HMD

hot metal detectors

Specifier's Catalog

98/9900
March 1993

Cast Housing

Quartz Lens Housing

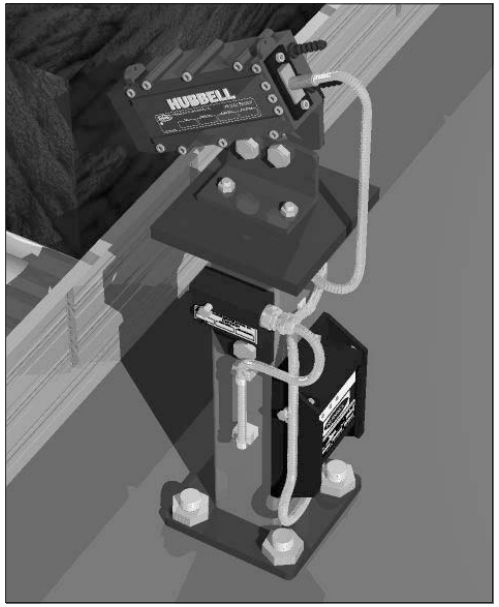
Remote Tubular Lens with Optical Lead

Controller Module in Mounting Cradle

HUBBELL

Applications

- **Trip levels as low as 575°F**
- **Excellent steam penetration**
- **Sensing ranges in excess of 70 feet**
- **Wide variety of interchangeable lenses**
- **Remote lenses and optic leads for 350°F or 750°F ambients.**
- **Optional analog output to facilitate alignment and maintenance**
- **Efficient cooling and purge options**
- **AC & DC detectors with single or dual switching outputs**
- **Protected against continuous short circuit**
- **Optional internal testing circuit**



Hubbell's Hot Metal Detectors (HMD) sense the infrared radiation emitted from hot products via a lens system onto a photoelectric-diode. This activates a switched output once the infrared radiation exceeds a preset level.

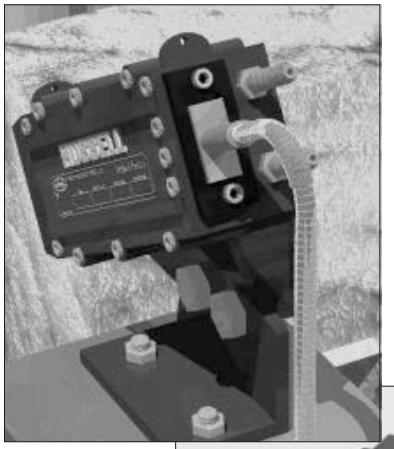
Hubbell's design goals were to develop a modular unit that utilized the latest technology constructed to work in the severest of applications.

Fulfilling these goals led Hubbell to design both a self-contained unit in a cast aluminum housing and a remote controlled unit with separate lens. By utilizing a modular assembly throughout the design process, Hubbell's HMD assemblies offer simplified setup, adjustment and maintenance. Further, this type of approach facilitates the replacement of individual components in the field using standard tools.

By utilizing the latest electronic technologies, they were able to develop a hot metal detector with superior sensitivity in a durable housing. In particular, Hubbell's HMDs are resistant to water, steam, most chemicals, wide variations of ambient temperatures and severe vibrations.

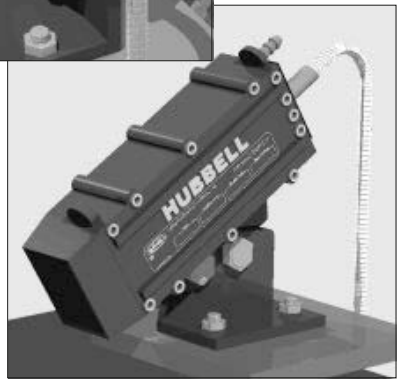
As in many mills, HMDs are a prime input to process controls. Hubbell has introduced an **optional supplementary analog** output (non-linear). This allows the user to identify dirty lenses, and sporadic performance. Also, the analog output and a basic light source can be used to align the detectors without involving a hot product.

Combining these features, well engineered installations, and a complete line of accessories, Hubbell's Hot Metal Detectors are especially suited to give long and trouble free operation in almost any environment.



A note about this catalog...

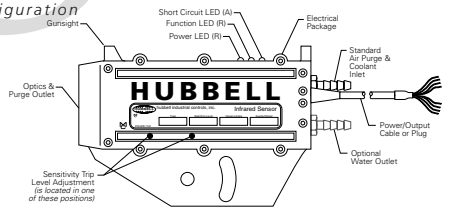
Unlike other catalogs that you might be familiar with, this catalog is designed like a workbook to get you to the correct answer quickly. Each section of the catalog supplies the technical information needed to answer a portion of the **decision tree shown on pages 12 & 13.** Once you have determined the part number from this decision tree, you need only to look it up in the accompanying price list. This approach assures that you will be ordering the correct product every time for your application. So please take a few minutes and read this catalog completely.



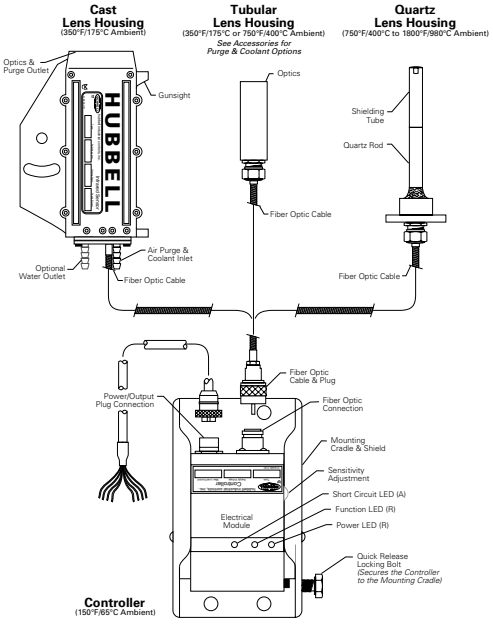
These illustrations show several remote mounted Infrared Hot Metal Detectors in use on a billet mill. The unit mounted on top of the stand is a 0.5° x 10° Cast Lens Housing and it is being used to measure the length of the slabs. A Tubular Lens Housing is mounted on the side of the stand and is measuring the rough heights of the slabs. Notice how the controller is mounted behind the stand to protect it from radiant heat.

Self-Contained vs. Remote

Self-Contained Configuration



Remote Controlled Configuration



Hubbell's Hot Metal Detectors are offered in two different physical configurations — Self-Contained Units and Remote Controlled Units.

The **Self-Contained HMDs** are units constructed around the cast aluminum housing. The lens, electronics and switching circuitry are entirely enclosed in this single housing. This type of housing offers the following features:

- Alignment gunsight
- Simple installation
- No extra optical cables to mount

The **Remote Controlled HMDs**, in contrast, are constructed around a separate housing for the electronics and switching circuitry that is connected to the lens housing via an armored flexible fiber optic cable. Remote lenses and their optical leads can be mounted in areas with high ambient temperatures. This type of setup offers features that could better fit your application:

- Small lens housings for tight installations
- The electronics can be located in an easily accessible area
- The ability to view hot product closely and accurately while placing electronics in well protected area

No matter which configuration you select for your application, Hubbell's HMDs offer adjustable sensitivity that can be used to vary the trip level of each device by ±50°F. This allows Hubbell's HMDs to detect a range of target temperatures from +575°F (+300°C) to +2000°F (+1000°C) or higher.

All of Hubbell's HMDs can be configured with the field of view, electronic switching capability, and infrared set points to meet your application.

Note — LEDs – (A) is a light amber colored LED and (R) is a red colored LED. The Short Circuit LED is light when a short circuit is encountered. The Power LED is light when power is "On" to the HMD. The Function LED is light when the HMD detects an object.

Lens Options

Hubbell's HMD lens come in two formats with various fields of view. First, there are the remote lens which includes a stainless steel tubular housing with various circular field of views, a quartz rod lens with a stainless steel shielded probe and an aluminium cast lens housing with a rectangular field of view. Secondly, this same cast housing is used for the self-contained detector with interchangeable lens modules.

These lens housings were designed with Hubbell's commitment to modular techniques. Their construction allows the user to interchange the lens module, regardless whether it is a self contained or remote format, and obtain the exact lens arrangement to suit each application. Because of these alternatives and the varied field of views, it is possible to accommodate the monitoring of both large and small product at close proximity or at substantial distances. Even hot products that deviate greatly from the center of the conveyor system can be monitored with the correct lens arrangement (i.e. 0.5° x 25°).

