Model 840-C HandHeld Optical Power Meter

OPERATOR'S MANUAL

Newport®

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 the photodetector are 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. 17492-02, Rev. J
IN-03901 (08-00)

EC DECLARATION OF CONFORMITY

Model 840-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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Definitions

A	amps
ABS	flameproof (when treated), rugged plastic
AC	Alternating Current
A/D	Analog-to-Digital converter
BAT	battery option
BIC	biconic fiber connector
BNC	standard coaxial connector type
°C	degrees Centigrade
dB	decibels
dBm	decibels, referred to 1 mW power level
DC	direct current
DIN	German National Standard
EDCU	Electronic Display and Control Unit
E^2PROM	electrically eraseable, programmable read-only memory
°F	degrees Fahrenheit
Hz	hertz (cycles per second)
IR	infrared
I-V	current-to-voltage converter
kHz	kilohertz
kOhm	kiloOhms
LCD	liquid crystal display
mA	milliamps
mm	millimeters
mV	millivolts
nA	nanoamps
nF	nanofarads
Ni-Cd	nickel-cadmium
nm	nanometers
NVRAM	non-volatile random access memory
P-P	peak-to-peak
PROM	programmable read-only memory
RH	relative humidity
SL	silicon visible type detector
S/N	serial number
ST connector	fiber optic connector type
ST	silicon wand visible type detector
µA	microamps
µS	microsecond
V	volts
W	watts

Specifications

Physical Specifications

Electronic Display and Control Unit

Dimensions:	7.2" x 3" x 1.5"
Weight:	500 grams
Enclosure:	Flame resistant ABS
Connectors:	Input: 8-pin sub-mini DIN Analog Output: BNC
Charger:	DC power Jack, 5.5mm.
Photodetectors	See the appropriate instruction manuals and data sheets for these specifications

Electrical Specifications

Electronic Display and Control Unit

Input Current To Power Conversion:

Displayed Power Reading:	Input Current (A) ÷ Detector Responsivity (A/W) P=I/R(I)
Input Voltage Burden:	5µV at zero current input. 10µV max. at full range, except 100µV max on 5mA range.
Input Noise:	The noise performance of the meter is ±1 A-D count or better when in either the linear or peak-to-peak mode, regardless of the sensor capacitance, internal resistance or feedback ranging resistor (see limits below).
Input Voltage Drift:	±0.6mV/°C; ±1 mV/Mo.
Source Resistance:	>30kΩ
Source Capacitance:	<14nF (includes input cable)
Setting Time:	2 seconds to within 1 digit of final reading (fast mode)
Reading Rate:	2.5 readings per second typical

Analog Output Voltage:

Current Range	Accuracy* ±(%output + offset)	Full Range Output
100nA	2.5% + 15mV	1V
1µA	2% + 10mV	1V

* (18°C - 28°C, 1 year. Incl. I-V Converter and Output Amp.)

Analog Output Response: 10µS time constant (typ.)

A-D Output Accuracy: Absolute power measurement accuracy is typically limited by the calibration accuracy of the sensor. For relative power measurements, the electronic accuracy is often the limiting factor.

Current Range	Accuracy, P-P Current Sinewave* 50Hz - 1kHz	1 - 2kHz	2 - 5kHz
10uA	1% + 10nA	2% + 10nA	5% + 10nA
100uA	1% + 100nA	2% + 100nA	5% + 100nA
1mA	1% + 1uA	2% + 1uA	5% + 1uA
5mA	1% + 10uA	2% + 10uA	5% + 10uA

Current Range	Accuracy, P-P Current Squarewave* 50Hz - 1kHz	1 - 2kHz	2 - 5kHz
10uA	5% + 10nA	1% + 10nA	2% + 10nA
100uA	5% + 100nA	1% + 100nA	2% + 100nA
1mA	5% + 1uA	1% + 1uA	2% + 1uA
5mA	5% + 10uA	1% + 10uA	2% + 10uA

* (Incl. I-V converter, P-P to DC converter and A-D converter.)

Current Range	Max A-D Output	Accuracy, DC current* ±(%Input + Offset)	A-D Resolution
100nA	99.99nA	0.5% + 50pA	10pA
1uA	999.9nA	0.25% + 500pA	100pA
10uA	9.999uA	0.25% + 5nA	1nA
100uA	99.99uA	0.25% + 50nA	10nA
1mA	999.9uA	0.25% + 500nA	100nA
5mA	9.999mA	0.25% + 5uA	1uA

* (Includes I-V converter and A-D converter errors.)

Temperature Coefficient:	0.1 x Appropriate Accuracy Specification/°C.
Operating Environment:	0°C to 50°C, <80% Relative Humidity up to 35 °C. Reduce RH limit by 3%/°C above 35 °C.
Storage Environment:	-25°C - 60 °C, <90% Relative Humidity up to 35 °C. Reduce RH limit by 3%/°C above 35 °C.
Power:	6V, 600mA NiCd battery pack.
Battery Life:	18 Hours (backlight on)
Battery Indicator:	Display indicates when 10% battery life is left.
Display:	Triplexed, backlighted, LCD
System Accuracy:	Refer to Table 2.6.1

Measurement Mode:

Display Calculation*	Display Unit	Comment
I/R	W	Lin
(I-Id)/R	W	Bkgnd,Lin
I/R/Pref	—	Lin,Ref-dB
(I-Id)/R/Pref	—	Bkgnd, Lin, Ref-dB
$10\log\left\|\frac{I/R}{1mW}\right\|$	dBm	Log
$10\log\left\|\frac{(I-Id)/R}{1mW}\right\|$	dBm	Bkgnd, Log
$10\log\left\|\frac{I/R}{Pref}\right\|$	dBm	Log, Ref-dB
$10\log\left\|\frac{(I-Id)/R}{Pref}\right\|$	dBm	Bkgnd, Log, Ref-dB
Pref	Sto	Store

*When "– – –" is displayed, R=1

Section 1
General Information

1.1 Introduction

This instruction manual contains the necessary information for operation and maintenance of the Newport Model 840-C HandHeld Power 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 840-C HandHeld Power Meter. It contains a product description, discusses safety, and gives the features and options that are available.
- Section 2 explains the principles of operation of the Model 840-C Power Meter as well as Newport's Model 818 Series Detectors.
- Section 3 contains system operation procedures for the HandHeld Power Meter and accessories.
- Section 4 provides for Maintenance and Adjustment of the HandHeld Power Meter.
- Section 5 provides instructions for obtaining factory service.
- Section 6 contains reference drawings.

