USER MANUAL

M-LINK | PC-Based Power & Energy Monitor

gentec-e·o
PARTNERS for ACCURACY

121-103350

WARRANTY

The Gentec-EO PC M-LINK has a one-year warranty (from date of shipment) against material and/or workmanship defects, when used under normal operating conditions. The warranty does not cover damages related to battery leakage or misuse.

Gentec-EO Inc. will repair or replace at Gentec-EO Inc.'s option, any M-LINK that proves to be defective during the warranty period, except in the case of product misuse.

Any attempt by an unauthorized person to alter or repair the product voids the warranty.

The manufacturer is not liable for consequential damages of any kind.

In case of malfunction, contact your local Gentec-EO distributor or nearest Gentec-EO Inc. office to obtain a return authorization number. The material should be returned to:

Gentec Electro-Optics, Inc.
445, St-Jean-Baptiste, Suite 160
Québec, QC
Canada   G2E 5N7

Tel: (418) 651-8003
Fax: (418) 651-1174
e-mail: service@gentec-eo.com

Website: www.gentec-eo.com

CLAIMS

To obtain warranty service, contact your nearest Gentec-EO agent or send the product, with a description of the problem, and prepaid transportation and insurance, to the nearest Gentec-EO agent. In any cases you will need a RMA number to return your equipment. Gentec-EO Inc. assumes no risk for damage during transit. Gentec-EO Inc. will, at its option, repair or replace the defective product free of charge or refund your purchase price. However, if Gentec-EO Inc. determines that the failure is caused by misuse, alterations, accident or abnormal conditions of operation or handling, you will be billed for the repair and the repaired product will be returned to you, transportation prepaid by the customer.

SAFETY INFORMATION

Do not use the PC M-LINK with the M-LINK if the device or the detector looks damaged, or if you suspect that the M-LINK is not operating properly.

Appropriate installation must be done for water-cooled and fan-cooled detectors. Refer to the specific instructions for more information. The user must wait for a while before handling these detectors after power is applied. Surfaces of the detectors get very hot and there is a risk of injury if they are not allowed to cool down.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Caution: Changes or modifications not expressly approved in writing by Gentec-EO Inc. may void the user's authority to operate this equipment.

SYMBOLS

The following international symbols are used in this manual:

Refer to the manual for specific Warning or Caution information to avoid any damage to the product.

DC, Direct Current

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1. THE M-LINK SINGLE CHANNEL LASER POWER/ENERGY METER
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1.1 Introduction

To obtain full performance from the M-LINK and the PC M-LINK, we recommend that you read this manual carefully.

The PC M-LINK software transforms your PC screen into a large M-LINK screen enabling you to control and see your information from a distance and transfer data to a PC for sophisticated data analysis.

The M-LINK is a microprocessor-based power and energy meter that uses the latest technology to provide a multitude of options in a user-friendly environment. It is a complete power and energy meter that can provide a statistical analysis of your measurements.

There is no need to enter the head specifications when connecting the new Gentec-EO power or energy detector heads, for head version 5 and above. The M-LINK is already internally set up to accept all the Gentec-EO wattmeter, Photodiode and Joulemeter heads with a DB-15 connector head version 5, 6 and 7. The M-LINK accepts the PE, UM, PH, QE series or an XLE-4. (Note that PC software PC-M-LINK is not compatible with UM.)
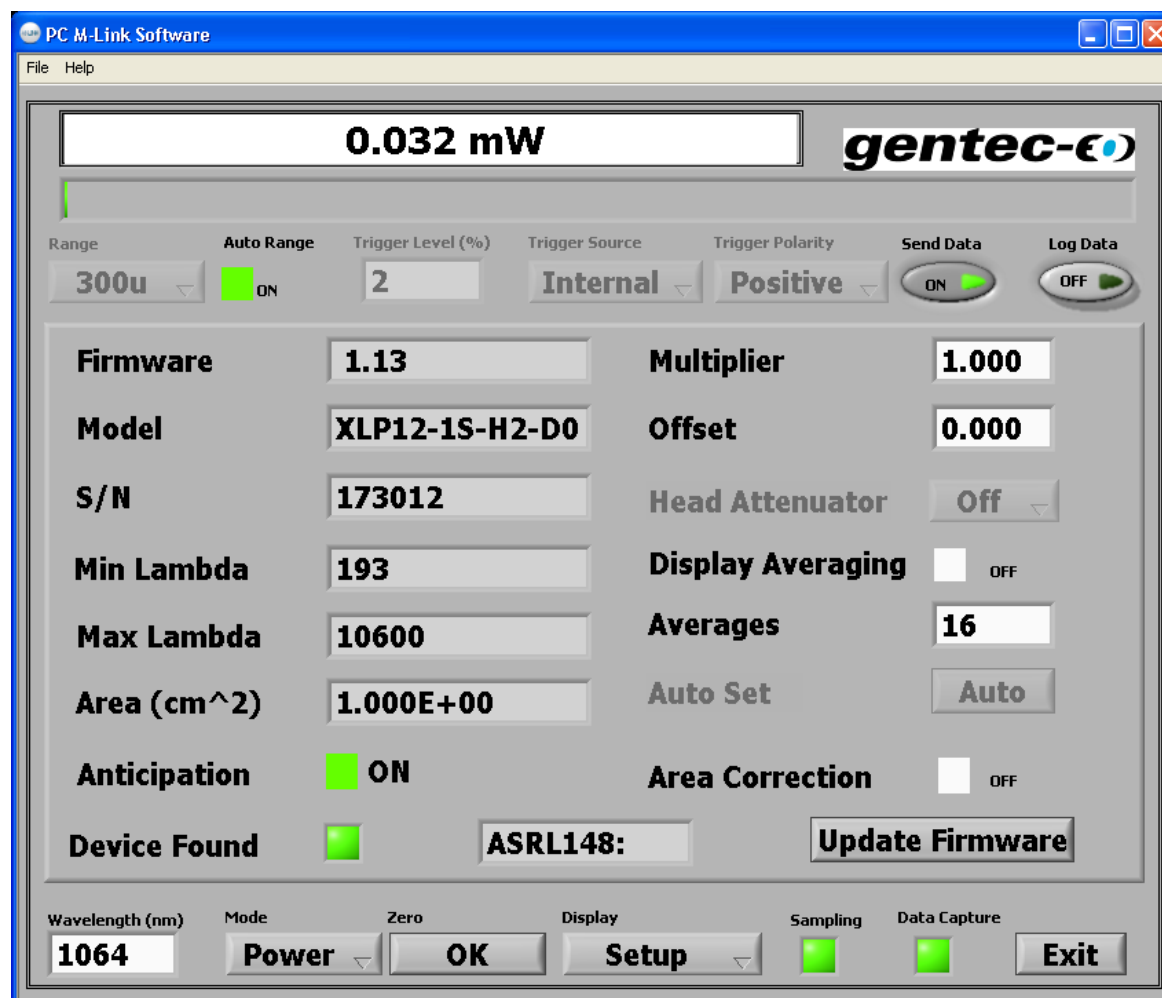
Fig 1.1 PC M-LINK user's interface

Unpacking

Each Gentec-EO M-LINK is thoroughly tested and calibrated prior to shipment.

Visually inspect every M-LINK unit after removing it from the shipping containers. If you see any damage, retain all packaging materials and shipping receipts. Any damage claim should be made promptly to the transportation company. Notify the nearest Gentec-EO representative concerning the claim, so that any repair or replacement can be arranged as soon as possible.

You can download the PC M-LINK program from our website. Go to the **Downloads** section of our website: www.gentec-eo.com/downloads. Click on the file name and download it to your PC. The specific actions necessary vary between browser and browser settings. After it is transferred, open the file on your PC and follow the instructions to uncompress and install it.

1.2 Specifications

The following specifications are based on a one-year calibration cycle, an operating temperature of 18 to 28ºC (64 to 82ºF) and a relative humidity not exceeding 80%.

Table 1-1 List of Specifications

	Power meter specifications
Power Range	4 pW to 30 kW
Power Scales [2] **(photo diode head)**	1 nW, 3nW, 10nW, 30nW, 100nW, 300nW, 1µW, 3µW, 10µW, 30µW, 100µW, 300µW, 1mW, 3mW, 10mW, 30mW, 100mW, 300mW, 1W, 3W
Power Scales [2] **(thermal head)**	300uW, 1mW, 3mW, 10mW, 30mW, 100mW, 300mW, 1W, 3W, 10W, 30W, 100W, 300W, 1kW, 3kW, 10kW, 30 kW
Pyroelectric in power mode range (UM-B)	100µW, 300µW, 1mW, 3mW, 10mW, 30mW, 100mW, 300mW
Resolution (digital)	Current scale/3000
Monitor Accuracy	±0.5 % ±2 digits [1]
Response Time (accelerated)[2]	Head dependant
Statistics	Current value, Max, Min, Average, Std Dev., RMS stability, PTP stability.
Data Storage	Continuous on hard drive

	Energy meter specifications
Energy Range	30 fJ to 30 kJ
Energy Scales [2] (photo diode head)	300fJ, 1 pJ, 3 pJ, 10 pJ, 30 pJ, 300pJ, 1 nJ, 3 nJ, 10 nJ, 30 nJ, 100nJ, 300nJ, 1 uJ, 3 uJ,10uJ, 30uJ, 100μJ, 300μJ, 1mJ, 3mJ, 10mJ, 30mJ
Energy Scales [2] (thermal head)	3mJ, 10mJ, 30mJ, 100mJ, 300mJ, 1J, 3J, 10J, 30J, 100J, 300J, 1kJ, 3kJ, 10kJ, 30kJ
Resolution (digital) [2]	Current scale/3000
Accuracy [3]	1.0 %±2 digits < 1 kHz
Default Trigger Level	2 %
Software Trigger Level	0.1% to 99%, 0.1% resolution
Repetition Frequency [4]	1.0 kHz for data acquisition in real time with time stamp, no missing point
Frequency Measurement	Accurate frequency measurement up to 1kHz 0-1000 Hz: 0.1% accuracy
Statistics	Current value, Max, Min, Average, Std Dev., RMS stability, PTP stability, Pulse #, Repetition Rate, Avg Power.
Data Storage	Continuous on Hard drive

	General Specifications
Digital Display	PC
Display Rate	3 Hz numeric display
	3 Hz bar graph display and needle display
Scope	500 divisions
Data Displays	Real time, Scope, Averaging, Statistics, Digital tuning needle, Setup
User input correction factors	1 multipliers and 1 offsets (7 digits floating point)
Analog Output	amplified signal of the head: 0 – 1.832 volt, ± 4% for wattmeter
	± 2% for joulemeter
	Energy heads and power heads are offset by approximately 626 mV
	Radiometer heads are offset by 1.25V
Positive External trigger	4.5 to 10 V @ 20 mA, optically isolated.
External trigger pulse width	0.7 us minimum, no maximum time.
Internet Upgrades	Yes
PC Serial Commands	USB
No missing point throughput serial frequency	1000 Hz (Turbo Mode)
	See rep rate note about being PC dependant
Dimensions	106 mm(W) x 34 mm (H) x 147 mm (D)
Weight	0.424 kg
Power Supply	USB

[1] The 2.5µV bias can induce an error into low power measurements with low sensitivity detectors. It is essential to use the Zero Offset to rezero the M-LINK before making a measurement in these conditions. It is always good practice to use the Zero Offset. See section 2.2.