A summary of the lens features are shown in the table below. Line drawings of the various housing shapes are shown on the previous page.

The **Remote Tubular Lens Housing** is available in field of views from 1° to 20°. The name clearly describes the construction of the housing — a cylindrical stainless steel tube with a recessed lens. All the components in the housing including the housing itself can be replaced in the field. All tubular housings use the same fiber optic cable in lengths available up to 8 meters. A dimensional illustration of the tubular lens is shown on page 20.

The second housing style, **Remote Quartz Housing**, only available with 1° field of view, is specifically designed to handle high ambient temperatures, ≤1800°F (≤1000°C), with radiant temperatures of ≤2200°F (≤1200°C). It also is very effective in areas of severe contamination. It is only available for remote controlled units. See page 20 for dimensions.

The third housing style, **Cast Housing**, is available in field of views from 1° to 7° plus rectangular field of views of 0.5° x 5°, 0.5° x 10° and 0.5° x 25°. These rectangular fields of view are only available in this housing when used as a self contained unit. The housing dimensions are show on page 20 and are identical for either self-contained or remote controlled units.

	Lens Size								
	1	2	3	4	5	6	7	8	9
Field of View	1°	4°	7°	12°	20°	0.5° x 5°	0.5° x 10°	0.5° x 25°	2°
Scanned Area @ 3 feet	1" (20)	3" (70)	5" (120)	8" (210)	14" (340)	0.5" x 4" (10 x 100)	0.5" x 8" (10 x 200)	0.5" x 20" (10 x 500)	2" (60)
Lens Length	7.48" (190)	4.33" (110)	3.15" (80)	4.33" (110)	3.15" (80)	7.48" (190)	7.48" (190)	7.48" (190)	5.12" (130)
Remote Tub. Housing	✓❖	✓	✓	✓	✓				✓
Remote Cast Housing						✓	✓	✓	
Self-Contained Cast Housing	✓	✓	✓			✓	✓	✓	✓

❖ The Quartz Lens has approximate field of view of 1° and requires a 650°F controller and switches at 850°F (450°C).

Note — All dimensions are in inches with millimeteres in the parentheses unless otherwise noted.

Infrared Considerations

Hubbell's Hot Metal Detectors are precalibrated to switch according to the amount of infrared radiation being emitted from the hot product. The point of switching is dependent upon the following factors:

- The type and texture of the target material being viewed
- The amount of hot product within the scanned viewing area
- Cold black spots and background infrared radiation
- Obstructions in the scanned viewing area (steam, water, etc.)

In this section, we will cover these points and their affect.

Target Properties

Hubbell's HMDs receive infrared energy that is produced by many hot products. Infrared radiation is produced as a material is heated. As the target becomes hotter, the spectrum of this infrared radiation widens and the level of infrared radiation increases until it begins to include portions of the visible light spectrum. This is why metals begin to glow red as they are heated.

Every material emits different levels and quantities of infrared radiation. Also, the amount of radiation emitted is related to the surface condition of the material. As the material becomes more oxidized, the infrared radiation levels increase; meaning, a highly smooth, clean surface will emit less radiation.

To demonstrate these concepts, both independently and together, we've included several charts on page 21. The first table shows emissivity factors for different materials. The emissivity of a given material is the measurement of its energy radiating efficiency. Though emissivity is not used to set Hubbell's HMD detection or trip levels, they do give the layman a reference point for which materials will emit the most infrared radiation. The second table shows how the emissivity for steel increases as the surface becomes more oxidized.

Field of View & IR

With a specific lens arrangement, the area being scanned increases as the distance increases between the detector and the target. Equally, the intensity and proportion of the infrared radiation relative to the field of view decreases as the distance increases.

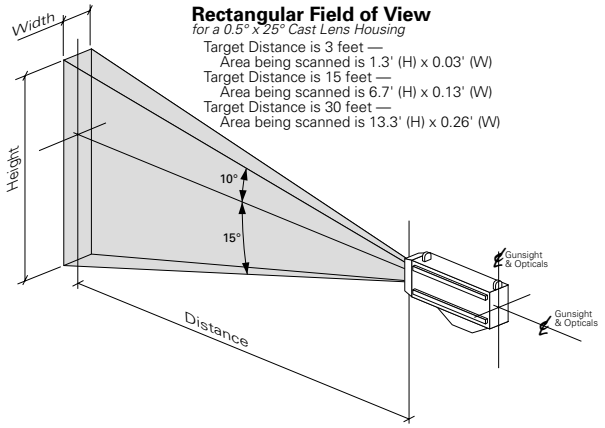
Considering these factors, optimum performance is normally obtained by mounting the HMD as close to the target as practical and selecting a lens that allows the target to fill a 100% of its field of view. Theoretically, at a scanning distance of 30 feet a 7° field of view will require a target to be nearly four feet in diameter.

A detector set a little over 10 feet directly above the target using a 0.5° x 25° field of view will scan an area that is only 1" wide by 55" tall. This type of field of view gives a very complete coverage of a conveyor system that might not have the target moving down the center of it. This narrow scanning path offers the accuracy needed to gauge lengths of steel products.

It is important to note that the trip levels stated for the HMDs are based on the targets filling 100% of that view. Targets can be smaller than the field of view (down to 0.5% of FOV) and still be sensed accurately. This is done by selecting a detector with a much lower trip level than the hot product's actual temperature.

It is normal practice, regardless of the size of the target, to select a HMD with a trip level 200°F to 400°F lower than the actual temperature of the target.

The graphs right and below show the relationship between distance and field of view for both spot and rectangular FOVs.



This illustration shows the relationship between distance of the object and the field of view for a 0.5° x 25° lens.

Cold Spots, Background Infrared Radiation and Obstructed View

Three common problems with infrared detection are caused by cold spots on the target, background IR and obstructed view.

Cold spots occur on the target through localized cooling due to water collection. This especially happens along the edges of the target. These cold spots can cause intermittent switching of the detector. This problem is most prominent in rod and wire mills where the target size can be extremely small (<0.25"ø) and several drops of water would substantially cool the entire diameter.

The solution for this type of problem is found in two formats. First, you could install two HMDs in tandem scanning areas that are only several inches apart. When both units give the same "off" signal then the target is accepted as being no longer in front of the detectors. The second solution is to use a 575°F controller to scan a 1100°F target with only a small portion of the field of view filled with the target. With this type of arrangement, a small cold spot will not affect the detector's logic. Hubbell's HMDs are unique in offering very high sensitivity to overcome this problem.

The second problem, **background infrared radiation (IR)**, is caused by a wide variety of sources. The additional IR can come from infrared energy bouncing off the sides of the conveyor system, hot equipment in the background, and even sunshine directly hitting the detector. This type of problem is difficult to predict and is substantially minimized by filters within Hubbell's HMDs.

Usually, the solution to this problem comes from several sources. First, you can control the field of view of the HMD so that the background source is not seen by the detector. Secondly, you can reposition the detector so that it cannot see the source of the IR. Lastly, if the IR comes from an independent line or light source, you can shield the HMD with a simple barrier.

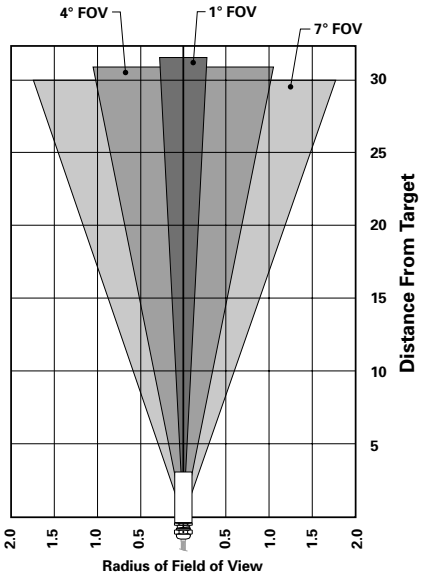
The third problem, **obstructed view**, again comes from a wide variety of sources. The sides of the conveyor system can obstruct the view, and so can water or steam. Steam, in particular, can either absorb the IR, greatly reducing the signal, or reflect the IR, increasing the signal.

