI9056 Interrupt Control/Status register at PCIBAR0 base address + offset 68H must have bits 18 and 19 set to a logic high in order for DMA interrupts to occur on DMA channels 0 and 1, respectively.

DMA transfers are configured and controlled via PCI9056 DMA registers. The PCI9056 DMA registers are at PCIBAR0 base address + offset 80H to B8H. These registers control the transfer direction, size, source address, and destination address for DMA channels 0 and 1.

Digital Input/Output Registers (Read/Write) – (PCIBAR2 + 8008H)

DIGITAL INPUT/OUTPUT REGISTERS

Sixteen digital TTL input/output channels numbered 0 through 15 may be individually accessed via these registers. Channels 0 to 15 are accessed at the carrier base address +8008H via data bits 0 to 15. Channel input signal levels are determined by reading this register. Likewise, channel output signal levels are set by writing to this register. Note that the data direction, input or output, must first be set via the Direction register at base address plus 8010H.

Channel read/write operations use 8-bit, 16-bit, or 32-bit data transfers with the lower ordered bits corresponding to the lower-numbered channels for the register of interest. All input/output channels are configured as inputs following a power-on or software reset.

Differential Input/Output Register (Read/Write) – (PCIBAR2 + 800CH)

Twenty-four differential channels numbered 16 through 39 may be individually accessed via this register. Channels 39 to 16 are accessed at the carrier base address +800CH via data bits 23 to 0. Channel input signal levels are determined by reading this register. Likewise, channel output signal levels are set by writing to this register. Note that the data direction, input or output, must first be set via the Direction register at base address plus 8010H.

Channel read/write operations use 8-bit, 16-bit, or 32-bit data transfers with the lower ordered bits corresponding to the lower-numbered channels for the register of interest. All input/output channels are configured as inputs following a power-on or software reset.

Differential I/O Channel and Corresponding Register Bits							
Ch 23	Ch 22	Ch 21	Ch 20	Ch 19	Ch 18	Ch 17	Ch 16
D7	D6	D5	D4	D3	D2	D1	D0

Ch 31	Ch 30	Ch 29	Ch 28	Ch 27	Ch 26	Ch 25	Ch 24
D15	D14	D13	D12	D11	D10	D9	D8

Ch 39	Ch 38	Ch 37	Ch 36	Ch 35	Ch 34	Ch 33	Ch 32
D23	D22	D21	D20	D19	D18	D17	D16

Direction Control Register (Read/Write) – (PCIBAR2 + 8010H)

DIRECTION CONTROL REGISTER

The data direction (input or output) of the 16 digital channels and 24 differential channels is selected via this register. The data direction of channels 0 to 15 is controlled as two channel groups. Channels 0 and 1 are set/controlled via bit-0, while channels 2 and 3 are set/controlled via data bit-1, as shown below. Setting a bit low configures the corresponding channel data direction for input. Setting the control bit high configures the corresponding channel data direction for output.

Channels and Corresponding Register Bits							
Ch15, Ch14	Ch 13, Ch 12	Ch 11, Ch 10	Ch 9, Ch 8	Ch 7, Ch 6	Ch 5, Ch 4	Ch 3, Ch 2	Ch 1, Ch 0
D07	D06	D05	D04	D03	D02	D01	D00

Ch 23	Ch 22	Ch 21	Ch 20	Ch 19	Ch 18	Ch 17	Ch 16
D15	D14	D13	D12	D11	D10	D09	D08

Ch 31	Ch 30	Ch 29	Ch 28	Ch 27	Ch 26	Ch 25	Ch 24
D23	D22	D21	D20	D19	D18	D17	D16

Ch 39	Ch 38	Ch 37	Ch 36	Ch 35	Ch 34	Ch 33	Ch 32
D31	D30	D29	D28	D27	D26	D25	D24

The default power-up state of these registers is logic low. Thus, all channels are configured as inputs following system reset or power-up. Reading or writing to this register is possible via 32-bit, 16-bit or 8-bit data transfers.

DIGITAL INTERRUPT REGISTERS

Interrupt Enable Register (Read/Write) – (PCIBAR2 + 8014H)

The Interrupt Enable Register provides a mask bit for each channel from 0 to 7. A "0" bit will prevent the corresponding input channel from generating an external interrupt. A "1" bit will allow the corresponding channel to generate an interrupt.

The Interrupt Enable register at the PCIBAR2 base address + offset 8014H is used to control channels 0 through 7 via data bits 0 to 7.

All channel interrupts are disabled (set to "0") following a power-on or software reset. Reading or writing to this register is possible via 32-bit, 16-bit or 8-bit data transfers.

In addition to this register interrupts must be enabled via the PCI9056 control registers, in order to generate interrupts. The PCI9056 Interrupt Control/Status register at PCIBAR0 base address + offset 68H must have bits 8 and 11 set to a logic high in order for interrupts to occur.

DIGITAL INTERRUPT REGISTERS

Interrupt Type (COS or H/L) Configuration Register (Read/Write) - (PCIBAR2 + 8018)

The Interrupt Type Configuration Register determines the type of input channel transition that will generate an interrupt for each of the eight possible interrupting channels. A "0" bit selects interrupt on level. An interrupt will be generated when the input channel level specified by the Interrupt Polarity Register occurs (i.e. Low or High level transition interrupt). A "1" bit means the interrupt will occur when a Change-Of-State (COS) occurs at the corresponding input channel (i.e. any state transition, low to high or high to low).

The Interrupt Type Configuration register at PCIBAR2 base address + offset 8018H is used to control channels 0 through 7. For example, channel 0 is controlled via data bit-0.

All bits are set to "0" following a reset which means that, if enabled, the inputs will cause interrupts for the levels specified by the digital input channel Interrupt Polarity Register.

Channel read or write operations use 8-bit, 16-bit, or 32-bit data transfers. Note that no interrupts will occur unless they are enabled by the Interrupt Enable Register.

