LPCIe-8124-C

Advanced 4CH Encoder Card
with High-Speed Triggering

User's Manual

Manual Rev. 2.00

Revision Date: Dec. 31, 2015

Part No: 50-11260-1000

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Revision History

Revision	Release Date	Description of Change(s)
2.00	Dec. 31, 2015	Initial Release

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Preface

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Take note of the following conventions used throughout this manual to make sure that users perform certain tasks and instructions properly.


NOTE:

Additional information, aids, and tips that help users perform tasks.


CAUTION:

Information to prevent ***minor*** physical injury, component damage, data loss, and/or program corruption when trying to complete a task.


WARNING:

Information to prevent ***serious*** physical injury, component damage, data loss, and/or program corruption when trying to complete a specific task.

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1 Introduction

The LPCIe-8124-C is an advanced quadrature encoder counter board featuring position comparison and high speed trigger pulse output. A state-of-the-art FPGA allows it to meet most machine maker requirements for high frequency encoder input and trigger pulse output.

The LPCIe-8124-C utilizes FPGA and FIFO to ensure that all comparison points automatically load and are compared with internal comparators, eliminating the need for software support. Trigger pulse frequency can be up to 5MHz and encoder input frequency can be up to 20MHz. Noise disturbance is prevented by a digital filter, and, pulse width ia adjustable by software. Comparator output mutually corresponds to trigger output. Trigger output pulses are counted and the result stored in the trigger counter.

The LPCIe-8124-C offers board index design supporting one unique index number in the PC system. For input and output channel, TTL (without isolation) and Open Collector (with isolation) are available, with the former meeting high frequency demands and the latter providing circuit protection.

ADLINK provides a Windows WDM driver and DLL function libraries aid application development.

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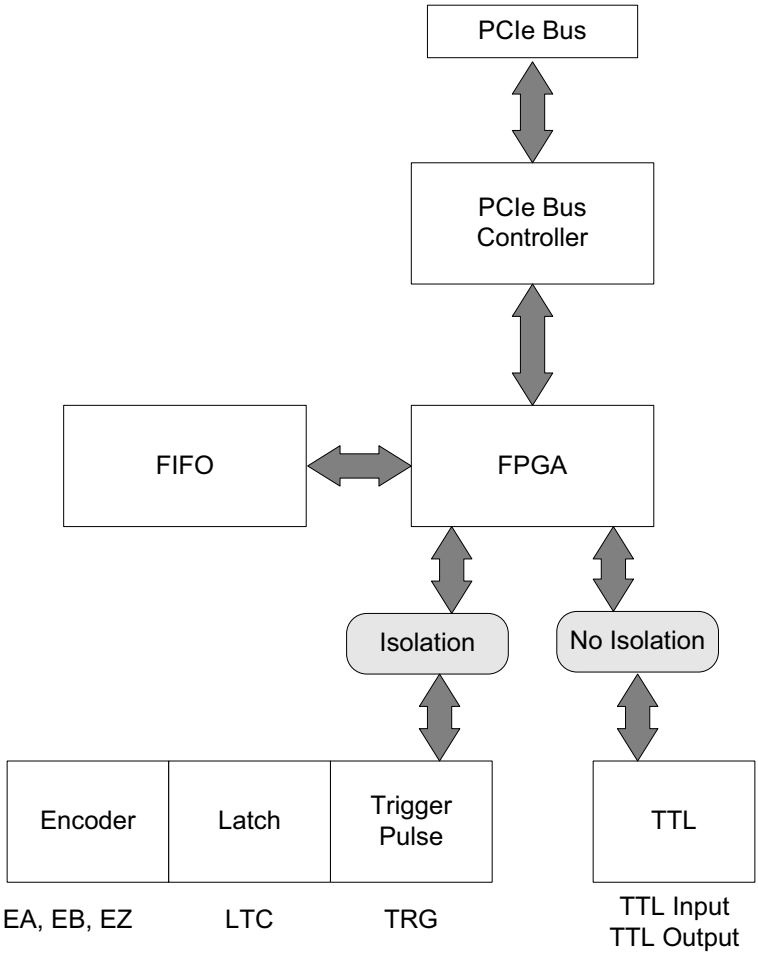


Figure 1-1: LPCIe-8124-C Block Diagram

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1.1 Features

- x1 lane PCI Express Interface
- 4-bit board ID for multiple boards in one system
- 4 differential quardrature encoder counter input channels
- Each encoder counter input pair supports 1/2/4x A/B phase, dual pulse (CW/CCW) and signed pulse (OUT/DIR)
- Internal digital filter
- 4 trigger output channels via both open collector and TTL pins
- Trigger pulse width software programmable from 0.1μs to 3.2765ms
- Trigger output channels selected from all comparators, manual trigger commands, EZ signal, and timers on demand
- 4 trigger counters determine accuracy of trigger output pulse count
- 4 comparators comparing encoder counter and FIFO data
- 10 comparators comparing encoder counter and linear data
- Encoder counter sources selected from encoder input pins or timers
- Comparator data updated by next FIFO data or linear data when encoder counter is compared and trigger is output
- 14 comparators select one of 4 trigger output channels individually
- 4 channel TTL output pins for general purpose or trigger output
- 4 channel TTL input pins for general purpose or timer start signal
- 4 channel high speed latch input pins for counters
- EZ and latch input pins can be used for general purpose input
- Latch input logic selectable by rising or falling edge
- Encoder counter clear via EZ input pin as zero operation
- Programmable interrupt sources from linear data finished,

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triggered, FIFO empty/full/low, latched, TTL input on.

- Switch setting for trigger output default level while powered on
- Trigger output pin logic programmable
- DLL and driver support for Windows 7/8.1

1.2 Specifications

Main Chip	
Vendor	Xilinx
Reference Clock	40Mhz
Encoder Counters	
Channels	4
Wiring	Dual differential pairs or single-ended pair
Input Isolated Photo-coupler	HCPL-0631
Isolated Voltage	2500 Vrms
Maximum Input Frequency	20MHz (under 4xAB mode)
Supported Modes	AB phase x1/2/4, CW/CCW, OUT/DIR
Data Length	32 bits
Digital Filter	Yes
Zero Operation	EZ input
Counter Comparators	
Comparators	14
Data Length	32-bit
Trigger Pulse Width	0.1μs to 3.2765ms programmable
Internal Timers	
Timers	4
Timer Base	400ns
Resolution	14-bit
Synchronous Start Signal	TTL input or register setting
Synchronous Stop Signal	Register setting
Trigger Output	
Channels	4
Maximum Output Frequency	5Mhz
Output	Open collector or TTL

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Open Collector Isolated Photo-coupler	HCPL-0631
Open Collector Isolated	2500 Vrms
Continuous Triggering	Timer, FIFO or linear function data reloading
Interrupt	When triggered
Trigger Counter	Yes
Comparator FIFO	
FIFO	4
FIFO Depth	1023x32bits
Interrupt	Empty/low/full (1/4,1/2,3/4)
Auto Reload	Yes, with next FIFO data to comparator when compared
Comparator Linear Function	
Linear Functions	10
Start Address Length	32 bits
Repeat Length	32 bits
Interval Length	13 bit
Direction Length	1 bit
Interrupt	When repeat counts to 0
Auto-reload	Of next linear data to comparator when compared
Latch Input	
Pins	4
Input Isolated Photo-coupler	HCPL-0631
Isolated Voltage	2500 Vrms
Bandwidth	10Mhz
Interrupt	When latched
TTL Input	
Pins	4
TTL Input Mode	General purpose or timer synchronous start signal
TTL Output	
Pins	4
TTL Output Mode	General purpose or trigger output
General Specifications	

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Connectors	50-pin SCSI
Operating Temperature	0°C to70°C
Storage Temperature	-20°C to 80°C
Humidity	5-85% non-condensing
Power Consumption	
Slot (input)	+3.3V DC, 0mA (unused)
	+12V DC +-5%, 400mA (max)
Isolation Power from PCIe Bus	+12V to isolated +5V DC
Dimensions	153(L) X 69(W) mm

1.3 Supported Software

Programming Library

ADLINK provides Windows WDM driver and DLL function library for the LPCIe-8124-C. These function libraries are shipped with the board. It supports for Windows 7/8.1.

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1.4 PCB Layout

NOTE:

All dimensions shown are in millimeters (mm).