[2] Varies with detector head.

[3] Including linearity.

[4] **This is PC dependant.** The application software warns the user if the application cannot keep up and recommends to reduce the rep rate.

1.3 Connector Descriptions

Fig. 1-2 M-LINK Connectors (USB side)

Fig. 1-3 M-LINK Connectors (DB-15 side)

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1-   **USB INTERFACE CONNECTOR:**

This interface allows remote control and data transfers between the M-LINK and a computer that has a USB communication port.

2-   **2-**   **External trigger:**

The Input connector is a Female BNC. The External trigger is TTL compatible. The monitor detects a trigger on the rising or falling side of the external trigger signal. The polarity is user selectable. M-Link is a sampled measurement system. The instrument keeps of buffer of pre-trigger data, and a buffer of post trigger data. Each buffer is the same width in time, and the width is dependent on the sensor in use. The minimum buffer width $80\mu s$, but it can scale up to as much as 260ms depending on the sensor. The pre and post rigger buffers widths are 1.6 times the sensor rise time. The buffer sizes are limited and will never be less than 80us per

buffer, or greater than 260ms per buffer. The sensor rise time can be found in the sensor specification sheet.

Example:

A QE12SP-S-MT has a 20 μs rise time. 1.6 x 20µs = 32us. This head will result in minimum sample buffers of 80us, pre and post trigger. As long as the trigger edge occurs in the ±80µs trigger window around the pulse peak, the pulse will be accurately measured. Figure 1.4 illustrates this.
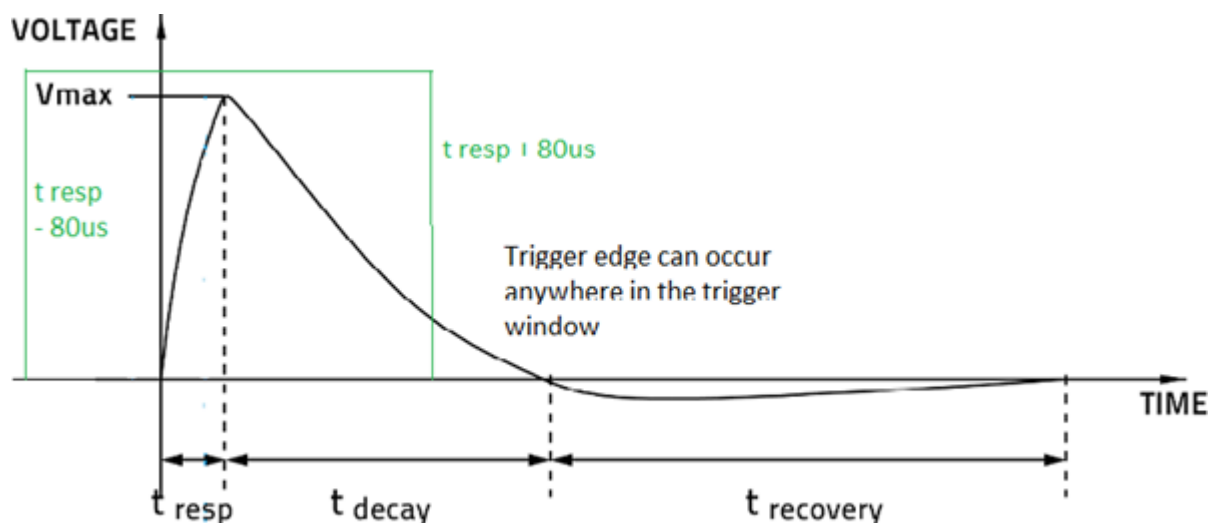
Fig. 1-4 Accurate external trigger zone, QE12SP-S-MT

.A QE65ELP-H-MB has a 6ms rise time.

The External trigger must be 1.6 x 6ms = 9.6ms before or 9.6ms after the laser pulse..

3-   **Status LED:**

The LED will turn on if the M-LINK is under power. The LED will flash if the head is not connected.

4-   **Analog-out:**

The analog output of the M-LINK is the amplified signal from the detector head, that the ADC sees. For power heads:

Analog Voltage = (Power or Energy measured / Current scale) * 1.832 + Voffset V

It is recommended to block off any optical power, make a zero offset and note the Voffset (Voffset is around 0.626 V, but with a power head may be different depending on how much power has been zeroed). It is not anticipated. For joulemeter heads, the output will follow the joulemeter pulse, use an oscilloscope or an acquisition card to measure the signal. The formula is $(V_{max}-V_{min})$ * 1.832. V_{max} is the maximum of the pulse. V_{min} is the voltage just before the pulse starts to rise.

5-   PROBE INPUT JACK:

The M-LINK uses a DB-15 female connector to mate with the detector heads (probes).

The M-LINK can take advantage of our *Personal wavelength correction*™. It reads the memory in the *Smart Interface* connector to provide a wavelength correction that is based on spectral data measured from that specific detector.

Supported Heads version

Power Detector	≥5
Photodiode Detector	≥8
Energy detector	≥6
Active photodiode (PHXB and PEXB)	≥1

The supported head are equipped with an "intelligent" DB-15 male connector that mates directly with the DB-15 female connector. They do not require an adaptor.

Energy detector heads prior to version 4 have a BNC connector. Contact your vendor for a hardware upgrade.

WARNING: This DB-15 connector, though similar to that of the former TPM-310 and TPM-330 monitors, is incompatible with the power detector heads of PS-310 Series Version 1 and PS-330 Series Version 1. These heads use a different technology and do not have the same pin-out configuration.

Any attempt to modify connectors of the early version heads to mate with the M-LINK could result in damage to the monitor.

2.   GETTING STARTED
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This section contains important information concerning the installation and operation of the M-LINK.

The M-LINK is delivered ready to use. Just insert a detector head in the DB-15 Detector Input Jack, insert the USB cable into the M-LINK and into the PC, and start the software.

2.1 Quick power and energy measurement procedure

This section applies to all M-LINK versions. It will show you the fastest way of making a **laser power and energy measurement** with the M-LINK and a Gentec-EO power or energy detector.

The monitor automatically recognizes all the Gentec-EO **supported** heads. All custom technical data required for optimum operation of the detector will be automatically downloaded from the EEPROM in the DB-15 connector. This data includes sensitivity, model, serial number, version, wavelength correction factors, and time response.

The first 11 steps are for M-LINK initialization, steps 12 to 14 refer to the PC M-LINK:

1- Install the power or energy detector head on its optical stand.

2- Turn the M-LINK off (unplug it) and connect a supported head to the M-LINK using the **Detector INPUT DB15**.

3- The M-LINK reads the head when a new one is connected. Power down is not required but you need to restart the application.

4- To avoid any information loss, be sure not to insert a head while the M-LINK is being powered-up or while you send the Reset Device command.

5- Slide the latch to the left to lock the connector into place.

6- Switch the M-LINK ON (plug it in).

7- Power heads default the M-LINK to power measurement; energy heads default the M-LINK to energy measurement.

8- Remove the head's protective cover.

Put the detector head into the laser beam path. The entire laser beam must be within the sensor aperture. Do not exceed maximum specified densities, energies or powers. For the most accurate measurement, spread the beam across 60% to 80% of the sensor area.

Attention: Power heads can be used with both CW and pulsed lasers.

Energy heads can only be used with pulsed lasers.

9- For power heads (using the M-LINK), go to step 8. For energy heads, go to step 13.

Adjusting the zero (steps 8 to 10)

10- Block off laser radiation to the detector.

11- The power read by the PC M-LINK when no laser beam is incident on the detector may not be exactly zero. The detector is either not thermally stabilized OR there was a heat source in the field of view of the detector when you turned on the M-LINK.

12- To reset the zero, wait until the reading has stabilized, right click and select **Zero Offset**. You are now ready to make an accurate measurement.

Notes:

• Refer to specific power detector documentation for complete installation and operating instructions.

• The power detectors are thermal sensors sensitive to temperature variations.

For high-precision measurements, we recommend:

• Allowing the power detector temperature to stabilize before zeroing the M-LINK.

• Not touching the detector head when handling the power detector. Touch the stand.

• Avoiding forced airflow or drafts around the detector.

13- Apply the laser beam to the detector head. The laser beam average power or energy will be displayed on the computer screen.

14- If the USB drivers and/or PC M-LINK have not been installed, install the USB drivers (see 3.1.1) then install PC M-LINK (self-directed).

15- Start the PC M-LINK software on the PC. Click Start / Programs /GENTEC-EO/ PC M-LINK.

16- The PC M-LINK will automatically detect the M-LINK com port, if it fails, select the correct COM Port (see section 3.2.3.2) and click Reconnect. You should see values pertaining to the current settings on the PC M-LINK.

2.2 USER INTERFACE

2.2.1   *Start the PC M-LINK software on the PC.*

Click Start / Programs /GENTEC-EO/ PC M-LINK Software.