Interrupt Polarity Register (Read/Write) – (PCIBAR2 + 801C)

The Interrupt Polarity Register determines the level that will cause a channel interrupt to occur for each of the channels enabled for level interrupts. A "0" bit specifies that an interrupt will occur when the corresponding input channel is low (i.e. a "0" in the digital input channel data register). A "1" bit means that an interrupt will occur when the input channel is high (i.e. a "1" in the digital input channel data register). Note that no interrupts will occur unless they are enabled by the Interrupt Enable Register. Further, the Interrupt Polarity Register will have no effect if the Change-of-State (COS) interrupt type is configured by the Interrupt Type Configuration Register.

The Interrupt Polarity register at the PCIBAR2 base address + offset 801CH is used to control channels 0 through 7.

All bits are set to "0" following a reset which means that the inputs will cause interrupts when they are below the TTL threshold (provided they are enabled for interrupt on level).

DMA REGISTERS

DMA Control Register (Read/Write) - (PCIBAR2 + 8028H)

The DMA Control Register is used to request a DMA Demand mode transfer. The transfer must include the Static RAM Memory as either the source or the destination.

Bit-0 is used to request a DMA channel 0 transfer while bit-1 is used to request a channel 1 DMA transfer. The bit must to set to logic high to request a transfer. Once set, the bit will remain set until the DMA transfer has completed.

The size of the DMA transfer must be set in the DMA Transfer Size register corresponding to the channel handling the transfer. See the description of the DMA Transfer Size registers in the following paragraphs. In addition, the DMA transfer size, direction, source and destination must be set in the PCI9056 DMA control registers. The PCI9056 DMA registers are at PCIBAR0 base address + offset 80H to B8H. See the PCI9056 user's manual and Acromag's software source code which provides an example for further details.

The DMA Control and DMA Transfer Size registers are only used to initiate DMA Demand Mode transfers. These registers are used to illustrate DMA Demand Mode data transfers. Writing to this register is possible via 32-bit, 16-bit or 8-bit data transfers.

DMA Transfer Size Registers (Read/Write) - (PCIBAR2 + 802CH and 8030H)

The DMA Transfer Size Register is used to set the size of the DMA Demand mode data transfer that moves data to or from the on board Static RAM memory. The on board static RAM has 256K memory locations. As such, the maximum value that can be written to this register is 3FFFFH which corresponds to 2^{18}. A value of 3FFFFH would specify the move of 256K long words.

The DMA Transfer Size Register at base address + 802CH is used to set the DMA channel 0 data transfer size. The register at base address + 8030H is used to set the DMA channel 1 data transfer size. Writing to this register is possible via 32-bit, 16-bit or 8-bit data transfers.

STATIC RAM MEMORY

Static RAM Memory (Read/Write) – (PCIBAR2 + 100000H to 1FFFFFH)

The Static RAM memory space is used to provide read or write access to on board SRAM memory. The Static RAM device has a 256K x 36-bit memory configuration. Reading or writing to this memory space is possible via 32-bit, 16-bit or 8-bit data transfers.

PCI9056 REGISTERS

PCI9056 Registers (Read/Write) – (PCIBAR0)

The PCI9056 is configured for (PLX PCI9056 chip) C Mode Local bus operation. The PCI9056 User's Manual references to C Mode configuration only apply to the DX boards. The DX boards use the, C Mode, generic 32-bit non-multiplexed address and data bus interface for communication between the PCI9056 and the Xilinx FPGA.

PCI9056 USERo CLOCK CONTROL

Note the PCI9056 USERo signal is a general purpose output controlled from the PCI9056 Configuration registers. The "o" at the end of this signal name indicates that this is an output signal.

A DX on board clock is used to clock the PCI9056 Local bus, SRAM interface, CPLD operation, and FPGA operation. The DX Board clock can be one of two sources. The Board clock can be either 33MHz or the frequency provided by the Xilinx FPGA on the PLL_CLK signal. Clock signal selection is controlled via the PCI9056 USERo signal.

The default power-up condition of the DX board enables the on board 33MHz crystal as the active clock. However, after the FPGA is configured to drive the PLL_CLK signal with a user defined frequency, the PLL_CLK signal can be selected as the board clock.

The USERo control signal, output from the PCI9056, is used to select between the 33MHz clock and the user defined clock (PLL_CLK). The user defined clock must be defined in the FPGA and output from the FPGA on signal PLL_CLK. The Digital Clock Manager of the FPGA offers a wide range of clock management features including clock multiplication and division for generation of a user defined clock (PLL_CLK). A 33MHz crystal generated clock signal (FPGA_CLK_PLL) is input to the FPGA for use in generation of the user defined clock signal PLL_CLK. The PLL_CLK can be a minimum of 10MHz and a maximum of 100MHz. Since the PLL_CLK signal is generated and driven by the FPGA, it will only be available after the FPGA is configured. See the example VHDL file included in the engineering design kit and the Xilinx documentation on the Digital Clock Manager for more information.

The USERo signal is controlled via a PCI9056 device register over the PCI bus. The PCI9056 User I/O Control register at PCIBAR0 base address + offset 6CH must have bit-19 set to a logic high to select USERo to be an output from the PCI9056. In addition, User I/O Control register at PCIBAR0 base address + offset 6CH must control bit-16 to select the DX board clock frequency. Bit-16 set to logic high causes the Board clock to be 33MHz. Bit-16 set to logic low will select the PLL_CLK as the Board clock frequency.

PCI Address	Bit-16 USERo	PCI9056 Runtime Register User I/O Control
PCIBAR0 + 6CH	Logic "0"	Board clock becomes PLL_CLK
	Logic "1"	Board clock 33MHz (Default)

Note that the Xilinx FPGA can not be reconfigured with the PLL_CLK signal selected. The first step in FPGA reconfiguration is to clear the FPGA device and this will disable the PLL_CLK signal. Without a board clock the DX board will lock up and require a system power down to reactivate. **The USERo clock control signal must be set to logic high prior to FPGA reconfiguration.**

4.0 THEORY OF OPERATION

This section contains information regarding the hardware of the board. A description of the basic functionality of the circuitry used on the board is also provided. Refer to the Block Diagram shown in Drawing 4501-988 as you review this material.