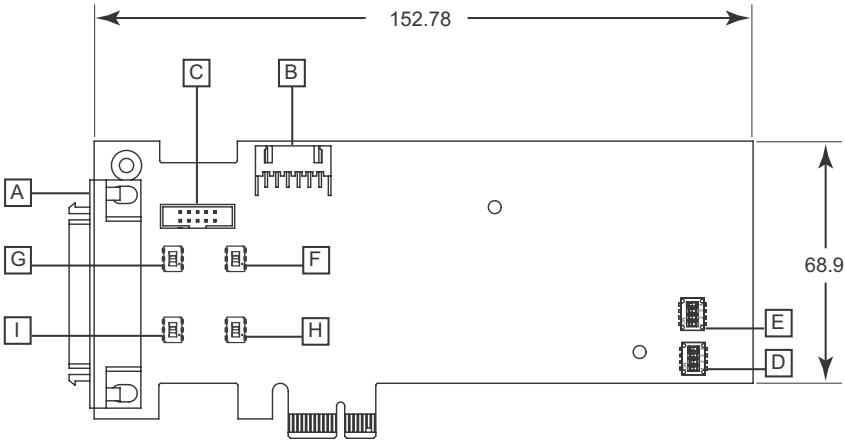


Figure 1-2: PCB Layout

A	CN1	SCSI 50-pin connector
B	CN2	TTL output
C	CN3	External power input
D	SW1	Board ID Switch 0 to 15
E	SW2	Default Trigger Level
F	TSW1	Trigger Mode Setting for TRG1
G	TSW2	Trigger Mode Setting for TRG2
H	TSW3	Trigger Mode Setting for TRG3
I	TSW4	Trigger Mode Setting for TRG4

Table 1-1: PCB Layout Legend

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1.5 CN1 Pin Assignments

CN1 is a 50-pin SCSI connector for I/O signals, with 4X Isolated Latch Inputs, 4X A-B-Z Encoder Inputs, 4X TTL level Inputs, 4X TTL level outputs and 4X Isolated Outputs.

.

#	Name	I/O	Function
1	INCOM1	-	Latch input common
2	LTC1	I	Latch input
3	INCOM2	-	Latch input common
4	LTC2	I	Latch input
5	EGND	-	Trigger output common
6	TRG1	O	Trigger output 1
7	EGND	-	Trigger output common
8	TRG2	O	Trigger output 2
9	EA1+	I	A-phase encoder (+)
10	EA1-	I	A-phase encoder (-)
11	EB1+	I	B-phase encoder (+)
12	EB1-	I	B-phase encoder (-)
13	EZ1+	I	Z-phase encoder (+)
14	EZ1-	I	Z-phase encoder (-)
15	EA2+	I	A-phase encoder (+)
16	EA2-	I	A-phase encoder (-)
17	EB2+	I	B-phase encoder (+)
18	EB2-	I	B-phase encoder (-)
19	EZ2+	I	Z-phase encoder (+)
20	EZ2-	I	Z-phase encoder (-)
21	TTL-IN1	I	TTL input signal
22	TTL-IN2	I	TTL input signal
23	TTL-OUT1	O	TTL output signal
24	TTL-OUT2	O	TTL output signal
25	DGND	-	TTL signal ground
26	INCOM3	-	Latch input common
27	LTC3	I	Latch input

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#	Name	I/O	Function
28	INCOM4	-	Latch input common
29	LTC4	I	Latch input
30	EGND	-	Trigger output common
31	TRG3	O	Trigger output 3
32	EGND	-	Trigger output common
33	TRG4	O	Trigger output 4
34	EA3+	I	A-phase encoder (+)
35	EA3-	I	A-phase encoder (-)
36	EB3+	I	B-phase encoder (+)
37	EB3-	I	B-phase encoder (-)
38	EZ3+	I	Z-phase encoder (+)
39	EZ3-	I	Z-phase encoder (-)
40	EA4+	I	A-phase encoder (+)
41	EA4-	I	A-phase encoder (-)
42	EB4+	I	B-phase encoder (+)
43	EB4-	I	B-phase encoder (-)
44	EZ4+	I	Z-phase encoder (+)
45	EZ4-	I	Z-phase encoder (-)
46	TTL-IN3	I	TTL input signal
47	TTL-IN4	I	TTL input signal
48	TTL-OUT3	O	TTL output signal
49	TTL-OUT4	O	TTL output signal
50	DGND	-	TTL signal ground

1.6 Differential Trigger Output

CH1 to CH4 triggers can be set for differential trigger output by TSW1 to TSW4. XXXX. When set for differential trigger output, CN1 pin assignment is as follows.

#	Name	I/O	Function
5	TRG1-	O	Trigger output 1-
6	TRG1+	O	Trigger output 1+

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#	Name	I/O	Function
7	TRG2-	O	Trigger output 2-
8	TRG2+	O	Trigger output 2+
30	TRG3-	O	Trigger output 3-
31	TRG3+	O	Trigger output 3+
32	TRG4-	O	Trigger output 4-
33	TRG4+	O	Trigger output 4+

Table 1-2: Differential Trigger Output Pin Assignments

1.7 CN2 TTL Output

CN2 is a 6-pin header.

#	Name	I/O	Function
1	+5V	-	+5V power supply
2	TTL-OUT1	O	TTL output signal
3	TTL-OUT2	O	TTL output signal
4	TTL-OUT3	O	TTL output signal
5	TTL-OUT4	O	TTL output signal
6	DGND	-	TTL signal ground

Table 1-3: TTL Output Pin Assignments

1.8 CN3 External Power Input

CN3 is a 10-pin header.

#	Name	I/O	Function
5	TRG1-	O	Trigger output 1-
6	TRG1+	O	Trigger output 1+
7	TRG2-	O	Trigger output 2-

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#	Name	I/O	Function
8	TRG2+	O	Trigger output 2+
30	TRG3-	O	Trigger output 3-
31	TRG3+	O	Trigger output 3+
32	TRG4-	O	Trigger output 4-
33	TRG4+	O	Trigger output 4+

Table 1-4: External Power Input Pin Assignments


NOTE:

EPWR power range is from +5V to +24V. XXXX.

1.9 Signal Connections


CAUTION:

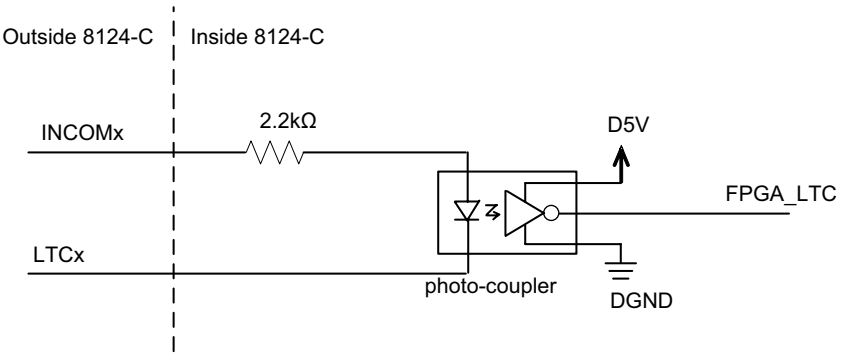
Please refer to the following before connecting the LPCIe-8124-C to an end device.

1.9.1 Isolated Input Ports (LTC, INCOM)

Each of 4 pairs of isolated input ports comprises an INCOMx terminal and an LTCx. Because the input port of the photo coupler utilized on LPCIe-8124-C is single-directional, LTC signal must be lower than INCOM signal. When there is a differential voltage between LTCx and corresponding INCOMx, the photo coupler turns on automatically. An internal resistor, as shown, removes the requirement to attach additional resistors. Forward current of the input signal is 7.5mA to 12.5mA. Typical forward voltage is 1.65V, and maximum forward voltage 1.9V. Appropriate voltage should be applied on LTCx and INCOMx.

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CN1 Pin	Name	Description
1	INCOM1	In1 Com
3	INCOM2	In2 Com
30	INCOM3	In3 Com
32	INCOM4	In4 Com
2	LTC1	Isolated Latch 1
4	LTC2	Isolated Latch 2
27	LTC3	Isolated Latch 3
29	LTC4	Isolated Latch 4



1.9.2 Isolated Encoder Differential Input

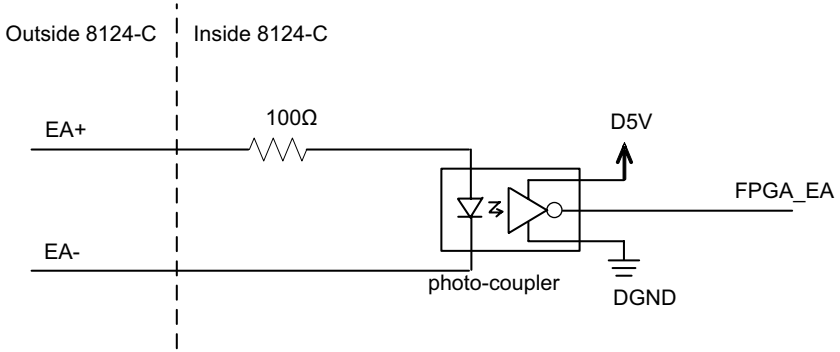
For the 4 pairs of A-B-Z encoder signal inputs, the typical forward voltage of the input diode is 1.65V and forward current of the input diode is 7.5mA to 12.5mA. An internal resistor is as shown, such that if no external resistor is connected, voltage difference between Encoder+ and Encoder- should be lower than 5VDC.

