LeCroy PE*Tracer* EML™

PCI Express Multi-Lane Protocol Analyzer

QuickStart User Manual

For Software Version 4.30
Manual Version 4.30

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1. Overview

1.1 PCI Express^{TM} 16-Lane Protocol Analyzer

The LeCroy PE*Tracer* EML™ is a PCI Express 16-lane advanced verification system. The PE*Tracer* EML allows semiconductor, motherboard and add-in card manufacturers to capture, analyze and view PCI Express traffic. By leveraging years of experience in protocol analysis tools for emerging markets, the PE*Tracer* EML blends sophisticated functionality with intuitive controls to speed the development and testing of PCI Express IP cores, semiconductors, bridges, switches and systems.

There are two ways to connect the PE*Tracer* EML to the point-to-point PCI Express bus, using either a card-edge slot interposer card or a mid-bus probe. PCI Express traffic can then be non-intrusively recorded. Live data is sent from the PE*Tracer* EML to a PC in order display real-time statistics. Sophisticated trigger options are used to capture and buffer only data of interest. Real-time hardware filters in the system filter out unwanted traffic in order to maximize memory buffer utilization. Captured data is uploaded to the PC for further processing and displayed by the powerful CATC Trace^{TM} software.

PE*Tracer* EML provides accurate, reliable and complete decodes of Transaction Layer Packets (TLPs), Data Link Layer Packets (DLLPs), and all PCI Express ordered sets. The buffer size has been increased in the *PETracer* EML to 4GB per direction. PCI Express Specification 1.0 and 1.0a are supported at the full-speed of 2.5GHz per lane. Automatic disparity checking, lane deskewing and data descrambling are all supported. The FPGA based design is fully field upgradeable. The PE*Tracer* EML can be controlled remotely via the user's LAN.

Sophisticated controls allow the user to decide what is captured and how it is viewed in order to analyze design problems and perform root cause analysis. Powerful triggering conditions allow the user to trigger on Error, Link, TLP, DLLP or any user-defined data pattern in the traffic. Each type of trigger condition can be cascaded to create complex multi-layer triggers. Trigger points can be set to any location within the buffer to allow the user to capture data before and after the trigger. Full-featured filtering capabilities allow engineers to isolate areas of interest. Captured packets can be expanded or collapsed. Columns are user configurable to allow hiding fields that are not relevant. Powerful search capabilities further enhance the users abilities to solve engineering and production problems.

The PE*Tracer* EML includes a powerful expert system that incorporates detailed knowledge of the hierarchy and intricacies of the PCI Express protocol specification to create multiple graphical views of PCI Express data. These Windows-based color-coded graphical views have been optimized for fast and easy navigation through a captured traffic session. Each packet is decoded to display packet direction, sequence number, timestamp, packet type and other packet specific fields. Errors are detected at all levels of the protocol hierarchy and color highlighted for the user. Error conditions include: DLLP CRC, LCRC, ECRC, delimiter, disparity and symbol errors. Real-time statistics and post processing traffic summaries give the big picture of the data captured. Statistics can be viewed in tabular form or viewed in graphical form. Traffic summary views are hyperlinked back to data traces to quickly jump to the source of bugs.

The PCI Express protocol data can be viewed in several different hierarchical views. Data can be displayed at the physical layer with Link Tracker to display either 10B/8B codes, Symbols or hex in either raw or scrambled formats. Traffic can also be displayed at the packet or Link layer or in the application layer (split view). Placing the mouse pointer over packet data causes a tooltip with an explanation of the field. Tooltips explain annotations and often display substantial additional information about selected fields.

The PE*Tracer* EML is the first add-in module to utilize LeCroy's most advanced Universal Protocol Analysis System^{TM} (UPAS), the UPAS 100K platform. The expanded memory buffer of 4GB per direction allows the user to capture deeper traces over a longer time period. The platform also provides scalability for the future with expanded hardware capabilities and the capacity for two independent plug-in modules in the same chassis. The UPAS 100K was specifically designed to support high-speed serial protocols like PCI Express.

