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User Manual

3sigma

Single-Channel
Laser Power/Energy Meter



COHERENT

User Manual
3sigma
Single-Channel
Laser Power/Energy Meter

COHERENT
7470 SW Bridgeport Rd.
Portland, OR 97224

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Preface

This manual contains user information for the 3sigma laser power and energy meter.

U.S. Export Control Laws Compliance

It is the policy of Coherent to comply strictly with U.S. export control laws.

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification should be obtained from Coherent or an appropriate U.S. Government agency.

Product and Publication Updates

To download free 3sigma application software, or to view information that may have been added or changed since this publication went to print, connect to www.coherent.com.

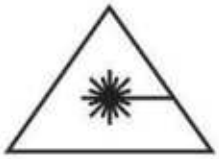
Symbols Used in This Document



This symbol is intended to alert the operator to the presence of dangerous voltages associated with the product that may be of sufficient magnitude to constitute a risk of electrical shock.



This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.



This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

SAFETY

Carefully review the following safety information to avoid personal injury and to prevent damage to this meter or any sensor connected to it. There are no user-serviceable parts in this instrument.

Electrical Safety



Use only the power cord specified for the meter. The grounding conductor of the cord must be connected to earth ground.



Do not operate the meter if its panels are removed or any of the interior circuitry is exposed.



Do not operate the meter in wet or damp conditions, or in an explosive atmosphere.

Other Safety Warnings



Operate the meter only within the specified voltage range.



Do not apply a voltage outside the specified range of the input connections.



Provide proper meter ventilation.



Do not operate the meter if there are suspected failures. Refer damaged units to qualified Coherent service personnel.

Declaration of Conformity

CE-12.22 Revision AB

Declaration of Conformity

We

Coherent, Inc. (formerly, Molectron Detector, Inc.)
7470 SW Bridgeport Road
Portland, Oregon, USA 97224

declare that the

3sigma

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated per testing to EN61326 Electromagnetic Compatibility Product Family Standard for Measurement, Control and Laboratory Equipment to include the following test specifications as of July 2001:

EN55011 Class A Radiated Emissions
EN55011 Class A Conducted Emissions

EN61000-4-2 Electrostatic Discharge – Performance Criteria B
Unit may respond to an ESD event but will return to normal without user intervention.

EN61000-4-3 Radiated Immunity – Performance Criteria A
EN61000-4-4 Electrical Fast Transient Immunity - Performance Criteria A
EN61000-4-5 Electrical Slow Transient Immunity- Performance Criteria A
EN61000-4-6 Conducted RF Immunity - Performance Criteria A
EN61000-4-11 Power Line Dropout - Performance Criteria A

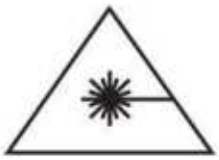
Senior Engineering Manager, Instruments Date: 4/07/04

General Manager, LMC Date: 4/07/04

Coherent, Inc Page 1 of 1

QUICK START

This section presents a series of "mini-tutorials" explaining how to connect a sensor to your 3sigma and begin taking measurements within minutes! For more in-depth information, refer to "Operation" on page 21.



Follow all laser safety procedures. The laser must be blocked or switched OFF before beginning any of the procedures described in this section.



Power to the 3sigma instrument must be OFF before beginning any of the procedures described in this section.



Do not exceed the power/energy density limits of the sensor.

Measuring Average Power With a Pyroelectric Sensor

Figure 1 shows how to set up a pyroelectric sensor to take an average power measurement.

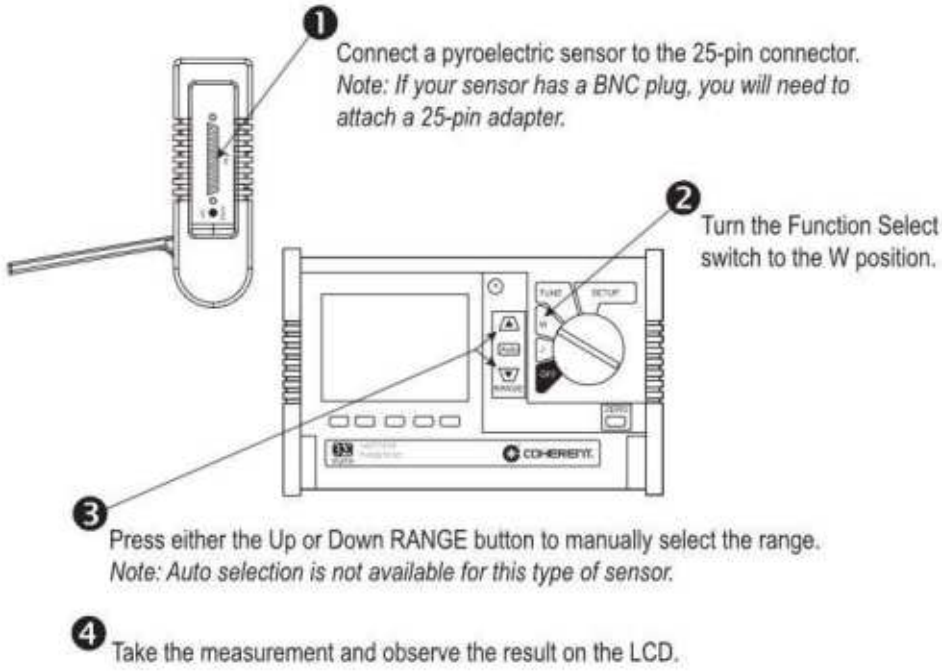


Figure 1. Measuring Average Power With a Pyroelectric Sensor

Measuring Power With a Thermopile or Optical Sensor

Figure 2 describes how to take a power measurement using a thermal or optical sensor.

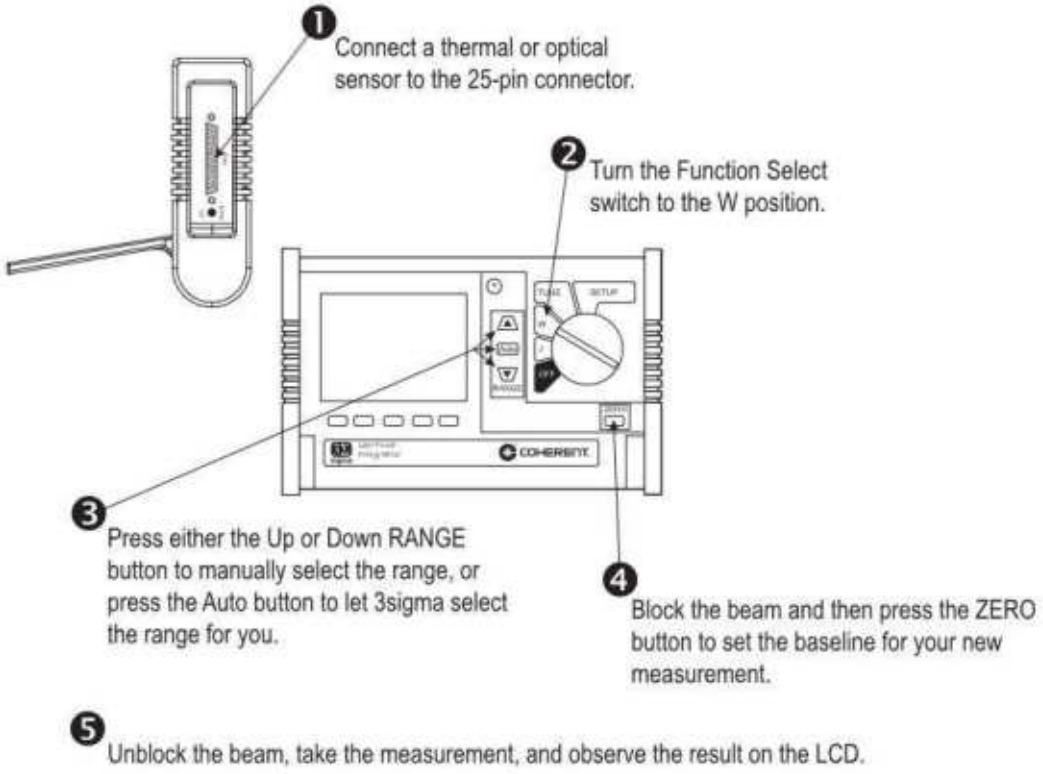


Figure 2. Measuring Power With a Thermopile or Optical Sensor

Measuring Energy With a Pyroelectric Sensor

Figure 3 outlines how to set up a pyroelectric sensor to take an energy measurement.

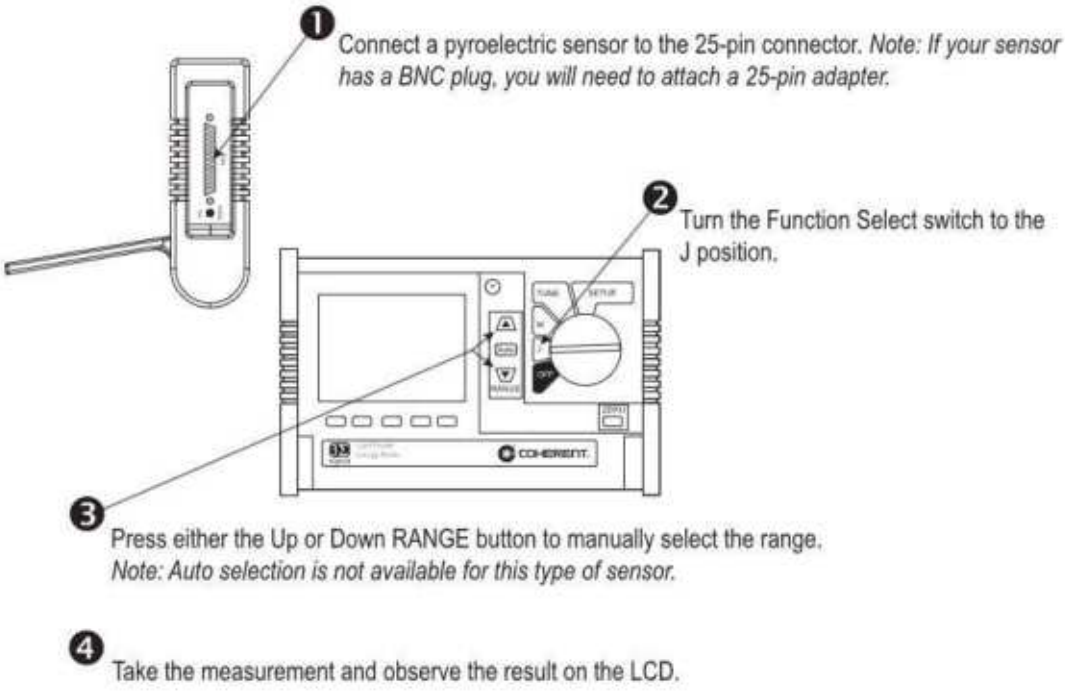
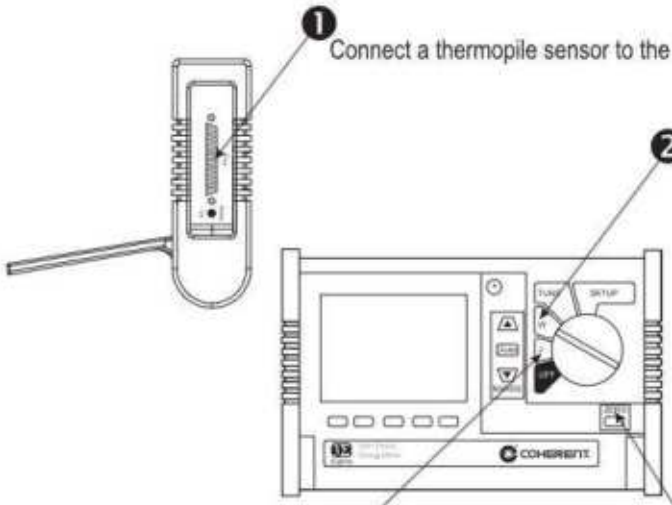


Figure 3. Measuring Energy With a Pyroelectric Sensor

Measuring Energy With a Thermopile Sensor

Figure 4 explains how to take an energy measurement using a thermal sensor.



❶ Connect a thermopile sensor to the 25-pin connector.

❷ Turn the Function Select switch to the W position and then find the appropriate W range by taking a couple of sample measurements. The appropriate range is the lowest range available that does not give an overrange error during the test measurement.

❸ Block the beam and then press the ZERO button to set the baseline for your new measurement.

❹ Turn the Function Select switch to the J position. The RANGE buttons, ZERO button, and AUTO RANGE function should not be used during this type of measurement. If an overrange error occurs, the range must be adjusted by returning to the W mode.

When 3sigma is prepared for the first measurement, the READY indicator displays at the top of the screen. During the measurement, the INT indicator displays, showing that the meter is currently integrating the reading. The ZERO button should not be pressed between measurements.

❺ Unblock the beam, take the measurement, and observe the result on the LCD.

Figure 4. Measuring Energy With a Thermopile Sensor

DESCRIPTION

Thank you for purchasing 3sigma—a multifunction, portable, laser power/energy meter that is compatible with many of our pyroelectric sensors, as well as our PowerMax® thermal sensors, and new optical sensors.

This section discusses the following topics:

- Sensor compatibility (page 12)
- Front panel (page 13)
- Right side panel (page 18)
- Left side panel (page 19)

Specific features and capabilities of the 3sigma include:

- High resolution ¼ VGA dot matrix LCD display
- Compact, rugged enclosure that includes a protective cover and stand
- Auto range (thermopile and optical sensors only)
- RS-232 port (standard)
- Analog output
- Smart probes - pyroelectric, thermopile, Silicon, Germanium, and InGaAs
- Tune mode
- Joulemeter:
  - Wide dynamic range: 50 nJ to 300 J, 1 to 1,000 Hz
  - Capture every pulse to 1 kHz
  - Pulse sampling to 4 kHz
  - Statistical functions: average, standard deviation, minimum, or maximum (for 2 to 99,999 pulses)
- Power Meter:
  - Measure power or long pulse energy
  - Wide dynamic range: 1 nW to 10 kW power, or 10 mJ to 300 J energy
  - Ambient offset



- Precise wavelength correction
- Statistical functions: average, standard deviation, minimum, or maximum (for 2 to 9,999 seconds)

The versatile 3sigma measures:

- Power–W
- Energy–J
- Frequency (Rep Rate)–Hz
- Fluence–J/cm 2

3sigma is applicable for:

- Field service
- Laser production test
- Medical laser system performance
- Optical power
- Pulsed laser energy stability

Sensor Compatibility

The sensors listed below are compatible with 3sigma, if the sensor was shipped to you January 2002 or later. If you purchased one of these sensors prior to that date, please contact Coherent (refer to Table 11 on page 80).