CN1 Pin	Name	Description
9, 15, 34, 40	EAn+	Isolated Encoder A +
10, 16, 35, 41	EAn-	Isolated Encoder A -
11, 17, 36, 42	EBn+	Isolated Encoder B +
12, 18, 37, 43	EBn-	Isolated Encoder B -

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CN1 Pin	Name	Description
13, 19, 38, 44	EZn+	Isolated Encoder Z +
14, 20, 39, 45	EZn-	Isolated Encoder Z -

Note: n=1, 2, 3, 4



1.9.3 Isolated Output Ports (TRG/TRG+, EGND/TRG-)

For the 4 independent isolated output ports, trigger outputs can be individually set as differential trigger outputs by switches TSW1 to TSW4.

	Signal-end Trigger Output TSWx = "S"		Differential Trigger Output TSWx = "D"	
CN1 Pin	**Name**	**Description**	**Name**	**Description**
5	EGND	Output reference	TRG1-	Trigger 1-
6	TRG1	Trigger 1	TRG1+	Trigger 1+
7	EGND	Output reference	TRG2-	Trigger 2-
8	TRG2	Trigger 2	TRG2+	Trigger 2+
30	EGND	Output reference	TRG3-	Trigger 3-
31	TRG3	Trigger 3	TRG3+	Trigger 3+

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	Signal-end Trigger Output TSWx = “S”		Differential Trigger Output TSWx = “D”	
32	EGMD	Output reference	TRG4-	Trigger 4-
33	TRG4	Trigger 4	TRG4+	Trigger 4+

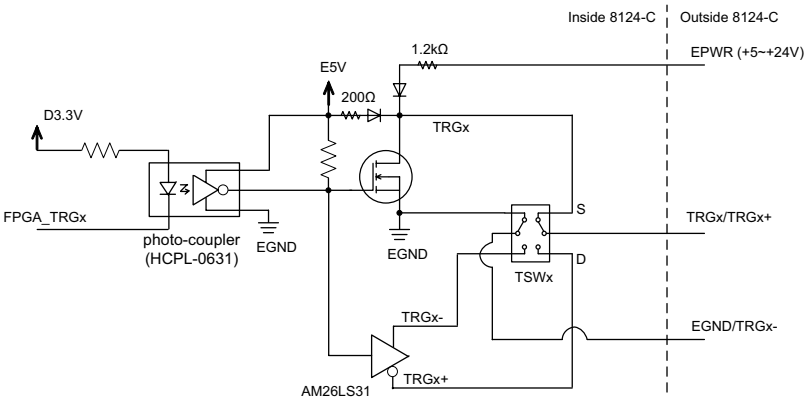


Figure 1-3: Trigger Output Circuit

Three types of connection are supported for any device. TTL/24V single-end output (TSWx = “S”), with trigger output capable of outputting TTL signal by onboard 5V power, in which external power can also be input from EPWR of CN3 and external power can be +5V~+24V, with the output current differing based on different external power (inside resister is 1.2kΩ). Also supported are Open collector output (TSWx = “S”) and differential output (TSWx = “D”), as follows.

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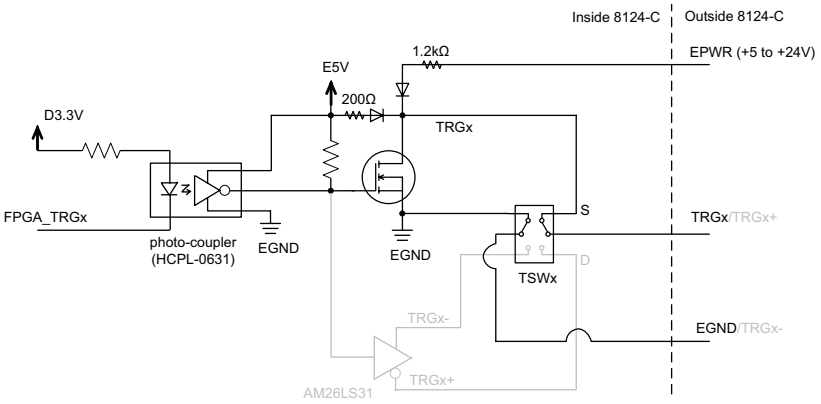


Figure 1-4: TTL/24V Single-end Output

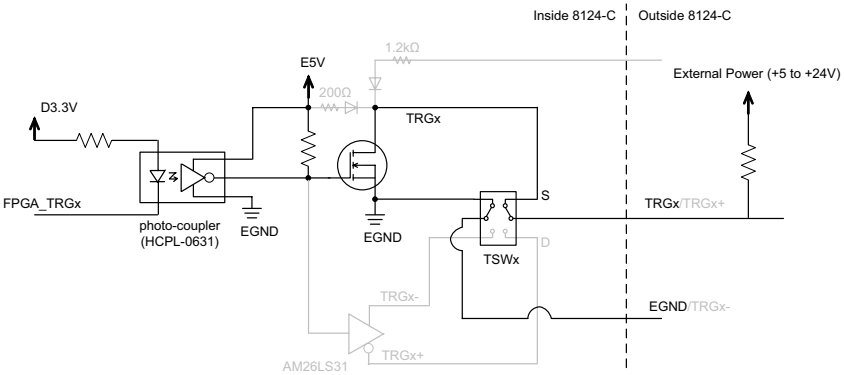


Figure 1-5: Open Collector Output

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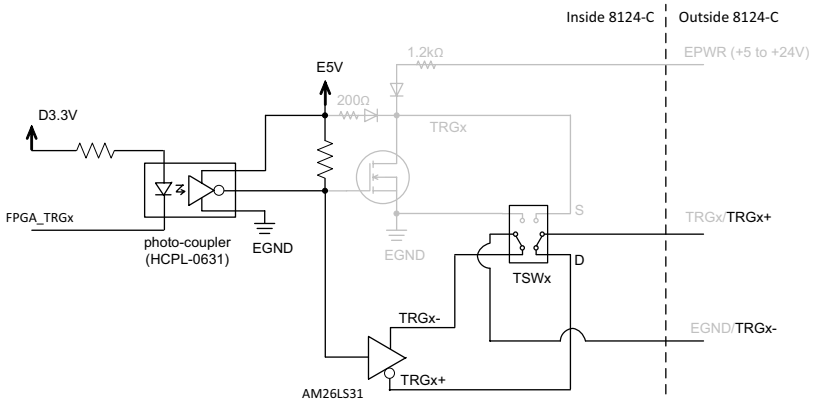


Figure 1-6: Differential Output

1.9.4 TTL Input Ports

For the 4 single-ended TTL-level input ports, maximum input voltage 4.6VDC.

CN1 Pin	Name	Description
21	TTL-IN1	TTL Level Input port 1
22	TTL-IN2	TTL Level Input port 2
46	TTL-IN3	TTL Level Input port 3
47	TTL-IN4	TTL Level Input port 4
25, 50	DGND	TTL Input reference GND

1.9.5 TTL Output Ports

For the 4 single ended TTL-level output ports, maximum output or sink current of each channel is 25mA and maximum output voltage is D5V.

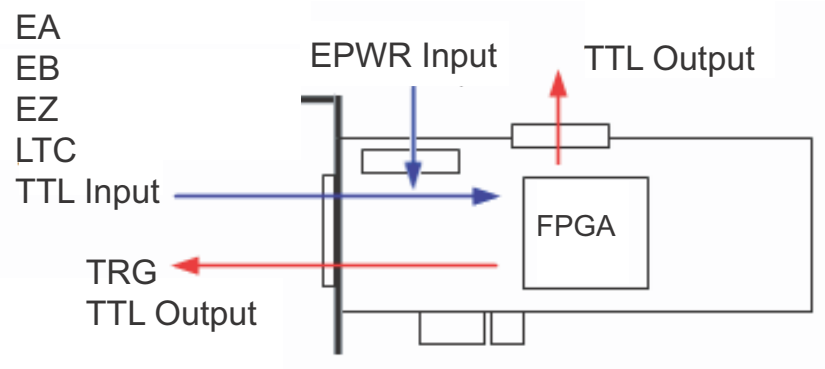
CN1 Pin	Name	Description
23	TTL-OUT1	TTL Level Output port 1

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CN1 Pin	Name	Description
24	TTL-OUT2	TTL Level Output port 2
48	TTL-OUT3	TTL Level Output port 3
49	TTL-OUT4	TTL Level Output port 4
25, 50	DGND	TTL Input reference GND

1.10 Trigger Board Overview

Input and output are as follows:



In the LPCIe-8124-C, all position comparison and mapping tasks are executed within the FPGA.:

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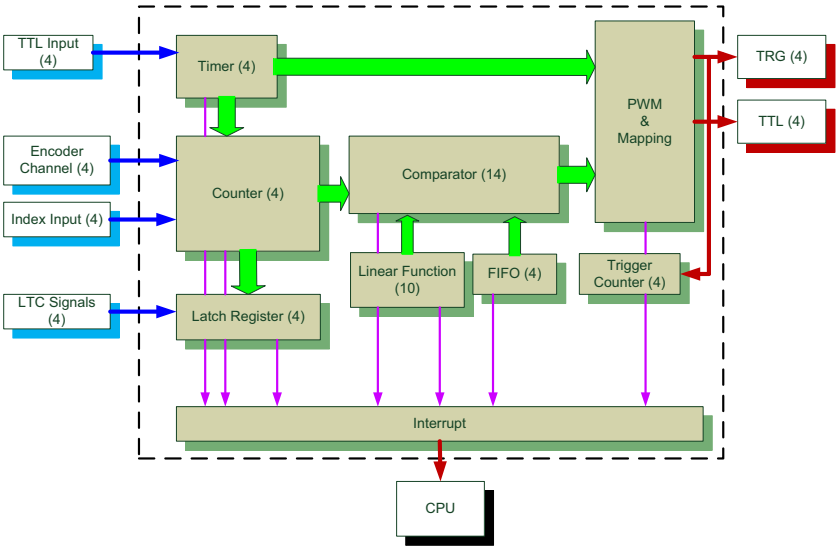


Figure 1-7: Trigger Board Functional Block Diagram

FIFO automatically loads comparison points into 32-bit comparator. The comparator will compare the data from counter and FIFO individually. Due to the mapping mechanism, several combinations are provided for users to continuously send out the trigger pulse with isolation or non-isolation channels. Latch signal can let users retain and retrieve the position data at very short time.

Linear function will automatically load the next comparing points with a fixed incremental value into 32-bit comparator. Just like FIFO's purpose, the new comparing points will be loaded once the previous comparing point is compared and pulse is triggered.

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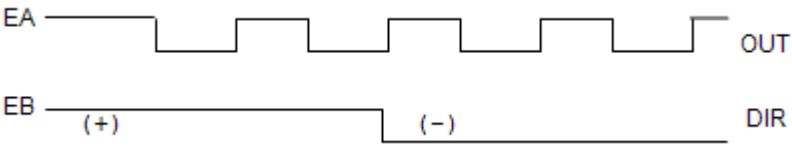
1.10.1 Encoder Channel

The LPCIe-8124-C has four 32-bit binary up/down counters to keep the present feedback position from each encoder channel. The counter counts signal inputs from the EA and EB pins. The counter source could be assigned to internal timer.

It accepts 3 types of pulse inputs: (1). Single pulse mode (OUT/DIR) (2) Dual pulse mode (CW/CCW) (3) 90° phase shifted signals (AB phase mode). 90° phase shifted signals maybe multiplied by a factor of 1, 2 or 4. The 4xAB phase mode is the most commonly used in incremental encoder device. For example, if a rotary encoder has 2000 pulses per phase (A or B phase), then the value read from the counter will be 8000 pulses per turn or –8000 pulses per turn depending on its rotating direction. The three options will be explained as follows.

Single Pulse Mode (OUT/DIR Mode)

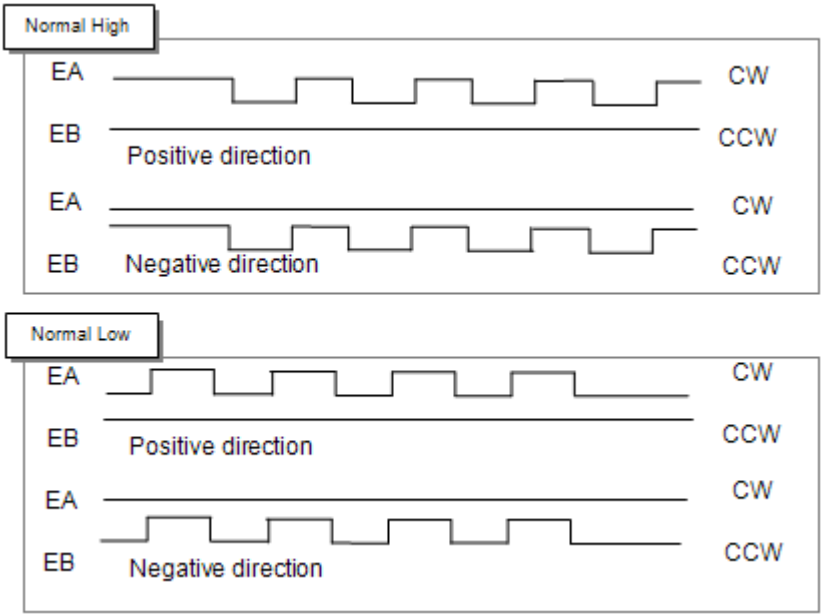
In this mode, EA is dedicated to the count the pulses and EB is to represent the direction. Simply put, we call it as PULSE/DIR mode. The DIR signal represents direction as positive (+) or negative (-). User can decide the normal high or normal low for those two channels according to users' devices. For example, we set these two input channel as normal high. The EA can count the pulse input when the signal level changes from high to low. EB will see the high level as positive direction unless the level changes to low level. The waveform is as follows.



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Dual Pulse Mode (CW/CCW Mode)

In this mode, EA is dedicated to count the pulses from external source and view it as clockwise direction (CW). EB is dedicated to count the pulses from external source and view it as counterclockwise direction (CCW). Simply put, EA counts up and EB counts down. User can decide the normal high or normal low for those two channels according to users' devices. The following diagrams show the normal high and normal low cases individually.

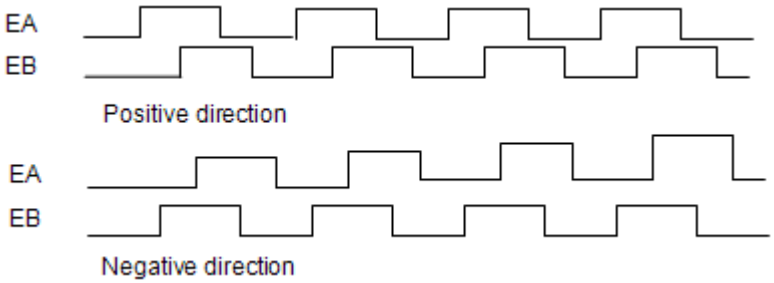


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90° phase shifted signals (AB phase Mode)

In this mode, EA signal is a 90° phase leading or lagging to EB signal. “Lead” or “lag” of phase difference between two signals is caused by the turning direction of the motor. The up/down counters counts up when the phase of EA signal leads the phase of EB signal.

The following diagram shows the waveform.



1.10.2 Index Input (EZ)

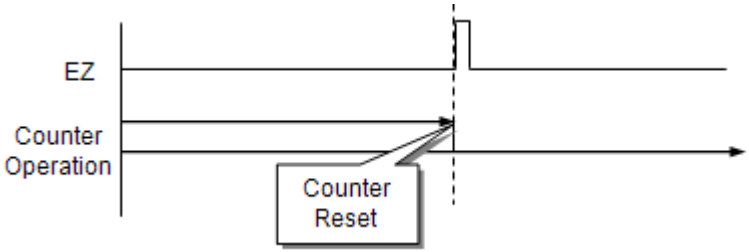
The index input (EZ) signals of the encoders are used as the “ZERO” reference. This signal is common on most rotational motors. EZ can be used to define the absolute position of the mechanism. The input logic polarity of the EZ signals is programmable with ADLINK library.

With EZ signal, users can realize the homing procedure and clear the counter as zero.

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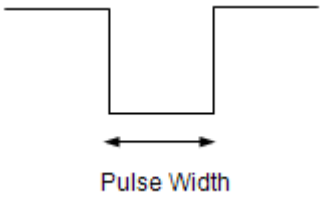
1.10.3 Homing with EZ Signal

The LPCIe-8124-C can clear the counter value as zero according to the edge of EZ signal. Homing by edge can let users meet best homing positioning purpose. Rising or falling edge is supported. The following diagram shows the case about the homing by rising edge.



1.10.4 Trigger Pulse Width

For different applications, the trigger pulse width requirement is different. As for this reason, the trigger pulse width can be adjustable. The available values are from 0.1μs to 3.2765ms. The maximum frequency is up to 5 MHz.



1.10.5 Linear Function

Linear function is used to generate a new comparing position by a fixed incremental value linear function, Y=Y'+A. Y means a calculated comparing position, the linear data. Y' means a previous comparing position. Every time the position is compared, a new data is calculated by adding 'A', the fixed incremental value. This mechanism makes a the continuous triggering function.

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1.10.6 FIFO

FIFO is first-in-first-out storage. It is used for storing some preset position data for comparing. Every time the position is compared, a new data is retrieve from FIFO into comparator. This mechanism makes a the continuous triggering function.

1.10.7 PWM & Mapping

PWM is used for adjusting pulse width of trigger. It could also be switched to a toggle mode. In this mode, the pulse level will change from low to high or high to low at every time when compared.