PE*Tracer* EML has full x16 lane analysis capabilities as well as many innovative triggering and filtering options that allows the user to easily diagnose problems and test for interoperability and standards compliance in order to quickly create marketable PCI Express products.

1.2 CATC Trace Software

The PETracer EML utilizes the CATC Trace to assist users in analyzing how PCI Express components work together, diagnose problems, and test for interoperability and standards compliance.

The CATC Trace is a powerful and intuitive expert software system embedding detailed knowledge of the protocol hierarchy and intricacies, as defined in the protocol specification. The software allows the user to control the analyzer and set specific real-time triggering and filtering conditions. The CATC Trace utilizes a Windows-based graphical display that has been optimized for fast and easy navigation through a captured traffic session. Users are alerted as violations are detected at all levels of the protocol layering and can easily drill down on areas of interest or collapse and hide fields that are not relevant.

For additional information on the CATC Trace, please download the White Paper from the LeCroy website:

http://www.catc.com/support/white_papers/index.html.

1.3 Specifications

The following specifications describe a combined PETracer EML and Universal Protocol Analyzer System.

Package

Dimensions:	UPAS 100K:
	11.5 x 5.75 x 16.25 inches (29.21x 14.6x 41.275cm)
	PETracer EML Plug-in:
	9.16x 6x 1.25inches (23.26x 15.24x 3.175cm)
Connectors:	2 Probe Data
	UPAS AC power connection
	External trigger connection
	(TRIG IN/OUT, BNC)
	2 High Speed Expansion Ports (SFP)
	PC connection (USB 2.0)
	Break-out-board (type "D")

Power Requirements

90-254 VAC, 47-63 Hz, 100W maximum (universal input)

Environmental Conditions

Operating Range:	0 to 40 °C (32 to 104°F)
Storage Range:	-20 to 80 °C (-4 to 176°F)
Humidity:	10 to 90%, non-condensing

Switches

Power:	On/Off
Manual Trigger	When pressed forces a trigger event

Indicators (LEDs)

UPAS:

Power:	Illuminated when analyzer is powered on
System Status:	Lights during initialization/power up of UPAS. Blinks if self-test fails.
Triggered:	Lights when a trigger event occurs.
Slot 1 Status:	Illuminates when the analyzer in Slot 1 is recording
Slot 2 Status:	Illuminates when the analyzer in Slot 2 is recording

PETracer EML
Plug-in LEDs:

Activity:	Illuminated when the analyzer is actively recording traffic data
Cable Setup:	Illuminates when cable is correctly connected between front of analyzer and interposer.

Probing Characteristics

Connection:	PCI Express Slot Interposer

Recording Memory Size

4 GBytes per direction for trace capture, timing, and control information.

Basic Trigger Events

TLP Headers	TLP Type: Mem, I/O, Cfg, Msg, Cpl, Any Traffic Class number
DLLP Messages	Ack/Nak, InitFC1, InitFC2, UpdateFC, PM, Vendor
Link Conditions	Link Alive, Electrical Idle Link Condition, TS1 Ordered Set, TS2 Ordered Set, Skip Ordered Set, Electrical Idle Ordered Set, FTS Ordered Set, DLLP, TLP, Training Control Blts
Payload	Customizable Payload, Mask, Match
Errors	DLLP CRC, TLP CRC, Delimiter, EDB (End-of-Bad Packet), Disparity, Symbol, Idle Data Skip Late DLLP Ordered Set Format
Breakout Board	Filter in/out capabilities

Reporting and Statistics

Transport Layer Packet	Memory Read 32-bit, Memory Read 64-bit, Memory Write 32-bit, Memory Write 64-bit, I/O Read Request, I/O Write Request, Configuration Read Type 0, Configuration Write Type 0, Configuration Read Type 1, Configuration Read Type 1, Message, Message with Data, Completion, Completion with Data, Completion for Locked Memory Read, Completion for Locked Memory Read with Data, Requesters, Completers, Traffic Class Number, Virtual Channel ID Number
Data Link Layer Packet (DLLP)	Ack, Nak, PM, Vendor, InitFC1-P, InitFC1-NP, Init-FC1-Cpl, Update FC-P, Update FC-NP, Update FC-Cpl, InitFC2-P, InitFC2-NP, Init-FC2-Cpl, Flow Control
Link Transactions	Implicit, Explicit, Incomplete

