Model 1825-C
Power/Energy Meter

OPERATOR'S MANUAL

Newport®

Model 1825-C
Power/Energy Meter

Warranty

Newport Corporation warrants this product to be free from defects in material and workmanship for a period of 1 year from the date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned, transportation prepaid. Repaired products are warranted for the balance of the original warranty period, or at least 90 days.

Limitation of Warranty

This warranty does not apply to defects resulting from modification or misuse of any product or part. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular use. Newport Corporation shall not be liable for any indirect, special, or consequential damages.

Statement of Calibration

This instrument has been inspected and tested in accordance with specifications published by Newport Corporation.

The accuracy and calibration of this instrument and photodetector (where applicable) is traceable to the National Institute for Standards and Technology through equipment which is calibrated at planned intervals by comparison to the certified standards maintained at Newport Corporation.

Part No. 19572-01, Rev. F
IN-04925 (07-97)

Newport®

EC DECLARATION OF CONFORMITY

Model 1825-C

We declare that the accompanying product, identified with the "CE" mark, meets the intent of the Electromagnetic Compatability Directive, 89/336/EEC and Low Voltage Directive 73/23/EEC.

Compliance was demonstrated to the following specifications:

EN50081-1 EMISSIONS:
Radiated and conducted emissions per EN55011, Group 1, Class A

EN50082-1 IMMUNITY:
Electrostatic Discharge per IEC 1000-4-2, severity level 3
Radiated Emission Immunity per IEC 1000-4-3, severity level 2
Fast Burst Transients per IEC 1000-4-4, severity level 3
Surge Immunity per IEC 1000 4-5, severity level 3

IEC SAFETY:
Safety requirements for electrical equipment specified in IEC 1010-1.

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Safety Symbols and Terms

The following safety terms are used in this manual:

The **Warning** heading in this manual explains dangers that could result in personal injury or death.

The **Caution** heading in this manual explains hazards that could damage the instrument.

In addition, a **Note** heading gives information to the user that may be beneficial in the use of this instrument.

General Warnings and Cautions

The following general warnings and cautions are applicable to this instrument:

Warning

This instrument is intended for use by qualified personnel who recognize shock hazards or laser hazards and are familiar with safety precautions required to avoid possible injury. Read the instruction manual thoroughly before using, to become familiar with the instrument's operations and capabilities.

Warning

The American National Safety Institute (ANSI) states that a shock hazard exists when probes or sensors are exposed to voltage levels greater then 42VDC or 42V peak AC. Do not exceed 42V between any portion of the Model 1825-C (or any attached detector or probe) and earth ground or a shock hazard will result.

Caution

There are no user serviceable parts inside the Model 1825-C. Work performed by persons not authorized by Newport may void the warranty. For instructions on obtaining warranty repair or service please refer to section 5 of this manual. Do not operate this unit via its AC Adaptor without the included rechargeable battery pack installed. Use only the AC Adapter provided with the Model 1825-C by Newport.

Abbreviations

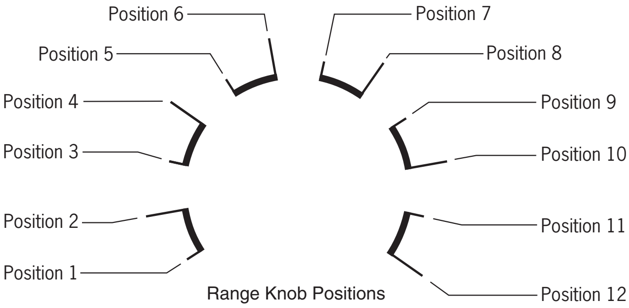
A	amps
AC	alternating current
ADC	analog-to-digital converter
BAT	battery
BIC	biconic fiber connector
BNC	standard coaxial connector type
°C	degrees Centigrade
DC	direct current
°F	degrees Fahrenheit
Hz	hertz (cycles per second)
I-V	current-to-voltage converter
kHz	kilohertz
kΩ	kiloOhms
LSD	least significant digit
mA	milliamps
mV	millivolts
nA	nanoamps
nF	nanofarads
nm	nanometers
P-P	peak-to-peak
RH	relative humidity
S/N	serial number
μA	microamps
μs	microseconds
V	volts
W	watts

Specifications

Physical Specifications

Dimensions:	3.75 × 7.5 × 9.25 in. (95 × 191 × 235 mm)
Weight:	5 lb (2.3 kg)
Enclosure:	Metal case, painted
Connectors:	Signal Input BNC; Signal Output BNC; Power 2.5 mm Phone Jack
Power:	12 VDC, 200 mA unregulated
Battery Life:	20 hours
Battery Type:	Lead acid rechargeable, 1000 cycles
Display:	3.5 digit annunciated LED and analog meter
Reading Rate:	12 Hz Max.
Range Switch:	12 position, 6 decades of gain
Operating Environment:	<90 % RH Noncondensing. 5 to 40°C
Storage Environment:	<90 % RH Noncondensing. -25 to 60°C
Compatible Detectors:	Low-Power Detectors; Except 818-F-SL and 818-F-IR
	High-Power Detectors
	Energy Detectors; Except 818J-S10

Electrical Specifications:(0)



Range Switch Position	**1 & 2**	**3 & 4**	**5 & 6**	**7 & 8**	**9 & 10**	**11 & 12**
Full scale measurement (divide value by calibration factor mantissa)						
Semiconductor	200nA	2µA	20µA	200µA	2mA	20mA(1)
Thermopile	2mV(2)	2mV	20mV	200mV	2V	20V(3)
Pyroelectric	20mV	200mV	2V	20V	200V	2kV(4)
Relative noise factor (peak-to-peak, measured relative to full scale)						
Semiconductor	0.2%	0.02%	0.1%	0.01%	0.01%	0.01%
Thermopile	0.03%	0.03%	0.2%	0.02%	0.02%	0.01%
Pyroelectric	0.3%	0.09%	0.2%	0.02%	0.01%	0.01%
Analog Output Bandwidth (7)						
Semiconductor	150Hz	150Hz	25kHz	25kHz	150kHz	150kHz
Thermopile	5Hz	5Hz	20kHz	20kHz	100kHz	100kHz
Pyroelectric	75kHz	75kHz	75kHz	75kHz	200kHz	200kHz

Full scale analog output 2V
Analog output drift .... <0-2% / 1 hour at constant temperature
Analog output offset .... <10mV
Analog output noise(5) .... <0.1% + relative noise factor × calibration factor mantissa(6)
Calibration accuracy .... <0.1% + 1% / calibration factor mantissa(6)
DC accuracy .... <0.2% + calibration accuracy
Analog output accuracy .... <0.3% + DC accuracy
Peak-to-Peak accuracy .... <0.5% + DC accuracy + analog output noise / 2
Pulse accuracy .... <0.5% + DC accuracy + analog output noise / 2
Integration accuracy .... <0.7% + DC accuracy + analog output noise / 2
Display resolution .... full scale measurement / 2000
Minimum pulse slope .... 10V / sec
Allowed detector responsivity limits:
Semiconductor .... 1×10^{2} A/W to 1×10^{-8} A/W
Thermopile .... 1×10^{5} V/W to 1×10^{-5} V/W
Pyroelectric .... 1×10^{7} V/J to 1×10^{-3} V/J

(0) Guaranteed after 30 min. warm up period.
(1) Maximum measurable current is 10mA.
(2) In Thermopile mode, ranges **1 & 2** are identical to **3 & 4**.
(3) Maximum measurable voltage in Thermopile mode is 2V.
(4) Maximum measurable voltage in Pyroelectric is 200V.
(5) Measured with 818-SL, 818T-10 or 818J-25 detector, respectively.
(6) Calibration factor mantissa range is **1** to **10**.
(7) Amplifier bandwidths are higher internally.