Mapping means four trigger signals are not one-to-one mapping to four comparators. For example, Comparator 1 could be linked to trigger channel 2. Comparator 2 could be linked to trigger channel 1 and 4. Comparator 2 and 4 could be linked to channel 3.

1.10.8 Digital Filter

The digital filter is used to filter noise behind the encoder input circuit. The encoder signals are typically disturbed with environmental noise, and such noise affects the accuracy of the position count which is generated by calculating the encoder input pulse quantity. The position counter will increase or decrease because of the noise blending with the normal encoder signals. In this card, signals over 5 MHz will be filtered which means that the signals are regarded as noise if its frequency is over 5 MHz. For instance, if the input signal frequency is 2 MHz and accompanied with 8 MHz noise coupling, after filtered, the 2 MHz will be reserved for the decoding process.

1.10.9 Trigger Counter

In general, the accuracy of trigger pulse output quantity may be misjudged because the incorrect image retrieved. During a line scan process, the frame grabber will trigger the CCD capturing the line image after receiving the trigger signal from the encoder board. Therefore, if the encoder does not properly issue a trigger pulse to frame grabber, then the incorrect image may be retrieved. However, there are many possibilities will may cause this problem,

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such as a missing encoder signal, a cable becoming disconnected, abnormal trigger levels, etc. One method to reduce maintenance time is by direct observation of the trigger output pulse quantity from the embedded trigger counter inside the on-board FPGA.

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2 Getting Started

2.1 Package Contents

The package should include the following items.

- LPCIe-8124-C 4CH encoder comparison trigger board
- External power supply bracket

If any of these items are missing or damaged, contact your dealer. Save the shipping materials and carton to ship or store the product in the future.

2.2 Hardware Installation

2.2.1 Hardware Configuration

The LPCIe-8124-C is fully Plug and Play compliant, such that memory allocation (I/O port locations) and IRQ channel of the PCIe card are assigned by system BIOS. Addresses are assigned on a board-by-board basis for all PCIe cards in the system.

2.2.2 PCIe slot Selection

The LPCIe-8124-C can be used in any PCIe slot.

2.2.3 Installation Procedures

1. Read through this manual and set up the board index with SMD switch. The ID range is from 0 to 15.
2. Turn off the computer and all connected accessories (printer, modem, monitor, etc.) Remove the cover from your computer.
3. Select a vacant PCIe expansion slot.
4. Before handling the LPCIe-8124-C, discharge any static buildup on your body by touching the metal case of the computer. Hold the edge of the card and do not touch the components.
5. Position the board into the selected slot.

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6. Secure the card in place at the rear panel of the system unit using screws removed from the slot.

2.2.4 Troubleshooting:

If the system fails to boot or erratic operations occur with the LPCIe board in place, an interrupt conflict (possibly incorrect ISA setup) may be at fault. Consult the BIOS documentation for your system.

Ensure the card is listed in the device's Control Panel. If not, check the LPCIe settings in the BIOS or use another PCIe slot.

2.3 Software Driver Installation

Download the LPCIe-8124-C setupdisk from ADLINK's website and:

1. Follow the procedures in the installer.
2. After installation is complete, restart W.

2.4 Board Index Switch Setting

The SW1 switch is used to set board unique index. Its range is from 0 to 15. For example, the board index is 1 if you switch on pin 1 and switch off pin 2, 3 and 4.



2.5 Default Trigger Level

The SW2 switch sets the TRG pin's default level when powered on. Each bit represents one TRG channel. "ON" is default for TRG channel set to +5V and OFF to 0V. Manufacturer's default is ON.



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2.6 Setting Trigger Mode

Trigger Output mode is set by TSW1 to TSW4 switches. The (factory default) S setting is for single-end trigger output and D for differential. See “Isolated Output Ports (TRG/TRG+, EGND/TRG-)” on page 13..



Figure 2-1: TSW1 toTSW4 Switches

2.7 Trigger Board Operation

2.7.1 Position Comparison

The LPCIe-8124-C provides position comparison functions for each channel. Once the counter reaches a preset value set by the user, the LPCIe-8124-C will generate the trigger pulse. TRGx pins are for trigger pulse output channels. Users can also choose TTL Output pins for this purpose. TRG is an open collector pin.

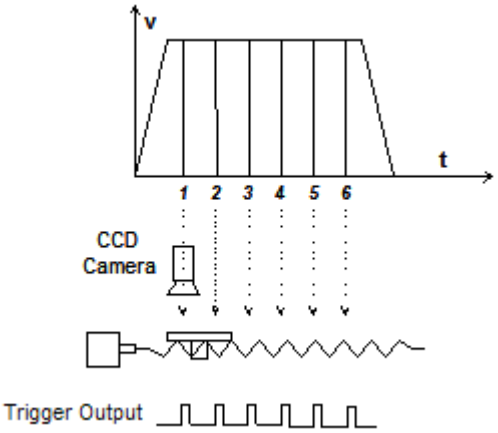
The comparing method is “equal”. Consequently, when the counter value is exactly equal to the preset value by users, the trigger pulse will be generated. At the same time, the next comparing points saved in FIFO or linear function will automatically loaded into comparator. The following is an example for continuous trigger application.

Example: Using the continuous position comparison function.

In this application, the table is controlled by the motion command, and the CCD Camera is controlled by the position comparison out-

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put of the LPCIe-8124-C. An image of the moving object is easily obtained.



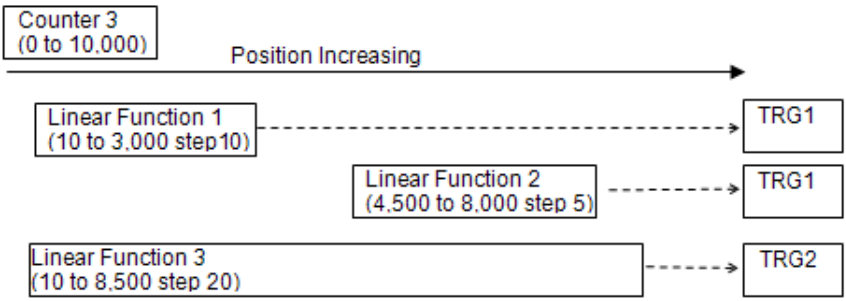
2.7.2 Position Latch

The position latch function is fulfilled by LTC signal, the counter value latch channel of which, once the signal is active, will be saved to the latched register to be retrieved any time.

2.7.3 Linear Function

Each of 10 linear functions is independent, such that overlapped is possible during operation. Each linear function has its own comparator which can be linked to any one of four counters. Accordingly, a variety of trigger modes is possible, as follows:

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Using three linear functions as an example, if the trigger interval and range are set as shown, to counter3 and comparator3 and linear functions to trigger output pins TRG1, TRG1, and TRG2 respectively, when the counters start counting from 0 to 10,000, the trigger pins will output pulses respectively when the compare conditions are met inside linear function.

2.7.4 FIFO Mode

Continuous triggering is fulfilled by linear function and FIFO. These two modes have their own comparators and can be used at the same time. FIFO mode is normally for random data comparison. The data can be preset into FIFO for continuous triggering. Each FIFO has 1023 random comparison data spaces. If more random data is present poll FIFO empty status or wait for interrupt event and refill reset random data.

2.7.5 Timer Function

The 4 timers are started by TTL input and can be set to counters to simulate encoder inputs, or to output to trigger pins directly. The timer is designed by a down-counter and a counter value must be set into the timer for down counting. Once the timer counter reaches zero, the timer will output a pulse to trigger pin or increase encoder counter by 1. The down counting speed is 400ns and the maximum counter value is 14-bit.

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2.8 Multiple Board Operation

The maximum installation in one PC system is 16 pieces, providing 64 channels for triggering. Since the LPCIe-8124-C is Plug-and-Play compatible, the base address and IRQ settings for card are automatically assigned by BIOS when powered on.

When multiple cards are applied to a system, user can select the unique index number with S1 and can control each board accordingly. For example, if three LPCIe-8124-C cards are plugged in to PCIe slots, corresponding channel numbers are as follows.

Card ID	CH 1	CH 2	CH 3	CH 4
1	0	1	2	3
2	0	1	2	3
3	0	1	2	3



NOTE:

The index number is not accumulated if more than one board is installed in the PCIe slot.

2.9 Interrupt Control

The LPCIe-8124-C can generate an INT signal to the host PC when enabled by calling _8124_set_int_factor. Parameter of intFactor of the function should be set to 0 to disable the interrupt service.

Factors triggering the interrupt include:

- PWM:

  When PWM receives a comparing trigger including manual trigger

- FIFO level:

  When FIFO level reaches that set call “_8124_set_fifo_level”.

- FIFO empty
- FIFO full
- LTC:

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When a latch counter event occurs

- TTL-IN

When the timer is triggered by TTL-IN

- Linear function

When linear comparison finishes

The following shows the architecture of an interrupt factor for each channel. Note that the INT factors of the last channel (ch 4) are not the same as others, being used to configure the interrupt of linear function.