Split Transaction	Successful Completion, Unsupported Request, Cfg Request Retry, Completer Abort, Incomplete
Error Reports	Bad ECRCs, Bad LCRCs, Invalid 10b code, Running Disparity Error, End of Bad Packet, Delimiter Error, TS Data Error, Ordered Set Format Error, Idle Error

2. Installation

PETracer EML is an factory-installed hardware module that is sold as part of the Universal Protocol Analyzer System 100K (UPAS 100K).

You can begin making PCI Express recordings after following the steps in this chapter.

2.1 System Components/Packing List

- Factory-installed PETracer EML Analyzer module(s)
- One USB cable
- One BNC cable
- PETracer software program CD-ROM
- Two Probe data cables
- Breakout board with cable
- PCI Express Slot Interposer probe
- User Manual

2.2 Host PC Requirements

PETracer EML connects to a Host PC. Please consult the readme file on the installation CD for the latest PC requirements.

2.3 Analyzer LED Descriptions

When powered on, the PETracer EML activates the user-accessible controls and LEDs on the front and rear panels of the UPAS.

Warning Do not open the UPAS enclosure. There are no operator serviceable parts inside. Refer servicing to LeCroy.

UPAS LEDs (from left to right)
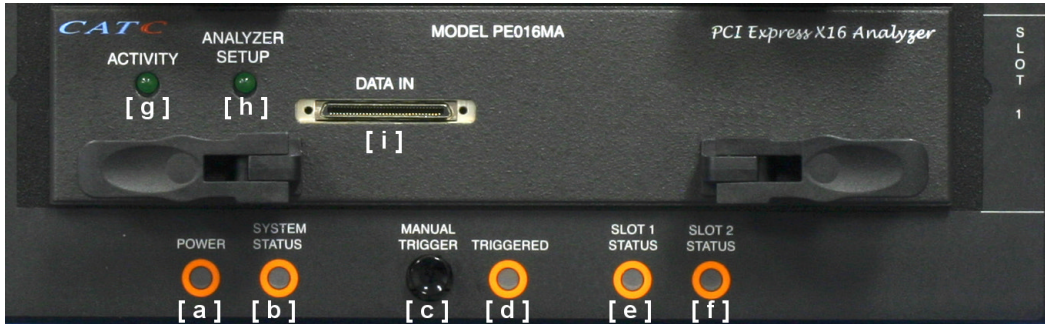
- [a] **Power** indicator LED for UPAS - Lights when the unit power is switched on.
- [b] **System Status** indicator LED for UPAS - Lights during initialization/power up of UPAS base unit. Blinks if a self-test fails.
- [c] The **Manual Trigger** push-button - Forces a trace trigger.
- [d] **Triggered** LED - Lights when the unit triggers on an event.
- [e] **Slot 1 Status** - Illuminates when the analyzer in Slot 1 is recording
- [f] **Slot 2 Status** - Illuminates when the analyzer in Slot 2 is recording

PETracer EML Module

- [g] **Activity** LED - Illuminates when there is traffic on the link.
- [h] **Analyzer Setup** LED - Illuminates when cable is correctly connected between front of analyzer and interposer.
- [i] Probe Data Connector.

