



DIAMOND SYSTEMS CORPORATION

GPIO-MM-21 User Manual

FPGA-based PC/104 Digital I/O Module

User Manual v1.01



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General Description

Overview

The GPIO-MM-21 is a PC/104 board featuring 96 Digital I/O (DIO) lines. The DIO function is implemented in FPGA cores, emulating quad 82C55A PPI chips.

Two 50-pin I/O header provide for external DIO connections. Direction on all ports is selected by programming control registers in the FPGA. All I/O lines are buffered with transceivers, whose directions are controlled by logic that responds to the direction control values written to the registers. Each line is capable of sinking 64mA in a logic low state or sourcing 15mA in a logic high state. The board requires only +5V for operation.

DIO headers are organized to allow direct interfacing to OPTO-22s isolated I/O racks, including the G4 series, the PB16-H, -J, -K, -L, PB8H, and the PB24HQ. These racks and I/O modules allow up to 3000 VRMS isolation between the computer and the user's signals. All control signals, power, and ground on the DIO header match the corresponding signals on these I/O racks, so a single 50-pin ribbon cable, such as Diamond Systems' C50-18, is all that is needed to make the connection.

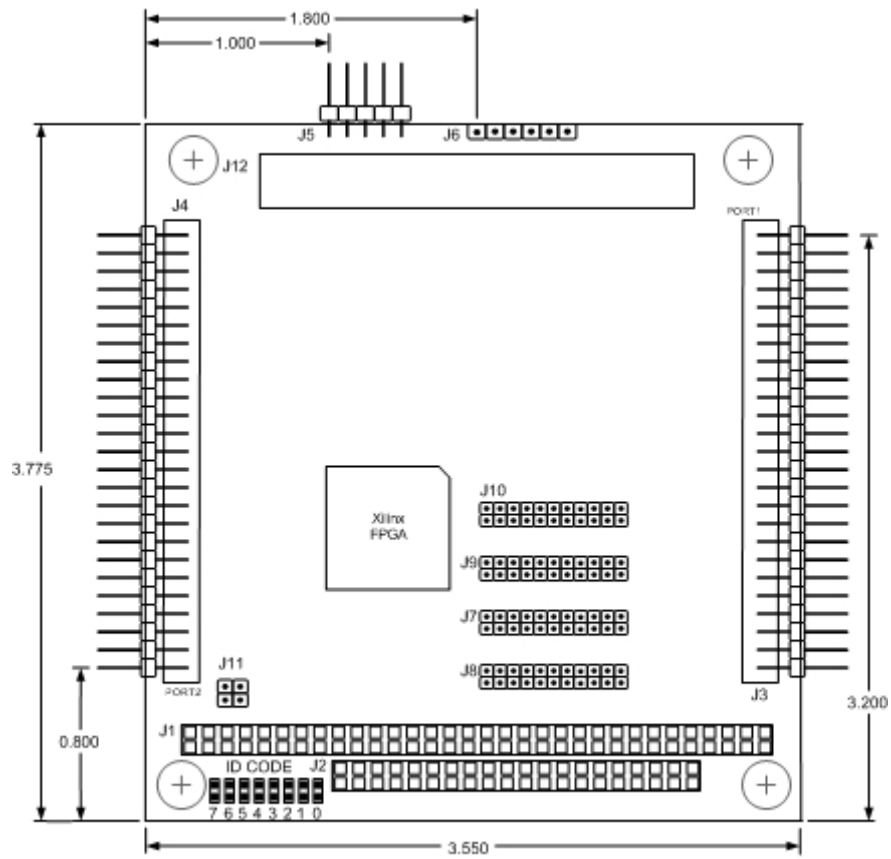
Digital I/O Features

- Quad 82C55A Parallel Peripheral Interfaces (PPI) logic implemented in FPGA cores.
- Each 82C55A has three 8-bit I/O ports for a total of 96 DIO lines, which connect to two 50-pin headers for external connections.
- Port direction and operation is selected through software programmable control registers.
- All lines are buffered with transceivers.

Board Layout

Board Drawing

Figure 1: GPIO-MM-21 Board Layout



I/O Connector Pinout

Digital I/O Header Pinout

Connectors J3 and J4 provide 50-pin general-purpose DIO interfaces. The connectors connect directly to the FPGA, which implements the functionality of four 82C55A PPI chips. This gives a total of 96 bidirectional DIO lines.

The J3 and J4 pins can be configured to pull-up to +5V or pull-down to ground using jumper J11, as described in Section 4, Board Configuration, Line Pull-up/pull-down Selection.