J5-09
J5-09B
J5-09-2k
J25LP-1A
J25LP-2A
J25LP-3A
J25LP-4A
J25LP-3A-2K
J25LP-4A-2K
J50LP-1A
J50LP-2A
J50LP-3A
J50LP-4A
J50LP-3A-2K
J50LP-4A-2K

Front Panel

Figure 5 shows the layout of the 3sigma front panel.

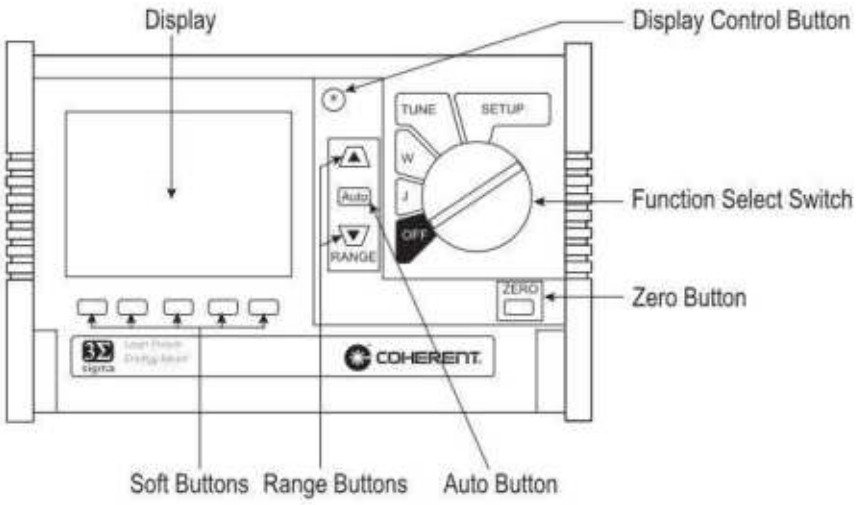


Figure 5. Front Panel

Display

The LCD display is where all available information, either text or graphics, appears. It refreshes at a rate of 3 Hz, except in Tune mode, which has an update rate of 9 Hz.

The display is visually divided into three horizontal sections: top, center, and bottom, as shown in Figure 6.

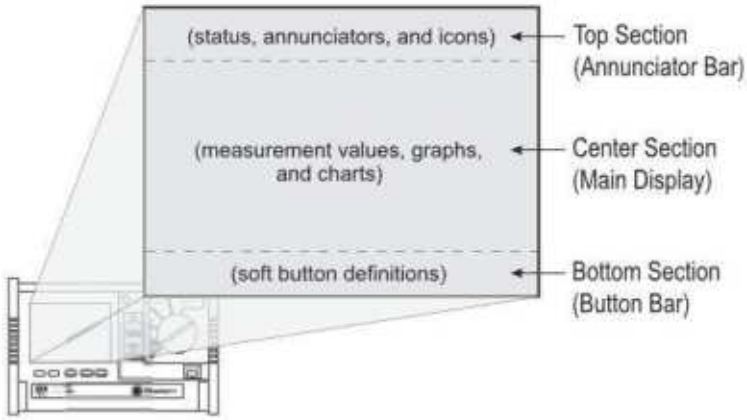


Figure 6. Display Sections

Top Section (Annunciator Bar)—The top section displays annunciators (indicators), which appear as either text or icons.

Center Section (Main Display)—This section shows measured and computed values, charts, and graphs.

Bottom Section (Button Bar)—The bottom part of the display is the soft button definition section. This section is divided into five columns, with each column corresponding to a button located immediately below it along the bottom edge of the display. The text displayed in each column indicates the current function of the corresponding button (exceptions are noted below).

Display Control Button

Tapping the Display Control button (that is, pressing the button and then releasing it within ½ second) toggles the on/off state of the backlight, regardless of the backlight mode (timed or normal). If the Display Control button is held for more than ½ second, the display contrast is cycled in slow increments. When adjusting contrast, release the button when the desired contrast level is found.

(*Firmware V1.07 and later*) Pressing and holding the Display Control button for more than ½ second incrementally adjusts the LCD display contrast until it reaches either the minimum or the maximum contrast intensity. At that point, contrast begins adjusting towards the other extreme. Example (refer to Figure 7): Assuming that minimum (lightest) contrast intensity = 1 and maximum (darkest) contrast intensity = 10, the sequence of contrast changes is: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 2, 3, 4, 5 . . .

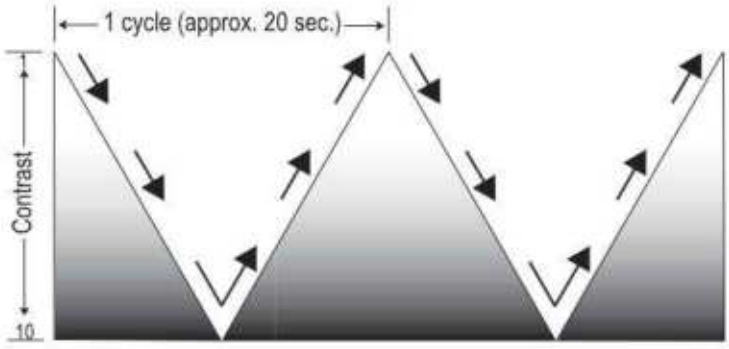


Figure 7. LCD Display Contrast Adjustment

Whenever 3sigma powers-up and the Display Control button is initially pressed and held, contrast adjusts towards the minimum (lightest) contrast level. Also, whenever 3sigma first powers-up, contrast intensity is automatically set to the last contrast level previously used.

Function Select Switch

Turning this five-position rotary switch allows selection of the following operational modes:

- Setup—used to set most instrument parameters, and confirm or edit system values
- Tune—provides an active view of measurement data
- Watts—measures power
- Joules—measures energy
- Off—shuts down the instrument

Refer to "Instrument Modes" on page 33 for detailed information about each operational mode.

Zero Button

The following section concerns only thermopile and optical sensors. Pyroelectric sensors are discussed, below.

Pressing this button sets the current sensor input voltage as the zero baseline voltage. To read the lower ranges correctly, the instrument will generally need to be zeroed after power-up. A sudden change in the ambient temperature of the sensor may also require a re-zeroing of the instrument. When 3sigma is in Auto range and you press the Zero button, the zero is measured and nulled for all the allowed ranges for the connected sensor. When the instrument is not in Auto range, only the currently selected range is zeroed.

Zeroing may take up to 30 seconds.

Normally, the Zero button is pressed with the laser blocked from the connected sensor. If a finite power level is present at the sensor, the instrument will attempt to null it out. A Bad zero warning appears if a given power input is too large to null on the more sensitive ranges.

If the Bad zero warning appears:

- Press the Dismiss soft button (for more information, refer to "Soft Buttons" on page 17).
- Select a new range
- Press the Zero button again

The following section concerns only pyroelectric sensors. Thermopile and optical sensors are discussed, above.

This discussion only pertains to 3sigma instruments using firmware V1.07 and later.

Pyro zeroing refers to dynamically correcting the baseline voltage of a pyroelectric sensor. There are three instances when this correction takes place:

1. Powering-up 3sigma with a pyro sensor attached. In this case, the zero cycle runs automatically as part of the power-up sequence.
2. Plugging in a pyro sensor when the instrument is already powered up.
3. Pressing the Zero button. In pyro mode, pressing the Zero button always causes the instrument to run a zero cycle on the sensor.

There is no need to press the Zero button unless a BCLIP error occurs. For more information about BCLIPs, refer to "Baseline Clip (BCLIP)" on page 28.

Depending on how far out the baseline is, the zero cycle takes from ½ to 3 seconds. A "Wait…" indicator appears on the screen while the zero cycle is running.

For accurate pyro zeroing:

- *There must be no pulses coming out of the sensor.* To get an accurate zero: shut off the beam or remove the sensor from the beam, wait three seconds for the sensor baseline to stabilize, and then press the Zero button. Measurements can resume once the zero cycle is complete.
- *Run the sensor within the specified repetition rate.* If the sensor is running at a higher than specified repetition rate and a

BCLIP error occurs, pressing the Zero button may not clear the error.

For more information about BCLIPs, refer to "Baseline Clip (BCLIP)" on page 28.

Auto Button

This section only pertains to thermopile sensors (except in Joules mode) and optical sensors.

Pressing the Auto button instructs the 3sigma instrument to select the best measurement range for the incoming signal. In Auto mode, the instrument automatically switches to either a lower range (if available) when the power drops below 8% of the full scale range, or a higher range (if available) when the instrument overranges.

Range Buttons

The Up and Down Range buttons manually select the measurement range.

- Range Up selects the next higher full-scale range, but only if the new range is valid for the attached sensor.
- Range Down selects the next lower full-scale range, but only if the new range is valid for the attached sensor.

Soft Buttons

The operation currently being performed by the instrument defines the function of each of the five soft buttons. These definitions display as text in the button bar, directly above the buttons. Text color and background color show if a particular function is available to the user—normal video (black lettering on a white background) means that a button function is available. Reverse video (white text on a dark background) indicates the function is currently selected.

Right Side Panel

Figure 8 shows the RS-232 and power connections on the 3sigma right side panel.

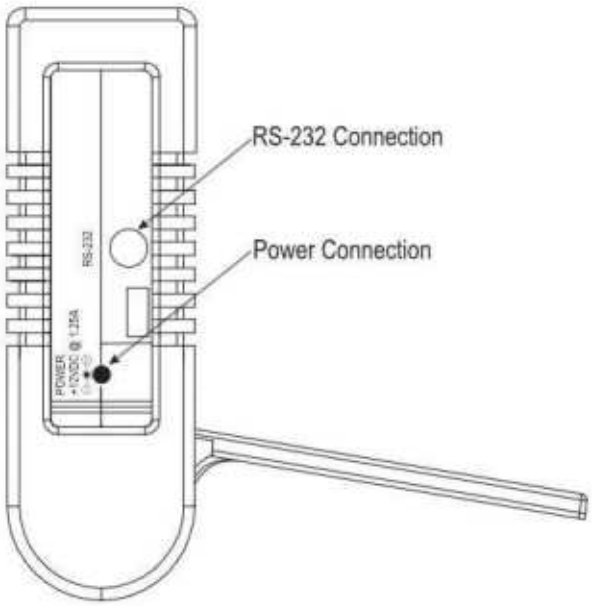


Figure 8. Right Side Panel

RS-232 Connection

This is an RS-232, female, miniature 6-pin DIN. For a list of pin assignments, refer to Table 14 on page 88. Table 15 on page 89 shows the wiring configuration between the mini-DIN 6-in connector and a DB-9 connector.

An RS-232, male, miniature 6-pin DIN to 9-pin, female, D-sub adapter is available from Coherent.

Power Connection

Connect the supplied power cord to this jack. The 3sigma requires a custom AC adapter, which is shipped with the unit. If the adapter is lost, contact Coherent for a replacement.

Left Side Panel

Sensor and analog out locations are shown in Figure 9.

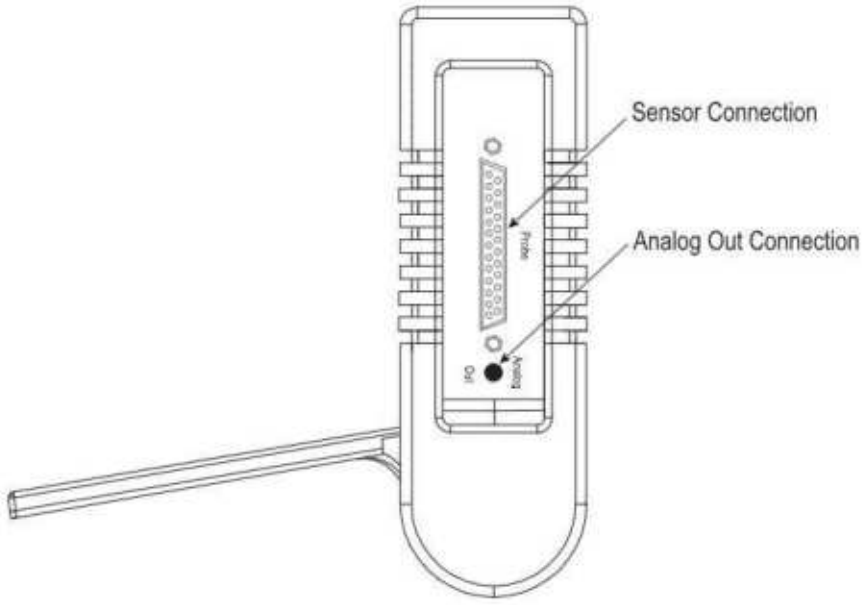


Figure 9. Left Side Panel

Sensor Connection

Use this connection to attach a DB-25 smart sensor.

If your sensor has a BNC plug, you will need to attach a 25-pin adapter, available from Coherent.

Analog Out Connection

The Analog Out connection can be used to connect to another device, like an oscilloscope or an analog display. This connection requires a cable with a SMB connector (available from Coherent).

OPERATION

This section discusses the following topics:

- Display data (this page)
- Annunciators (page 24)
- Range selection (page 27)
- Baseline clip (BCLIP) (page 28)
- Error displays (page 28)
- Power up display (page 31)
- Data entry (page 31)
- Instrument modes (page 33)

Display Data

Display data consists of either data entry information or measurement display information. Whenever the instrument cannot display meaningful data, the data is labeled invalid, stale, or not available. These three conditions are discussed in the following paragraphs.

Invalid Data

Display information is considered invalid if it is not valid under the current conditions. Generally, invalid display information appears on a data entry screen because a selection made in one of the entry screen fields makes another field invalid for the current conditions. For example, the backlight data entry screen has two data entry fields: the timer timeout value and the on/off timer status. If the timer status is *off*, the timeout value is not applicable because the timer is disabled. Invalid data displays using a dimmed font.