2.2.2   *Make a connection with the M-LINK*

The PC M-LINK will automatically detect the M-LINK com port, if it fails, select the correct COM Port (see section 3.2.3.2)

2.2.3   *The Energy Setup Window*
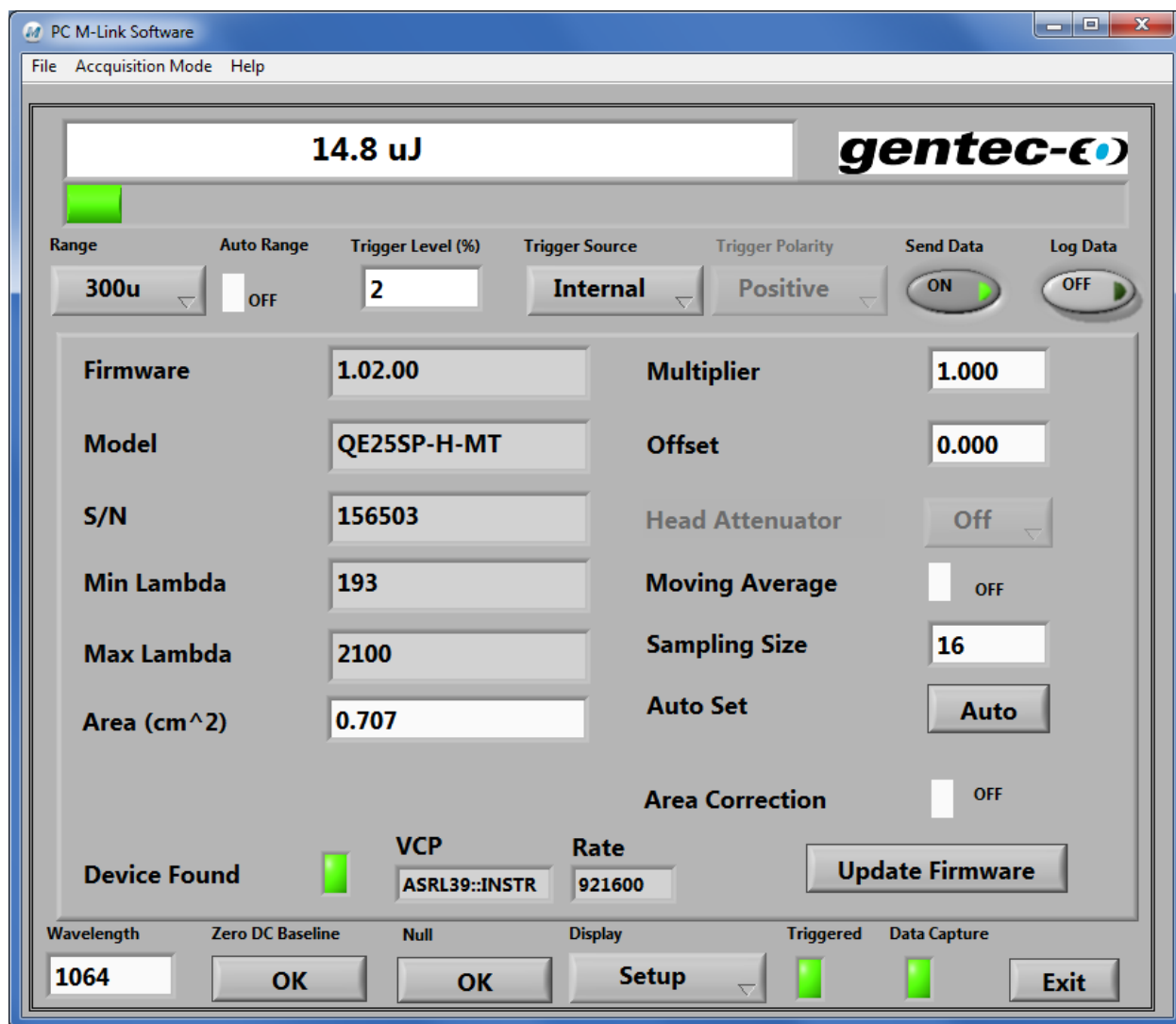
Fig. 1-5 The Energy Set-up Window

2.2.4   The Wattmeter Setup Window
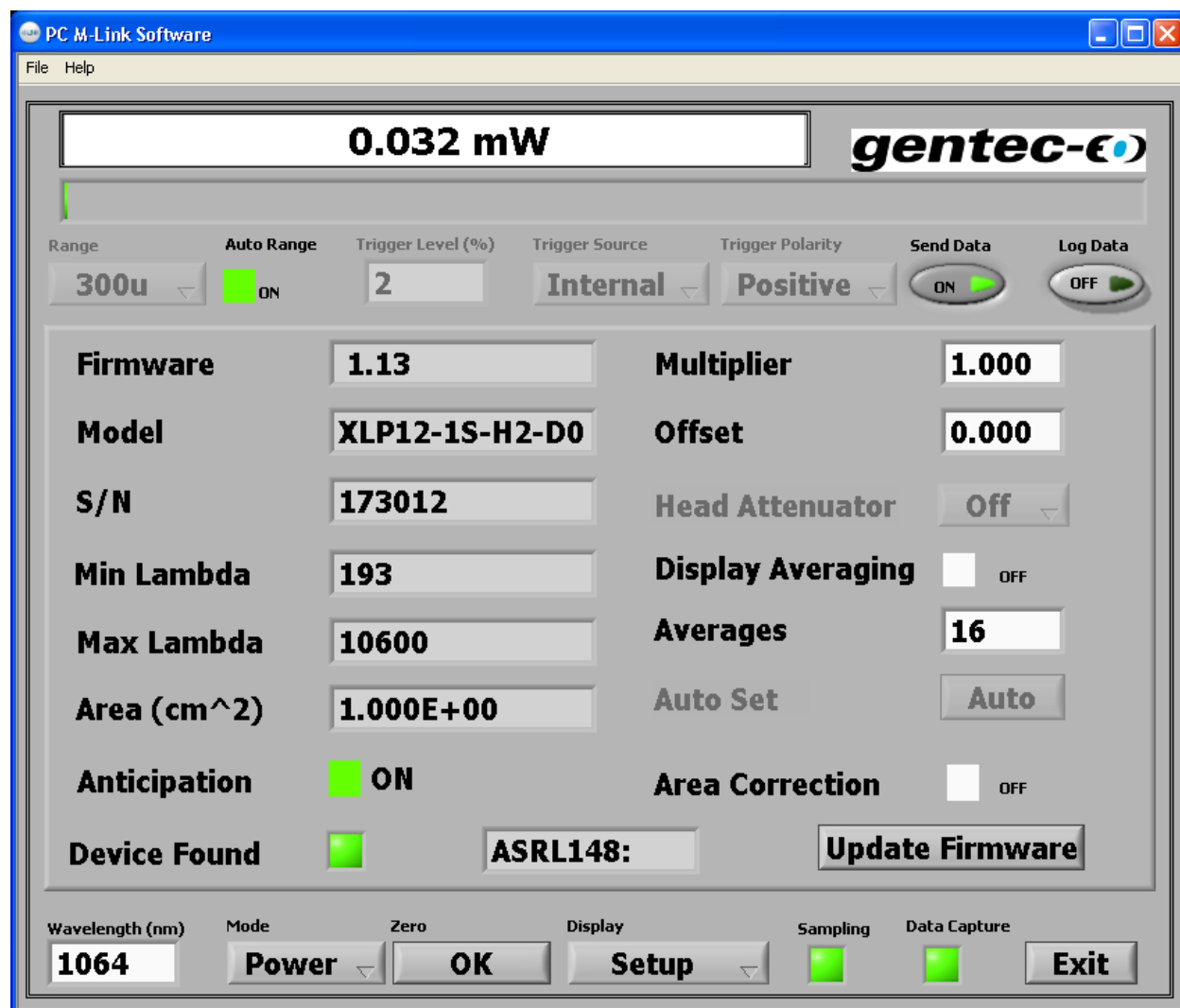
Fig. 1-5 The Wattmeter Setup Window

2.2.4.1   *The Measurement*

In Power mode

The Current value is updated at 3Hz.

When you change the scale, the acquisition and all display modes stop for a few milliseconds.

In Energy mode

The Current value is updated at 3Hz. But all data in the statistics are updated at up to 1 kHz in real time. Single shot measurement is always Valid. When you change the scale you might have a false measurement but the next measurement is accurate. There is no need for "Zero offset" in energy mode because the M-LINK compensates for an analog drift as long as the voltage is in range of the analog to digital converter.

When you change the scale, the acquisition and all display modes will stop for a few milliseconds.

To measure higher repetition rates it is possible to use the "Turbo Mode". Simply go to the "Acquisition Mode" menu on the upper right corner of the window. Select "Turbo Mode. When using the "Turbo Mode" only the statistics Window is available. It is possible to do statistics on a small batch size. It is also possible to log data in the "Turbo Mode".

2.2.4.2   *Range & Autorange*

The available range depends on the head ranges and the monitor's physical range.   Autorange tries to find the best measurement scale.

2.2.4.3   *Trigger Level*

The trigger level only works if an energy detector head is connected or if a power detector head is used in **Pulse Energy (Calorimeter)** mode. This option allows you to change the **Trigger Level** from 2% of the full-scale default value. This proves to be especially useful in noisy environments. Acceptable values range from 0.1% to 99% in 0.1% increments. Caution should be taken when choosing a lower trigger level than the 2% default value in a high noise environment.   You have to disable the autoscale in order to change the trigger level. When Auto range is turned on it resets the trigger to 2%.

Caution! If you select a high value trigger level the M-LINK may not be able to detect all the values of widely varying energy levels in **auto range mode**. The auto range function uses the energy level of the last pulse to set the scale level. Therefore, it will not detect the next pulses, if they are lower than the trigger level. As a result, the auto range may become caught on a high scale value. To avoid this problem, select a lower value for the trigger level, change the scale manually, or reset the auto range mode by reselecting **auto** in the **Range** menu.

Erratic triggering?

In electrically noisy environments, it is possible that the M-LINK will inadvertently trigger on the noise. If it does, increase the trigger level to 3% or higher if necessary.

It is always good practice to reduce electrical noise generation, or shield the detector and monitor, when measuring very low pulse energies.

You can also set the M-LINK to be triggered externally, via the BNC port. Just Select EXTERNAL for the trigger Source. It is possible to select the trigger polarity. Positive is a trigger source that goes low to High. Negative is for a trigger source that goes high to low.

2.2.4.4   *Send data*

This commands the M-LINK to Send data.