Bit	CH0	CH1	CH2	CH3	CH4
0	PWM0	PWM1	PWM2	PWM3	LIN0
1	FIFO0 Level	FIFO1 Level	FIFO2 Level	FIFO3 Level	LIN1
2	FIFO0 Empty	FIFO1 Empty	FIFO2 Empty	FIFO3 Empty	LIN2
3	FIFO0 Full	FIFO1 Full	FIFO2 Full	FIFO3 Full	LIN3
4	LTC0	LTC1	LTC2	LTC3	LIN4
5	TTL-IN0	TTL-IN1	TTL-IN2	TTL-IN3	LIN5
6	-(*)	-	-	-	LIN6
7	-	-	-	-	LIN7
8	-	-	-	-	LIN8
9	-	-	-	-	LIN9

* (-) : reserved bit (set to 0)

Interrupt functions detect interrupt signals under Windows.

To use the interrupt functions:

1. Enable the expected interrupt factors.

   `"_8124_get_int_factor"`

2. Call the wait function.

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```
"_8124_wait_single_int"
```

3. After the interrupt process, disable the interrupt service.

```
"_8124_get_int_factor"
```

Example:

```
_8124_set_int_factor( CardId, Channel, 0x4); //
     FIFO empty
…(FIFO operation)…

// wait FIFO empty interrupt
// FactorBitNum = 2
// 10 seconds time-out
_8124_wait_single_int( CardId, Channel, 2, 10000
     );
…
_8124_set_int_factor( CardId, Channel, 0 )//
     Disable the interrupt service.
```

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Appendix A TriggerMaster Utility

After installing the hardware (Chapters 2 and 3), it is necessary to correctly configure all cards and double check the system before running. This chapter gives guidelines for establishing a control system and manually testing the cards to verify correct operation. The TriggerMaster software provides a simple yet powerful means to setup, configure, test, and debug for trigger system, like a line scan system that uses 8124-C cards.

Note that TriggerMaster is only available for Windows XP/7/8.1 with a screen resolution higher than 1024x768. It cannot be executed under a DOS environment.

A.1 Running TriggerMaster

After installing the software drivers for the card in Windows XP/7/8.1, the TriggerMaster program can be located at <chosen-path>\8124-C\TriggerMaster_LPCIe-8124.exe. To execute the program, double click on the executable file or use Start -> Program Files -> ADLINK -> 8124-C -> TriggerMaster.

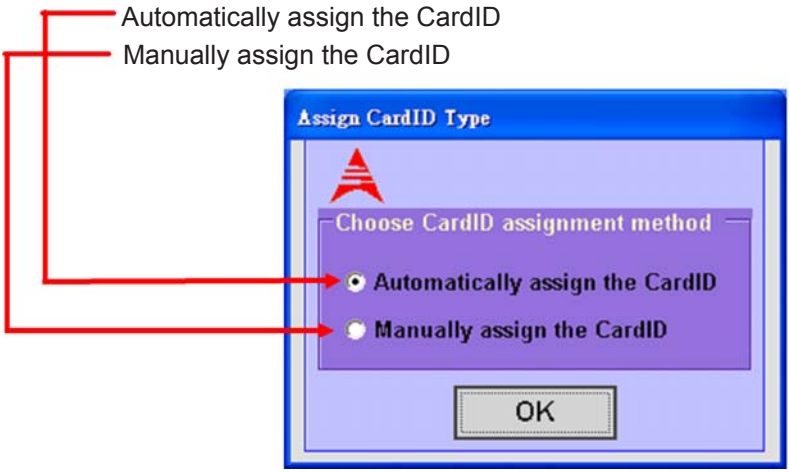
A.2 About TriggerMaster

Before running TriggerMaster please note that TriggerMaster is a program written in VB.Net 2003, and is available only for Windows XP/7/8.1 with a screen resolution higher than 1024x768. It cannot be run under DOS.

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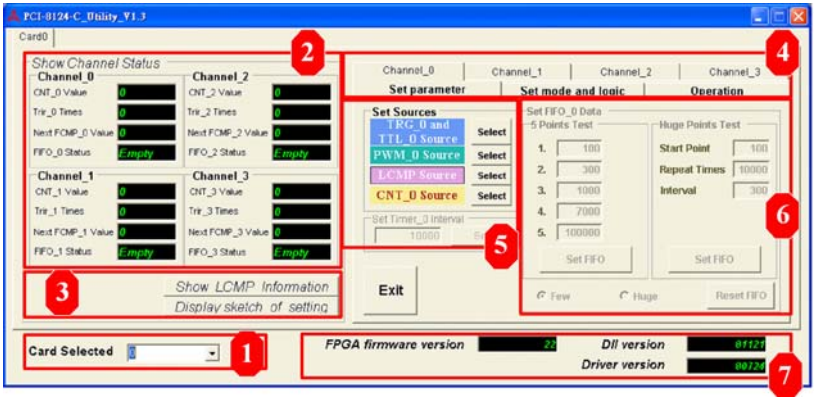
A.3 TriggerMaster Form Introduction

A.3.1Assign ID Type Dialog



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A.3.2Main Form



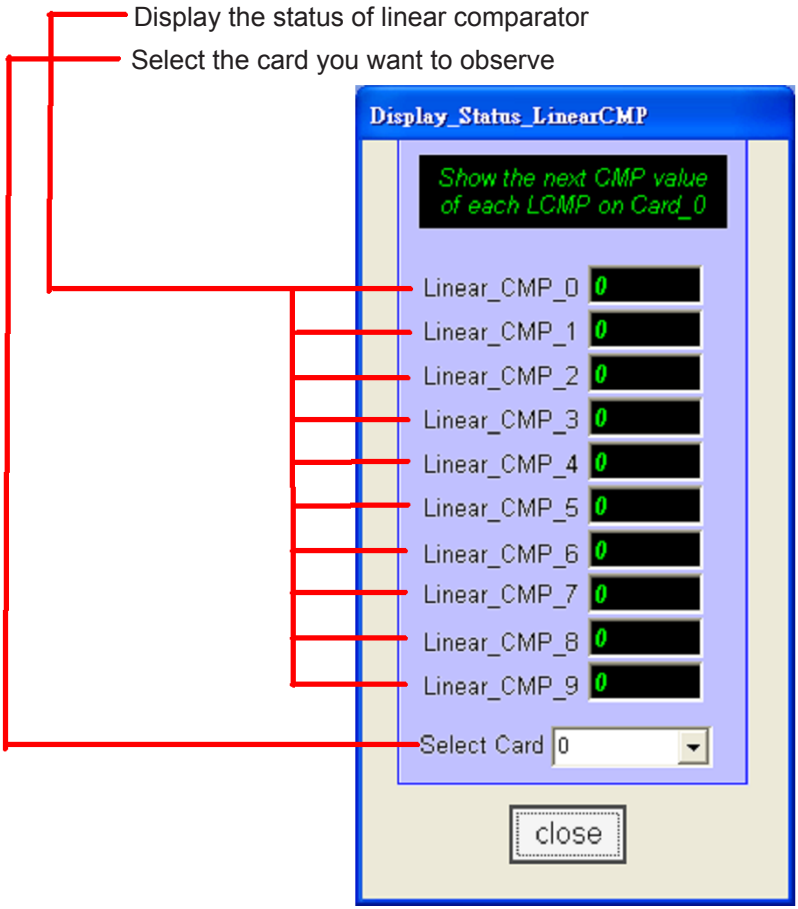
1. **Card Selected**: Choose the card to operate. Note: the card must be selected first.
2. **Show Channel Status**:
   - ▷ CNT_# Value: Display the value of encoder counter. The related function is **`_8124_get_encoder_value`**.
   - ▷ Trir_# Times: Display the value of trigger counter. The related function is **`_8124_get_pwm_trigger_count`**.
   - ▷ Next FCMP_# Values: Display the next compared value in FIFO comparator. The related function is **`_8124_get_comparator_data`**.
   - ▷ FIFO_# Status: Display the status of FIFO comparator. The related function is **`_8124_get_fifo_sts`**.
3. **LCMP_Informaton and sketch_of_setting Forms**:
   - ▷ Show_LCMP_Information: Display the Display_Status_LinearCMP form to observe the status of each linear comparator.
   - ▷ Display sketch_of_setting: Display the sketch_of_setting form to see the overview of all settings.
4. **Tab Switch**: Switch the channel and parameter setting tabs.

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5. **Set Sources**:
   - ▷ TRG_# and TTL_# Source: Display the Set_TRG_&_TTL_Out form to set source, logic and mode for TRG output and TTL output for TRG_# and TTL_# output. The related functions are **_8124_set_trigger_source**, **_8124_set_trgOut_logic**, and **_8124_set_ttlOut_source**.
   - ▷ PWM_# Source: Display the Choose_PWM_Source form to set the source for PWM_#. The related function is **_8124_set_pwm_source**.
   - ▷ LCMP Source: Display the Set_Linear_Comparator form to set each linear comparator. The related functions are **_8124_enable_linear_set**, **_8124_set_linear_compare**, and **_8124_set_linear_source**. Note: the setting in this form is for all channels.
   - ▷ CNT_#: Display the Set_CNT_Source form to set the source for counter_#. The related function is **_8124_set_counter_source**.
   - ▷ Set_Timer_# Interval: Set the interval timer. The unit is millisecond. The related function is **_8124_set_Timer**.
6. **Set FIFO_# data**:
   - ▷ 5 Points Test: In this area user can set five data into the FIFO comparator once to verify the functionality of FIFO compare. The related function is **_8124_set_fifo_array**.
   - ▷ Huge Points Test: In this area user can input a large number of data into the FIFO comparator. The related function is **_8124_set_fifo_array** ().
   - ▷ Note: if FIFO comparator is not selected the source for the PWM_#, this area is locked.
7. Displays version: Displays the libray, firmware and the driver version. The related funcion is **_8124_get_version**.

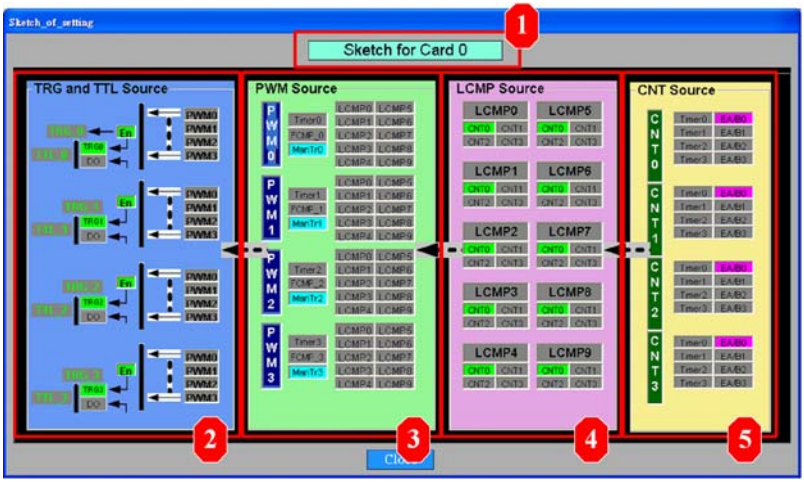
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A.3.3Display _Status_LinearCMP Form



A.3.4Sketch_of_setting Form

This Sketch_of_setting form allows you to conveniently observe the all settings. When changing any settings, the Sketch_of_setting form updates immediately.

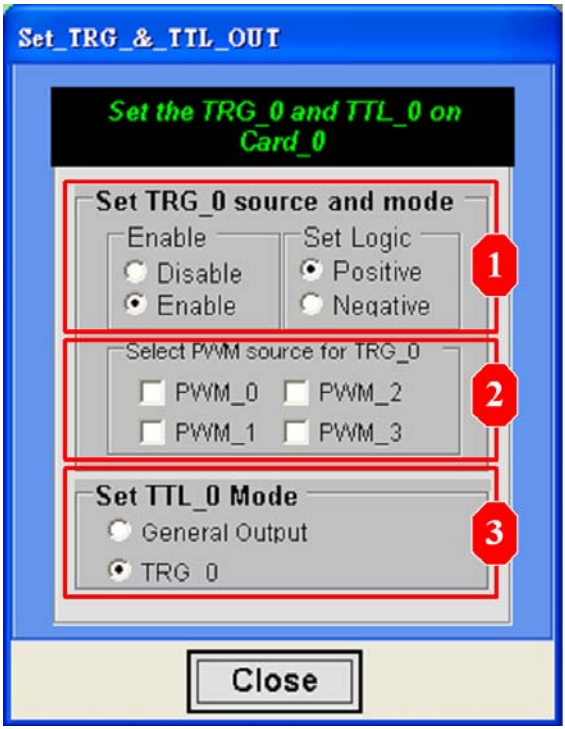


1. **Sketch for Card #**: Describe which card is showing.
2. **TRG and TTL Source**: Describe the status of setting of TRG-OUT and TTL-OUT sources. The light green means the source is chosen.
3. **PWM Source**: Describe the status of setting of PWM source. The light blue means the source is chosen. Note: the ManTr# is always chosen.
4. **LCMP Source**: Describe the status of setting of linear comparator source. The light green means the source is chosen.
5. **CNT Source**: Describe the status of setting of counter source. The light purple means the source is chosen.

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A.3.5Set_TRG_&_TTL_Out Form

In this form, you can set operation logic, operation mode, source, and En/Disable options for TRG-OUT and TLL-OUT.

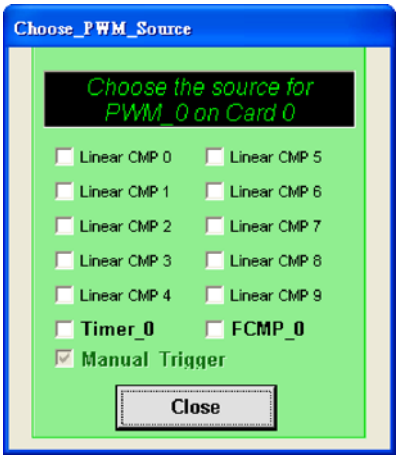


1. **Set TRG_# source and mode**: Set En/Disable and operation logic for the TRG-OUT. The related function is **`_8124_set_trgOut_logic`**.
2. **Select PWM source for TRG_#**: Select the PWM source for TRG-OUT. The related function is **`_8124_set_trigger_source`**.
3. **Set TTL_# Mode**: Set the TTL-OUT mode to be general output or be TRG-OUT. The related function is **`_8124_set_ttlOut_source`**.

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A.3.6Choose_PWM_Source Form

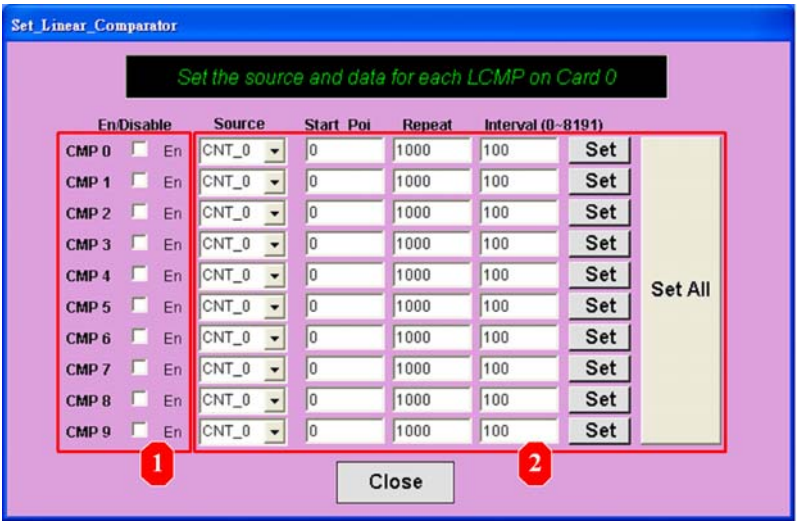
In this form, you can choose the source for PWM. Note: the manual_Trigger is always selected. The related function is **`_8124_set_pwm_source`**.



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A.3.7Set_Linear_Comparator Form

In this form, you can set the En/Disable, choose source, and set parameters for each linear comparator.

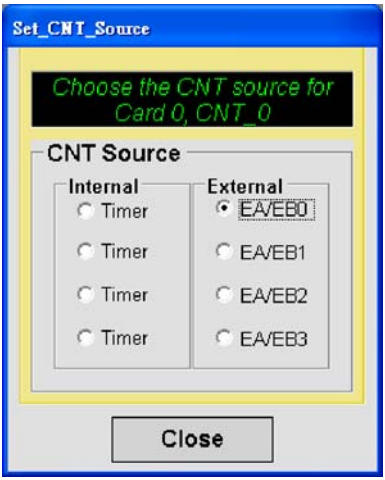


1. **En/Disable**: Set En/Disable for each linear comparator. The related function is **`_8124_enable_linear_set`**.
2. **Set the source and parameters for linear comparator**: Set the source and start point, repeat times and interval to the linear comparator. The related function is **`_8124_set_linear_compare`**.

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A.3.8Set_CNT_Source Form

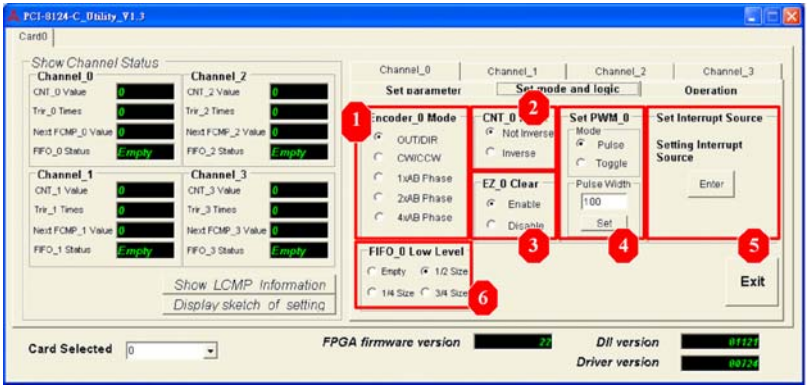
In this form, you can set the source for the encoder counter. There are total eight kinds of input sources for encoder counter on LPCIe-8124-C. Only one type can be selected at the same time. The related function is **`_8124_set_counter_source`**.



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A.3.9Encoder_# Mode

Enter Set mode and logic tab by clicking the Set mode and logic tag as show below:

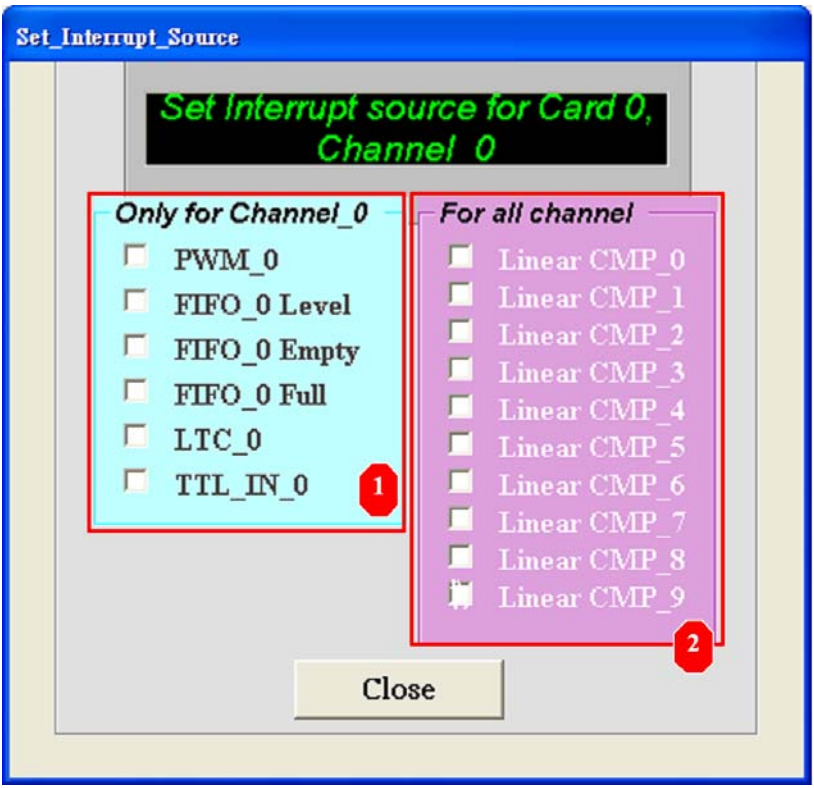


1. **Encoder_# Mode**: Set the encoding mode for encoder including OUT/DIR, CW/CCW, 1xAB phase, 2xAB phase and 4xAb phase. The related function is **`_8124_set_encoder_input_mode`**.
2. **CNT_# Mode**: Set the count mode counting up or counting down for counter. The related function is **`_8124_set_encoder_up_down_count`**.
3. **EZ_# Clear**: En/Disable the EZ clear function. The related function is **`_8124_set_ez_clear`**.
4. **Set PWM_#**: Set the PWM mode and its width. The related functions are **`_8124_set_pwm_mode`** and **`_8124_set_pwm_pulse_width`**.
5. **Set Interrupt Source**: Click the Enter button to display the Set_Interrupt_Source form. In the form, user can set various interrupts for each channel and linear comparator interrupt for all channels.
6. **FIFO_# Low Level**: Set the FIFO comparator low level. The related function is **`_8124_set_fifo_level`**.

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A.3.10Set_Interrupt_Source Form

In this form, you can set the various interrupt events for each channel and linear comparator interrupt event for all channels.



