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Molectron
DETECTOR, INCORPORATED

EM400/EM500

Single-Channel Joulemeter

ENERGY MAX®



USER MANUAL

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Molectron Detector, Incorporated
7470 SW Bridgeport Road
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Phone: 800.366.4340 or 503.620.9069
Fax: 503.620.8964
www.molectron.com

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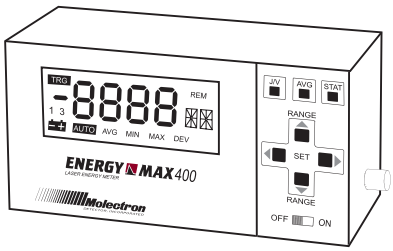
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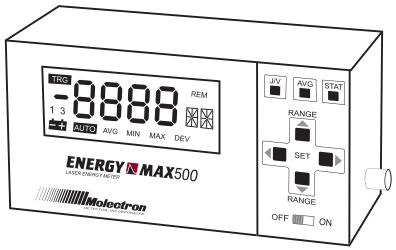
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Features & Description

Overview





Thank you for purchasing a Molectron EM400/EM500. These devices are portable, battery-operated, single-channel laser joulemeters for production line testing and field service applications. Microprocessor-based instruments, they are designed to operate with Molectron's J25 and J50 series pyroelectric probes. The EM500 has an added computer interface capability.

The EM400/EM500 is fast, accurate, and easy to use. It features a large 4-digit numeric display and an AUTO-OFF feature to conserve battery life. It supports a wide range of user-selected calibration factors and a wide dynamic range of inputs. It displays directly in energy units. The EM500 features a 3-wire RS232 interface, an analog output, an audible tuning function, and an internal rechargeable battery. Both units include an AC adapter, which also charges the internal battery of the EM500.

The EM400/EM500 has three operating modes:

- Normal mode displays the instantaneous energy of the laser on a pulse-to-pulse basis.
- Average mode calculates and displays a user-selected 2-99 pulse average.
- Statistics mode accumulates 2 to 9999 pulses and provides four kinds of numeric results (Average, Minimum, Maximum, and Standard Deviation) for the accumulated set.

Controls

Arrow Keys

Press the  key to select a higher range in Normal or Average mode or to increase the value in Set functions.

Press the  key to select a lower range in Normal or Average mode or to decrease the value in Set functions.

Press  and/or  to select digits in Set functions, to select a computation function (Average, Minimum, Maximum, or Standard Deviation) in Statistics mode, or to operate the Audible Tuning Function.

AVG Key

Press  to enter Average mode and to perform averaging operations.

J/V Key

Press  to enter Normal mode and its functions, and to switch the reading between Joules and Volts.

On/Off Switch

Slide OFF ON to the right to power up the EM400/EM500.

STAT Key

Press  to enter Statistics mode and to perform statistical operations.

Indicators

Audible Tuning

The Audible Tuning function can be entered from either Normal or Average mode. When enabled, the audible tone sets to 50% of its maximum frequency. When the initial reading (the reading at the moment the audible tone is enabled) is increased by 100%, the audible tone increases to 100%. Likewise, a 100% decrease lowers the frequency to zero. When the audible tone reaches 100% or more (the display has increased 100% or more), the tone will beep on and off.

Press the ◀■ and ■▶ keys simultaneously to activate the Audible Tuning function.

Press the ◀■ and ■▶ keys simultaneously when the audible tone output is 100% or more to reset at 50% frequency.

Press the ◀■ and ■▶ keys simultaneously when the audible tone output is less than 100% to disable the Audible Tuning function. Reminder: if the audible tone output is at 100% or more, pressing the ◀■ and ■▶ keys will restart the function. If it is at less than 100%, pressing the same keys will disable the function.

Note: The EM500 Analog Output value is not valid while the instrument is in Audible Tuning mode (the output value will still not exceed the specified 2.00V threshold).

AVG Indicator

The indicator **AVG** flashes during Average mode. It's activated steadily when the mean is being displayed in Statistics mode.

Battery Indicator

The EM400 and the EM500 indicate  when the battery is low. When lit, replace the 9V battery in the EM400 or recharge the internal battery in the EM500 with the supplied AC wall adapter. Note: Accurate readings cannot be made when the Battery Indicator is lit.