Section 1
General Information

1.1 System Overview

The Model 1825-C is an accurate and flexible optical power and energy measuring instrument that provides features typically found only on advanced single purpose optical meters: Simple front panel controls, annunciated digital and analog displays, and compatibility with Newport's full line of detector families allow the Model 1825-C to meet almost any DC, AC peak-to-peak, pulsed or integrated exposure measurement requirement with minimum fuss. Compatible with Newport's Low-Power, High-Power, and Energy detector families, the Model 1825-C provides the features you need without the expense of purchasing multiple single purpose optical meters. The Model 1825-C Power/Energy Meter and its accessories are presented in Figure 1. Section 1.5 of this manual presents a brief description of compatible Newport detectors.

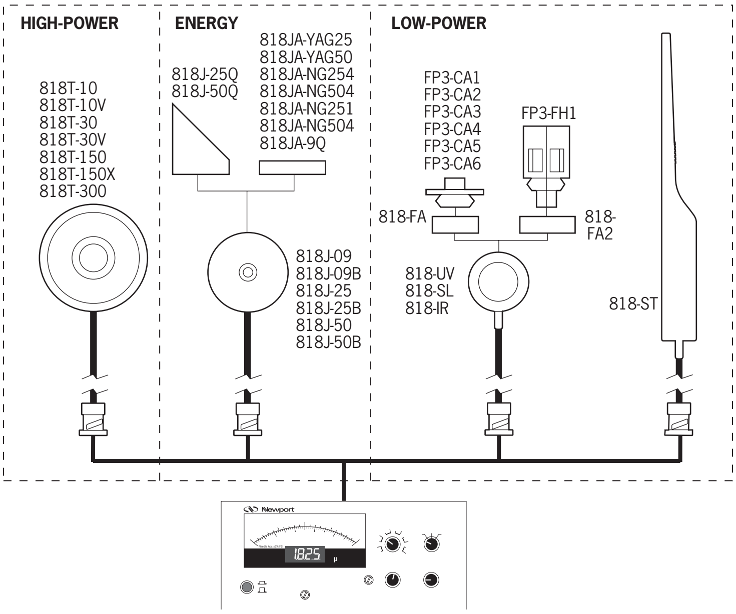


Figure 1 — Model 1825-C and Accessories

1.2 Scope of this manual

Please carefully read this instruction manual before using the Model 1825-C Power/Energy Meter. Be especially careful to observe the warnings and cautions throughout this manual. If any operating instructions are **not** clear, contact Newport Corporation.

This instruction manual contains the necessary information for operation and maintenance of the Newport Model 1825-C Power/Energy Meter as well as information for troubleshooting and obtaining service if necessary. This information is divided into the following sections:

- Section 1 provides general information about this manual and the Model 1825-C.
- Section 2 explains System Operation procedures for the Model 1825-C and accessories.

- Section 3 discusses the Principles of Operation of the Model 1825-C.
- Section 4 provides for Test, Maintenance and Adjustment of the Model 1825-C.
- Section 5 provides instructions for obtaining factory service.

1.3 Unpacking and Inspection

All Model 1825-C Power/Energy Meters are carefully assembled, tested and inspected before shipment. Upon receiving this instrument, check for any obvious signs of physical damage that might have occurred during shipment. Report any such damage to the shipping agent immediately. Retain the original packing materials in case reshipment becomes necessary.

1.4 Preparation for Use

The Model 1825-C Power/Energy Meter should have some operations performed before measurements are made. These include:

- Charging the batteries (Section 2.4.1)
- Connection and calibration of the detector (Section 2.4.4)

1.5 Optional Accessories and Services

Many detectors and detector accessories are available for use with the Model 1825-C Power/Energy Meter. In addition, detector accessories are available. Refer to Figure 1 for the Model 1825-C Power/Energy Meter family tree. For more information, please refer to the Newport Catalog.

Section 2

System Operation

2.1 Introduction

This section contains the information needed to prepare and operate the Model 1825-C Power/Energy Meter. Operation consists of using the Model 1825-C to perform basic optical power or energy measurements using one of Newport's compatible detectors.

2.2 Display

The Model 1825-C combines a fast response 3.5 inch analog display with a 3.5 digit annunciated LED display, see Figure 2. The full scale reading of the analog display alternates between 2 and 5 as the RANGE knob is rotated so that it can display signals below 2.00 with higher resolution. The analog display matches the digital display (within ±1 division typ.) and the annunciators always indicate the current measurement units. The digital display is more accurate than the analog display.

To facilitate measurements of integrated, AC peak-to-peak or pulsed signals, both the analog and digital displays hold their last value for about 20 seconds before falling back to zero. If a new signal arrives before the display has reset itself to zero, the new signal is acquired and displayed.

The BAT annunciator lights when the battery voltage reaches 7 volts and indicates that recharging is needed. See Section 2.4.1, Battery Charging. To increase battery life, the digital display dims while the analog display backlight brightens as ambient light levels decrease. Avoid prolonged operation when the BAT annunciator is lit, measurement accuracy can degrade. The batteries are protected from deep discharge damage and will automatically disconnect when they are discharged below 6V.

If one needs to operate the meter even after the battery discharge protection is activated, there is no need for waiting for batteries to be charged up. You can operate the 1825-C as soon as the charger is plugged into it.

Table 1 — Model 1825-C Display Annunciators

Annunciator	Comment
BAT	Battery voltage has reached 7 volts (approx. 10% battery life left).
CAL	Indicates that the Calibration Factor decimal number is being displayed
TRIG	Indicates that a signal has crossed the threshold that triggers the meter to take a reading, (INTG, PULSE and peak-to-peak modes).
READ	Indicates that the meter is showing a valid reading.
W, J	Watt and Joule units annunciators, respectively.
n, μ, m, k	Exponent prefixes for the Watt and Joule annunciators.