2.2.4.5   *Log data*

This command logs data on your PC Hard drive. The log is the same output as the Graphic. Set the Graphic to continuous. Select a file name and path to store the data. Press Log Data to log the data. The software will continue logging data until you close the file. Reset the Graphic to continuous if you want a continuous time stamp. Once you do so, the software will continue to use that file until you close it.

2.2.4.6 *Firmware*

The firmware version of your M-LINK.

2.2.4.7 *Model and S/N*

The head name and serial number.

2.2.4.8 *Min Lambda & Max Lambda*

The available minimum and maximum wavelengths of the head (in nanometer).

2.2.4.9 *AREA*

The default Area is 0.707e-1. You have to enter the area of your head manually. Activate the Area Correction in order to have your measurement in J/cm^2.

2.2.4.10 *Corrections*

The user can apply a multiplier and an offset value to the detector reading. Correction factors are most useful when sampling a percentage of a powerful laser beam or correcting for absorption along an optical chain.   The menu displays the values of the correction factors that are being applied to the measurements.

Multiplier & offset: Correction factor to be applied to the measurement.   The Formula is (Value * Multiplier) + Offset.   The default value for the multiplier is 1, and the default for the offset is 0. For example, if you are measuring the laser beam passing through the 99.9% back reflector of a laser (giving 1/1000th of the real value), choose **Multiplier** and enter 1000 in the dialog box. The M-LINK displays the laser's power rather than the measured 0.1% sample on the main display.

It is essential to make sure that the actual measured value also complies with the power and energy limits of the detector head. The auto range option is the default selection. You can select a specific range but it must always be based on the actual physical measured values and **not on the corrected value**. Of course, the displayed values and the display scale selection are then calculated to take into account the correction factors.

Note that the **Statistics** are calculated for the corrected values only.

To disable the correction factor, touch the check box corresponding to the correction factor (multiplier or offset) in the **Corrections** menu window.

Average: The number of measurements to be averaged. In wattmeter mode, it's the average off a 10Hz measurement. Click the Display Averaging to active the averaging.

2.2.4.11 *Update Firmware.*

The M-LINK has the ability to update its firmware.

> Step #1: Download the new firmware in the **Downloads** section on the Gentec-EO web site.

> Step #2 Select "LOAD NEW FIRMWARE FILE" in the Upgrade Firmware utility, Select the file you have just downloaded.

> Step #3 Select "Update firmware", we recommend not to make anything on your computer while the M-LINK is updating for about 5 minutes. If you have a laptop, connect the external power supply.

2.2.4.12 *Zero Baseline*

The M-LINK has the ability to zero the baseline of the joulemeter in case the offset is too high. This function should only be used if you see an invalid OUT on a selected range, this should not occur very often.

2.2.4.13 *Mode*

The Mode button enables you to activate the Energy mode with the thermal heads.

2.2.4.14 *Null*

In the Joulemeter window it is a math subtraction. When the user presses the button, whatever reading is current will be used as the subtraction value until the button is released. This feature is needed to make accurate measurements when using Noise suppression on very noisy signals. It does the same thing as entering the negative value of a reading in the offset control, it just makes it easier.

For example:

Connect the external trigger of your laser to the M-LINK. Block the Laser beam. Select the Noise Suppression. Start the statistics until the reading is stable. Make a Null, this will cancel the average noise. Unblock the laser beam. Make the measurement.

2.2.4.15 *Display*

You can Select the Display mode of your choice. The possible display modes are: Statistics, Graphic, Histogram, Setup and Needle.

2.2.5   The statistics display

Click on Start to begin the statistics. The Batch Size is the number of measurements the statistics analyses. Select Continuous if you want to collect statistics continually. If the statistics In Range LED goes red, one of the points went out of range and the statistics values may be incorrect. In Energy mode the average power can't be computed if the rep rate is lower than 1 Hz. The M-LINK can't measure rep rates lower than 1 Hz.
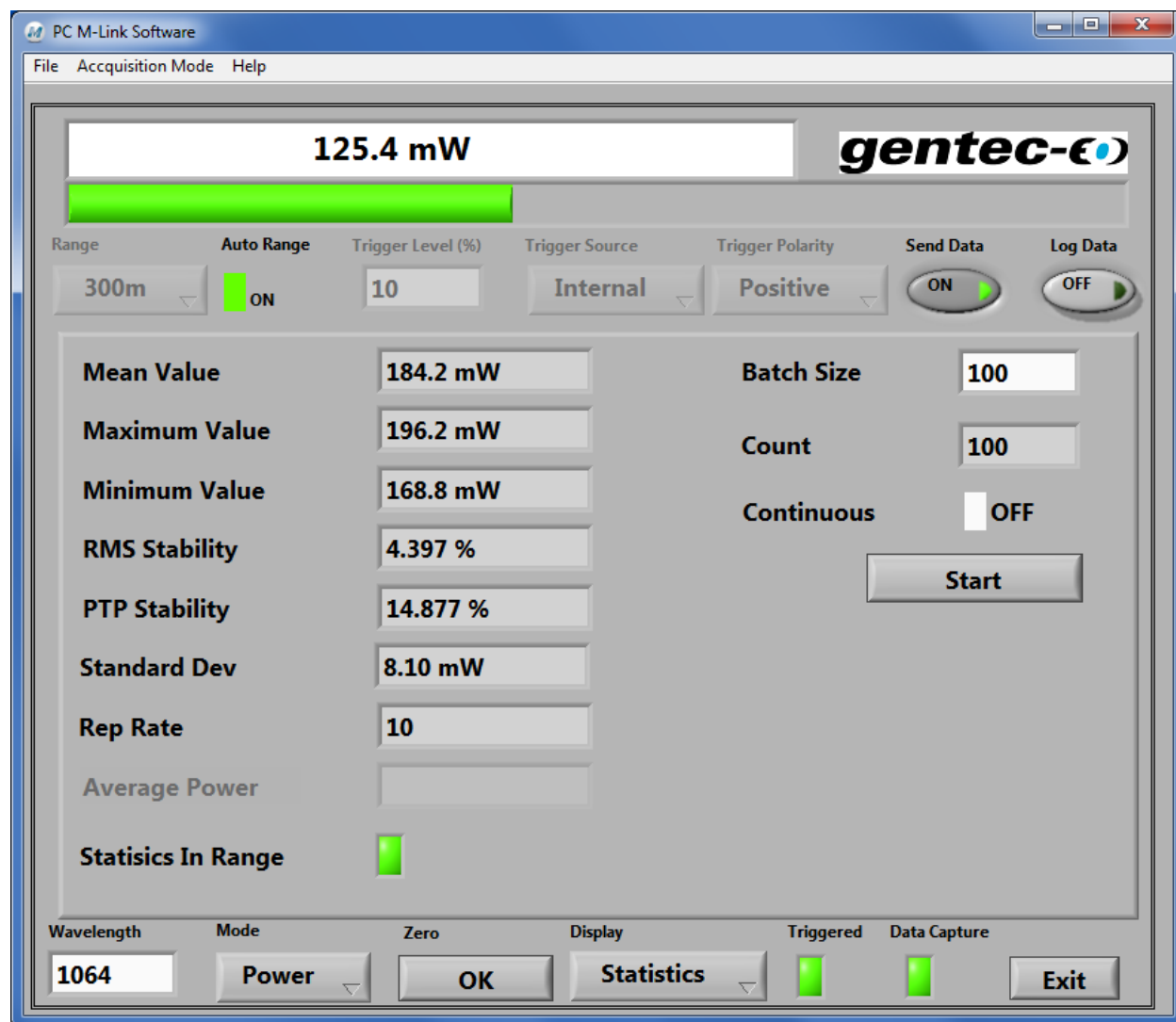

Fig. 1-6 The Statistics Display

2.2.6   The Noise Suppression

The M-LINK has a special proprietary algorithm that can lower the noise induced error when reading low level energy, or energy readings of any level with noise present. This feature greatly reduces the effect of noise on the peak to peak measurement in Joulemeter or Radiometer mode. To activate this special function, select the number of sampling size that you want to use. M-LINK will need to measure the number of pulse selected in the Sampling Size before the algorithm will settle to the noise suppressed value. Once the readings have stabilized, any subsequent reading will be stable until the Sampling Size is changed. The system will then stabilize to the new value. Larger Sampling Sizes will result in more noise suppression. To see the stabilizing effect, start the statistics and restart the batch while watching the RMS or PTP Stability until you have a stable reading. Noise suppression works best using the external trigger. This function will greatly improve the accuracy of the lowest scale or in any scale when used in a noisy environment.

You can also use the NULL function with Noise Suppression to improve the accuracy

For example:

Connect the external trigger of your laser to the M-LINK. Block the Laser beam. Select the Noise Suppression. Start the statistics until the reading is stable. Make a Null, this will cancel the average noise offset. Unblock the laser beam. Make the measurement with the noise suppression.

2.2.7   *The Histogram*

The number of Bins is the number of vertical lines in the Histogram.