DEV Indicator

DEV switches on when Standard Deviation is being displayed in Statistics mode.

LCD Numerical Display

Four-digit numeric field
· Displays the instrument reading in Joules or Volts in all modes.
· Displays the constant value in Set functions.



Two-character alphanumeric field
· Displays the units of measure.
· Displays auxiliary information in Set functions.



MAX Indicator

MAX indicates the statistical Maximum is being displayed in Statistics mode.

MIN Indicator

MIN indicates the statistical Minimum is being displayed in Statistics mode.

TRG Indicator

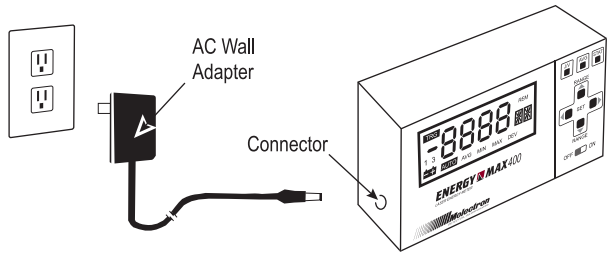
TRG indicates a valid trigger during live measurement. Flashes once for each trigger at repetition rates below 3 pps. Activated steadily at repetition rates above 3 pps.

Other Connectors

AC Wall Adapter Connector

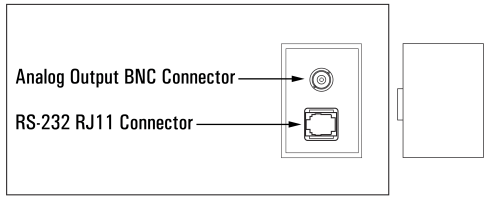
Located on the left side of the instrument, it connects to the wall adapter (supplied), allowing the unit to be powered from AC line power and the internal battery of the EM500 to be recharged. A replacement adapter, if needed, should be rated 18 V DC (±1 V DC), 500 mA. The output connector should be 5.1 mm (.20") O.D. and 2.55 mm (0.100") I.D.

Under normal conditions, the EM400's battery will last 4 hours and the EM500's internal NI-Cad battery will last 6 hours with a recharge time of 14 hours.



Analog Out Connector

To access the Analog Out connector, press down on the compartment cover on the back of the EM500. Slide it outward, away from the center of the instrument. Connects to a voltmeter or a data acquisition system. It provides a DC voltage proportional to the display reading. The output is scaled for 2 Volts full scale for the range selected.

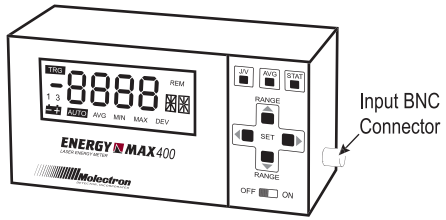


The Analog Output BNC's maximum output is 2.00 Volts. Even though the EM500 LCD may exceed its selected full scale under some conditions, the Analog Output value will never exceed 2.00 Volts.

Example: The LCD reads 3.47 mJ on the 20 mJ range (about 17 percent of full scale). The analog output will read 0.347 VDC.

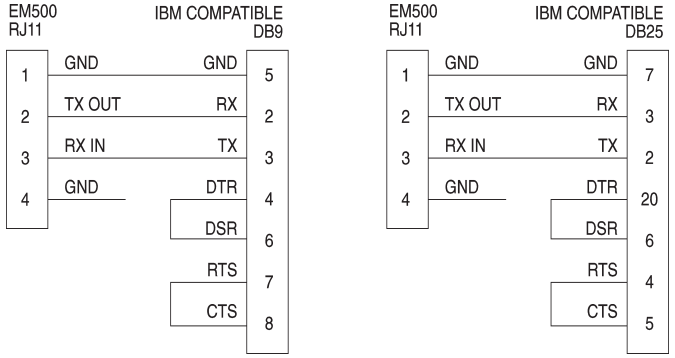
Input BNC Connector

Located on the right side of the instrument, the Input BNC connects to a Molectron J25 or J50 series pyroelectric probe.