1.2 Manual Addenda

Information concerning changes or improvements to this instrument which occur after the printing of this manual will be found on the addendum sheet(s) included with this manual.

NOTE

Please review the addendum sheet(s) in this manual before attempting to operate or service this instrument.

1.3 Product Description

The Model 840-C is a powerful handheld dual-microprocessor based optical power measuring instrument. It makes sensitive DC or AC Peak-to-Peak optical power measurements with the convenience of full spectrum sensor calibration, quick sensor change, and a host of user-friendly features. The Model 840-C and its accessories are presented in Figure 1.

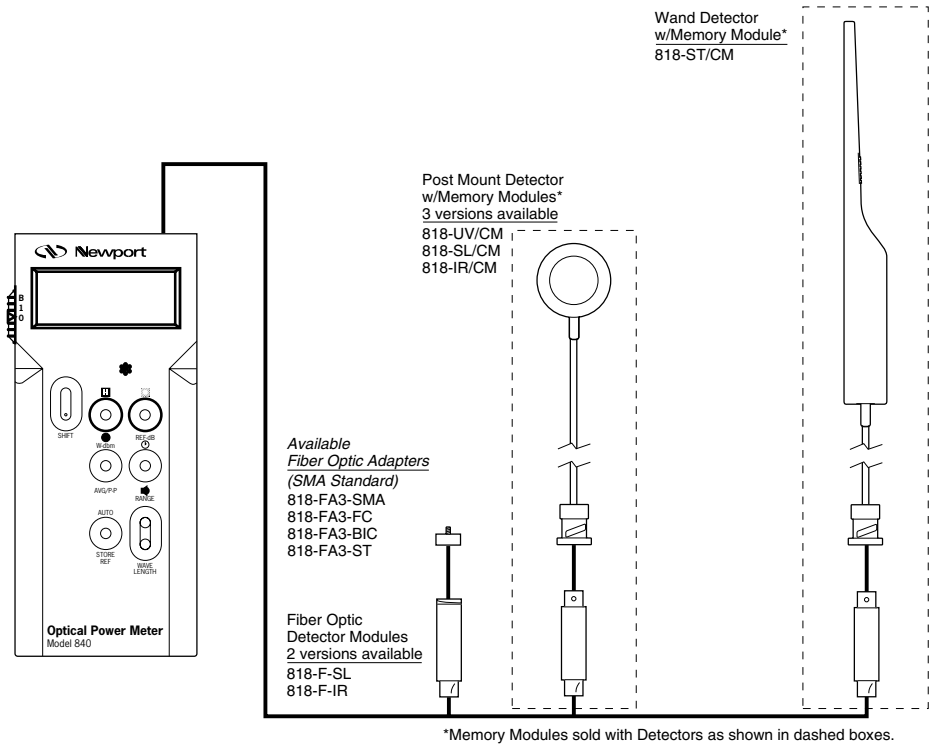


Figure 1 Model 840-C Controller and Compatible Detectors

The Model 840-C operates with Newport's line of optical detectors through the use of an in-line calibration module. This Cal Module supplies calibration and detector information while still allowing the detector to be detached and used with other equipment in the lab. For use in fiber optic applications, a combined detector-calibration module provides connectorized input at the meter (Model 818-F Series modules).

The Model 840-C has been designed with the most frequently used keys placed within natural reach. A backlit
4-digit liquid crystal display (LCD) permits easy reading in darkened areas. An audio indicator allows the user to maximize a signal without having to look at the display.

The analog output allows other instrumentation to monitor the Model 840-C power readings by providing a voltage output proportional to detector current. The Model 840-C's ultra low noise, thermally stable, trans-impedance input amplifier optimizes the detector sensitivity and linearity.

1.3.1 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 RMS between any portion of the Model 840-C (and its detector) and ground or a shock hazard will result.

WARNING

Use only the AC Adaptor provided with the Power Meter by Newport.

WARNING

Do not exceed 30V RMS between the detector input connector and earth ground and do not connect any conducting detector housing to anything that may have a voltage higher than 30V.

CAUTION

Avoid making sharp bends in sensor lead wires. Bending lead wires at a sharp angle can damage the wire causing sensor failure.

1.4 Getting Started

Please carefully read this instruction manual before using the Model 840-C HandHeld Power Meter. Alignment of the detector may require care and patience for optimum performance in some situations. Be especially careful to observe the warnings and cautions throughout this manual (see Section 1.8). If any operating instructions are **not** clear, contact Newport Corporation.

1.5 Unpacking and Inspection

All Model 840-C HandHeld Power Meters are carefully assembled, and then inspected mechanically, electrically, and optically 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.

1.6 Specifications

Detailed specifications of the Model 840-C HandHeld Power Meter may be found immediately preceding this section of the instruction manual or in Tables 1, 2 & 3.

1.7 Warranty Information

Warranty information may be found on the page preceding the Table of Contents in this manual. Should it be necessary to exercise the warranty, contact your Newport representative or the factory to determine the correct course of action. Newport Corporation maintains offices worldwide; these offices are listed in the General Catalog and on the back cover of this manual. Information concerning the application, operation, or service of this instrument may be directed to any of these locations.

1.8 Saftey 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 **NOTES** heading gives information to the user that may be beneficial in the use of this instrument.

Section 2
Principles of Operation

2.1 Introduction

This section contains a brief overall functional description of the Model 840-C and its detector measurement considerations. Information pertaining to the Model 840-AC wall mount Adaptor operation is also included. The Model 840 Hand Held Optical Power Meter System typically includes a photodetector, a memory module, and an electronic display. Some systems have the photodetector combined with the memory module (such as those with the fiber input module).

2.2 Photodetector

The photodetector is a sensor which is connected to its **matched** Detector Cal Module through a cable with a standard BNC connector. The photodetector is a semiconductor photodiode which generates current proportional to the total amount of light incident upon the detector. The photodetector is operated without voltage bias to reduce dark currents and shot noise. The current is then measured by the 840-C power meter, and converted into optical power as described in Section 2.4.

2.3 Memory Module

The memory module is an in-line device that supplies calibration information about its **matched** photodetector to the 840-C power meter. It is connected to the photodetector via a BNC connector and to the electronic display by a sub-miniature eight-pin DIN connector. The memory module is separate from the power meter so that photosensor and memory modules can be quickly changed without opening up the electronic display. The memory module may be separated from the photodetector to allow the photodetector to be used as an input sensor to other common power meters or an oscilloscope.

