Scanning Hot Metal Detector

HMD-SM Operator’s Manual

Revision 2.1
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1. Introduction

The Logika Technologies scanning mode hot metal detector, Model HMD-SM, is designed for the automation of steel, aluminum and other metal mill production lines. It includes a rugged enclosure, protecting state-of-the-art electronics and will withstand the harsh ambient conditions present in heavy industrial environments. The HMD-SM is used to detect hot metal in a range of temperatures, shapes and sizes of wire, bar, strip, thin plate, thick plate, billet, and slab production facilities.

The scanning mode feature allows the HMD to detect hot metal across the entire width of a production line. It also enables the HMD to be installed remotely from the hot metal target, further protecting the electronics and extending the life of the sensor.

2. Description

2.1 Model Nomenclature

HMD - SM - _Scan angle_ - Power Input _ - R

<table>
<thead>
<tr>
<th>Base Model</th>
<th>Scan angle</th>
<th>Power Input</th>
<th>R(Relay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMD-SM</td>
<td>10: 10 Degree</td>
<td>110: 110 VAC</td>
<td>1 Normal Open</td>
</tr>
<tr>
<td></td>
<td>30: 30 Degree</td>
<td>220: 220 VAC</td>
<td>1 Normal Close</td>
</tr>
<tr>
<td></td>
<td>50: 50 Degree</td>
<td>24: 24 VDC</td>
<td></td>
</tr>
</tbody>
</table>

Table 1
2.2 Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temp</td>
<td>No water cooling: 0°C to +50°C (32°F to 120°F)</td>
</tr>
<tr>
<td></td>
<td>With water cooling: 0°C to 120°C (32°F to 250°F)</td>
</tr>
<tr>
<td>Detect Range</td>
<td>0.2-8m</td>
</tr>
<tr>
<td>LED Indicators</td>
<td>Green = power on, Red = target detect, Orange= Detector signal saturation or dirty lens, Off=Alarm</td>
</tr>
<tr>
<td>Output</td>
<td>Relay NO/NC 250VAC@ 1A, or 24VDC@ 1A, closing: 7.5ms, opening: 3ms DC 24V PNP, NPN Transistor output: max 100mA Diagnostic outputs: control, alarm, signal amplitude</td>
</tr>
<tr>
<td>Power Input</td>
<td>24 VDC, 110VAC, 220VAC @ 30VA</td>
</tr>
<tr>
<td>Cable</td>
<td>16 wires multi-conductor TEFLEN cable with 9 x 20Ga and 7 x 24Ga Insulation 20MΩ, 500VDC, ≥500°C (930°F)</td>
</tr>
<tr>
<td>Housing</td>
<td>Hermetically sealed cast aluminum enclosure rated IP66, includes cooling water connections and air purge.</td>
</tr>
<tr>
<td>Size</td>
<td>Enclosure; 315 mm L x 110 mm W x 264 mm H (with mounting bracket) (12.4”L x 4.3”W x 10.4”H)</td>
</tr>
<tr>
<td>Weight</td>
<td>7kg or 15 lb</td>
</tr>
<tr>
<td>Min Target Temp</td>
<td>250°C (480°F)</td>
</tr>
<tr>
<td>Scanning Angle</td>
<td>10°, 30°, 50°</td>
</tr>
<tr>
<td>Water Cooling</td>
<td>25°C, 4 bars pressure (60 psi), 1-2L/min (0.26 to 0.52 USG), ¼” flexible tube</td>
</tr>
<tr>
<td>Air Purging</td>
<td>50 to 200 g/cm² (0.7 to 2.8 psi), 4-16L/min (0.14 to 0.56 cfm) ¾” compression fitting</td>
</tr>
</tbody>
</table>

Table 2

2.3 Operating Principle

Detector - The HMD-SM uses a Lead Sulfide (PbS) photocell, which is characterized by a very strong signal output for the range of infrared energy emitted by steel, compared with other detector materials. The high signal-to-noise ratio from this detector virtually eliminates detection errors. Figure 2.1 shows the various types of photocell spectrums and the infrared emission spectrum of steel in 250°C and 1000°C.
Scanning System- The HMD-SM uses a scanning optical bench that enables hot metal detection across a broad angle of detection. The optical field is scanned using a rotating drum of multiple mirror facets that reflect the energy from the hot metal target in the scanning field to the PbS photocell, see Figure 2.2 for details. The infrared energy is converted to an electronic signal by the PbS photocell, which is then processed by the electronic circuit and changed to a logic signal for analysis and control purposes.