RS-232 RJ11 Connector

To access the RS232 connector, press down on the compartment cover on the back of the EM500. Slide it outward, away from the center of the instrument. The RJ11 connector provides a 3-wire interface with an IBM compatible computer through a standard 25-pin or 9-pin D sub connector. In the connector supplied with the EM500, the RTS/CTS and DTR/DSR jumpers loop the PC's handshaking lines back to the PC to allow 3-wire data transmission; these jumpers may not be required for all PC-based applications.



Safety & Maintenance

Cautionary Statements & Precautions

These terms may appear on the product:
Warning indicates a personal injury hazard.
Caution indicates a hazard to property including the product.

Review the following safety precautions carefully to avoid injury or prevent damage to the instrument or other equipment through misuse.

- Do not operate with suspected failures. If you suspect that this product is damaged, have it inspected by qualified Molectron service personnel.
- Do not operate this product from a power source that applies more than the voltage specified.
- Do not apply a voltage outside the range specified to any terminal.
- Do not operate this product if its panels are removed.
- Do not operate this product in wet or damp conditions or in an explosive atmosphere.
- To prevent the product from overheating, provide proper ventilation.

The only user-serviceable parts of the EM400/EM500 are the batteries.

User Maintenance

When the instrument activates , the EM400 battery must be replaced or the EM500 battery must be recharged.

Energy readings are not accurate while the instrument displays .

Replace the EM400's battery by pressing down on the battery compartment cover located on the back of the instrument. Slide it outward, away from the center of the instrument.

The EM500 rechargable battery is not user-serviceable. Recharge it using the included AC Adapter.

There are no user-serviceable parts to an EM400 except the replaceable battery and there are no user-serviceable parts of the EM500 at all.

Service & Calibration

To maintain optimum NIST traceable performance, return the instrument to Molectron for annual recalibration. In addition to recalibration, Molectron takes advantage of this annual service to upgrade firmware if necessary and verify the unit functions within Molectron's strict performance standards.

Always contact Molectron before returning an instrument for calibration. To prepare an instrument to Molectron:

1. Contact Molectron Detector's Customer Service Department at (800) 366-4340 for a Return Material Authorization number. **Note:** Material will not be accepted without a pre-assigned RMA number.
2. Attach a tag to the instrument, indicating the owner's name and address, contact person (if different than owner), instrument serial number and assigned RMA number.
3. Pack the instrument in the original packaging. If original packaging is not available, wrap the instrument with polyethylene sheeting (or equivalent) and pack it in a corrugated cardboard carton with at least 7.5 cm (3") on all sides. Use a carton with at least 170 kg (375 lb) test strength.
4. Seal the carton tightly with shipping tape. Print TO and FROM addresses and RMA number clearly on the outside of the carton.

Operation

A Typical Energy Measurement

Measuring energy using and EM400/EM500 and a Molectron Pyroelectric Detector is easy. For a complete list of compatible Detectors, see ***Compatible Probes & Ranges***.

CAUTION: Do not exceed the power/energy density for the probe. Consult the detector data sheet, or test the setup with a damage test slide as appropriate.

1. With the laser beam blocked or the laser turned OFF and the EM400/EM500 turned OFF, place the pyroelectric probe in the path of the laser beam.
2. Connect the probe to the EM400/EM500 Input Connector using the BNC cable supplied with the probe.
3. Switch ON the EM400/EM500.
4. Press [J/V] to place the instrument in Normal mode. Press [J/V] until the desired units (J/mJ/µJ or V/mV/µV) are shown.
5. Unblock the laser beam or start the laser. Verify proper beam alignment on the center of the probe surface.
6. Adjust the range by pressing [▲] or [▼] until **TRG** is activated and a reading in Joules or Volts appears on the LCD. If the LCD indicates OL, press the [▲] button until a valid reading occurs.

AUTO-OFF Feature

The EM400/EM500 has an AUTO-OFF feature to conserve battery life. Whenever there is five minutes of front panel inactivity, the instrument shows a series of dashes (----) on the LCD display and automatically goes into AUTO-OFF. To resume operation from an AUTO-OFF state, complete a power cycle by moving the On/Off switch to the OFF position and then back to the ON position.