PCI INTERFACE LOGIC

A PLX Technology PCI9056 IC installed on the board provides a 66MHz 32-bit interface to the carrier/CPU board per PCI Local Bus Specification 2.2. The interface to the carrier/CPU board allows complete control of all board functions.

The PCI9056 is compliant with both 5V, and 3.3V signaling. The PCI bus VIO signals are tied directly to the PCI9056 chip which monitors the voltage present on VIO to automatically implement the matching signaling voltage.

Note that the DX board requires that system 3.3 volts be present on the PCI bus 3.3V pins. There are some older systems that do not provide 3.3 Volts on the PCI bus 3.3 volt pins. The DX boards will not work in these systems.

This is a master/target board, with the PCI bus interface logic contained within the PCI9056. This logic includes support for PCI commands, including: configuration read/write, and memory read/write. In addition, the PCI interface performs parity error detection, uses a single 2Meg base address register (PCIBAR2), and implements target abort, retry, and disconnect. The logic also implements interrupt requests via interrupt line INTA#.

The PCI9056 becomes the PCI bus master to perform DMA transfers on channels 0 and 1. The DMA control registers of the PCI9056 chip can be configured for DMA block mode and demand mode. The example device driver can be used to exercise DMA block and demand modes of operation. For other DMA modes of operation see the PLX Technology PCI9056 user manual.

The DMA demand mode requires Xilinx FPGA hardware to drive two PCI9056 signals active to request the DMA transfer of data. The signal DREQ0# is driven active to request a DMA channel 0 transfer. The signal DREQ1# is driven active to request a DMA channel 1 transfer. To identify the pins corresponding to these signals, see the Constraints.UCF file provided in the engineering design kit.

This DX board does not utilize the PCI9056 PCI power management functions. The power management request signal PME# is not used and is tied high with an external pullup resistor.

The internal PCI Arbiter is not used. External pull-up resistors are tied to the REQ[6:1]# input and GNT[6:1]# output signals of the PCI9056 chip.

NOT USED PCI9056 FUNCTIONS

Many features of the PCI9056 are not used in the example design but are available if enabled. It is beyond the scope of this document to duplicate the PCI9056 User's Manual. Please refer to the PCI9056 User's Manual (See Related Publications) for more detailed information.

The PCI9056 is hardwired for "C" bus mode. This is a generic 32-bit non-multiplexed address and data bus interface.

THEORY OF OPERATION CONTINUED

The example design implements the PCI9056 as the local bus master. The local bus is the bus interface between the PCI9056 and the Xilinx FPGA. As the local bus master, the PCI9056 responds to BREQi assertion to relinquish local bus ownership. The example design has BREQi tied low. The Xilinx FPGA does not request the local bus. However, the FPGA may drive BREQi high if the FPGA must take control of the local bus.

The example design implements single cycle mode. In single cycle mode the PCI9056 issues one ADS# per data cycle. The starting address for a single cycle data transfer can be on any address.

Burst read and write cycles can be implemented but must be enabled in the PCI9056 and supported in the logic of the FPGA. The PCI9056 Local Address Space 0/Expansion ROM Bus Region Descriptor register at PCIBAR0 base address + offset 18H must have bit-24 set to a logic high to enable bursting.

TTL / DIFFERENTIAL INPUT/OUTPUT LOGIC

Sixteen TTL and 24 Differential I/O are provided through the Field I/O Connector (refer to Table 2.1). *Field I/O points are NON-ISOLATED.* This means that the field return and logic common have a direct electrical connection to each other. As such, care must be taken to avoid ground loops. Ignoring this effect may cause operation errors, and with extreme abuse, possible circuit damage.

Digital TTL input/output channels (0-15) to the FPGA are buffered using 5 volt buffered line drivers. Field inputs to these buffers include transient protection devices on each line and a 4.7K pullup resistor to +5V. Output operation is considered 'Fail-safe'. That is, the Digital Input/Output signals are always configured as inputs upon power-up or software reset. This is done for safety reasons to ensure reliable control under all conditions.

FPGA TTL input/output channels (0-15) should be defined as Open Drain. This is accomplished inside the FPGA by driving the data together with the active low output enable signal of the output block. See the example design provided in the engineering design kit.

Digital TTL channels (0-7) of this model can be configured to generate interrupts for Change-Of-State (COS) and input level (polarity) match conditions on all channels. The interrupt is released via a write to the corresponding bit of the Interrupt Status/Clear register.

Differential channels (16-39) to the FPGA are buffered using EIA RS485/RS422 line transceivers. Field inputs to these transceivers include transient protection devices on each line and a 120 ohm socketed termination resistor. Signals received are converted from the required EIA RS485/RS422 voltages to the TTL levels required by the FPGA. Likewise, TTL signals are converted to the EIA RS485/RS422 voltages for data output

transmission. The direction control of the differential channels is independently controlled.

SYNCHRONOUS SRAM

A 256K x 36-bit synchronous SRAM is provided on the DX board. The address, data, and control signals are directly connected to the FPGA. To identify the pins corresponding to these signals, see the Constraints.UCF file provided in the engineering design kit.

Address and control signals are applied to the SRAM during one clock cycle, and two clock cycles later the associated read or write data cycle occurs. Please refer to the IDT71V65603 Data Sheet (See Related Publications) for more detailed information.

SERIAL EEPROM

A 128 x 16-bit Serial EEPROM is wired to the PCI9056 to provide power-up configuration information required by the PCI9056 device. The stored data in the EEPROM contains PCI device and vendor ID information. In addition, the PCI interrupt line, PCI base address size and user options such as burst enabled are specified in this memory device. The contents of the serial EEPROM can be changed using the PCI 9056 VPD function. Acromag software also provides the functions needed to implement read and write operation to the serial EEPROM.