The solution to this problem requires only common sense. Remember, you are reading and measuring an energy source. The detector needs a clear path to the target. If the sides of the conveyor system are tall, the detector will need to be mounted higher. As well, if the conveyor system uses an open roller bed, you can mount the detector beneath the roller bed and look up through it. If you have a high steam concentration, the air purge on the lens housing can be increased to clear a pathway. In all cases, mounting the lens as close to the target as possible will clearly minimize this problem. This is the advantage of the remote lens housings.

Fiber Optic Cable Lengths

A final note on fiber optic cables. They are sheathed in a flexible stainless steel jacket. Hubbell can supply the specific length of fiber optic cable you need for your installation. However with especially long cables, you need to consider the light/energy loss in the optical cable. For each additional meter of fiber optic cable over a total 3 meter length, the effective trip level of the utilized controller will be reduced 85°F (30°C).

Circular Field of View



All Dimensions in Feet

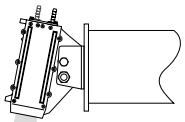
This illustration shows the relationship between distance of the object and the field of view of various size lenses.

Mounting Considerations

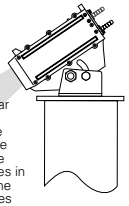
To help consolidate the information presented on the previous pages, we have developed several illustrations. The illustration below shows three typical positions for HMDs. At each position, advantages and special considerations that must be recognized are identified.

The illustration to the right is "problem – solution" orientated. Utilizing Hubbell's experience with HMDs, the most common problems encountered with HMDs during installation were compiled with their solutions.

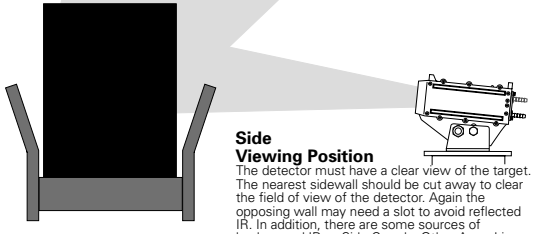
These illustrations encompass a large majority of the installations usually encountered. The suggestions given by them apply to all lens housings and will help you to select the correct field of view and position for Hubbell's HMDs. If you need special help with any installation, Hubbell has application engineers to assist you.



Above Viewing Position
The detector is getting a clear view of the target. The only possible sources of background IR could be the roller bed itself or reflected IR from the floor pan area. With this in mind, the HMDs are normally mounted to the ouput side of a roller or alternatively a slot is cut in the floor pan greater than the field of view of the detector. In this position, cooling of the detector will need careful consideration and must be mounted well above the product.

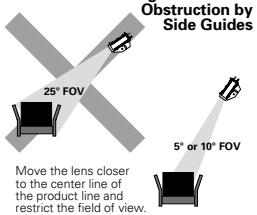


Angled Viewing Position
The detector does have a clear view of the target. However, careful consideration must be made of background IR. Some sources for background IR are Side Guards, Other Assy. Lines in the background, as well as, the floor pan. This position reduces the heat radiating on the detector.



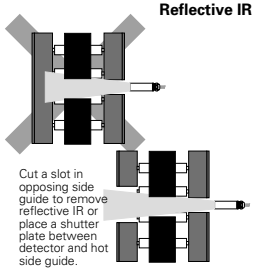
Side Viewing Position
The detector must have a clear view of the target. The nearest sidewall should be cut away to clear the field of view of the detector. Again the opposing wall may need a slot to avoid reflected IR. In addition, there are some sources of background IR — Side Guards, Other Assy. Lines in the background, etc. However, this position gives excellent shielding from radiating heat.

Background IR and Obstruction by Side Guides



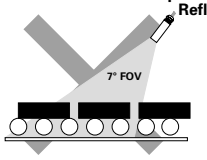
Move the lens closer to the center line of the product line and restrict the field of view.

Reflective IR

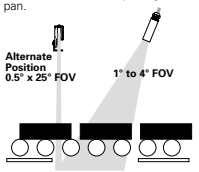


Cut a slot in opposing side guide to remove reflective IR or place a shutter plate between detector and hot side guide.

Multiple Targets & Reflective IR



Move detector above product line and restrict field of view to limit viewing of multiple targets. As an alternative, you can position the detector 90° to product line and take advantage of 0.5° FOV. To remove reflective IR, cut an opening in floor pan.



Cooling & Purge Options

Obviously where high ambient temperatures are present, remote lenses should be considered. This removes the necessity to provide water cooling which is costly to install and maintain.

However, often self-contained or even remote lenses are installed in areas with ambient temperatures above the allowed limits. Hubbell's Hot Metal Detectors and Remote Lens Housings can be supplied with cooling and purge options to protect them from radiant and ambient heat, as well as contamination.

All of Hubbell's HMDs can be equipped with air purge/cooling systems or water cooling systems. These cooling and purge systems allow the detector and lens to be installed in areas having extreme ambient temperatures. Left are illustrations showing some of the cooling schemes that are available.

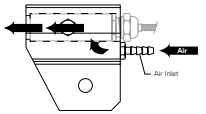
When air is used as the coolant on the cast housings, the user has the option to order the detector with the cooling air being recirculated or alternatively vented through the front as a lens purge. Air cooling typically will offer a +70°F to +85°F of cooling. An air flow of 1 ft^3/min to 2 ft^3/min at 10 psi should be used. For severe conditions, 5 ft^3/min at 15 psi can be used.

Water cooling of the cast housings is accomplished by a built-in closed loop radiator cooling chamber. When utilizing water cooling, the water pressure should be no more than 10 psi with a flow of 0.5 gpm (minimum flow of 0.2 gpm). The cooling capabilities of water can be calculated with the equations shown below.

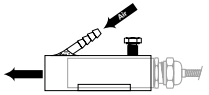
In severe conditions, an air purge nozzle is added to the cast housing in front of the lens glass to help direct the purge and prevent impurities from contaminating the lens. This purge nozzle can also be added to purely enhance the purge pressure and further protect the lens.

The air and water cooling connections are $^5/_{16}$"ø ID tubing connectors which allows for easy installations. The remote tubular lenses are mounted as modules in the purge/cooling chamber allowing quick removal.

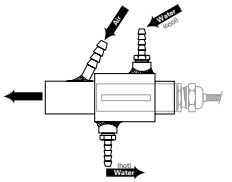
The recommended tubing to be used with this type of connector is either $^5/_{16}$"ø ID Tygon® Black Fluran tubing or $^1/_4$"ø NPT (M) Teflon® PFA pipe. Both are available in a variety of lengths, and can be fitted with readily available fittings and valves. In general, both of these types of tubing have a working range of -40°F (-40°C) to +400°F (+200°C), a working pressures of 125 psi and conform to many federal specifications.



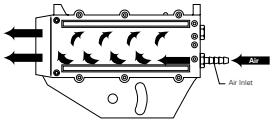
Air Purged/Cooled Standard Tubular Lens Mounting Block



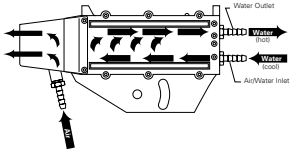
Air Purged Tubular Lens Mounting Bracket



Air Purged/Water Cooled Tubular Lens Mounting Bracket



Illustrated above is the cooling paths for combined air purge/cooling arrangement for self-contained and remote housings.



Illustrated above is the cooling paths for water cooling with separate air purge for the lens on the self-contained and remote lens. Note the nozzle on the left end is added for severe conditions.

Water Cooling Capacity Equations

For Cast Housing

$$\text{Cooled Sensor Temperature} = \frac{(\text{Sensor Ambient} + (2 \times \text{Water Inlet Temperature}))}{2}$$

Note — Only the back panel is cooled and radiant heat should be shielded from the front panel.

For Tubular Housing

$$\text{Cooled Sensor Temperature} = \frac{(\text{Sensor Ambient} + (2 \times \text{Water Inlet Temperature}))}{3}$$

Lens & Switching Level Guidance

Unlike pyrometers and proximity sensors, the process of selecting the proper lens and switching level for HMDs is not as specific, though in most cases it is fairly straightforward. Many different working combinations are possible. In this section, we'll give you guidance on which lens/switching level combinations should be used in various installations and why.

Important Note — All of the following discussions are based on several key facts. First, the target material is steel. If your material is something other than steel you can use the emissivity table on page 21 to determine the difference in the infrared energy. Emissivity is a linear variable; meaning that if your material has an emissivity 10% lower than steel, you will need to select a controller temperature that is 10% lower. Second, remember that you need to reduce the controller temperature by 85°F (30°C) for every meter of fiber optic cable over 3 meters in length.

