MODLINE 3™

INFRARED THERMOMETER

INSTALLATION / OPERATION MANUAL

Revision M1
December 2011

The product meets:
EC Directive 2004/108/EC, Electromagnetic Compatibility (EMC)
EC Directive 2006/95/EC, Low Voltage (LVD)
and carries the CE mark

NIST Calibration Provider

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Part No. 050403 Rev M

FOREWORD

An Introduction to the MODLINE 3 Infrared Thermometer

The IRCON MODLINE 3 Infrared Thermometer is a non-contact temperature measuring instrument. It monitors temperature continuously, without contact, by sensing the infrared energy radiated by a target object. A MODLINE 3 Infrared Thermometer generates a digital temperature display, and with appropriate options, can provide control functions based on process temperature levels.

IRCON's MODLINE 3 System is a blend of proven temperature measuring techniques and modern solid state technology. It is an accurate, reliable, and versatile instrument. This system's design gives you the power to make choices from all the available sensors and optional equipment to match your process requirements.

A Word About IRCON, Inc.

The IRCON quality system is certified to International Quality Standard ISO 9001, model for quality assurance in design/development, production, installation, and servicing. IRCON has committed to providing quality products and services that meet customers needs and provide total customer satisfaction.

A Word About the Manual

To understand your system and its capabilities, we recommend a careful review of the manual before you start the installation. This manual is assembled with the information you need to install, operate, and maintain the MODLINE 3 system you selected. The CONTENTS pages show the section headings, a brief section description and a list of the section headings. Sections 1, 5, 6 , 7 and 8 are general information on the system equipment, functions and features. Section 2 is repeated as Section 2 FO, to show the differences in installation of fiber optic sensors. Sections 3, and 4 explain the installation and checkout of the major components. Sections 3 and 4 are augmented by Sections 3C and 4C to show the differences in operation and testing for a System with No Controller options and one with an On-Off Controller. Sections 3P and 4P show the differences for PID Controllers. Section 9 Addendum contains information on requirements and cabling. Appendix A contains the NEMA Safety Guidelines. The Index provides page numbers for section headings, sub-headings, components, key words, abbreviations and acronyms.

CE

Regarding European Electromagnetic Compatibility Directive 2004/108/EC and Low Voltage Directive 2006/95/EC Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory use; this device carries the CE mark.

The MODLINE3 System has been tested to and meets the following:
EN61326-2: Emissions Standard for Industrial Environment
EN61326-2: Immunity Standard for Industrial Environment
EN61010-1: Safety Requirements for Electrical Equipment for Measurement

CAUTION

Interchanging non-CE-approved components such as older sensing heads, indicators, PC boards, and cables will not maintain compliance with the CE directive.

IEC

NOTICE: This equipment provides protection against electrical shock and arcing as directed by IEC 348, Second Edition, dated 1978

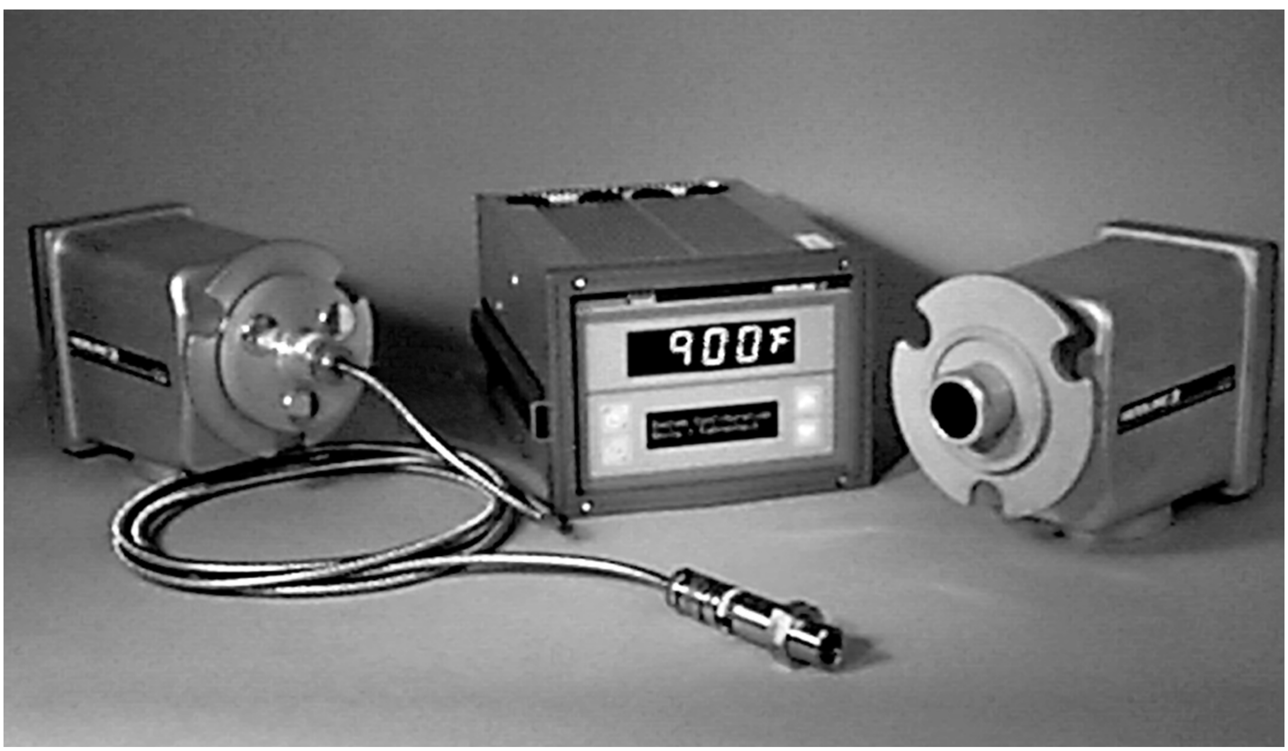
Applications Assistance

IRCON, Inc. has a proud tradition of commitment to the industries we serve. Our instruments are conceived, engineered, and manufactured with your applications in mind. This commitment goes beyond delivery of a quality instrument. If you need help in installing or using your instrument, contact IRCON Applications Engineering. Our Applications Specialists will give you the help you need!

Telephone: +1 800 227 8074 (USA/Canada), +1 831 458 3900

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired!

MODLINE 3 DISPLAY PANEL



MODLINE 3 INDICATOR / PROCESSOR AND SENSORS

Note: Your MODLINE 3 System will have one indicator / processor and one sensor, see Section 1.4.

WARRANTY

IRCON, Inc. warrants equipment manufactured by it to be free from defects in materials and workmanship for a period of one year from the date of shipment by IRCON. Customer-paid repairs are warranted for 90 days from date of shipment. If within such period any such equipment shall be proved to IRCON's satisfaction to be so defective, such equipment shall be repaired or replaced at IRCON's option, provided the defective equipment is returned to IRCON, transportation charges prepaid by purchaser. This warranty shall not apply **(a)** to equipment not manufactured by IRCON, **(b)** to equipment which shall have been repaired or altered by others than IRCON so as, in its judgement, to affect the same adversely, or **(c)** to equipment which shall have been subject to negligence, accident or damage by circumstances beyond IRCON's control or to improper operation, maintenance or storage, or to other than normal use or service. With respect to equipment purchased by IRCON but not manufactured by IRCON, the warranty obligations of IRCON shall in all respects conform and be limited to the warranty actually extended to IRCON by its supplier (the manufacturer). The foregoing warranties do not cover reimbursement for transportation, removal, installation, or other expenses which may be incurred in connection with repair or replacement.

Except as may be expressly provided in an authorized writing by IRCON, IRCON shall not be subject to any other obligations or liabilities whatsoever with respect to equipment manufactured by IRCON or services rendered by IRCON. ***THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES EXCEPT WARRANTIES OF TITLE, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.***

LIMITATION OF LIABILITY

Anything to the contrary herein contained notwithstanding, ***IRCON, ITS CONTRACTORS AND SUPPLIERS OF ANY TIER, SHALL NOT BE LIABLE IN CONTRACT, IN TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) OR OTHERWISE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER.*** The remedies of the purchaser set forth herein are exclusive where so stated and the total cumulative liability of IRCON, its contractors and suppliers of any tier, with respect to this contract or anything done in connection therewith, such as the use of any product covered by or furnished under the contract, whether in contract, in tort (including negligence or strict liability) or otherwise, shall not exceed the price of the product or part on which such liability is based.

⚠ WARNING ⚠

Risk of Personal Injury

When this instrument is being used in a critical process that could cause property damage and personal injury, the user should provide redundant device or system that will initiate a safe process shutdown in the event that this instrument should fail. The user should follow NEMA Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control.

A copy of the guidelines is reprinted in Appendix A.

CONTENTS

Section 1 — General Information

This section acquaints you with your MODLINE 3 System. It describes the instrument components and gives you the "feel" of the MODLINE 3—model identification, specifications, and standard system configurations.

Section 2 — Sensors

This section describes the SLR Sensors of the MODLINE 3, with primary emphasis on installation procedures. Care spent in the installation will be rewarded by accurate, reliable measurements and trouble-free operation.

Section 2F — Sensors (Fiber Optic Version)

This section describes the Sensors of the Fiber Optic System, with primary emphasis on installation procedures. It involves positioning the Focusable Reimaging Lens or Extension Tip of the Fiber Optic Cable.

Section 3 — Indicator Processor

This section provides the information you will need to install the MODLINE 3 Indicator/Processor. General installation requirements are given for physically mounting the enclosure. Wiring details are provided for all standard and optional features.

Section 3C — Indicator / Processor (On-Off Controller)

This section provides the information you will need to install the MODLINE 3 On-Off Controller. It is supplementary to the general procedures for all MODLINE 3 Indicator / Processor, as described in Section 3. Perform the procedures in Section 3C after you have completed all appropriate procedures in Section 3.

Section 3P — Indicator / Processor (With PID Controller Option)

This section provides the information you will need to install the MODLINE 3 PID Controller. It is supplementary to the general procedures for all MODLINE 3 Indicator / Processor, as described in Section 3. Perform the procedures in Section 3P after you have completed all appropriate procedures in Section 3.

Section 4 — Operation

The operating procedures in this section are common to all MODLINE 3 instruments. If your Indicator / Processor is equipped with an On-Off or PID Controller, the additional operating procedures for these options are added as supplementary sections.

Section 4C — Operation (On-Off Controller)

This section describes the setup and operating procedures for a MODLINE 3 On-Off Controller. It is supplementary to the general set-up and operating procedures for all MODLINE 3 Indicator/Processors, described in Section 4.

Section 4P — Operation (PID Controller)

This section describes the setup and operating procedures for a MODLINE 3 PID Controller. It is supplementary to the general set-up and operating procedures for all MODLINE 3 Indicator/Processors, described in Section 4.

Section 5 — Maintenance & Service

This section provides information you will need to perform routine maintenance and service on your MODLINE 3 instrument. Basic troubleshooting suggestions are also provided.

Section 6 — Optional Accessories

This section describes the common accessories.

Section 7 - Applications Guide

This section provides information about specific infrared concepts and gives practical applications advice.

Section 8 - Digital Communications

This section provides information about the RS-485 Digital Interface.

Section 9 - Addendum

Section 1 — GENERAL INFORMATION

The purpose of this section is to acquaint you with your MODLINE 3 instrument. It describes the instrument components and gives you an idea of the part they play in over-all operation.

Unpack and inspect each component as you follow the general descriptions. Details of installation and operation are given later. In this section, we give you the "feel" of the MODLINE 3—model identification, specifications, and standard system configurations.

Section **Page**

Section 1 — GENERAL INFORMATION

1.1 PRELIMINARY INSPECTION

MODLINE 3 instruments are delivered in plastic wrappings, cradled in foam plastic liners inside rugged cartons. Unpack the Indicator/ Processor, Sensor and if ordered, its fiber optic components, Signal Cable, all mounting hardware, and any accessories you may have ordered as shown on the packing list. Place these on a workbench or desk before removing plastic covers. Save the cartons until you are sure you will have no further use for them.

All components are carefully inspected and tested both mechanically and electrically before shipment. Inspect each component carefully to determine if any damage occurred in transit. If such damage is noted, promptly inform the freight agent delivering the instrument.

Check the packing slip to make sure that all the accessories you may have ordered are included.

The tips of fiber optic components are protected by plastic covers. Leave these in place for the time being.

A small IRCON screwdriver is supplied with the sensor. Put them in a safe place; you will need them during the installation.

NOTICE

If damage has been noted and you wish to ship the instrument back to IRCON for service, or if you wish to ship the instrument to another plant location, please use the shipping carton in which the instrument was originally packed.

Place all components back into the wells of the foam liner and seal the carton securely.

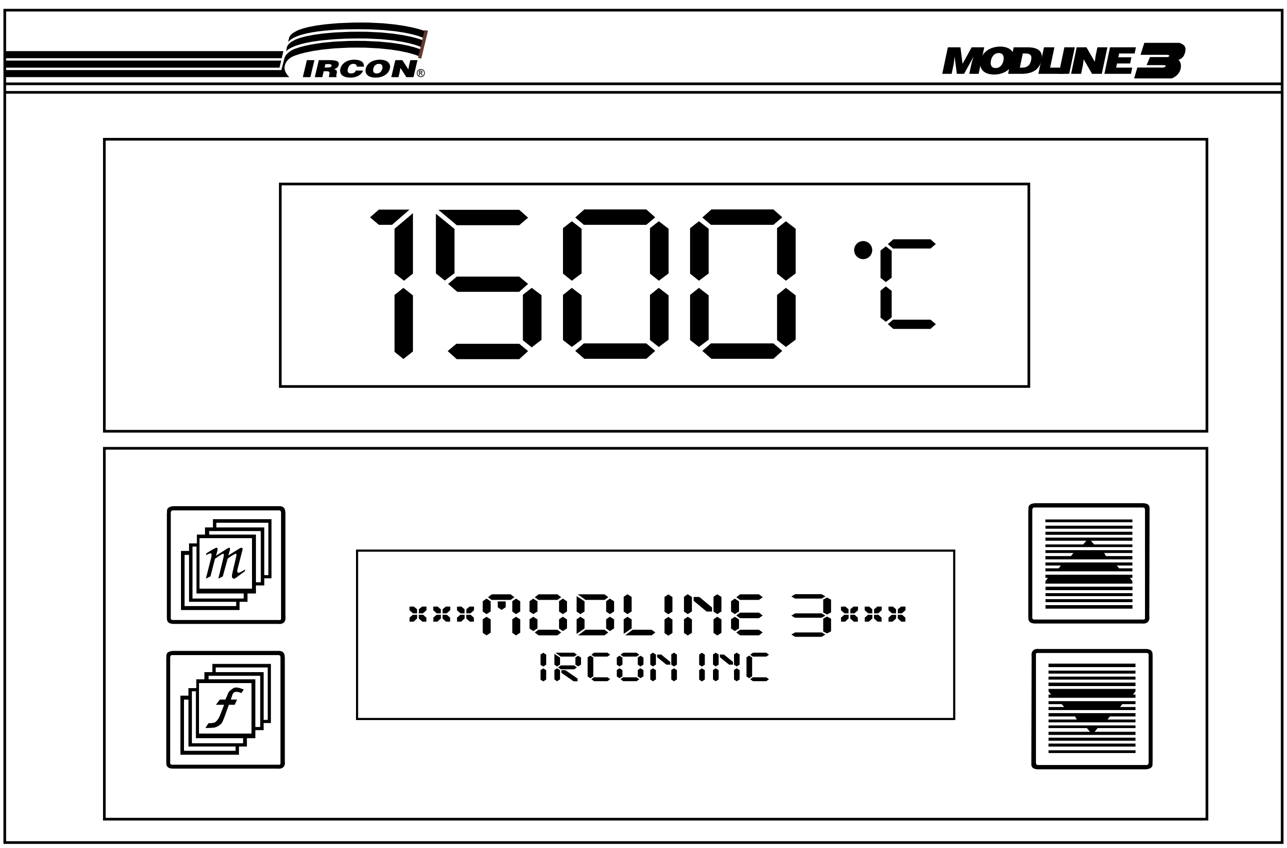


FIG. 1.1 – MODLINE 3 FRONT PANEL

Section 1 — GENERAL INFORMATION

1.2 DESCRIPTION

The IRCON MODLINE 3 is a non-contact temperature measuring system. It measures temperature indirectly by measuring infrared energy radiated by the object or "target." The intensity or "brightness" of radiation varies with the temperature of the object and is therefore an ef fective means of temperature measurement.

THE SYSTEM
IRCON's MODLINE 3 System consists of a Sensor and an Indicator / Processor linked by a Signal Cable as shown in Fig. 1.2. The Sensor is the "eye" of the system, located at some point where it has a clear view of the target object. It delivers temperature signals to the Indicator / Processor that can be located at an observation or control station.

The Indicator / Processor processes the incoming signals and provides a temperature display . A choice of Analog Signal Outputs, 4 to 20 mA, 0 to 20 mA, or 5 uA per degree is available and may be used to drive remote temperature indicators, recorders, and data acquisition devices. The RS-485 Digital Communications Interface can transfer temperature data to a computer or other digital device. When an On-Of f or a PID controller option is selected, measured temperature levels may be made to provide alarming or control the temperature of the process.

INDICATOR/PROCESSOR
The Indicator / Processor shown in the Basic System in Fig. 1.2 processes the temperature signals and provides a front panel display of temperature. It houses all of the controls and signal processing elements needed to set up and operate the system. Its built-in power supply provides regulated operating voltages for the signal processing circuits. The Indicator / Processor , shown in Fig. 1.3 is working with a fiber optic Sensor.

