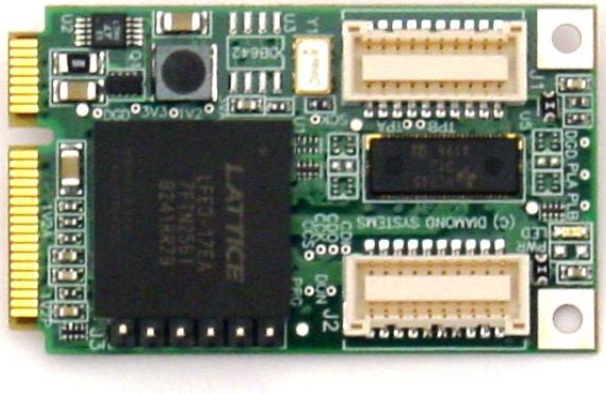
DS-MPE-GPIO

PCIe MiniCard Digital I/O Module with FPGA

Rev A.1 June 2015



Revision	Date	Comment
A.0	8/27/2014	Initial release
A.1	6/17/15	Corrected pin out information

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1. IMPORTANT SAFE HANDLING INFORMATION

WARNING!

ESD-Sensitive Electronic Equipment

Observe ESD-safe handling procedures when working with this product.

Always use this product in a properly grounded work area and wear appropriate ESD-preventive clothing and/or accessories.

Always store this product in ESD-protective packaging when not in use.

Safe Handling Precautions

This board contains a high density connector with many connections to sensitive electronic components. This creates many opportunities for accidental damage during handling, installation and connection to other equipment. The list here describes common causes of failure found on boards returned to Diamond Systems for repair. This information is provided as a source of advice to help you prevent damaging your Diamond (or any vendor's) embedded computer boards.

ESD damage – This type of damage is usually almost impossible to detect, because there is no visual sign of failure or damage. The symptom is that the board eventually simply stops working, because some component becomes defective. Usually the failure can be identified and the chip can be replaced. To prevent ESD damage, always follow proper ESD-prevention practices when handling computer boards.

Damage during handling or storage – On some boards we have noticed physical damage from mishandling. A common observation is that a screwdriver slipped while installing the board, causing a gouge in the PCB surface and cutting signal traces or damaging components.

Another common observation is damaged board corners, indicating the board was dropped. This may or may not cause damage to the circuitry, depending on what is near the corner. Most of our boards are designed with at least 25 mils clearance between the board edge and any component pad, and ground / power planes are at least 20 mils from the edge to avoid possible shorting from this type of damage. However these design rules are not sufficient to prevent damage in all situations.

A third cause of failure is when a metal screwdriver tip slips, or a screw drops onto the board while it is powered on, causing a short between a power pin and a signal pin on a component. This can cause overvoltage / power supply problems described below. To avoid this type of failure, only perform assembly operations when the system is powered off.

Sometimes boards are stored in racks with slots that grip the edge of the board. This is a common practice for board manufacturers. However our boards are generally very dense, and if the board has components very close to the board edge, they can be damaged or even knocked off the board when the board tilts back in the rack. Diamond recommends that all our boards be stored only in individual ESD-safe packaging. If multiple boards are stored together, they should be contained in bins with dividers between boards. Do not pile boards on top of each other or cram too many boards into a small location. This can cause damage to connector pins or fragile components.

Power supply wired backwards – Our power supplies and boards are not designed to withstand a reverse power supply connection. This will destroy each IC that is connected to the power supply (i.e. almost all ICs). In this case the board will most likely will be unrepairable and must be replaced. A chip destroyed by reverse power or by excessive power will often have a visible hole on the top or show some deformation on the top surface due to vaporization inside the package. **Check twice before applying power!**

Overvoltage on digital I/O line – If a digital I/O signal is connected to a voltage above the maximum specified voltage, the digital circuitry can be damaged. On most of our boards the acceptable range of voltages connected to digital I/O signals is 0-5V, and they can withstand about 0.5V beyond that (-0.5 to 5.5V) before being damaged. However logic signals at 12V and even 24V are common, and if one of these is connected to a 5V logic chip, the chip will be damaged, and the damage could even extend past that chip to others in the circuit