2.4 Rear Panel Description

From left to right, the UPAS rear panel contains the following components:

Figure 1: Rear Panel
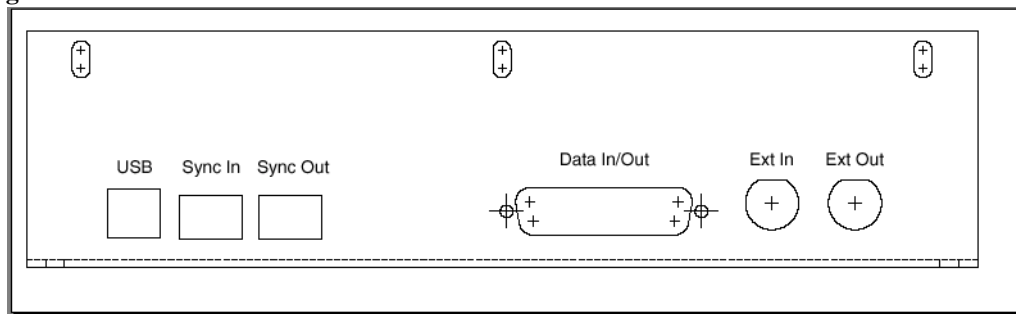
USB type "B" host computer connector
>   This connector links the analyzer to the Host PC. for the purpose of transmitting commands from the PC to the analyzer and uploading traces from the analyzer's recording memory to the PETracer EML software for viewing and analysis.

SFP "Sync In" and "Sync Out" Connectors
>   These connectors allow multiple UPAS 100K chassis to send synchronization and control messages to one another. Currently, these ports are not activated and are reserved for a future release.

RS-232 40 pin "Data Input/Output" Connector
>   This connector links a 40 pin RS-232 cable to an external breakout board. The breakout board allows signals to be sent from the analyzer to an external device such as an oscilloscope or from an external device to the analyzer for the purpose of triggering on an external input. You configure input/output signalling through the Recording Options dialog box. Breakout board use is described at the end of this chapter.

BNC Connectors "Ext. In" and "Ext. Out"
>   These BNC connectors allow the analyzer to transmit or receive external signals.

Wide range AC connector module (Not shown - sits left of illustrated panel)
>   — Power socket
>
>   — Power on/off switch
>
>   — Enclosed 5x20 mm 2.0A 250 V fast acting glass fuse

Warning For continued protection against fire, replace fuse only with the type and rating specified above.

2.5 Setting Up the Analyzer

Step 1 Remove the Analyzer/UPAS from its shipping container.

>   The Analyzer module will already be installed in the UPAS.

Step 2 Connect the Analyzer unit to a 100-volt to 240-volt, 50 Hz to 60 Hz, 120 W power outlet using the provided power cord.

Note The Analyzer is capable of supporting supply voltages between 100-volt and 240-volt, 50 Hz or 60 Hz, thus supporting all known supply voltages around the world.

Step 3   Turn on the power switch on the rear of the UPAS.

Note   At power-on, the analyzer initializes itself in approximately five seconds and performs an exhaustive self-diagnostic that lasts about fifteen seconds. The Status LED of the UPAS base unit turns red on power up/initialization. The LED remains on approximately 20 seconds while the analyzer performs self-diagnostic testing. If the diagnostics fail, the Status LED will blink red, indicating a hardware failure. If this occurs, call LeCroy Customer Support for assistance.

Step 4   Insert the CD into the CD ROM drive of the PC that will be controlling the analyzer.

Step 5   Connect the USB cable between the USB port on the back of the analyzer and a USB port on the PC.

The host operating system detects the analyzer and begins to install the USB driver.

Step 6   Follow Windows on-screen Plug-and-Play instructions for the automatic installation of the analyzer as a USB device on the Host PC (the required USB files are included on the PETracer EML CD). Step through the Windows hardware wizard. The wizard will automatically install the analyzer as a USB device on the PC. When the wizard prompts you for driver information, point it to the CD which should be in your disk drive and install **upas100k.sys**.

## 2.6 Installing the PE*Tracer* Software

Once PETracer EML has been recognized as a USB device, install the PETracer software on the Host PC.

Step 1   On the PC, select **Install Software** from the installation CD and follow the on-screen instructions.

The PETracer software will install on the PC hard disk.

Step 2   To start the application, launch the CATC PE*Tracer* program from the Start menu:
Start > Programs > CATC > PETracer.

