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LASER POWER DETECTORS

310 SERIES V2

INSTRUCTION MANUAL

121-16471



Revision 2

December 2001

Warranty

GENTEC warrants each instrument of its manufacture to be free from any defects in material and workmanship. Our obligation under this warranty is limited to service or adjustments on any instrument returned to our factory for that purpose, and to the replacement of any defective parts thereof. This warranty covers instruments within one year after the shipping date to the original purchaser. Should the instrument show any defects, the instrument must be returned prepaid by the original purchaser for inspection. If it is determined that the defect has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost after submitting an estimate to the purchaser.

Any damage due to misuse of the product or by any attempt to alter or repair the product by an unauthorized person is not covered by this warranty.

GENTEC is not liable for consequential damages of any kind.

Customers must fill in and mail the warranty card to validate the guarantee.

In case of malfunction, before returning any material, contact your local GENTEC distributor or GENTEC office to obtain a return authorization number. Material should be returned to:

For customers in U.S.A:

GENTEC Electro-Optics, Inc
121, Emerson Street
Palo Alto, California
94301-1020

Tel: (650) 321-4258
Fax: (650) 321-6607
e-mail: gentec@aol.com

For customers in other countries:

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

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

www.Gentec-EO.com

NOTE: Instruments for which the warranty has expired must be returned prepaid to the factory for repairs.

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1 310 SERIES POWER DETECTORS



1.1 INTRODUCTION

The GENTEC 310 Series power detector family includes six air-cooled thermal sensors:

One surface absorber sensor (PS-310), which presents an excellent spectral uniformity response from 190nm to 40 μ m, is useful for wide band applications.

One high damage threshold (PS-310 WB) surface absorber sensor designed for use at moderate energy densities and high average power densities.

Four volume absorber sensors (PSV-3101, 3102, 3103, 3104) are designed to be used with high peak power pulsed lasers.

All these detectors can measure up to 3 Watts of average power without an optional heat sink, and 10 Watts with the 310 heat sink installed (see Fig. 1-1 and 1-2). They have the same dimensions and sensor elements, differing only by their optical radiation absorber. An electrical heater is standard on all devices.

Our calibrations are NIST traceable.

The PS-310, PSV-3103 and PS-310WB are optically calibrated against our 1.064 μ m "Gold" standard, that is optically calibrated at NIST.

The PSV-3101, 3102, 3104 are calibrated by electrical equivalence, against NIST traceable electrical standards.

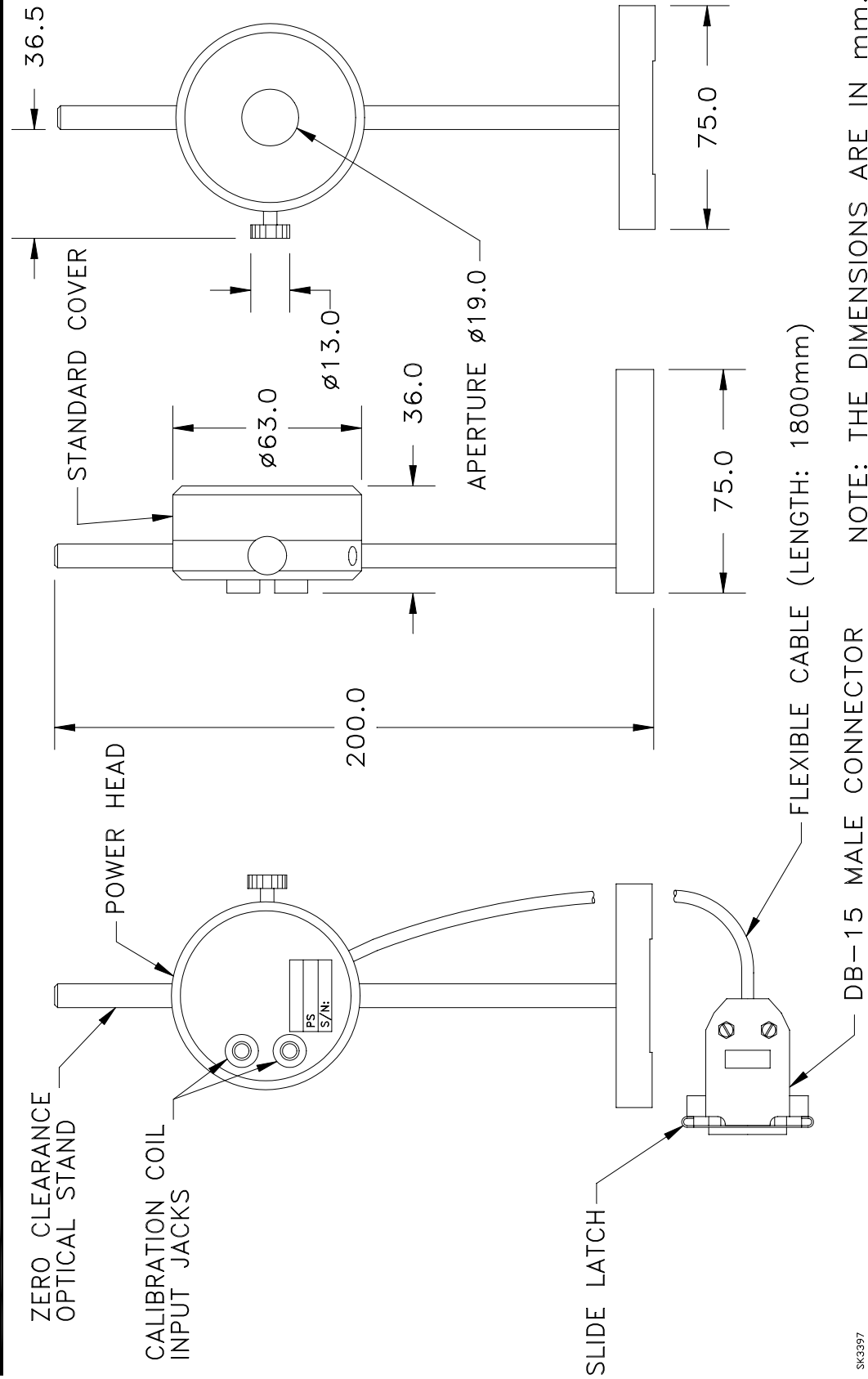
The 310 Series power detectors are simple and effective devices. A planar thermopile mounted on a massive aluminum heat sink generates a Seebeck effect voltage when heat flows through it. Optical radiation being converted into heat by the absorbing material applied to the sensor element will generate a proportional output voltage. This planar thermopile technology is insensitive to beam position and diameter. There is no critical alignment of the detectors, allowing for faster set-up and extremely flexible operation.