2. INTRODUCTION

2.1 Description

The DS-MPE-GPIO is a rugged, low cost 36-channel digital I/O PCIe MiniCard module that is ideal for digital I/O expansion in embedded and OEM applications. An FPGA provides 36 buffered digital I/O lines that can be configured to operate in simple I/O mode in the form of 8-bit and 4-bit ports, or in counter/timer and pulse width modulator modes. Two ports are fixed digital I/O ports with programmable direction in 8-bit groups. One port can operate as either a 4-bit DIO or 4 counter/timers with 1 input and 1 output per counter. One port can operate as either 8 DIO or up to 4 pulse width modulators.

2.2 Features

- 36 buffered digital I/O lines
- Configurable for up to 4 24-bit pulse width modulators
- Configurable for 4 programmable counter/timers
- 32245 transceivers for high current output
- Software programmable pull-up/pull-down

2.3 Software Support

- Linux 2.6.16, 2.6.27, 2.6.31, and 2.6.32
- Windows Embedded Standard 7, XP, CE
- Universal Driver support for all functions

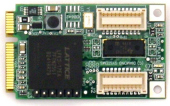
2.4 Mechanical, Electrical, Environmental

- PCIe MiniCard full size format
- Dimensions: 50.95mm x 30mm (2” x 1.18”)
- -40°C to +85°C ambient operating temperature
- Power input requirements: +3.3VDC +/- 5%

3. PACKING LIST

The DS-MPE-GPIO product comes with the PCIe MiniCard hardware assembly, a cable kit with two digital I/O cables, and a hardware kit containing mounting screws.

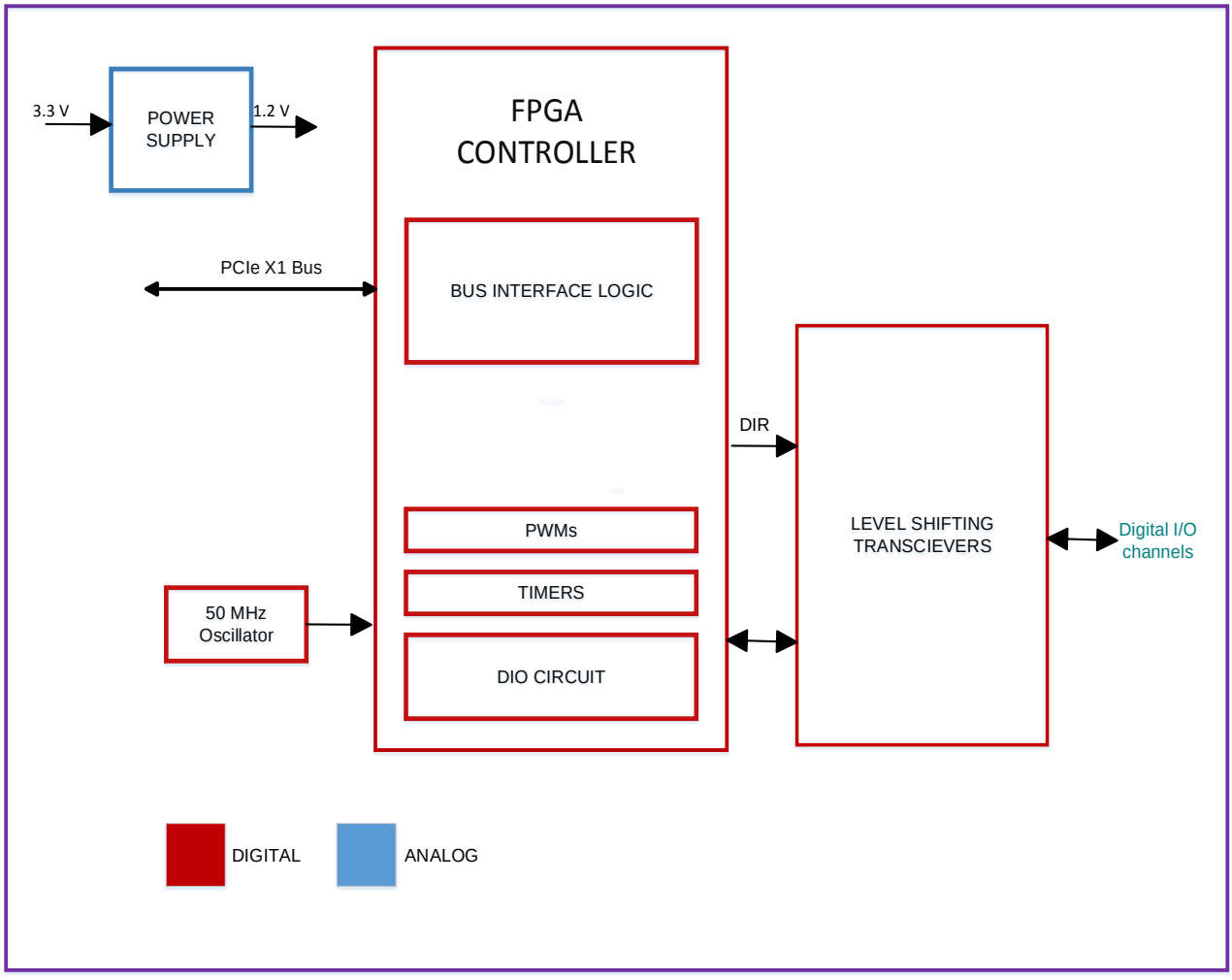
Quantity	Part Number	Description
1	9150480	DS-MPE-GPIO hardware assembly
1	6800502	Hardware Kit with mounting screws
1	CK-DAQ02	Cable Kit with two digital I/O cables