2.4 Functional Description

The Model 840-C is a 4-digit, ±9999 count autoranging current meter with six DC current ranges, four AC current ranges, and a photodetector. A simplified block diagram of the Model 840-C is shown in Figure 2. The input amplifier, a low noise current-to-voltage (I-V) converter, buffers and amplifies the incoming signal. This stage is followed by an A-D converter that digitizes the conditioned analog input signal, providing information in a form usable by the two microprocessors. The microprocessors modify the data according to the wavelength calibration information and then display the corrected reading in subunits of watts.

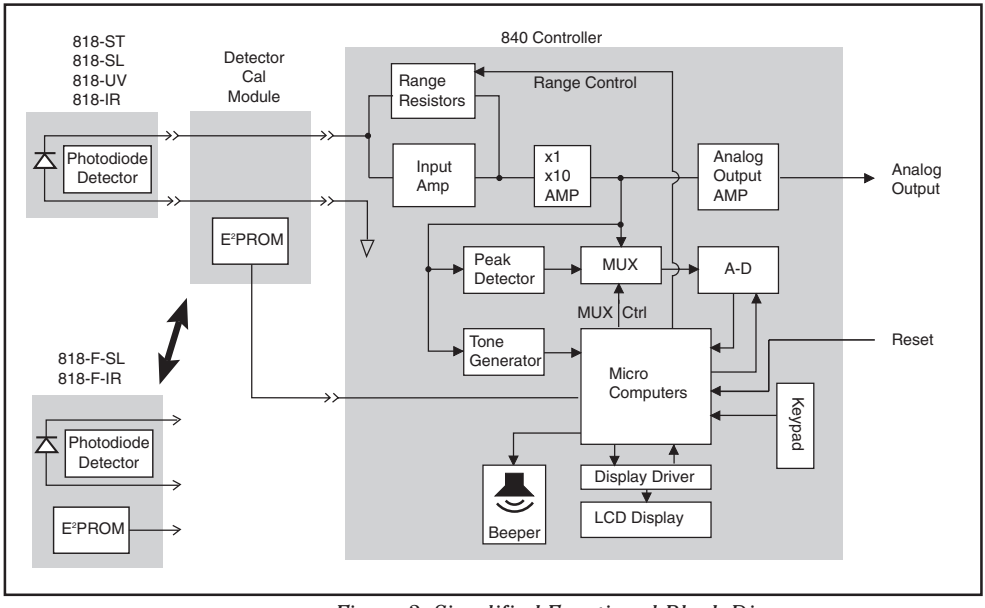


Figure 2 Simplified Functional Block Diagram

Also of importance are the DC and AC electrical characteristics and conditions under which overload can occur. Tables 1 and 2 present the **electrical** accuracy and overload conditions for DC and AC signals respectively. Note that final system accuracies are very detector and use specific. More information can be found in Section 2.5 of this manual.

Table 1 DC Range Electrical Accuracy and Overload Conditions

Power Range[1]	Maximum Reading[1,2]	Current Range[1]	Accuracy[3] ±(%Rdg + %Full Scale) 18°C - 28°C
100.0 nW	99.99 nW	100.0 nA	0.5 + 0.05[4]
1.000 µW	999.9 nW	1.000 µA	0.25 + 0.05
10.00 µW	9.999 uW	10.00 µA	0.25 + 0.05
100.0 µW	99.99 uW	100.0 µA	0.25 + 0.05
1.000 mW	999.9 uW	1.000 mA	0.25 + 0.05
5.00 mW	4.999 mW	5.00 mA	0.25 + 0.05

Notes:

1. Assuming detector response in the range 0.1 to 1.0 Amp/Watt. For detector response smaller than 0.1 Amp/Watt, divide power range and maximum reading by the ratio of the order of magnitude of the detector response to 0.1. For example, if the detector response is 0.03 Amp/Watt, divide power range and maximum reading by 0.01/0.1=0.1, so the ranges will be from 1uW to 100mW.
2. Power above the maximum will result in "OL" display.
3. Electrical accuracy depends on current range. Detector calibration accuracy usually limits reading accuracy.
4. Typical

Table 2 AC Range Electrical Accuracy and Overload Conditions[1]

Wave Shape	Frequency Range	Accuracy[2] ±(%Rdg + %Full Scale) 18°C - 28°C
Sinewave	50 Hz – 1 kHz	1.0 + 0.1
Sinewave	1 kHz – 2 kHz	2.0 + 0.1
Sinewave	2 kHz – 5 kHz	5.0 + 0.1
Squarewave	50 Hz – 250 Hz	5.0 + 0.1
Squarewave	250 Hz – 2 kHz	1.0 + 0.1
Squarewave	2 kHz – 5 kHz	2.0 + 0.1

Notes:

1. Holds for powers at or above 10.00µW.
2 Electrical accuracy depends on current range. Detector calibration accuracy usually limits reading accuracy.

2.4.1 Input Amplifier

The input buffer amplifier provides signal gain for further processing while simultaneously supplying the necessary isolation between the input signal and the A-D converter. The input buffer is composed of an inverting, low noise, two stage, chopper stabilized amplifier chain. The first stage gains are 20dB, 40dB, and 60dB. The second stage gains are 1dB and 10dB. The amplifier gain is controlled by the first microprocessor.

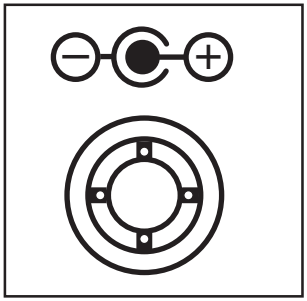
2.4.2 Microprocessors and Detector Cal Module (E^2PROM)

The first microprocessor performs gain control and the necessary calculation to convert from detector current to optical power using the detector response data. This data is stored in the Detector Cal Module and accessible to the electronic controller through an eight-pin sub-mini DIN connector.

In addition, a second microprocessor performs the mathematical operations necessary to implement the features of the Model 840-C such as **BACKGROUND**, **dBm**, **P-P** and to drive the LCD display.