Vertical Scanning field- The HMD-SM is manufactured with one of three vertical field angles 10, 30 and 50 degrees, selected at the time of purchase. This enables the sensor to cover the entire process area but not scan beyond the process line where interfering sources of infrared energy may be present.
Figure 2.3  HMS - SM Vertical Scanning Field

For example, if a hot metal target is located 4 meters (13’) from the front of the HMD with a HMD-SM-30 detector selected, the vertical scanning field is 2.10 meters or 84 inches.

**Horizontal Scanning field** - A manual adjustable shutter on the shroud is used for the horizontal measurement angle change from 1 to 3 degrees (see Section 3.1 “Mounting Distance”). For example, if a shutter width angle distance, the scanning width is 8mm. A positive output signal will result if any portion of the hot metal is within the 8 mm scanning field. For different targets, see the **mounting distance** in section 3.1 for more details.

**2.4 Automatic Threshold Level Adjustment**

The HMD-SM includes an Automatic Threshold Level Adjustment to decrease the detector signal when hot metal is detected to prevent detector signal saturation. The user adjusts the base gain level via a potentiometer mounted on the sensor’s control panel (See Sections 5.2 and 5.3 for additional details on the use of this feature). The detector will return to the base signal level upon exit of the hot metal from the scanning detection field. This feature makes the sensor more stable and significantly reduces detection errors caused by target black spots or varying surface temperature as well as interference from water vapor and oxide scale.

**2.5 Other Features**

- Fast response time to the hot metal target in and out of the scanning field
Detects low temperature and low emissivity targets in harsh environments; even with infrared reflection or roller heat radiation interference.

Pulse signal treatment circuit design lessens detector power consumption and temperature drift.

3. Location and Mounting

3.1 Sensor Location

The ideal location should allow the HMD scanning field to cover the entire process line, protect it from absorbing excessive heat, and be close enough for the detector to get sufficient infrared energy from the target.

Mounting Distance- Check the HMD mounting distance listed on table 3 for different targets. Find the size of the target, select an approximate mounting distance. Use Figure 2.3 for calculating the scanning field and select the ideal scanning angle (10°, 30°, or 50°) to make sure the sensor’s scanning field covers the entire process area. The vertical scanning field should be oriented across the width of the process line for best coverage.

<table>
<thead>
<tr>
<th>Target</th>
<th>HMD Distance</th>
<th>Target</th>
<th>HMD Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire rod, 5-12 mm</td>
<td>0.2 - 3.0 m</td>
<td>Steel Strip</td>
<td>0.6 - 2m</td>
</tr>
<tr>
<td>Bar, 10x10-40x40 mm</td>
<td>0.2 - 4.0 m</td>
<td>Thin Plate</td>
<td>1.0 - 6.0 m</td>
</tr>
<tr>
<td>Square Billet</td>
<td>0.5 - 6.0 m</td>
<td>Thick Plate</td>
<td>1.0 - 8.0 m</td>
</tr>
<tr>
<td>Large Billet(Bloom)</td>
<td>&gt;2.0 m</td>
<td>Slab</td>
<td>&gt;2.0 m</td>
</tr>
</tbody>
</table>

Table 3

Interference- Reduce or eliminate background infrared radiation sources, such as other hot processes behind the target and reflected sunlight:

1. Select the appropriate scanning angle when originally placing order to avoid “over-scanning”.
2. Gradually reduce the sensitivity adjustment on the HMD-SM’s control panel until the background interference is not detected (when no target metal is within the scanning field). See the “Operation” chapter in this manual for additional details.
3. In occasional severe environments, install a heat proof enclosure around the HMD to protect it from overheating and use ventilation to drive away particulate and vapor.

Other considerations for installation

1. Locate the HMD to reduce interfering infrared sources and choose a detection field that minimizes the presence of dirt, smoke and water vapor or other infrared absorbing chemicals.
2. Only part of the target needs to be in the sensor’s scanning field to trigger a hot metal output signal.
3.2 Sensor Mounting

- **Mounting Foot**: The HMD-SM has an adjustable mounting foot designed to allow easy rotation through horizontal and vertical axes. The HMD is secured to the mounting foot with one 18mm bolt and can be installed onto a support bracket. The support must be sufficiently rigid to absorb any excessive site vibrations that can affect the output of the detector.

- **Purge Air, Cooling Water**: The HMD-SM has a water-cooling jacket to cool down sensor temperature and an air-purged shroud for protection of lens; allowing the sensor to be used in harsh environments with high temperatures, steam, dust and smoke. Please see Section 4.2 Plumbing Connection and Section 4.3 Air-Purge Connection for further details on installation.