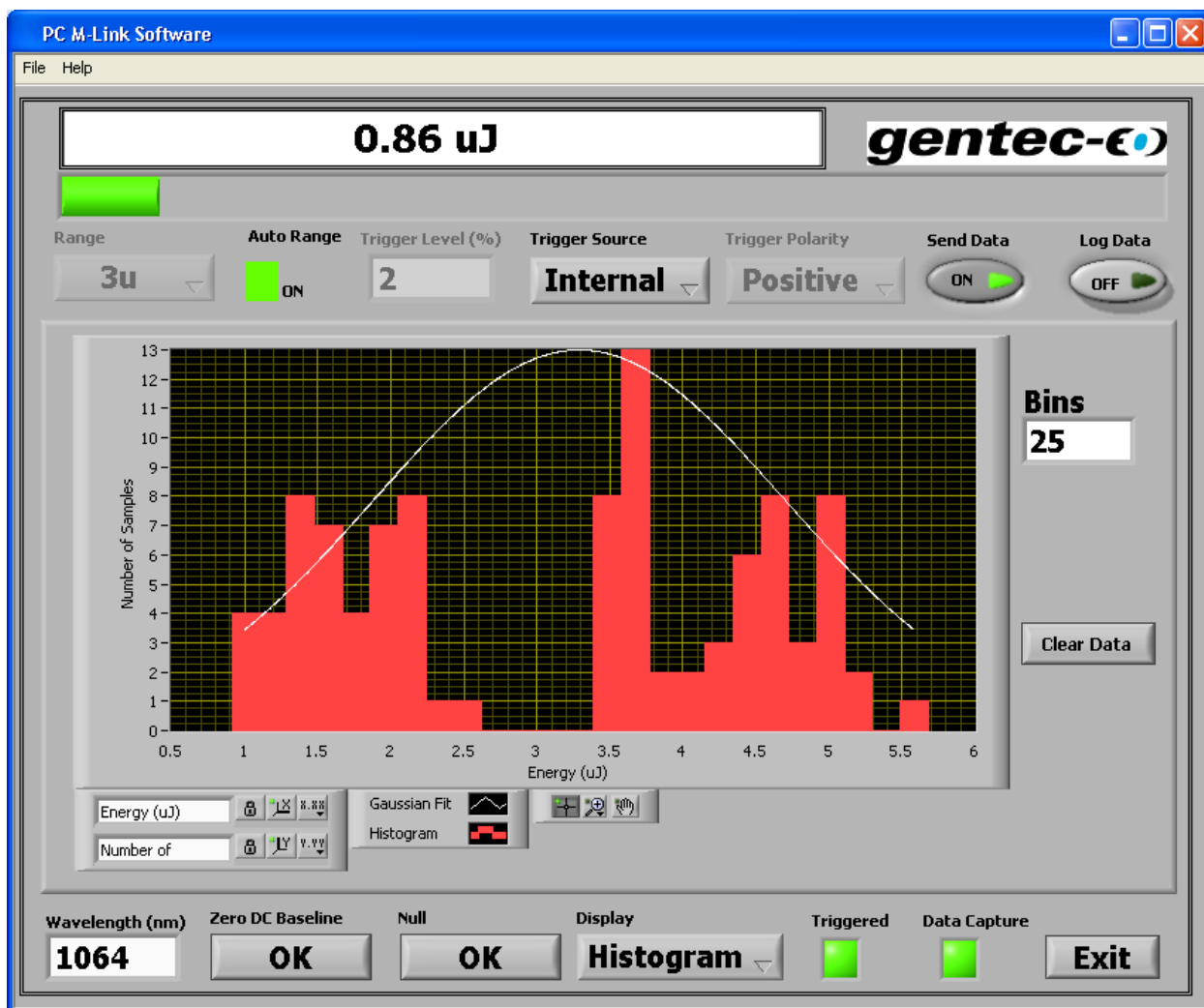To restart the histogram, press Clear Data.

Fig. 1-7 The Histogram Display

2.2.8   The Scope Display

The Plot Size number is the number of points before the graph gets refreshed.

The Auto Reset will Retrace a new graph automatically after 100 measurements, if the Auto Reset is not On, the graph will stop and show the last 100 points.
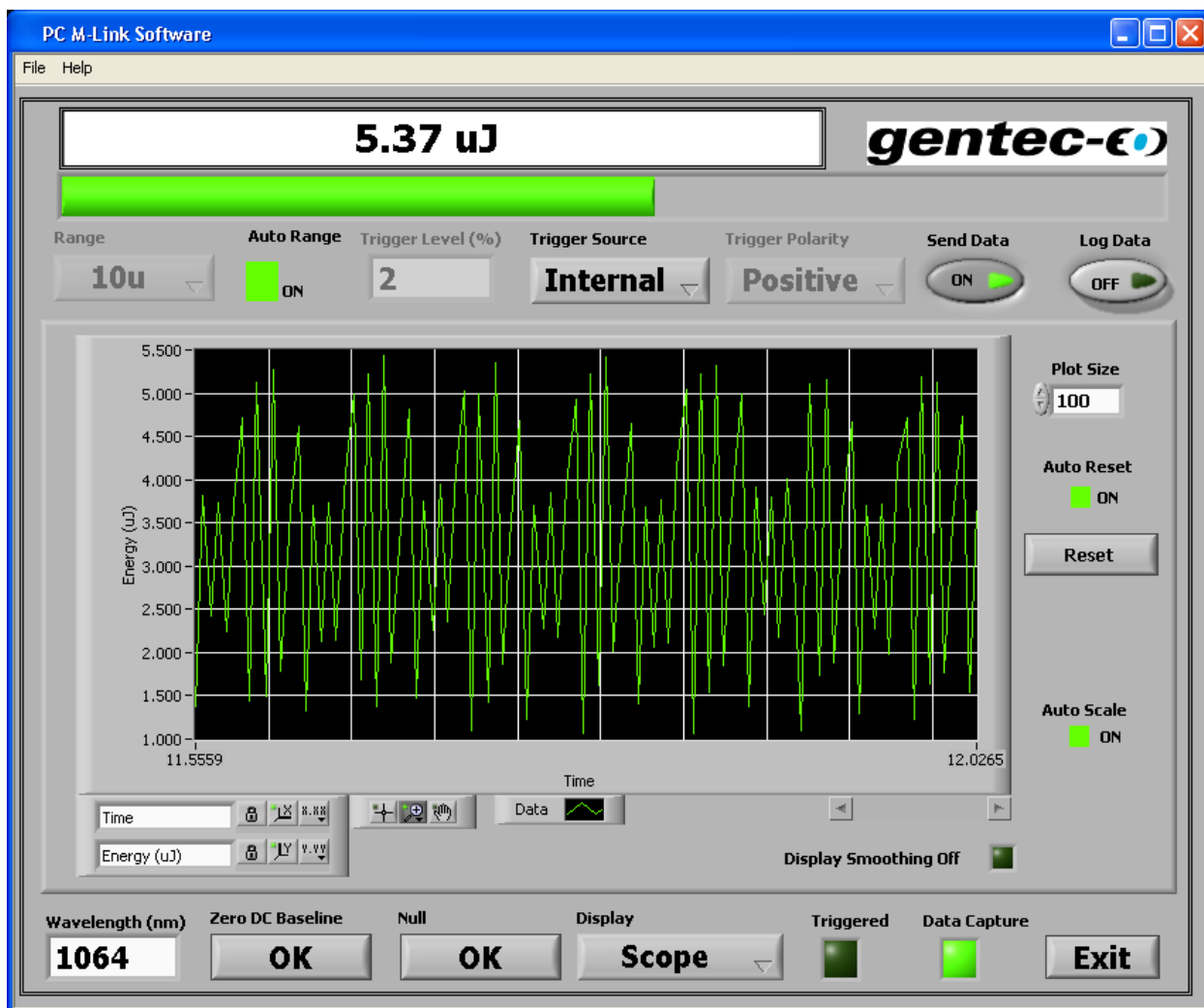
Fig. 1-8 The Scope Display

2.2.9   The Scope Settings
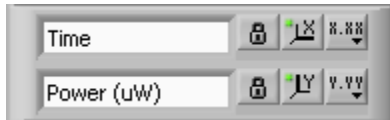
2.2.9.1   *Time:*

The 🔒 is the **Scale Lock** button to toggle autoscaling for each scale.

The 📈 is the **Autoscale** button to adjust the scale to reflect the data you wire to the graph or chart.

The 🔢 is the **Scale Format** button to configure the format, precision and mapping mode, set the visibility of the scale and scale label, and specify the grid color.

2.2.9.2   *Power or Energy:*

The 🔒 is the **Scale Lock** button to toggle autoscaling for each scale.

The 📈 is the **Autoscale** button to adjust the scale to reflect the data you wire to the graph or chart.

The 🔢 is the **Scale Format** button to configure the format, precision and mapping mode, set the visibility of the scale and scale label, and specify the grid color.

2.2.9.3   *Graphic options*

The ✛ is the **Cursor Movement Tool** - Moves the cursor on the display. This button applies only to graphs.

The 🔍 is the **Zoom** - Zooms in and out of the display.

The ✋ is the **Panning Tool** - Picks up the plot and moves it around on the display.

The [Data 〜] in the **Plot Legend** - Defines the color and style of the plots.

2.2.10   Averaging

The **Averaging** will use the number entered in the Setup Menu. The way to operate it is the same as the histogram display.

This is a bar and line plot. The min is a white bar plot, the max is a blue bar plot, and the mean is a yellow line plot. Each set of bars represent the min, max, and mean of the statistical batch.

The **Bin Size** (number of samples used to compute the min, mean, and max in each bar) is computed as:

Bin Size = Plot Size / Number of Bins. If the **Plot Size** is set to 100 and the **Number of Bins** is set to 10, then there will be 10 samples in each bin.
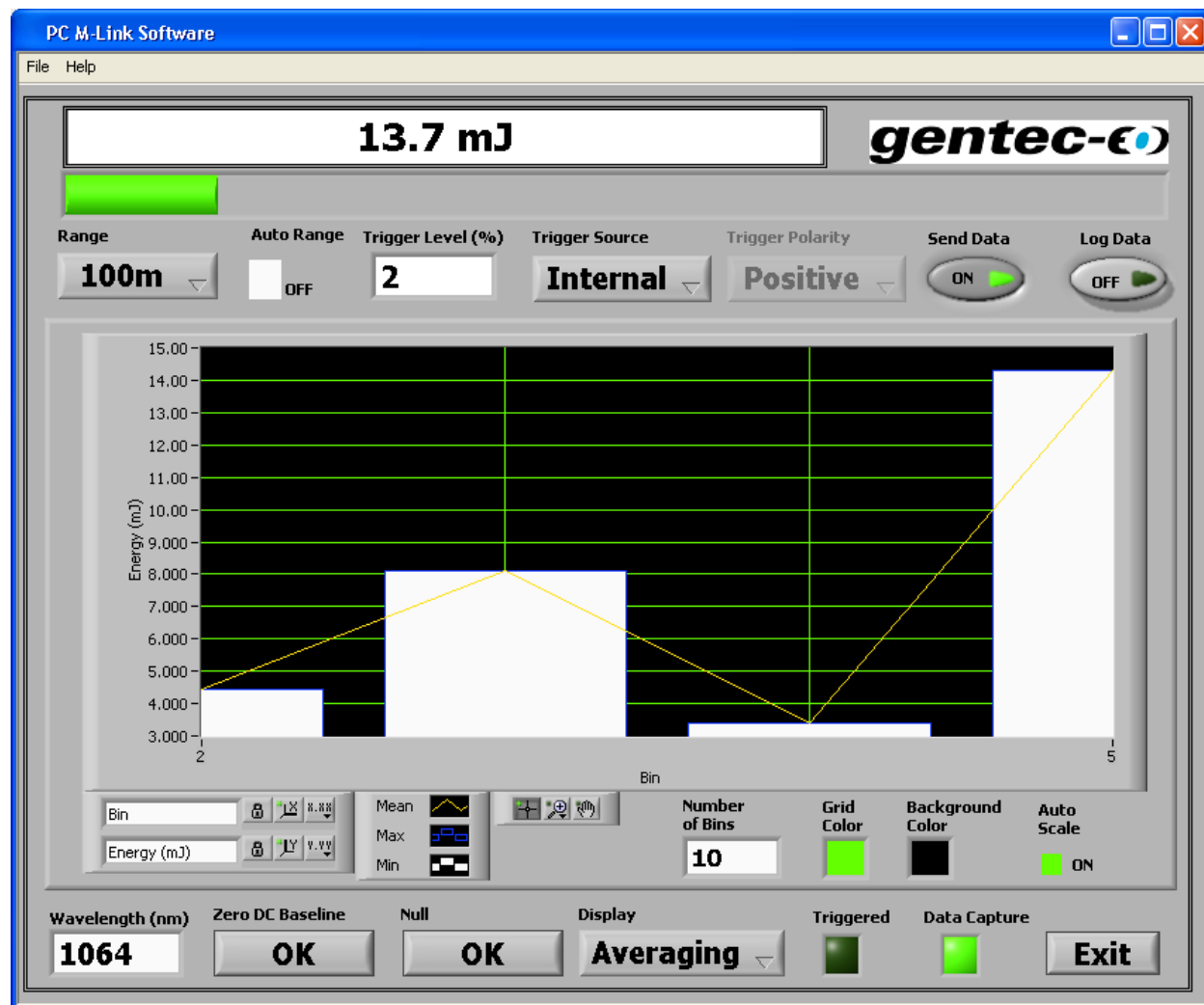
Fig. 1-9 The Averaging Display