The microprocessor used is the Motorola MC68HC705C8 (with 8K PROM). Software for the microprocessor is kept within the one-time-programmable read-only-memory bundled on the microprocessor chip. Temporary storage is provided by RAM that is internal to the microprocessor. This RAM is used to store calibration constants that are read from the EPROM at power-up. It is also used to store the reference power level and status flags for the present mode of operation. This RAM is maintained in sleep mode when the Model 840-C is turned off.

2.4.3 AC Wall Mount Adaptor



The Model 840-C may be operated off line power through the use of the supplied AC Adaptor. This unit accepts AC line power (mains power) and provides a DC voltage to the Model 840-C through a 5.5mm diameter phone jack (see schematic symbol at left).

CAUTION

Do *NOT* attempt to use the supplied AC Adaptor to recharge any type of battery than the approved Ni-Cd batteries for the Model 840-C. Doing so may damage the batteries, the instrument, or both.

2.4.4 Ni-Cd Rechargeable Batteries

The Model 840-C is operated with a rechargeable Ni-Cd battery. The battery pack is recharged through the supplied AC adaptor. When the instrument is off, the batteries will recharge in 8 hours. The Ni-Cd batteries may be recharged indefinitely with no damage.

2.4.5 Reset Switch

There is a Reset push button switch available for the 840-C. It would, when pressed, momentarily, reset the 840-C. It is accessible via an opening on the backside of the 840-C. Use a non-conductive tool to access it. To reset the 840-C:

- turn 840-C power switch off
- press the reset switch
- turn the 840-C power switch on.

2.5 Measurement Considerations

This section describes detector and attenuator characteristics, optical and electrical considerations, and environmental conditions. The accuracy of the Model 840-C is generally limited by the accuracy of the detector calibration. Making accurate measurements of optical power is dependent upon controlling the environmental conditions, specifically temperature and illumination conditions, and understanding the factors that affect power measurement.

2.5.1 Quantum Detector Calibration and Accuracy

Newport Corporation calibrates its photodetectors using secondary standards directly traceable to the United States National Institute of Science and Technology or to the National Physical Laboratory in Great Britain. Since the details and accuracy of the calibration procedure vary with each photodetector model, a more detailed description of the calibration restrictions is supplied with each individually calibrated photodetector.

In general, detector calibration accuracy is ±3% to ±10% in absolute terms, and varies with wavelength. Each detector will have some variation in the response over different sections of the surface, caused by variations in the semiconductor material. 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 the light source onto detector surface. Inaccurate readings and possible detector damage may result. Consult the detector manual for damage thresholds.

Individual detector responses change with time, especially in the ultraviolet. They should therefore be calibrated at 1 year intervals 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.

2.5.2 Quantum Detector Temperature Effects

Photodiode characteristics are significantly affected by temperature. At longer wavelengths, quantum detectors typically lose sensitivity with increasing temperature. However, the detector/amplifier combination noise increases exponentially with temperature. For silicon detectors, this is generally on the order of a few picoamps at temperatures near room temperature. With uncooled germanium detectors, however, this drift is on the order of a few nanoamps, or typically 1,000 to 10,000 times greater than silicon. These drifts can be nulled. (See 3.4.4) Since drift changes occur with time, the **BACKGROUND** should be set just prior to any measurements.

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

Since different detectors differ significantly in their characteristics, consult the appropriate detector manual for information about the details of the detector you are using.

2.5.3 Ambient and Stray Light

Ambient and stray light striking the detector will be measured by the Model 840-C, and should be considered when making careful measurements. Ambient light can be distinguished from dark current 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 both emits a significant amount of infrared radiation, and because it radiates at a temperature significantly different from ambient. 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.

The effects of ambient light are greatly reduced when using a fiber-connectorized input with the Model 840-C. If free space beam measurements are desired, using the supplied attenuator will reduce stray light, and often improve the ratio of source signal to that due to the ambient conditions. 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 which is not coming from the source, and turning off room and other lights.

2.5.4 Environmental Measurement Conditions

All measurements should be made at ambient temperature within the range 0°C to 50°C, and with a relative humidity of 0% to 80% up to 35°C. For instruments operating above 35°C derate humidity specification 3% per °C up to 50°C. If the instrument has been subjected to extremes of temperature, allow sufficient time for internal temperatures to reach environmental conditions. Typically, it takes 30 minutes to stabilize a unit that is 10°C (18°F) out of specified temperature range.

The photodetector should be at or below the calibration temperature.

NOTE

The photodetectors supplied with this instrument have characteristics which are temperature dependent. Dark noise and detector response change with temperature. See the appropriate detector data sheet for more information.

System Accuracy

As previously discussed total system accuracy depends both on electronic uncertainties and detector calibration uncertainties. Table 3 details total system accuracy when making absolute power measurements.

Table 3 Total System Accuracy

Model 840-C System Performance Specs.

	840-UV	840-SL	840-IR	840-ST	840-F-SL	840-F-IR
Application Type	Free-space beams	Free-space beams	Free-space beams	Free-space beams	Optical fibers	Optical fibers
Wavelength Range	250-1100 nm	400-1100 nm	800-1800 nm	400-1100 nm	400-1100 nm	800-1800 nm
Detector Housing	Cylinder	Cylinder	Cylinder	Wand	Connectorized Fiber	Connectorized Fiber
Newport Detector	818-UV	818-SL	818-IR	818-ST	818-F-SL	818-F-IR
Detector Material	Silicon 11.2 mm dia	Silicon 11.2 mm dia	Germanium 3 mm dia	Silicon 10x10 mm	Silicon 3 mm dia	Germanium 3 mm dia
Measurement Range w/o Attenuator	100pW-0.2mW -70 to +7dBm (typ)	100pW-2mW -70 to +3 dBm (typ)	100pW-2mW -70 to +3 dBm (typ)	100pW-2mW -70 to +3 dBm (typ)	100pW-2mW -70 to +3 dBm (typ)	100pW-2mW -70 to +3 dBm (typ)
Measurement Range with Attenuator	100 nW-0.2W -40-23 dBm	100 nW-2 W -40-33 dBm	100 nW-2W -40-33 dBm	100nW-2W -40-33 dBm	Not Applicable	Not Applicable
Resolution	10 pW (-80 dBm)	10 pW (-80 dBm)	10 pW (-80 dBm)	10 pW (-80 dBm)	10 pW (-80 dBm)	10 pW (-80 dBm)
NIST-Traceable Calibration Accuracy (nm)	250 to 1000, ±2% 1010 to 1100, ±3%	400 to 1000, ±2% 1010 to 1100, ±3%	780 to 1700, ±3% 1710 to 1800, ±5% With Attenuator ±6%	400 to 1000, ±2% 1010 to 1100, ±3%	400 to 1000, ±2% 1010 to 1100, ±3%	780 to 1700, ±3% 1710 to 1800, ±5%
Detector Housing Dimensions	0.75" x 1.5" dia. (19 mm x 38 mm)	0.75" x 1.5" dia. (19 mm x 38 mm)	0.75" x 1.5" dia. (19 mm x 3 mm)	(clearance around photodiode area)	1.5" x 0.5" dia. (38 mm x 12.5 mm) 0.15"D x 0.75"W, (4 x 19 mm), overall length, 7" (178 mm)	1.5" x 0.5" dia. (38 mm x 12.5 mm)