4. FUNCTIONAL OVERVIEW

4.1 Functional Block Diagram

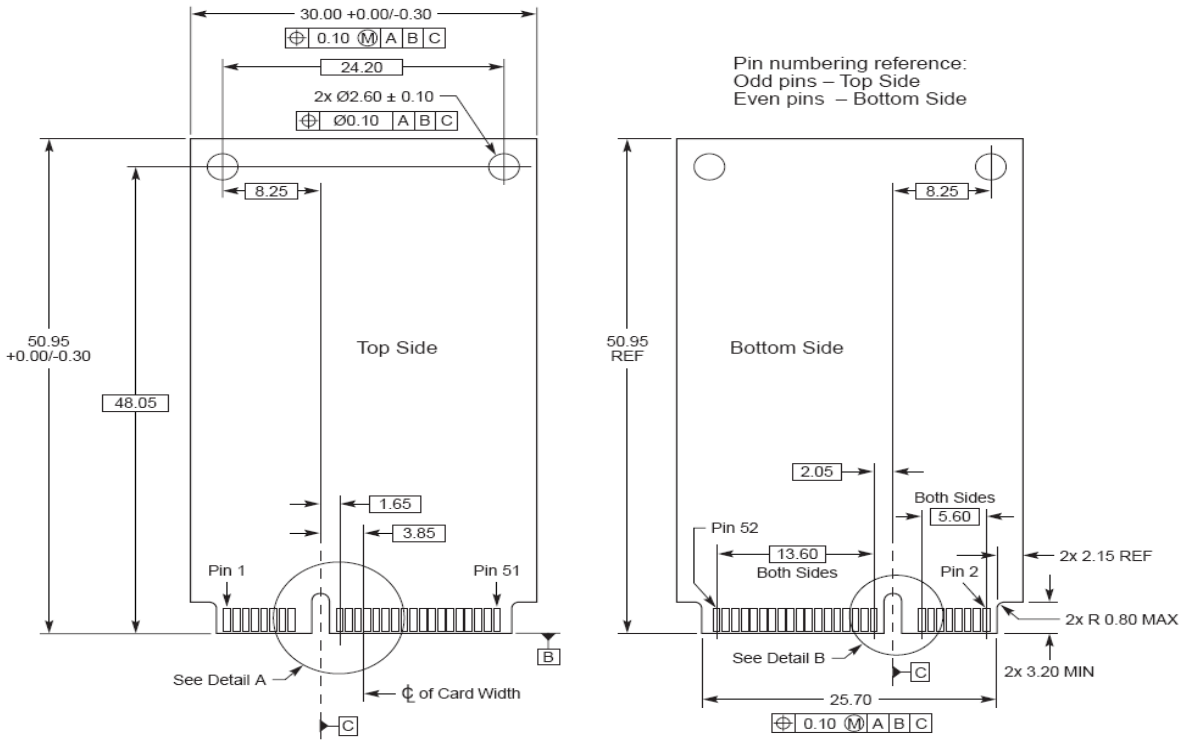
The DS-MPE-GPIO block diagram is shown below.