- **High Heat Option**: If the ambient temperature is more than 250°C (480°F), we recommend HMD-FOC, Fiber Optical Hot Metal detector. The lens is separate from the detector and connected by fiber optical cable which can bear high temperatures.

- **Caution**: For installation environments that contains excessive water vapor or smoke, additional ventilation such as air curtains or fans should be used to clear the area so the sensor can “see” the hot metal target.

4. Utility Connections

4.1 Electrical Connections

- **Electrical Overview**: All electrical connections (power and signal) to the HMD-SM are made via a 15 pin male Harting connector, a supplied 2-meter long cable with quick fitting on one end and terminal pins on the other end for junction box connections. Other cable lengths are available from Logika Technologies Inc. upon request.

- **Cable Specification**:
  - 16 conductors cable, color coded, with 9 conductors 20 AWG unshielded (9 x 0.6 mm²), 7 conductors 24 AWG shielded (7 x 0.34 mm²)
  - Teflon insulation for high temperature applications.
  - Outer metallic braided for mechanical protection.
  - Overall diameter of 9 mm.
  - Minimum bending radius of 30 mm.

- **Junction Box Wiring**: Please see Figure 4.1 for the sensor wiring diagram. The supplied cable should be connected directly to the terminals of a junction box. The shield should be connected to ground to eliminate electrical noise which may trigger false detection signals. Any unused output wires must have insulation protection or be connected to free terminals in the junction box.

- **Power Connections**: Power Input (please specify power input at time of order).
  See the Figure 4.1 for detail wirings for different power supply input
Static Transistor Output-
- PNP: Terminal 4B White, 24VDC on detect, maximum current 100 mA
- NPN: Terminal 4A Black, 0VDC on detect, maximum current 100mA

Output Response time:
- HMD-SM-10: 1ms
- HMD-SM-30: 2ms
- HMD-SM-50: 4ms

Relay Output- Single pole double throw contacts, contact capacity rating 250VAC/1A or 24VDC/1A, relay closes time 7.5ms, relay releases time 3ms.
- Terminal 5C White/Orange: NC, Open = detect
- Terminal 5B White/Blue: NO, Closed = detect
- Terminal 5A White/Purple: COM

Sensor Diagnostics Outputs- Relay and voltage signals to indicate sensor conditions. All the outputs voltages are referred to 0VDC (Figure 4.1, Terminal 3B).

1. Control Output (Figure 4.1, Terminal 2A Green):
   - Normal Output: 24VDC
   - Diagnostic Alarm Output: 0VDC, indicated if one or more occurs:
     - Dust or vapor interference on glass
     - Target temperature drop
     - Signal saturation

2. Alarm Output (Figure 4.1, Terminal 4C):
   - Normal Output: 24VDC
   - Alarm output: 0VDC indicated if one or more occurs:
     - Power input loss
     - Scanning motor runs abnormally
     - The temperature inside the enclosure is higher than 55°C (130°F)

3. Signal Amplitude Output (Figure 4.1, Terminal 3C): 0-13.5 VDC analog output, proportional to the photocell output signal. This signal may indicate that the sensor’s protective lens glass needs to be cleaned or the sensor’s sensitivity needs to be increased. Signal amplitude output is influenced by:
   - Sensor installation environment and location
   - Target size
   - Target temperature
   - Distance between the sensor and the target
   - Vapor in the field
   - Dust on the Lens
   - Sensitivity Adjustment Setting
After the installation and setup are done, the sensor runs normally. Measure the signal amplitude output voltage for later maintenance reference.

![HMD-SM Wiring Diagram]

**Figure 4.1: HMD-SM Wiring Diagram**

### 4.2 Cooling Water Connection

- **Description** - When the ambient temperature is higher than 50°C (120°F), cooling water system is required to protect the electronics inside the enclosure. Two Ø10mm OD barbed fittings are available beside the electrical connector for cooling water to circulate inside the enclosure, the direction is not necessary.

- **Cooling Water Requirements**
  - Clean industrial water
  - Maximum water inlet temperature 25°C (77 °F).
  - Maximum water pressure 4 bars (60 PSI)
  - Water flow rate of 1 to 2 L/min (0.035 to 0.71 ft³/min)

- **Connection** - Use Ø10mm ID or 3/8” ID hose for connections
  - One fitting is connected to plant’s water supply
  - The other one is connected to drain
  - Both fittings should be secured with hose clamps
  - Setup the cooling water flow rate by Figure 4.2
4.3 Purge Air Connection

- **Description**: Compressed plant air can be used to protect the lens from dust and vapor. Purge air cleans the lens, reduces maintenance times, and prolongs sensor life where dust or corrosive vapor is present.