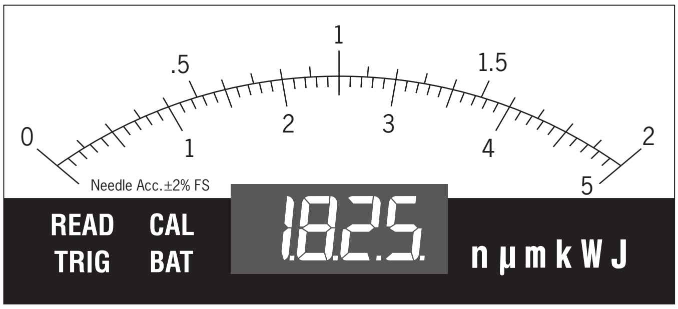


Figure 2 — Model 1825-C Display

2.3 Front and Rear Panel Controls

Operating controls and settings for the Model 1825-C are found on both the front and rear panels. For general operation, only the front panel controls are used. The rear panel controls and settings are primarily used for meter/detector setup. The front panels of the Model 1825-C are shown in Figure 3. The following table gives a short description of each control:

Table 2 — Model 1825-C Controls

Control	Description	Comment
POWER	Push Button	Turns the Model 1825-C on and off
Meter Adjust	1 Turn Trim Pot	Unlabeled. Calibrates the analog needle zero, (factory set).
CAL	10 Turn Pot	Sets the Calibration Factor decimal number.
ZERO	10 Turn Knob	Zeros the display. Used to eliminate ambient signals and electronic offsets.
AVERAGE	1 Turn Click-Off Knob	Turns on and adjusts PULSE/P-P averaging time.
RANGE	12 Position Knob	Adjusts the meter's signal gain, 12 positions, 6 decades.
MODE	3 Position Knob	Sets the meters signal measurement mode: CW, INTEGRATE or PULSE/P-P.
CAL	Slide Switch	Selects between CAL, NORMAL and BEEP operation.
SETUP	8 Switch Dip Bank	Configures the meter to the type of detector being used.
EXP. ADJ.	Rotary Dip Switch	Sets the Calibration Factor exponent.
ACCEL. ADJ.	10 Turn Trim Pot	Sets the thermopile acceleration time constant.

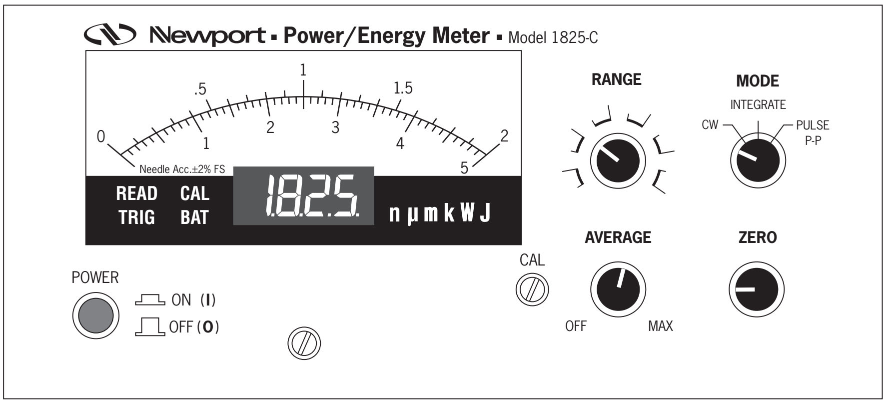


Figure 3 — Model 1825-C Front Panel Detail

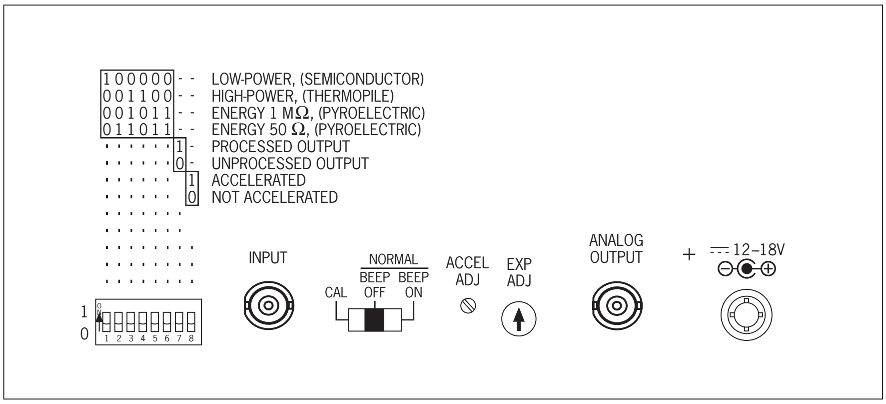


Figure 4 — Model 1825-C Rear Panel Detail

2.3.1 RANGE

The RANGE knob adjusts the signal gain of the Model 1825-C. It has twelve positions covering 6 decades of signal gain. Intermediate gain positions only change the full scale reading of the analog display and do not effect either the digital display or the analog output. Turn the RANGE knob clockwise (counter clockwise) to decrease (increase) signal gain. The RANGE positions 1 thru 12 with position 1 being the furthest CCW postion, are illustrated in the figure on page ix.

2.3.2 ZERO

This knob will adjust the display and analog output values down to zero. It is used to zero the display to remove the effects of ambient signals before making a measurement. The ZERO function has the capability of offsetting signals over a 5 decade range. Turn the ZERO knob CW to **decrease** the negative (offsetting) signal that is injected.

Always use the ZERO knob to eliminate ambient and/or offset signals to insure accurate readings.

2.3.3 AVERAGE

This front panel knob adjusts the PULSE/P-P signal averaging of the Model 1825-C's display and analog output between off and maximum averaging. Use this knob to slow down the response of the display when observing noisy signals. A soft detent indicates the signal averaging "off" position. Averaging only works in INTEGRATE and PULSE/P-P modes.

2.3.4 MODE

The front panel MODE knob sets the method of signal acquisition that the Model 1825-C will use with a given detector. Not every mode can be used with every detector. Table 3, below, indicates which modes are compatible with the various Newport detector types.

Table 3 — MODE Switch Position and Detector Compatibility

MODE Position	Compatible Detectors	Comment
CW	Low-Power, High-Power	Measures average optical power.
INTEG	Low-Power, High-Power	Measures energy resulting from integrated power.
P-P†	Low-Power	Measures peak-to-peak optical power.
PULSE†	Energy	Measures pulse energy.

†While P-P and PULSE are the same position on the MODE switch, the meter's operation will differ due to the settings of the SETUP dip switches for the different detector types. See Section 2.3.6.

2.3.5 CAL Slide Switch

The rear panel CAL slide switch performs the functions described in the table below:

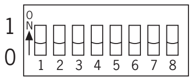
Table 4 — CAL Slide Switch Functions

Switch Position	Function
CAL	Display the Calibration Factor mantissa.
NORMAL, BEEP OFF	Take readings normally.
NORMAL, BEEP ON	Take readings normally but beep with each pulse triggering. (INTEGRATE & PULSE/P-P modes only)

2.3.6 SETUP Dip Switches

The rear panel SETUP dip switches configure the meter to the type of Newport detector that the meter will be used with. The following table identifies the function each SETUP switch position performs:

Table 5 — SETUP Dip Switch Functions

SETUP Switch	Switch Position	Function
	1	Selects current amplification (1) otherwise (0).
	2	Selects voltage amplification (1) otherwise (0).
	3	Selects 50Ω (1) or 1 MΩ (0) voltage input impedance for Energy detectors.
	4	Selects for the type of detector; High-Power (1) otherwise (0).
	5&6	Selects for the type of detector; Energy (11) otherwise (00).
	7	Selects processed analog output (1) or unprocessed output (0).
	8	Selects accelerated voltage response (1) or unaccelerated response (0).