A built-in calibration heater bonded to the thermopile surface enables an electrical equivalence calibration capability. When a DC voltage is applied to this resistance, heat is generated in the planar thermopile and sensed as optical power by the detector.

The PS-310, PS-310WB, PSV-3101, 3102, 3103, and 3104 detectors are supplied with a DB-15 "intelligent" male connector, a 180cm length flexible cable, two calibration coil input banana jacks and a zero clearance optical stand.

310 Series Without Heatsink

Fig. 1-1

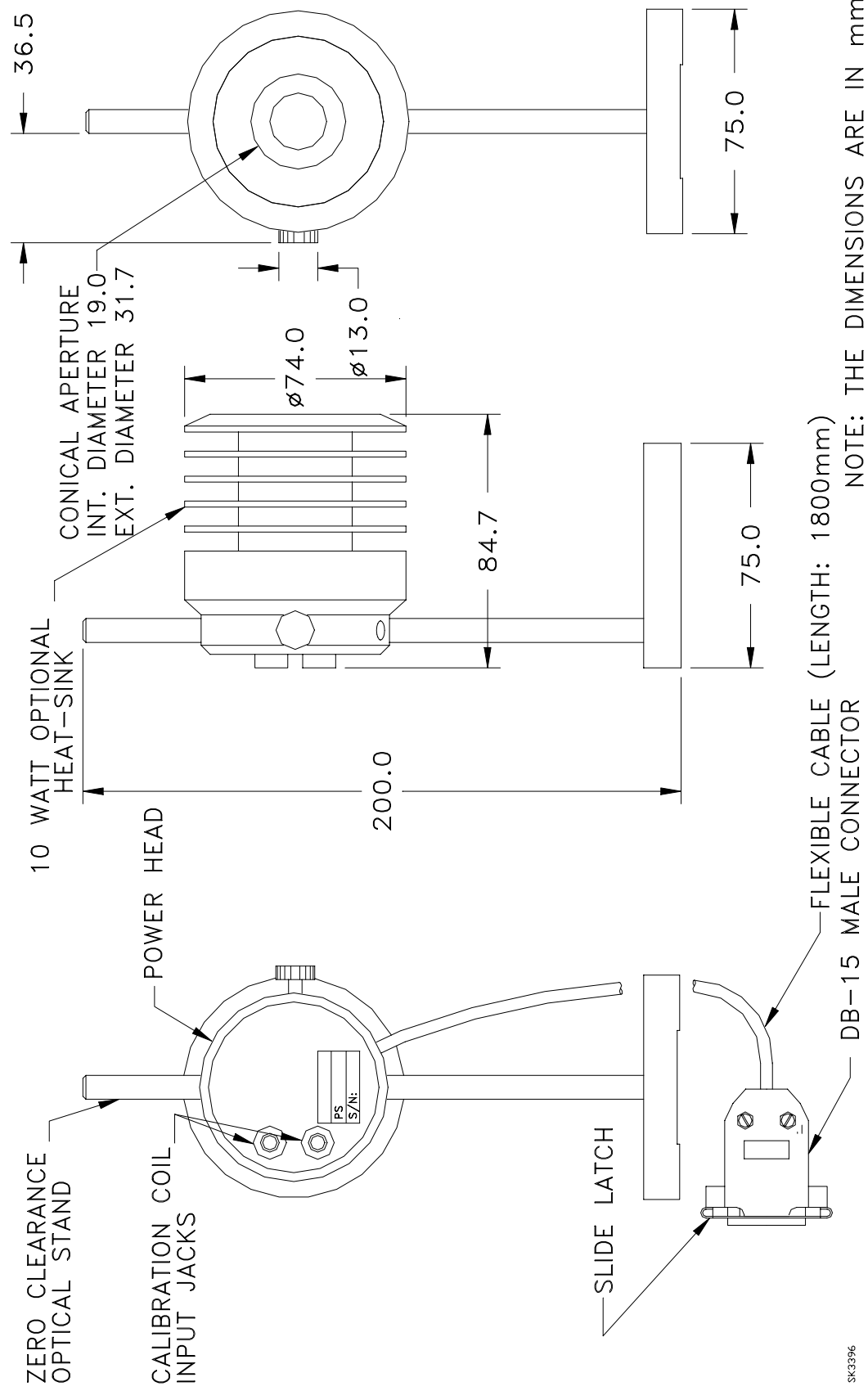


SK3397

NOTE: THE DIMENSIONS ARE IN mm.

310 Series With Heat Sink

Fig. 1-2



SK3396

NOTE: THE DIMENSIONS ARE IN mm.