The PETracer EML program opens.
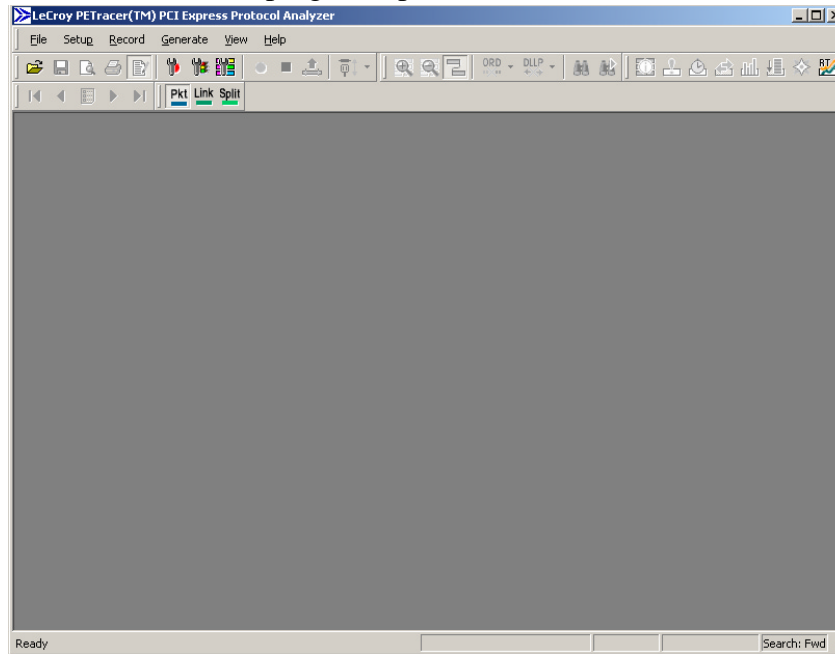
> **Note**   The software may be used with or without the analyzer. When used without an analyzer attached to the computer, the program functions as a Trace Viewer to view, analyze, and print captured traffic.

2.7 Connecting the Analyzer to the Device Under Test

PETracer EML components used in the installation:

Probe Data cable (2). Each cable supports x16 data from one direction.

PETracer EML x16 Slot Interposer. The slot interposer provides the point of attachment for the analyzer to the Device Under Test (DUT). The interposer is designed to fit between a motherboard and one of its cards - for example, a LAN card. The interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a black female connector that accepts a x16 PCI Express device such as a graphics card, and two interposer cable connectors that connect the interposer to the analyzer.
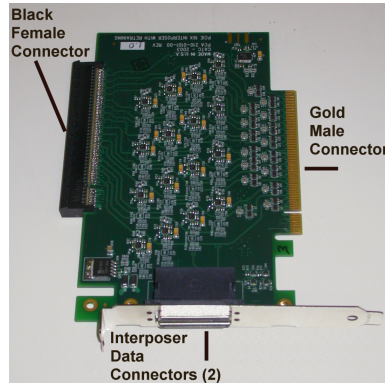
USB Cable. This cable is used to connect the UPAS 100K to the host PC running the PETracer software.

2.8 Installing the Interposer

To install the interposer, perform the following steps.

Step 1   If not already powered off, power off the UPAS 100K analyzer and the DUTs.

Step 2   Insert the gold male connector on the interposer probe into a x16 PCI Express slot in the motherboard.

Step 3   Insert the PCI Express DUT into the interposer's black female device connector.

Step 4   The slot interposer is shipped from LeCroy with a metal face plate for attachment to a PC case. If you are working with a motherboard that is not in a PC case, you may prefer to remove the metal face plate so the interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the interposer.

Connecting the Probe Data Cable and USB Cable

To connect the interposer data cable,

Step 1 Connect the two probe data cables to the interposer card and to the analyzer. It does not matter which slot you plug the cables into on the analyzer as the direction of the data is determined automatically by the software.

Step 2 Connect the provided USB cable between the UPAS 100K analyzer and the PC host system that will run the PETracer software.

Power On Analyzer and DUT

Step 1 Power on the UPAS 100K. The analyzer's green Power LED will light, and the red Status LED will turn on for approximately 20 seconds while the analyzer performs self-diagnostics.