4.2 Mechanical Board Drawing

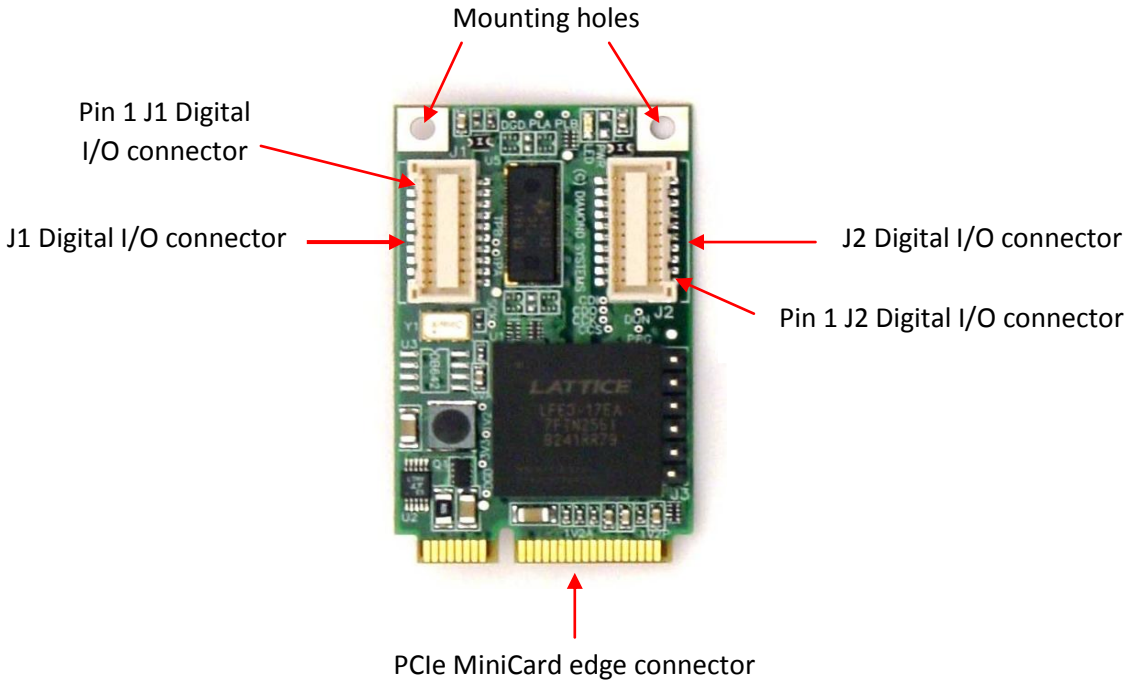
The DS-MPE-GPIO conforms to the PCIe MiniCard electromechanical specification revision 1.2, full size format. Overall dimensions are 50.95mm L x 30.00mm W.

The two mounting holes are isolated from the CPU ground and not connected to any ground lines.



5. INSTALLATION

The DS-MPE-GPIO plugs in to any socket meeting the PCIe MiniCard specifications. It has two connectors for the various digital I/O lines and a pair of mounting holes. To install the DS-MPE-GPIO, fully insert the board into a PCIe MiniCard connector and secure in place by inserting one screw from the hardware kit into each of the mounting holes, see the diagram below.



6. CONNECTOR PINOUT AND PIN DESCRIPTION

6.1 PCIe MiniCard Edge Connector

The DS-MPE-GPIO module is compatible with the standard Mini PCIe socket pinout as shown below.