2.2.11   The Needle

The **RESET** button resets the Needle Minimum (in black) and Maximum (in red).

The **Needle Scale** enables you to use the Minimum and the Maximum as the Needle Min and Max values.

The **Show Ramp** option enables a green, orange and red rainbow on the Needle scale.
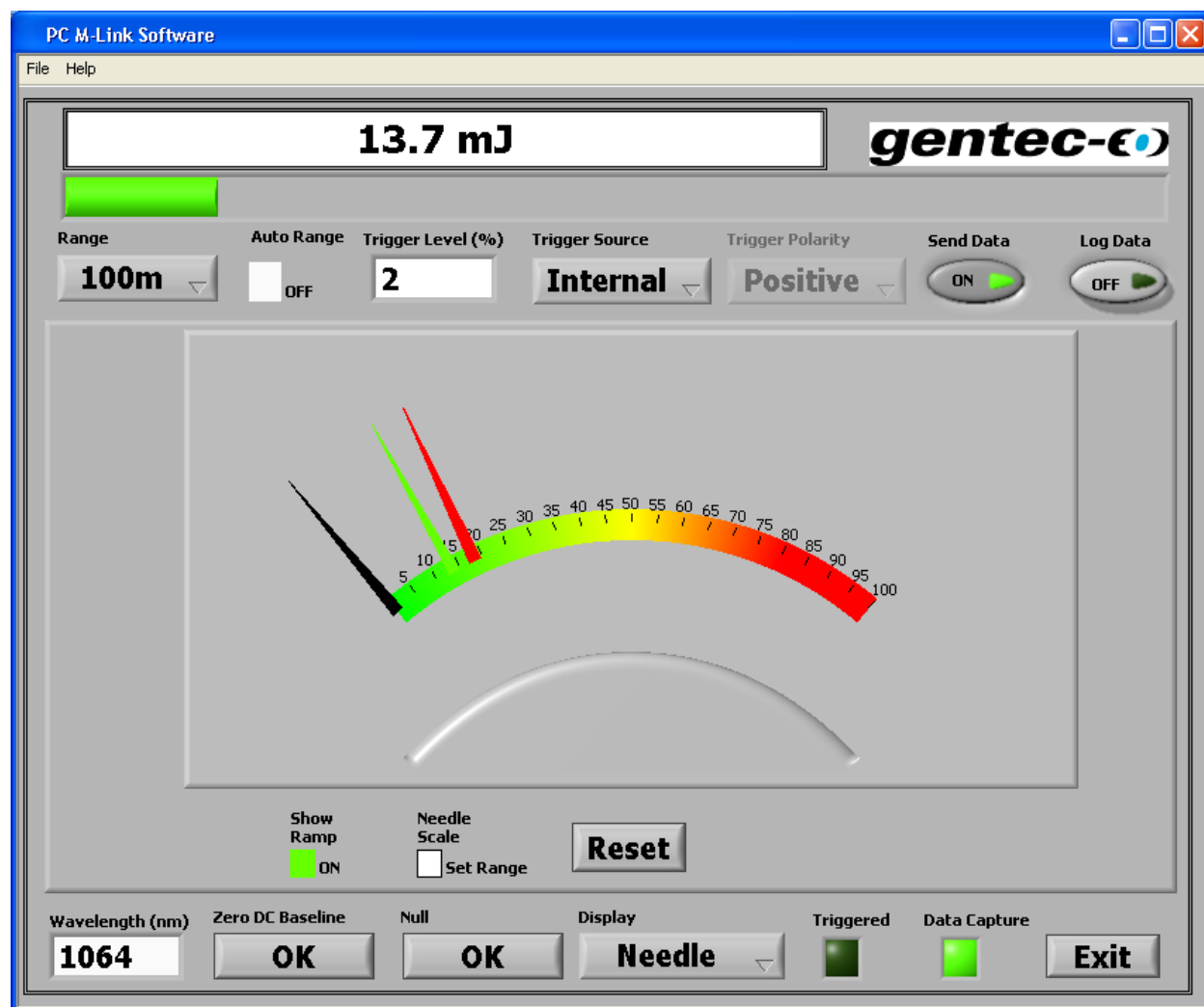
Fig. 1-10 The Needle Display

2.2.12   *Detecting missing laser pulses.*

The M-LINK detects the missing laser pulses using the External Trigger and the Histogram Display.

> Step 1: Connect the External trigger of your Laser to the External trigger of the M-LINK using the BNC connector.

> Step 2: Select the External trigger from the Status Window.

> Step 3: Select the Histogram Display in the Display Menu.

> Step 4: Start your laser and place your Cursor on the left x-axis, the upper corner of the histogram shows the number of pulses that are missed. Reset the histogram using the clear command.

2.2.13   Recommended PC

Basic functions work well on PCs dated 2004 and later. If you want to measure higher than 800 kHz, you have to use a computer with Dual Core or better and working on WinXP. If you want to be sure to capture all points and you have a laser frequency above 800 Hz, do not run other programs at the same time.

In statistics mode, the frequency measurement resets itself after the pulse number reaches the number of pulses set in the Status menu. If you want the reset to occur less frequently, set a very high number.

3. Installation and communication
▼

3.1 Installation

The M-LINK is not required for the PC M-LINK software installation. Do not plug the M-LINK into your PC until the PC M-LINK software has been installed because the installer loads the required USB drivers. Ensure that the M-LINK is connected to the USB port when you are ready to run the PC M-LINK software.

Connect the M-LINK USB port, located on the top panel of the instrument (see Figure 1-2), to the host device serial connector using the proper cable. The M-LINK comes with a standard USB cable.

3.1.1 To Install USB drivers for Windows™:

Installing the LabView software also installs the USB drivers. The drivers are not on the CD, but are embedded in the installer files. LabView first installs the M-LINK software. Then it runs the "USB driver installer-R2" automatically.

3.2 Setting up Communication to the M-LINK

3.2.1 Connecting the PC M-LINK to the M-LINK

3.2.1.1 Download the PC M-LINK file and execute it

Download PC M-LINK from our website, www.gentec-eo.com/downloads, in the **Downloads** section. Execute the downloaded file by SINGLE-clicking it, or, if the internet browser has the option of executing the file, execute it from the current location on the website.

3.2.1.2 Installation

Install the PC M-LINK. Press the Next button until it installs itself.

3.2.2 Running PC M-LINK

3.2.2.1 Start the PC M-LINK

Make sure that the M-LINK is connected to the PC M-LINK using the USB cable port. Start the PC M-LINK by clicking Start > Programs > Gentec-eo > PC-interface(M-LINK) menu.

3.2.2.2 Exit the PC M-LINK program

To exit use the **Exit** button on the lower right corner.

3.2.3 Connect to the M-LINK with HyperTerminal

3.2.3.1 Install the USB drivers

Installing the LabView software also installs the USB drivers.

3.2.3.2   *Verify COM Port*

To verify the USB installation and find the COM port number click:

Start → Settings → Control Panel → System → Device Manager

Scroll down to **Ports (COM & LPT)** and SINGLE click that line. One of the options should be

USB-to-Serial (COM#**)**

Note the COM port number. You need it for the next step.

You may use any serial communications software that you are familiar with. Our instructions are for HyperTerminal because it is widely available on PCs with Windows™. Click:

Start → Programs → Accessories → Communications → HyperTerminal

To save communication setting, enter a name for the connection. In the drop down menu "**Connect Using**" select the COM port that the USB driver was installed on (Section 3.2.3.2). Click **OK**.

Enter the following settings into the communications parameter window that appears next.

Bits per second	921600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

Click **OK** to begin entering serial commands in the HyperTerminal window.

3.2.3.3   *To echo commands*

The commands you type do not appear in the HyperTerminal window, unless you set the HyperTerminal up to do so. Only the response from the M-LINK is displayed. If you prefer to see the commands you are typing, on the HyperTerminal window, click the **File** menu and execute the following sequence:

File → Properties → Settings (tab) **→ ASCII setup →** select "**Echo typed characters locally**" **→ OK**

3.2.3.4   *Test the connection*

Before typing a command, you must send a carriage return by pressing the enter key. The instrument will return the baud rate you selected in section 3.2.3.2, or it will return ERR if the Baud rate has already been set. The communications link is now established.

How the Instrument Chooses its Baud Rate

The M-LINK instrument will use the highest available PC baud rate. PC's running a language that uses an alphabet such as English generally will have a maximum baud rate of 921600. PC's using a symbol based language such as Japanese run slower baud rates, usually with a maximum of 115200.