Normal Mode

Normal mode displays the instantaneous energy of the laser on a pulse-to-pulse basis.

Press J/V to enter Normal mode.

J/V Selection

The EM400/EM500 can display Joules (J), millijoules (mJ), or microjoules (μJ); or Volts (V), millivolts (mV), or microvolts (μV).

From Normal mode, press J/V to shift between Joules and Volts.

Range Selection

During operations in Normal mode, press ▲ to select a higher range or

▼ to select a lower range.

Calibration Set Function

Before operating the EM400/EM500 with a probe, the correct calibration factor (Responsivity or Rv) for that probe must be entered. The probe Rv number is printed on the probe label in units of Volts/Joule. If the Rv number is printed in units of Volts/millijoule, multiply this number by 1000 to get Volts/Joule.

1. Press [J/V] to enter Normal mode. The EM400/EM500 must be in Normal mode to enter the Calibration Set function.
2. Press and hold [J/V] until the LCD changes (about four seconds) to the Calibration Set function.
3. Press [◀] and [▶] to select digits and [▲] or [▼] to change the values of the selected digits.
4. Press [J/V] to return to Normal mode.

During the Calibration Set function, the EM400/EM500 displays a three-digit mantissa and a single-digit (positive or negative) exponent.

Example: To set a calibration factor of 8.00 Volts/Joule, set the LCD digits to read 8.00 +0 (8.00×10^{0}). For a calibration factor of 0.800 Volts/Joule, set digits to 8.00 -1 (8.00×10^{-1}).

Average Mode

Average mode provides pulse smoothing (reducing pulse-to-pulse variation). It calculates and displays a user-selected pulse average.

Press [AVG] to enter Average mode. The AVG annunciator will flash.

Average Pulse Set Function

Use this function to select a pulse average.

1. Press and hold [AVG] until the LCD changes (about four seconds) to the Average Pulse Set function.
2. Press [◀] or [▶] to select digits and [▲] or [▼] to change the values of the selected digits.
3. Press [AVG] to return to Average mode.

Example: To set the unit to average 20 pulses, set the LCD digits to read 20-1. Use any number 2-99.

Range Selection

During Average mode operations, press [▲] to select the next higher range and [▼] to select the next lower range.

Statistics Mode

Statistics mode accumulates a set of pulses (2 to 9,999) and provides four kinds of numeric results (Average, Minimum, Maximum, and Standard Deviation) for the accumulated batch. The batches can be set to restart automatically at the end of each batch or only when [STAT] is pressed.

Note: Statistics mode can be entered from either Normal or Average mode, but the instrument must be in Statistics mode to enter the Statistics Batch Set function.

Press [STAT] to enter Statistics mode. One of the Statistics annunciators MAX, MIN, AVG, DEV) will light up and remain steadily lit.

Statistics Batch Set Function

Select the number of pulses to accumulate or to select Manual or Auto Restart while in Statistics mode. During the Statistics Batch Set function, the LCD displays four digits representing the pulses to accumulate, while the two-character alphanumeric field indicates whether the instrument is set for Manual Restart (MR) or Auto Restart (AR). During Auto Restart, the LCD shows the results of the previous batch.

1. Press and hold [STAT] until the LCD changes (about four seconds) to the Statistics Batch Set function.
2. Press [◀■] or [■▶] to select digits and [▲] or [▼] to change the values of the selected digits or to select Manual Restart (MR) or Auto Restart (AR).
3. Press [STAT] to return to Statistics mode.

Example: 1200MR sets the unit to collect 1200 pulses, with manual reset before continuing.
1000AR collects 1000 pulses, then automatically restarts the batch.

Statistics Functions

After the EM400/EM500 accumulates a batch of pulses, the results are displayed as one of four computations: Average, Minimum, Maximum, and Standard Deviation.

1. While in Statistics Mode, press ◀■ or ■▶ until the annunciator for the desired function is steadily activated.
2. Press STAT ■ to restart a batch for either Manual and Auto Restart functions.

Remote Operation

Serial Port Parameters

The EM500 accepts single-byte commands via the 3-wire RS-232 serial port. The EM500 sends a data stream of raw ADC readings representing joulemeter pulses. These readings must be scaled by the computer to display Joules or Volts.