1.2 POWER DETECTOR CONNECTOR

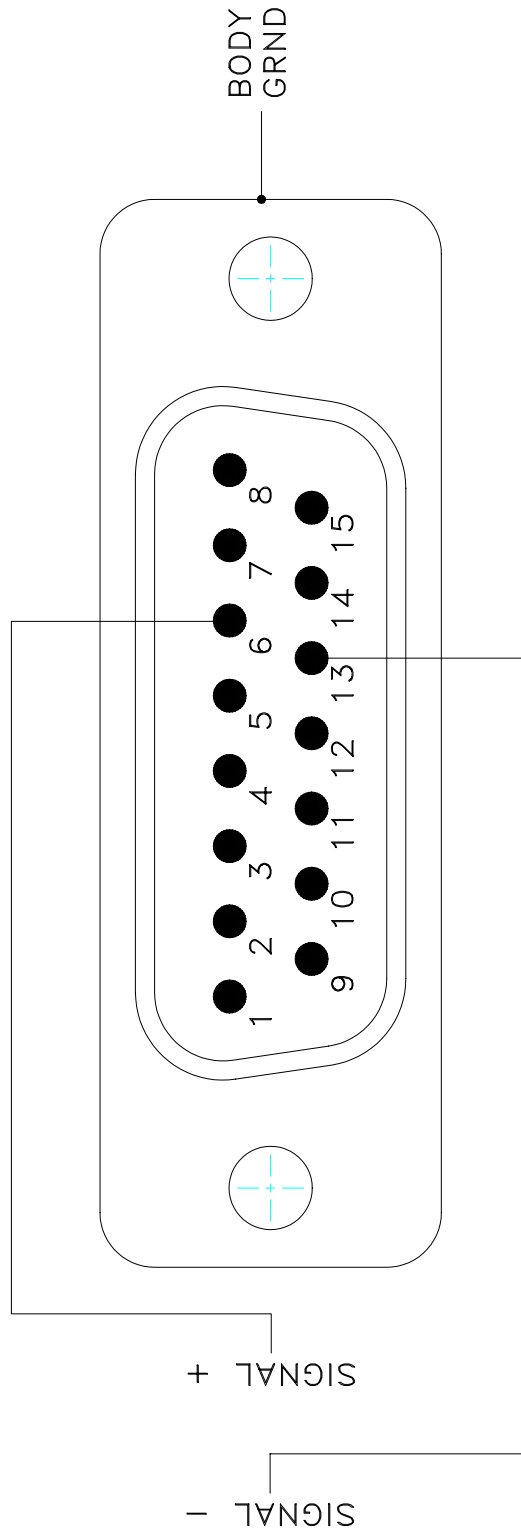
The DB-15 male "intelligent" connector contains an EEPROM (Erasable Electrical Programmable Read-Only Memory) programmed with the calibration sensitivity and other data relating to the specific PS Series detector head in use.

This connector allows the TPM-300 or DUO monitors to adjust their characteristics automatically to the power sensor being connected. No calibration procedure is required when installing the power heads, thus permitting faster set-ups.

Although the programmed calibration sensitivity cannot be changed by the user, the internal calibration heater permits power sensor verification and enables the detection of output sensitivity changes or sensor damage. Call the nearest GENTEC distributor for a surface absorber re-coating or replacement, a volume absorber replacement and/or a complete head recalibration.

The DB-15 connector pin-out is composed of (see Fig. 1-3):

1-	USED BY TPM-300
2-	" " " "
3-	" " " "
4-	" " " "
5-	" " " "
6-	SIGNAL +
7-	USED BY TPM-300
8-	" " " "
9-	" " " "
10-	" " " "
11-	" " " "
12-	" " " "
13-	SIGNAL -
14-	USED BY TPM-300
15-	" " " "
SHELL	- BODY GRND



PS-310/310WB SPECIFICATIONS

	PS-310		PS-310WB
Sensor Diameter	19 mm		17 mm
Aperture Diameter (with no heat-sink) (with heat-sink) (1)	19 mm 32 mm		19 mm 32 mm
Spectral Range	190 nm to 40 μm		190 nm to 40 μm
Max. Average Power (with no heat-sink) (with heat-sink)	3 Watts Watts	10	3 Watts 10 Watts
Max. Average Power (intermittent: 2 min.)	4.5 Watts Watts	15	4.5 Watts 15 Watts
Max. Average Power Density (cw)	200 W/cm ² (2)		>50 kW/cm ² (8)
Max. Peak Pulse Power Density	2.5 MW/cm ² (3-8)		40 MW/cm ² @ 248 nm (nsec) 10 ³ MW/cm ² @ 1.053 nm (nsec)
Max. Single Pulse Energy Density	0.8 J/cm ² @ 1.064 μm (μsec)		0.75 J/cm ² @ 248 nm (nsec) 10 J/cm ² @ 1.064 μm (μsec)
Min. Detectable Average Power (4)	100 μW		100 μW
Typical Sensitivity (in 200 Ω load)	130 mV/W		108 mV/W
Ambient Temperature sensitivity coefficient: (7) (%/ $^{\circ}\text{C}$)	-0.05		-0.05
Detector Accuracy (5-6-7)	$\pm 2\%$		$\pm 2\%$
Linearity	$\pm 0.5\%$		$\pm 0.5\%$
Beam Size & Position Dependence	$\pm 1\%$		$\pm 1\%$
Dimensions (mm) (with no heat-sink) (with heat-sink)	63 \varnothing x 36 x 84.7	74 \varnothing	63 \varnothing x 36 74 \varnothing x 84.7

(1) Heat-sink has a conical condenser aperture.
 (2) At 10.6 μm .
 (3) With 100 μs pulse width.
 (4) Using proper thermal isolation or isoperibol enclosure.

(5) Optically calibrated @ 1.064 μm
 (6) At the specified calibration power.
 (7) With reference to the specified calibration ambient temperature.
 (8) At 1.06 μm .