WAKE#	1	2	**+3.3V**
COEX1	3	4	**GND**
COEX2	5	6	+1.5V
CLKREQ#	7	8	UIM_PWR
GND	9	10	UIM_DATA
REFCLK-	11	12	UIM_CLK
REFCLK+	13	14	UIM_RESET
GND	15	16	UIM_VPP
	KEY		
RSVD(UIM_C8)	17	18	**GND**
RSVD(UIM_C4)	19	20	W_DISABLE#
GND	21	22	**PERST#**
PERN	23	24	**+3.3V**
PERP	25	26	**GND**
GND	27	28	+1.5V
GND	29	30	SMB_CLK
PETN	31	32	SMB_DATA
PETP	33	34	**GND**
GND	35	36	USB-
GND	37	38	USB+
+3.3V	39	40	**GND**
+3.3V	41	42	NC
GND	43	44	NC
NC	45	46	NC
NC	47	48	+1.5V
NC	49	50	**GND**
NC	51	52	**+3.3V**

6.2 Digital I/O (J1, J2)

The digital I/O is provided on two miniature 20-pin headers with 18 lines per header plus protected +3.3V and ground.

J1

+3.3V (fused)	1	2	DIO A0
DIO A1	3	4	DIO A2
DIO A3	5	6	DIO A4
DIO A5	7	8	DIO A6
DIO A7	9	10	DIO B0
DIO B1	11	12	DIO B2
DIO B3	13	14	DIO B4
DIO B5	15	16	DIO C0 / PWM 0
PWM 1 / DIO C1	17	18	DIO C2 / PWM 2
PWM 3 / DIO C3	19	20	Ground

J2

+3.3V (fused)	1	2	DIO D0 / CTR 0 In
CTR 1 In / DIO D1	3	4	DIO D2 / CTR 2 In
CTR 3 In / DIO D3	5	6	DIO D4 / CTR 4 In
CTR 5 In / DIO D5	7	8	DIO D6 / CTR 6 In
CTR 7 In / DIO D7	9	10	DIO E0 / CTR 0 Out
CTR 1Out / DIO E1	11	12	DIO E2 / CTR 2 Out
CTR 3 Out / DIO E3	13	14	DIO E4
DIO E5	15	16	DIO F0 / CTR 4 Out
CTR 5 Out / DIO F1	17	18	DIO F2 / CTR 6 Out
CTR 7 Out / DIO F3	19	20	Ground

Connector Part Number / Description

JST B20B-GHDS-G-TF 2x10 1.25mm pitch vertical SMT latching connector

7. ARCHITECTURE OVERVIEW

7.1 Bus Interface

The FPGA utilizes a PCI Express x1 bus interface. The design includes a PCIe core to implement the PCIe interface.

7.2 FPGA

The FPGA is a Lattice Semiconductor ECP3 family (LFE3) in BGA256 package. The FPGA includes an SPI core to gain access to the FPGA configuration flash memory. This allows the FPGA code to be updated in the field without requiring a JTAG cable or 3rd party software.

7.3 Digital I/O

The 36 digital I/O lines are provided by the FPGA. They can operate in simple I/O mode in the form of 8-bit and 4-bit ports or in counter/timer and PWM modes. Two ports are fixed I/O ports with programmable direction in 8-bit groups. One port can operate as either 4 in / 4 out or 4 counter/timers with 1 in and 1 out per counter. One port can operate as either 8 I/O or up to 4 PWM.

All digital I/O lines are connected to transceivers to provide higher output current and to protect the FPGA from overvoltage or ESD. All lines have software configurable pull-up / down resistors.

7.4 Pulse Width Modulators

The FPGA includes 4 24-bit pulse-width modulator (PWM) circuits. Each circuit includes a period register as well as a duty cycle register. Both registers may be updated in real-time without stopping the PWM. Duty cycles from 0-100% inclusive are supported, as well as both positive and negative output polarity. The PWM clock may be selected from the on-board 50MHz clock or a 1MHz clock derived from the 50MHz clock. The PWM outputs are enabled on general purpose I/O pins with limited voltage and current capability. The user must determine whether these pins provide the appropriate voltage and current levels for the intended application or whether additional buffering or amplification is required.