- **Purge Air Requirements**
  - Must be clean, dry instrument air, no oil, dust and contaminants included. Poor air quality will result in dirty lens and decrease detector performance. If the quality of compressed air can’t be guaranteed, it is better not connect it to the sensor to avoid the lens contaminated and affect the sensor’s performance.
  - Air filtration prior to the inlet fitting is recommended to improve the quality of purge air
  - Air Pressure range from 50 to 200 g/cm² (0.7 psi to 2.8 psi)
  - Air Flow rate from 4 to 16 L/min (0.14 to 0.56 ft³/min)

- **Connection**: Connect the plant air source to the purge air barbed fitting on the sensor’s lens shroud with Φ10mm ID (or 3/8” ID) hose. Purge air flows out of the sensor shroud and dissipates into the ambient environment.

5. Operation

5.1 Control Panel

The HMD-SM Sensor’s Control Panel is located at the rear of the enclosure. The following functions are available on the Control Panel, see Figure 5.1.

**Web**: [www.logikatech.com](http://www.logikatech.com)  **Phone**: 905-829-5841  **Fax**: 905-829-8787  **Email**: info@logikatech.com
LED = Process Status Indicator
Green: No target detected, standby mode.
Red: Target detected.
Orange: Sensor signal saturation or dirty lens.
Off: Alarm

Push Button = Test Button, turns on internal sensor test signal, at the same time activates visible laser positioning beam for easy target aiming when the button is pressed.

N = Normal Sensitivity Threshold Level Adjustment Potentiometers. When adjust to maximum sensitivity (7), detect target temperature 400 °C (752 °F) or higher.
H = High Sensitivity Threshold Level Adjustment Potentiometers. When adjust to maximum sensitivity (7), detect target temperature 250 °C (482 °F) or higher.

Adjust sensitivity of the detector within each range, 1 to 7 refers low to high

Toggle Switch = Sensitivity range selection, N (normal) or H (high), use corresponding potentiometer for the sensitivity adjustment.

!!!!!Note: Improve the sensitivity may trigger fault detection signal

Figure 5.1: HMD-SM Control Panel

5.2 Automatic Threshold Level Description

Definition- The HMD-SM includes an Automatic Threshold Level Adjustment. The sensor’s built in circuit will automatically adjust the signal output when hot metal enters scanning field to prevent detect signal from saturation. According to different field applications, base threshold signal level is determined on installation. Follow “Base Threshold Level Adjustment Procedure” in this section to setup the right threshold level.

Sensitivity- Flip sensitivity toggle switch to N (or H), Tune the corresponding threshold level potentiometer clockwise will increase the sensitivity leveled from 1 to 7 in its range. The
lower the potentiometer setting, the hotter the target should be and the more interfering background radiation will be eliminated.

**N:** Normal sensitivity, for steel target temperature higher than 400°C (752°F)

**H:** High sensitivity, for steel target temperature from 250°C - 400°C (480°F-750°F).

- **Base Threshold Level Adjustment Procedure**

  1. Align the HMD to the target or put Logika Hot Metal Simulation Test Bar in the HMD-SM’s scanning field.

  2. **Normal (N) Sensitivity**
     - Flip the sensitivity toggle switch to N
     - Tune normal threshold level potentiometer to 3 (middle position).
     - Adjust the potentiometer until the LED color changes from green to red.
     - This is the lowest threshold setting for this application. Turn potentiometer one unit higher (clockwise) as the operating base threshold level setup.

  3. **High (H) Sensitivity**
     - Flip the sensitivity toggle switch toward H
     - Tune high threshold level potentiometer to 3 (middle position)
     - Adjust the potentiometer until the LED color changes from green to red.
     - This is the lowest threshold setting for this application. Turn the potentiometer one unit higher (clockwise) as the operating base threshold level setup.

  4. If the LED does not change from green to red with hot metal in HMD scanning field, first make sure the sensor is aligned properly and the target metal temperature is over 250 °C (480 °F), then adjust the shutter width in front of the shroud (Section 3.2 Horizontal Scanning field). The sensor will receive more infrared radiation energy from target. Go back to the above steps to reset the threshold level.

  **Caution**- After long time operation, the temperature of rollers will increase similarly to the target temperature. To avoid false signal triggered by hot rollers, the HMD’s scanning field must be set at the gap between the two rollers.

- **5.3 Remote Threshold Sensitivity**

  On the control panel
  Turn both POTs to level 1, flip the toggle switch to N
  On the control room, use a 10k POT and a toggle switch for remote sensitivity setup.