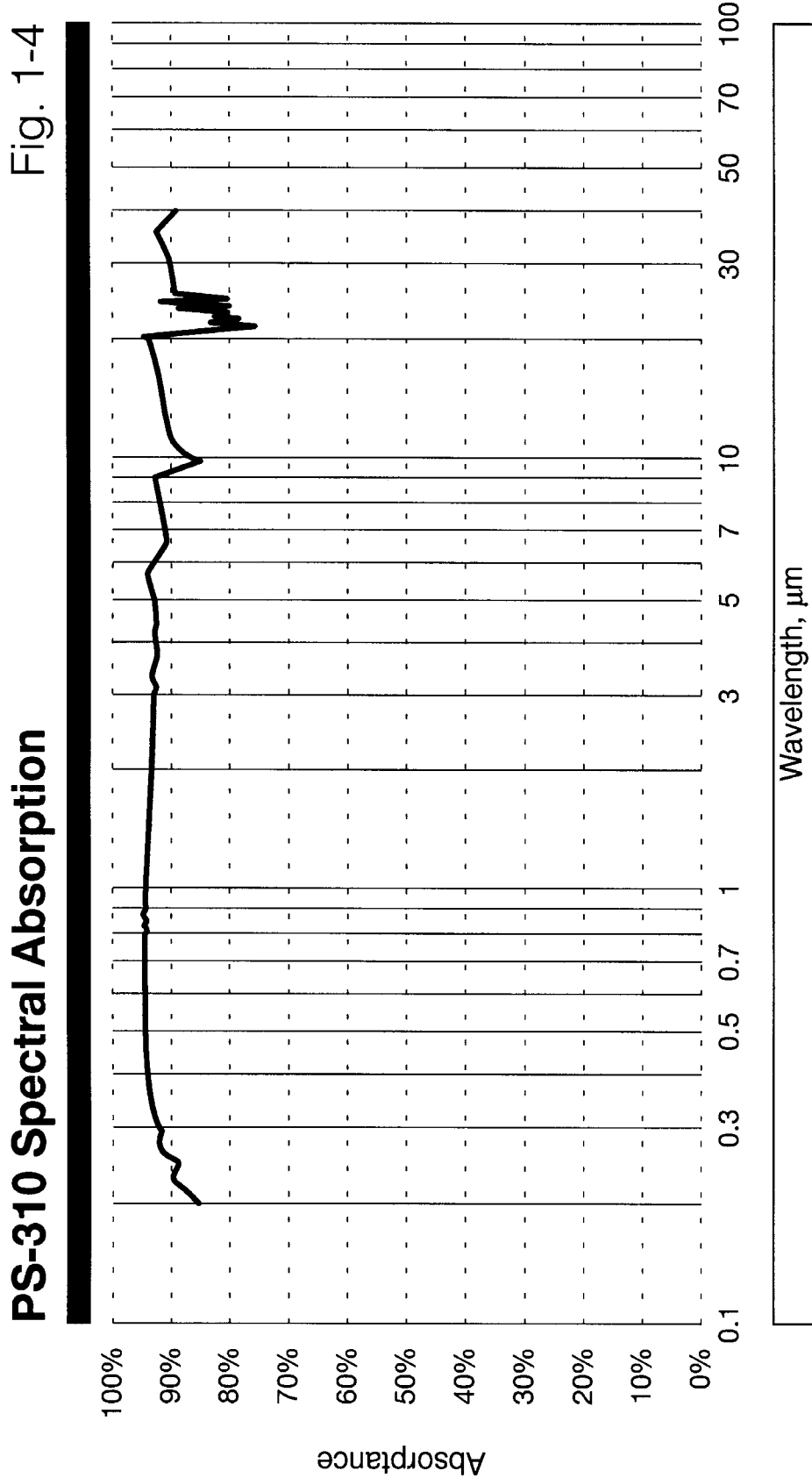
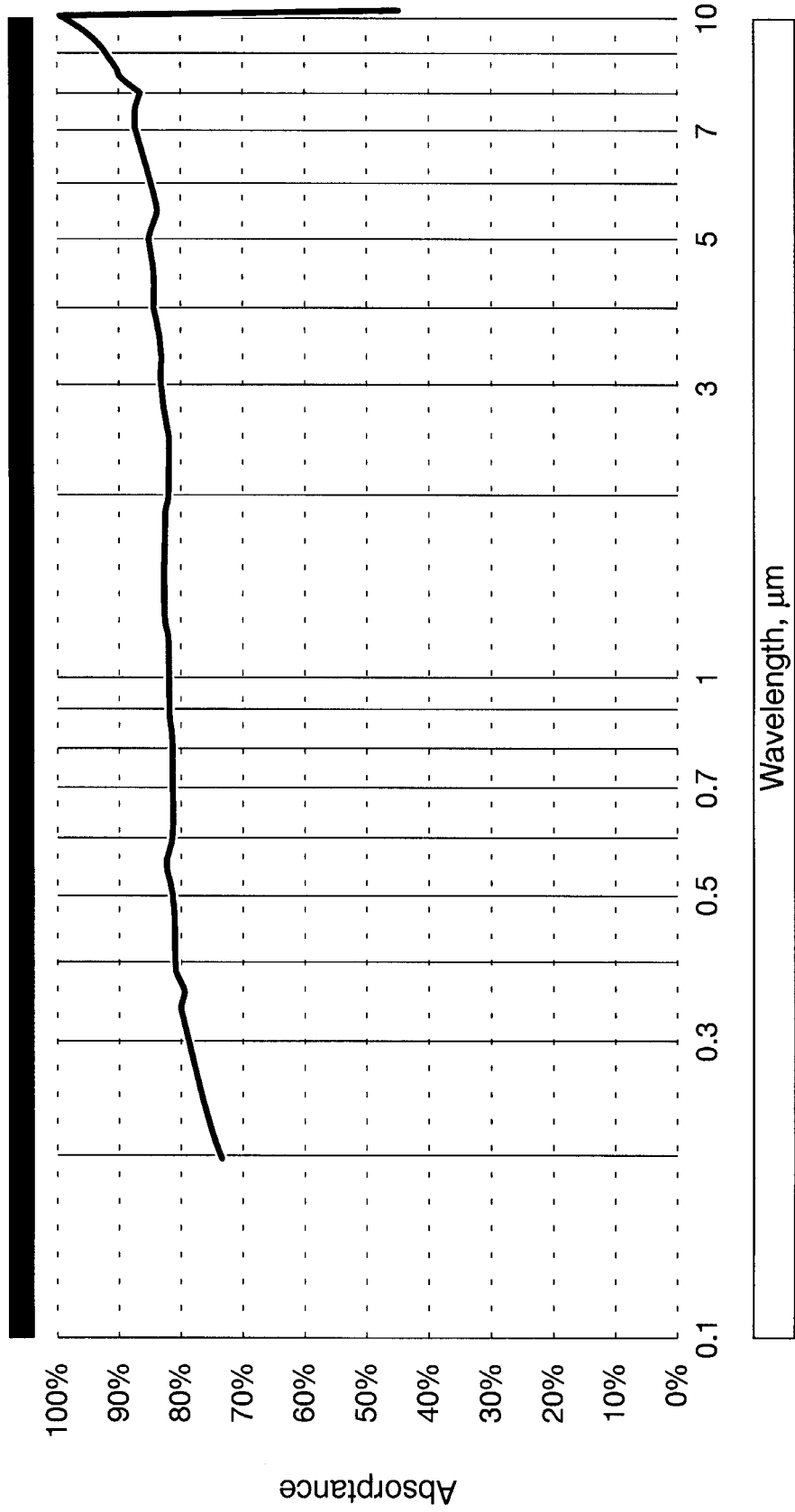