The following table shows the 82C55A port arrangement. Ports 1 and 2 are on connector J4 and ports 3 and 4 are on connector J3.

<i>J4</i>			<i>J3</i>				
Port 1A7	1	2	Port 2A7	1	2	Port 4A7	
Port 1A6	3	4	Port 2A6	3	4	Port 4A6	
Port 1A5	5	6	Port 2A5	5	6	Port 4A5	
Port 1A4	7	8	Port 2A4	7	8	Port 4A4	
Port 1A3	9	10	Port 2A3	9	10	Port 4A3	
Port 1A2	11	12	Port 2A2	11	12	Port 4A2	
Port 1A1	13	14	Port 2A1	13	14	Port 4A1	
Port 1A0	15	16	Port 2A0	15	16	Port 4A0	
Port 1B7	17	18	Port 2B7	17	18	Port 4B7	
Port 1B6	19	20	Port 2B6	19	20	Port 4B6	
Port 1B5	21	22	Port 2B5	21	22	Port 4B5	
Port 1B4	23	24	Port 2B4	23	24	Port 4B4	
Port 1B3	25	26	Port 2B3	25	26	Port 4B3	
Port 1B2	27	28	Port 2B2	27	28	Port 4B2	
Port 1B1	29	30	Port 2B1	29	30	Port 4B1	
Port 1B0	31	32	Port 2B0	31	32	Port 4B0	
Port 1C7	33	34	Port 2C7	33	34	Port 4C7	
Port 1C6	35	36	Port 2C6	35	36	Port 4C6	
Port 1C5	37	38	Port 2C5	37	38	Port 4C5	
Port 1C4	39	40	Port 2C4	39	40	Port 4C4	
Port 1C3	41	42	Port 2C3	41	42	Port 4C3	
Port 1C2	43	44	Port 2C2	43	44	Port 4C2	
Port 1C1	45	46	Port 2C1	45	46	Port 4C1	
Port 1C0	47	48	Port 2C0	47	48	Port 4C0	
+5V	49	50	Ground	+5V	49	50	Ground

NOTE: The connector is labeled “Port 2,” which should not be confused with DIO ports A, B and C.

<i>Signal</i>	<i>Description</i>
Port 1A0-Port 1A7	8255-1 Port A, bits 0-7
Port 1B0-Port 1B7	8255-1 Port B, bits 0-7
Port 1C0-Port 1C7	8255-1 Port C, bits 0-7
Port 2A0-Port 2A7	8255-2 Port A, bits 0-7
Port 2B0-Port 2B7	8255-2 Port B, bits 0-7
Port 2C0-Port 2C7	8255-2 Port C, bits 0-7
Port 3A0-Port 3A7	8255-3 Port A, bits 0-7
Port 3B0-Port 3B7	8255-3 Port B, bits 0-7
Port 3C0-Port 3C7	8255-3 Port C, bits 0-7
Port 4A0-Port 4A7	8255-4 Port A, bits 0-7
Port 4B0-Port 4B7	8255-4 Port B, bits 0-7
Port 4C0-Port 4C7	8255-4 Port C, bits 0-7
+5V	+5 volt DC from the PC/104 bus.
Ground	Digital ground from the PC/104 bus.

Auxiliary I/O Header Pinout

The auxiliary I/O header (J5) is provided for bidirectional, TTL-level, general-purpose I/O.

1	AUXIO_0
2	AUXIO_1
3	AUXIO_2
4	AUXIO_3
5	GND

<i>Card Voltage Type</i>	<i>Pin Configuration</i>
AUXIO_0-AUXIO_3	Four bidirectional, TTL-level, general-purpose I/O signals.
GND	Ground

Board Configuration

Base Address Selection

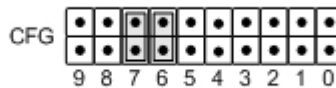
Jumper J10, positions 4-9, is used to configure the base address of all four 8255 registers (The 8255 register map occupies 16 bytes of I/O address space, as described in Section 5, I/O Map).

Jumper the locations as shown in the table to set the 8255 base addresses.