Stale Data

Measurement data is considered stale when a pyroelectric sensor is attached and a trigger cannot be detected. Stale measurement displays using a dimmed font.

Whenever stale data is encountered, the last non-stale data will continue to display.

Not Available Data

Measurement data may be unavailable at various times of operation. The following conditions will result in data categorized as not available:

- The instrument power is turned on and no pulse triggers are detected with a pyroelectric sensor
- The function mode changes and no pulse triggers are detected with a pyroelectric sensor
- Statistics mode is entered and batch data is not compiled
- The instrument is in Joules mode and no pulse measurements have been taken with a thermopile sensor

Not available data displays as a string of five dashes (-----).

Units

Measurement and display values are displayed using one of the following specific formats:

Area

Area is expressed in cm^2 (centimeters squared).

Date

The calendar date displays in month (three letters), day (two digits), year (four digits) format. Example: Oct 23, 1948.

Frequency

Frequency is expressed in Hz (hertz).

Joules

Joules are expressed in:

- fJ (femtojoules)
- pJ (picojoules)
- nJ (nanojoules)
- mJ (microjoules)
- mJ (millijoules)
- J (joules)
- kJ (kilojoules)
- MJ (megajoules)

- GJ (gigajoules)
- TJ (terajoules)

When area correction is enabled, all units are expressed in terms of joules per cm^2. In other words, the $/cm^2$ suffix is always appended to the joules units.

Percent

Percent units are expressed using the % sign following a one-, two-, or three-digit percentage value.

Responsivity

Responsivity is expressed in

- V/J (volts per joule) for pyroelectric sensors
- V/W (volts per watt) for thermopile sensors
- A/W (amperes per watt) for optical sensors.

Watts

Watts are expressed in:

- fW (femtowatts)
- pW (picowatts)
- nW (nanowatts)
- mW (microwatts)
- mW (milliwatts)
- W (watts)
- kW (kilowatts)
- MW (megawatts)
- GW (gigawatts)
- TW (terawatts)

When area correction is enabled, all units are expressed in terms of watts per cm^2. In other words, the $/cm^2$ is always appended to the watts units.

Wavelength

Wavelength is expressed in nm (nanometers).

Annunciators

All annunicators display in a fixed position on the annunciator bar. Which annunciators display in the annunciator bar are determined by the specific type of sensor being used, and the options you select.

There are six versions of the annunciator bar. Four are shown below. The other two are related to the Tune mode and appear under "Tune" on page 39.

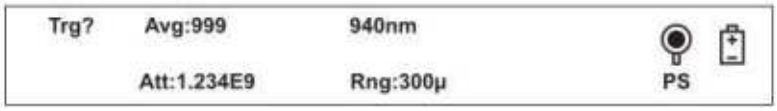


Figure 10. Annunciator Bar (Pyroelectric Sensor)

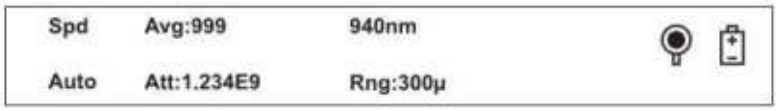


Figure 11. Annunciator Bar (Thermopile Sensor/Watts Mode)

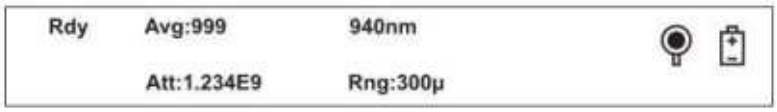


Figure 12. Annunciator Bar (Thermopile Sensor/Joules Mode)

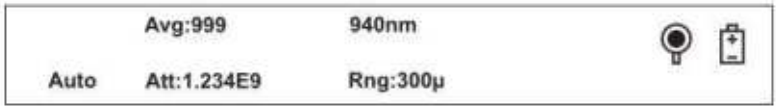


Figure 13. Annunciator Bar (Optical Sensor/Watts Mode)

Attenuator

The attenuation factor is a ratio and has no units. If attenuation correction is enabled, the Attenuator annunciator position displays **ATT:**, followed by the attenuation factor. Otherwise, the Attenuator annunciator position is blank.

Auto Range

The Auto Range indicator annunciates the state of the auto ranging of the instrument. **Auto** displays when auto ranging is active. Otherwise, nothing displays in this position.

Battery Status

A blinking Battery Status annunciator displays only when the battery needs recharging; otherwise, nothing appears in this position. *It is important to note that during this "low battery" condition, setup parameters cannot be saved.* Battery energy can be conserved by turning off the back light. It takes approximately ten hours to fully charge a battery that has been completely discharged.

Should a battery replacement become necessary, return the unit to Coherent for servicing.

Display Average

Display values are averaged either by samples (for pyroelectric sensors), or time (for thermopile and optical sensors).

- When display averaging is enabled and a pyroelectric sensor is attached to the instrument, **AVG:**, followed by the number of pulses (expressed without units), appears in the Display Average annunciator position. Example: **AVG:1234**.
- When display averaging is enabled and a thermopile or optical sensor is attached to the instrument, **AVG:**, followed by the number of seconds and the letter **s**, appears in the Display Average annunciator position. Example: **AVG:994 s**.

When display averaging is not enabled, the Display Average annunciator position is blank.

Sensor Status

The Sensor Status annunciator position reports a sensor connected status. A fixed sensor symbol indicates a sensor-connected condition, and a blinking sensor symbol indicates a sensor-not-connected condition.

Pulse Sampling

Pulse sampling refers to how many pulses are read within a series of pulses. For example, when receiving 2,500 pulses per second, pulse sampling reads (that is, samples) every third incoming pulse. Table 1 shows how many pulses are sampled, depending on the number of incoming pulses per second.

Table 1. Pulse Sampling According to the Number of Incoming Pulses

Incoming Pulses	Pulses Read
<1,000	Every pulse is read (pulse sampling is not active)
1,000 to 2,000	Every other pulse is read
2,001 to 3,000	Every third pulse is read
3,001 to 4,000	Every fourth pulse is read
>4,000	Pulse sampling continues but is not within instrument specifications

The Pulse Sampling (**PS**) icon appears in the annunciator bar only when pulse sampling is actually taking place.

Range

If a sensor is attached, the currently selected range displays in the Range annunciator position. The range is displayed as **RNG:**, followed by the full scale range display value of the primary measurement mode for the attached sensor. For pyroelectric sensors, the primary measurement mode is joules (J). For thermopile or optical sensors, the primary measurement mode is watts (W). The unit identifier (J or W) does not display as part of the annunciator. If no sensor is attached, this annunciator position is blank.

Ready

The Ready annunciator only applies when a thermopile sensor is attached and Joules mode is selected. This combination of sensor and mode enables the instrument to mathematically integrate power to obtain total energy delivered to the sensor by a laser. *For this action to occur, the laser must be pulsed.* When integration data is available, the Ready annunciator displays **Rdy**. While the power pulse is being integrated, the Ready annunciator displays **Int**.

Speedup

The Speedup annunciator only applies when a thermopile sensor is attached to the unit and Watts mode is selected. **SPD** displays in the Speedup annunciator position whenever displayed measurement data is calculated using the speedup algorithm. Otherwise, the Speedup annunciator is blank.

Trigger

The Trigger annunciator only applies when there is an attached pyroelectric sensor. When a trigger is detected, **TRG** displays in the trigger annunciator position. **TRG?** displays in the absence of a trigger.

Wavelength

The wavelength of operation displays in the Wavelength annunciator position as an integer value, followed by wavelength units. For example, **940 nm** displays if the wavelength is 940 nanometers.

Range Selection

Measurement range values are selected in decade steps. This means that each value is either ten times more or ten times less than the previous value, depending on whether you use the Up or Down Range button. Example: If the setting is currently 30 W and you press the Down Range button once, the setting changes to 3 W. Conversely, if the current setting is 30 W and you press the Up Range button once, the setting changes from 30 W to 300 W. These settings are called *full scale range*, which refers to the highest measurement that can be taken before the range has to be adjusted to accommodate the incoming signal. As an example, if the incoming signal measures 45 W and the current measurement range is 30 W (which is full scale range for that setting), you will see the OVR (short for "overrange") error message on the display. (For more information about OVR, refer to "Range Errors" on page 28.) In this example, the error can be corrected by pressing the Up Range button once to move into the 300 W range (which automatically makes 300 W the new full scale range).

The instrument is limited to a narrow group of adjacent ranges, depending on the type and characteristics of the attached sensor and other measurement settings. When area correction is enabled, **/cm^2** is appended to Joule and Watt units.

Baseline Clip (BCLIP)

Pyroelectric sensors produce a negative offset proportional to the average power applied. A BCLIP error is produced when the average power, and thus the negative baseline voltage, exceeds the ability of 3sigma to measure in the negative direction.

3sigma normally injects a positive voltage that compensates for the negative voltage produced over the full-scale operating range of the sensor. A BCLIP error may indicate that 3sigma is not able to apply enough compensation under the current operating conditions. That is, the average power applied to the sensor is too high, or there is a technical problem with the 3sigma.

Average power is computed as irradiance times frequency. Example: 1 J at 1 Hz = 1 W average power. Reducing the irradiance or the frequency of the laser can reduce average power.

The following factors may cause a BCLIP error to display:

- Using a 3sigma that has a November 2001 or earlier calibration date. *Contact Coherent to arrange for a recalibration of your 3sigma.*
- Using a JSA sensor adapter with a defective input path. *Contact Coherent to arrange repair of your JSA sensor adapter.*
- Using an active sensor that has an incorrect value of DC offset stored in its EEPROM. *Contact Coherent for assistance.*
- Using a 3sigma unit that has a bad or corrupt calibration table, which, in turn, causes the unit to incorrectly configure its offset control circuitry. *Contact Coherent for assistance.*

For more information, refer to "Zero Button" on page 15.

Error Displays

Errors are classified as either range, typical, or unexpected. These errors are discussed in the following paragraphs.

Range Errors

It is normal to put the instrument in an overrange, baseline clip, or sensor saturation condition while searching for the best measurement range. When the instrument detects an overrange condition, measurement values are replaced by the letters, **OVR**. When the instrument detects a baseline clip condition, measurement values are

replaced by the letters, **BCLIP**. When the instrument detects a sensor saturation condition, measurement values are replaced by the letters, **PSAT**.

The Tune mode graphical display is undefined when a range error occurs. However, the numeric display values in the annunciator bar display the error when a range error occurs. For more information about Tune display, refer to "Tune Display" on page 39.

Typical Errors

Text indicating typical errors displays in the center display section. In data entry screens, the error is suppressed until the data entry screen is completed.

The following are typical error messages:

- *No Probe*—A valid sensor has not been detected.
- *Not available*—The requested function is not available.

You can dismiss the error by correcting the condition that caused the error.

Unexpected Errors

Unexpected errors display in a new window that covers the entire center display section, as shown in Figure 14.



Figure 14. Error Window

You can dismiss the error window by pressing the Dismiss button. Upon error dismissal, the display is restored to its previous state. In data entry screens, errors are suppressed until the data entry screen is completed. An exception to this is when damage to equipment is evident. In this case, the current data entry screen is automatically aborted and an error popup window and error button bar appear.

The following are unexpected error messages:

- *Bad zero*—Zero on a selected range is unsuccessful (the offset is too large to be nulled). Re-zero in a more stable environment or select a different range.

- *Damage temperature exceeded*—The sensor has overheated. Increase cooling or discontinue use.

If the Damage temperature exceeded error is not corrected, continued sensor operation may cause permanent damage.

- *Initialization failed*—Fatal error. Return the instrument to Coherent.
- *Invalid switch setting*—The switch is stuck between two positions. Rotate the switch until it locks into position. If that is unsuccessful, return the instrument to Coherent.
- *NVRAM communication failure*—A failure has occurred while trying to read the internal EEPROM. Return the instrument to Coherent.
- *Probe checksum error*—The sensor internal EEPROM checksum check has failed, causing the instrument to give readings which are nominally close, but not calibrated. Contact Coherent for assistance.
- *Probe communication failure*—This may be due to a sensor and/or instrument failure, or possibly a sensor connector-seating problem. Disconnect and then reconnect the sensor. If the problem persists, return the instrument to Coherent.
- *Probe/firmware version mismatch*—The sensor data EEPROM version has exceeded the capability of the instrument firmware. That is, the instrument does not recognize the newer sensor EEPROM format. Return the instrument to Coherent for a firmware upgrade.
- *Probe NVRAM corrupt*—The sensor EEPROM is corrupted. Return the sensor adapter to Coherent for reprogramming.
- *Unrecognized Probe*—The instrument does not recognize the attached sensor. The sensor is either not a valid Coherent product, or does not have a functioning EEPROM. Readings are not allowed.

If a problem persists, contact Coherent for assistance (see "Coherent Service Centers" on page 80).

Power Up Display

The unit powers up in less than a half second after turning the instrument on. If any errors are detected during power-up initialization, the instrument attempts to immediately display an unexpected error condition. When power-up initialization is complete, the instrument is in the state of the last power-down. The state may be modified due to a different sensor attached or a different function switch setting. If no sensor is attached, the instrument immediately displays a No Probe error condition.

Data Entry

Methodology

The data entry screens are located entirely in the center display section. The button bar shown in Table 15 contains Left arrow, Right arrow, Up arrow, Down arrow, and Enter buttons, which define the edit functions of the soft buttons.



Figure 15. Button Bar: Soft Button Edit Functions

The Left and Right arrow buttons step the edit cursor between editable fields, skipping disabled fields. The Up and Down arrow buttons change the editable field at the cursor. Digits of numerical values, including the exponent of scientific notation values, can be edited. Each digit is considered a field. Decimal points, polarity (i.e., + or -), units, display tags, and the exponent marker (i.e., **E**) are not editable. The minus sign in the exponent and base is indirectly editable by editing the value to below 0. The currently addressed field (indicated by the cursor position) is identified by applying reverse video to the field.