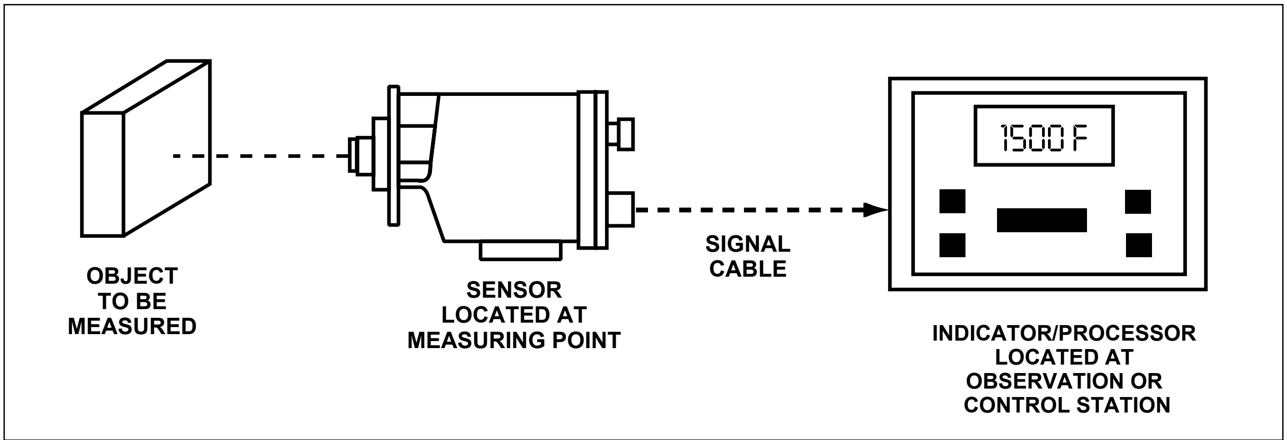


FIG. 1.2 – BASIC MODLINE 3 SYSTEM

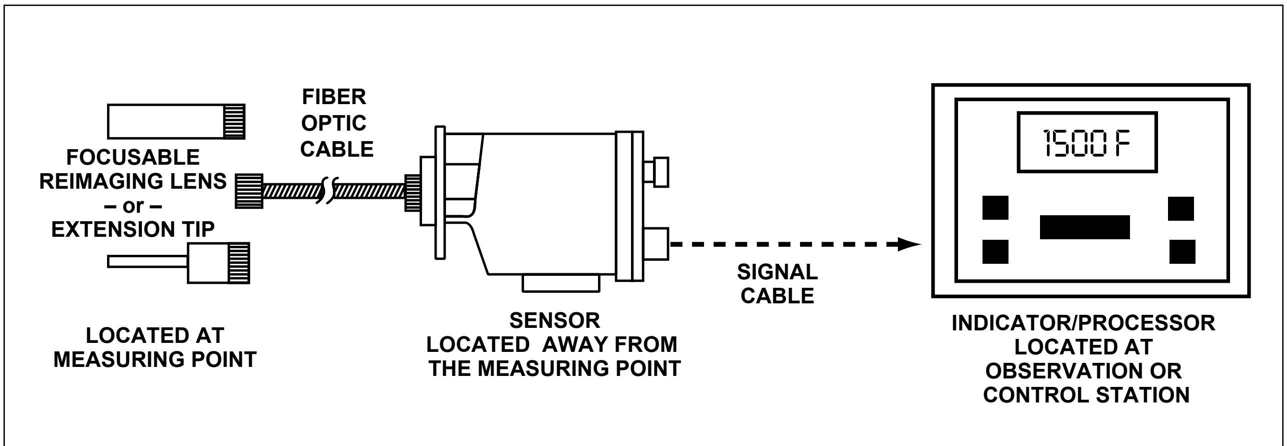


FIG. 1.3 – MODLINE 3 SYSTEM WITH FIBER OPTIC SENSOR

INDICATOR/PROCESSOR - *Continued*

Once inside the Indicator / Processor, the temperature signal is linearized and scaled to the range of the instrument. The temperature is displayed on a large digital display . All the operating controls for the Indicator / Processor are on the front panel.

SENSOR

The Sensor is an electro-optical device that senses infrared energy radiated by any object in its field of view. Its basic elements are an optical system and infrared detector as illustrated in the simplified diagram in Fig. 1.4. The fiber optic principles are shown in Fig. 1.5.

The optical system guides the infrared radiation to the detector. The detector produces an electrical signal proportional to the radiant intensity and therefore analogous to the temperature being observed.

Note: Series 3L and 3R Sensors have two detectors, which measure infrared radiation at two wavelengths and compute the ratio of the two radiation levels. This ratio serves as the output signal.

All MODLINE 3 Sensors work on the basic principle shown in Fig. 1.4, but they differ in the type of optical system and the type of infrared detector used.

The optical elements and detectors in the various Sensor Series are designed so the Sensor responds to infrared radiation in a certain band of wavelengths. It does not respond to radiation at other wavelengths. In effect, the Sensor ignores materials such windows or atmospheres that would otherwise give false measurements and it concentrates on the target material.

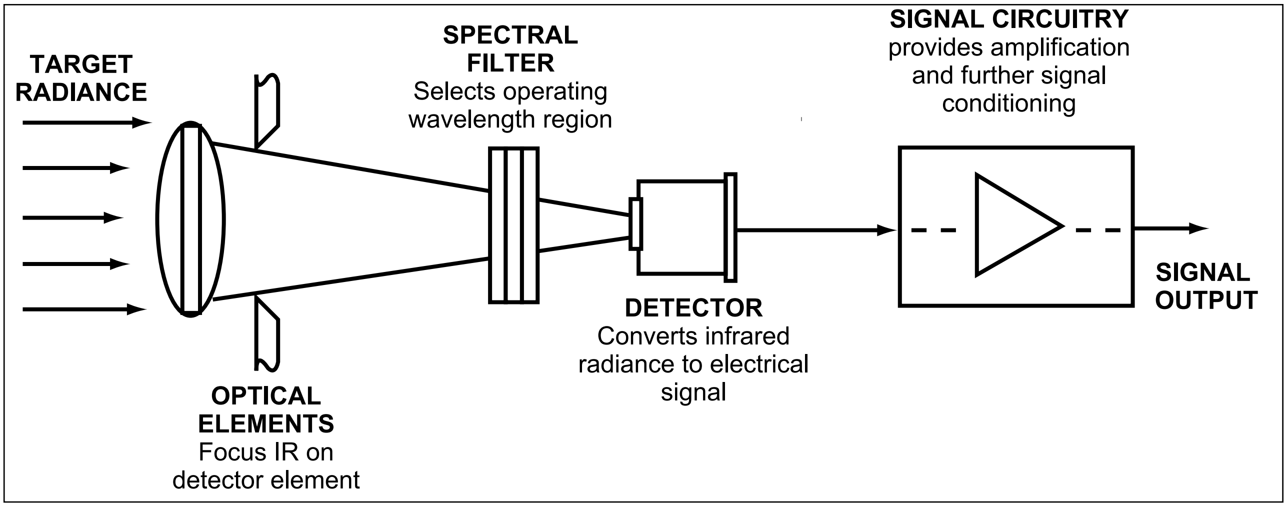


FIG. 1.4 – SENSOR PRINCIPLE

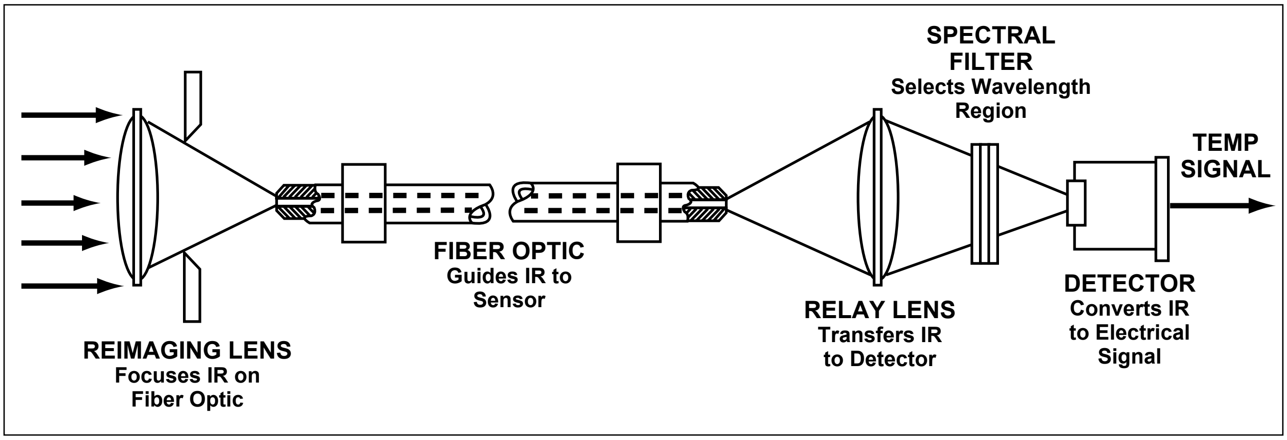


FIG. 1.5 – FIBER OPTIC SENSOR PRINCIPLE

Section 1 — GENERAL INFORMATION

SENSOR - *Continued*

There are many Sensor models to choose from. Each model is different in a number of ways:

1. The range of temperatures it measures.

   The Sensor is designed and calibrated to produce a zero signal output at a certain minimum temperature, and a maximum signal output at a certain maximum temperature.

2. The infrared wavelengths it responds to.

   The optical elements and detectors are designed so the sensor responds to infrared radiance in a certain band of wavelengths. In effect, the Sensor ignores materials and atmospheres that would otherwise give false measurements. It has the ability to concentrate on the materials of interest.

   Example: Sensor Series 700 responds to radiance in the 4.8 to 5.3 micron band. Glass is practically opaque and radiates strongly in this wavelength band. This band is also “a window” between two regions where carbon dioxide (CO_2 at 4.2 to 4.4 microns) and water vapor (H_2O at 5.6 to 8.0 microns) in the atmosphere absorb infrared radiation. A Sensor Series 700 is ideal for measuring a glass surface temperature and the measurements are not degraded by atmospheric conditions.

3. The type of optical system it uses:

   - SLR (Single Lens Reflex) Sensors, described in Section 2, use through the lens sighting and focusing.
   - Sensors using flexible fiber optic cable, described in Section 2F, use a focusable reimaging lens or an extension tip.

4. The target area it resolves at a given distance.

   The optical elements are designed to view certain surface areas at given Sensor-to-target distances. Higher resolutions give you the ability to view smaller objects at a particular viewing distance.

   Example: At a given viewing distance, a high resolution Sensor would be more desirable than a low resolution sensor for viewing a wire rod. A low resolution sensor would be fine for viewing the surface of a large steel plate at the same distance.

You may choose from the many important characteristics by specifying the Model Number of the Sensor Series, as shown in Section 1.5.

1.3 SPECIFICATIONS

Overall System

SPECTRAL RESPONSE
Each MODLINE 3 Series operates in a discrete wavelength band as shown in the Model Identification Table in Section 1.5.

CALIBRATION / BLACKBODY ACCURACY
Sensors 200, 3G, 3R, 3V and 3W
Within 0.6% of reading (+ 1 digit) or 5°F (3°C), whichever is larger
Sensors 340, 600, 700, 800 & 3L
Within 0.6% full scale (+ 1 digit) or 5°F (3°C), whichever is larger

REPEATABILITY @25°C:
Within 0.1% of full-scale temperature (+1 digit)

RESPONSE TIME AT ANALOG OUTPUT
Adjustable from 0.01 to 60 seconds.
**See Section 1.5 for limitations.*

NEMA 4
The Sensor Housing and Indicator/Processor Enclosure are rated NEMA 4 (IP66).

OPERATING AMBIENT
without auxiliary cooling
Sensor* Series 200 and 3 G:
32 to 150°F (0 to 60°C)
Sensor* Series 3L and 3R:
32 to 130°F (0 to 55°C)
Sensor* Series 3V and 3W:
50 to 113°F (10 to 45°C)
Sensor* Series 340, 600, 700, and 800:
50 to 130°F (10 to 55°C)
**See Section 1.5 for restrictions.*
Sensor Cable PVC:
220°F (100°C) Max. Temp.
Sensor Cable Silicone Rubber:
400°F (200°C) Max. Temp.
Indicator / Processor:
32 to 122°F (0 to 50°C)

HUMIDITY
10 to 90% non-condensing

SIZE INDICATOR / PROCESSOR
See Figure 3.2.

SIZE SENSOR
See Figures 2.6 and 2F.12.

ANALOG OUTPUTS, 0 TO 10 Vdc OR SELECTABLE CURRENT OUTPUTS
- 0 to 20 mAdc with a 1000 Ω max.
- 4 to 20 mAdc with a 1000 Ω max.
- 5μAdc per degree F or C (provides 1mV per degree, when used with a 200 Ω 0.1% resistor)

**See Section 4.21 for limitations.*
All Outputs are isolated from ground

DIGITAL COMMUNICATIONS
RS-485 Digital Interface

EMISSIVITY RANGE*
Emissivity is 0.100 to 1.000.
**See Sections 1.5 and 7.2 for limitations.*

E-SLOPE RANGE*
E Slope is 0.850 to 1.150.
**See Section 7.4.*

POWER REQUIREMENTS
90 to 250Vac, 50/60Hz, 40VA max.

WEIGHT
Sensor: 7 to 8 lb (3.2 to 3.6 kg)
Indicator/Processor:
Approximately 9 lbs (4 kg)

Series 3L & 3R Sensor a Two Color Pyrometer

3L SPECTRAL RESPONSE
Adjacent bands: 1.50 to 1.60 μ; and 1.65 to1.71 μ

3R SPECTRAL RESPONSE
Adjacent bands:0.7 to 1.08 μ and a narrow band centered at 1.08μ

SIGNAL REDUCTION RANGE
Caused by low emissivity, nonresolved or an obliterated target above 1500°F (800°C) for 3R Series or 575°F (300°C) for 3L Series. It will tolerate about 95% reduction in radiation intensity.

INVALID ALARM
Form C relay outputs rated at 24 V AC/DC;
@ 1 Amp. Resistive or Inductive.

Peak Picker

RISE TIME
Same as selected Response Time, from 0.01 to 60 seconds.

DECAY RATE
Adjustable 0.00 to 300°F per second or 0.00 to 300°C per second.

PEAK PICKER RESET:
Internal Reset has Two Modes: Manual and Auto.
External Reset via contact closure.

On/Off Controllers with Relay Outputs

RESPONSE TIME
Same as selected Response Time, from 0.01 to 60 seconds.

RELAY DELAY TIME
1 to 2 milliseconds.

REMOTE SET POINT
Set Point 1 has an Input Signal of 4 to 20 mA, 50 Ω load, daisy chain compatible
INTERNAL SET POINT:
Adjustable over full temperature span of the instrument model

RELAY OUTPUTS
Two Form C relay outputs rated at 24 V AC/DC; @ 1 Amp. Resistive or Inductive.
HYSTERSIS
2°F (2°C)

PID Controllers With Deviation Alarms

PID OUTPUT
4 to 20 mAdc, Isolated
1000 Ohm maximum

REMOTE SET POINT
Input Signal of 4 to 20 mA, 50 Ω load, daisy chain compatible

INTERNAL SET POINT:
Adjustable over full temperature span of the instrument model

PROPORTIONAL BAND (P)
0.1 to 200.0%

RESET RATE (I)
0.01 to 99.00 repeats per minute, with an Off position

RATE TIME (D)
0.001 to 9.900 minutes, with an Off position

LOAD DEMAND
0 to 100% of output

MANUAL ADJUST
0.0 to 100.0% of output

DEVIATION ALARM SET POINTS
Adjustable for HI and LO set points over the full temperature span of the instrument model, each with an Off position

DEVIATION ALARM OUTPUT
Relay Outputs for HI and LO Alarms use two Form C relay outputs rated at 24 V AC/DC;
@ 1 Amp. Resistive or Inductive.

1.4 COMPONENTS

Your MODLINE 3 System consists of the following instruments and optional accessories. Check the packing slip list for the items and accessories you have ordered:

- One Sensor with a Sensor-to-Indicator / Processor 12 foot Signal Cable.
- One Indicator / Processor.
- Mounting Brackets and Screws for the Indicator/Processor Unit.
- Two grounding strain reliefs, one small / one large, for each System. Systems having an On-Off or PID Controller receive two small / one large.
- An Installation and Operation Manual

Fiber optic sensors are supplied by IRCON with a 10 foot (3 meter) fiber optic cable.

- The fiber optic sensor lens, extension tips and accessories are described in Section 2F.

You may order accessories as described and shown in Section 6 and listed here:

- AA-3, or AA-5 Air Purge (optional).
- WJ-5 Water Cooling Jacket (optional).
- WA-3 Water Cooling Accessory (optional).
- TM-6 Tripod (optional).
- SB-1 or SB-3 Swivel Base (optional).

You are expected to supply the peripheral items for the Infrared Thermometer System. The following is a list of the suggested items:

- Air Tubing and Fittings to link the air supply to the Sensor air purge.
- Water tubing and fittings for the WJ-5 Water Jacket or the WA-3 Cooling Accessory.
- Conduit and fittings for AC Power lines.
- Two-Pole Vac Safety Switch.
- Shielded Cables, grounding strain relief fittings, and RS-485 Digital Communications cables are described in Section 9.1.
- Chart Recorders, Analog and Digital Meters or a Host Computer / PLC (optional).