<i>I/O Address</i>	<i>Jumper Position</i>					
	<i>9</i>	<i>8</i>	<i>7</i>	<i>6</i>	<i>5</i>	<i>4</i>
0220h	Out	In	In	In	Out	In
0240h	Out	In	In	Out	In	In
0250h	Out	In	In	Out	In	Out
0260h	Out	In	In	Out	Out	In
0280h	Out	In	Out	In	In	In
0290h	Out	In	Out	In	In	Out
02A0h	Out	In	Out	In	Out	In
02B0h	Out	In	Out	In	Out	Out
02C0h	Out	In	Out	Out	In	In
02D0h	Out	In	Out	Out	In	Out
02E0h	Out	In	Out	Out	Out	In
0300h	Out	Out	In	In	In	In
0330h	Out	Out	In	In	Out	Out
0340h	Out	Out	In	Out	In	In
0350h	Out	Out	In	Out	In	Out
0360h	Out	Out	In	Out	Out	In
0380h	Out	Out	Out	In	In	In
0390h	Out	Out	Out	In	In	Out
03A0h	Out	Out	Out	In	Out	In
03C0h	Out	Out	Out	Out	In	In
03E0h	Out	Out	Out	Out	Out	In

The following example selects an 8255 base address of 0330h.

Figure 2: Set 8255 Base Address to 0330h



I/O Map

Sixteen registers are used for DIO programming, as shown in the following table. The offsets shown in the table are from the base address set using jumper J10, as described in the Board Configuration section.

<i>Offset</i>	<i>Description</i>
00h	8255-1 port A DIO register
01h	8255-1 port B DIO register
02h	8255-1 port C DIO register
03h	8255-1 control and status register
04h	8255-2 port A DIO register
05h	8255-2 port B DIO register
06h	8255-2 port C DIO register
07h	8255-2 control and status register
08h	8255-3 port A DIO register
09h	8255-3 port B DIO register
0Ah	8255-3 port C DIO register
0Bh	8255-3 control and status register
0Ch	8255-4 port A DIO register
0Dh	8255-4 port B DIO register
0Eh	8255-4 port C DIO register
0Fh	8255-4 control and status register

Register Bit Descriptions

Refer to the I/O Map section for the DIO register set list.

8255 Data Registers

DIO Base+00h (8255-1 Port A)
DIO Base+04h (8255-2 Port A)
DIO Base+08h (8255-3 Port A)
DIO Base+0Ch (8255-4 Port A)

DIO Base+01h (8255-1 Port B)
DIO Base+05h (8255-2 Port B)
DIO Base+09h (8255-3 Port B)
DIO Base+0Dh (8255-4 Port B)

DIO Base+02h (8255-1 Port C)
DIO Base+06h (8255-2 Port C)
DIO Base+0Ah (8255-3 Port C)
DIO Base+0Eh (8255-4 Port C)

Bit:	7	6	5	4	3	2	1	0
Name:	DATA							

DATA 8-bit parallel data. On reset, the port is set to input mode and the port is held at a logic level 1 until the reset signal is removed. The port remains in input mode until changed using the control register. Following a reset, all lines are set to input mode.

8255 Control and Status Registers (Basic Mode Definition – MSFLAG=1)

DIO Base+03h (8255-1)

DIO Base+07h (8255-2)

DIO Base+0Bh (8255-3)

DIO Base+0Fh (8255-4)

Bit:	7	6	5	4	3	2	1	0
Name:	MSFLAG	MSELA		PADIR	PCUDIR	MSELB	PBDIR	PCLDIR

PCLDIR Port C (lower) direction. Sets the direction of the port C I/O signals 0-3.

0 = output

1 = input ◀ (Reset value)

PBDIR Port B direction. Sets the direction of the port B I/O signals.

0 = output

1 = input ◀ (Reset value)

MSELB Group B mode selection. Sets the mode of operation for the group B signals.

0 = mode 0 ◀ (Reset value)

1 = mode 1

NOTE: 1. Only mode 0 is currently implemented.

2. All output registers are reset when the mode is changed.

PCUDIR Port C (upper) direction. Sets the direction of the port C I/O signals 4-7.

0 = output

1 = input ◀ (Reset value)

PADIR Port A direction. Sets the direction of the port A I/O signals.

0 = output

1 = input ◀ (Reset value)

MSELA Group A mode selection. Sets the mode of operation for the group B signals.

00h = mode 0 ◀ (Reset value)

01h = mode 1

1xh = mode

NOTE: 1. Only mode 0 is currently implemented.

2. All output registers are reset when the mode is changed.

MSFLAG Mode set flag. Selects the port configuration mode.

0 = Bit set/reset control register mode

When MSFLAG is reset, this register is used to set/reset individual Port C bits.

1 = Basic mode definition control register mode ◀ (Reset value)

When MSFLAG is set, this register is used for direction and mode selection.