Editable fields from a list of selections are edited as a unit. For example, for an On/Off field, only **On** or **Off** is displayed when using the Up and Down arrow buttons to scroll through the selections. Editing numerical digits has rollover implications for the next most significant digit. Keep the following in mind:

- Pressing the Up arrow button increments the digit by one.
- Pressing the Down arrow button decrements the digit by one.

- If the incremented digit rolls over from **9** to **0**, the next most significant digit is also incremented by one. When the next most significant digit rolls over from **9** to **0**, the same rollover rules cascade to the next most significant digit, and so forth.
- If the expected incremented value could result in a final value that is out of range, the increment is prevented.
- If the decremented digit rolls over from **0** to **9**, the next most significant digit is also decremented by one. When the next most significant digit rolls over from **0** to **9**, the same rollover rules cascade to the next most significant digit, and so forth.
- If the expected decremented value could result in a final value that is out of range, the decrement is prevented.
- Rollover rules extend to the exponent when editing a scientific notation value base component.

The soft button farthest to the right is usually defined as the Enter button. When a selection requires multiple button presses, the Enter button is generally used to commit a selection. For example, a data entry screen requires the user to increment or decrement digits of a number. By pressing the Enter button, you commit the currently displayed number to use.

All data entry screens include a Cancel field. If the Cancel field is selected when the Enter button is pressed, the data entry is aborted, the data entry screen goes away, and no changes take effect.

Instrument Modes

This section discusses the operational and functional instrument modes available with 3sigma. Let's start by defining those terms.

Operational mode refers to the Setup, Tune, (W)atts, (J)oul es, and Off instrument settings. These settings appear next to the Function Select switch on the front instrument panel, as shown in Table 16.

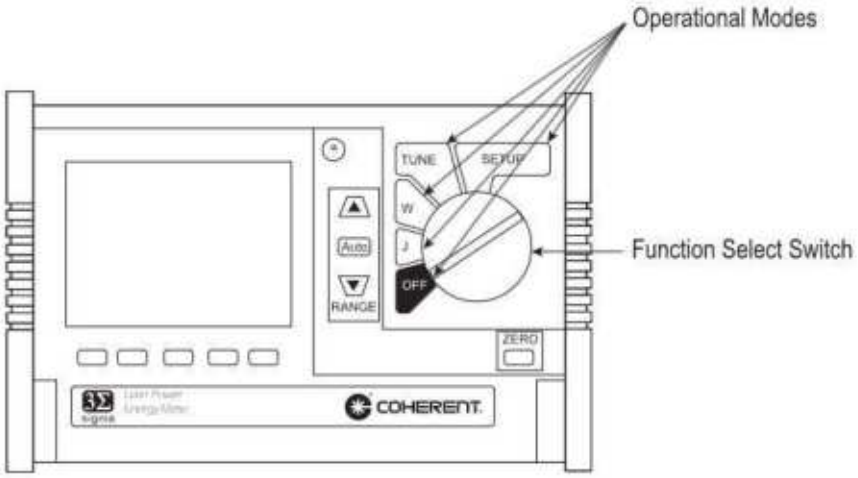


Figure 16. Operational Mode Settings

Select the operational mode of the instrument by turning the Function Select switch. When a mode is exited and then later reentered, the button bar—and all *functional mode* parameters (discussed next) relevant to that button bar—are restored.

Functional mode is a setting within an operational mode. Depending on which soft button is pressed (selected), the instrument will be in one of the following functional modes:

- No buttons pressed = normal functional mode
- Avg button pressed = average functional mode
- Stat button pressed = statistics functional mode

The user can set many of the activities available within these functional modes. The following sections describe all functional modes, organized under the appropriate operational mode.

Joules

Energy (joules) measurements may be taken using pyroelectric sensors (for pulsed lasers) or thermopile sensors (for long-pulsed lasers). Measurement data always displays in the Main Display section.

Joule measurements are not available with an optical sensor.

Table 2 lists the functional mode menus available in Joules mode.

Table 2. Functional Mode Menus (Joules Mode)

Functional Mode	Thermopile Sensor	Pyroelectric Sensor
Normal	Avg, Stat	Avg, Hz, Stat, Trig
Average	Setup	Hz, Setup, Trig
Statistical	Auto, Setup, Start	Auto, Setup, Start, Trig

Measurement Display Screens

If attenuation correction is enabled, the displayed measurement value is corrected to reflect the true laser output.

The normal Joules mode display shows a four-digit value, followed by the appropriate joules unit, as shown in Figure 17 through Figure 19.



Figure 17. Joules Mode Normal Display (Example)



Figure 18. Joules Mode Normal Display With Frequency Display (Example)

The example shown in Figure 19—which displays Joules mode (integrated power with a thermopile sensor) on the first line, followed by average power on the second line—is only available for 3sigma instruments running firmware V1.07 or later.



Figure 19. Joules Mode Normal Display With Average Power Display (Example)

Functional Mode Menus

Here is a description of all functional mode menus that appear when the Joules mode is selected by using the Function Select switch:

Auto

Selecting this mode automatically restarts the batch count, according to the batch size previously set in Setup mode (see "Setup" on page 42). Otherwise, the batch count must be manually restarted.

Avg

You may apply data smoothing by configuring the instrument on the Joules Setup screen (Avg > Setup). Data smoothing reduces the rapid changing of the measurements on the screen as each new data value updates the measurement values. Window size is available from 2 to 999 pulses (for a pyroelectric sensor), or 2 to 999 seconds (for a thermopile sensor).

Hz

(*pyroelectric sensor only*) Use this mode to display frequency.

Setup

This mode allows you to set up the appropriate statistical batch size for taking a joules reading. Batch size has a range of 2 to 99,999 pulses (for a pyroelectric sensor), or 2 to 9,999 seconds (for a thermopile sensor).

Start

Use this mode to manually start the batch count, according to the batch size previously determined in Setup mode (see "Setup" on page 42).

Stat

The Statistics Joules mode display (refer to Figure 20) shows a series of four-digit, fixed-point values, with the appropriate unit always in some form of joules. Statistical data for a pyroelectric sensor is generated on a pulse-by-pulse basis, while statistical data for a thermopile sensor is generated over time. Each quantity is labeled above the values with **Mean**, **Std Dev** (standard deviation), **Min** (minimum), and **Max** (maximum). The current batch count, expressed without units, is always displayed in slightly smaller text at the bottom center of the center display section.

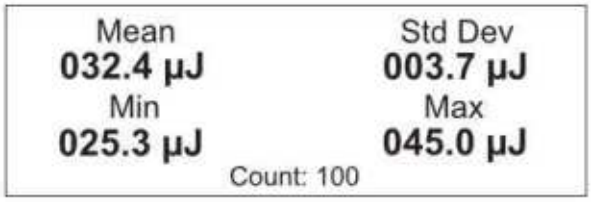


Figure 20. Joules Mode Statistics Display With Pyroelectric Sensors (Example)

Trig

(*pyroelectric sensor only*) The trigger level is the percentage of the full scale value of the current range at which a trigger is detected. Trigger level can be set from 2 to 20 percent.

Watts

Power (watts) measurements may be taken using pyroelectric sensors (for pulsed lasers), thermopile sensors (for pulsed or continuous lasers), or optical sensors (for continuous lasers). There are slight variations in the user interface, depending on which type of sensor is being used. Measurement data is always displayed in the Main Display section.

Measurement Display Screens

If attenuation correction is enabled, the displayed measurement value is corrected to reflect the true laser output.

The normal Watts mode display shows a four-digit value, followed by the appropriate watts unit, as shown in Figure 21 and Figure 22.



Figure 21. Watts Mode Normal Display (Example)

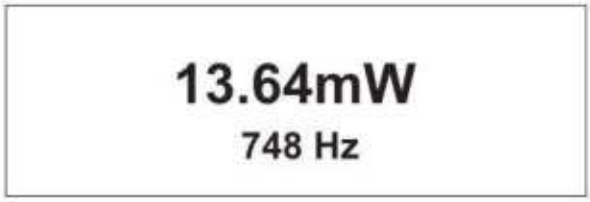


Figure 22. Watts Mode Normal Display With Frequency Display (Example)

Table 3 lists the functional mode menus available in Watts mode.

Table 3. Functional Mode Menus (Watts Mode)

Function Mode	Thermopile or Optical Sensor	Pyroelectric Sensor
Normal	Avg, Speed up, Stat	Avg, Hz, Stat, Trig
Average	Setup, Speed up	Hz, Setup, Trig
Statistical	Auto, Setup, Speed up, Start	Auto, Setup, Start, Trig

Functional Mode Menus

Here is a description of all functional mode menus that appear when the Watts operational mode is selected by using the Function Select switch:

Auto

Selecting this mode automatically restarts the batch count, according to the batch size previously set in Setup mode (see "Setup" on page 42). Otherwise, the batch count must be manually restarted.

Avg

You may apply data smoothing by configuring the instrument on the Setup screen (Avg > Setup). Data smoothing reduces the rapid changing of the measurements on the screen as each new data value updates the measurement values. Window size is available from 2 to 999 pulses (for a pyroelectric sensor), or 2 to 999 seconds (for a thermopile or optical sensor).

Hz

Use this mode to display frequency.

Setup

This mode allows you to set up the appropriate statistical batch size for taking a watts reading. Batch size has a range of 2 to 99,999 pulses (for a pyroelectric sensor), or 2 to 9,999 seconds (for a thermopile or optical sensor).

Speed up

(*thermopile sensor only*) This mode is used to obtain quicker measurement data as the sensor initially heats up. For more information about this functional mode, refer to "Setup Topics" on page 44.

Start

Use this mode to manually start the batch count, according to the batch size previously determined in Setup mode (discussed under "Setup" on page 42).

Stat

The statistics Watts mode display shows a series of four-digit, fixed-point values, with the appropriate units always in some form of watts. Statistical data for a pyroelectric sensor is generated on a pulse-by-pulse basis. Statistical data for thermopile or optical sensors is generated over time. Each quantity is tagged above the values with **Mean**, **Std Dev** (standard deviation—appears only when using a pyroelectric sensor), **Min** (minimum), and **Max**

(maximum). The current batch count, expressed with no units, is always displayed in slightly smaller text at the bottom center of the center display section, as shown in Figure 23.

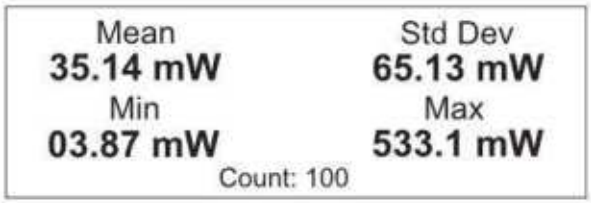


Figure 23. Watts Mode Statistics Display With Pyroelectric Sensors (Example)

When a thermopile or optical sensor is installed, the count is expressed in seconds, as shown in Figure 24.

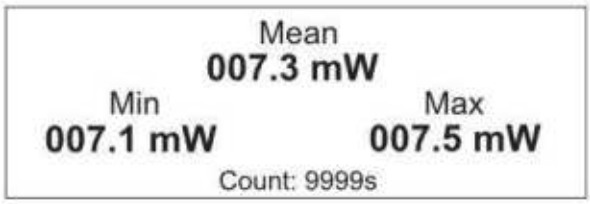


Figure 24. Watts Mode Statistics Display With Thermopile or Optical Sensors (Example)

Trig

(*pyroelectric sensor only*) The trigger level is the percentage of the full scale value of the current range at which a trigger is detected. Trigger level can be set from 2 to 20 percent.

Tune

Tune mode charts provide an active view of measurement data. Measurement units are either joules when a pyroelectric sensor is attached, or watts when a thermopile or optical sensor is attached.

Tune Display

The Tune display resembles an oscilloscope trace. As the trace progresses from left to right, each new trace is added to it. The chart display is refreshed at the Tune mode display refresh rate of 9 Hz. Each trace point is composed of the average of all the measurement values consumed by the instrument in one Tune mode display refresh cycle. The Max line (shown as a dashed line on the display) reflects the peak value of the pulses received and that is why, on

occasion, the trace line may be some distance from the Max line. When the trace arrives at the right edge of the Tune chart, the trace is cleared and a new trace starts at the left edge.

A numeric scale having four reference points is on the outside of the left edge of the chart (see Figure 25). A maximum level dashed line appears above the maximum value measured since the Tune mode was either started or cleared. The live and maximum measurement values are displayed in the annunciator bar. If the attached sensor is a pyroelectric sensor, the trace will not proceed unless there is triggering.

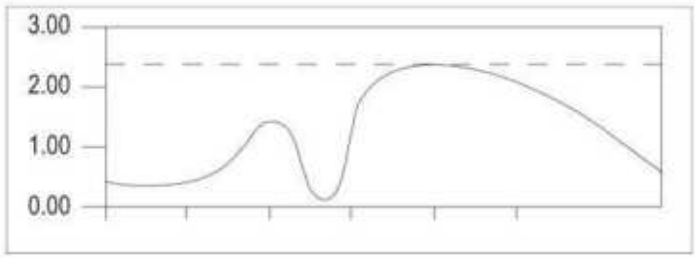


Figure 25. Tune Display (Example)

Pressing the Zoom button advances to the next zoom selection, with the chart appropriately scaled (see "Zoom Selections" on page 42, for more information).

Pressing the Freeze button toggles the freeze state of the Tune chart. When the chart is frozen, the Freeze button definition text displays in reverse video. Freezing the chart causes the trace to stop, although chart data collection continues in the background. Unfreezing the chart causes the chart to instantly jump ahead to its most current representation of measurement data.

Pressing the Clear button restarts the trace and resets the Max line.

Trend Display

The Trend display is similar to the Tune display, except that the data displayed on the chart is a representation of the summary of *all* samples since the chart was either started or cleared. It resembles a once-through oscilloscope trace that does not erase or retrace when it reaches the right edge of the chart.

The size of the Trend buffer is configurable in either pulses for pyroelectric sensors or elapsed time for thermopile and optical sensors. The chart display refreshes at 9 Hz. Each trace is composed of the average of all the measurement values consumed by the instrument

in the trend incremental update interval. The trend incremental update interval is the trend history size divided by the number of trace plotted points in the chart.