By default the EEPROM memory is read/write enabled. Removal of resistor network device R1 disables writes to the PCI bus configuration EEPROM memory. Refer to Resistor Location Drawing 4502-039 to identify the board location of R1. Note removal of resistor R1 also disables writing the flash configuration device.

CLOCK CONTROL

The DX board clock is routed to the PCI9056 Local bus pin, SRAM, CPLD, and FPGA using a low skew clock driver (Cypress CY2305). The input to the CY2305 can be one of two sources. The on board 33MHz crystal oscillator is input to the CY2305 upon power-up (as the default condition). After the FPGA is configured, an FPGA generated clock signal (PLL_CLK) can be selected as the board clock. The PLL_CLK signal is selected as the board clock by setting the USERo PCI9056 output signal to logic low. See the "PCI9056 USERo CLOCK CONTROL "section of chapter 3 for additional details.

5.0 SERVICE AND REPAIR

Surface-Mounted Technology (SMT) boards are generally difficult to repair. It is highly recommended that a non-functioning board be returned to Acromag for repair. The board can be easily damaged unless special SMT repair and service tools are used. Further, Acromag has automated test equipment that thoroughly checks the performance of each board. When a board is first produced and when any repair is made, it is tested, placed in a burn-in room at elevated temperature, and retested before shipment.

SERVICE AND REPAIR ASSISTANCE

Please refer to Acromag's Service Policy Bulletin or contact Acromag for complete details on how to obtain parts and repair.

PRELIMINARY SERVICE PROCEDURE

Before beginning repair, be sure that all of the procedures in Section 2, Preparation For Use, have been followed. Also, refer to the documentation of your carrier/CPU board to verify that it is correctly configured. Replacement of the board with one that is known to work correctly is a good technique to isolate a faulty board.

***CAUTION**: POWER MUST BE TURNED OFF BEFORE REMOVING OR INSERTING BOARDS*

WHERE TO GET HELP

If you continue to have problems, your next step should be to visit the Acromag worldwide web site at http://www.acromag.com. Our web site contains the most up-to-date product and software information.

www.acromag.com

Choose "Bus Board Products" then go to the "Support" tab in the Acromag banner to access:

- Application Notes
- Frequently Asked Questions (FAQ's)
- Knowledge Base
- Tutorials
- Software Updates/Drivers

An email question can also be submitted from within the Knowledge Base or directly from the "Contact Us" tab.

Acromag's application engineers can also be contacted directly for technical assistance via telephone or fax through the numbers listed at the bottom of this page. When needed, complete repair services are also available.

6.0 SPECIFICATIONS

PHYSICAL

Single PMC Board

Height	13.5 mm (0.531 in)
Stacking Height	10.0 mm (0.394 in)
Depth	149.0 mm (5.866 in)
Width	74.0 mm (2.913 in)
Board Thickness	1.59 mm (0.062 in)

Connectors

- **PMC**: PCI Local Bus Interface: Two 64-pin female receptacle header (AMP 120527-1 or equivalent).
- **Front Field I/O:** 68-pin, SCSI-3, female receptacle header (AMP 787082-7 or equivalent) for all front I/O models.
- **Rear Field I/O:** 64-pin female receptacle header (AMP 120527-1 or equivalent) for PMC rear I/O models only.

Table 6.1: Power Requirements for Example Design

5V Maximum rise time of 100m seconds

Power Requirements		PMC Modules
5V (±5%)	Typical	800mA
	Max.	1.0A
3.3V (±5%)	Typical	440mA
	Max.	600mA
+/-12V (±5%)	Not used	

On Board 1.5V Power to Virtex II FPGA	Current Rating
1.5V (±5%)	5A Maximum

ENVIRONMENTAL

Operating Temperature: 0 to +70°C. –40°C to +85°C (E Version)
Relative Humidity: 5-95% Non-Condensing.
Storage Temperature: -55°C to 125°C.
Non-Isolated: Logic and field commons have a direct electrical connection.

Radiated Field Immunity (RFI): Complies with EN61000-4-3 (10V/m, 80 to 1000MHz AM & 900MHz. keyed) and European Norm EN50082-1 with no register upsets.

Cunducted R F Immunity (CRFI): Complies with EN61000-4-6 (10V/rms, 150KHz to 80MHz) and European Norm EN50082-1 with no register upsets.

Electromagnetic Interference Immunity (EMI): No register upsets occur under the influence of EMI from switching solenoids, commutator motors, and drill motors.

Surge Immunity: Not required for signal I/O per European Norm EN50082-1.

SPECIFICATIONS

Electric Fast Transient (EFT) Immunity: Complies with EN61000-4-4 Level 2 (0.5KV at field I/O terminals) and European Norm EN50082-1.

Electrostatic Discharge (ESD) Immunity: Complies with EN61000-4-2 Level 3 (8KV enclosure port air discharge) Level 2 (4KV enclosure port contact discharge) Level 1 (2KV I/O terminals contact discharge) and European Norm EN50082-1.

Radiated Emissions: Meets or exceeds European Norm EN50081-1 for class B equipment. Shielded cable with I/O connections in shielded enclosure are required to meet compliance.

Reliability Prediction

Mean Time Between Failure: 1,125,663 hours @ 25°C, Using MIL-HDBK-217F, Notice 2.

FPGA (DX503)

Xilinx XC2V500-4FG456

- 500K System Gates
- 32 Multiplier Blocks
- 32 18Kbit SelectRAM Blocks
- 8 Digital Clock Managers

FPGA (DX2003)

Xilinx XC2V2000-4FG676

- 2Meg System Gates
- 56 Multiplier Blocks
- 56 18Kbit SelectRAM Blocks
- 8 Digital Clock Managers

Synchronous SRAM

256K x 36-bit Integrated Devices Technology IDT71V65603

- 133 Megahertz Speed

Digital TTL Input/Output

TTL Channel Configuration: 16 Bi-directional TTL Transceivers Direction controlled as pairs of channels (Channels 0-15)

Reset/Power Up Condition: All Digital Channels Default to Input.