1. Only for Channel_#: Set the various interrupt events for channel_#. The related function is `_8124_set_int_factor`.
   - ▷ **PWM_#**: Set the PWM event to the interrupt factor. This interrupt event occurs when the PWM receives a trigger single.
   - ▷ **FIFO_# Level**: Set the FIFO_# level event to the interrupt factor. This interrupt event occurs when the data in FIFO is less than FIFO level.

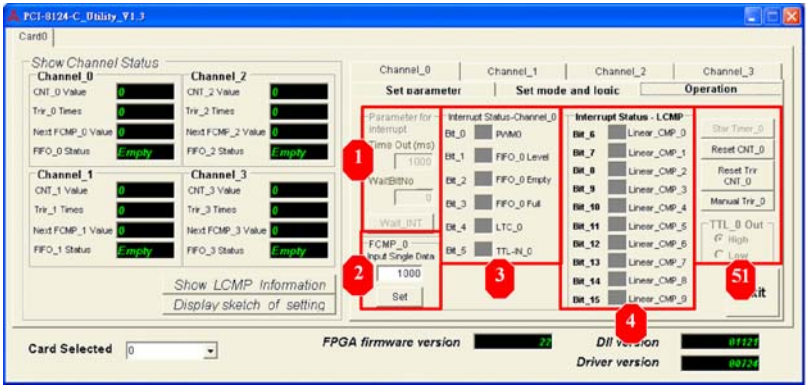
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- ▷ **FIFO_# Empty**: Set the FIFO_# empty event to the interrupt factor. This interrupt event occurs when the FIFO is empty.
- ▷ **FIFO_# Full**: Set the FIFO_# full event to the interrupt factor. This interrupt event occurs when FIFO is full.
- ▷ **LTC_#**: Set the LTC_# event to the interrupt factor. This interrupt event occurs when specified latch contition meet.
- ▷ **TTL_IN_#**: Set the TTL_IN_# event to the interrupt factor. This interrupt event occurs when TTL_IN_# receives a signal.

2. **For all channel**: Set the linear comparator event to the interrupt factor. This interrupt event occurs when the comparing in linear comparator is finished.

A.3.11 Set_Interrupt_Source form

Enter Operation tab by clicking the Operation tag show as below:



1. **Interrupt parameters**:
   - ▷ **Time Out (ms)**: Set the time out for waiting interrupt.
   - ▷ **WaitBitNo**: Input the bit number which user want to wait the interrupt.
   - ▷ **Wait_INT**: Start to wait interrupt. The related function is **`_8124_wait_single_int`**.
2. **FCMP_# Input Single Data**:
   - ▷ Input single one data into FIFO comparator.
3. **Interrupt Status-Channel_#**: Show the status of interrupt of each channel; color yellow means waiting, color green means received interrupt, color green means time out.
4. **Interrupt Status – LCMP**: Show the status of interrupt for linear comparator interrupt; color yellow means waiting, color green means received interrupt, color green means time out.

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5. **Buttons**:
   - ▷ **Start Timer_#**: Start the interval timer.
   - ▷ **Reset CNT_#**: Reset the counter value.
   - ▷ **Reset Trir CNT_#**: Reset the trigger counter value.
   - ▷ **Manual Trir_#**: Trigger pulse manually.
   - ▷ **TTL_# Out**: TTL_out output high or low. If TTL_Out mode is trg-out, it can't be operated.

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Important Safety Instructions

For user safety, please read and follow all **instructions**, **WARNINGS**, **CAUTIONS,** and **NOTES** marked in this manual and on the associated equipment before handling/operating the equipment.

- Read these safety instructions carefully.
- Keep this user's manual for future reference.
- Read the specifications section of this manual for detailed information on the operating environment of this equipment.
- When installing/mounting or uninstalling/removing equipment:
  - Turn off power and unplug any power cords/cables.
- To avoid electrical shock and/or damage to equipment:
  - Keep equipment away from water or liquid sources;
  - Keep equipment away from high heat or high humidity;
  - Keep equipment properly ventilated (do not block or cover ventilation openings);
  - Make sure to use recommended voltage and power source settings;
  - Always install and operate equipment near an easily accessible electrical socket-outlet;
  - Secure the power cord (do not place any object on/over the power cord);
  - Only install/attach and operate equipment on stable surfaces and/or recommended mountings; and,
  - If the equipment will not be used for long periods of time, turn off and unplug the equipment from its power source.

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- Never attempt to fix the equipment. Equipment should only be serviced by qualified personnel.
- A Lithium-type battery may be provided for uninterrupted, backup or emergency power.

WARNING:

Risk of explosion if battery is replaced with an incorrect type; please dispose of used batteries appropriately.

- Equipment must be serviced by authorized technicians when:
  - The power cord or plug is damaged;
  - Liquid has penetrated the equipment;
  - It has been exposed to high humidity/moisture;
  - It is not functioning or does not function according to the user's manual;
  - It has been dropped and/or damaged; and/or,
  - It has an obvious sign of breakage.

Please pay strict attention to all warnings and advisories appearing on the device, to avoid injury or damage.



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Getting Service

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