A numeric scale having four reference points is located on the outside of the left edge of the chart (shown in Figure 26). Maximum and minimum level dashed lines appear at the maximum and minimum values, respectively, as measured since the Trend mode was either started or cleared. The minimum and maximum measurement values are displayed in the annunciator bar. If the attached sensor is a pyroelectric sensor, the trace will not proceed unless there is triggering. Figure 26 shows an example of the trend display:

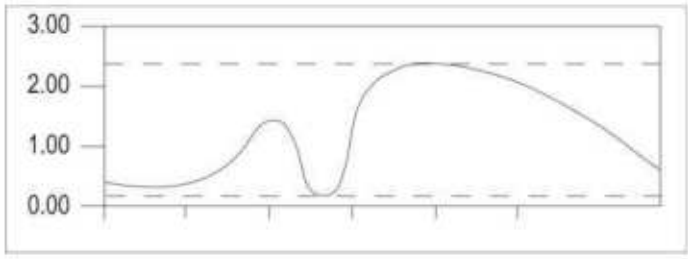


Figure 26. Trend Display (Example)

Pressing the Clear button clears the chart and history buffer, resets the trace to the beginning, and resets the minimum and maximum values displayed in the annunciator bar. Data collection continues.

As with the Tune display screen, pressing the Zoom button advances to the next zoom selection with the chart appropriately scaled (see "Zoom Selections" on page 42 for more information). Otherwise, the button bar remains the same.

Pressing the Setup button enters the trend history size data entry screen (described next under "Trend History Size").

Pressing the Tune button accesses the tune display screen.

Trend History Size

You may configure the size of the trend history buffer whenever the Trend chart is displayed in Tune mode. Which trend history data entry screen appears depends on the type of sensor being used:

- Pyroelectric sensors readings are expressed in pulses (with a range of 264 to 99,999 pulses)
- Thermopile and optical sensors are expressed in time (with a range of 1 min to 99 hrs and 59 mins)

Zoom Selections

Tune mode charts normally display with data scaled at the current measurement range. With the range set at its optimum point for a given laser input, the chart curve should use most of the vertical range of the chart display. At a less-than-optimum range setting, you may zoom in to the signal by pressing the Zoom button, which is at the far left position of all Tune mode button bars. When the button name displays **Zoom**, the zoom selection is 1X, which is full scale for the current range. Pressing the Zoom button steps to the next highest zoom selection, as shown in Table 4.

Table 4. Zoom Settings

SETTING	ZOOM SELECTION
Zoom	Full scale
2X	Minimum to one-half scale
3X	Minimum to one-third scale
4X	Minimum to one-fourth scale

Pressing the Zoom button while it is displaying 4X automatically cycles the setting back to Zoom (1X).

When a zoom setting changes, the name of the soft button automatically updates to reflect the new setting.

Setup

Most instrument system configuration activities are performed in Setup mode. You can confirm or edit system values by navigating among different parameter topics, and then selecting a topic by pressing the corresponding soft button. During navigation, the following information displays in the center display section, as shown in Figure 27.



Figure 27. Setup Screen (Example)

Setup Screen Details

Probe Resp

The first part of this field indicates the responsivity value of the attached sensor, and is expressed in the following units: pyroelectric sensors (V/J), thermopile sensors (V/W), and optical sensors (A/W). The second part (after @) displays the sensor calibration wavelength.

Probe Cal Date

This value shows the sensor calibration date.

Wavelength Corr

The first part indicates the value you entered for wavelength of operation. The second part of this field (after /) indicates if the wavelength correction for this wavelength is enabled. The valid selections for the second part are *On* and *Off*.

Attenuation Corr

The first part of this field indicates the value you entered for attenuation. The second part (after /) shows if attenuation correction is enabled. The valid selections for the second part are *On* and *Off*.

Area Corr

The first part indicates the value you entered for beam area. The second part (after the /) shows if area correction is enabled. The valid selections for the second part are *On* and *Off*.

Host Interface

This field indicates the type of host interface installed in the instrument and the current baud rate.

Navigation Methodology

Setup topics are arranged in a list. Items in the list are accessible by paging through the list visible in the bottom display section. The topics are distributed among multiple pages with up to four topics per page. Paging is accomplished by pressing the <more> soft button (always the last soft button on the right). When you are on the last page, pressing the <more> soft button causes wrapping back to the first page of topics. Press the appropriate soft button to select the topic to edit. From there, the normal data entry screen is presented.

Setup Topics

Pressing a Setup topic soft button accesses a data entry screen. This section describes each of the data entry screens.

Setup Save

You can save the current instrument setup in one of five user-definable setup positions.

Setup Recall

Use this soft button to recall any one of five previously-saved setup configurations, or reset the instrument to factory default.

Wave

You can configure the instrument to make measurement data correction based on the wavelength of the laser. Sensors are calibrated at a single wavelength and include a wavelength correction table for use when the wavelength differs from the calibration wavelength. You can enter the actual wavelength of the laser, and if wavelength correction is to be enabled. Valid selections for the enable field are *On* and *Off*. If wavelength correction is disabled—that is, Off—the wavelength field displays as invalid.

Atten

Press this button to configure the instrument to make measurement data correction based on the presence of an optical attenuator with a known attenuation factor. You can also enter the attenuation factor, and enable attenuation correction. Attenuation is between 1.000E0 and 1.000E6. Valid selections for the enable field are *On* and *Off*.

Area

You can configure the instrument to express measurement data as a function of area by entering the beam area, and enabling area correction. Area is limited from 0.001 to 999.999 cm^2. Valid selections for the enable field are *On* and *Off*.

Speedup

(*thermopile sensor only*) Speedup is prediction of measurement data to better reflect true measurement values. It is used to obtain quicker measurement data as the sensor initially heats up. Valid selections for the Speedup mode are *Full* and *Partial*. *Full speedup* means the instrument always applies the speedup algorithm to measurement data. *Partial speedup* indicates the instrument applies the speedup algorithm only when the difference between the true and predicted measured values is greater than 1%. When displayed measurement

data is calculated using the speedup algorithm, **SPD** displays in the Speedup annunciator position. Otherwise, the Speedup annunciator position is blank.

Comm

On this menu you can configure serial port communication parameters for the host interface. Valid selections for baud rate are *9600*, *38400*, *57600*, or *115200*. Valid selections for stop bits are *1* or *2*. Valid selections for parity are *None*, *Even*, or *Odd*. Valid selections for pacing are *None* or *Xon/Xoff*.

Backlight

Press this button to configure the Display Backlight mode of the instrument, and assist in battery charge conservation by using the automatic backlight timer to manage the display backlight. With this feature enabled, the backlight automatically turns off after a configurable period of front panel inactivity. The backlight timeout value range is 1 to 20 minutes. Valid selections for this mode are *Normal* and *Timed*. If the selected mode is not Timed, the time field is dimmed (invalid).

Auto Power

You can configure the Automatic Power Off mode of the instrument and assist in battery charge conservation by using the automatic power off timer to manage power. With this feature enabled, the instrument automatically turns off after a configurable period of front panel inactivity. The auto power off timeout value range is 10 to 60 minutes. Valid selections for this mode are *Timed* or *Off*. If the selected mode is not Timed, the time field is dimmed (invalid).

Analog Out

Press this button to select the voltage source of the analog output connector. Valid selections for the analog output source are *Live* and *Sampled*.

Live displays the incoming sensor signal, pulse-for-pulse, after it passes through a buffer. *Live* may also include input from other sources, for example, noise artifacts.

Live is available only with a pyroelectric sensor. The Live sensor input may be attenuated by a factor of ten before it is buffered to the analog output.

Sampled means the analog voltage output is proportional to the energy in a pulse. Full scale energy is represented by one volt. For example, a pulse energy at full scale always equals one volt, a pulse energy at half-scale always equals one-half volt, etc.

(Sampled analog output source only) Analog out may have as much as a 12 mV offset. To measure offset, disconnect the sensor and measure the voltage of the analog out. The difference between zero and the voltage at the analog out is the offset. You can subtract this offset from all future readings.

Analog out represents watts, not energy, when 3sigma is in single-pulse thermopile (energy from a thermopile pulse) mode.

System Information

The System Information data entry screen is a display screen only. It shows the firmware version number, the type of interface, and the serial number of the instrument.

Off

Setting the Function Select switch to *Off* immediately shuts down the instrument.

To restore power after Auto Power has automatically turned instrument power off, you must rotate the Function Select switch to the Off position and then back to the appropriate mode.

COMPUTER INTERFACE

This section explains the commands and queries that allow you to control and operate 3sigma via an RS-232 interface. Topics discussed in this section include:

- Special considerations (page 48)
- Syntax (page 49)
- Host comand quick reference (page 50)
- Communication commands (page 54)
- Display commands (page 55)
- Error commands (page 56)
- Instrument and probe device information commands (page 58)
- Measurement data collection commands (page 59)
- Measurement setup commands (page 61)
- SCPI mandatory commands (page 70)
- SCPI optional commands (page 71)
- System option commands (page 72)
- Trigger commands (page 73)
- Output data format (page 74)

Before attempting to communicate with the 3sigma via the RS-232 interface, verify that all host communication settings match the 3sigma settings (RS-232 baud rate, parity, etc.)

Normally, flow control is not used; however, Xon and Xoff may be used as an option. Data width is 8 bits.

Special Considerations

Data Terminators

All data passing through the host interface must be properly terminated. This is especially important when using the RS-232 host interface because there is no low-level signaling mechanism to indicate the end of a data transmission.

Data Received by the Instrument

Data received by the instrument must be terminated by a carriage return (decimal 13 byte). A line feed (decimal 10 byte) following the carriage return is ignored, so strings can be terminated with a carriage return and line feed pair. A command or query is considered incomplete without the terminator.

Data Sent by the Instrument

All data sent by the instrument is terminated by a carriage return (decimal 13 byte) and line feed (decimal 10 byte) pair.

Using an RS-232 Interface

Data Pacing

The host can control the pace of data from the instrument using the popular XON/XOFF method for serial communication software flow control. The host can stop the instrument from sending data by sending ASCII XOFF (decimal 17 byte). The host can enable the instrument to send data by sending ASCII XON (decimal 19 byte). Sending XOFF while disabled or sending XON while enabled is redundant and has no additional effect. It is essential to avoid disabling data flow for long periods of time to avoid losing data due to send buffer overflow. If data flow is enabled with data already in the buffer, the data is immediately sent as fast as the baud rate allows.

Service Request

The instrument occasionally needs to signal the host that data is available to read. The host can wait for the service request marker (ASCII ENQ or decimal 5 byte), which indicates that data is available. Available data can be either measurement data or error information. In most cases the, host remote control program knows the source of the available data from its current activity and can retrieve

the data using the appropriate commands. The service request marker will not be sent when the host is waiting for a reply from a query.

The RS-232 service request marker can be selected *enabled* or *disabled*. If it is disabled, the host must poll for available data.

Kill Output Request

3sigma is capable of storing 10,000 data records. When a fetch record query is executed for a large number of records, the time to transmit those records can be prohibitively lengthy. By sending a kill output request (ASCII ESC or decimal 27 byte), you can have the host terminate the transmission of lengthy data in process. When the instrument receives the kill output request, data being sent at the moment the request is received will be terminated.

Syntax

Commands are specified using standard SCPI notation syntax. Refer to the SCPI specification for more information. Briefly, the short form of a word is specified in upper case and the alternate long form is specified as the entire word. Character case is ignored. A command must be sent in either long or short form, but not a combination of both. For example, the **initiate** command is specified as "INITiate". The long form is "initiate" and the short form is "init". Sending either form is valid in either upper case or lower case or mixed case. Sending "initia" is not valid. The command delimiters are from the set of delimiters {:,;<space><tab>}.

Table 5 shows the Backus-Naur Form (BNF) notation used to describe commands and queries in this section.

Table 5. Backus-Naur Form (BNF) Notation

SYMBOL	MEANING
< >	Defined element
|	Exclusive OR
{ }	Group; one element is required
[ ]	Optional; may be omitted

Host Command Quick Reference

This section gives a brief description of all 3sigma commands. For detailed information about a specific command, go to the page referenced in the right-hand column of Table 6, below.

There are two types of commands: *set* and query. A *set command* changes an instrument setting or performs a specific action. A *query command* causes the instrument to return data and information about its status.

In the following table:

- A set command appears as the basic command name only.
- A query command consists of the basic command name, followed by a question mark.
- A set and query command (which represents two separate commands: a set command and a query command) displays as the basic command name, followed by a question mark in parentheses (do not type the parentheses around the question mark when you enter a query command).

Here's an example of how each type of command appears in the table.

Command Name	Command Type
*Example	This is a set command. There is no associated query command.
*Example?	This is a query command. There is no associated set command.
*Example(?)	This is a set and query command.