Digital I/O DC Electrical Characteristics Channels 0 to 15

- Digital I/O DC Electrical Characteristics
- $V_{OH:}$ 3.8V minimum
- V_{OL}: 0.55V maximum
- I_{OH}: -32.0mA
- I_{OL}: 32mA
- V_{IH}: 3.5V minimum
- V_{IL}: 1.5V maximum

Propagation Delay Channels 0 to 15

- Driver/Receiver Input to Output Delay = 50ns Typical

Pull-up Resistors: 4.7KΩ pull-up resistor networks are installed in sockets. eight networks of 8 resistors each are utilized for the Digital I/O.

- R150 for Digital I/O (0 to 7)
- R151 for Digital I/O (8 to 15)

Differential Input/Output

Channel Configuration: 24 Bi-directional differential signals are independently direction controlled. Rear I/O models only provided 23 differential I/O channels.

Differential I/O Electrical Characteristics for Channels 16 to 39

- 2 V Min., 5V Max.: Differential Driver Output Voltage with 50Ω load.
- 3 V Max.: Common Mode Output Voltage.

The receiver contains a fail-safe feature that results in a logic high output state if the inputs are unconnected (floating).

- -0.2 Min to 0.2 Max: Differential Input Threshold Voltage $-7V \leq V_{CM} \leq 12V$
- 70mV Typical: Input Hysteresis
- 12KΩ Minimum Input Resistance

Differential Propagation Delay

- Driver Input to Output Delay = 50ns Typical
- Receiver Input to Output Delay = 50ns Typical

Termination Resistors: 120Ω termination resistor networks installed in sockets. Networks of 4 resistors each used for the differential signals.

- R162 for Differential Channels (16 to 19)
- R163 for Differential Channels (20 to 23)
- R164 for Differential Channels (24 to 27)
- R165 for Differential Channels (28 to 31)
- R166 for Differential Channels (32 to 35)
- R167 for Differential Channels (36 to 39)

Write Disable Jumper

Write Disable Jumper: Removal of resistor network R1 disables write to the PCI bus configuration EEPROM and the Xilinx FPGA configuration flash devices.

Board Crystal Oscillator: 33MHz **Frequency Stability:** ± 0.01%

PCI Local Bus Interface

PMC Compatibility: Conforms to PCI Bus Specification, Revision 2.2 and PMC Specification, P1386.1
PCI Master/Target: Implemented by PLX Technology PCI9056 Chip
2M Memory Space Required: One Base Address Register for 2M space.
PCI commands Supported: Configuration Read/Write memory Read/Write: 32,16, and 8-bit data transfer types supported.
Signaling: 5V or 3.3V Compliant
INTA#: Interrupt A is used to request an interrupt. Source of interrupt can be from the Digital I/O, or PCI9056 Functions.

APPENDIX

CABLE: MODEL 5028-432 (SCSI-3 to Round, Shielded)

Type: Round shielded cable, 34 twisted pairs (SCSI-3 male connector at both ends). The cable length is 2 meters (6.56 feet). This shielded cable is recommended for all I/O applications (both digital I/O and precision analog I/O).

Application: Used to connect Model 5025-288 termination panel to the board.

Length: Standard length is 2 meters (6.56 feet). Consult factory for other lengths. It is recommended that this length be kept to a minimum to reduce noise and power loss.

Cable: 68 conductors, 28 AWG on 0.050 inch centers (permits mass termination for IDC connectors), foil/braided shield inside a PVC jacket.

Connectors: SCSI-3, 68-pin male connector with backshell.

Keying: The SCSI-3 connector has a "D Shell".

Schematic and Physical Attributes: See Drawing 4501-919.

Electrical Specifications: 30 VAC per UL and CSA (SCSI-3 connector spec.'s). 1 Amp maximum at 50% energized (SCSI-3 connector spec.'s).

Operating Temperature: -30°C to +80°C.

Storage Temperature: -40°C to +85°C.

Shipping Weight: 1.0 pound (0.5Kg), packed.

TERMINATION PANEL: MODEL 5025-288

Type: Termination Panel For 68 Pin SCSI-3 Cable Connection

Application: To connect field I/O signals to the board. *Termination Panel:* Acromag Part 4001-066. The 5025-288 termination panel facilitates the connection of up to 68 field I/O signals and connects to the board (connectors only) via a round shielded cable (Model 5028-432). Field signals are accessed via screw terminal strips. The terminal strip markings on the termination panel (1-68) correspond to field I/O (pins 1-68) on the board. Each board has its own unique pin assignments. Refer to the board manual for correct wiring connections to the termination panel.

Schematic and Physical Attributes: See Drawing 4501-920.

Field Wiring: 68-position terminal blocks with screw clamps. Wire range 12 to 26 AWG.