Which Lens To Use

If the sole purpose of the installation is the general tracking of hot product that is traveling down the center of the conveyor system, a 7° spot lens is normally adequate. The 4° spot lens, on the other hand, is used for similar installations that require a restricted field of view due to background IR, etc. The 1° or 2° spot lens is normally used in installations where the lens is going to be set a substantial distance from the target. Both the 12° and 20° spot lens are used in installations that require a large field of view along both axes. An example of this would be on the cooling bed of a plate mill or a long length of rod with cold spots that oscillates about the center of the conveyor system.

The 0.5° x 25° lens (which can be shuttered to 5° or 10°) is used for the following applications:

- To give accurate length measurements
- To view a narrow target oscillating about the center of the conveyor system
- To restrict viewing on one axis
- To detect the whole width of the target
- To detect the leading edge of a wide target regardless of its profile
- Speed measurement of small displacements in time

The 1° quartz lens rod is specifically designed for high temperature installations where the lens module is located very close to the hot target. Remember, it has only a 1° circular field of view and will not scan a large area even at several meters.

Detector Trip Level

When selecting the detector trip level, you should select a trip level lower than the target temperature. For example, when detecting hot strip-billet at 1100°F to 1500°F, you should use a controller trip level temperature of 950°. If the target was above 1650°F, then a 1100° trip level should be considered.

This approach to selecting trip levels introduces a safety margin for those instances when there is steam or localized cold spots in the field of view. **A word of caution — by using this approach, it is important to take in consideration background and reflective IR in your installation.**

Partial Field of View

In many instances the target will not completely fill the field of view of the lens. This resulting partial field of view limits the amount of infrared energy received and will require you to select a lower temperature controller. Using a partial field of view and a low temperature controller, you can achieve highly sensitive and accurate installations.

Hubbell has included several tables and graphs that are used to determine which controllers work best. These tables and charts are meant as guidelines only.

Tables 1 & 2 are used with 0.5° x 25° lenses. Table 1 shows approximate controller temperatures needed based on the type of product and its temperature. This table supplies a very broad overview of various applications. For example, billet at 1300°F can be detected with a 750° controller.

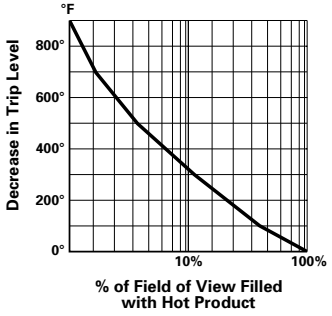
Table 2 shows the minimum vertical field of view necessary for various target and controller temperature combinations. For example, a target at 950°F can be detected when only 1% of the vertical field of view is filled using a 650° controller. If you are using a shuttered lens, calculate your vertical field of view using 25°.

Graphs 1 and 2 are used with the spot lenses. Graph 1 shows the temperature reduction necessary in selecting a controller for a partial field of view. For example, our target is 1300°F and the target will fill the field of view of the spot lens only 10%. Graph 1 shows we will need to select a controller temperature 300°F lower than the target or use a 950° controller.

Graph 2 shows the minimum field of view necessary based on the difference between the controller trip level and the product temperature. For example, we've decided to use a 650° controller and our target is 1100°F. Our target is 450° hotter than the controller. From the graph, we see that we need only a minimum of 1% of the field of view to get proper detection.

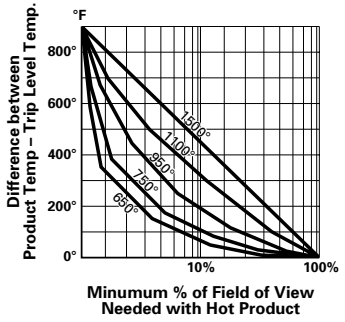
Graph 1 – Effective Trip Level vs. Field of View

for use with spot lenses



Graph 2 – Temperature Delta vs. Minimum Field of View

for use with spot lenses



Graph 3 – Adjustment Range of Controllers

The graph right shows the nominal set points of controllers (triangle) and the range of adjustment that is available for each controller via the sensitivity adjustment (dark gray bars). The light gray bars show the detection range for each controller. These are only approximates.

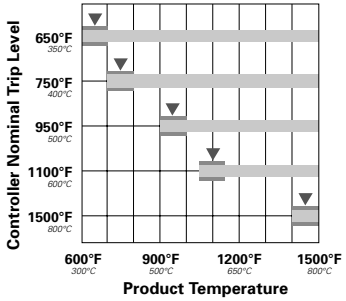


Table 1 – Detector/Controller Selection by Product Type

for use with 0.5° x 25° lenses

Type of Mill	Product Temperature Range: Below 950°F	1100°F – 1500°F	Above 1500°F❖
Rod/Wire	650°F	650°F	750°F
Bar/Sections	650°F	750°F	950°F
Billets	650°F	750°F	950°F
Strip/Plate	750°F	750°F	1100°F
Bloom/Slab	750°F	950°F	1100°F

❖ – with no black, cold spots

Table 2 – Minimum Field of View

for use with 0.5° x 25° lenses

Steel Temp.	Detector Trip Level: 650°F	750°F	950°F	1100°F	1500°F
750°F (400°C)	9%	N/D	N/D	N/D	N/D
850°F (450°C)	5%	100%	N/D	N/D	N/D
950°F (500°C)	1%	60%	100%	N/D	N/D
1100°F (600°C)	1/2%	20%	60%	100%	N/D
1500°F (800°C)	less than 1/2%	less than 5%	40%	60%	100%

N/D — Not Detectable

% of Vertical field of view required for 0.5° x 25° lens with 3 meters fishtail optic lead or 0.5° x 10° with 2 meters optic lead. Where site requirements necessitate incorporating longer lengths of optic lead, for each additional meter length above 3 meters add 30°C to stated steel temperature.

Self-Contained Sensors — 15% increased efficiency; 4° & 7° lens' — 30% increased efficiency.

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Ordering Procedure

Step 1 Do you need a self-contained or remote controlled unit?

See Page 4

- Self Contained Unit — Enter 8
- Remote Controlled Unit — Enter 9

Step 3 If you specified a remote lens, what type of lens housing do you need?

See Page 5

- Self-Contained Unit — 150°F Amb. 1°, 2°, 4°, 7°, 0.5° x 5°/10°/25° FOV — Enter X
- Tubular Lens Housing — 350°F Amb. 1°, 2°, 4°, 7°, 12°, 20° FOV — Enter T
- Cast Lens Housing — 350°F Amb. 0.5° x 5°/10°/25° FOV — Enter F
- High Temp. Tubular Lens Housing — 750°F Amb. 1°, 2°, 4°, 7°, 12°, 20° FOV — Enter H
- Quartz Lens Housing — 1800°F Amb. 1° FOV — Enter Q

Step 5 If you specified a remote lens, what length of fiber optic cable do you need?

See Page 5

- Self-Contained Unit — Enter X
- 2 Meters — Length – 78" (6'-6") — Enter 2
- 3 Meters — Length – 118" (9'-10") — Enter 3
- 4 Meters — Length – 157" (13'-1") — Enter 4
- 6 Meters — Length – 236" (19'-8") — Enter 6
- 8 Meters — Length – 315" (26'-3") — Enter 8

9	3	–	T	3	3

Step 2 Which temperature trip level do you need?

See Page 10-11

- 650°F / 350°C — Enter 3
- 750°F / 400°C — Enter 4
- 950°F / 500°C — Enter 5
- 1100°F / 600°C — Enter 6
- 1500°F / 800°C — Enter 8

Trip levels are preset off black oxidized steel plate.

Step 4 What lens field of view do you need?

See Page 5

- 1° — Enter 1
- 4° — Enter 2
- 7° — Enter 3
- 12° — Enter 4
- 20° — Enter 5
- 0.5° x 5° — Enter 6
- 0.5° x 10° — Enter 7
- 0.5° x 25° — Enter 8
- 2° — Enter 9

Cable connection (Step 7) is not available on remote controlled units. Plug connection (Step 7) is not available on self-contained water cooled units. Consult factory for other types of plugs and cable connections available.

Step 7 What type of electrical output connector do you require?