Section 3
System Operation

3.1 Introduction

This section contains the information needed to prepare and operate the Model 840-C as a power meter. Operation consists of using the Model 840-C to perform basic DC and AC peak-to-peak optical power measurements, compensating for dark current and ambient light, making ratio and logarithmic (dBm, dB) measurements, using the audio output and other functions.

3.2 Preparation for Use

The Model 840-C Power Meter should have some operations performed before measurements are made. These include:

- Charging of batteries (Section 3.2.1)
- Connection of the Sensor/Detector (Section 3.2.2)
- Powering the instrument (Section 3.2.3)

3.2.1 Battery Charging

The Ni-Cd batteries can be recharged by using the AC Adaptor at any time. The unit may be recharged indefinitely.

NOTE

The ⊟ annunciator turns on when the batteries have <10% life left.

NOTE

Do NOT operate the meter when the low battery indicator is on. Erroneous readings or keyboard responses may result.

NOTE

For maximum battery efficiency, charge the battery pack with AC power plugged in and the 840-C power switch off, and charge it only until it is fully charged (10 hours). Continuous charging over long periods of time will not damage the batteries, but useful life will gradually decrease. This loss is not permanent

and may be restored by cycling the battery pack through several complete charge/discharge cycles. The battery pack is capable of 500 to 1000 charge/ discharge cycles before a replacement is needed.

3.2.2 Sensor Connection/Removal

NOTE

Both the Detector Cal Module and the Model 818-F Series Detector/Memory Module combinations are installed and removed in the same manner.

CAUTION

Turn the unit off, before installing or removing any memory module.

Align the line on the memory module with the mark on the head of the Model 840-C power meter (See Fig. 3). Slide the module into the tube until the 8-pin sub-mini DIN connector begins to engage. Some small rotational adjustment of the module may be necessary when engaging the connector. Once engaged, firmly push the module in until the connectors are fully engaged.

To remove the module, grasp firmly and pull straight out.

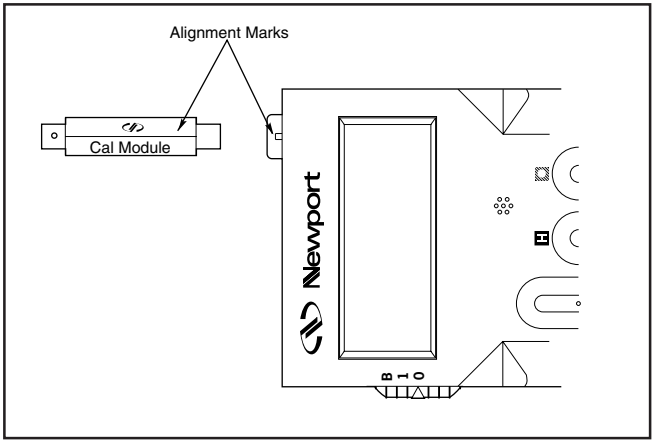


Figure 3 Detector Cal Module Installation

CAUTION

Do not force the connection beyond the elastic limits of the connectors. Great force is not required. If making the connection seems difficult, withdraw and examine the connector and socket for damage.

3.2.3 Power Up

During shipping and storage, it is likely that batteries have become discharged. Allow the AC adaptor to charge the batteries for at least 5 minutes before turning the power meter slide switch to **1** or **B**. Low batteries can cause non-fatal logic errors during turn on sequence.

Turn on the instrument by sliding the switch on the side of the instrument to the **1** position. At power-up the Model 840-C first performs a display segment-test. All segments and annunciators of the liquid crystal display (LCD) are momentarily turned on (approx. 3 sec.) for visual confirmation by the user (See Figure 4). If the display is blank, then turn 840-C off. Press the reset switch located in the back of the 840-C, using a non-conductive tool. Turn the 840-C on.

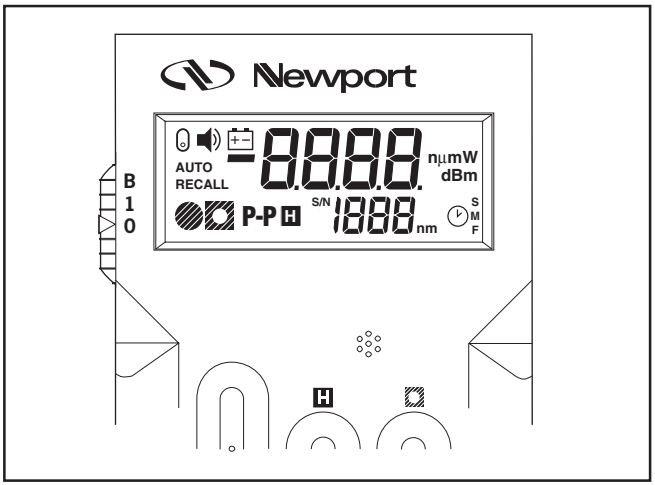


Figure 4 LCD Display

After the segment test, the 3 least significant digits of the sensor serial number will be displayed for approximately 1 second. (When powering up in the ATTN mode, the attenuator serial number is shown. This typically matches the sensor S/N.) Verify that the displayed sensor or attenuator serial number matches the serial number of the sensor and attenuator being used.

If the Model 840-C is being powered up for the first time after new batteries are installed or if the battery has deep discharged, it will automatically enter a default mode of operation. Note that the audio is turned off in the default mode of operation. Otherwise the Model 840-C powers up in the configuration it held when it was last shut off.

3.3 Model 840-C Controller

The following sections and Figure 6 provide a brief description of the display, controls, and connectors.