NOTE: When the control word is read, the value of MSFLAG is always 1, implying basic control word information is being read.

8255 Control and Status Registers (Bit SET/RESET Mode – MSFLAG=0)

DIO Base+03h (8255-1)

DIO Base+07h (8255-2)

DIO Base+0Bh (8255-3)

DIO Base+0Fh (8255-4)

Bit:	7	6	5	4	3	2	1	0
Name:	MSFLAG	-			BSEL			SET

SET Bit set/reset individual command.

0 = reset

1 = set

BSEL Port C bit select.

0 = bit 0

1 = bit 1

2 = bit 2

3 = bit 3

4 = bit 4

5 = bit 5

6 = bit 6

7 = bit 7

MSFLAG Mode set flag. Selects the port configuration mode.

0 = Bit set/reset control register mode

When MSFLAG is reset, this register is used to set/reset individual Port C Bits.

1 = Basic mode definition control register mode

When MSFLAG is set, this register is used for direction and mode selection.

NOTE: When the control word is read, the value of MSFLAG is always 1, implying basic control word information is being read.

Programming Digital I/O

Overview

GPIO-MM-21 provides 96 DIO lines using an FPGA core implementation of four 8255 devices (8255-1, 8255-2, 8255-3 and 8255-4). The 96 programmable I/O lines are buffered for enhanced output current. All I/O lines contain jumper-selectable 10K Ω pull-up/pull-down resistors.

96-bit Programmable Direction (8255)

Operation of the 8255 FPGA core should be as described in the 8255 PPI datasheet. Refer to the 8255 datasheet, Additional Information, for detailed register and programming information.

The 8255 has three parallel I/O ports. Ports A and B are 8-bit bi-directional I/O ports. Port C is divided into two 4-bit bi-directional I/O ports. For programming, the ports are arranged into two groups, as shown below.

<i>Port Group</i>	<i>Description</i>
A	8 bits of Port A and upper 4 bits (4-7) of port C.
B	8 bits of Port B and lower 4 bits (0-3) of port C.

NOTE: The port groups can be separately configured for different operating modes. However, GPIO-MM-21 only implements operating mode 0, which provides simple, bidirectional I/O without handshaking.

Port C bits may be individually set and reset by setting the MSFLAG in the 8255 Control and Status Register and programming the remaining register bits for the desired bit state.

Setting the 8255 Control and Status Register to the following values gives 16 possible I/O configurations.

<i>Status and Control Register Bits</i>				<i>Group A</i>		<i>Group B</i>	
PADIR	PCUDIR	PBDIR	PCLDIR	Port A	Port C (upper)	Port B	Port C (lower)
0	0	0	0	Output	Output	Output	Output
0	0	0	1	Output	Output	Output	Input
0	0	1	0	Output	Output	Input	Output
0	0	1	1	Output	Output	Input	Input
0	1	0	0	Output	Input	Output	Output
0	1	0	1	Output	Input	Output	Input
0	1	1	0	Output	Input	Input	Output
0	1	1	1	Output	Input	Input	Input
1	0	0	0	Input	Output	Output	Output
1	0	0	1	Input	Output	Output	Input
1	0	1	0	Input	Output	Input	Output
1	0	1	1	Input	Output	Input	Input
1	1	0	0	Input	Input	Output	Output
1	1	0	1	Input	Input	Output	Input
1	1	1	0	Input	Input	Input	Output
1	1	1	1	Input	Input	Input	Input

Specifications

General Specifications

- Base FPGA: Xilinx Spartan II, 200,000 gates, 40K RAM bits
- Input clock: 40MHz
- FPGA code storage: Flash memory, field upgradeable via JTAG
- ID indicator: 8-bit LED display indicates FPGA code personality; field upgradeable via JTAG
- Programmable I/O: 96, using 2 82C55A cores
- Output current, buffered I/O: Logic 0: 64mA max per line buffered I/O; Logic 1: -15mA max per line
- Dimensions: 3.55" x 3.775", PC/104 form factor
- PC/104 bus: 16-bit stackthrough ISA bus
- Power supply: +5VDC \pm 5%
- Operating temperature: -40° to +85° C
- Weight: 2.2oz

Additional Information

Datasheets

Datasheets provide programming reference information for the DIO functions.

1. [82C55A CMOS Programmable Peripheral Interface](#), Harris Semiconductor, March 1997

Technical Support

For technical support, please email support@diamondsystems.com or contact Diamond Systems Corporation technical support at 1-650-810-2500.