See Page 14

- 1 — Enter No — With IR self-check? — Potted Cable
- 2 — Enter Yes — Potted Cable
- 3 — Enter No — With IR self-check? — Plug (Quick Disconnect)
- 4 — Enter Yes — Plug (Quick Disconnect)

Step 9 is applicable for self contained or cast rectangular housings only. Water cooling is not available on self contained units with a plug connection. See Accessories Section for mounting brackets and cooling options on tubular lenses.

Step 9 What type of cooling do you need?

See Page 9

- X — Enter None
- A — Enter Air
- W — Enter Water

3	3	1	–	X	X

Step 6 What type of electrical ouput?

See Electrical Table on Page 14

Step 8 Do you need supplementary analog output for system monitoring?

See Page 14

- 1 — Enter Yes
- X — Enter No

Analog output (Step 8) is not available on 1500°F controllers. Analog output is between 2–4 volts and is for local monitoring only. Analog output will need a signal booster to pass signal to PLCs.

Step 10 Do you need air purge for the lens?

See Page 9

- A — Enter Air Purge with Air Cooling
- C — Enter Air Purge with Water Cooling
- X — Enter None

Step 10 is applicable for self contained or cast rectangular housings only. See Accessories Section for mounting brackets and cooling options on tubular lenses.

Instructions

Due to the many combinations available, Hubbell is using a multiple choice decision tree process to select the Hot Metal Detector for your application.

To use this process, simply follow the Steps 1–10. Answer each question in order and fill in the blank with the appropriate price list to determine the price of the unit.

To assist you in your choices, each step references you to a part of this catalog that offers additional information. For any options not shown consult the factory.

Insert your part number here for future reference.

□□-□□□-□□□-□□

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Electrical Options

Hubbell's Hot Metal Detectors are offered in many electrical configurations, each capable of meeting a wide range of applications.

They are available using either electro-mechanical relays and/or solid state circuitry for load switching in both AC and/or DC environments. Electrical packages with electro-mechanical relays are able to switch medium to low voltage contactors. The solid state circuitry is designed to handle low voltage applications including programmable controllers.

Below is a table showing the various features and specifications of each different electrical package that are presently available. For other electrical configurations consult the factory.

Electrical package #8 differs from the others because it uses a separate power pack. This electrical configuration offers a dual output of an isolated single pole reed relay and an isolated DC-NPN transistor output from an AC source. For further information about this package consult the factory.

Each of Hubbell's HMDs electrical packages can be ordered with optional self checking circuitry. The self-checking circuit is comprised of an infrared producing bulb that activates the photoelectric diode to test the switching circuit. This bulb is located in close proximity to the photoelectric diode. Because of its location, it can be used to visually check remote lens and their connecting fiber optic cables for breakage or contamination. It does not confirm the field of view of the lens.

The "Self Check – 1 Wire" circuit is provided through a single wire for connection by the user to the neutral line via a contact closure. The "Self Check – 2 Wire" is provided through two wires to be used as a contact closure. Source power is drawn from the supply power. Electrical diagrams of the self check circuits are shown in the bottom right corner of the next page.

Supplementary non-linear analog output is also available on most models. Analog output supplies direct electrical information from the photoelectric diode on the amount of infrared radiation being received in comparison to the detectors set trip level. The analog output is supplied through a three wire configuration. From this type of output, the user can observe the increasing and decreasing infrared detection levels, changes in the infrared readings over time vs. set points, as well as, align the detector without the need to switch it.

Each Hubbell HMD is supplied with either an electrical plug or standard wiring harness. Hubbell offers two standard plug arrangements with various pin-out configurations. They meet IP65 specifications. Specifications for these plug assemblies are shown in the accessories section of this catalog.

Electrical Output Type	Description	Operating Voltage/ Load Current	Switching Frequency	Switching Current	Short Circuit Protection (Overload)	Output Type & Function	Wiring Diagram
1	AC Thyristor Switching	120V AC	20 Hz	350 mA	350 mA	AC N.O.	1
2	NPN – 3 wire DC Transistor Switching	24V DC	1000 Hz	450 mA	500 mA	DC-NPN N.O.	2
3	PNP – 3 wire DC Transistor Switching	24V DC	1000 Hz	500 mA	500 mA	DC-PNP N.O.	3
4	Double Pole Reed Relay *(50 Ft. Cable Run Maximum)*	120V AC	1000 Hz	250 mA	—	AC N.O.	4
5	SPDT Control Relay	120V AC	20 Hz	2 A	5 A	AC N.O.	5
6	NPN Transistor Output with Single Pole Reed Relay	24V DC	1000 Hz	500 mA & 2 A	500 mA	DC-NPN N.O.	6
7	PNP Transistor Output with Single Pole Reed Relay	24V DC	1000 Hz	500 mA & 2 A	500 mA	DC-PNP N.O.	7
8	NPN Transistor Output with Single Pole Reed Relay *(DC Detector with AC Power Pack)*	120V AC	1000 Hz	500 mA & 2 A	500 mA	DC-NPN N.O.	8

AC Electrical Data

The following electrical data applies to AC – 2 wire configuration (Type 1) only:

Switching Speed	20 ms
Min. Load	20 mA
Leakage Current	5 mA
Voltage Drop	12V

Mechanical Relays

The following information applies to electrical packages w/ mechanical relays:

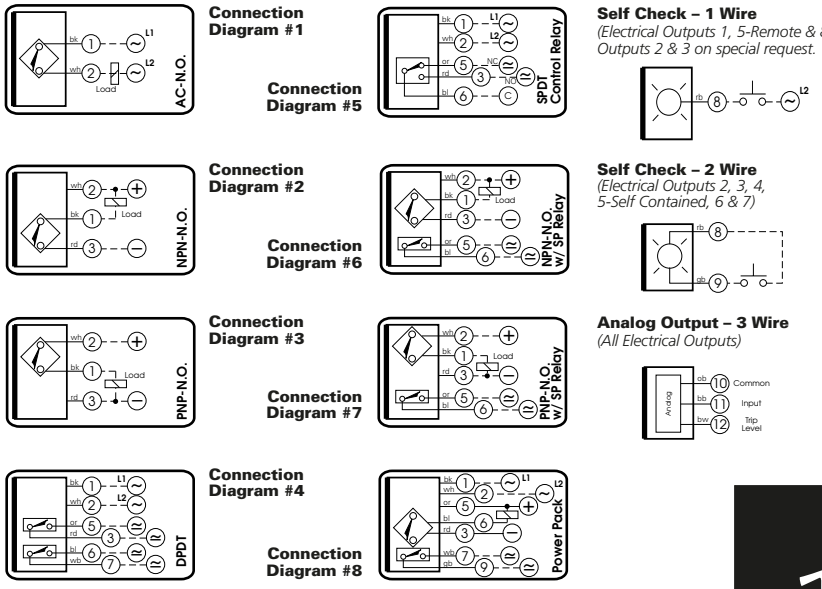
Relay Switching Speed

Double Pole Reed Relay	2 ms (On/Off)
SPDT Control Relay	20 ms (On) 10 ms (Off)
Single Pole Reed Relay	2 ms (On/Off)

Connection Diag.

For further information on connection diagrams see Hubbell's Proximity Sensor Catalog . Wiring color key is:

or	Orange
bl	Blue
bk	Black
wh	White
rd	Red
gr	Green
wb	White/Black Trace
rb	Red/Black Trace
gb	Green/Black Trace
ob	Orange/Black Trace
bb	Blue/Black Trace
bw	Black/White Trace



Note: When Connection Diagrams 4–8 are supplied with cable, the cable leads are not color coded but are number coded per the diagrams.