You may order an analog output resistor of the type described in Section 3.8:

- Resistor: 200 Ohm @ 0.1% tolerance, IRCON Part Number 514692.

1.5 MODEL IDENTIFICATION

MODLINE 3 Systems are identified by blocks of model number digits as shown in the example below. The complete model number and serial number of your instrument are shown on the packing slip and on the identification plate behind the back cover of the Indicator/Processor . Section 1.5 identifies all the models.

The serial number and Blocks A and B of the model number are also shown on the serial plate of the Sensor.

Example:

3 3	–	0 5 F 0 5	–	0	–	0	–	0	–	0
A		B		C		D		E		F

A. 33 = Modline 3 / Series 340
B. 05F05 = 150 to 500°F Temperature Range; D/50 Resolution
C. 0 = Signal Conditioning – Peak Picker and Track & Hold
D. 0 = Analog Current Output – 4 to 20 mA, 0 to 20 mA, and 5uA per degree
E. 0 = Digital Signal Output – RS 485 Interface
F. 0 = No Controller Output .

Block F indicates: a No Controller Output, a Two Point On-Off Controller with Relay Output, or a Thee Point PID Controller with Analog Output and Deviation Alarms.

Note: The number 9 in any block of the model number indicates that the system is specially modified in that area.

1.5 MODEL IDENTIFICATION - Continued

The blocks identify the model number and series designation. These charts identify the series, features and options.

Example for Series Designation Block:

A	B	C	D	E	F
3 3	0 5 F 0 5	0	0	0	0

BLOCK A - SERIES DESIGNATION

The first two digits are called Block A and denote the System Series.

3 2	Series 200
3 3	Series 340
3 6	Series 600
3 7	Series 700
3 8	Series 800
3 G	Series 3G
3 L	Series 3L
3 R	Series 3R
3 V	Series 3V
3 W	Series 3W

BLOCK B - TEMPERATURE RANGE, OPTICAL CHARACTERISTICS AND FIBER OPTIC OPTIONS

The next five digits are called Block B. The first two digits of this five digit block designate full scale temperature in hundreds of degrees. The third digit designates whether the calibration is in ° F or ° C. The fourth and fifth digits designate the Optical Resolution Factor and Spot Size Option of the Sensor.
Response Time Per Model - Sensors in these charts are marked to show response times.

① Limited range of response time is 0.10 to 60 seconds.

② Limited range of response time is 2.0 to 60 seconds.

③ Limited range of response time is 0.25 to 60 seconds.

④ Limited range of response time is 1.0 to 60 seconds.

⑤ Response time of 0.02 to 60 seconds for 3LSensor,

☛ All others have a range of 0.01 to 60 seconds.

Series 200 * — 0.70 to 1.00 µ (microns)

2 0 F 0 5 = 900 - 2000°F, D/50
2 4 F 1 0 = 1000 - 2400°F, D/100
3 0 F 2 0 = 1200 - 3000°F, D/200
4 8 F 3 0 = 1400 - 4800°F, D/300
1 1 C 0 5 = 500 - 1100°C, D/50
1 3 C 1 0 = 550 - 1300°C, D/100
1 4 C 1 0 = 600 - 1400°C, D/100
1 5 C 2 0 = 650 - 1500°C, D/200
1 6 C 3 0 = 800 - 1600°C, D/300
2 6 C 3 0 = 750 - 2600°C, D/300

* *Emissivity span is restricted to 0.3 to 1.0 for the first 100°F or 55°C for all temperature ranges.*

Series 200 * — *Fiber Optic* — 0.70 to 1.00 µ (microns) with a 10 foot (3m) fiber optic cable

2 5 F F 5 = 1200 - 2500°F, D/30
2 5 F F 8 = 1200 - 2500°F, Extension Tip
3 0 F F 6 = 1300 - 3000°F, D/60
3 0 F F 7 = 1300 - 3000°F, D/30 x D/150
3 0 F F 8 = 1300 - 3000°F, Extension Tip
4 8 F F 6 = 1800 - 4800°F, D/60
4 8 F F 7 = 1800 - 4800°F, D/30 x D/150
4 8 F F 8 = 1800 - 4800°F, Extension Tip
1 5 C F 5 = 650 - 1500°C, D/30
1 5 C F 8 = 650 - 1500°C, Extension Tip
2 0 C F 6 = 700 - 2000°C, D/60
2 0 C F 7 = 700 - 2000°C, D/30 x D/150
2 0 C F 8 = 700 - 2000°C, Extension Tip
2 6 C F 6 = 750 - 2600°C, D/60
2 6 C F 7 = 750 - 2600°C, D/30 x D/150
2 6 C F 8 = 750 - 2600°C, Extension Tip

* *Emissivity span is restricted to 0.2 to 1.0 for the first 100°F or 55°C for all temperature ranges.*

Series 340 — 3.43 µ (microns) & (0.14 µ band)

② 0 4 F 0 5 = 75 - 400°F, D/50
① 0 5 F 0 5 = 150 - 500°F, D/50
0 6 F 0 5 = 200 - 600°F, D/50
1 0 F 1 0 = 300 - 1000°F, D/100
1 5 F 1 0 = 500 - 1500°F, D/100
② 0 2 C 0 5 = 25 - 200°C, D/50
① 0 3 C 0 5 = 75 - 300°C, D/50
0 4 C 0 5 = 100 - 400°C, D/50
0 5 C 1 0 = 150 - 500°C, D/100
0 8 C 1 0 = 200 - 800°C, D/100

Series 600 — 2.0 to 2.6 µ (microns)

① 0 4 F 1 5 = 150 - 400°F, D/150
① 0 5 F 1 5 = 200 - 500°F, D/150
0 6 F 1 5 = 250 - 600°F, D/150
0 8 F 1 5 = 350 - 800°F, D/150
1 0 F 1 5 = 500 - 1000°F, D/150
1 4 F 1 5 = 600 - 1400°F, D/150
① 0 2 C 1 5 = 80 - 200°C, D/150
① 0 3 C 1 5 = 120 - 300°C, D/150
0 4 C 1 5 = 160 - 400°C, D/150
0 6 C 1 5 = 250 - 600°C, D/150
0 8 C 1 5 = 350 - 800°C, D/150

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Section 1 — GENERAL INFORMATION

BLOCK B - Continued

Series 700 — 4.8 to 5.3 µ (microns)

④ 0 6 F 0 5 = 100 - 600°F D/50
① 1 0 F 0 5 = 200 - 1000°F D/50
1 5 F 1 0 = 500 - 1500°F D/100
2 5 F 1 0 = 500 - 2500°F D/100
④ 0 3 C 0 5 = 50 - 300°C D/50
① 0 6 C 0 5 = 100 - 600°C D/50
0 8 C 1 0 = 300 - 800°C D/100
1 3 C 1 0 = 300 - 1300°C D/100
2 5 C 1 0 = 1000 - 2500°C D/100

① *Adjustable range of response time is 0.10 to 60 seconds.*

④ *Adjustable range of response time is 1.0 to 60 seconds.*

Series 800 — 7.92µ (microns) & (0.3µ band)

③ 0 8 F 0 2 = 75 - 800°F D/20
③ 0 4 C 0 2 = 25 - 400°C D/20

③ *Adjustable range of response time is 0.25 to 60 seconds.*

1 8 F 0 5 = 500 - 1800°F D/50
2 0 F 1 0 = 600 - 2000°F D/100
2 5 F 1 5 = 700 - 2500°F D/150
1 0 C 0 5 = 250 - 1000°C D/50
1 1 C 1 0 = 350 - 1100°C D/100
1 4 C 1 5 = 400 - 1400°C D/150

* *Emissivity span is restricted to 0.3 to 1.0 for the first 100°F or 55°C for all temperature ranges.*

Series 3G * — *Fiber Optic* — 1.5 to 1.6µ (microns) & (0.16µ band)
with a 10 foot (3m) fiber optic cable

2 2 F F 5 = 650 - 2200°F, D/30
2 2 F F 8 = 650 - 2200°F, Extension Tip
2 5 F F 6 = 800 - 2500°F, D/60
2 5 F F 7 = 800 - 2500°F, D/30 x D/150
2 5 F F 8 = 800 - 2500°F, Extension Tip
1 2 C F 5 = 350 - 1200°C, D/30
1 2 C F 8 = 350 - 1200°C, Extension Tip
1 4 C F 6 = 450 - 1400°C, D/60
1 4 C F 7 = 450 - 1400°C, D/30 x D/150
1 4 C F 8 = 450 - 1400°C, Extension Tip

* *Emissivity span is restricted to 0.3 to 1.0 for the first 100°F or 55°C for all temperature ranges.*

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Series 3L ⑤ — 1.50 to 1.60 µ (microns) & 1.65 to 1.71 µ

1 0 F 0 5 = 500 - 1000°F D/50
1 4 F 1 0 = 700 - 1400°F D/100
✓ 1 8 F 1 0 = 1000 - 1800°F D/100
0 5 C 0 5 = 250 - 550°C D/50
0 7 C 1 0 = 400 - 750°C D/100
✓ 1 0 C 1 0 = 550 - 1000°C D/100

✓ *Indicates 1.00 to 1.20 microns and 1.65 to 1.71 microns.*

⑤ *Response time of 0.02 to 60 seconds.*

Series 3R — 0.7 to 1.08 µ (microns) & 1.08 µ

2 5 F 0 5 = 1300 - 2500°F D/50
3 2 F 0 5 = 1800 - 3200°F D/50
4 0 F 1 0 = 2000 - 4000°F D/100
6 5 F 1 5 = 2500 - 6500°F D/150
1 4 C 0 5 = 700 - 1400°C D/50
1 6 C 0 5 = 900 - 1600°C D/50
2 0 C 1 0 = 1100 - 2000°C D/100
2 4 C 0 5 = 900 - 2400°C D/50
3 5 C 1 5 = 1500 - 3500°C D/150

Series 3R — *Fiber Optic* — 0.7 to 1.08 µ (microns) & 1.08 µ
with a 10 foot (3m) fiber optic cable

2 5 F F 5 = 1300 - 2500°F, D/30
2 5 F F 8 = 1300 - 2500°F, Extension Tip
3 2 F F 5 = 1800 - 3200°F, D/30
3 2 F F 8 = 1800 - 3200°F, Extension Tip
4 0 F F 5 = 2000 - 4000°F, D/30
4 0 F F 8 = 2000 - 4000°F, Extension Tip
6 5 F F 6 = 2500 - 6500°F, D/60
6 5 F F 7 = 2500 - 6500°F, D/30 x D/150
1 4 C F 5 = 700 - 1400°C, D/30
1 4 C F 8 = 700 - 1400°C, Extension Tip
1 6 C F 5 = 900 - 1600°C, D/30
1 6 C F 8 = 900 - 1600°C, Extension Tip
2 0 C F 5 = 1100 - 2000°C, D/30
2 0 C F 8 = 1100 - 2000°C, Extension Tip
2 4 C F 6 = 900 - 2400°C, D/60
2 4 C F 7 = 900 - 2400°C, D/30 x D/150
3 5 C F 6 = 1500 - 3500°C, D/60
3 5 C F 7 = 1500 - 3500°C, D/30 x D/150

CONTINUED ON THE NEXT PAGE.

BLOCK B - Continued

Series 3V — 0.9 to 0.97 µ

① 1|0|C|0|2 = 400 - 1000°C D/20

① 1|2|C|0|5 = 450 - 1200°C D/50

① *Adjustable range of response time is 0.10 to 60 seconds.*

Series 3V — *Fiber Optic* — 0.9 to 0.97 µ
with a 10 foot (3m) fiber optic cable

‡ ① 1|5|C|F|5 = 500 - 1500°C, D/30

‡ ① 1|5|C|F|8 = 500 - 1500°C, Extension Tip

① *Adjustable range of response time is 0.10 to 60 seconds.*

‡ *These models are restricted to sensing head ambient temperature of 50 to 113°F (10 to 45°C) and a minimum emissivity setting of 0.400.*

Series 3W — 0.9 to 1.08 µ

‡ ① 1|5|F|0|2 = 600 - 1500°F D/20

① 2|7|F|1|0 = 900 - 2700°F D/100

‡ ① 0|8|C|0|2 = 300 - 800°C D/20

① 1|5|C|1|0 = 500 - 1500°C D/100

① *Adjustable range of response time is 0.10 to 60 seconds.*

‡ *These models are restricted to sensing head ambient temperatures of 50 to 113°F (10 to 45°C) and a minimum emissivity setting of 0.400.*

Series 3W — *Fiber Optic* — 0.9 to 1.08 µ
with a 10 foot (3m) fiber optic cable

‡ ① 2|2|F|F|5 = 800 - 2200°F, D/30

‡ ① 2|2|F|F|8 = 800 - 2200°F, Extension Tip

‡ ① 2|7|F|F|5 = 900 - 2700°F, D/30

‡ ① 2|7|F|F|8 = 900 - 2700°F, Extension Tip

‡ ① 1|5|C|F|5 = 500 - 1500°C, D/30

‡ ① 1|5|C|F|8 = 500 - 1500°C, Extension Tip

① 1|8|C|F|6 = 600 - 1800°C, D/60

① 1|8|C|F|7 = 600 - 1800°C, D/30 x D/150

① *Adjustable range of response time is 0.10 to 60 seconds.*

‡ *These models are restricted to sensing head ambient temperatures of 50 to 113°F (10 to 45°C) and a minimum emissivity setting of 0.400.*

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BLOCK C - SIGNAL CONDITIONING

Indicates type of signaling condition included in the Indicator / Processor.

0 Peak Picker and Track & Hold – standard features
Digits 1 to 8 are reserved for other options.
9 Reserved for special features.

BLOCK D - ANALOG SIGNAL OUTPUT

Designates the types of analog signal outputs available in the Indicator / Processor. BLOCK D is (0), (1) or (9 for special feature).

0 4 to 20 mA, 0 to 20 mA, or 5uA per degree –Selectable

1 0 to 10 Vdc

BLOCK E - DIGITAL SIGNAL OUTPUT

Indicates the type of digital signal output or interface used as the standard feature.

0 RS 485 Digital Communications Interface is standard.
Digits 1 to 8 are reserved for other options.
9 Reserved for special features.

BLOCK F - CONTROLLER OUTPUT

Indicates the type of process control action in the Indicator / Processor.

0 No controller options
1 PID Controller with deviation alarms
2 2-Point On/Off Controller with relay outputs
Digits 3 to 8 are reserved for other options.
9 Reserved for special features.

NOTES

1.6 SPECIAL MODIFICATION

There are no special modifications to this instrument. It is a standard model in all respects.

Section 2 — SENSORS

This section describes the Sensors of the MODLINE 3, with primary emphasis on installation procedures.

Sensor installation is very important to the accuracy of the system. It involves positioning the Sensor for a clear view of the target without interference from other objects or materials in the area you are measuring. Care spent in this part of the installation will be rewarded by accurate, reliable measurements and trouble-free operation.

Section **Page**

Section 2 — SENSORS

2.1 DESCRIPTION

MODLINE 3 Sensors are precision electro-optical instruments that sense infrared radiation and develop a signal proportional to the radiant intensity. The signal is coupled through the Signal Cable to the Indicator/Processor, where it is scaled to the temperature range of the instrument.

MODLINE 3 Sensors are variable focus instruments that feature through-the-lens sighting by means of a viewing telescope eyepiece on the backplate (see Fig. 2.1). A circular reticle visible through the eyepiece outlines the area being measured. The infrared detector in the Sensor "sees" the same image that is visible inside the reticle.

There are two housing styles as illustrated in Fig. 2.1. Series 200, 600, 3G, 3V and 3W Sensors are supplied in the cylindrical housing. The larger, rectangular housing is used for Sensor Series 340, 700, 800, 3L and 3R. This difference in housing style accommodates differences in optical design, detector type, and other features. However, the operating procedures, such as sighting and focusing, are the same with all housings.

The temperature signal is brought out of the sensor via a connector on the backplate. A screw-on mating connector on the signal cable assures that the Sensor cable connection will be drip-tight and dust-tight.

Every step has been taken to assure accurate measurement with repeatability. If the Sensor is installed with reasonable care, it will provide precise temperature measurement.