Table 6. Host Command Quick Reference

COMMUNICATION COMMANDS		
COMMAND	DESCRIPTION	PAGE #
Serial Port		
SYSTem:COMMunicate:SERial:BAUD(?)	Selects, transmits, and receives baud rate	54
SYSTem:COMMunicate:SERial:PACE(?)	Sets hosting communication low-level data pacing method	54
SYSTem:COMMunicate:SERial:PARity(?)	Selects parity bit setting	55
SYSTem:COMMunicate:SERial:SBITs(?)	Selects number of stop bits used	55
SYSTem:COMMunicate:SERial:SERVice(?)	Selects state of service request marker feature	55

Table 6. Host Command Quick Reference (Continued)

DISPLAY COMMANDS		
COMMAND	**DESCRIPTION**	**PAGE #**
DISPlay:CLEar	Clears display text and enables live measurement data display	55
DISPlay:TEXT	Sets display text in the measurement display area	56
ERROR COMMANDS		
COMMAND	**DESCRIPTION**	**PAGE #**
SYSTem:ERRor:ALL?	Queries all error records in queue	57
SYSTem:ERRor:CLEar	Clears all error records in queue	57
SYSTem:ERRor:COUNT?	Queries number of current error records in queue	57
SYSTem:ERRor:NEXT?	Queries next error record in queue	57
INSTRUMENT AND PROBE DEVICE INFORMATION COMMANDS		
COMMAND	**DESCRIPTION**	**PAGE #**
Instrument		
SYSTem:INFO:INSTrument:CALDate?	Queries instrument calibration date	58
SYSTem:INFO:INSTrument:SERNumber?	Queries instrument serial number	58
Probe		
SYSTem:INFO:PROBe:CALDate?	Queries probe calibration date	58
SYSTem:INFO:PROBe:MODEL?	Queries probe model	58
SYSTem:INFO:PROBe:RESPonsivity?	Queries probe responsivity	59
SYSTem:INFO:PROBe:SERNumber?	Queries probe serial number	59
SYSTem:INFO:PROBe:TEMPerature?	Queries probe head temperature	59
SYSTem:INFO:PROBe:TYPE?	Queries probe type	59
MEASUREMENT DATA COLLECTION COMMANDS		
COMMAND	**DESCRIPTION**	**PAGE #**
Data Gating		
ABORt	Disables measurement data collection	59
INITiate	Enables measurement data collection	60
Data Query		

Table 6. Host Command Quick Reference (Continued)

FETCh:ALL?	Queries all available data records	60
FETCh:MISSing?	Queries number of missed data records due to buffer overflow	60
FETCh:NEXT?	Queries next available data record(s)	60
FETCh:NRECords?	Queries number of available data records	61
MEASUREMENT SETUP COMMANDS		
COMMAND	**DESCRIPTION**	**PAGE #**
Area Correction		
CONFigure:AREA:APERture(?)	Sets aperture area	61
CONFigure:AREA:CORRection(?)	Enables or disables area correction	61
Attenuation		
CONFigure:ATTEnuation:CORRection(?)	Enables or disables attenuation correction	61
CONFigure:ATTEnuation:FACTor(?)	Sets attenuation factor for connected probe	62
CONFigure:ANAlog:SOURce(?)	Selects voltage source of analog output connector	62
CONFigure:FUNCtion?	Queries position of function switch	62
CONFigure:SPEEDup(?)	Selects speedup mode	62
CONFigure:ZERO(?)	Sets current probe input voltage as zero baseline voltage	63
Display Data Averaging		
CONFigure:AVErage:PULSe(?)	Sets data averaging window size (pyroelectric probes)	63
CONFigure:AVErage:TIME(?)	Sets data averaging window size (thermopile/optical probes)	63
Measurement Data Format		
CONFigure:READings:CONTinuous(?)	Selects mode of data delivery (thermopile/optical probes)	65
CONFigure:READings:HEADers(?)	Selects if data value ID strings prefix values are used	66
CONFigure:READings:SEND(?)	Selects which non-statistical measurement data is reported	66
Probe Wavelength Correction		
CONFigure:WAVElength:CORRection(?)	Enables or disables wavelength correction	67

Table 6. Host Command Quick Reference (Continued)

CONFigure:WAVElength:WAVElength(?)	Sets operational wavelength	68
Range Control		
CONFigure:RANGe:AUTO(?)	Enables automatic selection of instrument measurement range	68
CONFigure:RANGe:SELect(?)	Selects instrument range	68
Statistical Batch Control		
Batch Size		
CONFigure:STATistics:BATchsize:PULSe(?)	Sets statistics batch size (pyroelectric probes)	69
CONFigure:STATistics:BATchsize:TIME(?)	Sets statistics batch size (thermopile/optical probes)	69
CONFigure:STATistics:MODE(?)	Enables or disables statistical data collection and reporting	69
CONFigure:STATistics:RESTartmode(?)	Selects action to be taken at end of a statistical batch	70
CONFigure:STATistics:START	Terminates current statistical batch and starts a new one	70
SCPI Mandatory Commands		
Command	**Description**	**Page #**
*IDN?	Queries instrument identification string	70
*RST	Resets instrument	70
*TST?	Runs instrument self-test procedure	71
SCPI Optional Commands		
Command	**Description**	**Page #**
*RCL	Recalls selected setup from nonvolatile memory	71
*SAV	Saves current setup to nonvolatile memory	71
System Option Commands		
Command	**Description**	**Page #**
SYSTem:OPTion:BACKlight(?)	Controls LCD backlight mode	72
SYSTem:OPTion:POWer:AUTOoff(?)	Sets auto power-off timeout	72
SYSTem:STATus?	Queries system status	73

Table 6. Host Command Quick Reference (Continued)

TRIGGER COMMANDS		
COMMAND	DESCRIPTION	PAGE #
TRIGger:LEVel(?)	Sets trigger level (pyroelectric probes)	73

Communication Commands

Communications parameters may be changed remotely. Any changes to the communications settings will take effect after the next *RST command or power-off/power-on cycle.

Serial Port

Serial port commands apply only when a serial port interface module is installed.

Baud Rate

Selects the transmit and receive baud rates together. Select the baud rate to match the baud rate of the remote control device. Choose the highest baud rate at which reliable communications will continue.

Command: SYSTem:COMMunicate:SERial:BAUD {DEFault|9600|38400|57600|115200}
Default is 9600

Query: SYSTem:COMMunicate:SERial:BAUD?
Reply: 9600|38400|57600|115200

Data Pacing

Selects the low-level data pacing method for instrument-to-host communication. XON represents the XON/XOFF pacing method: XON enables data flow while XOFF disables data flow.

Command: SYSTem:COMMunicate:SERial:PACE {DEFault|XON|NONE}
Default is NONE

Query: SYSTem:COMMunicate:SERial:PACE?
Reply: XON|NONE

Parity

Selects the parity bit setting. Choose the parity bit setting to match the parity bit setting of the remote control device.

Command: SYSTem:COMMunicate:SERial:PARity {DEFault|EVEN|ODD|NONE}
Default is NONE

Query: SYSTem:COMMunicate:SERial:PARity?
Reply: EVEN|ODD|NONE

Stop Bits

Selects the number of stop bits used. Choose the number of stop bits to match the number of stop bits used on the remote control device.

Command: SYSTem:COMMunicate:SERial:SBITs {DEFault|1|2}
Default is 1

Query: SYSTem:COMMunicate:SERial:SBITs?
Reply: 1|2

Service Request

Selects the state of the service request marker feature. If the service request marker feature is on, the service request marker (ASCII ENQ or decimal 5 byte) is sent by the instrument to indicate that data is available. If the feature is disabled, the host must poll for available data.

Command: SYSTem:COMMunicate:SERial:SERVice {DEFault|OFF|ON}
Default is ON

Query: SYSTem:COMMunicate:SERial:SERVice?
Reply: OFF|ON

Display Commands

The host interface can set or query the measurement display area text in the center section of the display. Note that the literal text in the measurement data display area is referenced and this may not necessarily represent valid measurement data.

Display Clear

Clears the display text and enables measurement data to be displayed live.

Command: DISPlay:CLEar

Query: none

Display Text

Sets the display text in the measurement display area (the center section of the display). When text is displayed through the host interface, it remains until it is cleared from the front panel, changed again from the host interface, or a display clear (DISP:CLE) is sent. The amount of text that can be displayed is limited to the space required to fit one line across the center section of the display (about 30 characters). The string is centered in the display. Oversized strings are left- and right-truncated. All text within the quoted string is displayed.

Command: DISPlay:TEXT <quoted display text >

Query: none

Error Commands

Programming errors occasionally occur while testing or debugging remote programs and, less often, during measurement. Errors are returned in ASCII string form. Error strings follow the SCPI standard for error record definition:

<error code>,<quoted error string><CR><LF>

The host must query for errors in two steps. First, query for the number of error records available (N). Second, query N times for the error records. Errors are stacked up to 20 deep. With error overflow, the last error in the error list is an indication of error overflow. An error overflow usually indicates that a previous error has cascaded, thereby causing other errors (which you can ignore).

Error record queries are destructive reads. As each error record is read by the host, the error count automatically decrements by one.

Possible errors include:

- Error queue full
- Invalid parameter
- Not implemented
- Password required
- System error
- Unknown error
- Unrecognized command

If no errors have occurred, an error query will return a response of 0, No errors.

All Error

Queries for all error records in the error queue at the time of the query.

Command: none

Query: SYSTem:ERRor:ALL?
Reply: <all available error record(s)>

All Error Clear

Clears all error records in the error queue.

Command: SYSTem:ERRor:CLEar

Query: none

Error Count

Queries for the number of error records in the error queue at the time of the query.

Command: none

Query: SYSTem:ERRor:COUNT?
Reply: <count of error records stored>

Single Error

Queries for the next error record in the error queue. More than one error record may be queried using the optional <error record count> parameter.

Command: none

Query: SYSTem:ERRor:NEXT? [<error record count>]
Default for <error count> is 1
Reply: <next available error record(s)>

Instrument and Probe Device Information Commands

For the purposes of unit identification and quality control, the instrument—as well as compatible probes—can be queried.

Instrument

Calibration Date

Queries the calibration date of the instrument.

Query: SYSTem:INFO:INSTrument:CALDate?
Reply: <instrument calibration date>

The date is expressed using the format <3 character month name> <day of the month> <year>.

Serial Number

Queries the serial number of the instrument.

Query: SYSTem:INFO:INSTrument:SERNumber?
Reply: <instrument serial number>

Probe

If a probe information query is made with no probe connected, the host interface generates an error.

Calibration Date

Queries the calibration date of the probe.

Command: none

Query: SYSTem:INFO:PROBe:CALDate?
Reply: <probe calibration date>

The date is expressed using the format <3 character month name> <day of the month> <year>.

Model

Queries the currently-connected probe model.

Command: none

Query: SYSTem:INFO:PROBe:MODEL?
Reply: <probe model string>

The probe model string is the catalog name describing the attached probe.

Responsivity

Queries the currently-connected probe responsivity. The units of responsivity depends on the probe type.

Query: SYSTem:INFO:PROBe:RESPonsivity?
Reply: <float of form: m.mmmE+/-ee>

Serial Number

Queries the serial number of the probe.

Command: none

Query: SYSTem:INFO:PROBe:SERNumber?
Reply: <probe serial number>

Head Temperature

Queries the head temperature of the probe.

Command: none

Query: SYSTem:INFO:PROBe:TEMPerature?
Reply: <probe head temperature in degrees celsius>

Type

Queries the currently-connected probe type.

Command: none

Query: SYSTem:INFO:PROBe:TYPE?
Reply: NONE|THERMO|PYRO|SIL

Measurement Data Collection Commands

All measurements available from the front panel of the instrument are also available through the host interface. Measurement data is acquired from the instrument using the Measurement Data Collection commands, explained in this section.

Data Gating

The host has control over the quantity of measurement data being read and when it is read. Data collection is gated on and off using the INITiate and ABORt commands. Data logging is enabled after an INITiate command. Data logging is disabled after an ABORt command. Front panel operation is not affected by the host gating commands.

Abort

Disables measurement data collection.

Command: ABORt

Query: none

Initiate

Enables measurement data collection. This automatically resets the measurement data buffer to empty and clears the missing error count.

Command: INITiate

Query: none

Data Query

The host must query for measurement data in two steps: 1) query for the number of data records available (N), and 2) query N times for the data records.

The instrument stores a maximum of 10,000 data records.

For detailed information, refer to "Output Data Format" on page 74.

Data record queries are destructive reads. As each data record is read by the host, the data record count automatically decrements by one.

Fetch All Available Records

Queries for all available data records at the time of the query.

Command: none

Query: FETCh:ALL?
Reply: <all available records>

Fetch Missing Data Records Count

Queries for the number of missed data records due to buffer overflow.

Command: none

Query: FETCh:MISSing?
Reply: <count of missing data records>

Fetch Next Available Record(s)

Queries the next available data record(s) at the time of the query. More than one data record may be queried using the optional <record count> parameter.

Command: none

Query: FETCh:NEXT? [<record count>]
Default for <record count> is 1
Reply: <next available record(s)>

Fetch Available Record Count

Queries the number of data records available at the time of the query.

Command: none

Query: FETCh:NRECords?
Reply: <count of records available>

Measurement Setup Commands

The instrument may be configured to measure data through the host interface as well as the front panel. Many of the setup commands have an identical corresponding host command.

Area Correction

Aperture Area

Sets the aperture area, expressed in square centimeters (cm2).

Command: CONFigure:AREA:APERture <float of form: m.mmmE+/-ee>
Default is not applicable.

Query: CONFigure:AREA:APERture?
Reply: float of form: m.mmmE+/-ee

Area Correction Enable

Enables or disables area correction.

Command: CONFigure:AREA:CORRection {DEFault|ON|OFF}
Default is OFF

Query: CONFigure:AREA:CORRection?
Reply: ON|OFF

Attenuation

Attenuation Correction Enable

Enables or disables attenuation correction.

Command: CONFigure:ATTEnuation:CORRection {DEFault|OFF|ON}
Default is OFF

Query: CONFigure:ATTEnuation:CORRection?
Reply: OFF|ON

Attenuation Factor

Sets the attenuation factor for the currently-connected probe. The attenuation factor has no units. It must be greater than or equal to 1.0 otherwise an error will result.

Command: CONFigure:ATTEnuation:FACTor {DEFault|<float of form: m.mmmE+/-ee>}
Default 1.000E00

Query: CONFigure:ATTEnuation:FACTor?
Reply: <float of form: m.mmmE+/-ee>

Analog Output Source

Selects the voltage source of the analog output connector. This command has no apparent effect when a thermopile or optical probe is attached.

Command: CONFigure:ANAlog:SOURce
[DEFault|LIVE|SAMPled]
Default is SAMP

Query: CONFigure:ANAlog:SOURce?
Reply: LIVE|SAMP

Function Switch Position

Queries for the position of the function switch.

Command: none

Query: CONFigure:FUNCtion?
Reply: {J|W|TUNE|SETUP}

Speedup

Selects the speedup mode.

Command: CONFigure:SPEEDup {DEFault|OFF|FULL|PARTial}
Default is PARTial

Query: CONFigure:SPEEDup?
Reply: OFF|FULL|PART

Thermopile and Optical Probe Zero

(*thermopile and optical probes only*) Sets the current probe input voltage as the zero baseline voltage. The completion of this command can take up to 30 seconds. If auto ranging is active, the probe is zeroed for all usable ranges; otherwise, the probe is zeroed for the current range.