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General Specifications

Remote Controller

Housing	Aluminium with oven baked black paint
Watertight Rating	IP65; NEMA 3, 4, 12
Vibration Rating	Better than DIN 89011, Cat. 2; IEC 68-2-6, IEC 68-2-27
Shock	<30g for <11 ms (all 3 planes)
Vibration	<55 Hz – 1 mm amplitude (all 3 planes)
Operating Temperature Ranges	
650°/750°/950° Controller	-5°F (-20°C) to +150°F (+65°C)
1100°/1500° Controller	-5°F (-20°C) to +185°F (+85°C)
Short Circuit Protection	see page 14
Electrical Plug Rating	IP66; NEMA 3, 4, 12, 13
Repeatability (temp.)	≤1%

Self-Contained Detector/Cast Lens Housing

Housing	Aluminium with oven baked blue paint
Fittings	Brass
Lens	Tempered Crown Glass
Housing Seals	Neoprene & Cork
Watertight Rating	IP65; NEMA 3, 4, 12
Vibration Rating	Better than DIN 89011, Cat. 2; IEC 68-2-6, IEC 68-2-27
Shock	<30g for <11 ms (all 3 planes)
Vibration	<55 Hz – 1 mm amplitude (all 3 planes)
Operating Temperature Ranges	
650°/750°/950° Controller	-5°F (-20°C) to +150°F (+65°C)
1100°/1500° Controller	-5°F (-20°C) to +185°F (+85°C)
Purged Cooled Limits[1]	-5°F (-20°C) to +250°F (+120°C)
Water Cooled Limits[1]	+36°F (+2°C) to +350°F (+180°C)
Short Circuit Protection	see page 14
Connection Cable Rating	IP65; NEMA 3, 4, 12 – 1.5 meters of Ölflex® armored cable – 2/4 x 0.7 mm².
Repeatability (temp.)	≤1%

Tubular Lens Housing - Low Temperature
Step 3 – Option T

Housing	Stainless Steel
Fittings	Nickel Plated Brass
Lens	Tempered Crown Glass
Fiber Optic Glands	Neoprene
Watertight Rating	IP65; NEMA 3, 4, 12
Operating Temperature Ranges	
Ambient	-5°F (-20°C) to +350°F (+180°C)

Tubular Lens Housing - High Temperature
Step 3 – Option H

Housing	Stainless Steel
Fittings	Brass
Lens	Tempered Crown Glass
Fiber Optic Glands	Brass
Watertight Rating	IP65; NEMA 3, 4, 12
Operating Temperature Ranges	
Ambient	-5°F (-20°C) to +750°F (+400°C)

High Temperature Quartz Lens Housing
Step 3 – Option Q

Housing	Stainless Steel
Fittings	Brass
Lens Rod	Quartz
Watertight Rating	IP65; NEMA 3, 4, 12
Operating Temperature Ranges	
Ambient	-5°F (-20°C) to +1800°F (+1000°C)
Radiant[2]	≤+2200°F (≤+1200°C) max

Fiber Optic Cables

Housing	Stainless Steel/self-supporting gooseneck construction
End Fittings	Stainless Steel
Chemical Resistance	Unaffected by water, gasoline, oils, sulfuric acid and other organic acids
Watertight Rating	IP66; NEMA 3, 4, 12, 13
Vibration Rating	Better than DIN 89011, Cat. 2; IEC 68-2-6, IEC 68-2-27
Shock	<30g for <11 ms (all 3 planes)
Vibration	<55 Hz – 1 mm amplitude (all 3 planes)
Characteristics	Resistant to crushing loads and kinks.
Operating Temperature Ranges	
Ambient	15°F (-10°C) to +750°F (+400°C)
Minimum Bend Radius	2.5 x O.D.
Maximum Length	8 meters (26 feet)

Notes

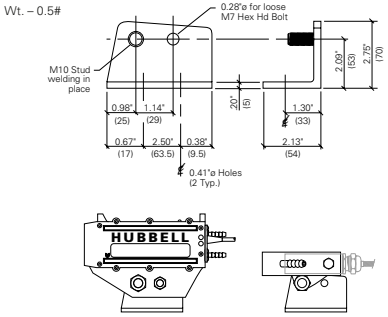
1 Purge Cooled Limits is based on an air purge rate of 1–5 ft³/min. @ 15 psi. Water Cooled Limits is based on a water source at +72°F (+22°C) at 0.5 gpm @ 10 psi.

2 Radiant temperature is based on an exposure to this maximum temperature for less than 5 minutes.

Accessories

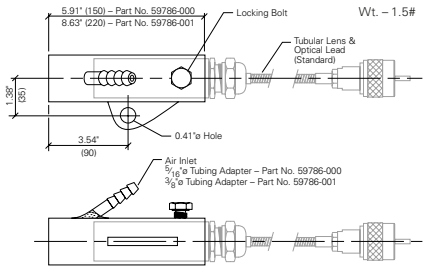
Standard "L" Mounting Bracket
Part No. 59784-000

This "L" Bracket is constructed of steel and is used for mounting the cast housings, the tubular lens mounting blocks and purge nozzles. It allows the housing to be precisely tilted ±45° from horizontal and fits the Universal Swivel Mount. The bracket includes all mounting hardware.



Air Purged Tubular Lens Mounting Bracket
for 2°–20° Tubular Lenses – Part No. 59786-000
for 1° Tubular Lenses – Part No. 59786-001

This Purged Mounting Bracket is entirely constructed of stainless steel for long life in harsh environments. This mount offers precise alignment of the lens to the target with air purge capabilities. The air purge inlet is a standard tubing connection. This purged mount is particularly useful in environments where steam and particulates must be cleared from the field of view with an air purge.

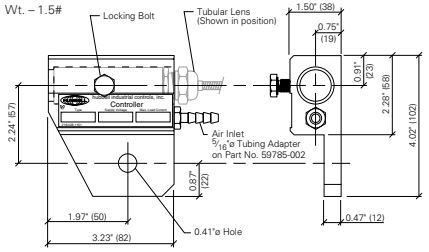


Prices for these items are located in the "Accessory Parts" Section of Price List 98/9900

Standard Tubular Lens Mounting Block
w/o Air Purge/Cooling – Part No. 59785-001
w/ Air Purge/Cooling – Part No. 59785-002

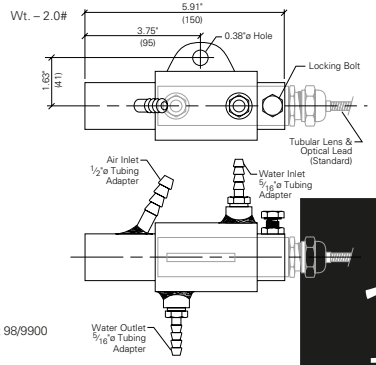
The Tubular Mounting Block is constructed of aluminium with oven baked black coating. This type of bracket offers convenient and precise mounting of tubular lens. In addition, it gives an extra degree of protection from impact loads to the lens housing and allows removal of the lens by a simple clamp bolt.

The Air Purged/Cooled Tubular Lens Mounting Block is similarly constructed and incorporates an air cooling chamber which vents as an air purge past the lens case.



Air Purged & Water Cooled Tubular Lens Mounting Bracket
for 2°–20° Tubular Lenses – Part No. 59787-000
for 1° Tubular Lenses – Part No. 59787-001

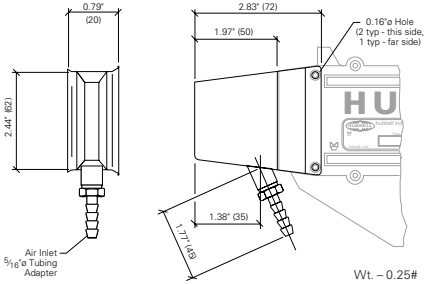
Constructed as the Purged Lens Mounting Bracket (left) with the addition of a cooling chamber which may be used with a water supply or an air supply instead of water (i.e. air cooling). This bracket is ideal for harsh installations.



Accessories cont.

Cast Housing Air Purge Nozzle
Part No. 59788-000

The Purge Nozzle is constructed of steel with zinc cadmium coating and oven baked black paint for long life. This air purge nozzle is used to further direct the air purge and increase the pressure to clear steam and particulate from the lens. Its construction allows for easy attachment to the cast housing with only an Allen wrench. It has an extra tubing fitting if additional air purge is required in severe environments.

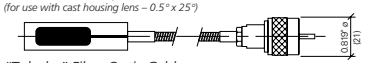


Wt. – 0.25#

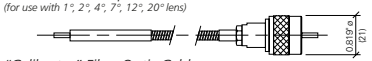
Fiber Optic Cables
Part No. LG-⁎-CB (Fishtail)
Part No. LG-⁎-AB (Tubular)
Part No. LG-15-BB (Calibrator)

Hubbell offers Fiber Optic Cables in various lengths up to 8 meters to suit each particular application. The fishtail optic cable is used with the cast lens housing, while the tubular optic cable is used with all the tubular and high temperature lens housing. To specify the length desired, replace the "⁎" with your required length in whole meters. Specifications of these fiber optic cables are available on page 16 and are original replacements to fiber optic cables suppled.