7.5 Counter / Timers

The module can be configured to provide 8 36-bit counter/timers with programmable up/down counting, divide-by-n function, and square wave / pulse output. The counters can be latched and read while counting.

7.6 Protected Power

The I/O connectors provide +3.3V protected with polyswitch resettable fuses to limit output current to safe levels and avoid damage to the module or the host SBC.

7.7 Interrupt Circuit

Interrupts enable the board to request service independently of the program operation, typically in response to a user defined time interval or external event. The board supports interrupts from variety of sources including the digital I/O channels and counters/timers. The application is responsible for providing the interrupt service routine to respond to the interrupt request. An un-serviced interrupt request may cause unpredictable results. Diamond System' Universal Driver software includes built-in interrupt handling routines that can link to user-defined code. This software lets you define the conditions that will generate an interrupt and then define the behavior of the system when an interrupt occurs.

8. SOFTWARE DRIVER OVERVIEW

The DS-MPE-GPIO module is configured by software. The board must first be initialized, then configured. These operations can be done either using Diamond System' Universal Driver (version 7.0 or higher) or by an independent set of equivalent register operations. Please refer to the DS-MPE-GPIO Control Panel Manual and DS-MPE-GPIO Universal Driver Software User Manual for more information.

8.1 Configuring Using Universal Driver

Diamond Systems provides a device driver which will enable access to the board functionalities via an easy to use API set. This driver is called the Universal Driver and is available in Windows XP and Linux 2.6.xx operating systems. The details on the Universal driver can be found in the Universal Driver manual and can be accessed online at http://docs.diamondsystems.com/dscud/manual_Main+Page.html. The Universal Driver software comes on the Diamond Systems Resource CD shipped with this product, or may be downloaded from the DS-MPE-GPIO webpage at http://www.diamondsystems.com/products/dsmpegpio

Configuring Using Register Operations:

The board can also be controlled using simple register read/write commands if you write your own driver. In typical modern operating systems, the user level applications cannot directly access the low level system information and don't have register level access. In order to communicate with any PCI device, a device driver is required.

The Universal Driver can be also be used to do register-level control, and a programmer can develop his own driver functionality that uses simple register read/write command after performing a PCI scan using the Universal Driver. Users of this type of access need to understand the board register map. This type of approach is suitable for someone who is very aware of the nature of low-level operations of hardware.

8.1.1 Interrupt level

Interrupts are used for hardware I/O operations that are independent of normal program flow. The DS-MPE-GPIO can be set up to generate interrupts under several circumstances. The board can generate interrupts to transfer digital data into the board, as well as at regular intervals according to a programmable timer on the board. Individual control bits are used to enable each type of interrupt.

Since the DS-MPE-GPIO board works on PCI Express bus architecture, the interrupt level is obtained as a result of a PCI scan performed by the device driver. To obtain the interrupt level used by the board, Diamond provides a default device driver, WinDriver, which can perform low level PCI commands and provide user level access to the board.

If you do not wish to use this driver and would like to develop your own driver, you need to be knowledgeable on the PCI / PCI express system architecture as well as the device driver model and architecture details for your chosen operating system.

9. SPECIFICATIONS

Number of digital I/O	36 buffered
Pull-up / pull-down	Software configurable resistors
Transceivers	32245 with high current output
Output Current	+/-24mA per line
Power-on / reset	Digital I/O in input mode
Pulse Width Modulators	4 24-bit circuits configurable 0-100% duty cycle On / off control Programmable polarity
Counter / timers	4 36-bit circuits configurable Programmable
Input power	+3.3VDC +/-5%
Power consumption	100mA @ 3.3V
Software drivers	Windows Embedded Standard 7, XP, CE Linux 2.6.16, 2.6.27, 2.6.31, and 2.6.32
Universal Driver	Support for all functions
Operating temperature	-40°C to +85°C
Operating humidity	5% to 95% non-condensing
MTBF	xxx hours
Form Factor	PCIe MiniCard full size
Dimensions	50.95mm x 30mm (2” x 1.18”)
Weight	8.5g (0.3oz)
RoHS	Compliant