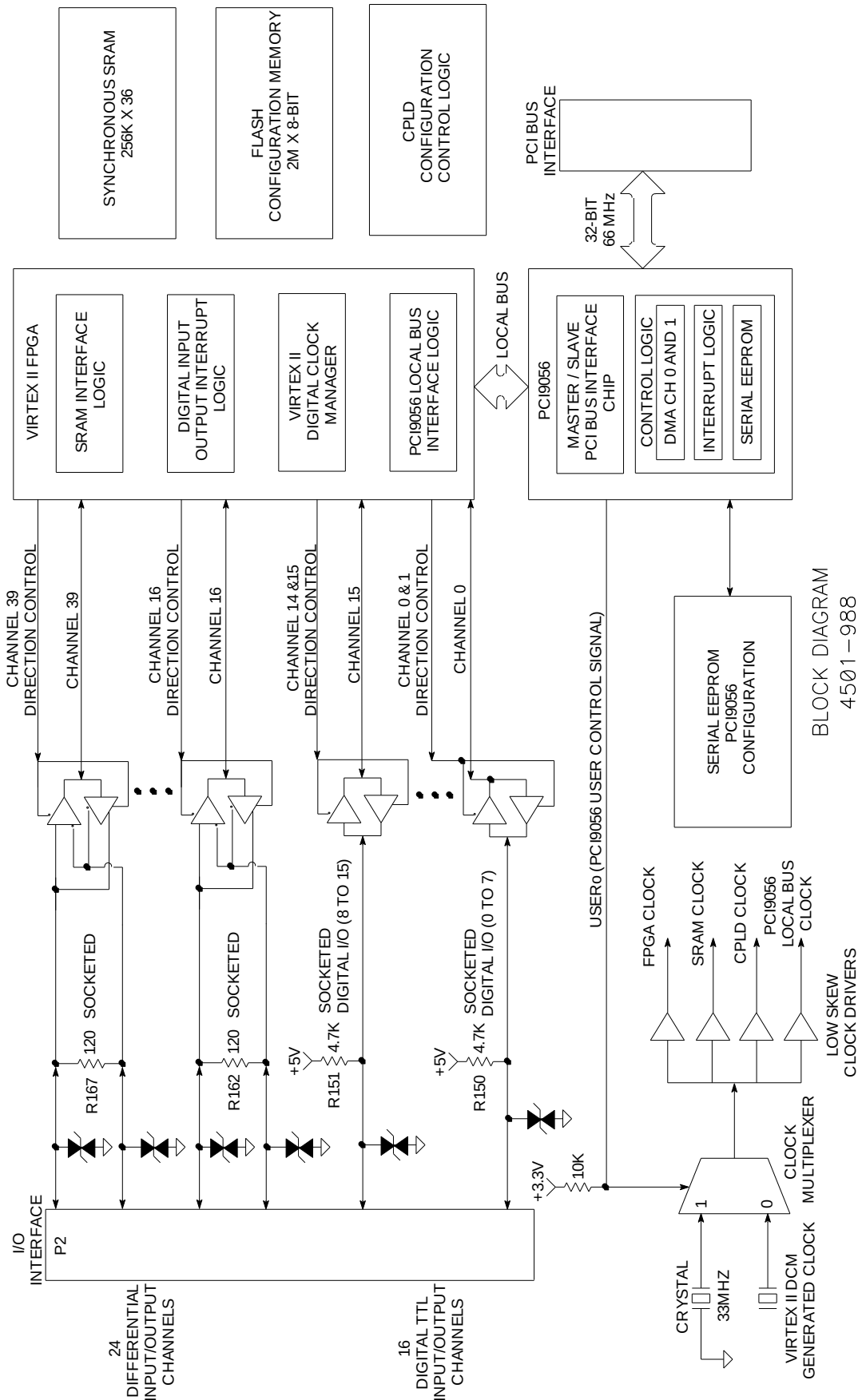
Mounting: Termination panel is snapped on the DIN mounting rail.

Printed Circuit Board: Military grade FR-4 epoxy glass circuit board, 0.063 inches thick.

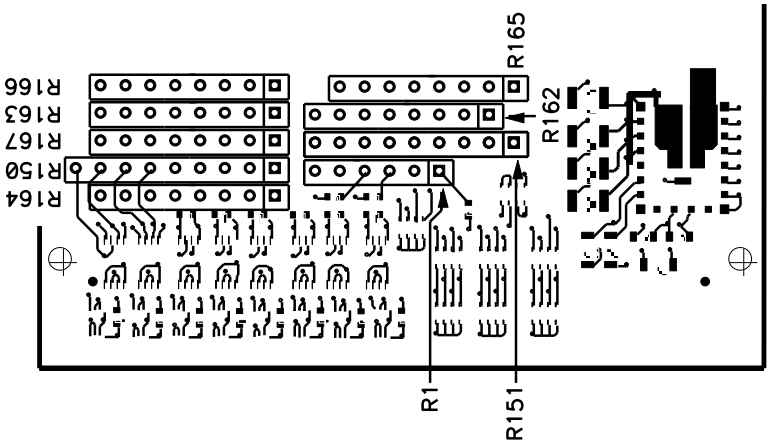
Operating Temperature: -40°C to +100°C.

Storage Temperature: -40°C to +100°C.

Shipping Weight: 1.0 pounds (0.5kg) packaged.