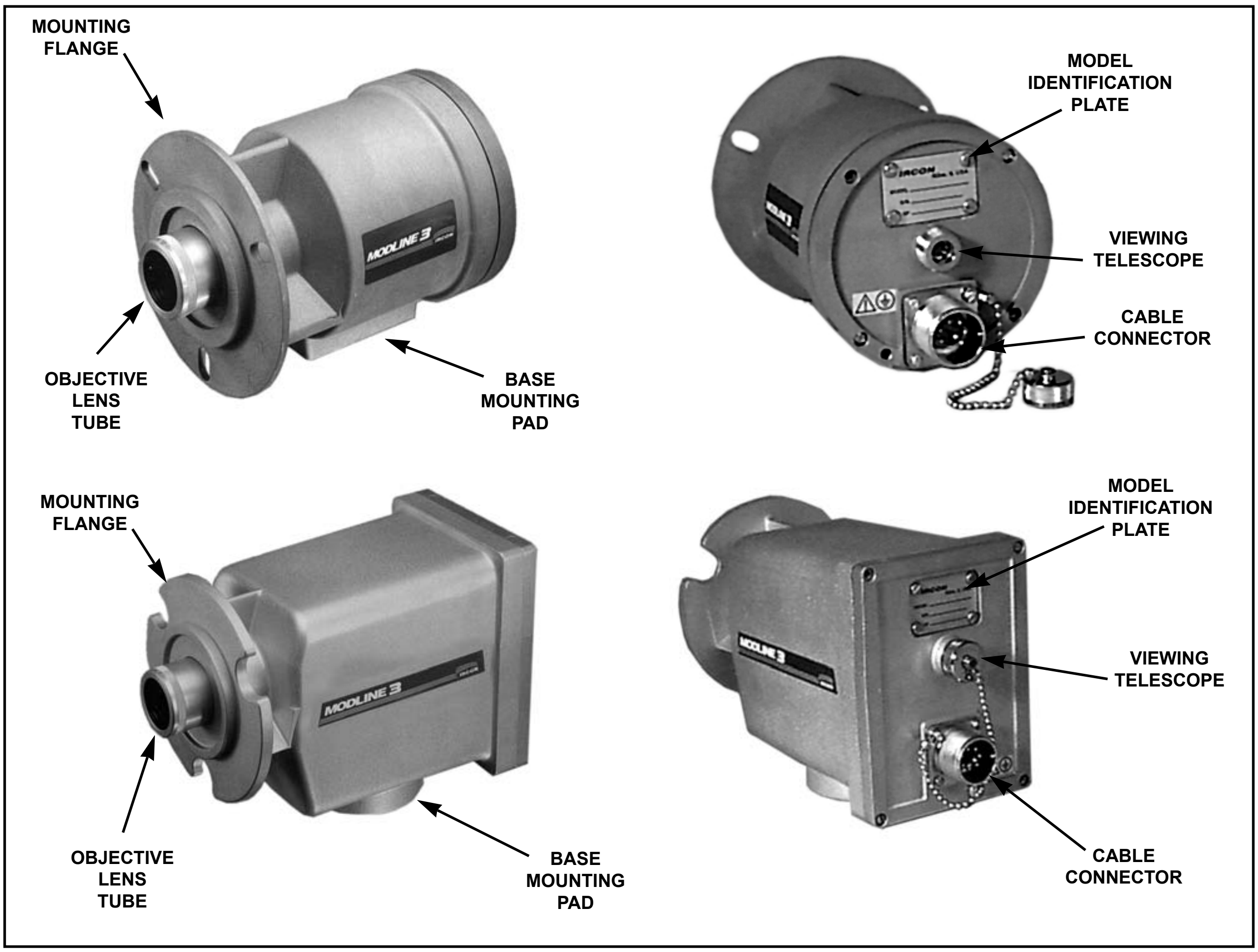


FIG. 2.1 - MODLINE 3 SENSORS

Section 2 — SENSORS

2.1 DESCRIPTION (Continued)

The MODLINE 3 Sensor Series include:

200 Sensor Series High Temperature Infrared Thermometer

Measures temperatures ranging from 900 to 4800°F (500 to 2600 °C). This series has many common incandescent applications; such as, most iron and steel foundry processes, forging, hardening and all types of semiconductor processes.

340 Sensor Series Infrared Thermometer

Measures temperatures ranging from 75 to 1500°F (25 to 800°C). This series measures clear films of C-H type plastics; such as, polypropylene, poly styrene, vinyls and nylon. It is also ideal for paints and organics; such as, waxes and oils.

600 Sensor Series General Purpose Infrared Thermometer

Measures temperatures ranging from 150 to 1400°F (80 to 800 °C). This series is commonly used in materials; such as, thick plastics, rubber, textiles and metals.

700 Sensor Series Infrared Thermometer

Measures temperatures ranging from 100 to 2500°F (50 to 2500 °C). This series measures glass surface temperatures in such operations as forming, bending, tempering, annealing and sealing.

800 Sensor Series Low Temperature Infrared Thermometer

Measures temperatures ranging from 75 to 800 °F (25 to 400°C). This series measures thin film of all polyester (PET) and fluorocarbon plastics, including thin glass and ceramic applications.

3G Sensor Series Infrared Thermometer

Measures temperatures ranging from 500 to 2500°F (250 to 1400 °C). This series is the best choice for medium temperature applications; such as, ferrous/non-ferrous metals and unoxidized metals.

3L Sensor Series Low Temperature Two-color Thermometer

Measures temperatures ranging from 500 to 1800°F (250 to 1000°C). This series is most appropriate for low temperature non-ferrous metal applications including aluminum. This series measures temperatures from the ratio of radiation signals of two wavelengths and not from an absolute intensity. Such things as dust and smoke in the sight path, dirty viewing windows, emissivity changes and small and moving objects that do not fill the optical field of view have no effect on the temperature readings as long as they affect both wavelengths equally. This technology will tolerate up to a 95% reduction in radiant intensity.

3R Sensor Series High Temperature Two-color Thermometer

Measures temperatures ranging from 1300 to 6500°F (700 to 3500°C). The Sensor Series 3R is most appropriate for difficult high-temperatures applications; such as, molten metals, wire and rod, ore smelting, vacuum furnaces and kilns. This series measures temperatures from the ratio of radiation signals of two adjacent wavelengths and not from an absolute intensity. Such things as dust and smoke in the sight path, dirty viewing windows, emissivity changes and small and moving objects that do not fill the optical field of view have no effect on the temperature readings as long as they affect both wavelengths equally. This technology will tolerate more than a 95% reduction in radiant intensity.

3V Sensor Series High Temperature Infrared Thermometer

Measures temperatures ranging from 400 to 1200°C. This series is tailored for measuring gallium arsenide (GaAs) wafer temperatures. The Sensor Series 3V is ideal for molecular beam epitaxy (MBE) applications using indium-free mounting of GaAs substrates for MBE growth.

3W Sensor Series Wafer Infrared Thermometer

Measures temperatures ranging from 600 to 2700°F (300 to 1500°C). This series is tailored for measurement of silicon (Si) wafer temperatures. Sensor Series 3W can operate over very wide temperature ranges, making it ideal for other high temperature applications.

TABLE 2.1 - MODLINE 3 SENSOR FOCUS RANGES

SENSOR SERIES	LENS TYPE	FOCUS RANGE
200 600 3V 3W	P-1	18 in. to ∞ 460 mm to ∞
	P-2	7 to 20 in. 180 to 500 mm
	P-3	4 to 7 in. 100 to 180 mm
	P-4	Fixed at 2 in. Fixed at 50 mm
340 700 With D/50 Optical Resolution	R-1	13 in. to ∞ 330 mm to ∞
	R-2	5 to 8 in. 130 to 210 mm
	R-3	3 to 4 in. 76 to 102 mm
340 700 With D/100 Optical Resolution	T-1	40 in. to ∞ 1020 mm to ∞
	T-2	15 to 27 in. 380 to 685 mm
	T-3	10 to 12 in. 254 to 302 mm
	T-4	Fixed at 6.4 in. Fixed at 163 mm
	T-5	Fixed at 4.2 in. Fixed at 107 mm

SENSOR SERIES	LENS TYPE	FOCUS RANGE
800	U-1	20 in. to ∞ 500 mm to ∞
	U-2	10 to 16 in. 254 to 406 mm
3G	P-1	20 in. to ∞ 500 mm to ∞
	P-2	8 to 20 in. 210 to 510 mm
	P-3	5 to 8 in. 130 to 210 mm
	P-4	Fixed at 1.7 in. Fixed at 44 mm
3L	LA-1	15 in. to ∞ 381 mm to ∞
	LA-2	9 to 15 in. 229 to 380 mm
3R	A-1	15 in. to ∞ 381 mm to ∞
	A-2	9 to 15 in. 229 to 380 mm

NOTES

1. Tolerance of Focus Range is ±10%
2. Lens type is printed on packing slip sent with instrument and is engraved on lens tube of Sensor (Table 2.1).
3. Focus Range is identical for equivalent lens ordered with protective window – i.e., PW-1 lens range is identical to P-1 range; PW-2 is identical to P-2; etc.
4. If you have ordered a fixed focused Sensor (lens type P-4, T-4 or T-5), you may check sighting and focusing by positioning the Sensor at the focal point or focus range of Table 2.1, viewing through the viewing telescope, and moving the Sensor forward or backward to watch the target come into focus.

Section 2 — SENSORS

2.2 OPTICAL CHARACTERISTICS

The Sensor is sensitive to infrared radiation in an area indicated by the CONE OF VISION in Fig. 2.2. It will measure temperature of objects inside the cone. It will not measure objects outside the cone. The diameter of the cone at any point will determine the area of measurement (spot size) at that point. Anything within that area will be focused on the detector element and will therefore produce a temperature signal.

When you sight the Sensor on an object, you are aiming the cone of vision so it falls on the object. When you focus the lens, you are adjusting it so the focal point is at the surface of the object. The measurement area will then be outlined in the reticle of the viewing telescope.

The formula in Fig. 2.2 defines the spot size at the focal point. Simply divide the Working Distance "D" (distance from front flange of sensor to target) by the Resolution Factor "F" of the Sensor to determine the Spot Size "d".

The Resolution Factor is designated by the Sensor model number labeled on the backplate of the Sensor.

Note: This is also Block B of the complete MODLINE 3 model number. Refer to Section 1.5 to determine the Resolution Factor of your Sensor.

Examples:
1. The 36-06F15 Sensor is a Series 600 Sensor with a resolution of D/150.
2. The 3G-18F05 Sensor is a Series 3G Sensor with a resolution of D/50.

Resolution is very important in non-contact temperature measurement. Ideally, the surface to be measured should be LARGER than the spot size at the viewing distance. If the target is smaller than the spot, the infrared detector will "see" not only the target but also the background behind it. This could lead to false temperature measurement, if the "background" is hotter than or cooler than the target. However with 3L and 3R Series, accurate readings are possible with unresolved targets as long as the background is much cooler than the target temperature.

Example: At a given viewing distance, a high resolution Sensor would be more desirable than a low resolution sensor for viewing a wire rod. A low resolution sensor would be fine for viewing the surface of a large steel plate at the same distance.

A good rule of thumb in locating and sighting the Sensor is that the target must be at least TWICE the spot size at the viewing distance. This safety margin allows for all of the following:

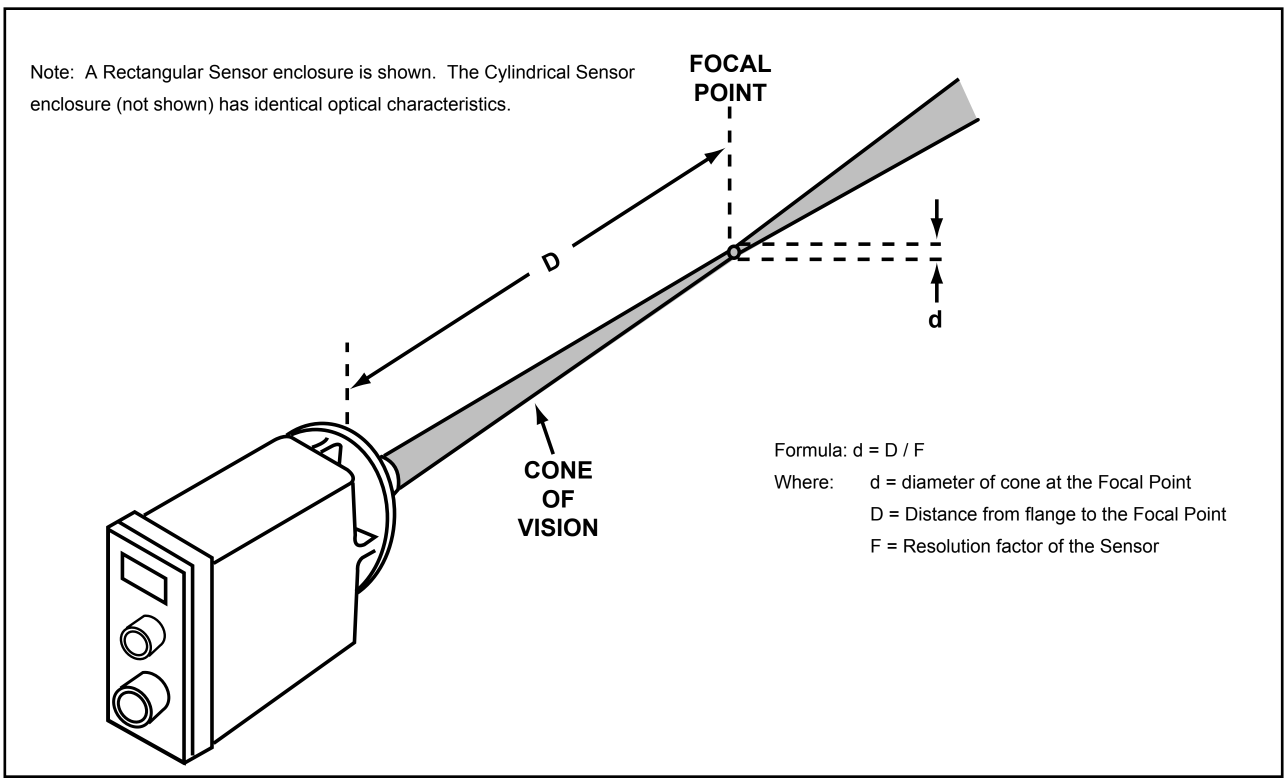


FIG. 2.2 - SENSOR CONE OF VISION

- small misadjustment of focus,
- small shifts in alignment between Sensor and target due to vibration or other factors,
- small amount of "optical spillage" inherent in all optical systems.

The importance of spot size vs. target size is demonstrated in Fig. 2.3, where a Sensor with a Resolution Factor of F = 50 is focused on a 1 inch rod at three different viewing distances.

In Diagram A, the rod is 100 inches (2540mm) away. The spot is 2 inches (50mm) in diameter at this distance. The 1 inch (25mm) diameter rod will fill only half the reticle. This is illustrated by the drawing at the left, where the large circle represents the total area visible in the viewing telescope, the small circle is the reticle, and the shaded area is the rod.

Suppose you move closer and refocus as in Diagram B. At a viewing distance of 50 inches (1270mm), the spot is 1 inch (25mm) in diameter, the same as the rod. Although the rod is exactly resolved, it does not give you the margin of safety to resolve the target.

Diagram C meets the resolution requirements stressed earlier. At a viewing distance of 25 inches (625mm), the spot size is 0.5 inch (12 to 13 mm) compared to the 1 inch (25mm) target size. The view in the telescope shows the target safely resolved in the reticle.

It is good practice to check the target resolution at regular intervals when the instrument is in operation. You can then correct any shifts in alignment before they cause measurement problems.

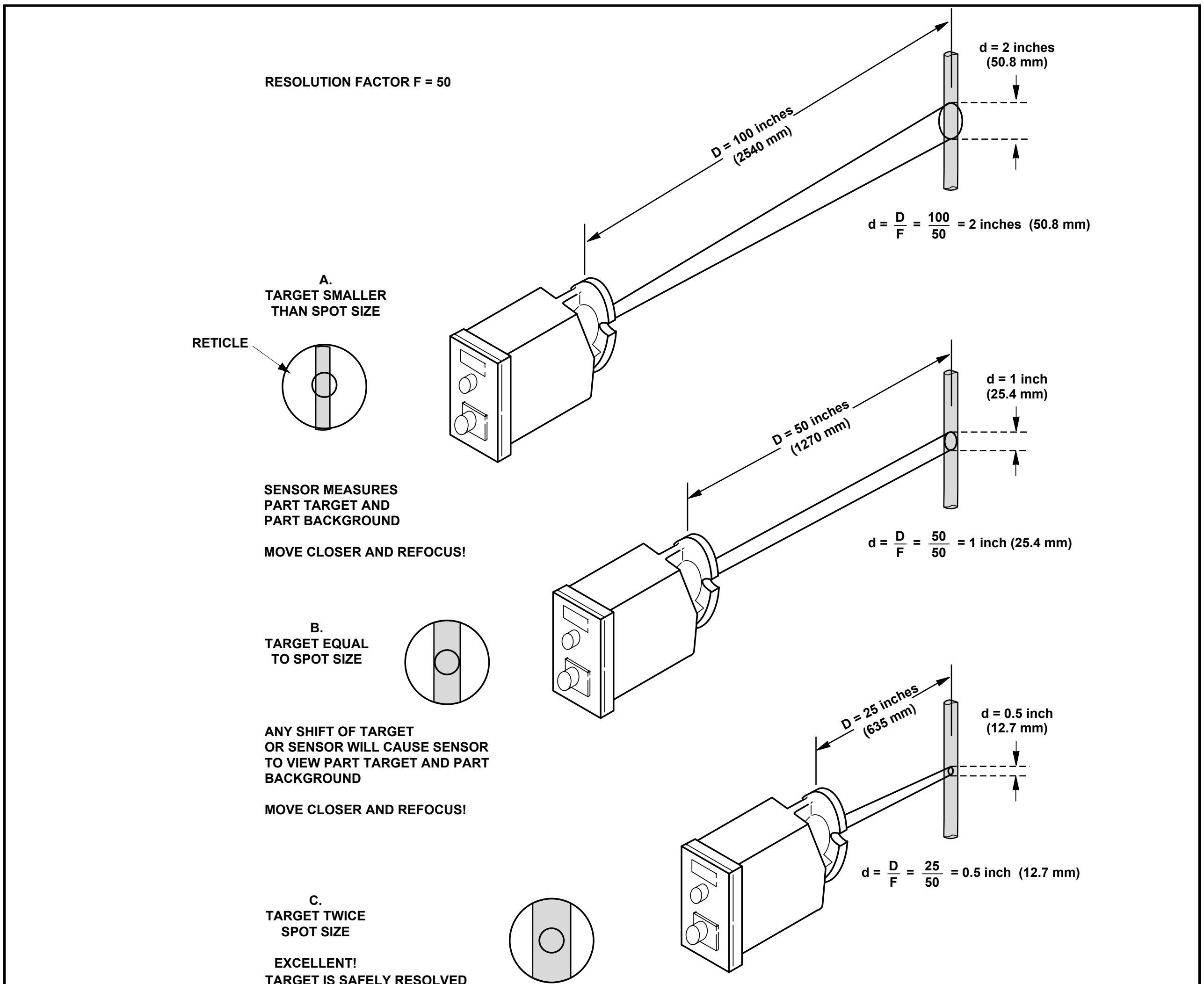


FIG. 2.3 - EFFECT OF VIEWING DISTANCE ON SPOT SIZE

OPTICAL CHARACTERISTICS FOR SERIES 3L AND 3R SENSORS.

