

# Smart QuadSensors™

Beampositioning with Laserpad, FieldMaster, FieldMaster-GS™ and Ultima LabMaster™

Catalog Number	Name	Power			Aperture (mm)	Notes	Spectral Range (µm)	Accuracy (± %)	For Single Shot Use with Ultima and FieldMaster-GS			Sensor Coating (note m)
		Max (W)	Min (W) (note f)	Resolution (W)					Max Pulse Length (s)	Max Joules	Min Joules	

## Standard Thermal Sensors: 6000 W/cm<sup>2</sup> maximum CW power density

33-7832	LM-200XL HTD	200	1.0	0.1	55	c	0.25-10.6	4	0.34	95	0.50	HTD
33-7857	LM-200 HTD	200	0.2, 0.1	0.01	19	k	0.25-10.6	5	0.12	10	0.07	HTD
33-7840	LM-200 HTD	200	0.2, 0.1	0.01	19	t	0.25-10.6	5	0.12	10	0.07	HTD
33-7865	LM-200B HTD	200	0.2, 0.1	0.01	19	c, w	0.25-10.6	5	0.12	10	0.1	HTD
33-7873	LM-150 FS HTD	150	0.1	0.01	19	r	0.25-10.6	5	0.12	10	0.07	HTD
33-7881	LM-100XL HTD	100	1.0	0.1	40		0.25-10.6	4	0.34	50	0.50	HTD
33-7899	LM-100 HTD	100	0.1	0.01	19		0.25-10.6	2	0.12	10	0.07	HTD
33-0472	LM-100B HTD	100	0.1	0.01	38	c, w	0.25-10.6	4	0.34	50	0.1	HTD
33-7915	LM-45 HTD	45	0.1	0.01	19		0.25-10.6	2	0.12	10	0.07	HTD
33-7923	LM-10 HTD	10	0.01	0.001	16		0.25-10.6	2	0.11	10	0.05	HTD
33-7931	LM-3 HTD	3	0.01	0.001	19		0.25-10.6	2	0.11	10	0.05	HTD

## High Power Thermal Sensors: 2500 W/cm<sup>2</sup> maximum CW power density

33-1132	LM-5000	5000	300	1.0	55	a, e, g	0.25-10.6	5	0.34	95	1.0	H
33-1124	LM-2500	2500	150	1.0	55	a, e, g	0.25-10.6	5	0.34	95	1.0	H
33-1116	LM-1000	1000	2.0, 10	0.1, 1.0	38	b, g	0.25-10.6	5	0.18	45	0.25	H

## Volume Absorbers for High Peak Power: 1 GW/cm<sup>2</sup> at 10 ns maximum peak power density

33-1017	LM-80V	80	0.5, 0.1	0.01	38	h	0.19-6.0	4	0.4	45	0.25	V
33-0993	LM-30V	30	0.1	0.01	19	h	0.19-6.0	3.5	0.17	10	0.07	V

## Excimer Special Coated Sensors: 2000 W/cm<sup>2</sup> maximum power density

33-1108	LM-200XLE	200	1.0	0.1	55	c	0.19-0.35	4	0.24	45	0.50	UV
33-1033	LM-100E	100	0.5, 0.1	0.01	40		0.19-0.35	5	0.34	50	0.25	UV
33-4508	LM-100EB	100	0.5, 0.1	0.01	38	c, w	0.19-0.35	5	0.34	50	0.25	UV

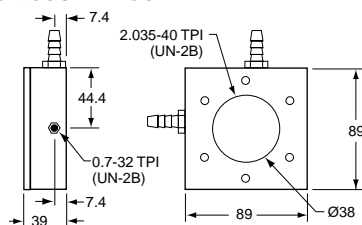
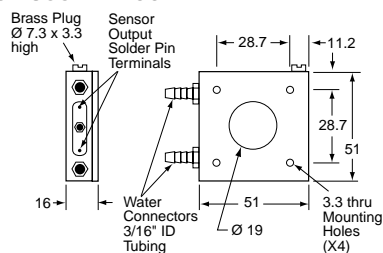
## Special Purpose Sensors: 2500 W/cm<sup>2</sup> maximum CW power density

33-1215	Beam Finder	1000	2.0	0.1	35	b, d, e	0.3-10.6	5	0.6	45	0.25	H
33-7907	LM-20 HTD	20	0.1	0.01	19	p	0.25-10.6	2	0.12	10	0.07	HTD

All SmartSensors are supplied with a 1.8 m (6 ft) cable (unless otherwise noted), stand and NIST traceable Calibration Certificate.