  See Figure 5.2 for detail wirings.
5.4 Test Function
To test the electrical integrity of the HMD-SM sensor, follow the steps below:

- Connect power supply to the HMD-SM, make sure the green LED is ON.
- Press and hold the “TEST” button when no target in the scanning field of view.
  - The LED turns to red
  - The relay clicks
  - Pin 4B (white, High=Detect) changes to 24VDC from 0VDC (compare to Pin 3B, Blue)
  - Pin 4A (Black, low=Detect) changes to 0VDC from 24VDC (compare to Pin 3B, Blue)

- Release the test button to return to normal operation and end the test function.

- **Remote test function:** See the Figure 5.3 for reference, it has the same function as the test button on control panel.

5.5 Troubleshooting
➢ **Missed Target**- If the HMD doesn’t act normally when a hot metal target is in the scanning field, there are two possibilities:

1. The Horizontal Scanning Angle Shutter located in front of the sensor is closed. Manually adjust the shutter to allow the target’s infrared energy to reach the detector.
2. The threshold sensitivity potentiometer is set too low. Go to Section 5.2, and recalibrate the Base Threshold Level.

➢ **False Positive Target Detected**-
1. The base threshold is set too high. Go to Section 5.2, and recalibrate the Base Threshold Level.
2. If step 1 does not correct false positives, check for background sources of radiation such as reflected sunlight or hot processes behind the target line. Correct these conditions as necessary by adjusting the sensor aiming or by blocking the interfering radiation source.

➢ **Diagnostic Signal Output Detected**- Check the diagnostic signals available and their status indication (see Section 4.1 Sensor Diagnostic Outputs for details). Correct fault conditions as necessary. See additional notes below:

➢ Control Output terminals 2A/3B output 0VDC- Check that the sensor wiring connections are correct, that the connections are secure and tight and that the power supply is proper and normal.

➢ Alarm Output terminals 4C/3B normally will output a signal of 24VDC. If the output is 0V following a detected error, the following situation may occur:

1. If the housing temperature is over 55°C (130°F), then water cooling must be used (see section 4.2). If water cooling is already in use, then check the water's inlet temperature and clogged water line.
2. If lens and temperature are fine, and alarm is still there. Measure the signal amplitude output, 0VDC means the Scanning Error (motor error or circuit error). Please contact Logika Technologies for resolution.

### 6. Maintenance

#### 6.1 Regular Maintenance

➢ **Diagnostics**- Usually, the HMD-SM does not need special maintenance. Regular attention to the following will ensure steady operation of the sensor:

➢ **Lens Cleaning**- periodically check the HMD-SM sensor’s glass for dust or oil residue, like a month or 2 months depended on the sensor’s environment and purge air quality. Open the black lens shroud and clean the glass with alcohol and lens paper or soft cloth.

➢ **Detector**- Monitor the Signal Amplitude Output (Terminal 3C, Figure 4.1) for the general conditions of the photocell and optical system.
Adjustments- The threshold level sensitivity (see Section 5.2) and the shutter may require adjustment if conditions are changed.

6.2 Returns of the HMD-SM

Contact us at 1-888-856-4452 (1-888-8LOGIKA) with the Serial Number of your HMD-SM before you return our product. If the problem cannot be resolved by telephone or email, we will provide you with a return authorization number.

Please return to:
Logika Technologies Inc.
2-2857 Sherwood Heights Drive,
Oakville, ON, L6J 7J9
Canada

Do not return the HMD-SM without a return authorization number. If the product is out of warranty, we will provide a repair estimate and then complete the repairs upon your approval.

7. Accessories- Hot Metal Simulation Test Bar

- In order to facilitate the installation, use and maintenance of HMD-SM hot metal detector and other infrared sensors, Logika has developed a hot metal simulation test bar, Model TP-1. This process simulation tool uses an AC power supply of 110/220V with the maximum power of 500 W. The power output can be adjusted by the potentiometer on the test bar to simulate different process temperatures.

- When using the TP-1 test bar, please note the following:
  - The power supply should be supplied with a ground.
  - The test bar is made of sensitive electronic components. Use care when handling the unit.
  - Maximum one hour continuous usage, turn the power off when it is not used.
  - The tungsten lamp tube can be replaced if it is burnt.
Figure 7.1: Hot Metal Simulation Test Bar Drawing
8. HMD-SM Enclosure Dimensions

All units are in mm

![Diagram of HMD-SM Enclosure Side View]

Figure 8.1: HMD-SM Enclosure Side View
Figure 8.2: HMD-SM Enclosure front View

Figure 8.3: HMD-SM Enclosure top View
Figure 8.2: Junction Box Dimension