Step 2 After the analyzer's red status LED turns off, power on the PCI Express system under test.

Step 3 Open the PETracer EML software on the PC host system. The analyzer is now ready for PCI Express traffic recording.

2.9 Making a PCI Express Recording

After connecting the analyzer to the device(s), you will need to configure the Recording Options. Then you can test the analyzer by creating a 16-Mbyte snapshot recording.

To make this recording, follow these steps:

Step 1 From the **Setup** menu, select **Recording Options**. You are going to open the Recording Options dialog to see what settings will be used in this recording.

**Step 2** Select the **General** tab.

The following window displays the factory default settings such as "Snapshot" and 32 Mbytes buffer size are displayed. For your first recording, you can leave these settings unchanged.
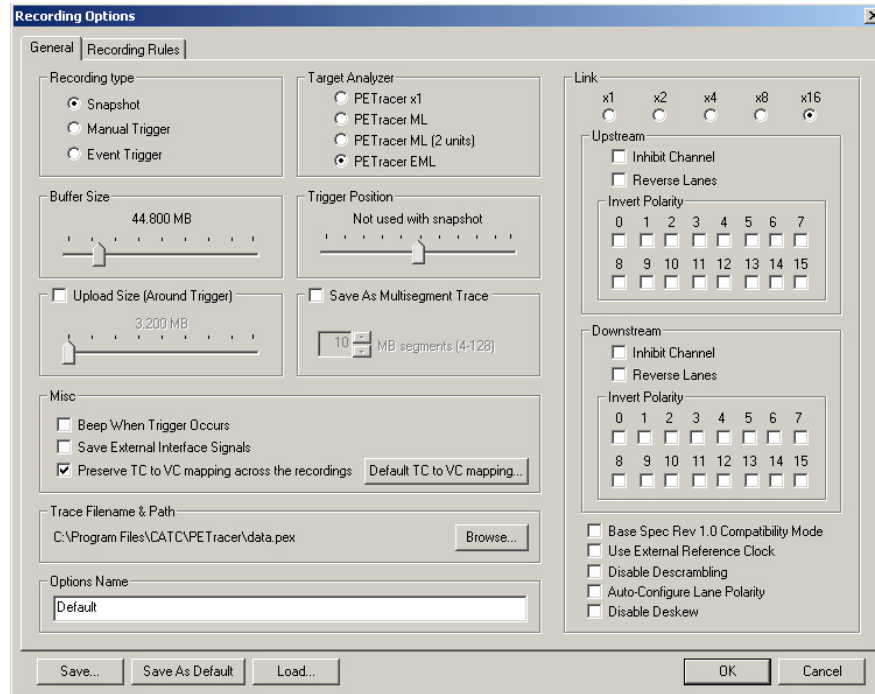
Step 3   In the **Link** section, specify the lane width of the PCI Express link to be analyzed. The rest of the settings in this section can be left at the factory defaults for most PCI Express systems.

Step 4   Click **OK** at the bottom of the Recording Options dialog box to apply the analyzer recording settings specified.

Step 5   Click the **Record** ● button.

Stopping a Recording

You can stop the recording process at any time by pressing the Stop button ■ . This will cause the analyzer to stop the recording and upload the trace to the host PC. If you press the Stop button again, the analyzer will temporarily halt the upload process and open the following dialog box:
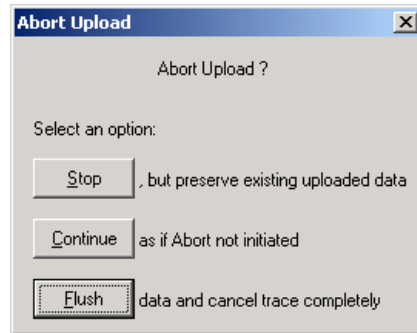
This dialog presents options for stopping, continuing, or aborting the upload:

- **Stop** - Aborts further trace upload and displays whatever trace data that has already been uploaded.

- **Continue** - Resumes the upload. This command tells the analyzer to finish uploading whatever trace data is still in its buffer.