Series 3L and 3R Sensors are unique among the MODLINE 3 Sensor family . They feature a dual detector assembly that measures temperature by comparing infrared radiation levels at two carefully selected wavelengths. Temperature readings are based on the ratio of the two radiation signals.

Because a Series 3L and 3R Sensor is sensitive to the ratio of radiation intensities at two wavelengths, rather than the absolute intensity of radiation at a single wavelength, these Sensors are almost immune to error caused by undersized objects that do not fill the field of view , and bursts of steam, dust, etc. in the sight path.

For example, a burst of steam between the target and Sensor cuts down the infrared radiation reaching the Sensor. A single wavelength Sensor would sense this as a decrease in temperature and falsely indicate a lower temperature. The 3L and 3R Sensors sense a decrease in radiation that is the same at both wavelengths, it "computes" the same ratio between the two signals and continues to give accurate temperature readings.

Reduction Ratio

The Series 3L and 3R Sensors have a limit as to how much the signal can be reduced. This is called the reduction ratio. The reduction in the signal can vary from 0% to as high as 95%.

Keep in mind, that three reduction sources cause the loss of signal:

- Low emissivity.
- Object is too small a target to sufficiently fill the telescope reticle.
- Obstruction caused by smoke, steam, dust, dirty window or a solid object.

The total loss in signal is an accumulation of all three reduction sources.

Example: Suppose you have an instrument with a design that allows a reduction of 95% of the signal. If you have an target with an emissivity of 0.25, you already have a 75% reduction in signal. That means you can only lose another 20% due to small objects obstructing the target. When you reach the limit of the reduction ratio the System will indicate "Invalid". This shows the signal is low . The system is forced to below zero scale and a relay closure takes place to indicate the reduction has reduced the signal by 95% or more.

In Summary

The spot size / target size relationship is not as critical as it would be for Sensors that simply measure radiation intensity at a single wavelength - but you must avoid objects in the same field of view which are comparable to or hotter than this target. Significantly cooler objects will not cause measurable errors. If possible, adhere to the target size is twice the spot size rule!

2.3 SIGHTING AND FOCUSING METHODS

The Sensor is sighted and focused as simply as an ordinary camera. You view the area to be measured through the viewing telescope on the backplate. A reticle in the viewing telescope outlines the exact area that will be measured. Then, by adjusting the lens while viewing the scene, you bring the target area into focus.

Before installing the Sensor, practice sighting and focusing on a few objects. This will give you a feel for the focusing range of the optical system and the measuring area at various distances.

1. Remove the plastic cap from the objective lens tube on the front of the Sensor, and unscrew the dust cap from the viewing telescope on the back plate.

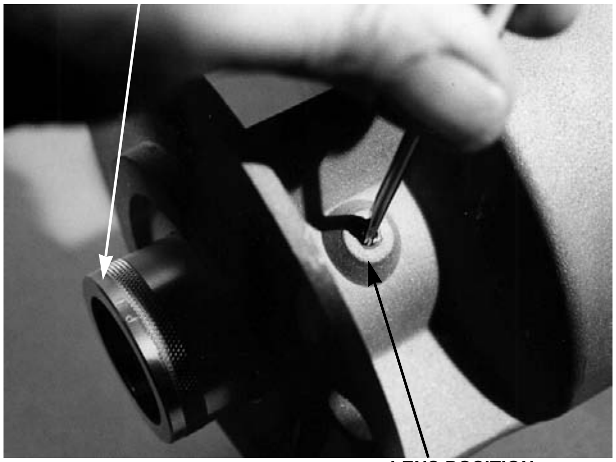
2. Use the small screwdriver supplied to loosen the lens position locking screw 1 or 2 turns. (See Fig. 2.4) The objective lens tube will now slide in and out to permit focusing.

3. Aim the Sensor at an object within the focal range of the objective lens as indicated in Table 2.1. *Note:* The lens type is engraved in the barrel of the lens tube as shown in Fig. 2.4.

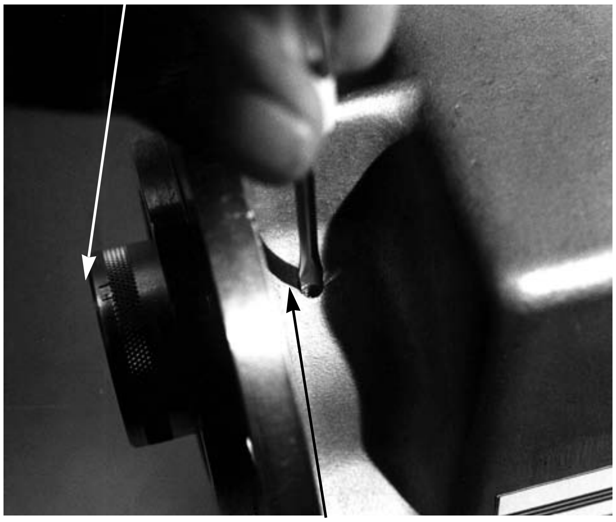
4. Look into the viewing telescope and note the small circular reticle. (See Fig. 2.3.) Slide the objective lens tube in or out until your target is in sharp focus. As you continue to look through the viewing telescope, move your head from side to side slowly and note whether the target appears to move with respect to the reticle. If it does, adjust the lens tube very slightly until there is no apparent motion between reticle and target. The instrument is then exactly in focus.

Tighten the Lens Position Locking Screw. Replace the cap on the viewing telescope only.

Note: If you have ordered a fixed focused Sensor (lens type P-4, T-4 or T-5), you may check sighting and focusing by positioning the Sensor at the focal point or focus range as shown in Table 2.1, viewing through the viewing telescope, and moving the Sensor forward or backward to watch the target come into focus.



CYLINDRICAL SENSOR



RECTANGULAR SENSOR

FIG. 2.4 - LOOSENING THE LENS POSITION LOCKING

IMPORTANT! When you complete your sighting and focusing routines, screw the dust cap back on the Viewing Telescope. This will prevent any extraneous interference from entering the optical system.

Section 2 — SENSORS

2.4 PRE-INSTALLATION NOTES

The following guidelines will help you in planning the installation of your Sensor.

a. Mechanical Mounting

The Sensor may be mounted either by the front flange or by the mounting pad at the bottom of the casting. Mounting accessories are described in Section 6.

If the proposed mounting surface is at earth ground potential, you can mount the Sensor directly to this surface with the bolts supplied. If the surface is not at earth ground potential, insulate the Sensor casting from the surface by inserting an insulating gasket, as in Fig. 3-14, and using insulating mounting hardware (user-supplied).

A 12 foot (4m) Signal Cable is standard. The maximum signal cable length between the Sensor and Indicator / Processor is 1000 foot (300m). Plan your mounting location and cable route according to Section 2.6 Signal Cable Installation.

Pre-focusing may be necessary if the Sensor is to be mounted in a hostile location or if accessories will prevent access to the lens when the Sensor is mounted. Pre-focus by setting up a well defined target such as a printed page at the exact distance of the target, then lock the lens tube in position. You can then secure the sensor housing to its mounting assembly (or related accessories).

b. Ambient Temperature

The ambient temperatures of the sensor housing must be held between the limits in Table 2.2. Some Sensor Series models have special restrictions on ambient temperature range, see Section 1.5.

SENSOR SERIES	AMBIENT TEMPERATURES	
200 & 3G	0 to 60° C	30 to 140° F
3L, 3R & 3W	0 to 55° C	30 to 130° F
3V	10 to 45° C	50 to 113° F
340, 600, 700 & 800	10 to 55° C	50 to 130° F

TABLE 2.2 SENSOR SERIES AMBIENT TEMPERATURE RANGES

If the ambient temperature at the mounting location is beyond these limits, precautions must be taken to protect the Sensor . A Model W A-3 Water Cooling Accessory or WJ-5 W ater Cooling Jacket is available for protection against excessive temperatures (see Section 6).

Insulation and reflective shielding for additional protection from extreme ambient temperatures and radiated heat are described further in Section 7.

Maximum temperature rating of the Sensor Cable is 200°F (100°C) for standard PVC-covered cable or 400°F (200°C) for special silicone rubber-covered cable. Plan the cable route accordingly.

c. Lens Protection

Be sure the lens is shielded from damage and is accessible for maintenance in the mounting arrangement you choose.

d. Air Purge

If dust, oil, vapors, etc. collect on the lens, low temperature indications will result. Use an IRCON Model AA-3 Air Purge to avoid this problem.

Or you may use a Model WJ-5 W ater Cooling Jacket it also features an integral air purge, see Section 6 for details.

e. Focal Limits

To permit focusing, the Sensor-to-target distance must be within the focal range of the objective lens. Ranges for the standard lenses for each Sensor are given in Table 2.1.

f. Use of Windows

If it is necessary to view the object through a window, as is the case when the object is being heated in a vacuum or inert atmosphere, be careful in selecting the window material. The material must have constant transmission characteristics in the operating wavelength range of the Sensor Series. Information on windows are provided in Sections 5 and 7.

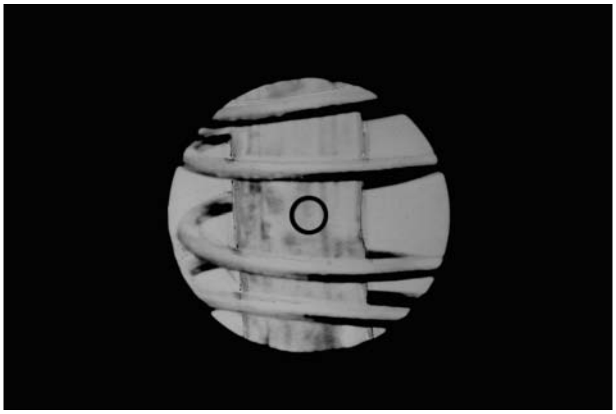


FIG. 2.5 - TARGET SEEN THROUGH VIEWING TELESCOPE

f. Spot Size and Resolution

Observe the guidelines in Section 2.2 regarding spot size and resolution. If possible, make sure the target surface is *at least twice the spot size* (or the spot size is *less than half the target size*) at the viewing distance.

Note: For Sensor Series 3L and 3R, review the Special Considerations in Section 2.2.

Fig. 2.5 is a photograph through a Sensor eyepiece, illustrating good target resolution and careful sighting. The Sensor is sighted between turns of a small induction heater coil and is focused on a rod inside the coil. The reticle shows excellent resolution of the rod surface, and there are no coil turns in the measuring area.

g. Intervening Objects

Errors can be caused by hot or cold objects between the Sensor and target. Any such object that happens to be inside the Cone of Vision will be visible to the detector, and may cause an error in the temperature reading.

Example: An object may be inside the Cone of Vision, cutting the path between the Sensor and the target, and be so far out of focus that it is not visible to you in the viewing telescope. Any such object will be visible to the detector.

Note: Refer to Section 7 for problems, that may come up, if you are viewing through an aperture, a window, through a sight or target tube.

Before selecting the mounting location, consider the sight path just as you do when you aim a camera to take a photograph. Try to picture the Cone of Vision, and if there is any possibility that an intervening object is within the cone, select a different viewing angle.

Note: Viewing angles are limited in some situations. Guidelines are provided in Section 7.

h. Reflections

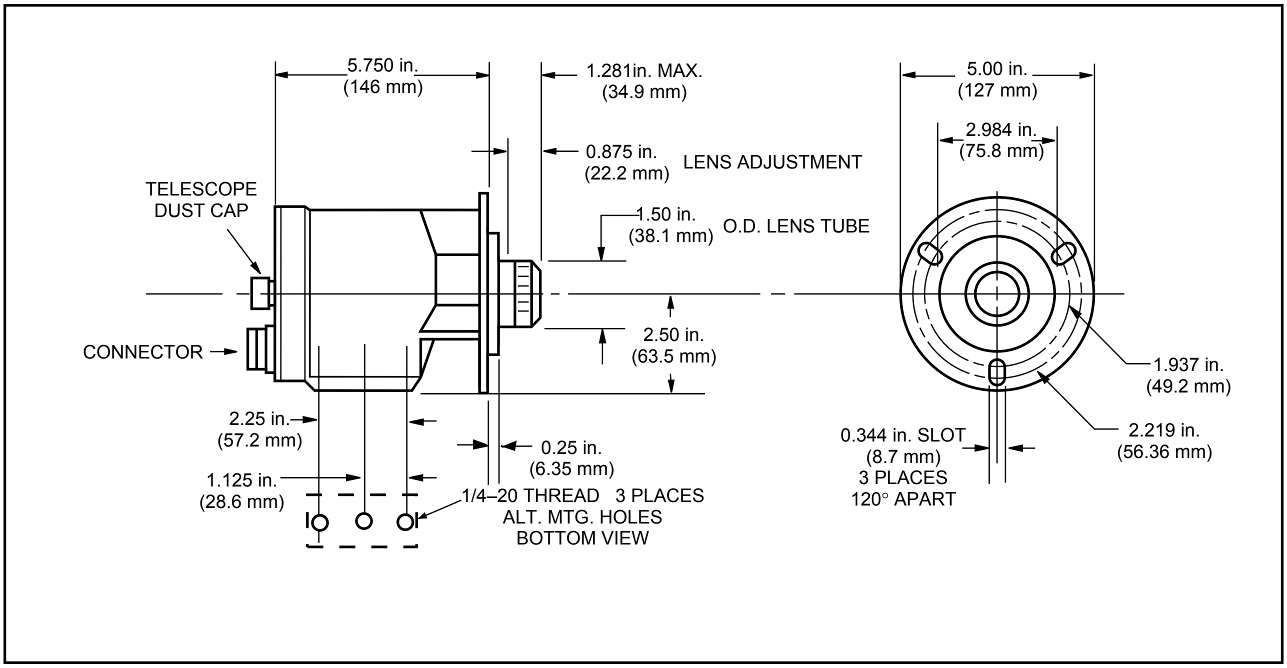
Reflections from other radiating objects represent a potential source of error in your temperature readings. For an opaque object, the total radiation seen by the Sensor will be a combination of intrinsic radiation plus reflected radiation.

Examples of interfering sources are hot furnace walls and heating elements that are hotter than or nearly as hot as the target object.

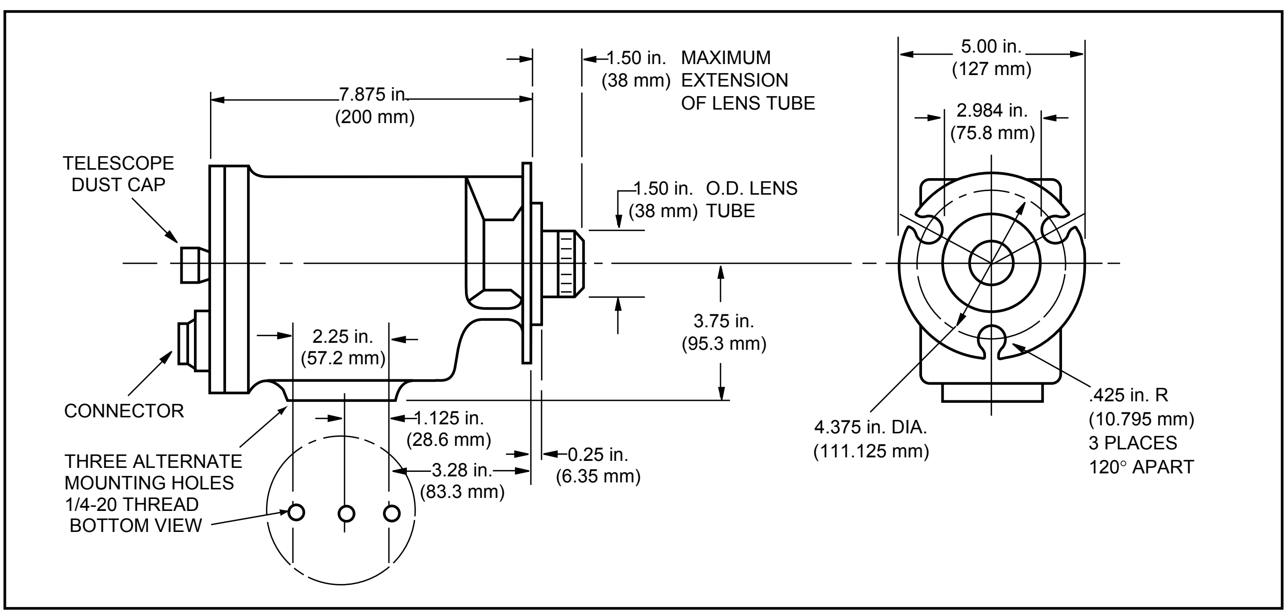
Most reflection problems can be eliminated by changing the viewing angle or shielding the reflections. Suggestions for anticipating and eliminating common reflection problems are provided in Section 7 of the manual. However, if you are faced with unusual reflection problems, call IRCON Technical Service for recommendations.

i. Indirect Viewing

In rare situations it may be necessary to view the target indirectly by means of a mirror. The characteristics of the mirror, and the positioning of both the Sensor and mirror are critical in this type of arrangement. Refer to Section 7 for further information in this matter.