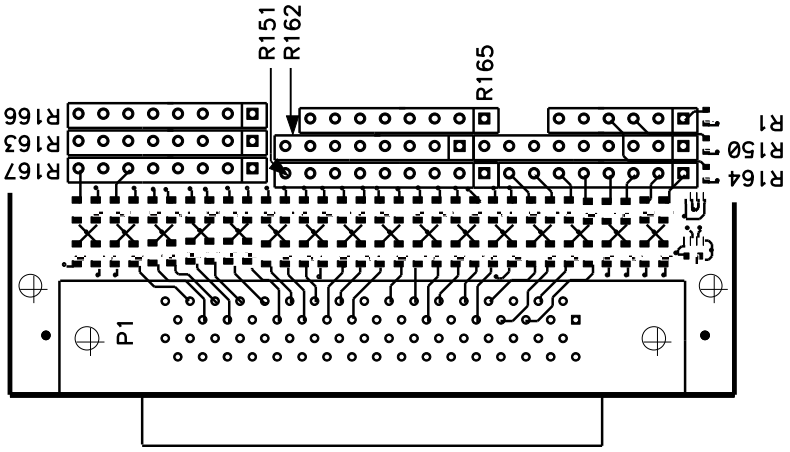

SYNCHRONOUS SRAM
256K X 36
FLASH
CONFIGURATION MEMORY
2M X 8-BIT
CPLD
CONFIGURATION
CONTROL LOGIC
PCI BUS
INTERFACE
32-BIT
66 MHz
VIRTEX II FPGA
SRAM INTERFACE
LOGIC
DIGITAL INPUT
OUTPUT INTERRUPT
LOGIC
VIRTEX II
DIGITAL CLOCK
MANAGER
PCI9056 LOCAL BUS
INTERFACE LOGIC
LOCAL BUS
PCI9056
MASTER / SLAVE
PCI BUS INTERFACE
CHIP
CONTROL LOGIC
DMA CH 0 AND 1
INTERRUPT LOGIC
SERIAL EEPROM
CHANNEL 39
DIRECTION CONTROL
CHANNEL 39
CHANNEL 16
DIRECTION CONTROL
CHANNEL 16
CHANNEL 14 &15
DIRECTION CONTROL
CHANNEL 15
CHANNEL 0 & 1
DIRECTION CONTROL
CHANNEL 0
SERIAL EEPROM
PCI9056
CONFIGURATION
BLOCK DIAGRAM
4501-988
USER0 (PCI9056 USER CONTROL SIGNAL)
SOCKETED
120
R167
SOCKETED
120
R162
+5V
4.7K
R151
SOCKETED
DIGITAL I/O (8 TO 15)
+5V
4.7K
R150
SOCKETED
DIGITAL I/O (0 TO 7)
+3.3V
10K
FPGA CLOCK
SRAM CLOCK
CPLD CLOCK
PCI9056
LOCAL BUS
CLOCK
LOW SKEW
CLOCK DRIVERS
CLOCK
MULTIPLEXER
1
0
I/O
INTERFACE
P2
24
DIFFERENTIAL
INPUT/OUTPUT
CHANNELS
16
DIGITAL TTL
INPUT/OUTPUT
CHANNELS
CRYSTAL
33MHZ
VIRTEX II DCM
GENERATED CLOCK