- (a) 7.5 liter/min cooling water required. Maximum temperature deviation 3%/min. Maximum flow deviation 2%/min.
- (b) 4 liter/min cooling water required. Maximum temperature deviation 3%/min. Maximum flow deviation 2%/min.
- (c) 1 liter/min cooling water required. Maximum temperature deviation 3%/min. Maximum flow deviation 2%/min.
- (d) Designed for system integration for measurement of power and position, for use on the Ultima only (supplied with 6 m [20 ft] cable and cooling hoses).
- (e) Supplied with 6 m (20 ft) cable.
- (f) Value to the left is for Ultima LabMaster and FieldMaster-GS, value to the right is for FieldMaster.
- (g) Single shot pulse readings only available on Ultima LabMaster and FieldMaster-GS.
- (h) Damage limit: Pulse 1 GW/cm<sup>2</sup>, measured at 1.06 µm, (10 ns pulse). Varies with wavelength, derate by 50% 0.26-0.35 µm, by 90% below 0.26 µm, Maximum Average Power Density 30 W/cm<sup>2</sup>.
- (k) Must be used with 110 VAC power for internal fan cooling for powers above 50 Watts.
- (m) See coating specifications
- (p) Designed for system integration, must be mounted to a heat sink.
- (r) Intermittent duty (2 min @ 150 W; 5 min @ 100 W; 20 min @ 40 W).
- (t) Must be used with 220 VAC power for internal fan cooling for powers above 50 Watts.
- (w) See sensor drawings at top of next page. These sensors require water cooling to operate at the maximum specified power ratings. They can also be operated using convection and conduction cooling methods.

ISO 9002 Certified

**33-0472 LM100B HTD****33-4508 LM100EB****33-7865 LM-200B HTD**

All dimensions shown in mm unless otherwise indicated.

**Semiconductor SmartSensors**

See pages 20-21 for sensor dimensions.

Catalog Number	Name	Power			Aperture (mm)	Spectral Range (μm)	Accuracy (±%) (note f)	Maximum Power Density (W/cm <sup>2</sup> )	Max Power with Attenuator (W)
		Max (mW)	Min (μW)	Resolution (nW)					
33-0951	LM-2 UV	30	0.01	1.00	6.0	0.25-0.4	8, 5	0.3	NA
33-0936	LM-2 VIS	50	0.01	1.00	7.9	0.4-1.064	5, 3	1.0	5.0
33-0944	LM-2 IR	10	0.5 z	1.00	5.0	0.8-1.55	4.5, 2	0.5	5.0

All SmartSensors are supplied with a 1.8 m (6 ft) cable, stand and NIST traceable Calibration Certificate.

(f) Value to the left is for Ultima LabMaster and FieldMaster-GS, value to the right is for FieldMaster.

(z) 1 μW for FieldMaster.

**Pyroelectric SmartSensors**

See pages 20-21 for sensor dimensions.

Catalog Number	Name	Energy			Power		Aperture (mm)	Spectral Range (μm)	Accuracy (±%)	Notes	Maximum Pulse Width (ms)	Maximum Repetition Rate (Hz)
		Max	Min (note v)	Resolution	Average Power Max	Min						
33-1140	LM-P-209	3 mJ	1.0 μJ	0.1 μJ	2 W	100 μW	9.0	0.19-10.6	5	y	0.10	200
33-1173	LM-P10i	10 J	0.5 mJ	10 μJ	10 W	0.5 mW	43.2	0.19-10.6	5 q	e, x	1.00	50
33-1165	LM-P10	20 J	0.7 mJ	10 μJ	10 W	0.7 mW	50.8	0.19-20	5 q	x	2.30	10
33-1199	LM-P10LP	20 J	0.7 mJ	10 μJ	10 W	0.7 mW	50.8	0.19-20	5 q	x	2.30	10
33-1157	LM-P5	5 J	0.5 mJ	10 μJ	5 W	0.5 mW	25.4	0.19-20	5 q	x	0.60	40
33-1181	LM-P5LP	5 J	0.5 mJ	10 μJ	5 W	0.5 mW	25.4	0.19-20	5 q	x	0.60	40
33-1207	LM-P5HR	5 J	0.5 mJ	10 μJ	5 W	0.5 mW	25.4	0.19-20	5 q	y, #	0.04	400