"Fishtail" Fiber Optic Cable
(for use with cast housing lens – 0.5° x 25°)



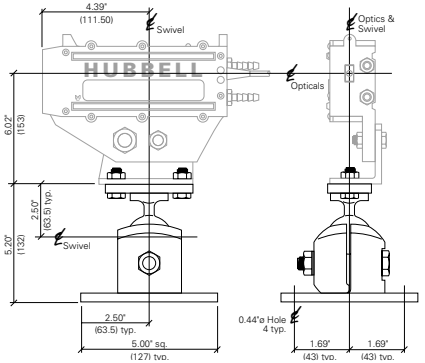
"Tubular" Fiber Optic Cable
(for use with 1°, 2°, 4°, 7°, 12°, 20° lens)



"Calibrator" Fiber Optic Cable
(for use with calibrator)

Universal Swivel Mount
Part No. 47925-005

The Universal Swivel Mount is constructed of steel with a hardened brass ball joint for long life. This mount offers precise alignment of the detector to the target with 360° circular rotation and 120° of tilt. To mount the Cast Lens Housing, you will need its standard "L" mounting bracket. The swivel mount includes all mounting hardware.

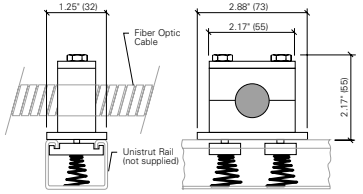


Wt. – 10.0#

Fiber Optic Mounting Bracket Assembly
Part No. 59790-000

Hubbell's Fiber Optic Mounting Bracket offers a clean and simply mounting procedure of fiber optic cables that helps prevent kinking and damage. They are constructed of aluminum with a wide variety of mounting possibilities to concrete, structural steel, Tubetrack®, and Unistrut®. This bracket is designed to prevent pinching of the fiber optic cables. The bracket includes all attaching hardware.

Wt. – 0.25#



Prices for these items are located in the "Accessory Parts" Section of Price List 98/9900

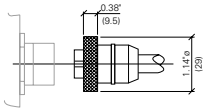
Electrical Plug Assembly – Female

These Plug Assemblies are specifically matched to fit Hubbell's HMDs. The cable length is available in 6 or 12 feet of neoprene cable with molded plug assembly. Hubbell's HMD have either a 6 pin or 12 pin round plug assembly depending on the electrical features you ordered.

Application Class:
Approvals ..... UL; CSA; IP65; NEMA 3, 4, 12
Ambient Temperature .....-13°F (-25°C) to 194°F (+90°C)

Materials:
Molded Body ..... Neoprene and Polychloroprene
Locking Ring ..... pre-nickeled CuZn
Leads ..... AWG 16
Contacts ..... pre-nickeled CuZn
Insulation ..... glass fiber Based

Electrical Data:
Nominal power ..... 7 A max.
Nominal voltage ..... 600V AC



Part Number	Cable Length	Mounting Style	Pin Config.
59780-022	6 ft.	Straight	6
59780-023	12 ft.	Straight	6
59780-025	6 ft.	Straight	12
59780-026	12 ft.	Straight	12

Pin #	Wire Color	Operation
1	Black	⁎
2	White	⁎
3	Red	⁎
4	Green	Ground⁎
5	Orange	⁎
6	Blue	⁎
7	White/Black Tracer	⁎
8	Red/Black Tracer	Self Check†
9	Green/Black Tracer	Self Check†
10	Orange/Black Tracer	Analog Common
11	Blue/Black Tracer	Analog Input
12	Black/White Tracer	Analog Trip Level

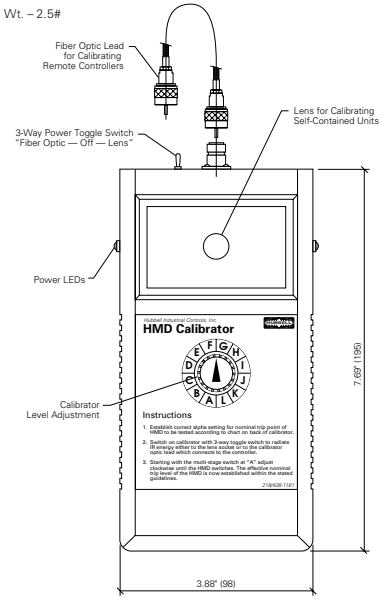
⁎ See Connection Diagrams on page 15 for outputs of these leads.

† Self Check on Wiring Diagrams 1, 5-Remote and 8 use only one wire connected to the neutral or common line via a contact closure. Self Check on Wiring Diagrams 2, 3, 4, 5-Self Contained, 6 and 7 use two wires as contact closure point. Power is supplied from the unit.

HMD Calibrator
Part No. 59791-000

The HMD Calibrator makes setup, checking and calibration of HMDs a snap in the field. Constructed of a light durable plastic housing weighing less than 2 pounds, this little device can quickly check many of Hubbell's HMD installation. It includes the 1.5 meter fiber optic cable (part no. LG-15-BB) for testing remote controllers and operates on two batteries (included).

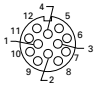
Wt. – 2.5#



Front View – Female

6 Pin Configuration

12 Pin Configuration



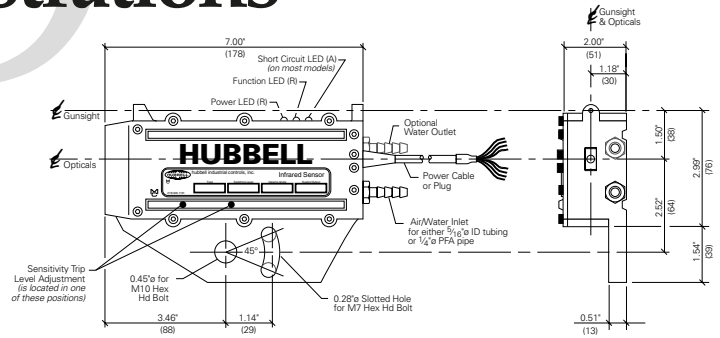
Prices for these items are located in the "Accessory Parts" Section of Price List 98/9900

D Dimensional Illustrations

All dimensions are in inches with millimeters in the parentheses unless otherwise noted.

Illustration #1

Cast Housing
Used in both Self-Contained and Remote Controlled Configurations
Weight – 3.8 lbs.



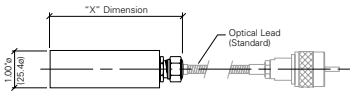


Illustration #2

Tubular Lens Housing — Low and High Temperature
Used in Remote Controlled Configurations
Weight – 0.4 lbs.

Lens Size	Field of View	"X" Dimension
1	1°	7.48" (190)
2	4°	4.33" (110)
3	7°	3.15" (80)
4	12°	4.33" (110)
5	20°	3.15" (80)
9	2°	5.12" (130)

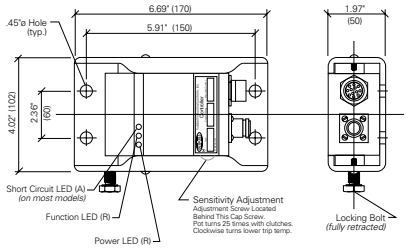
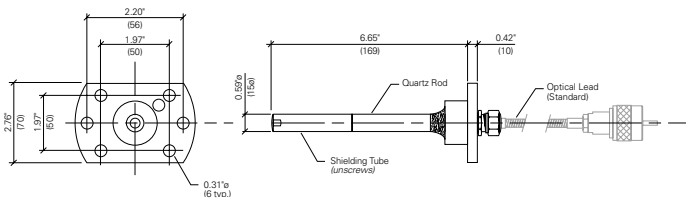


Illustration #3

Remote Controller Electronics Package in Mounting Cradle
Used in Remote Controlled Configurations
Weight – 4.5 lbs.

Illustration #4

Quartz Lens Housing
Used in Remote Controlled Configurations
Weight – 1.2 lbs.



F Emissivity Factors

The table at the right shows emissivity factors for various materials under different stages of manufacturing. If your particular material is not shown, consult the factory for the appropriate emissivity factor. The table below shows how oxidation can greatly effect the emissivity factor for a material. In general, as the oxidation increases — the emissivity factor increases.