3.3.1 Digital Display

The Model 840-C has a 4-digit backlit liquid crystal display (LCD). The minus sign is displayed. The plus sign is implied by the absence of the minus sign. The following annunciators are displayed on the LCD.

—	Low battery indicator.
nW, **uW**, **mW**, or **W** —	Nanowatts, microwatts, milliwatts, or watt display range selected.
dBm, **dB** —	Decibels relative to 1 mW (dBm) or decibels relative to user set level (dB) selected.

NOTE

When neither a watts-type or decibel-type annunciator is displayed, the meter is performing a linear ratio referenced to user set power.

RECALL —	Establishing or using a user set power.
AUTO —	Autorange selected.
—	Background correction selected.
—	Attenuator selected.
P-P —	Peak-to-Peak measurement selected.

NOTE

If **P-P**, indicating a peak-to-peak measurement is *NOT* displayed, then an averaged DC measurement is being taken.

H — Hold selected.

— Audio output selected.

— Shift selected.

S, **M**, or **F** — Slow, Med, or Fast time constant selected.

nm — Identifies wavelength used to determine detector responsivity.

NOTE

If nm is *NOT* displayed, detector or attenuator serial number or STO is being displayed.

3.3.2 Front Panel Controls

OFF/ON/BKLT — Three position slide switch found on side of Model 840-C near the display. The switch positions represent meter off (**0**), meter on with no backlit display (**1**), and meter on with backlit display (**B**).

Front Panel Controls — Momentary pushbuttons with tactile feedback. Also use the display to verify that pressing a key activated desired operating mode.

NOTE

The **REF-dB** and the **STORE** functions have two outcomes depending upon if either is held down for more than 3 seconds. See Sections 3.4.6.1 through 3.4.6.3 for more detailed information.

3.3.3 Input Connectors

The signal input connector is a standard 8-pin subminiature DIN connector that mates to the Detector Cal Module or the Model 840-F Series Detector-Memory Module combinations. The AC jack input is a 5.5 mm power jack which mates to the AC Adaptor.

3.3.4 Analog Output

A voltage level that is proportional to the incoming current can be monitored using the BNC analog output connector found near the Model 840-C display.

Range changes, even on autoranging, will change the constant of proportionality (gain) of the output signal. Range changes which are not apparent on the display may occur if the instrument is in autorange mode.

The analog output permits monitoring or recording of the signal from the current-to-voltage converter within the Model 840-C. Since the analog output scales from 0 to 1V for each gain stage of the input transimpedance amplifier, as the meter autoranges, the output voltage will develop discrete voltage jumps. To avoid this jumping, operation of the meter in manual ranging mode is suggested.

NOTE

The analog output voltage is the result of direct current-to-voltage conversion of the input current. The output voltage does *NOT* equal the displayed value and it is not affected by the operating mode of the meter.

The analog output is protected up to 20V RMS and during an input current overload the analog output is clamped to a maximum voltage swing of approximately ±4V. Although protected up to 20V to prevent instrument damage, a voltage applied to the analog output could cause an erroneous display, rather than the OL message.

CAUTION

Applying more than 20V RMS to the analog output connector may result in damage to the instrument.

Since the output of the current-to-voltage converter is bipolar, the inverting analog output can also be used to measure AC signals with the specified analog rise time. The analog output resistance is about 1kOhm.

3.4 Definitions of Key Functions

The various key functions of the Model 840-C modify the displayed value of sensor current measured by the front end amplifier to account for calibration values or display units. A valid key input is responded by the 840-C with a short audio response.

3.4.1 , Shift

The , **SHIFT** key toggles the keyboard between white and blue functions. When the , **SHIFT** annunciator is on, the blue key functions are enabled. The keyboard remains in a given mode until the **SHIFT** key is again depressed.

3.4.2 , Hold

The , **HOLD** key causes the meter to freeze the next power reading in the display and light the , **HOLD** annunciator. The display remains frozen until the , **HOLD** key is again pressed.

3.4.3 , Attenuator

The , **ATTENUATOR** key causes the meter to assume that the attenuator (supplied with the sensor) has been installed, and lights the , annunciator. The meter compensates for the detector plus attenuator combination. Pressing the , **ATTENUATOR** key again exits this mode.

3.4.4 , Background

The , **BACKGROUND** key causes the meter to retain the next current reading and subtract it from all subsequent current readings before subsequent calculations are performed. This allows the meter to subtract off (or zero) the signal from ambient surroundings before making a measurement. Depressing the BACKGROUND key again exits this mode.

3.4.5 W-dBm

The **W-dBm** key toggles between linear and logarithmic measurement modes. When in the linear mode the power level annunciators are **nW**, **W**, **mW** or **W**. When in logarithmic mode, the power annunciators are **dBm** or **dB**.

3.4.6 Avg/P-P

The **AVG/P-P** (Shift) key toggles between DC average (**AVG**) power and true AC Peak-to-Peak (**P-P**) power measurements. The Peak-to-Peak readings are independent of DC offsets and signal waveshape within the bandwidth limits of the amplifier.

When in the **AVG** mode the DC power is displayed. The front end of the Model 840-C ranges to obtain the best possible A/D resolution of this signal when in **AUTO** mode. The DC signal displayed is the result of an A/D conversion using an integration time of 100ms.

When in **P-P** mode, the **P-P** annunciator is lit and the difference between the highest and lowest measured powers of the AC signal is displayed. In **AUTO** mode, the Model 840-C ranges to maximize **P-P** signal while minimizing amplifier saturation when measuring a small AC signal in the face of large DC offsets.

3.4.7 REF-dB

The **REF-dB** key serves a dual function, accessed through either a momentary or a long (approximately 3 seconds) depression of the key. Both functions compare the measured power against a reference power before the result is displayed. Pressing the **REF-dB** key a second time exits the mode.

A momentary press of the **REF-dB** key (less than 3 sec.) causes the next power calculation to be temporarily saved and adopted as a reference power. The meter then displays ratio or dB calculations against this adopted reference.

When the **REF-dB** key is depressed for longer than 3 sec. the Model 840-C recalls the reference power level stored in long term RAM and uses this recalled value in subsequent calculations.

3.4.8 Store Reference

The **STORE REF** key serves a dual function, accessed through either a momentary or a long (approximately 3 seconds) depression of the key. The function allows either viewing of the reference power level stored in the long term RAM or storing of a new reference power level into that memory location. Pressing the **STORE REF** key a second time exits this mode.