To facilitate finding the maximum baud rate, the instrument enters an Autobaud routine when it is powered on or reset. The Autobaud routine sets the instrument baud rate to 921600 and waits until the

host sends it a character. The routine assumes the sent character was a carriage return. Based on the actual value of the received character the instrument determines the baud rate of the host PC and resets its baud rate to match. It then sends the discovered baud rate to the host PC.

The instrument can be forced to the Autobaud state at any time by sending a com break. A com break is an empty bit frame. The instrument contains circuitry that detects this event and forces a hardware reset of the instrument. This allows the application software to reset the instrument to a known state.

In the HyperTerminal window type **VER**, press ↵ **ENTER**. If the response you receive tells you your M-LINK version number, you are successfully connected and ready for serial command action.

3.2.3.5   *HyperTerminal settings shortcut*

When you end the session, HyperTerminal asks you if you want to save your settings. To avoid re-entering the communication parameters, save them by clicking **yes**. The next time you execute the string of commands as shown above, the name of your session will appear after HyperTerminal. Clicking on the session name opens the connection using the saved settings. To avoid re-entering the string of commands, put a shortcut to this file on your desktop:

Find the file name, right click on it and select **Shortcut** in the drop down menu.

3.2.4   Serial Commands

3.2.4.1   *M-LINK Serial commands*

All commands and replies are followed by a carriage return (0x0D) and a line feed (0x0A). If a command is used with no arguments it will become a query.

All commands except AUT, SRC, STR1 and SQL reply with:

Ok if the command executed correctly.

Err if the command could not be executed.

All Queries reply with the item that was queried or Err if the query could not be executed.

With the exception noted above, the host software should wait for an instrument reply before executing a subsequent command or query.

VER	Queries the Firmware Version. No arguments are used. Example. Send: verCRLF Reply: 1.03CRLF
RNG	Sets or Queries the instrument range Example. Send rng27CRLF sets the range to index 27, the 30mW or 30mJ range. See table below for ranges versus indices rngCRLF queries the current range. Example rngCRLF returns the range index Reply 27CRLF
TRG	Sets or Queries the instrument trigger level Example. Send trg15CRLF sets the trigger level to 15% of the set range. trgCRLF queries the current trigger level. Example trgCRLF returns the trigger level Reply 15.0CRLF

STR	Starts or stops the data flow.
	Example.
	Send str1CRLF The M-LINK sends data to the com port. Data is sent at the pulse rate for Energy, at the chop rate for Radiometers, and at 10Hz for Power.
	Send str0CRLF M-LINK stops sending data and replies Ok.
	Data is the hexadecimal data string. See the note below for how to decode this value.
MAX	Query only. Returns the maximum range index for the head in use.
	Example
	Send maxCRLF
	Reply 27CRLF
MIN	Query only. Returns the minimum range index for the head in use.
	Example
	Send minCRLF
	Reply 20CRLF

ZRO	Command only. Sets the DC offset of the signal to the desired value. Example Send zroCRLF Reply 27,2350,655CRLF The values used are for example only. 655 counts represent 400mV of offset. All heads use this value, except Radiometers which use 2048 counts, or 1.25V. 0 counts is 0V, 4095 counts is 2.5V. The reply is Range Index, Offset DAC code, ADC counts. If Auto Range is enabled, all ranges will be zeroed. If Auto Range is disabled, only the current range will be zeroed.
SQL	Command only. This command blocks the signal to the instrument. It is used to synchronize two instruments in dual channel usage. Example Send sql1CRLF will block the signal and stop triggering. Send sql0CRLF will unblock the signal and start triggering. This allows two instruments in energy mode to start triggering on the same pulse.
MRD	Query only. Returns the maximum reading for the head in use. Example Send mrdCRLF Reply 216.7E-6CRLF, The maximum reading is 216.7uJ or uW.
SPD	Enables or Disables anticipation for Thermopile heads. Example Send spd1CRLF Anticipation is on and M-LINK returns Ok. Send spd0CRLF Anticipation is off and M-LINK returns Ok.
SRC	Sets the trigger source for energy or radiometric measurement. Example Send src1CRLF Trigger source is external. Send src0CRLF Trigger source is internal.

POL	Sets the external trigger polarity for energy or radiometric measurement Example Send pol1CRLF Trigger polarity is rising edge. Send pol0CRLF Trigger polarity is falling edge.
PRB	Query only. Returns the head connected flag. If no head is present the command does not reply. This allows the control software to periodically poll for a head connection. Example Send prbCRLF Reply NCRLF N = 1, head is connected. No reply means no head is connected.
AUT	Command only. Enables or Disables Auto Ranging. Example Send aut1CRLF Enable Auto Range. Replies Ok. Send aut0CRLF Disables Auto Range, Replies Ok.
NAM	Query only. Returns the head name. Example Send nameCRLF Reply Head NameCRLF
SSE	Command only. Enables or Disables Single Shot Energy for Thermopile Heads. Example Send sse1CRLF Enable SSE Mode, M-LINK replies Ok. Send sse0CRLF Disables SSE Mode, M-LINK replies Ok. If a Thermopile head is not in use, M-LINK replies Thermopile Head Only.

| CUR | Query only. Returns the current measurement. The argument is 1 for Energy Heads, Radiometric Heads, or Radiometer heads in Energy mode, and 0 for all others.

Example

Send cur1CRLF

Reply DataCRLF

Data is in a hexadecimal data string. See the note below: Data Format used by M-LINK for how to decode this value. |
|---|---|
| AVG | Sets or Queries the sampling size of the noise suppression.

Example

Send avg16CRLF sets sampling size to 16 pulses, M-LINK replies Ok.

avgCRLF queries the current average.

Example

avgCRLF

Reply 16CRLF

Valid averages are powers of 2 from 1 to 128. If a non valid argument is sent, Err is returned and the value is left unchanged. |
| HVR | Query only. Returns the head version.

Example

Send hvrCRLF

Reply VersionCRLF |
| SSN | Query only. Returns the head serial number.

Example

Send ssnCRLF

Reply Serial NumberCRLF |

WAV	Sets the wavelength. Send Wav1064CRLF sets the wavelength to 1064 nm, M-LINK replies with the following: Min range, max range, current range, corrections active CRLF Corrections active is 1 if wavelength correction is active, 0 if they are not. If the wave command is sent with no argument or if the argument is outside the wave correction table, M-LINK returns ERR CRLF. Example Wav1064CRLF Reply 25, 35, 25, 0 Minimum range is 3 m(W or J), maximum range is 300 m(W or J), current range is 3 m(W or J), wavelength correction is inactive.

3.2.5   *Data Format used by M-LINK in wattmeter mode.*

PPPP,RRPPPPPPCRLF

PPPP is the pulse data (ADC counts) with 3000 being full scale. If the MSB is set, the reading is negative.

RR is the range index

PPPPPP is the pulse period count. 1 million counts represent 1 second.

Example 1, Positive Power Reading:

Data = 06BD,1B000774CRLF

The data is 0x06BD. The MSB is not set, and the counts are 06BD, or 1725 counts.

The range is 0x1B, or index 27 which is 30mW or 30mJ.

The reading will be 1725 / 3000 x 30mW = 14.47mW.

The period is 0x000774 or 1908 counts. 1E6 counts / second / 1908 counts = 524Hz.

Example 2, Negative Power Reading:

Data = 8099, 1E00186A0CRLF

The data is 0x8099.The MSB is set, and the counts are 0099, or 153 counts.

The range is 0x1E, or index 30 which is 1W or 1J.

The reading will be -153 / 3000 x 1W = -51mW.

The period is 0x0186A0 or 100000 counts. 1E6 counts / second / 100000 counts = 10Hz.

3.2.6   *Data Format in Energy Mode*

The M-LINK sends 7 bytes in Energy Mode. The data is terminated by a carriage return, so a carriage return must not be sent inadvertently. As M-LINK is building the data byte, it checks to see if the byte is a carriage return. If it is, it decrements it by one and sets a bit in a byte called the correction byte. The correction byte is structured so that it is always an even value, therefore it can never be a carriage return. This byte is sent after the 5 data bytes, and then the carriage return is sent.

Byte 1 is the upper 8 bits of the pulse data.

Byte 2 is the lower 4 bits of the pulse data and the upper 4 bits of the range index.

Byte 3 is the lower 4 bits of the range and the upper 4 bits of the period counts.

Bytes 4 and 5 are the remaining 16 bits of the period counts, twenty bits total.

Byte 6 is the correction byte

Byte 7 is the carriage return.

       Example with no byte corrections:

       The data is 0xA711F01EC2000D

       0xA7 byte 6

       0x11 byte 5

       0xF0 byte 4

       0x1E byte 3

       0xC2 byte 2

       0x00 byte 1, the correction byte

       0x0D byte 0, carriage return.

All the following is done in the host application

Byte 1 is the correction byte and is interpreted as follows:

Bit0 is not used, always set to 0

Bit1 set, increment byte 2 by 1, not set, byte 2 is ok

Bit2 set, increment byte 3 by 1, not set, byte 3 is ok

Bit3 set, increment byte 4 by 1, not set, byte 4 is ok

Bit4 set, increment byte 5 by 1, not set, byte 5 is ok

Bit5 set, increment byte 6 by 1, not set, byte 6 is ok

Bit6 set, the ADC returned 0 Counts, ambiguous data

Bit7 set, the ADC returned 4095 Counts, ambiguous data

Mask off the upper 12 bits, shift them right by 44 bits. The value is 0xA71, or 2673 counts.

Mask of the next 8 bits and shift the 36 bits to the right. The value is 0x1F, or range index 31.

Mask of the next 20 bits and shift the 16 bits to the right. The value is x01EC2, or 7874 period counts.

Mask off the next 8 bits and shift 8 bits to the right. The value is 0x00, so there are no errors or corrections.

Range 31 is 3, a full scale reading in any range is 3000 counts, so the value is 2673 / 3000 x 3 =2.673 Units.

The period full scale is 1E6, so the frequency of the data is 1e6 / 7874 = 127 Hz.

> Example with byte corrections:
>
> The data is 0x0C11F0FED2200D
>
> 0x0C byte 6
>
> 0x11 byte 5
>
> 0xF0 byte 4
>
> 0xFE byte 3
>
> 0xD2 byte 2
>
> 0x20 byte 1, the correction byte
>
> 0x0D byte 0, carriage return.