2.3.7 EXP. ADJ. Rotary Dip

The rear panel EXP. ADJ. rotary dip adjusts the display annunciator units to properly account for the sensitivity of a detector's calibration factor exponent. This allows the display to adjust between different detectors even when the responsivities of the two detectors may differ by many decades.

2.4 Using the System

The Model 1825-C Power/Energy Meter does not have a microprocessor. It relies on the user to properly install the calibration factor describing the detector and wavelength in use. In order to assure that measurements are accurately calibrated, please carefully read and follow the instructions regarding the Detector Calibration Factor. See Sections 2.4.4, 2.4.4.1 and 2.4.4.2.

2.4.1 Battery Charging

The lead-acid battery pack in the Model 1825-C is designed to provide many years of reliable operation before any need of replacement. The battery pack can be recharged by the AC Adaptor at any time and may be charged indefinitely without damage. The batteries will not discharge through the adaptor if power is removed. With the meter off, a full charge will be reached after 15 hours. With the meter on, the wall mount power supply will trickle charge the batteries. If you keep the Model 1825-C continuously connected to wall power, then it will always have a full charge ready for any portable use measurements.

1. Turn the Model 1825-C off and insert the charging plug into the rear panel 12V DC input.
2. Plug the AC adaptor into the wall. You may now turn the Model 1825-C back on.

NOTE

The battery pack is capable of 1000 to 2000 charge/discharge cycles before factory replacement is needed. If the battery is continuously charged, no charge/discharge cycles are accumulated.

NOTE

Prolonged operation after the BAT annunciator lights can cause inaccurate measurements. Eventually the meter disconnects the batteries to prevent deep discharge damage.

2.4.2 Power Up

Turn on the Model 1825-C by depressing the POWER button located on the front of the meter. The digital display should light indicating that the meter is operating. If the BAT annunciator is lit, operate the meter from the AC adaptor so the batteries can recharge. See Section 2.4.1.

2.4.3 Detector Connection and Setup

Connect the detector to the INPUT BNC found on the rear of the Model 1825-C. You may connect or disconnect any Newport Low-Power, High-Power or Energy detector at any time without damage. Adjust the SETUP dip switches to reflect the type of Newport detector that the Model 1825-C is being used with. If you are not using a Newport detector, follow the figure below when setting up the Model 1825-C. Information from this figure is reproduced on the rear panel of the Model 1825-C, see Figure 4.

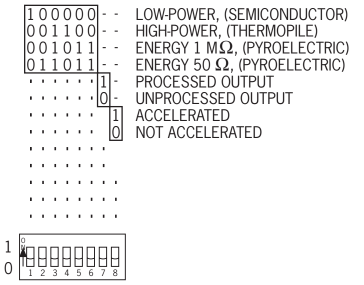


Figure 5 — Detector Setup Table

When using a Newport ENERGY (or pyroelectric) detector check the detector manual to determine if it should be operated with 50Ω or 1MΩ input impedance.

We recommend operating with UNPROCESSED OUTPUT and NOT ACCELERATED until you have read the manual sections explaining these features.

2.4.4 Setting the Detector Calibration Factor

The calibration factor tells the Model 1825-C how to account for a detector's responsivity at the measurement wavelength. Each Newport detector arrives with a full spectrum calibration report with detector responsivities and calibration factors listed in 10 nm increments. A calibration factor is calculated from a responsivity by simply taking the inverse of the responsivity and expressing it in scientific notation, i.e. “d.ddE±d”. Be sure to re-express the responsivity value in units of A/W or V/W before calculating the inverse. See Examples below.

Example 1: Responsivity R = 0.568 A/W thus the Calibration Factor = 1.76 E+0 W/A

Example 2: Responsivity R = 0.346 mV/W thus the Calibration Factor = 2.89 E+3 W/V

2.4.4.1 Calibration Factor Mantissa Entry

The calibration factor mantissa is the “d.dd” portion of the calibration factor value “d.ddE±d”. The mantissa is the most frequent calibration adjustment made when making measurements at various wavelengths. To set the mantissa, use the following procedure:

1. Slide the CAL switch to the CAL position.
2. Adjust the front panel CAL potentiometer until the display matches the calibration factor mantissa.

   Example: If the Calibration Factor = 2.89 E+3, then the display should indicate 2.89.

3. Return the CAL switch to the NORMAL, BEEP OFF (or NORMAL, BEEP ON) position.

2.4.4.2 Calibration Factor Exponent Entry

The calibration factor exponent is the ±d of the calibration factor value d.ddE±d. The Model 1825-C accounts for this exponent through its EXP. ADJ. rotary dip setting. The EXP. ADJ. rarely needs to be set more than once when using the Model 1825-C with a particular detector. However, it is still wise to check that the EXP. ADJ. does not need resetting when making measurements at multiple wavelengths. To set the EXP. ADJ. rotary dip, use the following lookup table:

Table 6 — EXP. ADJ Rotary Dip Switch Settings

Calibration Factor Exponent		-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
EXP. ADJ. Dip Setting	Low Power Detectors	–	–	–	–	–	0	1	2	3	4	5	6	7	8	9
	High Power Detectors	–	–	0	1	2	3	4	5	6	7	8	9	–	–	–
	Energy Detectors	0	1	2	3	4	5	6	7	8	9	–	–	–	–	–

2.4.5 Signal Averaging

The Model 1825-C provides an adjustable low pass filter for signal averaging in INTEG and PULSE/P-P modes. The effects of averaging cause the display to slow down its response to changes in signal level. Average feature is disabled in CW mode. It could be very useful when trying to observe noisy signals, or signals whose value fluctuates when in PULSE or Peak-to-Peak mode. If averaging is used in the INTEG mode, accuracy can be lost. We suggest checking that the use of averaging does not effect the INTEG result in each measurement situation.

2.4.6 Signal Integration

The Model 1825-C provides a circuit which measures optical energy by electronically integrating the signal from a power sensing detector. This mode of operation is only compatible with Low-Power and High-Power detectors. Signal integration is enabled when the MODE switch is set to INTEG.

The Model 1825-C uses a self-trigger-on-level method of integration. The TRIG annunciator lights and remains lit for the length of the integration. After the pulse integration is completed the READ annunciator lights indicate that the display value now represents a final result. The display units will indicate Joules as energy is the time integral of power:

$$E(\lambda) = \int_{t_0}^{t_1} P(\lambda)dt = \int_{t_0}^{t_1} \frac{V(t)}{R(\lambda)}\,dt$$

where:

V(t) = detector signal

R(λ) = detector responsivity

One can measure the accumulated energy from exposure using the INTEG mode. When a power, $P(\lambda,t)$, is incident on a power detector, the integration circuit behaves as is shown in Figure 6 below. The display then reflects the total energy, $E(\lambda)$, resulting from the detectors time exposure to the optical power, $P(\lambda,t)$.