**High Sensitivity**

33-1140	LM-P-209	3 mJ	1.0 μJ	0.1 μJ	2 W	100 μW	9.0	0.19-10.6	5	y	0.10	200
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**Large Aperture**

33-1173	LM-P10i	10 J	0.5 mJ	10 μJ	10 W	0.5 mW	43.2	0.19-10.6	5 q	e, x	1.00	50
33-1165	LM-P10	20 J	0.7 mJ	10 μJ	10 W	0.7 mW	50.8	0.19-20	5 q	x	2.30	10
33-1199	LM-P10LP	20 J	0.7 mJ	10 μJ	10 W	0.7 mW	50.8	0.19-20	5 q	x	2.30	10

**Standard Aperture**

33-1157	LM-P5	5 J	0.5 mJ	10 μJ	5 W	0.5 mW	25.4	0.19-20	5 q	x	0.60	40
33-1181	LM-P5LP	5 J	0.5 mJ	10 μJ	5 W	0.5 mW	25.4	0.19-20	5 q	x	0.60	40
33-1207	LM-P5HR	5 J	0.5 mJ	10 μJ	5 W	0.5 mW	25.4	0.19-20	5 q	y, #	0.04	400

All Pyroelectric SmartSensors are supplied with a 1.8 m (6 ft) cable, stand, damage test slide and NIST traceable Calibration Certificate.

(q) ±7% from 0.19-0.30 μm.

(v) 10x Amp available, (catalog number 33-0480), please call for details.

(y) For use with the Ultima LabMaster and FieldMaster-GS only.

(#) No test slide supplied.

(e) Max of 1 Joule for FieldMaster.

(x) Max pulse width is 0.3 ms for FieldMaster.

Further information on SmartSensor™ specifications can be found at <http://catalog.CoherentInc.com> or by calling your local Coherent sales representative.

## Sensor Dimensioned Drawings

<p>33-1132 LM-5000 33-1124 LM-2500 33-7832 LM-200XL HTD 33-1108 LM-200XLE</p>	<p>33-1116 LM-1000</p>	<p>33-7857 LM-200 HTD (110 VAC) 33-7840 LM-200 HTD (220 VAC)</p>
<p>33-1033 LM-100E 33-7881 LM-100XL HTD 33-1017* LM-80V</p>	<p>33-7873 LM-150FS HTD 33-0217 LaserMate 150</p>	<p>33-7899 LM-100 HTD 33-0209 LaserMate 100</p>
<p>33-7907 LM-20 HTD 33-0183 LaserMate 20</p>	<p>33-7915* LM-45 HTD 33-0993 LM-30V 33-0191 LaserMate 30</p>	<p>33-1215 Beamfinder</p>

All dimensions in mm unless indicated otherwise.

<p><b>33-7923 LM-10 HTD</b> <b>33-0175 LaserMate 10</b></p>	<p><b>33-7931* LM-3 HTD</b> <b>33-0167 LaserMate 3</b></p>	<p><b>33-0928 LM-1</b> <b>33-7956 LM-1 IR</b> <b>33-0159 LaserMate 1</b></p>
<p><b>33-0951 UV</b>      <b>33-0233</b> <b>33-0936 VIS</b>    <b>33-0241</b> <b>33-0944 IR</b>      <b>33-0258</b></p>	<p><b>33-1140 LM-P-209</b></p>	<p><b>33-1181 LM-P5LP</b></p>
<p><b>33-1165* LM-P10</b> <b>33-1157 LM-P5</b> <b>33-1207 LM-P5HR</b></p>	<p><b>33-1199 LM-P10LP</b></p>	<p><b>33-1173 LM-P10i</b> <b>33-0225 LaserMate P</b></p>

All dimensions in mm unless indicated otherwise.