Emissivity for Steel Based on the Level of Oxidation	
Clean unoxidized	0.25
Slight oxidation	0.50
Heavy oxidation	0.95

Material	Temp. Range °F (°C)	Emissivity f_{tr}
Aluminum		
Heavily oxidized	200° (93°) – 940° (504°)	0.200 – 0.310
Aluminum Oxide	930° (499°) – 1520° (827°)	0.420 – 0.260
Brass – Oxidized		0.610
Brick		
Red, rough, no gross irregularities	70° (21°)	0.930
Grog Brick, glazed	2012° (1100°)	0.750
Building	1832° (1000°)	0.450
Fireclay	1832° (1000°)	0.750
Carbon		
T-carbon	260° (127°) – 1160° (627°)	0.810 – 0.790
filament	1900° (1038°) – 2560° (1404°)	0.526
Rough plate	212° (100°) – 932° (500°)	0.770 – 0.720
Graphitized	212° (100°) – 932° (500°)	0.760 – 0.710
Candle Soot	206° (97°) – 520° (271°)	0.952
Lampblack-waterglass coating	209° (98°) – 440° (227°)	0.960 – 0.950
Chromium		
Polished	100° (38°) – 2000° (1093°)	0.080 – 0.360
Concrete Tiles	1832° (1000°)	0.630
Copper		
Plate Heated at 1110°F	390° (199°) – 1110° (599°)	0.570
Molten copper	1970° (1077°) – 2330° (1277°)	0.160 – 0.130
Glass		
Smooth	72° (22°)	0.940
Pyrex, lead and soda	500° (260°) – 1000° (538°)	0.950 – 0.850
Inconel		
Type X	450° (232°) – 1620° (882°)	0.555 – 0.780
Type B	450° (232°) – 1620° (882°)	0.350 – 0.550
Iron and Steel		
Cast Iron - Polished	392° (200°)	0.210
Cast Iron - Turned and Heated	1620° (882°) – 1810° (988°)	0.600 – 0.700
Wrought Iron	100° (38°) – 480° (249°)	0.280
Polished Steel Casting	1420° (771°) – 1900° (1038°)	0.520 – 0.560
Ground Sheet Steel	1720° (938°) – 2010° (1099°)	0.550 – 0.610
Oxidized Surfaces		
Iron Plate, pickled, rusted red	68° (20°)	0.610
Iron Plate, completely rusted	67° (19°)	0.690
Rolled Sheet Steel	70° (21°)	0.660
Oxidized Iron	212° (100°)	0.740
Cast Iron, oxidized at 1100°F	390° (199°) – 1110° (599°)	0.640 – 0.780
Steel, oxidized at 1100°F	390° (199°) – 1110° (599°)	0.790
Smooth oxidized electrolytic iron	260° (127°) – 980° (527°)	0.780 – 0.820
Iron oxide	930° (499°) – 2190° (1199°)	0.850 – 0.890
Iron, Rough-ingot	1700° (927°) – 2040° (1116°)	0.870 – 0.950
Sheet Steel		
Strong, rough oxide layer	75° (24°)	0.800
Dense, shiny oxide layer	75° (24°)	0.820
Cast Plate, smooth	73° (23°)	0.800
Cast Iron, rough, strongly oxidized	100° (38°) – 480° (249°)	0.950
Wrought Iron, dull oxidized	70° (21°) – 680° (360°)	0.940
Steel plate, rough	100° (38°) – 700° (371°)	0.940 – 0.970
Molten Surfaces		
Cast Iron	2370° (1299°) – 2550° (1399°)	0.290
Mild steel	2910° (1599°) – 3270° (1799°)	0.280
Steel	2730° (1499°) – 3000° (1649°)	0.420 – 0.530
Pure Iron	2760° (1516°) – 3220° (1771°)	0.420 – 0.450
Lead		
Heavy Oxidised @ 300°F	392° (200°)	0.630
Liquid	700° (371°) – 900° (482°)	0.500
Stainless Steel		
Type 304, after heating	420° (216°) – 914° (490°)	0.444 – 0.360
Type 304, after 42 hrs heating @ 980°F	420° (216°) – 980° (527°)	0.620 – 0.730
Type 310, from furnace	420° (216°) – 980° (527°)	0.900 – 0.970
Type 316, from furnace	450° (232°) – 1920° (1049°)	0.520 – 0.500
Type 347, from furnace	450° (232°) – 1650° (899°)	0.520 – 0.650

Specification Form for HMDs

Date | Salesman/Company

Instructions: Please fill out this form completely prior to placing your order. Attach a sketch of your installation to help clarify your answers. To help keep items clear use only one form per single application.

Company | Contact Person | Telephone

Street Address | City/State/Zip | Project Name

Product Description:

Type: ☐ Liquid ☐ Slab ☐ Plate ☐ Bloom ☐ Billet ☐ Strip ☐ Beam ☐ Angle ☐ Other ☐ Bar ☐ Rod .....

Temperature: ..... °F or °C (max) ..... °F or °C (min)

Speed: ☐ Constant ☐ Variable → ..... Max & Min

Gap Between Targets: ..... Distance ..... Time

Location on Conveyor: ☐ Center ☐ Drifting ☐ Bouncing → ..... Max & Min

Water on Target: ☐ Yes ☐ No

Black Spots ☐ Yes ☐ No

Environment Description:

Steam in Field of View: ☐ Never ☐ Intermittent ☐ Always

Reflective Surfaces: ☐ Side Rails ☐ Enclosures ☐ Bkgd. Lines ☐ Floorpans

Detector Requirements:

Mounting Position: ☐ Above ☐ Below ☐ To Side ☐ 30° ☐ 45° ☐ 60°

Distance to Target: ☐ <3 feet ☐ 3–9 feet ☐ >9 feet ..... Specific Distance/Restrictions

Function: ☐ Tracking ☐ Action Initiation ☐ Speed Control ☐ Cobble Alarm → ..... Specify Function in Detail

Field of View Requirements: ☐ Spotting Target ☐ Viewing Entire Target Width → ..... Specify FOV Requirements

Detector Features:

Housing Style: ☐ Self Contained ☐ Remote

Lens Housing: ☐ Cast ☐ Tubular ☐ Quartz

Air Purge for Lens: ☐ No ☐ Yes

Cooling: ☐ Water ☐ Air

HUBBELL HMD Hot Metal Detectors

Electric Features:

Output Required: ☐ AC ☐ DC-NPN ☐ DC-PNP ☐ Double Pole Reed Relay ☐ SPDT Control Relay ☐ NPN w/ Single Pole Reed Relay ☐ PNP w/ Single Pole Reed Relay ☐ Other → .....

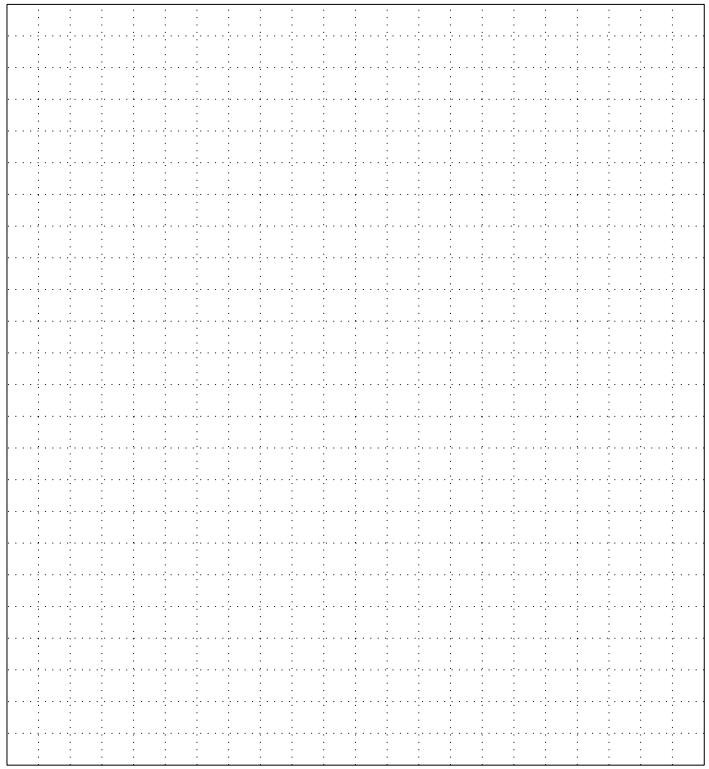
Supply Voltage: ..... ☐ AC ☐ DC

Analog Output: ☐ No ☐ Yes

Self-Check: ☐ No ☐ Yes

Electrical Connection: ☐ Wiring Harness ☐ Electrical Plug

Installation Sketch: *include approximate dimensions*



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