Fig. 1-5

PS-310WB Spectral Absorption

Fig. 1-5



PSV-3101/02/03/04 SPECIFICATIONS

	PSV-3101	PSV-3102	PSV-3103	PSV-3104
Sensor Diameter (mm)	17	17	17	17
Aperture Diameter (mm) with no heat-sink with heat-sink (1)	19 32	19 32	19 32	19 32
Spectral Range	190-250 nm	250-400 nm	.40-1.2 μm	9-11 μm
Max. Average Power (W) with no heat-sink with heat-sink	3 10	3 10	3 10	3 10
Max. Average Power (W) (intermittent: 2 min.)	4.5 15	4.5 15	4.5 15	4.5 15
Max. Average Power Density (W/cm^2)	30	10	30	4
Max. Peak Pulse Power Density (MW/cm^2)	10^2	10^5	10^5	10^2
Max. Single Pulse Power Density (J/cm^2)	0.4@190 nm 1.5@250 nm	1.6@250 nm 1.8@400 nm	2.4@400 nm 4.9@1.2 μm	4.0@10.6 μm
Min. Detectable Average Power (μW) (2)	100	100	100	100
Typical Sensitivity in 200 Ω load (mV/W)	130	130	130	130
Ambient Temperature sensitivity coefficient (%/°C) (5)	- 0.05	- 0.05	- 0.05	- 0.05
Detector Accuracy (%) (3-4-5)	± 2	± 2		± 2
Detector Accuracy (%) (4-5-6)			± 2	
Linearity (%)	± 0.5	± 0.5	± 0.5	± 0.5
Beam Size & Position Dependence (%)	± 1	± 1	± 1	± 1
Dimensions (mm) (with no heat-sink) (with heat-sink)	63 \varnothing x 36 74 \varnothing x 84.7	63 \varnothing x 36 74 \varnothing x 84.7	63 \varnothing x 36 74 \varnothing x 84.7	63 \varnothing x 36 74 \varnothing x 84.7

- (1) Heat-sink has a conical condenser aperture.
(2) Using proper thermal isolation or isoperibol enclosure.
(3) With electrical equivalence power.
(4) At specified calibration power.
(5) With reference to specified calibration ambient temperature.
(6) Optically calibrated @ 1.064 μm

2 OPERATION (without TPM-300 or DUO monitor)

- Warning:**
- 1- A dirty or polluted optical absorber can considerably alter the optical absorption and sensitivity of a wattmeter at different wavelengths. Refer to the "Optical Maintenance" section for further details.
 - 2- Additionally a dirty or polluted optical surface will considerably reduce the damage threshold of the optical absorber. Refer to the "Damage to the Optical Material" section for further details.

2.1 OPERATING INSTRUCTIONS (Power Measurement Procedure)

- 1- Install the power detector head on its optical stand.
- 2- Connect the power head to a high precision micro voltmeter with a $200 \pm 1\%$ Ohms input impedance (a DB-15 connector adapter will be required). Refer to section 1.2 for connector pin-out.
- 3- Remove the power detector cap.
- 4- Put the power head into the laser beam path (laser must be contained within the sensor area).
- 5- Block off laser radiation to the detector.
- 6- Switch on the micro voltmeter and adjust its range to that required for the measurement.

$$\text{Detector output voltage} = \frac{\text{(Expected power)}}{\text{(Calibration sensitivity of power detector)}}$$

- 7- Measure the zero level voltage offset from the detector when the reading has stabilized (once detector head has come to thermal equilibrium with ambient).
- 8- Apply the laser beam to the power head.
- 9- Measure the voltage output from the detector (wait ≈ 1 minute for the reading to stabilize).

10- The measured power is calculated as follows:

$$\begin{aligned}\text{Measured power} &= \frac{(\text{Output voltage} - \text{Zero level voltage})}{(\text{Calibration sensitivity})} \\ &= \frac{(V_{\text{out}} - V_{\text{zero level}})}{\text{Calibration sensitivity (mV/W)}} \\ &= \text{Watts}\end{aligned}$$

NOTE: The PS Series power detectors are opto-thermal sensors and are sensitive to temperature variations. To obtain the best accuracy, the following is recommended:

- Allow detector heads to thermally stabilize before measuring the zero level voltage.
- Do not manipulate the detector head with hands immediately prior to making power measurements or zero level adjustments.
- Avoid forced air flow or drafts around the detector head.
- At power levels <100 mW, an isoperibol enclosure will greatly reduce detector head sensitivity to the thermal environment.

2.2 SAFETY OPERATION NOTE

Diffusive surfaces:

When using the PS-310 WB, be aware of the $\approx 18\%$ diffused back reflection.

As on any diffusive surface, the light on the sensor coating is scattered more or less uniformly as a Lambertian diffuser. It is recommended to use the head with a black protective sleeve, or simply with a standard GENTEC 10 Watt heat sink. This will limit wide-angle diffuse reflections.

Volume absorber surfaces:

When using the PSV type volume absorbers, a specular reflection of $\approx 5\%$ is to be expected and should be controlled where it might cause problems. A simple method of control is to angle the reflection away from the main beam ($<10^\circ$) and dump it upon an appropriate absorber (i.e. flat black paint on a panel or plate).

3 CALIBRATION TEST



3.1 INTRODUCTION

An electrical heater coil is standard on all 310 series power detectors. This coil, bonded to the detection surface, provides the electrical equivalence calibration/test capability. It is therefore possible to electrically verify the calibration factor simply by using a precision DC voltage power supply.

This feature is useful:

To apply a correction factor to the detector calibration if the ambient temperature is different than the one specified on the calibration parameters sheet.

To apply a correction factor to the detector calibration for a spectral region other than the one for which it was calibrated at the factory.

NOTE: The PS-310 surface absorber power detector is optically calibrated @1.064 μ m at the factory. Its incident radiation absorption ratio is known to be 95.5%. This absorption ratio is valid within +/- 1% for the spectral region (400nm to 6 μ m). For other wavelengths, another absorption ratio must be considered and the power reading must be corrected accordingly (see Fig. 1-4).