## Sensor Damage Avoidance and Cooling

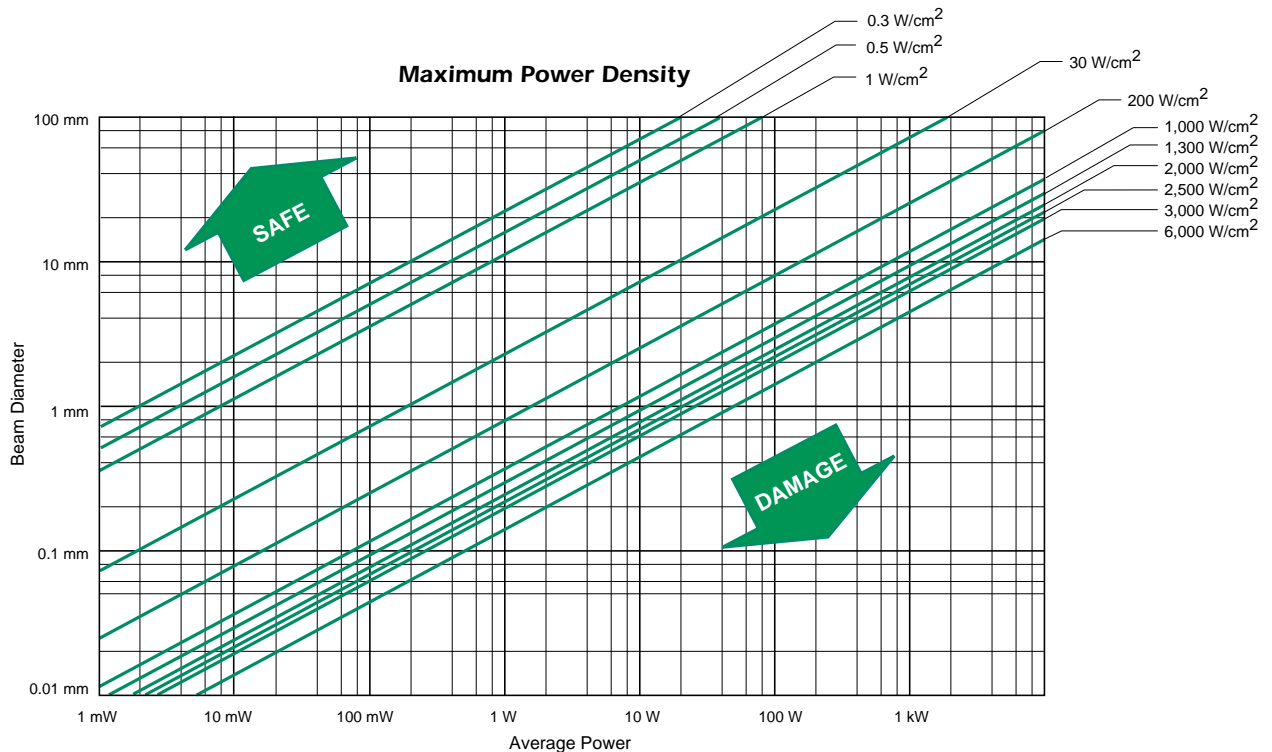
### High Power/Energy Operation and Avoidance of Sensor Damage

The various sensors are each designed to operate over a specified range of powers or energies. It is normally safe to operate up to the maximum value of the specified measurement range, but each sensor type has additional limits, expressed as the

maximum value for the power density (Watts/cm<sup>2</sup>) or energy density (Joules/cm<sup>2</sup>) at the sensor surface. The following details describe these limits for the different sensor types.



LM-10 HTD



Variation of beam diameter and power for average power densities of thermal and semiconductor sensors. Safe operating limit above damage threshold lines.

### Coherent Thermal Sensor Coatings

See page 18 to determine the coating used on a specific sensor.

	HTD	H	UV	P	V
<b>Maximum CW Power Density<sup>a</sup></b>					
Uniform distribution at 10 Watts (W/cm <sup>2</sup> )	6000 <sup>d</sup>	2500	2000	400	30
TEM <sub>00</sub> distribution over 1/e <sup>2</sup> area at 10 Watts (W/cm <sup>2</sup> )	3000 <sup>d</sup>	1300	1000	200	15
<b>Maximum Energy Density</b> (J/cm <sup>2</sup> )	1.75	1.1	0.5	3.3	10
<b>Maximum Peak Power Density (Single Shot)</b>					
1064 nm 20 ns FWHM (MW/cm <sup>2</sup> )	87 <sup>c</sup>	43 <sup>e</sup>	–	–	1000 <sup>a</sup>
<b>Wavelength Range</b> (nm)	200-11,000	200-11,000	200-350	200-20,000	190-6000

(a) Measured with 10 ns FWHM pulse width derate by 50% at 351 and 90% <260 nm.

(b) Measured per ISO 1012 single shot.

(c) 37 MW/cm<sup>2</sup> at 20 Hz.

(d) Derate by 80% at 3500 Watts.

(e) Derate by 45% at 532 nm.