Only Normal mode functions are accessible from the RS-232 port.

The EM500 has a fixed baud rate and other parameters. Set the computer port to the following parameters for interface with the EM500:

Baud Rate	9600 (default) or 19200 set with special command byte (0xf9 hex, 249 dec) at 19200 baud
Parity	None
Data Bits	8
Stop Bits	1

ADC Data Format

The ADC counts are transmitted in two-byte format. The two most significant bits (MSBs) of Data Byte 1 are always both set to 1 and bits seven and six are set to 1 and 0, respectively.

Data Byte One

Bit #	7	6	5	4	3	2	1	0
Mnemonic	1	1	Bit_{11}	Bit_{10}	Bit_9	Bit_8	Bit_7	Bit_6

Data Byte Two

Bit #	7	6	5	4	3	2	1	0
Mnemonic	1	0	Bit_5	Bit_4	Bit_3	Bit_2	Bit_1	Bit_0

The six least significant bits (LSBs) of Data Byte One represent the six MSBs of the ADC counts. The six LSBs of Data Byte Two represent the six LSBs of the ADC counts. Valid combined readings are from 0000 to 4096 (12 binary bits). However, the EM500 contains a 12-bit ADC with headroom and footroom yielding typical full-scale readings from 1500 to 2500 representing 2000 counts on the display. Also, the EM500 does not trigger on pulses less than 5% of full scale. Therefore, the minimum raw ADC readings are about 75 counts.

Note: See the ***Query Full Scale Reading*** Remote Command for instructions on computing Joules or Volts from raw ADC readings.

Commands

The EM500 operates serially one byte at a time. Upon receiving a valid command or auxiliary data byte, the EM500 returns an ACK (06 hex or dec). The single exception is data stream transmission, where the EM500 sends two bytes for every joulemeter pulse.

Certain commands require that additional bytes be sent from the computer. For example, setting the Calibration Factor (Rv) requires sending the bytes representing the Rv one at a time. Each of these auxiliary bytes is acknowledged with an ACK in less than 5 ms. However, the computer must not send another byte until it receives the ACK. Furthermore, multibyte command sequencess must be terminated with a LF character.

Query Firmware Version

33 dec 21 hex ! ASCII

EM500 sends its firmware version.

Auxiliary Send Bytes: none
Response Bytes: ASCII 3-digit numerals with decimal representing firmware version X.XX

Query Full Scale Reading 34 dec 22 hex " ASCII

The EM500 transmits the ADC counts that produce 2000 counts on the EM500 display for the current range. The number, a 4-digit ASCII, is used to interpret the EM500 readings sent in raw ADC count format.

Example: The EM500 is on the 2.000 Joule range. The Query Full Scale Reading command returns "2307" in ASCII (hex bytes: 32 33 30 37). The raw data reading is 1567 ADC counts (see ***Start Data Transmission*** Command). The reading in Joules: (Range Full scale / Query Full Scale Reading) x ADC Count, or (2.000 / 2307) x 1567 = 1.358 Joules.

Auxiliary Send Bytes: none
Response Bytes: ASCII 4-byte numeric value. Typically 1500 to 2500.

Query Measurement Mode 37 dec 25 hex % ASCII

Auxiliary Send Bytes: none
Response Bytes: Single ASCII char. Joules = 'J' (4A), Volts = 'V' (56)

Query Range 36 dec 24 hex $ ASCII

Auxiliary Send Bytes: none
Response Bytes: ASCII 2-char range exponent. Example: 0.002 range has exponent -3 (hex 2D 33).

Query Responsivity 35 dec 23 hex # ASCII

Auxiliary Send Bytes: none
Response Bytes: ASCII 3-digit mantissa with decimal, ASCII 'E', ASCII exponent sign '-' for negative exponents, ASCII 1-digit exponent (Rv in format X.XXEX or X.XXE-X).

Restore Default Setup 62 dec 3E hex > ASCII

This function does not allow RS232 access to the Average or Statistics modes; it only restores the factory setup for the instrument.