The PS-310 WB high damage threshold power detector is optically calibrated at the factory. Its incident radiation absorption ratio is known to be \approx 81.5%. This absorption ratio is valid for the spectral region (300nm to 3.5 μ m). For other wavelengths, another absorption ratio must be considered and the power reading must be corrected accordingly (see Fig. 1-5).

The PSV-3101/02/04 volume absorber power detector is electrically calibrated at the factory using an incident radiation absorption ratio of 94%, 94.5% and 96% respectively. This absorption ratio is valid to within 0.5% for the spectral regions stated in the table below. For other wavelengths, another absorption ratio must be considered and the power reading must be corrected accordingly.

The PSV-3103 volume absorber power detector is optically calibrated at the factory. Its incident radiation absorption ratio is known to be 95.2%. This absorption ratio is valid to within 0.5% for the spectral regions stated in the table below. For other wavelengths, another absorption ratio must be considered and the power reading must be corrected accordingly.

	Standard wavelength range	Absorption Ratio
PSV-3101	215 to 250 nm	94%
PSV-3102	280 to 400 nm	94.5%
PSV-3103	350 to 1200 nm	95.2%
PSV-3104	10.6	96%

Table 3.1

3.2 ELECTRICAL CALIBRATION TEST (PROCEDURE A: Fig. 3-1)

- a- Isolate the power head being tested from drafts, stray light and heat sources. Do not totally insulate the power head; it must dissipate its heat by convection.
- b- Connect the power head to the TPM-300 power monitor.
- c- Connect a stable DC voltage power supply to the heater coil using banana jacks.
- d- Determine the required calibration power level (e.g. 1 W).
- e- Set the TPM-300 for power measurement, according to the power level value specified in step d.
- f- Compute the required electrical power level according to the value specified in step d:

$$P_{\text{elect.}} = P \text{ of step d} \times A_r$$

Where A_r is the absorption ratio of the power head:

$$A_r = 0.955 \quad (\text{for PS-310 power heads: } 400 \text{ nm to } 6 \mu\text{m})$$

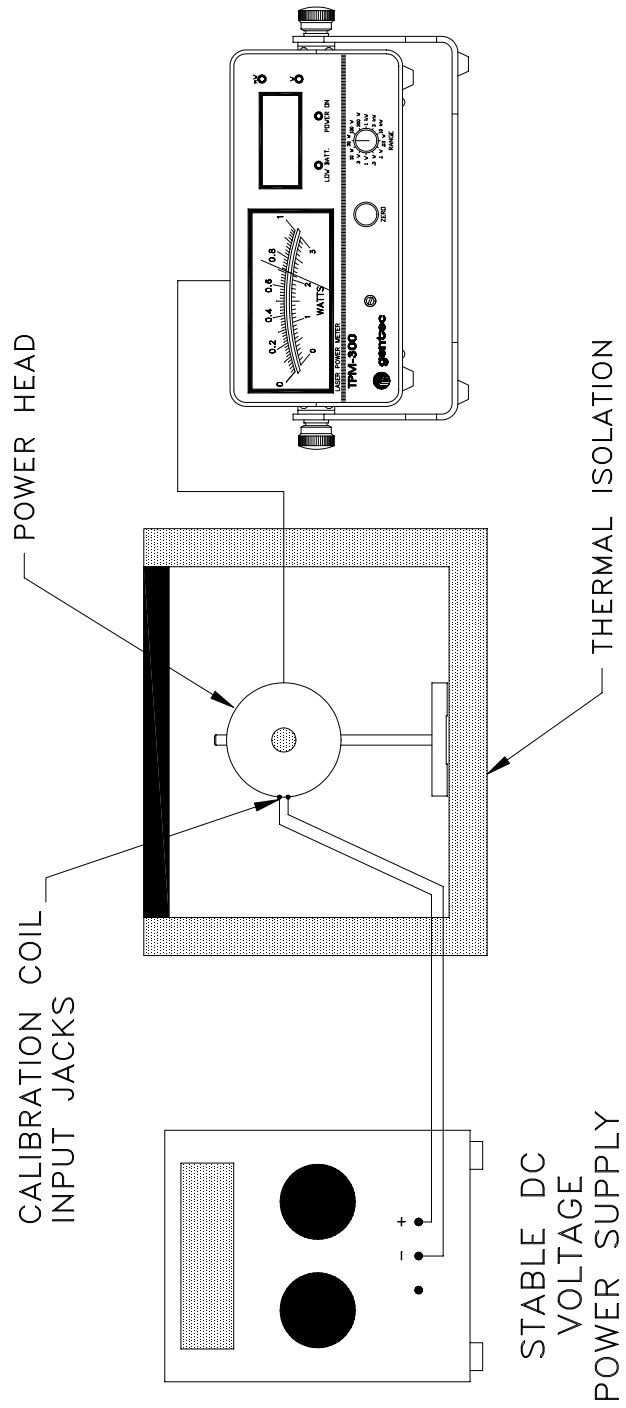
Note: For other wavelengths, refer to Fig. 1-4 in order to determine the corresponding absorption ratio. Refer to the specifications pages and table 3.1 for details relating to the PSV-3101/02/03/04 and PS-310WB.

- g- Using the DC voltage power supply, apply the electrical power, specified in step f, to the heater coil:

$$V_{\text{applied}} = (P_{\text{elect.}} \times R_{\text{coil}})^{1/2}$$

- h- Read the TPM-300 applied power. If the reading corresponds to the computed power, both the head and the meter are still in calibration. If not, use PROCEDURE B to test the detector head or contact the local GENTEC representative.

Setup for Electrical Calibration Test Proc. A Fig. 3-1



SK3402

3.3 ELECTRICAL CALIBRATION TEST (PROCEDURE B: Fig. 3-2)

- a- Isolate the power head under recalibration from drafts, stray light and heat sources. Do not totally insulate the power head; it must dissipate its heat by convection.
- b- Connect the power head to a high precision micro voltmeter with a $200 \pm 1\%$ Ohms input impedance. (A DB-15 connector adapter will be required. Refer to section 1.2 for connector pin out).
- c- Connect a stable DC voltage power supply to the heater coil, using banana jacks.
- d- Determine the required calibration power level (e.g. 1 W).
- e- Install a voltmeter and an ammeter.
- f- Compute the required electrical power level according to the value specified in step d.

$$P_{\text{elect.}} = P \text{ of step d} \times A_r$$

Where A_r is the absorption ratio of the power head:

$$A_r = 0.955 \quad (\text{for PS-310 power heads: } 400 \text{ nm to } 6 \mu\text{m})$$

Note: For other wavelengths, refer to Fig. 1-4 in order to determine the corresponding absorption ratio. Refer to the specifications pages and table 3.1 for details relating to the PSV-3101/02/03/04 and PS-310WB.