Command: CONFigure:ZERO

Query: CONFigure:ZERO?
Reply: BUSY|READY|ERROR

BUSY indicates a zero procedure is in process.

READY indicates the last zero procedure—if any—was successful.

ERROR indicates the last zero procedure—if any—failed.

Display Data Averaging

Depending on the type of probe attached, the data averaging window is expressed differently.

Data Averaging cannot be enabled if Statistics is enabled.

Pulses

Sets the data averaging window size expressed in number of pulses. The data averaging feature applies a moving average algorithm to the measurement data. This command only applies when a pyroelectric probe is attached.

Command: CONFigure:AVErage:PULSe {DEFault|OFF|2..999}
Default is OFF

Query: CONFigure:AVErage:PULSe?
Reply: OFF|2..999

Time

Sets the data averaging window size expressed in seconds. The data averaging feature applies a moving average algorithm to the measurement data. This command only applies when a thermopile or optical probe is attached.

Command: CONFigure:AVErage:TIME {DEFault|OFF|2..999}
Default is OFF

Query: CONFigure:AVErage:TIME?
Reply: OFF|2..999

Measurement Data Format

The data format commands are used to configure the form in which the instrument sends measurement data to the host. Data is sent to the host in ASCII text records. A record is a set of one or more data values generated at the same instant.

The front panel Function Select switch directs the focus of the type of measurement data that is presented at the host interface. For example, if the switch is set to J, you can expect to obtain only energy readings from the host interface. Table 7 details the output data types for the Function Select switch settings:

Table 7. Function Select Switch Output Data Types

Function Switch Setting	Output Data Type
J	Joules
W	Watts
Tune	Joules for pyroelectric probes, watts for thermopile and optical probes
Setup	Joules for pyroelectric probes, watts for thermopile and optical probes
Off	None

If area correction is active, the above units are expressed as units per square centimeter.

Measurement data presented at the host interface differs, depending if Statistics mode is active or inactive (for more details, refer to "Statistics Mode Enable" on page 69). If Statistics mode is active, the following data is available in a single data record at the completion of collection of a batch:

- Average
- Minimum
- Maximum
- Standard deviation

If Statistics mode is inactive, the following information is available with each data point:

- Joules or watts
- Pulse rate (if a pyroelectric probe is attached)
- Pulse period (if a pyroelectric probe is attached)
- Flags

A data point is internally generated by the instrument, according to the following rules:

- With every pulse—when a pyroelectric probe is attached and if Statistics mode is inactive
- With the completion of a batch of pulses—when a pyroelectric probe is attached and if Statistics mode is active
- When a measurement sample is taken—when a thermopile or optical probe is attached and if Statistics mode is inactive
- With the completion of a batch of samples determined by a time period—when a thermopile or optical probe is attached and if Statistics mode is active

Since thermopile and optical power measurements are continuous in nature (not event-based, as with pyroelectric probes), the delivery of this data may be configured as either a stream of sampled points or simply the last point recorded. For details, refer to "Continuous Data Delivery Mode," next.

The host may configure the presentation of data in a record. Data ID tags expression and content are configurable. If Statistics mode is active, all batch data is presented and is not selectable. The host may control the expression of data ID tags that precede each data item in a batch record. If Statistics mode is inactive, the host may control the data contents and the expression of data ID tags that precede each data item in a data record. For more information, refer to "Data Value Headers" and "Data Value Set Send" on page 66.

Continuous Data Delivery Mode

Selects if data delivery for thermopile or optical probes is presented in a continuous stream of sampled data points or simply the last data point sampled. If Statistics mode is active, the continuous data delivery mode has no effect.

Command: CONFigure:READings:CONTinuous {DEFault|LAST|STREam}
Default is LAST

Query: CONFigure:READings:CONTinuous?
Reply: LAST|STREam

Data Value Headers

Selects if data value identification strings will prefix data values reported over the host interface. Headers are in the form of <header>=<value>. The <header> is literally one of the IDs used in the data value send command.

Command: CONFigure:READings:HEADers {DEFault|ON|OFF}
Default is OFF

Query: CONFigure:READings:HEADers?
Reply: ON|OFF

As an example, if headers is ON, a data record could look like **PRI=1.449E-03**. If headers is OFF, a data record could look like **1.449E-03**.

Data Value Set Send

Selects which values are sent when non-statistical measurement data is reported over the host interface. One or more of the selections in the list below may be selected:

- Primary data value (includes watts or joules) (specify tag PRI)
- Pulse rate in hertz (if a pyroelectric probe is attached) (specify tag HZ)
- Pulse period in tenths of microseconds (if a pyroelectric probe is attached) (specify tag PER)
- Flags (specify tag FLAG)

The IDs may be specified in any order; however, the presentation of the data is in PRI, HZ, PER, then FLAG order depending on which IDs were selected. At least one ID must be selected. Note that this command only affects data records sent when Statistics mode is inactive. When Statistics mode is active, the presentation of batch data is not configurable and is in AVG (mean), DEV (standard deviation), MIN (minimum), then MAX (maximum) order.

Command: CONFigure:READings:SEND {PRI,HZ,PER,FLAG}
Default is PRI.

Query: CONFigure:READings:SEND?
Reply: PRI,HZ,PER,FLAG

The FLAG data item may be used so that accompanying qualification information is reported with each data record. Qualification information includes overrange and underrange conditions. The flag word is reported in ASCII form of a 32-bit hexadecimal number. Each bit has a qualification meaning, as described in Table 8.

Table 8. Data Value Set Send Bit Qualification Meaning

Bit Position	Hex Bit Mask	Qualification Meaning	Data Error String
14	00004000	Minimum baseline error	BCLIP
15	00008000	Overrange error	OVR
25	02000000	Pulse sampled data	(none)
27	08000000	Probe saturation error	PSAT
28	10000000	Negative power	(none)

Unspecified bits are reserved.

As an example, indicating to send PRI and FLAG, the host interface could send the following data records:

PRI=1.449E-03,FLAG=00000000	This record shows a data value of 1.449 mJ and no flag bits set.
PRI=OVR,FLAG=00008000	This record show an invalid data value with the over range bit set.

Probe Wavelength Correction

Wavelength Correction Enable

Enables or disables wavelength correction.

Command: CONFigure:WAVElength:CORRection {DEFault|OFF|ON}
Default is OFF

Query: CONFigure:WAVElength:CORRection?
Reply: OFF|ON

Wavelength

Sets the operational wavelength. Compensation for the wavelength is determined by the compensation table supplied by the connected probe. This value is transient. The default wavelength read from the probe is applied at power-up or when the probe is plugged in.

Command: CONFigure:WAVElength:WAVElength <0..99999>
Default is not applicable.

Query: CONFigure:WAVElength:WAVElength? [MAXimum|MINimum]
Reply: <0..99999>

Using the optional MIN and MAX parameters results in the minimum and maximum wavelengths that can be used for the connected probe. Stated accuracy is only guaranteed when the requested wavelength coincides exactly with a calibration wavelength stored in the attached probe.

Range Control

Auto Range Enable

Enables automatic selection of the instrument measurement range. When auto ranging is active, the instrument hunts for the best measurement range for the current probe and laser conditions. The hunt procedure may require several samples to arrive at the best range. Auto ranging does not apply when a pyroelectric probe is attached.

Command: CONFigure:RANGe:AUTO {DEFault|ON|OFF}
Default is OFF

Query: CONFigure:RANGe:AUTO?
Reply: ON|OFF

Range Value Select

Selects the instrument measurement range, expressed in scientific notation. The range value is normalized to the next highest 3 scale.

Command: CONFigure:RANGe:SELect <float of form: m.mmmE+/-ee>
Default is not applicable.

Query: CONFigure:RANGe:SELect? [MAXimum|MINimum]
Reply: <float of form: m.mmmE+/-ee>

Using the optional MAX and MIN parameters results in the maximum or minimum range that can be used for the units selected and the currently-connected probe. If auto ranging is active, the range returned from the query may not be the same as the range selected.

Statistical Batch Control

Sets statistics calculation parameters used in the statistics operating mode.

Batch Size

Pulses

Sets the statistics batch size that will take effect at the end of the current statistical batch. Batch size units are in pulses. This command applies only when a pyroelectric probe is attached.

Command: CONFigure:STATistics:BATchsize:PULSe {DEFault|2..99999}
Default is 100

Query: CONFigure:STATistics:BATchsize:PULSe?
Reply: 2..99999

Time

Sets the statistics batch size that will take effect at the end of the current statistical batch. Batch size units are in seconds. This command applies only when a thermopile or optical probe is attached.

Command: CONFigure:STATistics:BATchsize:TIME {DEFault|2..9999}
Default is 100

Query: CONFigure:STATistics:BATchsize:TIME?
Reply: 2..9999

Statistics Mode Enable

Enables or disables statistical data collection and reporting.

Command: CONFigure:STATistics:MODE {DEFault|OFF|ON}
Default is OFF

Query: CONFigure:STATistics:MODE?
Reply: OFF|ON

Statistics mode cannot be enabled if Data Averaging is enabled.

Restart Mode

Selects the action to be taken at the end of a statistical batch. AUTOmatic begins a new batch immediately upon logging the data from the previous batch. MANual requires the start signal (see "Restart a New Batch," below).

Command: CONFigure:STATistics:RESTartmode
{DEFault|MANual|AUTOmatic}
Default is MANual

Query: CONFigure:STATistics:RESTartmode?
Reply: MAN|AUTO

Restart a New Batch

Terminates the current statistical batch and starts a new one.

Command: CONFigure:STATistics:START

Query: none

SCPI Mandatory Commands

SCPI specifies a minimum set of IEEE-488.2 common commands (the mandatory commands). All common commands and queries start with an asterisk. Refer to the IEEE-488.2 specification for more detailed information.

Identification

Queries the instrument identification string, such as model name, firmware version, and firmware date.

Query: *IDN?
Reply: "Molectron Detector, Inc - 3Sigma – " + version + " – "+ firmware date

The dash sign delimits all fields within the reply string. The first field is always *Molectron Detector, Inc*. The second field is the product name, *3Sigma*. The third field is the version number, having the format V<major>.<minor><optional qualifier characters>. The fourth field is the firmware date, having the form <3 character month name> <day of the month> <year>.

For example, a typical identification string would look like:

Molectron Detector, Inc - 3Sigma - V1.3B - Jul 05 2001

Reset

Resets the instrument by putting it into the power-up state. This command has the same effect as a cold start of the instrument.

Command: *RST

Query: None

Self-test

Runs the instrument self-test procedure. Always returns a 0 (zero).

Query: *TST?

Reply: 0

SCPI Optional Commands

SCPI specifies various optional common commands. All common commands and queries start with an asterisk. Refer to the IEEE-488.2 specification for more detailed information.

Recall

Recalls and loads the indicated setup from nonvolatile memory. As with the *SAV command, up to five instrument setups can be recalled from nonvolatile memory. The same parameters that were previously saved are recalled.

Command: *RCL {0|1|2|3|4|5}

Query: None

Recalling setup 0 has special meaning. Setup 0 is the factory default setup.

Save

Saves the current instrument setup to the indicated setup location in nonvolatile memory. Up to five instrument setups can be saved in nonvolatile memory for later recall.

Command: *SAV {1|2|3|4|5}

Query: None

System Option Commands

The system option commands control functionality that is exclusive of instrument measurement functions. These commands can be sent at any time without affecting a measurement in progress.

Backlight

Controls the Backlight mode of the LCD. Battery charge is conserved when the backlight is off. The instrument can be configured to automatically turn off the backlight after a specific period of front panel inactivity. Selecting timed mode enables the backlight timer to automatically turn off the backlight when the backlight timer expires. Timed mode is selected by specifying a timeout value in minutes. Any button press or function switch change automatically restarts the backlight timer if the selected mode is timed.

Command: SYSTem:OPTion:BACKlight
{DEFault|NORMal|1..20}
Default is NORMal

Query: SYSTem:OPTion:BACKlight?
Reply: NORM|1..20

Auto Power Off

Sets the auto power-off timeout, expressed in minutes. Battery charge is conserved when this feature is active. The instrument can be configured to automatically power-off after a specified period of front panel inactivity. Setting the timeout to OFF disables the auto power-off function. Any button press or function switch change automatically restarts the auto power-off timer.

To restore power after Auto Power has automatically turned instrument power off, you must turn the Function Select switch to the OFF position and then back to the appropriate mode.

Command: SYSTem:OPTion:POWer:AUTOoff
{DEFault|OFF|10..60}
Default is 10

Query: SYSTem:OPTion:POWer:AUTOoff?
Reply: OFF|10..60

System Status

Queries the system status. Status is returned in a string expressed in hexadecimal integer form. The 32 status word is a bit-mapped status indicator. If a bit is set, the associated status is active; otherwise it is inactive. Table 9 describes the status bit mapping.

Table 9. Status Bit Mapping

BIT NUMBER	MASK	STATUS DESCRIPTION
0	00000001	Battery is low if the bit is set
1	00000002	Probe damage temperature is exceeded

Unspecified bits are reserved

Command: None

Query: SYSTem:STATus?
Reply: hexadecimal integer

Example: If the battery is low and the probe damage temperature has been exceeded, the query returns:

00000003 (Battery is low and probe damage temperature is exceeded)

Trigger Commands

Trigger Level

Sets the trigger level expressed as a percentage of full scale capability for pyroelectric probes. Thermopile and optical probe trigger levels are fixed.

Command: TRIGger:LEVel {DEFault|2..20}
Default is 10

Query: TRIGger:LEVel?
Reply: 2..20

Output Data Format

General Data Formats

Output data is in ASCII string form. When multiple data items are found in a single data record, the data items are separated by commas.

Units

All measurement data uses the fundamental units of its measured quantity. Example: When measuring power, watts—not milli-watts—are the fundamental unit. The only exception is the times-tamp, which is expressed in 200 µsec intervals. Units of statistical data are expressed in the natural unit for the attached probe. The natural unit for pyroelectric probes is joules and the natural unit for thermopile and optical probes is watts. The unit tags are implied and never included in the data strings.

When a pyroelectric probe is attached, watts is computed from joules as the product of joules times frequency. When a thermopile or optical probe is attached, joules is computed from watts by integrating power over time.