Series 200, 600, 3G, 3W and 3V



Series 340, 700, 800, 3L and 3R

FIG. 2.6 - SENSOR DIMENSIONS

2.5 SENSOR INSTALLATION

The Sensor is ordinarily mounted by the front circular flange or base mounting pad to fixed brackets which have been previously installed to provide the correct line of sight. Mounting dimensions for both types of enclosure are given in Fig. 2.6.

The Sensor may be mounted in any orientation that will af ford a clear , unobstructed line of sight and a reliable support.

BASE MOUNTING

If you are mounting the Sensor with no accessories, attach it to the fixture of your choice using three 1/4-20 NC bolts. Observe grounding precautions in Section 2.4(a).

In some cases, freedom of final adjustment in sighting may be desirable. In these cases the Swivel Mounting Base, Model SB-1 or SB-3, depending on Sensor Series, is recommended as an optional accessory. See Section 6 for a description of this accessory.

After first af fixing the Swivel Base to a rigid surface, mount the Sensor to the Swivel Base by means of two 1/4-20 NC bolts supplied, utilizing the tapped holes in the mounting pad on the underside of the Sensor.

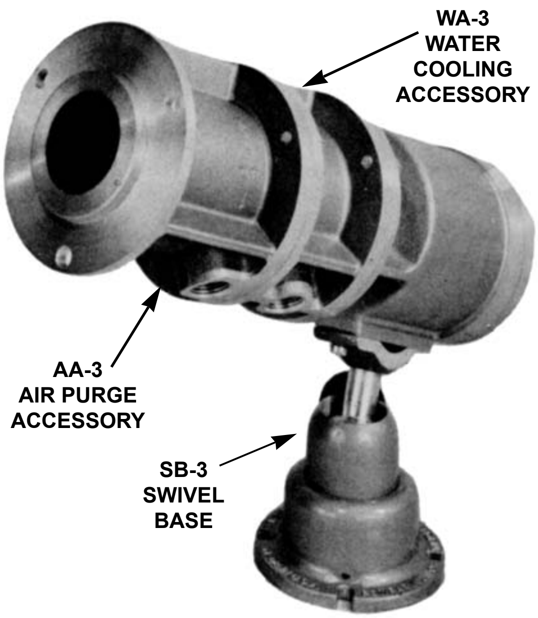
If you are using accessories such as the Model WA-3 Water Cooling accessory and/or Model AA-3 Air Purge, you can assemble and prefocus the Sensor and the accessories, then mount the complete assembly by means of the Sensor base pad. See Fig. 2.7 for an example of this arrangement.

FLANGE MOUNTING

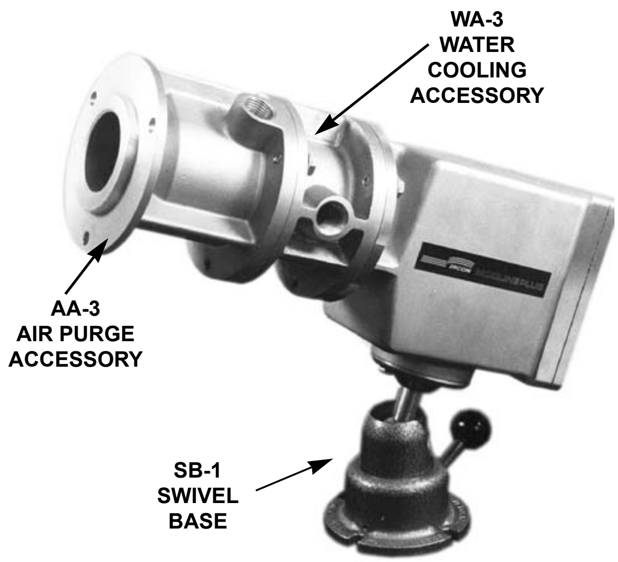
The Sensor can be flange mounted to mounting supports or accessories by means of three 5/16 x 18 NC bolts supplied. The mounting procedure is illustrated in Fig. 2.8. Observe the grounding precautions in Section 2.4(a).

Note: Models 200, 600, 3W, 3G and 3V are mounted by means of three bolt holes in front flange (Fig 2.8A). All other models have three bolt cutouts or "scallops" in front flange (Fig. 2.8B).

A Model PM-1 Pipe Mount is a convenient flange mounting accessory. (*Note:* The Model PM-2 Pipe Mount must be used instead, if the Sensor is to be attached to a Silicon Carbide Sight T ube or Target Tube.) See Section 6 for details on Pipe Mount accessories. After clamping this accessory to a pipe or stanchion, mount the Sensor to the pipe mount flange by means of the three 5/16 x 18 NC bolts supplied.



Series 200, 600, 3G, 3W and 3V (SB-3 Base)



All Other Models (SB-1 Base)

FIG. 2.7 - SENSOR WITH AIR PURGE AND WATER COOLING ACCESSORIES MOUNTED ON SWIVEL MOUNTING BASE

A. For Sensors with Three Mounting Holes in Flange and Three Long Holes in Rim

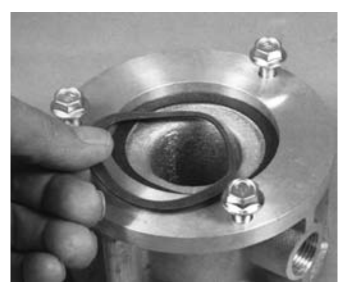
Insert one or two of the supplied gaskets in well of accessory, as required to form a good seal and still allow the flange surfaces to touch.

Insert front of Sensor into well and secure with three 5/16-18 NC bolts supplied.

B. For Sensors with Three Mounting Holes in Flange and Three Bolt Cutouts in Rim

Insert three 5/16-18 NC bolts loosely in holes of accessory.

Insert one or two of the supplied gaskets in well of accessory, as required to form a good seal and still allow the flange surfaces to touch.



Insert front of Sensor into well, and rotate so bolts capture flange. Tighten bolts.

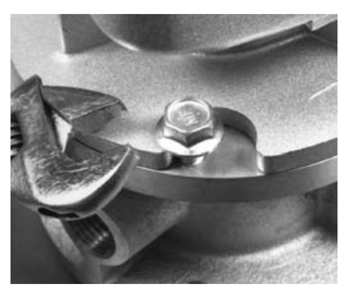


FIG. 2.8 - FLANGE MOUNTING PROCEDURE

2.6 SIGNAL CABLE INSTALLATION

The Signal Cable is the link between the Sensor and the Indicator / Processor. It is a shielded cable with insulation overall. A 12 foot (4m) Signal Cable is standard for the MODLINE 3. Signal cables up to a maximum of 1000 foot (300m) can be ordered in preassembled or or as kits in bulk-unassembled form .

If you have ordered a preassembled cable, you will receive the cable with the Sensor connector attached and the Indicator / Processor leads prepared for connection to the terminals. All that is necessary is to plug the cable connector into the matching connector on the Sensor backplate and tighten the locking ring. Then route the other end of the cable to the Indicator / Processor . Section 3 describes the connection to the Indicator / Processor terminals.

If you have ordered bulk, unassembled cable, prepare the cable and install the connector according to the instructions, in Section 9 Addendum.

When you have completed the assembly , plug the cable connector into the matching connector on the Sensor backplate and tighten the locking ring, then route the other end of the cable to the Indicator / Processor. Section 3 describes the connection to the Indicator / Processor terminals.

Signal Cable Routing

To avoid physical damage, the Sensor signal cable must be routed through areas free from plant traffic. The Signal Cable should be routed in a conduit by itself or with other signal carrying cables. Do not route the cable along ac power lines, relay wires, or other possible sources of interference. Avoid running the cable near strong magnetic fields such as those around large transformers, inductors, or saturable core reactors.

Local Electrical Codes

Use the wiring methods prescribed for your cabling carrying local low voltage sensor signals.

⚠ CAUTION ⚠

Do not route the cable across hot ovens or other hot surfaces. Maximum operating ambient temperature of the cable is 220 °F (100°C) for PVC covered cable or 400°F (200°C) for Silicone Rubber covered cable.

2.7 INSTALLATION CHECK LIST

To assure accurate, reliable and trouble-free operation of the Sensor, check your installation for the following:

❑ Sensor is properly mounted and aligned with no obstructions in optical path.

❑ Sensor is focused on target. Also, target size is at least twice diameter of reticle in viewing telescope (i.e. twice the spot size at the viewing distance). *Note:* Special requirements exist for Series 3L and 3R Sensors. See Section 2.2.

❑ Telescopic eyepiece of Sensor and all unused connectors are covered by a dust cap.

❑ Sensor is protected by air purge and clean purge air if atmosphere is dirty, oily, corrosive, or excessively humid.

❑ Sensor is adequately protected by water cooling and/or additional insulation if ambient temperature exceeds safe limits.

❑ Sensor is not subjected to reflections, that may cause inaccurate temperature readings of low temperature, low emissivity targets.

❑ Sensor is not subjected to radiated heat from oven walls, flames, etc. that will heat it beyond the normal case temperature. See Section 2.4 Reflections and Section 7.5 for the proper use of reflection shields.

❑ Mounting surface is not above earth ground potential. If it is then, insulate casting from surface as suggested in Section 3.14.

❑ Signal Cable is not routed through any area that will heat it beyond 220°F (100°C) for PVC-covered cable or 400°F (200°C) for silicone rubber-covered cable.

❑ Signal Cable is not routed along ac power line or other sources of electrical interference.

When you have completed all Sensor installation procedures, and checked them to your satisfaction, proceed to the Indicator/Processor installation as described in Section 3.

Main

Section 2F — SENSORS
(Fiber Optic Version)

This section describes the Sensors of the Fiber Optic System, with primary emphasis on installation procedures.

Sensor installation is very important to the accuracy of the system. It involves positioning the Focusable Reimaging Lens or Extension Tip of the Fiber Optic Cable for a clear view of the target without interference from other objects or materials in the area you are measuring, and mounting and connecting all components so the complete system will perform with peak efficiency. Care spent in this part of the installation will be rewarded by accurate, reliable measurements and trouble-free operation.

Section **Page**

2F.1 DESCRIPTION

MODLINE 3 Sensors are precision electro-optical instruments that sense infrared radiation and develop an electrical signal based on this radiation. The signal is coupled through a signal cable to the Indicator/Processor, where it is scaled to the temperature range of the instrument.

The Fiber Optic Sensor in Fig. 2F.1 is a highly specialized instrument. A fiber optic system serves as an extension of the optical system within the Sensor itself. A Reimaging Lens or Extension Tip mounted at the measurement point views the area to be measured. A flexible Fiber Optic Cable conveys infrared radiation from the measurement point to the optical system within the Sensor. The detector in the Sensor "sees" the same image viewed by the Reimaging Lens or Extension Tip.

Fig. 2F.1 shows a Series 3R Sensor equipped with a Reimaging Lens. Differences in component arrangements and complete installation instructions for all arrangements are described in this section of the manual. If the Sensor and its related components are installed with reasonable care it will provide precise temperature measurement.

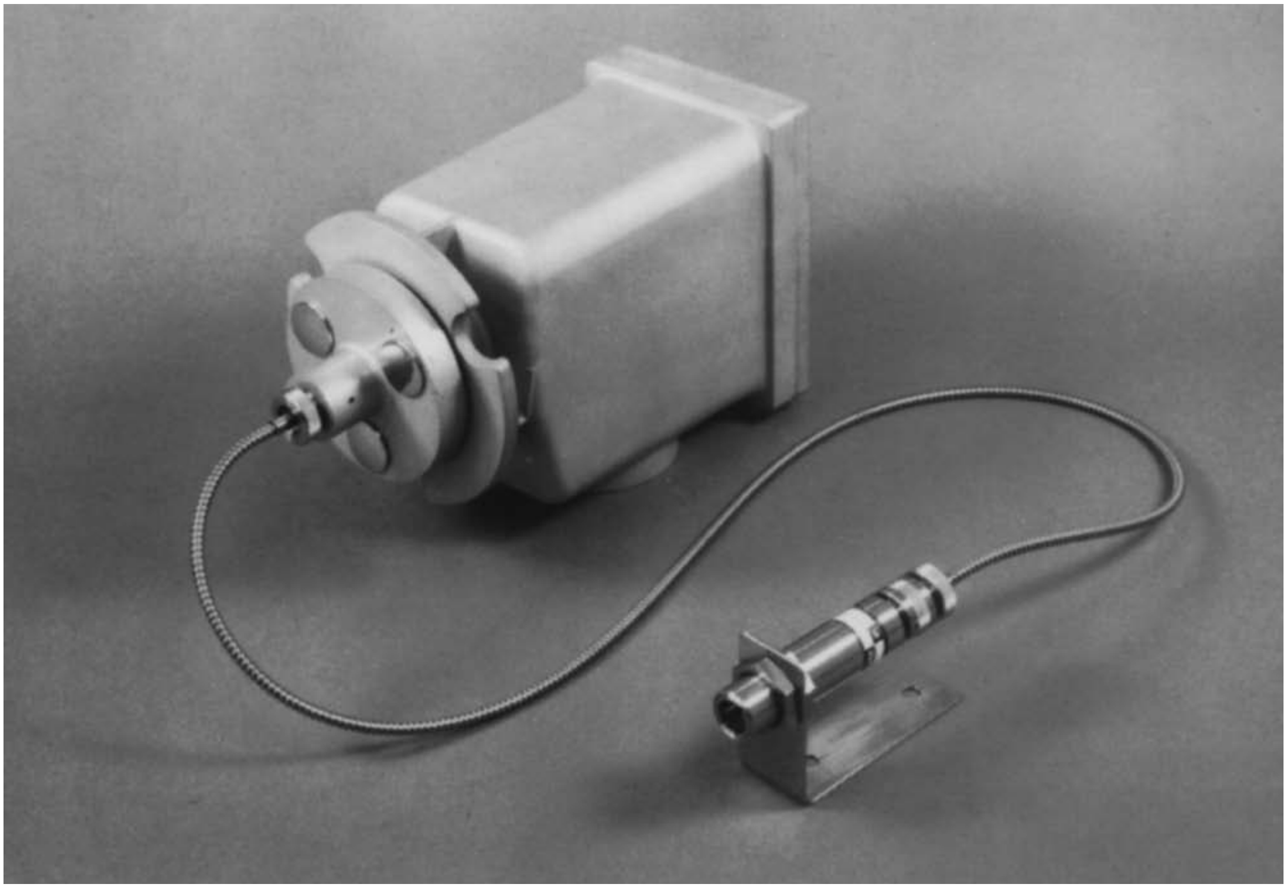


FIG. 2F.1 – TYPICAL FIBER OPTIC MODLINE 3 SENSOR

Section 2F — Fiber Optic SENSORS

2F.1a FIBER OPTIC SENSOR HOUSINGS

There are two styles of Fiber Optic Sensor housings in the MODLINE 3 System. Series 200, 3G, 3V, and 3W Sensors are supplied in a cylindrical housing as illustrated in Fig. 2F .2. The rectangular housing in Fig. 2F.3 is used for Series 3R Sensors. This difference in style accommodates dif ferences in optical design, detector type, and other features. However, operating procedures are the same with either housing.

The optical elements and infrared detector assembly of the Sensor are housed in a die cast, gasketed housing. The fiber optic mounting fixture is on the front flange of the housing. An internally threaded well aligns the tip of the fiber optic cable with the optical elements inside the housing.

The temperature signal is brought out via a watertight connector on the backplate. A screw-on mating connector on the signal cable assures that the cable connector will be drip-tight and dust-tight.

A mounting pad on the underside serves as a firm support for the housing. Three 1/4 x 20 NC bolts are supplied for mounting.

Dimensions of the two types of housing are shown in Fig. 2F.12.