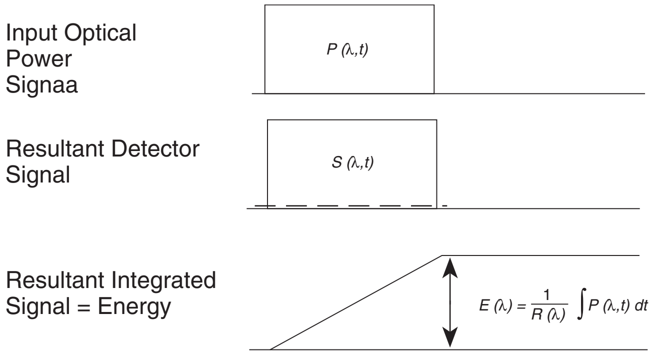


Figure 6 — Integrated Energy from Exposure to an Optical Signal

When a pulse of energy, $E(\lambda)$, is incident on a High-Power detector's surface, the detector responds with a voltage signal reflecting the thermal effects of the much slower heat pulse that the energy generates. The integration circuit then measures the energy in the pulse by integrating the voltage pulse, Figure 7.

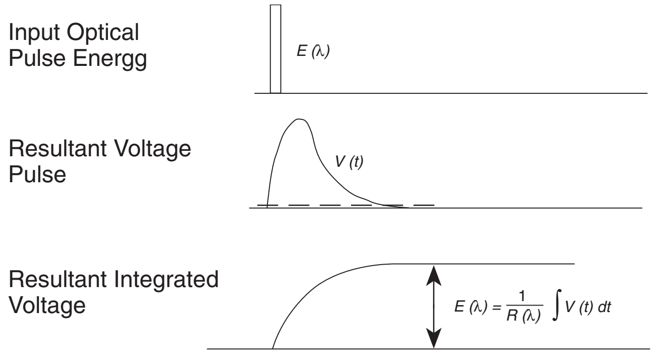


Figure 7 — Integrated Energy from a Pulse Energy Optical Source

2.4.7 Peak-to-Peak Power Measurement

The Model 1825-C allows one to measure AC Peak-to-Peak power when the MODE switch is set to P-P, (compatible with Low-Power detectors only). Peak-to-Peak detection only occurs when the detector signal **slope** exceeds a threshold. The result of this is that the Model 1825-C can measure the peak-to-peak amplitude of square waves down to DC but cannot detect sinewaves below 100 Hz. Figure 8 below illustrates the nature of a peak-to-peak signal.

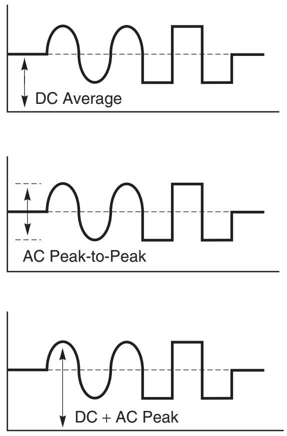


Figure 8 — Peak-to-Peak and Other Signal Types

If the CAL slide switch is set to BEEP ON while in the P-P mode, the Model 1825-C will give a short "click" with the arrival of each trigger. This is particularly useful for infrared wavelengths and for listening for changes in the pulse repetition rate.

2.4.8 Pulse Energy Measurement

The Model 1825-C can measure pulse energies with an Energy detector when the MODE switch is set to PULSE. (This MODE of operation is only compatible with Newport Energy detectors.) The Model 1825-C's PULSE mode automatically accounts for the baseline drift inherent in pyroelectric detectors when exposed to a pulse train (see Figure 9). As pulse acquisition is **slope** threshold triggered, adjustments to the RANGE knob must be made until the TRIG annunciator lights as each energy pulse arrives. Note that PULSE detection only occurs when the detectors signal **slope** exceeds a threshold.

At very low pulse repetition rates, the Model 1825-C will capture and display each pulse for about 20 seconds before the display falls back to zero. During this display hold time, the READ annunciator will light to indicate that the display holds a real reading rather than a signal offset arising from the ZERO adjustment. If a new pulse arrives before the display has fallen back to zero, the display simply captures and displays the new pulse.

If the CAL slide switch is set to NORMAL, BEEP ON while in the PULSE mode. The Model 1825-C will give a short "click" with the arrival of each pulse. This is particularly useful for infrared wavelengths and for listening for changes in the pulse repetition rate.

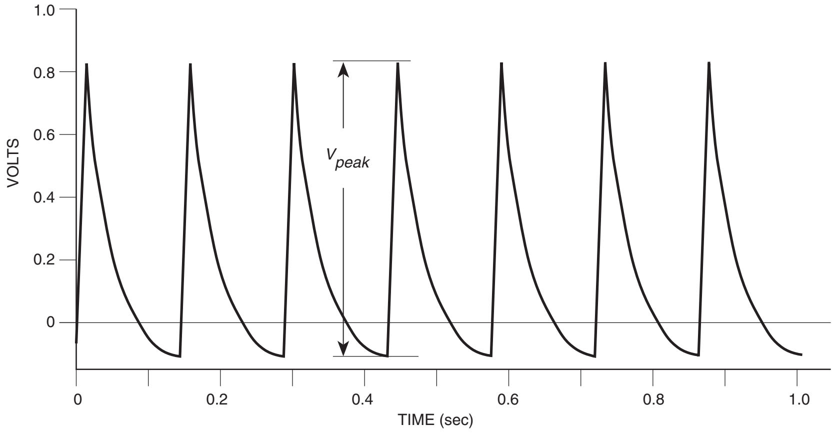


Figure 9 — Pulse Signal Detection

2.4.9 Detector Acceleration Time Constant

The Model 1825-C provides a circuit to electronically accelerate the risetime of Newport's High-Power thermopile detectors. Acceleration occurs when the SETUP switch position 8 is set to "1". A back panel potentiometer, ACCEL ADJ., is used to adjust the time constant of the acceleration circuit to match the time constant of the detector. Since most of Newport's High-Power detectors have a 1 sec. time constant, the ACCEL ADJ. potentiometer is tuned at the factory for this time constant. Good results are generally obtained without having to readjust the ACCEL ADJ.

NOTE

Rise time acceleration is only compatible with Newport High-Power (thermopile) detectors.