- g- Using the DC voltage power supply, apply the electrical power, specified in step f, to the heater coil.

$$V_{\text{applied}} = (P_{\text{elect.}} \times R_{\text{coil}})^{1/2}$$

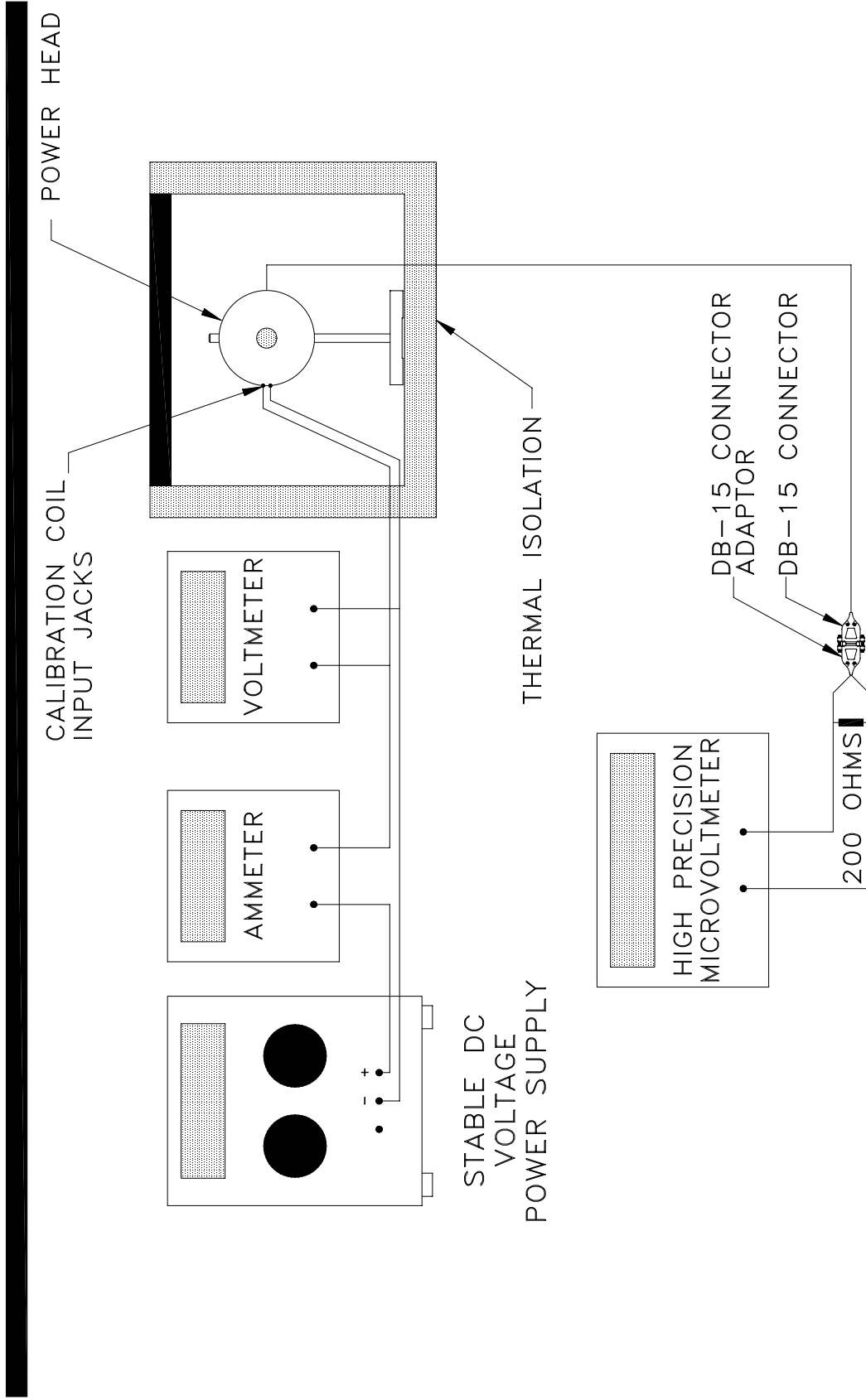
- h- Using the voltmeter and ammeter readings, compute the real power applied to the coil.

$$P_{\text{applied (elect.)}} = V_{\text{measured}} \times I_{\text{measured}}$$

$$P_{\text{applied (optical)}} = P_{\text{applied (elect.)}} \times (1/A_r)$$

- i- Divide the precision micro voltmeter reading by $P_{\text{applied (optical)}}$; the resulting volt/watt value should correspond to the calibration factor stated on the calibration certificate. If the result is significantly different, contact the local GENTEC representative.

Setup for Electrical Calibration Test Proc. B Fig. 3-2



4 DAMAGE TO THE OPTICAL ABSORBER MATERIAL

This damage is usually caused by exceeding the manufacturer's specified maximum incident:

- Average Power Density
- Peak Pulse Power Density
- Single Pulse Energy Density

Refer to the specifications pages for the 310 Series power head specifications. This damage can also be caused when using a detector with a contaminated absorber surface.

For the PS-310 power heads (1), consider the power heads to be out of calibration (2):

- When a visible alteration of the black coating is apparent (depending on the type of alteration observed, the power head will be out of calibration at different wavelengths).
- When you can see the white surface beneath the black coating.

For the PSV-3101/02/03/04 power heads, consider the detector to be out of calibration (2):

- In the presence of optically eroded absorber material from the polished front surface of the detector: this phenomenon is related to high single pulse energy density and high peak pulse power density.
- In the presence of a shattered or molten absorber: this phenomenon is related to high average power density.

For the PS-310WB power head, consider the detector to be out of calibration (2):

- In the presence of several optically eroded absorber materials from the front surface of the detector. This phenomenon is related to high "Single Pulse Energy Density" and high "Peak Pulse Power Density".
- In the presence of a shattered or molten absorber. This phenomenon is related to high "Average Power Density".