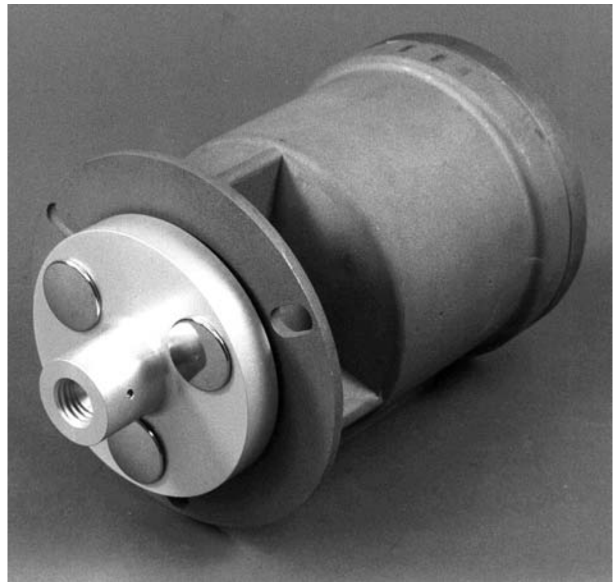


FIG. 2F.2 – CYLINDRICAL HOUSING

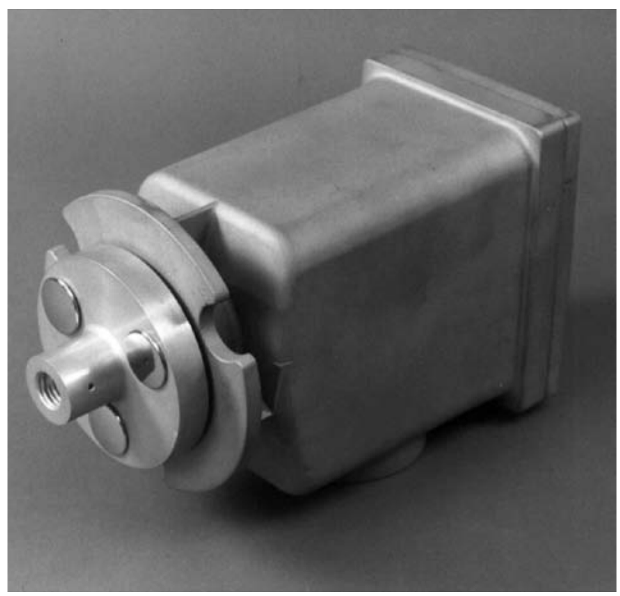


FIG. 2F.3 – RECTANGULAR HOUSING

2F.1b FIBER OPTIC CABLE

The Fiber Optic Cable (Fig. 2F .4) is the link between the target being measured and the optical system in the Sensor . It consists of a 0.08 inch fiber bundle protected by a flexible stainless steel armor sheath. Cables are available in standard 10 foot lengths (3 meters). Special length cables are available on special order.

Dimensions of the Fiber Optic Cable are shown in Fig. 2F.5.

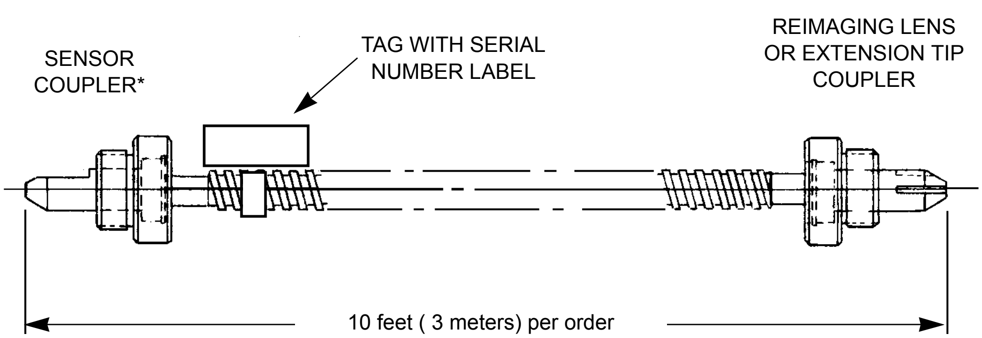
One end of the Fiber Optic Cable is fitted with a quick-connect coupler keyed to the mounting fixture on the front flange of the Sensor . The coupler at the other end of the cable is keyed to the fitting on a Reimaging Lens or Extension Tip.

This keying system not only distinguishes the ends of the Fiber Optic Cable, but also aligns the positions of the individual fibers that make up the cable. Thus, the fibers are automatically polarized (with respect to the Sensor and the Reimaging Lens or Extension Tip) exactly as they were during factory calibration. This prevents changes in system calibration due to misalignment of fibers.

FIG. 2F.4 – FIBER OPTIC CABLE

The Fiber Optic Cable has a Serial Number Tag, as shown in Fig. 2F .5. When shipped from the factory the Sensor and the Fiber Optic Cable serial numbers match.

Note: Blackbody recalibration is recommended after replacement of a fiber optic cable.



* Note that the two couplers are 'polarized' by their keying configurations for insertion into the Sensor fixture or the Reimaging Lens or Extension Tip coupler.

FIG. 2F.5 – DIMENSIONAL DIAGRAM OF FIBER OPTIC CABLE

Section 2F — Fiber Optic SENSORS

2F.1c FOCUSABLE REIMAGING LENS

A Focusable Reimaging Lens (Fig. 2F .6) provides an adjustable field of view for the Fiber Optic Cable. An adjustable lens is housed in a compact, stainless steel cylinder. A protective window guards the lens against dust, water, and contaminants.

The focal point is controlled by the spacing between the front and rear sections of the lens assembly. To change the focal point, you loosen the Lens Position Locking Screw and slide the rear section forward or backward. Tighten the Lens Position Locking Screw when focusing is complete.

The focusing range is shown on the model number label of the Reimaging Lens. The standard focus range is 10 inches (255mm) to infinity. The close focus lens provides a focus range of 6 to 10 inches (153 to 255mm).

The threaded well at the rear is keyed to the quick-connect coupler at the measuring tip of the Fiber Optic Cable. A threaded section at the front of the assembly may be used for panel mounting, for mounting in the Model MB-5 Mounting Bracket, or for attachment of accessories. Two hex nuts are supplied for mounting purposes.

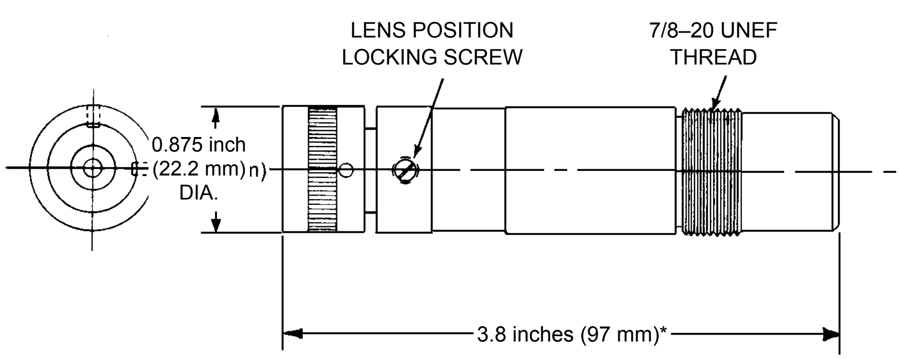
Focusable Reimaging Lens dimensions are shown in Fig. 2F.7.

FIG. 2F.6 – FOCUSABLE REIMAGING LENS

Optical Characteristics

The Focusable Reimaging Lens collects infrared radiation in an area indicated by the Cone of Vision in Fig. 2F.8. The diameter of the cone at any point determines the area of measurement (spot size) at that point. Anything within that area is coupled through the Fiber Optic Cable and focused on the detector elements in the Sensor to produce a temperature signal.

The formula in Fig. 2F .8 defines the spot size at the focal point. The Working Distance D (from the front of the Reimaging Lens to the target) divided



* Rear section of lens assembly pressed all the way into forward section (maximum focus distance). Length increases up to 4.7 inches (120 mm) when rear section is withdrawn (minimum focus distance).

FIG. 2F.7 – DIMENSIONAL DIAGRAM OF FOCUSABLE REIMAGING LENS by the Resolution Factor of the Reimaging Lens determines the Spot Sized.

The Resolution Factor is designated by the last two digits in Block B of the model number labeled on the Reimaging Lens. Refer to Section 1.5 to determine the Resolution Factor of your Reimaging Lens.

Example:

A Model 3G-25FF6 has a resolution of D/60.

Models with the XX-XXXF7 code, feature a unique rectangular resolution of D/30 x D/150. This rectangular "spot" is ideal for threading through narrow entries (i.e., between the turns of an induction heating coil to measure temperature of a workpiece within the coil).

Ideally, the surface to be measured should be LARGER than the spot size at the viewing distance. If the target is smaller than the spot, the infrared detector will "see" not only the target but also the background behind it. This may lead to false temperature measurement.

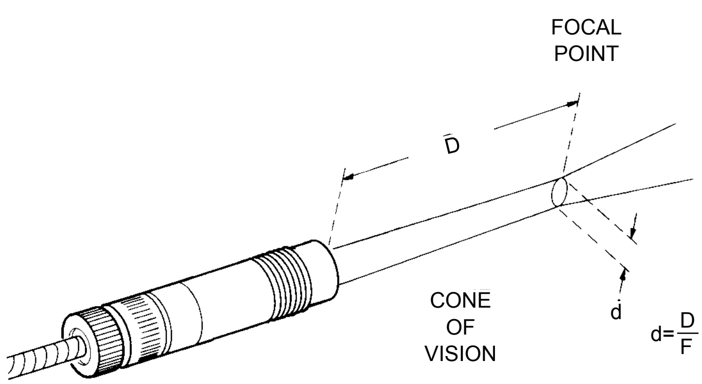
If you plan to measure temperature of a large target surface at a short distance, focus of the Reimaging Lens is not critical. Simply aim the Reimaging Lens so its Cone of Vision is centered on the object of interest, making sure there are no interfering objects in the sight path.

Aiming and focusing become very important for making measurements of small target surfaces and when sighting between objects. Optical considerations are detailed in Section 7.

Reimaging Lens Spot Check

To measure temperature of a small target surface, or to sight between other objects for the measurement, you must run a "spot check" that will show you the exact spot size at the measurement point. With this test, you shine a high-intensity light through the Fiber Optic Cable and Reimaging Lens, and project a spot of light on the target surface. This spot defines the area that will be measured.

You can perform a spot check to help you select a proper mounting location for the Reimaging Lens with respect to the target. To perform the spot check, you will need a high intensity light source such as the IRCON Model IL-5 Fiber Optic Illuminator or equivalent. The procedure is described in Section 7.15.



$$d = \frac{D}{F}$$

where: d = Diameter of cone at focal point

D = Distance from Lens to Focal Point

F = Resolution Factor of Lens

FIG. 2F.8 – CONE OF VISION FOR FOCUSABLE REIMAGING LENS

Section 2F — Fiber Optic SENSORS

2F.1d EXTENSION TIP

An Extension Tip (Fig. 2F.9) consists of a glass rod within a ceramic tube mounted in a stainless steel ferrule. The rod forms a rigid probe 0.22 inch (5.5mm) in diameter, which extends 6 inches (150mm) from the front of the ferrule.

The threaded well at the rear is keyed to the quick-connect coupler at the measuring tip of the Fiber Optic Cable. A threaded section at the front may be used for panel mounting or for mounting in the Model MB-5 Mounting Bracket. Two hex nuts are supplied for mounting purposes.

The rod consists of inert glass with no organic binders. Because the glass is immune to electro-magnetic fields, the tip can be inserted between the windings of an induction heating coil without disturbing the field or coupling it to the Sensor circuits. Dimensions of the Extension Tip are given in Fig. 2F.10.

FIG. 2F.9 – FIBER OPTIC EXTENSION TIP

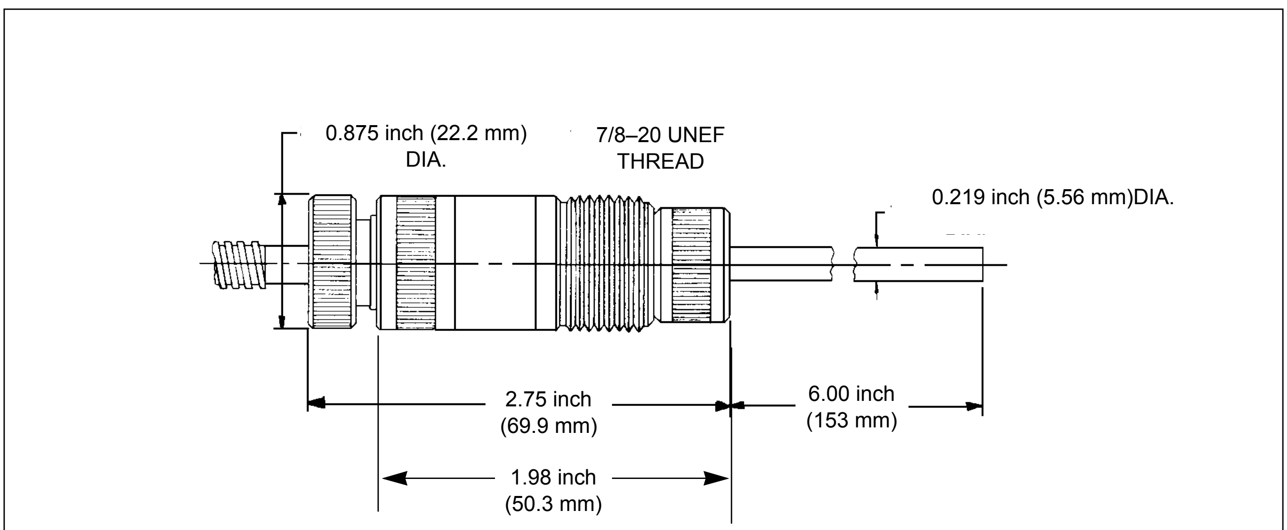


FIG. 2F.10 – DIMENSIONAL DIAGRAM OF EXTENSION TIP

Optical Characteristics

The Extension Tip is sensitive to infrared radiation in an area indicated by the Cone of Vision in Fig. 2F.11.

The diameter of the cone at any point determines the area of measurement (spot size) at that point. Anything within that area is coupled through the Fiber Optic Cable and is focused on the detector elements in the Sensor to produce a temperature signal.

When you sight the Extension Tip on an object, you are simply "aiming" the Cone of Vision so it falls on the object. The area you will measure is a function of the tip-to-target distance and the Resolution Factor of the Extension Tip. All standard Extension Tips have a fixed resolution of D/3. This means that the spot size expands at a rate of D/3, where "D" is the distance between the end of the Extension Tip and the surface of the target.

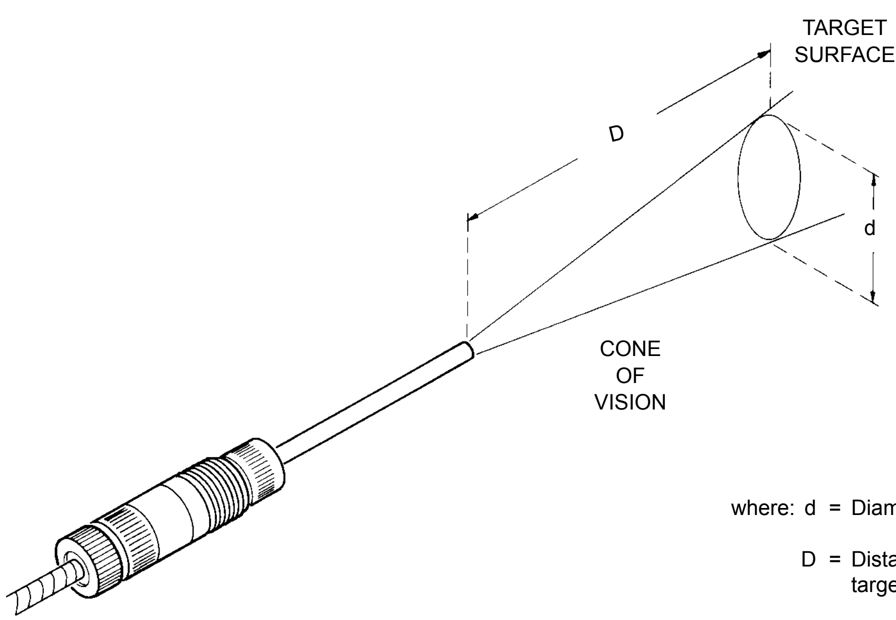
Example:

At a target distance of 2 inches (50mm) the Extension Tip will pick up infrared radiation from a circular area with a diameter of 2/3 = 0.67 inch (16mm).

If D is 18 inches (450mm), the cone of vision expands to 18/3 = 6 inches (150mm), and so on.

In most applications, an Extension Tip is used to measure large surfaces at short tip-to-target distance. In these cases the D/3 spot size will not create any problems.

However, consider the spot size and its relation to viewing distance when you plan your installation. If the target area is smaller than the spot size, the detector will "see" not only the target but also the background behind it. This may lead to false temperature measurement. Optical considerations are detailed in Section 7.



$$d = \frac{D}{3}$$

where: d = Diameter of cone at target surface

D = Distance from tip of glass rod to target surface

FIG. 2F.11 – CONE OF VISION FOR EXTENSION TIP

Section 2F — Fiber Optic SENSORS

2F.2 PRE-INSTALLATION NOTES

The Fiber Optic Sensor offers considerable freedom in locating and mounting the system elements – as long as the location and mounting facilities adhere to MODLINE 3 specifications!

Consider the Fiber Optic Sensor location.

- Will it have a good viewing pattern from the Reimaging Lens or Extension Tip?
- Will you be able to get a good view of your target object, or will this view be blocked by other objects in the area?
- Do you have a sturdy support for the Sensor Housing within Fiber Optic Cable range of the Reimaging Lens or Extension Tip?

Consider the Indicator/Processor location.

- Will the Indicator/Processor be within range of the Sensor Signal Cable?
- Will it have good access to an ac power source?
- Will it have good access to any recorder or other device that will use the temperature signal?

A. Mechanical Mounting

The Sensor is ordinarily mounted by the base mounting pad to a fixed mounting surface at some appropriate point.

If the proposed mounting surface is at Earth Ground potential, you can mount the Sensor directly to this surface with the bolts supplied. If the surface is conductive and not at Earth Ground potential, insulate the Sensor from the surface by inserting an insulating gasket and using insulating mounting hardware, as described in Section 3.14. The insulating gasket and insulating mounting hardware are user-supplied.

b. Ambient Temperature

Operating ambient temperatures of the fiber optic sensor series must be held between the limits in Table 2F.2. Some Series 3V models, have restrictions on operating ambient temperatures of 50 to 113°F (10 to 45°C), see Section 1.5.

c. Planning Your Installation

Table 2F.2 will help you plan the installation. It shows the relationship between components and lists some of the things to watch for in planning your installation.