A momentary press of the **STORE REF** key causes the Model 840-C to beep and to display the reference power stored in non-volatile RAM. STORE key operation is denoted in the wavelength display by **Sto**.

Depressing the **STORE REF** key for longer than 3 seconds causes the Model 840-C to double beep and overwrite the non-volatile memory location with the next power reading measured. The wavelength display will still indicate **Sto**.

3.4.9 , Tone

The **, TONE** key toggles the audio output of the Model 840-C on or off. When on, the Model 840-C indicates signal level through the frequency of an audio beeper. The higher the signal level, the higher the frequency. When in **AUTO** mode, the frequency may rapidly rise and fall if signal level changes cause the front end amplifier to auto range through gain stages. If the input signal is modulated, the audio output will similarly be modulated. Under such circumstances, it may be useful to use the manual ranging mode.

3.4.10 , Time Constant

The **, TIME CONSTANT** key cycles the display through three moving averages of recent A/D conversions. In the **F**ast mode the display shows the most recent A/D conversion. In the **M**edium mode the display shows the average of the 4 most recent conversions while in the **S**low mode, the display shows the average of the 16 most recent conversions.

3.4.11 Auto

The **AUTO** key toggles the Model 840-C between autoranging and manual ranging modes. If the **RANGE** key is pressed when in the **AUTO** mode, the Model 840-C exits the **AUTO** mode. When exiting the **AUTO** mode, the Model 840-C stays at the gain established by the autorange mode until manually altered.

3.4.12 Range

The **RANGE** rocker switch allows for manual increase or decrease of the gain of the front end amplifier by pressing either the up or down arrow. Pressing the ▲ key decreases amplifier gain (going to less sensitive ranges), while pressing the ▲ key increases the amplifier gain (going to more sensitive ranges). When **RANGE** is pressed, the Model 840-C enters manual ranging mode and remains there until **AUTO** is pressed.

Manual ranging is often useful when using the audio output or analog output features of the Model 840-C.

3.4.13 Wavelength

When the **WAVELENGTH** ▲ up or ▼ down rocker switch is depressed, the wavelength display increases or decreases. The speed with which the display scrolls rises as the key is held down longer. Adjustment in 1nm increments is possible by momentarily pressing the **WAVELENGTH** key. The Model 840-C adopts the calibration value appropriate for the wavelength displayed and the state of the ▨, **ATTENUATOR** annunciator.

NOTE

If WAVELENGTH key is pressed until the wavelength display exceeds the calibration spectrum of the sensor, the wavelength display indicates "- - -". In this mode, the value displayed is the electrical current.

3.5 Performing Basic Measurements

Basic measurement techniques for using the Model 840-C to measure DC and peak-to-peak optical power are covered in the following sections. Also included are methods of background correction, ratio measurements, making measurements in decibels (dBm and dB) and using the store and recall of reference power.

In general, absolute accuracy is limited by the accuracy of the detector calibration and environmental factors affecting the detector. See the appropriate detector manual for this information. Further discussion on these topics for Newport detectors is found in Section 2.5 of this manual.

3.5.1 Setting the Wavelength

In order to obtain accurate optical power measurements, it is necessary to set the instrument calibration wavelength to the wavelength of the light incident upon the photodetector. This instrument calibration wavelength is indicated in nanometers in the lower right hand side of the digital LCD display and is followed by the annunciator **nm**. Upon power-up, the wavelength will be the last used value. To change the wavelength, perform the following:

a. Determine the wavelength of the light being measured to the nearest **nm**. If the source is broadband, use either a value near the center wavelength of the light or the wavelength with greatest intensity.

Momentarily pressing the **WAVELENGTH** keys will increase or decrease the calibration wavelength by 1nm. Wavelength will continue to change as long as the wavelength key is held in.

b. If the wavelength is greater than the value displayed, depress the **WAVELENGTH ▼** key, and hold until the desired wavelength is reached.

c. If the wavelength is less than the value displayed, depress the **WAVELENGTH ▲** key, and hold until the desired wavelength is reached.

NOTE

Different detectors are sensitive over different wavelength ranges. See the appropriate detector manual and calibration data to determine the range of wavelengths for which the detector connected to the Model 840-C can be used. The calibration constants stored in the Detector Cal Module span only the wavelength range appropriate for the detector and are specific to that detector.

If the calibration wavelength cannot be set to within 1 nm of the desired value, then the detector/memory combination being used is not appropriate for this measurement. See Sections 4 and 5 for service or replacement.

3.5.2 Setting the Attenuator Status

Many Newport photodetectors are provided with calibrated attenuators. The calibration constants for an attenuator/detector combination are stored in the Detector Cal Module. To measure optical powers above the saturation limit of the photodetector (see appropriate photodetector manual), use an attenuator. When the attenuator is selected the following occurs:

a. The ▨, **ATTENUATOR** annunciator is displayed.

b. The detector calibration constants are computed including the effects of the attenuator.

If the attenuator is subsequently removed, the ▨, **ATTENUATOR** key should be pressed to turn the attenuator off. Subsequently, all displayed values will be computed using wavelength calibration constants computed for the detector without the attenuator.

NOTE

The transmission characteristics of each attenuator are slightly different; the user must, therefore be careful to use ONLY the attenuator and detector pair with the same serial numbers for which the particular Detector Cal Module is calibrated.

3.5.3 Power Measurements

a. Select autoranging for automatic power level shifting, or select manual ranging to the desired range for the expected power level.

b. Read the optical power on the digital display. Overrange is indicated by an OL message.

c. Select **P-P** to read the AC peak-to-peak content of the measured power.

3.5.4 Background Correction

a. Block the light from the source which is to be measured.

b. Press the ▨ , **BACKGROUND** key to suppress the effect of ambient light reaching the detector.

c. Unblock the source and read the power.

3.5.5 Ratio Measurements

When the ratio mode is selected by momentarily pressing the **REF-dB** key in linear mode with an on-scale reading on the display the following occurs:

a. The power annunciator (nW, µW, mW, W) turns off.

b. The next power reading is stored.

c. The stored reading is then algebraically divided into all subsequent readings and displayed.

When, under the same conditions, the **REF-dB** key is pressed for more than 3 seconds the following occurs:

a. The power annunciator (nW, µW, mW, W) turns off.

b. The **RECALL** annunciator is turned on.

c. The power level stored in long term RAM is recalled; all subsequent readings are algebraically divided by this value and displayed.