(1) For the PS-310 power heads, the use of a "Test Target" is suggested in order to insure that the laser beam will not damage the detector absorber coating (refer to GENTEC distributor).

(2) It is recommended to return a defective power head to the factory for any repair and/or recalibration (refer to the WARRANTY instructions).

5 OPTIONAL ACCESSORIES (310 Series)

310 Series Heat Sink:

For power requirements above 3 Watts, add a 310 heat sink. This accessory increases the maximum applicable power to 10 Watts. Its unique design features a conical condenser aperture, to retain ease of sensor alignment, and a heavy-duty three-turn thread for quick attachment to the power head.

To install the 310 heat-sink on the power head:

- 1- Remove the standard cover by unscrewing it (1). Refer to Fig. 1-1.
- 2- Install the 310 heat sink by screwing it on. Refer to Fig. 1-2.

310 Series Isoperibol Enclosure:

For low power measurements (<100 mW), the use of an isoperibol enclosure is recommended in order to eliminate external thermal interference with the 310 Series detector heads. Refer to the "Isoperibol Enclosure Instruction Manual" for installation and use.

310/330 Series Carrying Case:

For field applications and storage purposes, GENTEC offers a rugged carrying case designed to contain:

- 1 or 2 PS-310 power heads
- 1 optical stand
- GENTEC TPM-300 meter
- 1 PS-330 power head
- 1 310 heat-sink
- 1 wall plug-in power supply

(1) When removing the PS-310 standard cover or the 310 heat sink, caution must be taken in order to prevent damage to the thermopile. NEVER TOUCH THE OPTICAL ABSORBER WITH BARE HANDS.

6 OPTICAL MAINTENANCE

A wattmeter's optical absorber is an optical component.

Consequently, in order to obtain proper performance from it, it must be kept clean and dust free.

Furthermore a polluted absorber will have a much lower, laser fluence, damage threshold and can considerably alter the optical absorption and sensitivity of a wattmeter at different wavelengths.

Dirt or a pollutant baked onto an optical absorber, by the laser fluence, is possibly uncleanable and can cause irreparable damage to the absorber.

The calibration of your device will remain valid as long as the optical absorber is kept clean and dust free and that no visible damage is apparent on the absorber.

WARNING: NEVER TOUCH OPTICAL SURFACES WITH BARE FINGERS.

CLEANING PROCEDURES

Generally:

- Dust can be removed from the optical absorber with a stream of clean dry air.

Specifically for the PS-310:

- Apart from dusting the absorber, once it is dirtied, polluted or damaged, little can be done to clean this surface absorber. The only recourse is to get the detector recoated and recalibrated.

Specifically for the PSV-3101/02/03:

- The optical absorber for these wattmeters is a glass type material.
- Not knowing what type of pollutant has soiled the absorber, it is difficult to give one miracle recipe to effectively clean any pollutant.
- Typically the absorber can be cleaned using a clean optical wipe (having no cleaners or waxes) and "Spectranalyzed" grade (Gas Chromatography grade) acetone. We recommend the use of non-abrasive tissue wipes such as Kimwipes EX-L.
- The optical absorber must be cleaned by swabbing the absorber with an acetone moistened wipe from the center outwards in order not to drag pollutants from the outer edge of the absorber and the heater coil (the thermal paste at the outer edge of the absorber must not be rubbed onto the absorber).

Attention:

- **Never reapply a soiled wipe to the absorber, so as not to re-pollute the absorber with the dirt picked up by the wipe.**
- **Never rub the absorber with a dry wipe, it could scratch the glass absorber.**
- **Do not apply heavy pressure to the wipe when swabbing the absorber otherwise any abrasive pollutant or even the wipe itself could scratch the glass absorber and reduce its damage threshold.**
- **If any other solvent is used for cleaning, it must be compatible with the absorber and materials near the absorber, and must be chosen such that it does not leave any residue on the absorber. Once cleaned with this solvent the absorber must be re-cleaned with acetone.**

Specifically for the PSV-3104:

- The absorber for this wattmeter is a Teflon type material.
- Not knowing what type of pollutant has soiled the absorber, it is difficult to give one miracle recipe to effectively clean any pollutant.
- Typically the absorber can be cleaned using a clean optical wipe (having no cleaners or waxes) and "Spectranalyzed" grade (Gas Chromatography grade) acetone. We recommend the use of non-abrasive tissue wipes such as Kimwipes EX-L.
- The optical absorber must be cleaned by swabbing the absorber with an acetone-moistened wipe from the center outwards in order not to drag pollutants from the outer edge of the absorber and the heater coil.

Attention:

- **Never reapply a soiled wipe to the absorber, so as not to re-pollute the absorber with the dirt picked up by the wipe.**
- **Never rub the absorber with a dry wipe; it could scratch the absorber.**
- **Do not apply heavy pressure to the wipe when swabbing the absorber otherwise any abrasive pollutant or even the wipe itself could scratch the absorber and reduce its damage threshold.**
- **If any other solvent is used for cleaning, it must be compatible with the absorber and materials near the absorber, and must be chosen such that it does not leave any residue on the absorber. Once cleaned with this solvent the absorber must be re-cleaned with acetone.**

Specifically for the PS-310WB:

- The absorber for this wattmeter is a hard ceramic type material.
- Not knowing what type of pollutant has soiled the absorber, it is difficult to give one miracle recipe to effectively clean any pollutant.
- Typically the absorber can be cleaned using a clean optical wipe (having no cleaners or waxes) and "Spectranalyzed" grade (Gas Chromatography grade) acetone. We recommend the use of non-abrasive tissue wipes such as Kimwipes EX-L.
- The optical absorber must be cleaned by swabbing the absorber with an acetone-moistened wipe from the center outwards in order not to drag pollutants from the outer edge of the absorber and the heater coil.

Attention:

- **Never reapply a soiled wipe to the absorber, so as not to re-pollute the absorber with the dirt picked up by the wipe.**
- **If any other solvent is used for cleaning, it must be compatible with the absorber and materials near the absorber, and must be chosen such that it does not leave any residue on the absorber. Once cleaned with this solvent the absorber must be re-cleaned with acetone**



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