You can set or fine tune the ACCEL ADJ. to your particular detector. This is especially useful if you are monitoring the processed analog output on an oscilloscope or other time based or data logging instrument. This adjustment is required if you are using a High-Power detector that does not have a 1 sec. time constant. When the ACCEL ADJ. setting does not match the actual time constant of the attached detector, you will see some overshoot or undershoot on the **processed** analog output signal (see Section 2.4.10). To fine tune the ACCEL ADJ. potentiometer use the following procedure:

1. Set the SETUP dip switch to "0, 0, 1, 1, 0, 0, 1, 1". Connect your High-Power detector to the Model 1825-C and monitor the analog output on an oscilloscope.
2. Introduce a step function (or sub-hertz square wave) of optical power to the High-Power detector. You should observe a signal trace similar to Figure 10 below.
3. Adjust the ACCEL ADJ. potentiometer on the rear panel until the over-shoot or undershoot of the analog output signal is eliminated.

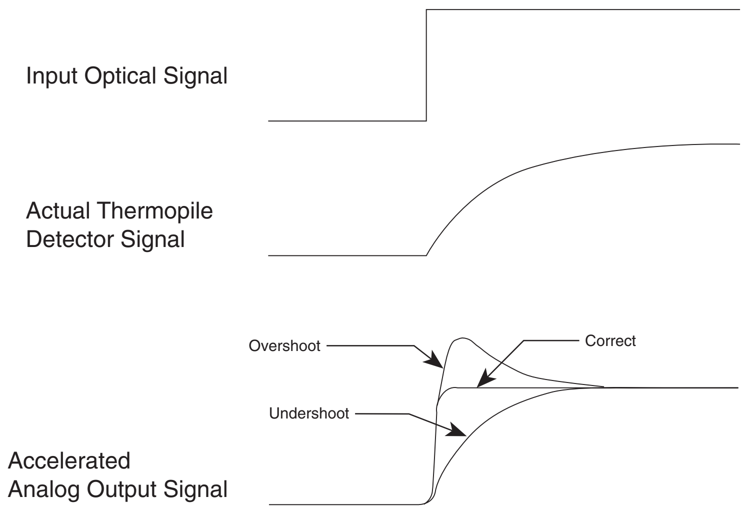


Figure 10 — Detector Time Constant ACCEL. ADJ. Setting

2.4.10 Analog Output

The Model 1825-C provides a 0 to 2 volt BNC analog output for signal monitoring. The analog output voltage reflects actual measurement by being equal to the digital display's digits and ignores the decimal point position. Thus, if the digital display indicates 1.560, then the analog output voltage will be 1.560 volts. If the display indicates 156.0 then the analog signal will still be 1.560 volts.

The analog output can be configured in two ways: "PROCESSED" or "UNPROCESSED". PROCESSED analog output reflects the cumulative effects of any signal conditioning such as signal averaging, integration and acceleration. UNPROCESSED analog output allows one to monitor the natural unconditioned signal response of the detector. In general, one normally uses the analog output in its PROCESSED state.

NOTE

The effects of any signal processing always show up on the display. The PROCESSED or UNPROCESSED degree of freedom in the analog output is independent of whether signal conditioning is occurring in the displayed value. For example: Signal averaging can be on and affecting noise level of the display while the analog output can be UNPROCESSED and still show the unaveraged noisy detector signal.

Section 3
Principles of Operation

3.1 Introduction

The Model 1825-C is a multiple function optical meter whose electronics can adapt to a number of signal measurement tasks. The Model 1825-C can be configured to measure DC current or voltage, AC peak-to-peak current or voltage, integrate DC current or voltage, or to accelerate exponential signals to their final values. This versatility is required to handle the various signals that Newport's **Low-Power**, **High-Power** and **Energy** detector families generate. These detector families are based on semiconductor, thermopile and pyroelectric detectors respectively.

A block diagram of signal flow through the Model 1825-C is shown in Figure 11. The actual flow through the diagram depends upon the MODE and SETUP switch settings.

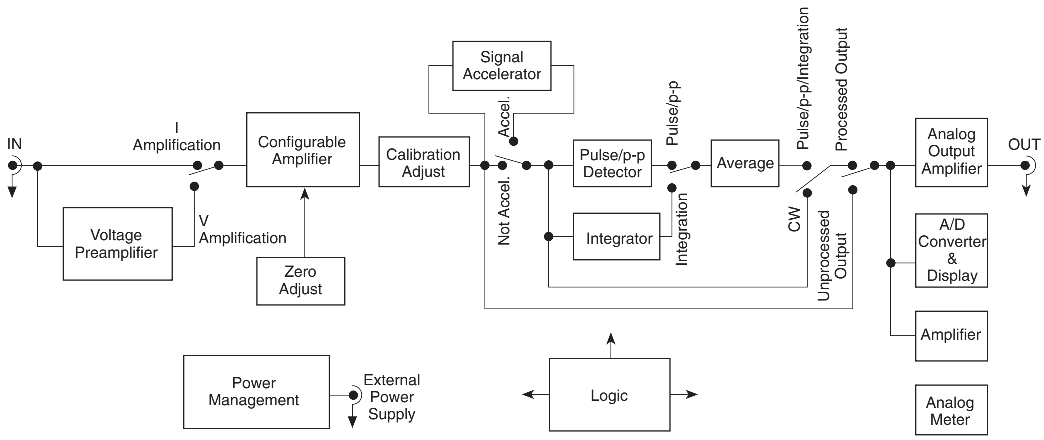


Figure 11 — Simplified Model 1825-C Functional Block Diagram

3.2 Functional Description

The Model 1825-C Power/Energy Meter is a configurable current or voltage measuring instrument optimized for use with semiconductor photodiodes (current measurement), disk thermopiles (voltage measurement) or pyroelectric (peak voltage measurement) detectors.

Detector signals are introduced to the Model 1825-C by way of a BNC input connector. A bank of dip switches found on the back of the Model 1825-C configures the amplifier as either a transimpedance current amplifier, a 1 MΩ input impedance voltage amplifier or a 50 Ω or 1 MΩ input impedance peak reading voltage amplifier. The amplified signal is then further processed via a Calibration Factor compensation (adjustable signal attenuator) stage and, if appropriate, a signal averaging circuit, and/or a signal integration circuit and/or Peak Detector and/or a signal accelerator circuit. The resulting signal is then sent to the A-D converter and displayed.

The flexibility of the Model 1825-C is required in order that it may properly measure the signals that various types of detectors make. Optical power or energy is related to a detector signal, S_d, in the following way:

$$\left(P \text{ or } E\right) = \frac{S_d}{R_\lambda}$$

For semiconductor photodiodes (Newport Low-Power Detectors), S_d, is a current, $S_d = I_d$. The 1825-C must be able to make sensitive low noise current measurements to be compatible with these detectors. For thermopile detectors (Newport High-Power Detectors), S_d, is a small voltage, $S_d = V_d$. The 1825-C must be able to sense microvolt levels with a 1 MΩ input impedance to be compatible with these detectors. For pyroelectric pulse energy detectors (Newport Energy Detectors), S_d, is a peak voltage $S_d = V_{pk}$. The Model 1825-C must be able to capture 2 µsec rise time voltage spikes using either a 50Ω or 1MΩ input impedance to be compatible with these detectors. A typical energy detector signal in response to a pulse train is shown below in Figure 12.