## Thermal Sensors

To avoid damage to the sensor surface keep the average CW power density below the maximum power density limit specified for that sensor. This limit is dependent on the absorptive surface coating used on that sensor. The sensor selection chart on page 18 shows the surface coating type for each thermal sensor and the chart on the bottom of page 22 shows the maximum CW power density limit. Use the appropriate line on the graph on page 22 to translate the power density limit ( $W/cm^2$ ) to a power limit (W) and the beam diameter for your laser. If you might exceed the limit, use a beam splitter or beam expander. If the thermal sensor is to be used for pulsed measurements, then keep the energy in any pulse below the limit shown in the sensor coating chart on page 22 and the peak power density below  $43 MW/cm^2$  (measured with a 20 ns 1.064  $\mu m$  pulse). This peak power density varies with wavelength, derate it by 44% for 532 nm. If the peak power density might exceed this limit, then use one of the Volume Thermal Absorbers (see page 24). Note that the high sensitivity LM-1 thermal sensors (33-0928 and 33-7956) have a

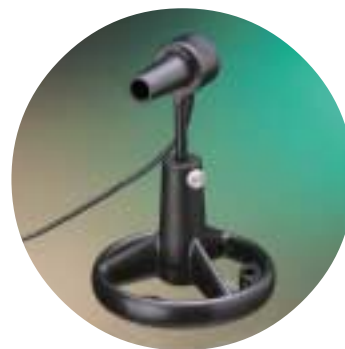
peak energy density rating, not a peak power density rating. This limit is the same as that for the pyroelectric sensors (see graph below).

## Semiconductor Sensors

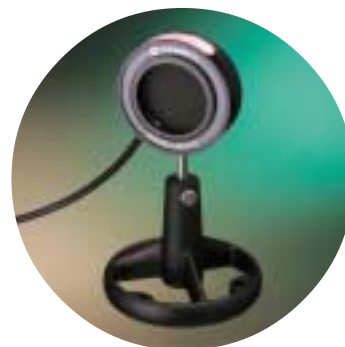
To avoid damage to the sensor surface, keep the CW power density below the maximum power density shown in the semiconductor sensor selection chart on page 19 and on the graph located on page 22. Use the appropriate line on the graph to translate the power density limit ( $W/cm^2$ ) to a power limit (W) for your beam diameter. If you might exceed the limit, use a beam expander, beam splitter or attenuator.

## Pyroelectric Sensors

To avoid damage to these sensors, only operate them with pulsed radiation and keep below the maximum average power limit as shown in the selection chart (on page 19). Also keep the energy density below the limit shown in the graph below. If your energy density might exceed the limit, use an attenuator or beamsplitter, as shown on page 25. A sensor damage test slide is also available (see page 27).