RESISTOR LOCATIONS



PMC DX503/DX2003

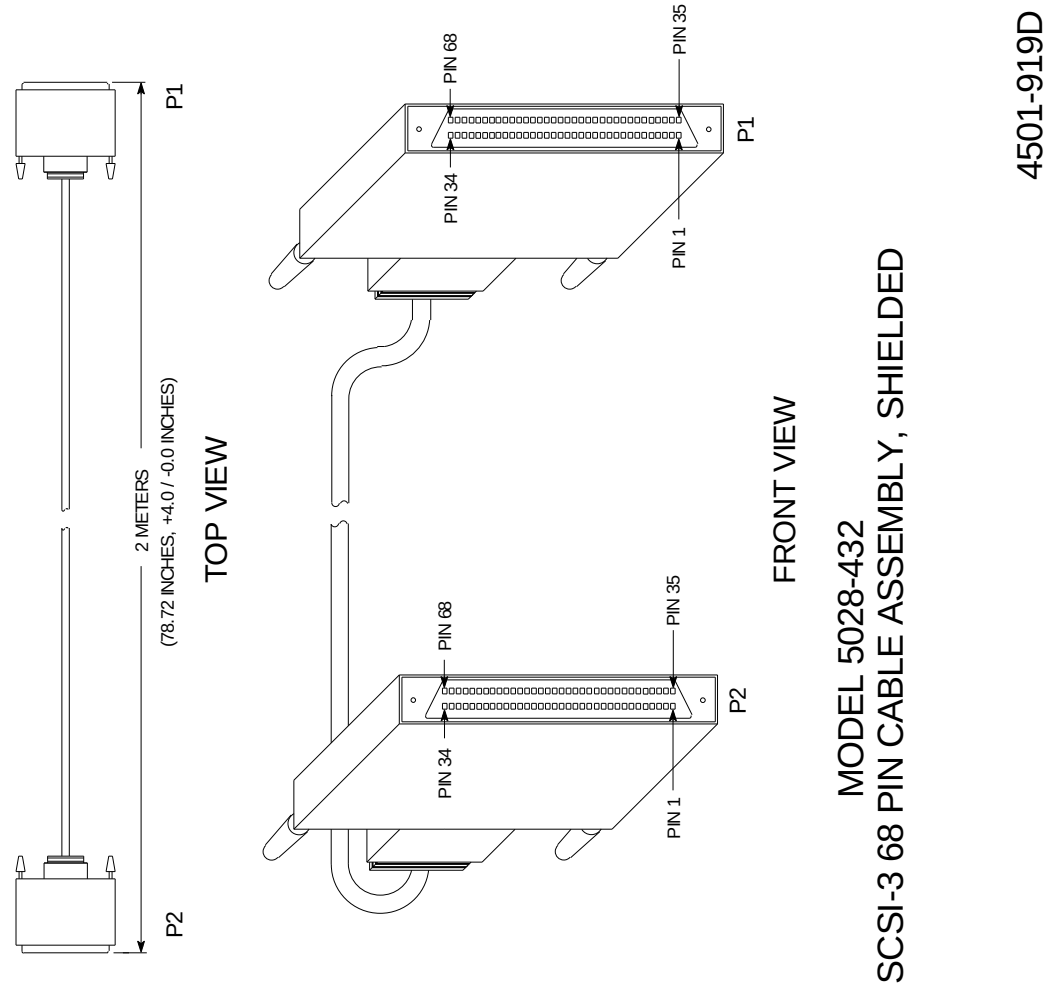
REAR

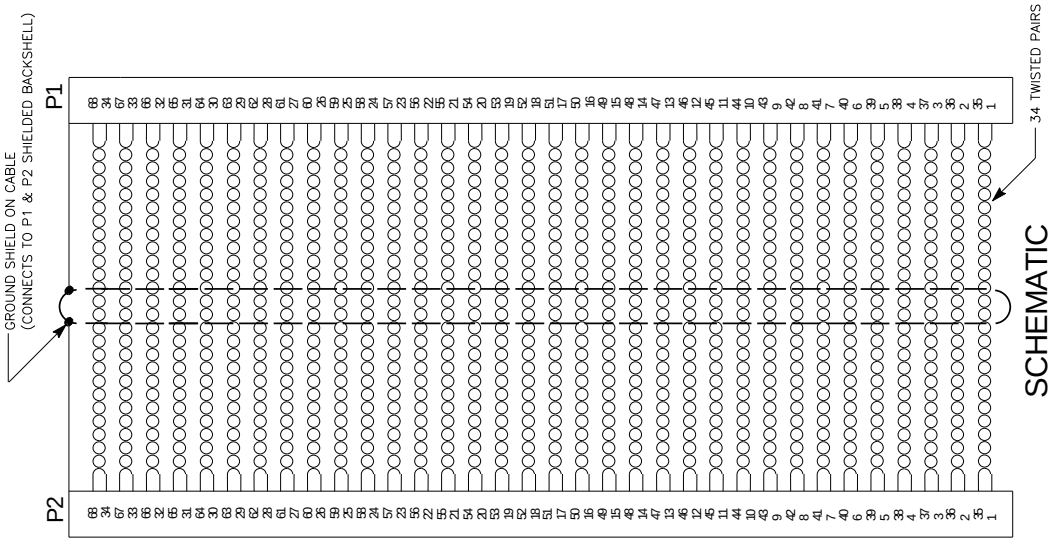


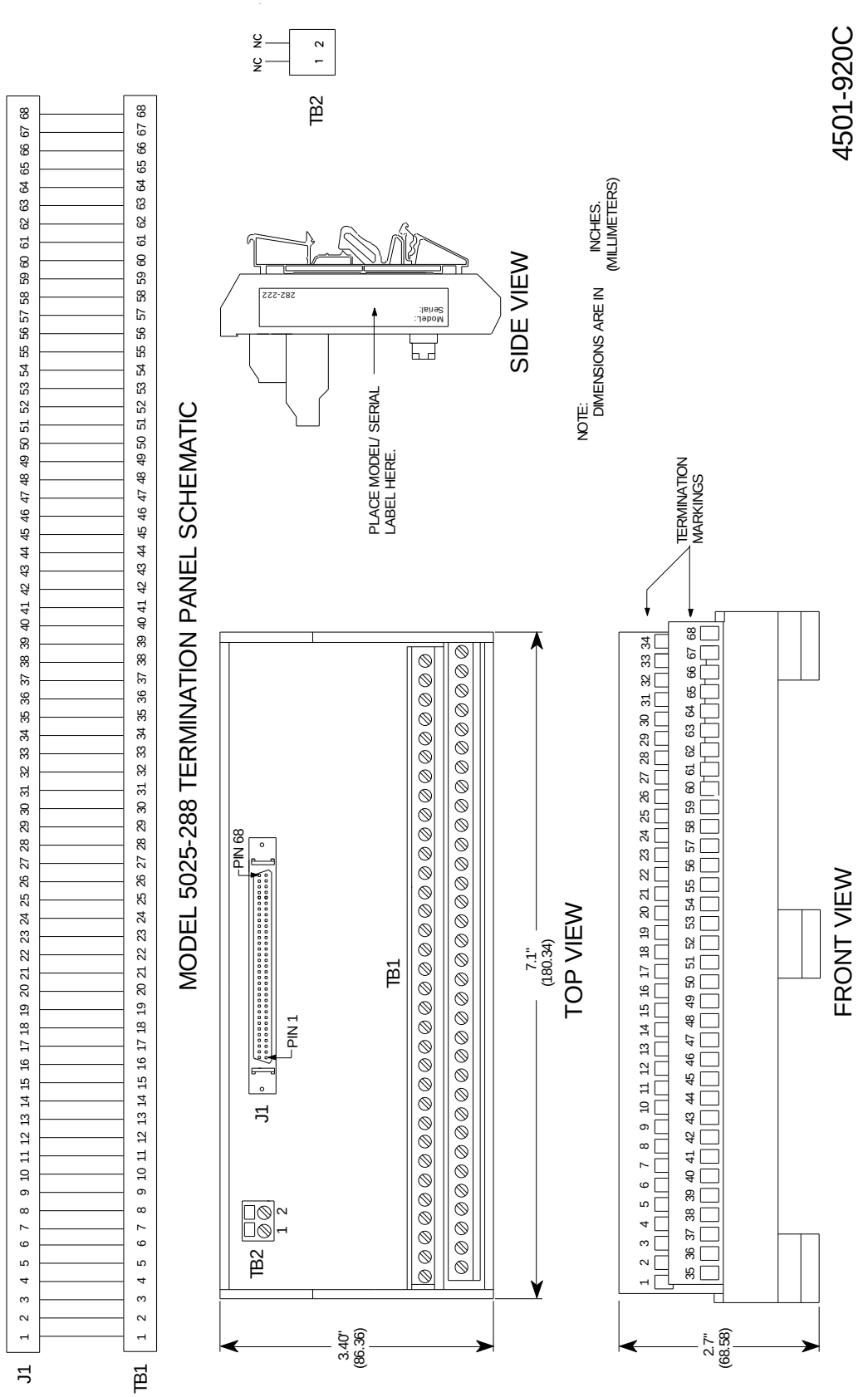
PMC DX503/DX2003

FRONT

4502-039


4501-919D
MODEL 5028-432
SCSI-3 68 PIN CABLE ASSEMBLY, SHIELDED
TOP VIEW
FRONT VIEW
P1
P2
2 METERS
(78.72 INCHES, +4.0 / -0.0 INCHES)
PIN 68
PIN 35
PIN 34
PIN 1


SCHEMATIC
P1
P2
GROUND SHIELD ON CABLE
(CONNECTS TO P1 & P2 SHIELDED BACKSHELL)
34 TWISTED PAIRS


MODEL 5025-288 TERMINATION PANEL SCHEMATIC
J1
TB1
TB2
NC NC
1 2
SIDE VIEW
PLACE MODEL/ SERIAL LABEL HERE.
Model:
Serial:
282-222
NOTE:
DIMENSIONS ARE IN INCHES.
(MILLIMETERS)
4501-920C
TOP VIEW
PIN 68
PIN 1
7.1"
(180.34)
3.40"
(86.36)
TERMINATION MARKINGS
FRONT VIEW
2.7"
(68.58)