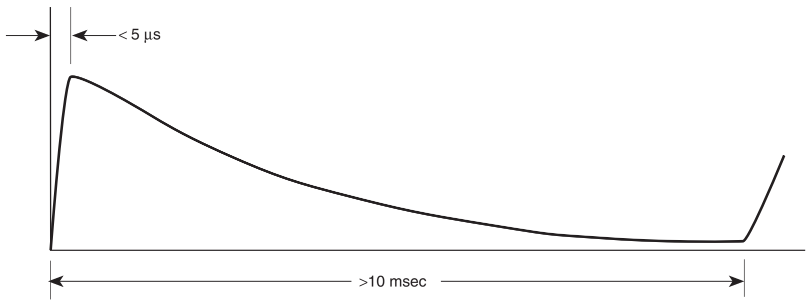


Figure 12 — Typical Energy Detector Signal Waveform

3.3 Measurements Considerations

This section describes detector and attenuator characteristics, optical and electrical considerations, and environmental influences on optical measurements. In general, the accuracy of measurement with the Model 1825-C is limited by the calibration accuracy of the detector calibration. Making accurate measurements of optical power or energy is, however, also dependent upon properly setting up the Model 1825-C, controlling temperature and illumination conditions and understanding the factors that affect optical measurements.

3.3.1 Detector Calibration and Accuracy

Newport Corporation calibrates its detectors using secondary standards directly traceable to the United States National Institute of Science and Technology (NIST) or to Great Britain's National Physical Laboratory, (NPL). The details and accuracy of the calibration procedure vary with each detector model but a detailed description of the calibration results is supplied with each individually calibrated detector.

In general, detector calibration accuracy varies from 2% to 5% in absolute terms. Each detector will have some variation in the response to wavelength and over different sections of its surface. Therefore, for the most reproducible measurements, light should illuminate the detector as uniformly as possible over as large an area as practical.

CAUTION

Avoid focusing a light source onto the detector surface. Inaccurate readings and possible detector damage may result. Consult the detector manual for saturation or damage thresholds.

NIST traceability requires that detectors be recalibrated on one year intervals. As individual detector responses change with time, especially in the ultraviolet, recalibration is necessary to assure confidence in the accuracy of the measurement. For the most reproducible measurements, the same detector should always be used for measurements which are to be directly compared.

3.3.2 Quantum Detector Temperature Effects

Semiconductor based photodiode detector characteristics (Newport Corporation **Low-Power** detectors) are affected by temperature. At longer wavelengths, quantum detectors typically lose sensitivity with increasing temperature. Of special note, the detector dark current increases exponentially with temperature. For silicon detectors, dark current is generally on the order of a few picoamps at room temperatures. With uncooled germanium detectors, however, this dark current is on the order of a nanoamp, typically 1,000 to 10,000 times greater than silicon. These dark currents can be zeroed by the Model 1825-C's ZERO knob. Since dark currents drift with temperature, the ZERO should be adjusted just prior to taking any measurements. The noise or drift in the dark current sets a lower bound on the measurement resolution which can be achieved with any given detector.

If the detector temperature is constant, sensitivity changes and dark current drifts are significantly reduced. In addition, if the detector is cooled, the dark current and dark current noise will decrease. For the most accurate measurements, particularly with germanium detectors, the user should cool the detector to approximately 0 °C and control the temperature to within ± 1 °C.

3.3.3 Thermopile Detector Temperature Effects

Disk thermopile based detector characteristics (Newport Corporation **High-Power** detectors) are significantly affected by temperature fluctuations arising from air flow disturbances. As the detector element is a heat measuring device, air flow disturbances often set a practical lower limit on the power that a detector can measure. In order to get the most out of any thermopile detector, be careful to shield the detector from air flow disturbances. Common sources of disturbance are air conditioners and people walking past the detector. At small signal levels, thermopiles will also observe people as radiating infrared sources.

3.3.4 Energy Detector Temperature Effects

Newport **Energy** detectors are AC coupled devices and thus are not susceptible to temperature induced DC signal offsets or noise floor changes.

3.3.5 Ambient and Stray Light

Ambient and stray light striking the detector will be measured by the Model 1825-C, and should be considered when making careful measurements. Ambient light can be distinguished from dark current (or the detector/meter noise floor) by either turning off or blocking the source *and* covering the detector face with opaque material such as a piece of black metal. Using the human hand to cover the detector is not advised because it emits a significant amount of infrared radiation. With the detector covered, a reading of the dark current may be made. Next, remove the material which is covering the detector and take another reading. The difference is the ambient light level.

NOTE

Changes in ambient light levels can occur from such factors as turning room lights on or off, or by moving people or equipment. Remember, if you can see your detector element, then your detector can see the light bouncing off your shirt!

The effects of ambient light are greatly reduced when using a fiber-connectorized signal input to the detector. If free-space beam measurements are desired, using an attenuator (**Low-Power** detectors have an OD3 attenuator included.) will reduce stray light and often improve the source signal to ambient signal noise level. Wavelength-specific filters, such as optical cutoff, bandpass, or spike filters can also be used if the signal wavelength spectrum permits. Other techniques to reduce stray light include using apertures, placing the detector in a box or other housing to shield the surface from light (or air currents when using Newport's **High-Power** disk thermopile detectors) which is not coming from the source, and turning off room and other lights.

3.4 Performing Basic Measurements

Basic measurement techniques for using the Model 1825-C are covered in the following sections. Also included are methods of background correction and common measurement errors. In general, the absolute measurement accuracy is limited by the accuracy of the detector calibration and environmental factors affecting the detector. See the appropriate detector manual for specific information on a particular detector model.

3.4.1 Making a CW Power Measurement

The following process describes the procedure for making a basic optical power measurement while properly removing influence of ambient light and other drift effects.

1. Set up the meter to reflect the Newport Low-Power or High-Power detector, the calibration factor at the wavelength of light you will be making your power measurement at. See Sections 2.4.4 through 2.4.4.2. Set the MODE knob to CW.
2. Cover or otherwise block the source that you will be measuring and adjust the RANGE knob until the ambient signal is displayed to three significant figures.
3. Use the ZERO knob to remove the ambient signal by zeroing the display. Increase the gain (RANGE knob) and re-zero until the display reaches its noise floor.
4. Uncover the source and adjust the RANGE knob until the source power is displayed at least to three significant figures of accuracy.
5. Record the display value and the appropriate units from that RANGE knobs position. This reading is your optical power.

The process as detailed assumes that the ambient signal is not changing between when you zero the display (step 3) and when you make your measurement, (step 5). Remember, though, if you can see your detector as you move around, then your detector can see you as a changing ambient signal!

3.4.2 Making a Signal Integration Measurement

The following process describes the procedure for making a basic signal integration measurement while properly removing influence of ambient light and other drift effects. The Model 1825-C's self-trigger-on-pulse method of signal capture requires that the source signal turn on to start the integration and turn off to stop the integration. This constrains the signal to be some sort of "pulse".