All the following is done in the host application

Byte 1 is the correction byte and is interpreted as follows:

Bit0 is not used

Bit1 set, increment byte 2 by 1, not set, byte 2 is ok

Bit2 set, increment byte 3 by 1, not set, byte 3 is ok

Bit3 set, increment byte 4 by 1, not set, byte 4 is ok

Bit4 set, increment byte 5 by 1, not set, byte 5 is ok

Bit5 set, increment byte 6 by 1, not set, byte 6 is ok

Bit6 set, the ADC returned 0 Counts, ambiguous data

Bit7 set, the ADC returned 4095 Counts, ambiguous data

Mask off the upper 12 bits, shift them right by 44 bits. The value is 0x0C1, or 193 counts.

Mask of the next 8 bits and shift the 36 bits to the right. The value is 0x1F, or range index 31.

Mask of the next 20 bits and shift the 16 bits to the right. The value is x0FED2, or 65234 period counts.

Mask off the next 8 bits and shift 8 bits to the right. The value is 0x40, so there are no errors but bit 5 is set so we will add 1 to byte 6, making it 0x0D. This means the pulse data is 0x0D1, or 209 counts.

Range 31 is 3, a full scale reading in any range is 3000 counts, so the value is 209 / 3000 x 3 = 0.209 Units.

The period full scale is 1E6, so the frequency of the data is 1e6 / 65234 = 15.3 Hz.

Scale	xx	
1f	00	*1 femtowatt or femtojoule*
3f	01	*3 femtowatts or femtojoules*
10f	02	*10 femtowatts or femtojoules*
30f	03	*30 femtowatts or femtojoules*
100f	04	*100 femtowatts or femtojoules*
300f	05	*300 femtowatts or femtojoules*
1p	06	*1 picowatt or picojoule*
3p	07	*3 picowatts or picojoules*
10p	08	*10 picowatts or picojoules*
30p	09	*30 picowatts or picojoules*
100p	10	*100 picowatts or picojoules*
300p	11	*300 picowatts or picojoules*
1n	12	*1 nanowatt or nanojoule*
3n	13	*3 nanowatts or nanojoules*
10n	14	*10 nanowatts or nanojoules*
30n	15	*30 nanowatts or nanojoules*
100n	16	*100 nanowatts or nanojoules*
300n	17	*300 nanowatts or nanojoules*
1u	18	*1 microwatt or microjoule*
3u	19	*3 microwatts or microjoules*
10u	20	*10 microwatts or microjoules*
30u	21	*30 microwatts or microjoules*
100u	22	*100 microwatts or microjoules*
300u	23	*300 microwatts or microjoules*
1m	24	*1 milliwatt or millijoule*
3m	25	*3 milliwatts or millijoules*
10m	26	*10 milliwatts or millijoules*
30m	27	*30 milliwatts or millijoules*
100m	28	*100 milliwatts or millijoules*
300m	29	*300 milliwatts or millijoules*
1	30	*1 Watt or Joule*
3	31	*3 watts or joules*
10	32	*10 watts or joules*
30	33	*30 watts or joules*
100	34	*100 watts or joules*
300	35	*300 watts or joules*
1k	36	*1 kilowatt or kilojoule*
3k	37	*3 kilowatts or kilojoules*
10k	38	*10 kilowatts or kilojoules*
30k	39	*30 kilowatts or kilojoules*
100k	40	*100 kilowatts or kilojoules*
300k	41	*300 kilowatts or kilojoules*
1meg	42	*1 megawatt or megajoule*
3meg	43	*3 megawatts or megajoules*
10meg	44	*10 megawatts or megajoules*
30meg	45	*30 megawatts or megajoules*
100meg	46	*100 megawatts or megajoules*
300meg	47	*300 megawatts or megajoules*

4.   MAINTENANCE

▼

4.1 USB installation for the M-LINK

The M-LINK has a USB type B port. When it is connected to a PC it emulates a standard serial port. It has a simple interface so that it is easy to design software for. The M-LINK can only function using the USB port power.

5. DECLARATION OF CONFORMITY

▼

Application of Council Directive(s):   2004/108/EC   EMC Directive

Manufacturer's Name:	Gentec Electro Optics, Inc.
Manufacturer's Address:	445 St-Jean Baptiste, suite 160
	(Québec), Canada G2E 5N7
European Representative's Name:	Laser Components S.A.S.
Representative's Address:	45 bis Route des Gardes
	92190 Meudon (France)
Type of Equipment:	Laser Power/Energy Meter
Model No.:	M-LINK
Year of test & manufacture:	2011

Standard(s) to which Conformity is declared:
EN 61326-1: 2006 Emission generic standard

Standard	Description	Performance Criteria
CISPR 11 :2009

A1 :2010 | Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement | Class A |
EN 61000-4-2 2009	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques- Electrostatic discharge.	Class B
EN61000-4-3 2006+A2:2010	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques- Radiated, Radio Frequency, electromagnetic field immunity test.	Class A
EN61000-4-4 2004+A1:2010	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques- Electrical fast transient/burst immunity test.	Class B
EN 61000-4-5 2006	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques- Surge immunity test.	Class B
EN 61000-4-6 2009	Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurements techniques- Immunity to conducted Radio Frequency.	Class A
EN 61000-4-11 2004	Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques- Voltage dips, short interruptions and voltage variations immunity tests	Class B
Class B
Class C
Class C
EN 61000-3-2:2006 +A1:2009	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase)	Class A

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place: Québec (Québec)
Date :   May 4, 2011

(President)

6. UKCA DECLARATION OF CONFORMITY

▼

UK
CA

Application of Council Directive(s):   2004/108/EC   EMC Directive

Manufacturer's Name:	Gentec Electro Optics, Inc.
Manufacturer's Address:	445 St-Jean Baptiste, suite 160
	(Québec), Canada G2E 5N7
European Representative's Name:	Laser Components S.A.S.
Representative's Address:	45 bis Route des Gardes
	92190 Meudon (France)
Type of Equipment:	Laser Power/Energy Meter
Model No.:	M-LINK
Year of test & manufacture:	2011

Standard(s) to which Conformity is declared:
EN 61326-1: 2006 Emission generic standard

Standard	Description	Performance Criteria
CISPR 11 :2009 A1 :2010	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement	Class A
EN 61000-4-2 2009	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques- Electrostatic discharge.	Class B
EN61000-4-3 2006+A2:2010	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques- Radiated, Radio Frequency, electromagnetic field immunity test.	Class A
EN61000-4-4 2004+A1:2010	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques- Electrical fast transient/burst immunity test.	Class B
EN 61000-4-5 2006	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques- Surge immunity test.	Class B
EN 61000-4-6 2009	Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurements techniques- Immunity to conducted Radio Frequency.	Class A
EN 61000-4-11 2004	Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques- Voltage dips, short interruptions and voltage variations immunity tests	Class B Class B Class C Class C
EN 61000-3-2:2006 +A1:2009	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase)	Class A

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place: Québec (Québec)
Date :   November 30, 2021

(President)

7. APPENDIX A

▼

7.1 Attenuator/Diffuser Calibration Procedure

7.1.1 Introduction:

These "Attenuator/Diffusers" must be **<u>user</u>** calibrated for wavelengths other than the calibration wavelength (typically 1.064μm).

The calibration procedure is relatively easy. First measure without the attenuator, then with the attenuator. The ratio of these measurements will be your correction.

7.1.2 When using an oscilloscope:

to calculate the energy reading (see joulemeter manual), Divide the joulemeter voltage output by the calibration sensitivity we provide.

*To use this procedure at a wavelength other than the wavelength stated on the calibration certificate, manually adjust the sensitivity value (of the cal. certificate) with the wavelength **correction multiplier** from the Personal Wavelength Correction certificate. Use this wavelength-adjusted sensitivity to calculate the energy readings used in the procedure that follows.*

7.1.3 When using a Gentec-EO M-LINK:

In the *Control* menu there should be **no check mark** in the *Attenuator* setting. It must be off to access the wavelength correction (*Settings → Corrections menu*. You need this to input the wavelength that you are calibrating at (see monitor manual). The *Attenuator* setting should be checked off if you are redoing a calibration at the same wavelength as stated on the joulemeter calibration certificate.

7.1.4 Procedure:

Step 1: Setup your joulemeter to measure the energy of your pulsed laser. If you are working at a wavelength other than the calibrated wavelength, adjust the sensitivity of your joulemeter for that wavelength; see *When using an oscilloscope or When using a Gentec-EO M-LINK or Duo monitor,* above. Ensure that the energy level is below the detector's damage threshold and your laser is still stable.

Step 2: Apply energy for a few minutes to warm up the detector. This will reduce any thermal bias.

Step 3: Measure the energy level without the attenuator. To reduce random uncertainty, average a number of shots. We recommend at least one hundred shots. This should reduce random errors by a factor of 10. (Square root of "n" assuming Gaussian distribution).

Step 4: Install the attenuator. Without changing the laser settings, measure the energy level by averaging the same number of shots. All laser settings must be the same as Step 3 (including beam size and position on the detector).

Step 5: Repeat the first measurement (Step 3) to make sure that nothing has changed during the procedure to invalidate the calibration. A larger change than the uncertainty of your measurements means that something has changed in the laser or in the environment. Add this to your ± uncertainty when you use the attenuator or try to stabilize the laser and the environment. Go back to Step 3.

The correction multiplier for the M-LINK and an Oscilloscope is calculated:

$$T_f = \frac{\text{Reading without attenuator}}{\text{Reading with attenuator}} \qquad \text{(no unit)}$$

Use this calibration factor for the "Attenuator/Diffuser" at the wavelength established in Step 1.

8.   APPENDIX B

▼

8.1 Recycling and Separation Procedure.

This section is used by the recycling center when the monitor is at the end of its life.   Breaking the calibration seal or opening the monitor will void the M-LINK warranty.

The complete Monitor contains:

1 Monitor

1 USB cable

1 Instruction manual

1 Calibration certificate

8.2 Separation:

Paper: Manual and certificate

Aluminums: Monitor enclosure.

Printed circuit board: inside the monitor.

8.3 Dismantling procedure:

To open the monitor:

Remove all the screws on both sides of the monitor:

Remove the PCB by sliding it out of the enclosure.

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PARTNERS for ACCURACY

WWW.GENTEC-EO.COM

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