LM-2 UV

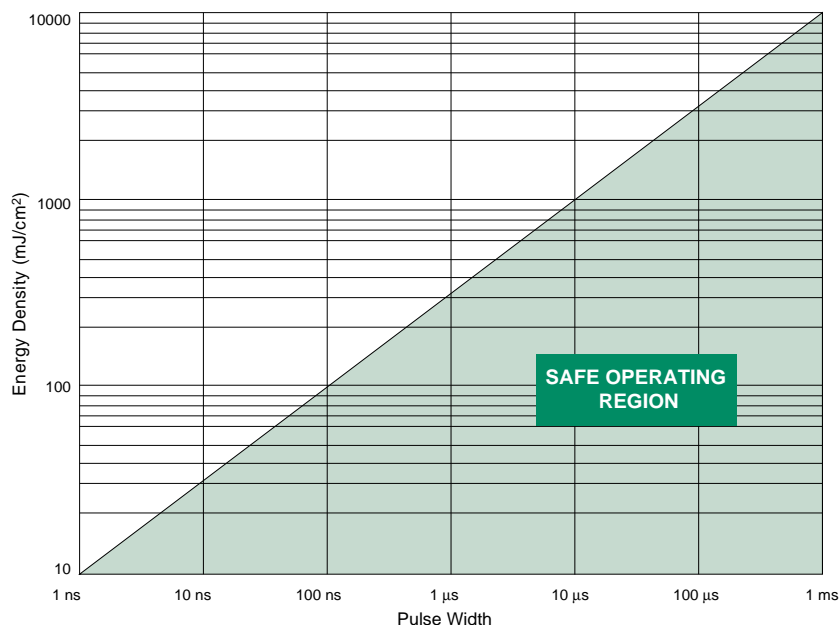


LMP-10i

### Thermal Sensor Glow

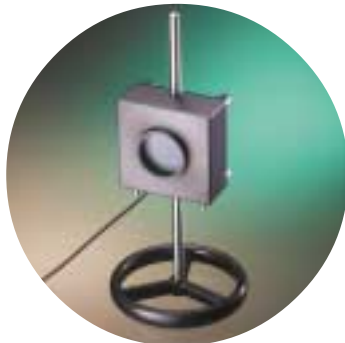
When operated close to their maximum power range, some thermal sensors may glow red hot from the absorbed laser radiation. This is normal, and the point that the sensors will “glow” is dependant on the sensor coating type (see the chart on bottom of page 22). The HTD coated sensors will glow well before they reach the damage threshold and can be operated in the “glowing mode” continuously. The H coated sensors will lightly glow within about 20% of its damage threshold and can be operated this way continuously. The UV and P coated sensors can glow within 5% of their damage thresholds and glowing should be a warning sign that damage is about to occur.

## Energy Density Damage Thresholds for Pyroelectric Sensors





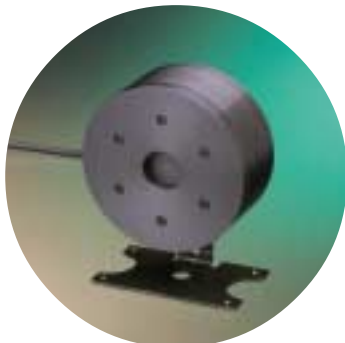
LM-80V



LM-5000



LM-200 HTD



LM-150 FS HTD

### Volume Thermal Absorbers

If the peak power density of your laser exceeds the limit for the standard thermal sensors ( $43 \text{ MW/cm}^2$ ), then the volume absorbers (see selection chart on page 18) may be the solution. These have a few-mm thick disk of absorbing glass attached to the sensor surface and a peak power density rating of  $1 \text{ GW/cm}^2$  (measured with a 10 ns,  $1.064 \mu\text{m}$  pulse). This peak power density limit varies with wavelength, derate it by 50% below  $0.35 \mu\text{m}$  and 90% below  $0.26 \mu\text{m}$ . The sensors are supplied with all three absorbing disks. There is a diffuser kit (33-1249) for the 33-0993 LM-30V SmartSensor™ that will increase the rating to  $10 \text{ GW/cm}^2$  at 1064 nm.

The glass disks can be damaged by irregular and non-circular beams, so the user can replace the glass with the aid of a convenient disk replacement kit.

### Volume Absorber Disk Replacement Kits

Catalog Number	Description
33-1462	Disk Replacement Kit for 33-0993 LM-30V (UV 0.19-0.35 $\mu\text{m}$ )
33-1470	Disk Replacement Kit for 33-0993 LM-30V (VIS 0.35-1.1 $\mu\text{m}$ )
33-1488	Disk Replacement Kit for 33-0993 LM-30V (IR 1.0-6.0 $\mu\text{m}$ )
33-1249	Diffuser Kit for 33-0993 LM-30V
33-1496	Disk Replacement Kit for 33-1017 LM-80V (UV 0.19-0.35 $\mu\text{m}$ )
33-1504	Disk Replacement Kit for 33-1017 LM-80V (VIS 0.35-1.1 $\mu\text{m}$ )
33-1512	Disk Replacement Kit for 33-1017 LM-80V (IR 1.0-6.0 $\mu\text{m}$ )

### Cooling Thermal Sensors

Most of the thermal sensor heads are adequately cooled by naturally convected air for continuous operation, but some of the higher power thermal sensors require water cooling (5 kW LM-5000, 33-1132; 2.5 kW LM-2500, 33-1124; 1 kW LM-1000, 33-1116; and 200 W LM-200XL HTD, 33-7832). See notes on page 18 on water flow requirements for these sensors.

Two thermal sensors (LM-200 HTD) have fan cooling (200 W, 33-7857 for 110 VAC and 200 W, 33-7840 for 220 VAC).

The compact portable limited duration test head 33-7873 LM-150 FS HTD can be used at the full 150 W rating for only ~2 minutes (100 W ~5 minutes, 40 W ~20 minutes). See the chart at right for other durations.

The compact Special Purpose Thermal Sensors 33-1215 (1 kW) and 33-7907 (20 W) have been designed for system integration, the 33-1215 requires water cooling and the 33-7907 must be attached to a heat sink.

**LM-150 FS HTD  
Power vs Duration**