1. Set up the meter to reflect the Newport Low-Power or High-Power detector, the calibration factor at the wavelength of light you will be making your energy measurement at. See Sections 2.4.4 through 2.4.4.2. Set the MODE knob to INTEG.
2. Cover or otherwise block the source that you will be measuring and adjust the RANGE knob until the ambient signal is displayed to three significant figures.
3. Use the ZERO knob to remove the ambient signal by zeroing the display. Readjust the RANGE knob and re-zero until the display reaches its noise floor on the lowest possible range.
4. Now "pulse" the source and adjust the RANGE knob until the TRIG annunciator lights to indicate that the signal has exceeded the trigger threshold. When the "pulse" is over, the READ annunciator will light to indicate that the display contains a good final value. Continue "pulsing" and adjusting the RANGE knob until the final value shows at least three significant figures of accuracy.
5. Record the display value and the appropriate units. This reading is your integrated signal "pulse" energy.

NOTE

The process as described above assumes that ambient "pulse" energy signals are not changing between when you zero the display (step 3) and when you make your measurement, (step 5). Fluorescent lamps are a common source of ambient pulsed light.

3.4.3 Making a Pulse Energy Measurement

The following process describes the procedure for making a basic optical pulse energy measurement while properly removing influence of ambient light and other drift effects.

1. Set up the meter to reflect the Newport Energy Detector, the calibration factor at the wavelength of light you will be making your energy measurement at. See Sections 2.4.4 through 2.4.4.2. Set the MODE knob to PULSE.
2. Cover or otherwise block the source that you will be measuring and adjust the RANGE knob until the ambient signal is displayed to three significant figures.

3. Use the ZERO knob to remove the ambient signal by zeroing the display. Readjust the RANGE knob and re-zero until the display reaches its noise floor at the lowest possible range.
4. Uncover the source and adjust the RANGE knob until the TRIG annunciator lights to indicate that the meter is capturing pulses. Continue adjusting the RANGE knob until the source pulse energy is displayed to at least three significant figures of accuracy.
5. Record the display value and the appropriate units from the RANGE knobs position. This reading is your optical pulse energy.

NOTE

The process as described above assumes that ambient pulse energy signals are not changing between when you zero the display (step 3) and when you make your measurement, (step 5). Fluorescent lamps are a common source of ambient pulsed light.

3.4.4 Common Measurement Errors

The most common sources of optical measurement error are listed in Table 8 below.

Table 7 — Common Measurement Errors

Type of Error	Type of Detector	What should be done?
Radiometry	Any	Check that all of the light is actually hitting the detector.
Ambient Light	Any	Check that any ambient light was ZEROed before the measurement was made.
Wavelength Calibration	Any	Check that the Calibration Factor for the measurement wavelength is properly set.
Low Battery Power	Any	Check that meter is not indicating low BAT.
Detector Saturation	Low-Power	Check that the optical power density remains below the detector's saturation threshold.
Meter SETUP Configuration	Any	Check that the SETUP dip switch bank is properly set up for the detector being used.

3.5 System Accuracy

The system measurement accuracy of the Model 1825-C Power/Energy Meter is primarily governed by the calibration accuracy of the attached detector. The electronic accuracy of the Model 1825-C generally exceeds the calibration uncertainties of a detector by a decade or more. However, as NIST calibration capabilities improve, system accuracies will begin to experience the influence of electronic accuracy uncertainties.

Section 4

Test, Maintenance and Troubleshooting

4.1 Maintenance Procedures

In cleaning the body of this instrument, use only a mild soap & water solution on a damp cloth.

CAUTION

Do not use acetone or other organic solvents (other than alcohol) on the Model 1825-C Power/Energy Meter. Organic solvents attack the paint.

4.2 Troubleshooting Guide

The following troubleshooting guide is intended to isolate and solve problems with the power meter so that, to the greatest extent possible, the return of the power meter/detector system to Newport will be unnecessary. For the problems that cannot be resolved with information in this manual, or for other situations that are not covered in this section, please see Section 5 for details on returning your entire system to Newport for service.

Table 8 — Symptom/Fault Troubleshooting Guide

Symptom	Possible Fault/Correction
Blank display.	Power switch OFF. Turn switch ON.
	Batteries drained. Recharge batteries per Section 2.4.1.
BAT indicator lit.	Batteries need charging. Recharge batteries per Section 2.4.1.
Display value does not change.	CAL slide switch set to CAL. Return switch to center.
Display indicates ––––	Signal overflow. Adjust RANGE knob clockwise.
Reading is different than expected.	See Table 7 Common Measurement Errors. Section 3.4.4.

Section 5
Factory Service

5.1 Introduction

This section contains information regarding obtaining factory service for the Model 1825-C Power/Energy Meter. The user should not attempt any maintenance or service of this instrument and/or accessories beyond the procedures given in Section 4: Test, Maintenance and Troubleshooting. Any problems which cannot be resolved using the guidelines listed in Section 4 should be referred to Newport Corporation factory service personnel. Contact Newport Corporation or your Newport representative for assistance.

The Model 1825-C contains no user serviceable parts. Its calibration accuracy is warranted for a period of 1 year. After 1 year, the unit should be returned to Newport Corporation for recalibration and NIST traceability recertification.

5.2 Obtaining Service

To obtain information concerning factory service, contact Newport Corporation or your Newport representative. Please have the following information available:

1. Instrument model number (On front panel)
2. Instrument serial number (On rear panel)
3. Description of the problem.

If the instrument is to be returned to Newport Corporation, you will be given a Return Number, which you should reference in your shipping documents.

Please fill out the service form, located on page 23, and have the information ready when contacting Newport Corporation. Return the completed service form with the instrument.

5.3 Service Form

Newport Corporation
U.S.A. Office: 949/863-3144
FAX: 949/253-1800

Name ______________________________ RETURN AUTHORIZATION # ______________

Company ______________________________ (Please obtain prior to return of item)

Address ______________________________ Date ______________________________

Country ______________________________ Phone Number ______________________

P.O. Number ______________________________ FAX Number ______________________

Item(s) Being Returned:

Model # ______________________ Serial # ______________________________

Description: ____

Reason for return of goods (please list any specific problems) ____________________

____

Please complete the below, as appropriate.

List all control settings and describe problem: ______________________________

____

____

____ (Attach additional sheets as necessary).

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Describe signal source. If source is a laser, describe output mode, peak power, pulse width, repetition rate and energy density.

Where is the measurement being performed?

(factory, controlled laboratory, out-of-doors, etc.) ______________________________

What power line voltage is used? ____________________ Variation? ____________________

Frequency? ______________________Ambient Temperature? ______________________

Variation? ______________ °F. Rel. Humidity? ______________Other? ______________

Any additional information. (If special modifications have been made by the user, please describe below).

____

____

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ISO 9001
FM 27207

Newport Corporation, Irvine, California, has been certified compliant with ISO 9001 by the British Standards Institution.

P/N 19572-01, Rev. F
IN-04925 (04-01)
Printed in the USA