3.5.6 Logarithmic (Log) Measurements (dBm and dB)

The Model 840-C can make logarithm (dBm and dB) measurements referenced to either a 1 mW power level or to any other observed power level with the use of the **REF-dB** key.

The basic procedure for using the Log mode is to select autorange and press the **W-dBm** key (dBm annunciator turns on). To get out of Log mode, press the **W-dBm** key again.

Because the logarithm of a negative number is undefined, *LO* is displayed if the logarithm of a negative number is attempted.

NOTE

Log measurements should always be made on the lowest possible range (without overranging). Readings on high ranges will not allow optimum calculations of the logarithm. When in doubt, use autorange.

3.5.6.1 Log measurements: 1 mW Reference (dBm)

The Log measurement mode displays the absolute value of 10 times the logarithm (base 10) of the input power, referenced to 1mW. The following equation illustrates this relationship:

$$\text{dBm reading} = 10\,\text{Log}(\text{Net Applied Power} / 1\text{mW})$$

$$= 10\,\text{Log}((I-I_d) / R) / 1\text{ mW})$$

where

I = detector input current

I_d = detector dark current

R = responsivity of the detector (A/W) (or detector with attenuator)

Using this reference power, the dBm reading span is from -80.00 dBm to +10.00 dBm (10 pW to 10 mW), when the detector responsivity equals 1.

To make dBm measurements (relative to 1 mW optical power) with background correction, proceed as follows:

a. Select autorange and a wavelength.

b. Block the light to be measured.

c. Select background correction using the ▨ BACKGROUND key. Display should read approximately zero, but will fluctuate depending upon the variations in the amount of light reaching the detector and the detector dark current fluctuations.

d. Illuminate the detector with the optical signal to be measured.

e. Press the **W-dBm** button, the **dBm** annunciator will appear on the display.

f. Take the reading from the display.

NOTE

When using log measurements with background correction, the signal after the subtraction of the stored offset power level may be negative. In this case, LO will be displayed since the log of a negative number is not defined. This will be automatically cleared when the signal becomes positive.

3.5.6.2 Log measurements: Other Reference Powers (dB)

Decibel (dB) measurements, referenced to optical power levels other than 1mW, can be read directly from the display of the Model 840-C by utilizing the **REF-dB** and **STORE** features.

To make dB measurements, proceed as follows:

a. Follow steps a - f above (Section 3.5.6.1) but illuminate the detector with desired reference signal in step d.

b. Press the **REF-dB** key momentarily. The following will occur:

   1. The Model 840-C will beep.
   2. The next power reading will be stored.
   3. The stored power reading is then algebraically divided into all subsequent power level readings and displayed (in dB).

The Model 840-C is now set up to make decibel (dB) measurements referenced to the stored power level. Simply input the power to be measured and take the reading from the display.

3.5.6.3 Store and Recall of the Long Term RAM Reference Power

The Model 840-C can store and recall from long term RAM memory the reference power level it uses to make decibel (dB) measurements. To view this power level, perform the following steps:

a. Perform step a. above (Section 3.5.6.2).

b. Press and hold the **STORE** key for more than 3 seconds. The following will happen:

   1. The Model 840-C will beep once initially and then beep twice at the 3 second mark.

   2. The next power reading will be stored into NVRAM. This stored reference power level can then be recalled at any later time until a new reference power level is saved through the **STORE** key.

c. Press the **STORE** key once again to exit the **STORE** mode.

d. Press and hold the **REF-dB** key for more than 3 seconds. The reference power stored in long term RAM will be recalled and algebraically divided into all subsequent power readings and the result displayed (in dB).

The stored reference power level can be used to make dB measurements at any time by pressing and holding the **REF-dB** key for more than 3 seconds.

3.6 Error Messages

Table 4 lists the error messages associated with Model 840-C operation.

Section 4
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. The detector should be cleaned only with lens paper and reagent grade alcohol that leaves no residue.

CAUTION

Do not use acetone or other organic solvents on the Model 840-C. Organic solvents attack the ABS Case.

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 4 Symptom/Fault Troubleshooting Guide

Symptom	Possible Fault/Correction
Blank display, unit does not power up.	- Turn unit off. Press the reset key located in the back of the unit. Turn unit on.
Low ⊟ Annunciator	- Low battery voltage. Recharge Ni-Cd batteries. If problem persists, call Newport.
Sensor S/N does not match S/N displayed at power up.	- Memory module mixed with wrong sensor. Locate proper sensor or memory module. - Attenuator S/N does not match Detector S/N. Exit ATTENUATOR mode, locate proper attenuator, or change detectors. Restart meter with new power up.
Readout is OL	- Current overload. Increase **RANGE** on meter or decrease input signal.

Table 4 Symptom/Fault Troubleshooting Guide (continued)

Symptom	Possible Fault/Correction
Readout with **dBm** or *LO*	- Current underflow. Decrease **RANGE** on meter or increase signal.
Readout is *OF*	- Sensor signal saturation. Decrease signal to the sensor.
Unit does not respond properly to keyboard input.	- Hold function is on. Turn off H, hold. - Batteries too low. Recharge NiCd Batteries. - µP locked up. Turn unit off. Press reset key located in the back of the unit. Turn unit on.
Display stays on when unit is turned off.	- Too little power to sense shutdown. Recharge batteries.

Section 5
Factory Service

5.1 Introduction

This section contains information regarding obtaining factory service for the 840-C HandHeld Optical Power Meter. The user should not attempt any maintenance or service of this instrument and/or accessories beyond the procedures given in Section 4: Maintenance and Trouble-shooting. 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 840-C electronic display contains no user serviceable parts. It is delivered in a permanently sealed condition. Its calibration accuracy is warranted for a period of two years. After two years, the unit should be returned to Newport Corporation for recalibration.

Calibration data for an individual detector is stored in the Detector Cal Module that accompanies each detector. The Model 840-C may be used with other Newport detector/attenuator combinations than the one supplied with the unit so long as an Detector Cal Module is calibrated for that detector.

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
2. Instrument serial number (Inside battery compartment.)
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 33, 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 _____

Country _____ Date _____

P.O. Number _____ Phone Number _____

Item(s) Being Returned:

Model # _____ Serial # _____

Description: _____

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

_____

Please complete the following, as appropriate:

List all control settings and describe problem: _____

_____

_____

_____(Attach any 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 should be included either on back or a separate sheet. (If special modifications have been made by the user, please describe).

Notes

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