Headers

Data headers may be enabled. A header is a data value identification string that precedes each data value to indicate the data type. Headers have the form <tag>=. For example, if only PRI is requested and headers are enabled, a data record could look like **PRI=2.665E-3**, as opposed to simply **2.665E-3** for disabled headers.

The strings used in the header tags are the same strings used when the CONF:READ:SEND command was issued.

Ordering

The presentation of the multiple data items is in PRI, HZ, PER, FLAG order, depending on which tags were selected. The order cannot be altered.

TROUBLESHOOTING

Table 10 lists possible problems and their solutions.

Table 10. Troubleshooting Guide

PROBLEM	PROBABLE CAUSE	SOLUTION
Attenuation correction does not function when a thermopile sensor is connected to 3sigma. *Optical and pyroelectric sensors are not affected.*	This is a known bug for instruments running firmware Version 1.05.	Contact Coherent to arrange for a firmware upgrade.
When using 3sigma, picowatts are incorrectly reported as femtowatts, and picojoules are incorrectly reported as femtojoules.	This is a known bug for instruments running firmware Version 1.05.	Contact Coherent to arrange for a firmware upgrade.

CALIBRATION AND WARRANTY

This section includes information on the following topics:

- Calibration (this page)
- Coherent calibration facilities and capabilities (this page)
- Limited warranty (page 78)
- Extended lifetime warranty (page 78)
- Warranty limitations (page 79)
- Obtaining service (page 79)
- Product shipping instructions (page 80)

Calibration

Coherent laser power and energy meters are precision instruments, capable of delivering very accurate measurements, as well as providing many years of useful service. To maintain this high level of performance, it is important to have your measurement system serviced and recalibrated once a year.

Coherent Calibration Facilities and Capabilities

As the largest laser manufacturer in the world, Coherent has been able to build state-of-the-art calibration facilities containing the widest possible range of laser types and technologies. This enables us to perform instrument and sensor calibration under virtually any combination of wavelength, power, and operating characteristics. Sensors are calibrated against NIST-traceable working standard sensors which are, in turn, calibrated against NIST-calibrated golden standard sensors. These working and golden standards are maintained with the utmost care, recalibrated annually, and verified even more regularly. We maintain multiple NIST-calibrated standards at many laser wavelengths to support the growing calibration needs of our customers. Optical calibration is a core competency at Coherent and we strive to continually improve our methods, precision, and repeatability. Additionally, most of the calibrations are performed with highly automated systems, thus reducing the possibility of human error to nearly zero. Strict quality inspections during many stages of calibration and testing assure a precise and accurate instrument that is NIST traceable and CE marked. The benefit to our customers is that instruments calibrated by Coherent will consis-

tently perform as expected under their actual use conditions. We are a registered ISO 9001:2000 company, our products are NIST traceable, and our calibration labs are fully ANSI Z540 compliant.

In addition to the technological advantage, we also strive to deliver the best service in the industry, with a knowledgeable and responsive staff, and rapid turnaround.

Limited Warranty

Coherent, Inc. (the "Company") warrants its laser power and energy meters and sensors products ("Products") to the original purchaser (the "Customer") that the product is free from defects in materials and workmanship and complies with all specifications, active at the time of purchase, for a period of twelve (12) months.

Coherent, Inc. will, at its option, repair or replace any product or component found to be defective during the warranty period. This warranty applies only to the original purchaser and is not transferable.

Extended Lifetime Warranty

Coherent, Inc. (the "Company") offers original purchasers (the "Customer") purchasing laser power and energy meters and sensors products ("Products") an extended, lifetime warranty program, which includes all parts and labor. In order to qualify for this warranty, a Customer must return the Product to the Company for recalibration and recertification (traceable to NIST and MIL-STD-45662A) within one year from the date of purchase, and annually thereafter. The Company will recertify the Product, provide software upgrades, and perform any needed repairs, for a fixed service fee (as established by the Company from time to time and in effect at the time of service).

If the Product fails and is returned to the Company within one year following the date of recalibration service, the Company will, at its option, repair or replace the Product or any component found to be defective. This warranty applies only to the original purchaser and is not transferable.

If the Product is not returned for recalibration or service prior to the one-year anniversary, the lifetime warranty program expires. The lifetime warranty program may be reinstated, at Coherent's option, after completion of a fee-based product evaluation and repair, and subsequent recalibration and recertification service.

Warranty Limitations

The foregoing warranties shall not apply, and Coherent reserves the right to refuse warranty service, should malfunction or failure result from:

- Damage caused by improper installation, handling, or use.
- Laser damage (including sensor elements damaged beyond repair).
- Failure to follow recommended maintenance procedures.
- Unauthorized product modification or repair.
- Operation outside the environmental specifications of the product.

Coherent assumes no liability for Customer-supplied material returned with Products for warranty service or recalibration.

THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES WHETHER WRITTEN, ORAL, OR IMPLIED. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL THE COMPANY BE LIABLE FOR ANY INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH ITS PRODUCTS.

Obtaining Service

In order to obtain service under this warranty, Customer must notify the Company of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. The Company shall, in its sole discretion, determine whether to perform warranty service at the Customer's facility, at the Company's facility or at an authorized repair station.

If Customer is directed by the Company to ship the product to the Company or a repair station, Customer shall package the product (to protect from damage during shipping) and ship it to the address specified by the Company, shipping prepaid. The customer shall pay the cost of shipping the Product back to the Customer in conjunction with annual recalibration and repair; the Company shall pay the cost of shipping the Product back to the Customer in conjunction with product failures within the first twelve months of time of sale or between annual recalibrations.

A Returned Material Authorization number (RMA) assigned by the Company must be included on the outside of all shipping packages and containers. Items returned without an RMA number are subject to return to the sender.

For the latest Customer Service information, refer to our website: www.coherent.com.

Detailed instructions on how to prepare a product for shipping are shown under "Product Shipping Instructions," below.

Table 11. Coherent Service Centers

LOCATION	PHONE	FAX	E-MAIL
USA	1.800.343.4912	971.327.2778	info_service@coherent.com
Europe	+49 (6071) 9680	971.327.2778	info_service@coherent.com
International	971.327.2700	971.327.2778	info_service@coherent.com

Product Shipping Instructions

To prepare the product for shipping to Coherent:

1. Contact Coherent Customer Service (refer to Table 11) for a Return Material Authorization number.
2. Attach a tag to the product that includes the name and address of the owner, the person to contact, the serial number, and the RMA number you received from Coherent Customer Service.
3. Wrap the product with polyethylene sheeting or equivalent material.
4. If the original packing material and carton are not available, obtain a corrugated cardboard shipping carton with inside dimensions that are at least 6 in (15 cm) taller, wider, and deeper than the product. The shipping carton must be constructed of cardboard with a minimum of 375 lb (170 kg) test strength. Cushion the instrument in the shipping carton with packing material or urethane foam on all sides between the carton and the product. Allow 3 in (7.5 cm) on all sides, top, and bottom.
5. Seat the shipping carton with shipping tape or an industrial stapler.
6. Ship the product to:

   Coherent, Inc.
   7470 SW Bridgeport Rd.
   Portland, OR 97224
   Attn: RMA # (*add the RMA number you received from Coherent Customer Service*)

APPENDIX A: PROGRAMMING EXAMPLES

The following examples can be utilized in a high-level programming language, such as BASIC, C, or LabVIEW®. Refer to the documentation of a particular language for information on how to embed host commands into the code and how to establish RS-232 communications.

Measurement Operation

This section presents two examples of how to collect measurements.

A Simple Measurement

The simplest measurement is composed of an instrument setup followed by a read command that will yield a single measurement data point.

Step	Command	Action
1	TRIG:LEV 5	Trigger level 5%
2	CONF:READ:SEND PRI	Collect primary units only
3	CONF:RANG:SEL 3E-3	Use 3 mJ range
4		Setup is complete
5	INIT?	Issue the initiate command
6		Wait for the ENQ service request marker
7	ABOR	Disable data collection
8	FETC:NEXT?	Query for the next data record which will give something like "0.950E+00"

Collecting Measurement Data

The host meters collection of available measurement data by first querying for the number of records available and then fetching the indicated number of records. For this example, assume the instrument setup performed through the host interface is identical to the example explained under "A Simple Measurement" on page 81.

Step	Command	Action
1		Setup as above
2	INIT	Issue the initiate command
3		Wait for the ENQ service request marker
4	ABOR	Disable data collection
5	FETC:NREC?	Query for the number of data records to read and possibly allocate storage to hold the data that will be queried later
6	FETC:ALL?	Query for all data records
7		Go to step 3 to wait for more data records or go to step 7 to quit

Collecting Error Information

The host meters collection error information in the same way it meters collection of available measurement data.

Step	Command	Action
1		ENQ service request marker is received
2		FETC:NREC? Query reveals there are no data records available so there must be error records to read
3	SYST:ERR:COUNT?	Query for the number of error records to read and possibly allocate storage to hold the records that will be queried later
4	SYST:ERR:ALL?	Query for all error records
5		Parse/decode the error records

The error collection handling commands should be integrated into the host's normal operational code so that error information can be constantly collected.

APPENDIX B: DEFAULT SETTINGS

Default settings are set at the Factory. You can restore the default settings at any time by going to the Setup Recall screen and selecting Factory default.

Table 12. Factory Default Settings

SETTING	DEFAULT
Analog Out	Live
Area Correction	Off
Area Value	1.0 cm^2
Attenuation Correction	Off
Attenuation Value	1.0
Auto Batch	Off
Auto Power Mode	Timed
Auto Power Timeout	10 min
Auto Range	Off
Avg Mode	Off
Avg Window Size (pyroelectric sensor)	100 pulses
Avg Window Size (thermopile/silicon sensor)	10 sec
Backlight Mode	Timed
Backlight Timeout	10 min
Batch Size (pyroelectric sensor)	100 pulses
Batch Size (thermopile/silicon sensor)	10 sec
Hertz Mode	Off
Range	3 J or 3 W
Serial Baud	9600
Serial Pacing	None
Serial Parity	None

Table 12. Factory Default Settings (Continued)

Serial Stop Bits	1
Speedup Enable	Off
Speedup Mode	Partial
Stat Mode	Off
Trend Size	10 min or 10,000 pulsed
Trigger Level	10%
Tune Mode	Tune
Wavelength Correction	Off
Wavelength Value	Calibration wavelength of sensor
Zoom Mode	1X

APPENDIX C: SPECIFICATIONS

Table 13 lists 3sigma specifications.

Table 13. Specifications

PARAMETER	DESCRIPTION
Analog Output	0 to 1 V output 150 to 300 ohms output impedance
Battery	Operating time (with full charge) 7 hrs (approx) Recharging time (with fully-discharged battery) 10 hrs (approx)
Calibration Accuracy	± 1% (NIST traceable)
Calibration Interval	One year
Dimensions Height Width Depth	 6.4 in (162.6 mm) 8.0 in (203.2 mm) 2.0 in (50.8 mm)
Linearity	± 1% (instrument)
Measurement Ranges (sensor-dependent) Pyroelectric Thermopile Optical	 3 µJ to 300 J 3 mW to 3 kW 300 nW to 30 mW
Power	100 to 240 VAC, 50 to 60 Hz (AC wall adapter included), and rechargeable NiMH battery
Regulations Met	CE, ISO 9000
Rep Rate	1 to 1,000 pps (4,000 pps using pulse sampling)
Resolution (sensor-dependent) Pyroelectric Thermopile Optical	 1 nJ 3 µW 100 pW
RS-232 Pinouts 1 2 3 5 6 8	 GND Receive (from computer to 3sigma) Transmit (from 3sigma to computer) - - -

Table 13. Specifications (Continued)

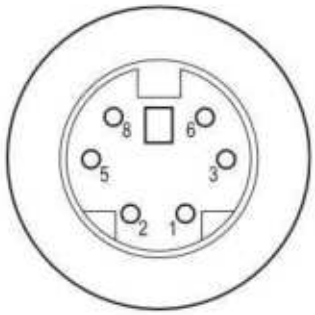
Parameter	Description
Analog Output	0 to 1 V output 150 to 300 ohms output impedance
Trigger	Selectable, 2 to 20% internal
Weight (approx)	2.6 lbs (1.2 kg)

RS-232 Pinouts

Table 14 shows the 3sigma RS-232 pinouts.

Table 14. RS-232 Pinouts

Pin	Assignment
1	GND
2	Receive (from computer to 3sigma)
3	Transmit (from 3sigma to computer)
5	-
6	-
8	-



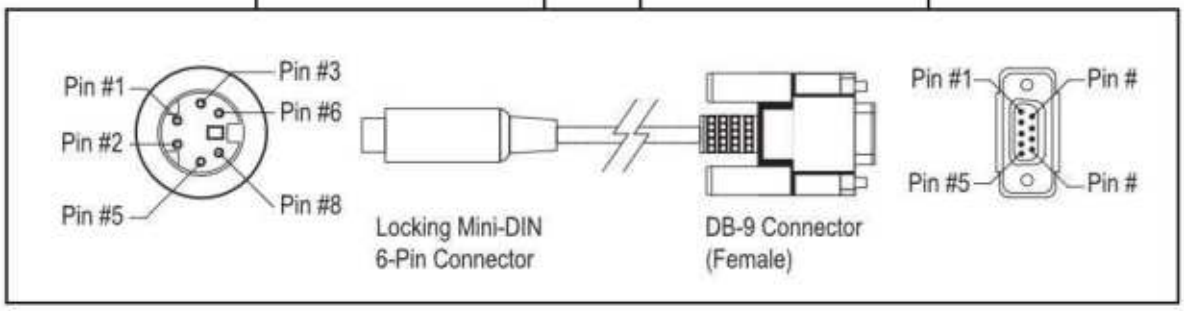
The above pinout chart refers to the connector on the 3sigma.

RS-232 Cable Assembly

Table 15 shows the wiring configuration between the mini-DIN 6-pin connector and a DB-9 connector.

Table 15. Mini-DIN 6-pin to DB-9 Wiring Configuration

MINI-DIN 6-PIN #		DB-9 PIN #
-		1
3	TO	2
2	TO	3
-		4
1	TO	5
-		6
-		7
-		8
-		9
Shell	TO	Shell



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