Measurement Mode:	Joules
Range:	2.000 Joules
Average Pulses:	50
Statistics Pulses:	50
Statistics Function Displayed:	Standard Deviation
Statistics Reset:	Auto

Auxiliary Send Bytes:	none
Response Bytes:	none

Set Joules Measurement 48 dec 30 hex 0 ASCII

Auxiliary Send Bytes: none
Response Bytes: none

Set Range 47 dec 2F hex / ASCII

Set range from 2mJ to 20J or 2mV to 20V. Non-valid range requests are ignored.

Auxiliary Send Bytes: ASCII 2-digit range exponent. Example: 0.002 range has exponent -3 (hex 2D 33).
Response Bytes: none

Set Responsivity 46 dec 2E hex . ASCII

Auxiliary Send Bytes: ASCII 3-digit mantissa with decimal, optional ASCII negative exponent sign (hex 2D = '-'), ASCII 1-digit exponent. Rv in format X.XXEX or X.XXE-X.
Response Bytes: none

Set Volts Measurement 49 dec 31 hex 1 ASCII

Auxiliary Send Bytes: none
Response Bytes: none

Start Data Transmission 60 dec 3C hex < ASCII

Auxiliary Send Bytes: none
Response Bytes: Transmits two bytes for each joulemeter pulse received. Data is transmitted in raw ADC count format.

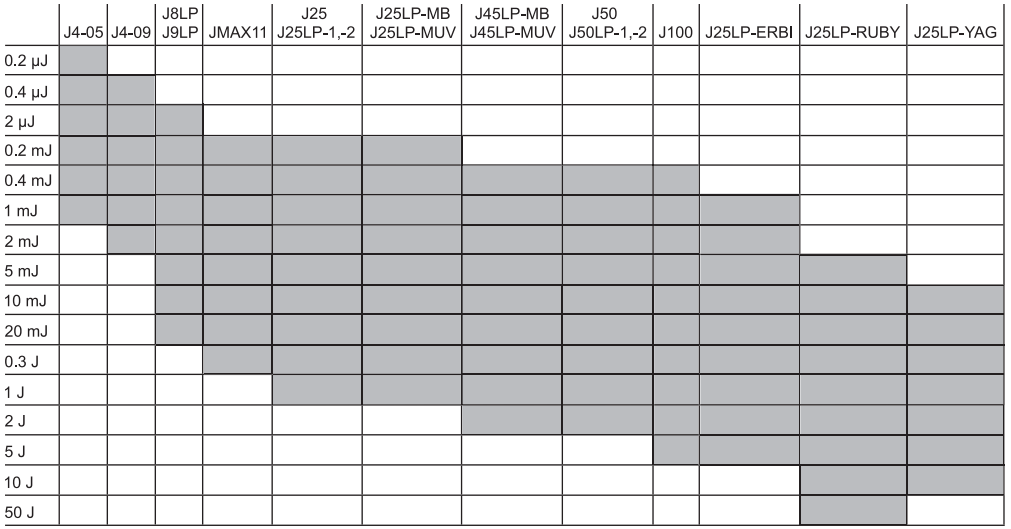
NOTE: The EM500 display is not updated while RS232 data transmission is enabled. Also note that data bytes are transmitted *only* when the EM500 is receiving input pulses greater than the 5% trigger level.

Stop Data Transmission 61 dec 3D hex = ASCII

Any byte sent to the EM500 during data transmission will stop the EM500 from sending data.

Auxiliary Send Bytes: none
Response Bytes: none

Compatible Detectors & Ranges



Frequently Asked Questions

For the latest updates to this list, or for more information about the EM400 or EM500 Joulemeters, visit us online at *www.molectron.com*.

The EM500 does not respond to remote commands which use auxiliary bytes.

The EM500 must receive a LF at the end of multi-byte commands. This distinguishes multi-byte commands from one-byte commands.

From where can the source code for the EM500 Application Program be downloaded?

Molectron does not supply the source code for this compiled application. Download EM500 LabVIEW tools from the Molectron website (www.molectron.com) for a better understanding of the communication protocols, or locate an RS-232 FAQ for more detailed information.

Can a bad data point ruin a Statistics Batch?

If one or more data points in a Statistical batch are out of range, then the entire batch is invalidated and an overrange value reported for all results.

How can I communicate with an EM500 using Microsoft's Hyperterminal?