- **Flush** - Flushes the trace without saving or displaying it.

If you allow the traffic data to be uploaded, it is automatically saved on the PC's hard drive as a file named **data<sn>.pex** (where **<sn>** is the serial number of the analyzer unit) or the name you assign as the default filename.

Step 6   To save a current recording for future reference, select **Save As** from the **File** menu.

Step 7   Give the recording a unique name, and save it to the appropriate directory.

2.10 External Interface Breakout Board

With each analyzer, LeCroy includes an External Interface Breakout Board for accessing several potentially useful standard, LV TTL output and input signals. The breakout board also offers a simple way to connect logic analyzers or other tools to the PETracer EML Analyzer unit. Six ground pins and one 5-volt pin are provided.

The Breakout Board connects via a cable to the **Data In/Out** connector located on the rear of the analyzer unit. Each signaling pin is isolated by a 100Ω series resistor and a buffer inside the Analyzer unit.

Data In/Out Connector (on cable)
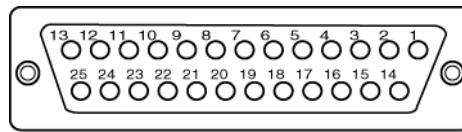
Pin-Outs for the Data In/Out Connector

The following table lists the pin-out and signal descriptions for the **Data In/Out** connector on a cable that connects to the Breakout board.

Data In/Out Connector – Pin-Out

Pin	Signal Name	Signal Description
1	RSV	Reserved
2	GND	Ground
3	GP OUT	General Purpose Output
4	TRG IN 1	Trigger In 1
5	GND	Ground
6	DATA 6	Data 6
7	DATA 4	Data 4
8	DATA 3	Data 3
9	DATA 1	Data 1
10	GND	Ground
11	RSV	Reserved
12	RSV	Reserved
13	+5V	+5 Volts, 250 mA DC Source
14	RSV	Reserved
15	GND	Ground
16	TRG OUT	Trigger Out
17	TRG IN 0	Trigger In 0
18	DATA 7	Data 7
19	DATA 5	Data 5
20	GND	Ground
21	DATA 2	Data 2

Pin	Signal Name	Signal Description
22	DATA 0	Data 0
23	GND	Ground
24	RSV	Reserved
25	RSV	Reserved

Note   (*) Pins 4 and 17 have the same function: they allow external signals to be used to cause triggering or recording. Pins 3 and 16 are used to transmit output signals. Pins 6, 7, 8, 9, 18, 19, 21, and 22 (data pins) are used to define data patterns for external input signals.

Note   All models of PETracer only support Data 0 - Data 3.

External Interface Breakout Board
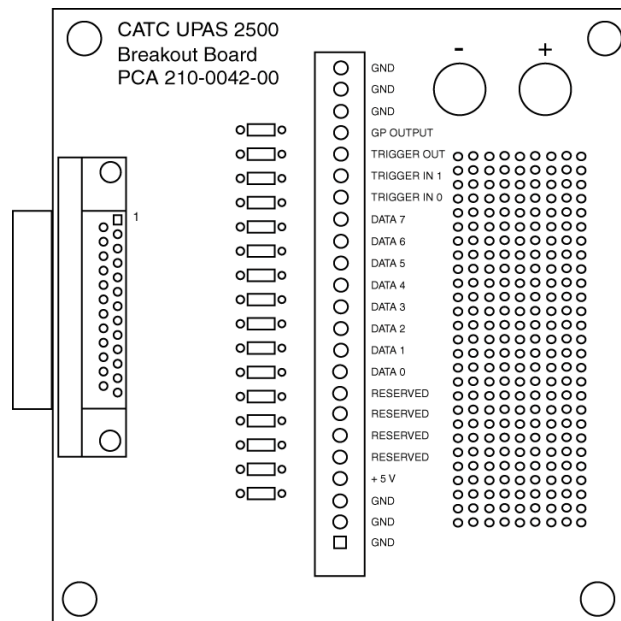
Prototype Rework Area

The Breakout Board contains a prototype rework area for making custom circuits for rapid development. The area consists of plated-through holes, 20 columns wide by 27 rows long. The top row of holes is connected to GND and the bottom row is connected to +5V. The remaining holes are not connected. Use the rework area to insert custom components and wire-wrap their respective signal, power, and ground pins.

Configuring the Analyzer for the Breakout Board

To configure the analyzer for the breakout board, see the section on Recording Options in the Online Help.

How to Contact LeCroy

Type of Service	Contact	
Call for technical support…	US and Canada:	1 (800) 909-2282
	Worldwide:	1 (408) 727-6600
Fax your questions…	Worldwide:	1 (408) 727-6622
Write a letter…	LeCroy Protocol Solutions Group Customer Support 3385 Scott Blvd. Santa Clara, CA 95054 USA	
Send e-mail…	support@CATC.com	
Visit LeCroy's web site…	http://www.lecroy.com/	

Limited Hardware Warranty

So long as you or your authorized representative ("you" or "your"), fully complete and return the registration card provided with the applicable hardware product or peripheral hardware products (each a "Product") within fifteen days of the date of receipt from LeCroy or one of its authorized representatives, LeCroy warrants that the Product will be free from defects in materials and workmanship for a period of three years (the "Warranty Period"). You may also complete your registration form via the internet by visiting http://www.lecroy.com/support/register/. The Warranty Period commences on the earlier of the date of delivery by LeCroy of a Product to a common carrier for shipment to you or to LeCroy's authorized representative from whom you purchase the Product.

What this Warranty Does Not Cover

This warranty does not cover damage due to external causes including accident, damage during shipment after delivery to a common carrier by LeCroy, abuse, misuse, problems with electrical power, including power surges and outages, servicing not authorized by LeCroy, usage or operation not in accordance with Product instructions, failure to perform required preventive maintenance, software related problems (whether or not provided by LeCroy), problems caused by use of accessories, parts or components not supplied by LeCroy, Products that have been modified or altered by someone other than LeCroy, Products with missing or altered service tags or serial numbers, and Products for which LeCroy has not received payment in full.

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During the Warranty Period, LeCroy or its authorized representatives will repair or replace Products, at LeCroy's sole discretion, covered under this limited warranty that are returned directly to LeCroy's facility or through LeCroy's authorized representatives.

How to Obtain Warranty Service

To request warranty service, you must complete and return the registration card or register via the internet within the fifteen day period described above and report your covered warranty claim by contacting LeCroy Technical Support or its authorized representative.

LeCroy Technical Support can be reached at 800-909-7112 or via email at support@catc.com. You may also refer to LeCroy's website at http://www.lecroy.com for more information on how to contact an authorized representative in your region. If warranty service is required, LeCroy or its authorized representative will issue a Return Material Authorization Number. You must ship the Product back to LeCroy or its authorized representative, in its original or equivalent packaging, prepay shipping charges, and insure the shipment or accept the risk of loss or damage during shipment. LeCroy must receive the Product prior to expiration of the Warranty Period for the repair(s) to be covered. LeCroy or its authorized representative will thereafter ship the repaired or replacement Product to you freight prepaid by LeCroy if you are located in the continental United States. Shipments made outside the continental United States will be sent freight collect.

Please remove any peripheral accessories or parts before you ship the Product. LeCroy does not accept liability for lost or damaged peripheral accessories, data or software.

LeCroy owns all parts removed from Products it repairs. LeCroy may use new and/or reconditioned parts, at its sole discretion, made by various manufacturers in performing warranty repairs. If LeCroy repairs or replaces a Product, the Warranty Period for the Product is not extended.

If LeCroy evaluates and determines there is "no trouble found" in any Product returned or that the returned Product is not eligible for warranty coverage, LeCroy will inform you of its determination. If you thereafter request LeCroy to repair the Product, such labor and service shall be performed under the terms and conditions

of LeCroy's then current repair policy. If you chose not to have the Product repaired by LeCroy, you agree to pay LeCroy for the cost to return the Product to you and that LeCroy may require payment in advance of shipment.

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