1. Doubleclick the Hypertrm.exe icon.
2. For the Connection Description, use EM500.
3. At the Connect To window, select Direct to Com1 (or whichever port you're using).
4. At the COM Properties window, select the following parameters:
   - Bits per second: 19200
   - Data bits: 8
   - Parity: None
   - Stop bits: 1
   - Flow control: Hardware
5. While the connection is attempted (it may fail), exit Hyperterminal. When prompted to save the session, do so.
6. Right click on the resulting Em500.ht file and select Properties.
7. Under the Settings tab, choose Emulation: VT52.
8. Press OK to close the window.
9. Doubleclicking the EM500.ht will now cleanly connect to an attached EM500. Commands may be typed and the EM500 will respond in the same screen.

Specifications

Instrument Specifications

Display	4-digit numeric LCD Two alphanumeric characters Annunciators for trigger, statistics functions, and low battery
Ranges	Five Volt ranges: 2mV, 20mV, 200mV, and 20V[1] Available Joule ranges depend on selected Responsivity [1] Maximum Input Voltage: 9 VDC
Maximum Input Pulse Amplitude	9 Volts peak
Minimum Input Trigger Level	5% of full scale
Maximum Rep Rate	500 Hz (probe-dependent)
Linearity	±1%
Accuracy	±1%
Input Impedance	1 MΩ
Trigger Level	5% of full scale
Averaging	2-99 pulses

Calibration Factors	1.00×10^{-3} to 9.99×10^{3}
EM500 Analog Output	2 volts full scale
Output Impedance	100 Ω
Data Conversion Digital Resolution	12-bit resolution
EM500 RS-232 Interface	3-wire, polled operation
EM500 RS-232 Baud Rate	9,600 (default) or 19,200
EM500 RS-232 Parity	None
EM500 RS-232 Data Bits	8
EM500 RS-232 Stop Bits	1
Battery Life, EM400, Alkaline 9 V	4 hr
Battery Life, EM500 internal NiCad	6 hr

EM500 Battery Recharge Time	14 hr
Battery AUTO-OFF Timeout	5 min
Dimensions	20.62 cm x 10.16 cm x 5.72 cm (8.12 in x 4.0 in x 2.25 in) plastic enclosure
Weight, EM400	419.6 g (14.8 oz)
Weight, EM500	632.2 g (1 lb, 6.3 oz)

Factory Default Settings

Before shipment, the attributes of the EM400/EM500 are set as follows:

Measurement Mode:	Joules
Range:	2.000 Joules
Average Pulses:	50
Statistics Pulses:	50
Statistics Function Displayed:	Standard Deviation
Statistics Reset:	Auto

Warranted Characteristics

Power

90-264 VAC, 47-63 Hz, 25 VA

Atmospherics

Temperature[2]

Operating, 0° C to +50° C
Storage, -40° C to +75° C
[2]Maximum operating temperature is decreased 1° C per 305 m (1,000 ft) above 1,525 m (5,000 ft)

Relative Humidity

0-95% at or below +30° C
0-75% from +31° C to +50° C

Altitude

Operating: to 4,570 m (15,000 ft)
Non-operating: to 12,190 m (40,000 ft)

Dynamics

Random Vibration

Operating: 0.31 g rms, from 5-500 Hz, 10 minutes each axis
Non-operating: 2.46 g rms, from 5-500 Hz, 10 minutes each axis

Emissions[3]

Meets or exceeds the requirements of the following standards

EN 50081-1	European Community Requirements
EN 55011	Radiated Emissions Class A
EN 55011	Conducted Emissions Class A

[3]To maintain emission requirements when connecting to the serial interface, use only high-quality, double-shielded (braid and foil) cables. The cable shield must have a low impedance to the connector housings at both ends.

Susceptibility

Meets or exceeds the requirements of the following standards

EN 50082-1	European Community Requirements
IEC 802-2	Electrostatic Discharge, Performance Criteria B
IEC 801-3	Radiated Susceptibility 3 V/meter from 27MHz to 500MHz unmodulated

Performance Criteria: Maximum meter deviation ±3% of reading

Maximum LCD reading ±3% of reading
IEC 801-4 Electrical Fast Transient/Burst

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