If you have any trouble in the design or lay-out of your system, contact our Technical Service Department. Our Technical Service specialists will be glad to discuss any problems with you and offer suggestions that may solve these problems!

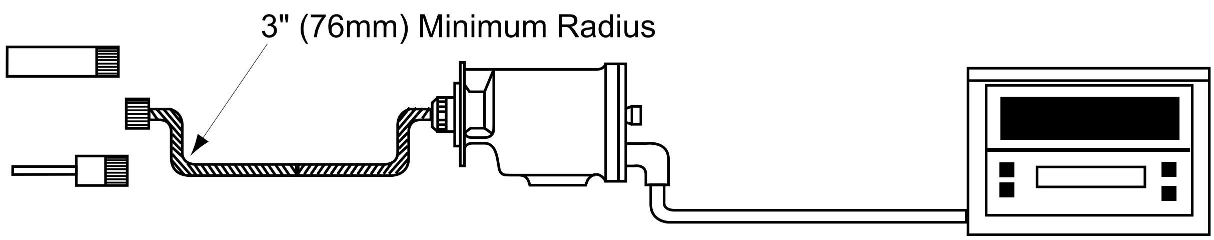
d. Model Number and Serial Number

IMPORTANT: The model number and serial number of a MODLINE 3 System are recorded on the model number labels of the Reimaging Lens or Extension Tip, and Fiber Optic Cable. Each system is factory calibrated with the combination of components specified at the time of order. If you are installing more than one system, make sure all component serial numbers are properly matched.

SENSOR SERIES	AMBIENT TEMPERATURES	
200 & 3G	0 to 60° C	30 to 140° F
3R & 3W	0 to 55° C	30 to 130° F
3V	10 to 45° C	50 to 113° F

TABLE 2F.1 – SENSOR SERIES AMBIENT TEMPERATURE RANGES

TABLE 2F.2 – PLANNING THE FIBER OPTIC SYSTEM INSTALLATION



Reimaging Lens or Extension Tip	Fiber Optic Cable	Sensor Housing	Signal Cable	Indicator/Processor
Clear view of target with minimum obstructions (*Section 2F.1c/2F.1d)* Secure mounting arrangement to prevent shifting from vibration, physical contact, etc. (*Section 2F.4*) Observe operating ambient temperature: (*Section 1.5)* Protected from physical abuse and environmental conditions. *Note:* Reimaging Lens may require AA-5 Air Purge in dirty or dusty locations. Accessible for routine maintenance. *(Section 5 for Fiber Optic Maintenance)*	Protected from physical abuse or harmful environment. Not immersed in water or subject to liquid spray. Cable should be supported mechanically, if practical, to prevent excessive flexing. Observe operating ambient temperature *(Section 2F.2.)* Standard Fiber Optic Cable lengths are 10 feet (3m). Bends in cable must have a radius of at least 3 inches (76 mm). Stainless steel armor sheath of cable must be insulated from surfaces that are not at Earth Ground potential. *(Section 2F.5)* If used with Reimaging Lens, coupler at Sensor flange should be accessible for spot check on target during installation or maintenance. *(Section 2F.1c and 5.2b)*	Protected from physical abuse or harmful environmental conditions. Sensor is drip-tight and dust-tight, but must be protected from other conditions. Secure mounting arrangement. Observe ambient temperature range of your Sensor Series, as stated in Section 1. Backplate accessible for connection of Signal Cable. Front flange accessible for connection of Fiber Optic Cable.	Protect from physical abuse and harsh environmental conditions. Use conduit if necessary. The Sensor Cable shield <u>must be</u> grounded to the Indicator / Processor, as in Section 3.5. Do not route along ac power lines, high power relay wires, or other sources of interference. Do not run in the same conduit as power lines, relay wires, etc. Avoid routing near strong magnetic fields (large transformers, inductors, or saturable core reactors). Observe ambient temperature limits: Standard PVC 220°F or 100°C max. Silicone Rubber 400°F or 200°C max.	Accessible to Signal Cable and to wiring from auxiliary equipment. Protect from physical abuse and from harsh environmental conditions. Observe Ambient Temperature limits: (*Section 1.3)*

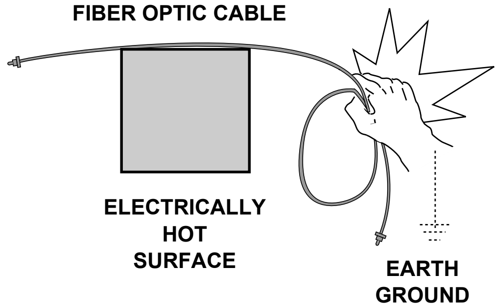
Section 2F — Fiber Optic SENSORS

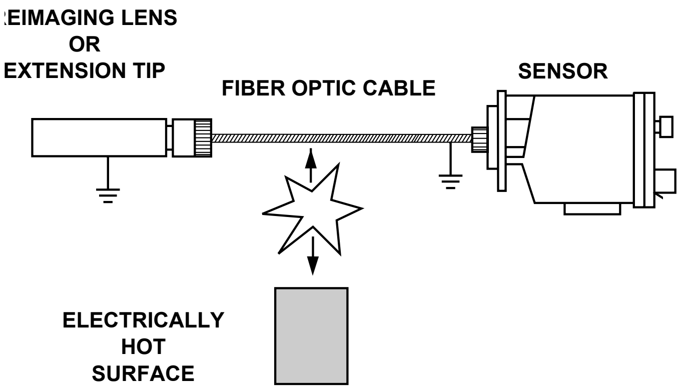
WARNING

The armor sheath of the Fiber Optic Cable is electrically conductive, and can present the possibility of electrical shock, if not handled with caution in the vicinity of components that are above Earth Ground potential. Hazardous conditions are summarized below.

1. Exercise caution when you route the Fiber Optic Cable. It is equivalent to handling a non-insulated electrical wire. DO NOT allow the cable sheath to contact any electrically "hot" surface!

   Note: IRCON can provide a Fiber Optic Sleeve Kit (L120K2) as an aid for reducing static discharge. Contact our Technical Service Department for information.

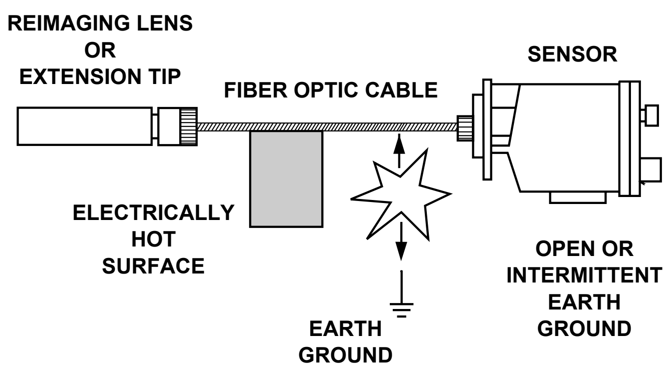




2. Do not connect the Sensor, the fiber optic cable, the reimaging lens or the extension tip to Earth Ground. Connect the Earth Grounds as in Section 3.14. This automatically grounds the Fiber Optic Cable sheath when the cable is coupled to the Sensor, and also grounds the Reimaging Lens or Extension Tip coupled to the end of the cable.

   DO NOT place yourself between this grounded cable sheath, or the components coupled to its ends, and any electrically "hot" surface!

3. Be alert for poor electrical grounding (open ground or intermittent ground contact) when you install the system. If any Fiber Optic component contacts an electrically "hot" surface under these conditions, the danger of electrical shock exists between all Fiber Optic components and Earth Ground!



Please be aware of these and other safety hazards! OBSERVE STANDARD PLANT SAFETY PRACTICES FOR ROUTING, MOUNTING, AND INSULATING ELECTRICAL CONDUCTORS IN AREAS WHERE ELECTRICAL POWER SOURCES ARE PRESENT!

2F.3 MOUNTING A SENSOR

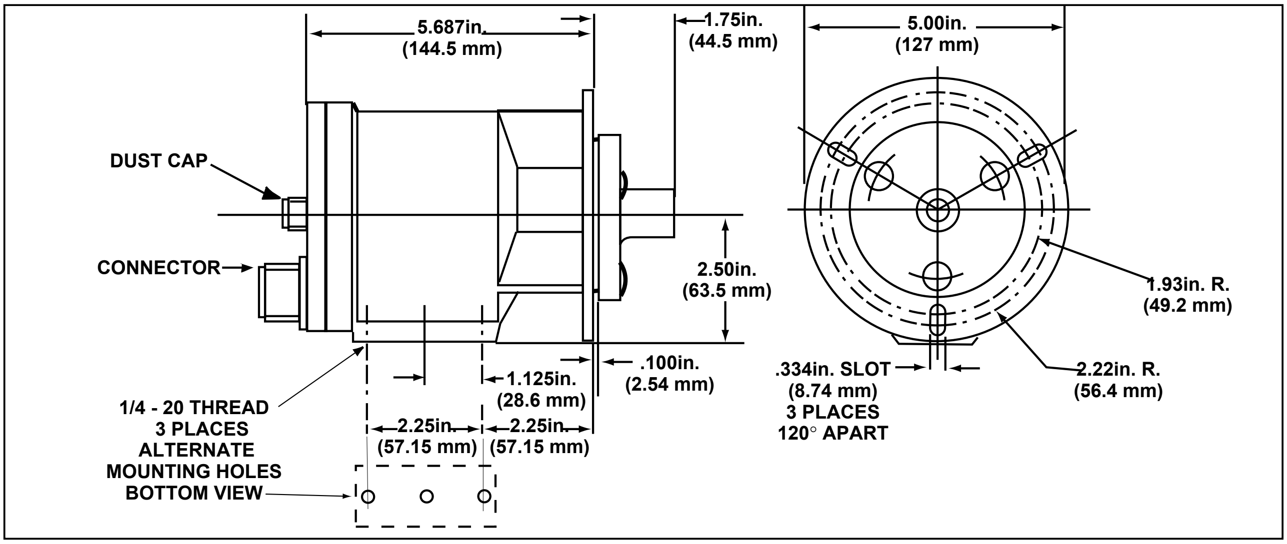
The Sensor is ordinarily mounted by the base mounting pad to a fixed mounting surface at some appropriate point. Mounting dimensions are given in Fig. 2F.12. Three 1/4 –20 mounting bolts are supplied with the Sensor.

If the proposed mounting surface is n<u>ot</u> at Earth Ground potential, see Sections 2F .2 and 3.14 for insulating information.

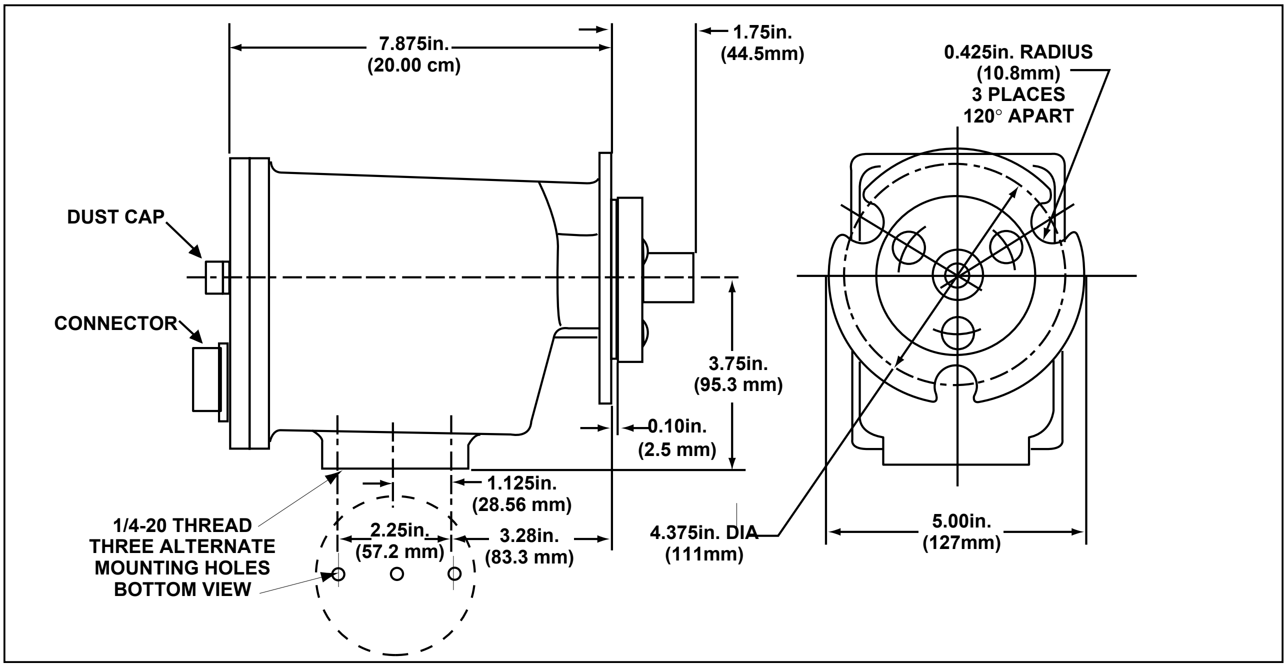
WARNING

Refer to Page 2F-10 to evaluate possible electrical safety hazards when mounting a Sensor.

The temperature of the Sensor must be held within the Ambient Temperature Range specified in Section 1.3. If ambient temperature at the mounting location is beyond these limits, protect the Sensor by means of insulation and/or reflective shielding.



Series 200, 3G, 3V, and 3W



Series 3R

FIG. 2F.12– SENSOR DIMENSIONS

Section 2F — Fiber Optic SENSORS

2F.4 MOUNTING THE REIMAGING LENS OR EXTENSION TIP

A Focusable Reimaging Lens or an Extension Tip is the element that views the target and collects the infrared radiation that will be processed by the Fiber Optic System. As such, it requires special care in mounting. Not only must it be mounted securely and protected from any possible damage, but also must be carefully aligned for a clear, unobstructed view of the object to be measured.

The following guidelines will help you in carrying out the installation.

2F.4a GENERAL INFORMATION

A threaded section on the barrel of a Reimaging Lens, or on an Extension Tip ferrule, may be used as a means of mounting. This mounting thread can be inserted through a 7/8-inch (21mm) hole and secured by the two retaining nuts (supplied), or it can be screwed into a hole that is tapped to accept a 7/8–20 UNEF thread, as in Section 2F.4b. Mounting accessories are also available as described in Section 6.

- The position of the Reimaging Lens or Extension Tip with respect to the object being measured is very important! Before you select your mounting location, refer to Section 7.10.
- Consider the environmental conditions at the mounting point. A Reimaging Lens or an Extension Tip is water-tight and dust-tight. It must be protected against all other environmental conditions.
- Make sure the protective window of a Reimaging Lens or the tip of the glass rod of an Extension Tip is accessible for periodic cleaning. Also, make sure the mounting facility for a Reimaging Lens allows access for focusing.
- The ambient temperature at the mounting point must be within acceptable limits.

  Reimaging Lens: 0 to 400°F (0 to 200°C)

  Extension Tip: 0 to 575°F (0 to 300°C)
- Fiber Optic Cable is not to be immersed in water or subjected to liquid spray. Liquid seeping through the armor sheath can erode and damage the glass fibers.
- Dust, oil, vapors, etc. which collect on the protective window of a Reimaging Lens can result in low temperature indications. Use an IRCON Model AA-5 Air Purge accessory to avoid this problem. This accessory is described in Section 6.

  The air purge will prevent condensation (and possible lens damage) in harsh environments, but *only* if you provide a supply of clean, dry instrument air or filtered dry plant air. Install filters in the air line if necessary. A flow rate of 1 ft^3/min (0.03 m^3/min) is recommended.
- Errors can be caused by objects between the Reimaging Lens or Extension Tip and the target. Any such object that happens to be inside the Cone of Vision will be visible to the detector in the Sensor, and may cause an error in temperature reading. If there is any possibility that an intervening object is within the cone, select a different viewing angle.

  Note: Refer to Section 7 for guidance in choosing the angle.
- Reflections from other radiating objects represent a potential source of error in your temperature readings. The total radiation seen by the detector will be a combination of intrinsic radiation and reflected radiation.

  Examples of interfering sources are hot furnace walls and heating elements that are hotter than the target object.
- Most reflection problems can be eliminated by changing the viewing angle or shielding the reflections. Suggestions for anticipating and eliminating common reflection problems are provided in Section 7. If however, you are faced with unusual reflection problems, call IRCON Technical Service for recommendations.

- In most installations the front face of a Reimaging Lens or the tip of an Extension Tip is parallel to the target surface, and the optical axis is exactly perpendicular to the surface. However, you may find it necessary to mount the unit so the optical axis is at some other angle to the target (e.g., to avoid intervening objects or reflections, or simply for a more convenient mounting arrangement). In this case the "spot" will be elliptical rather than circular, but as long as the target surface is large enough to accommodate the widest axis of the spot, this will not present a problem.

  Note: Before considering this type of arrangement, refer to Section 7.

- Be careful in selecting the window material when the object is to be heated in a vacuum or inert atmosphere. The material must have constant transmission characteristics in the wavelength range of the instrument. Recommended window materials for each instrument series are provided in Section 7.

- If you have any questions about window material, contact our Applications Engineering Department for recommendations.

- For an Extension Tip, avoid temperature shocks (e.g., quenching the hot tip with cold water spray). This can cause the glass to shatter.

  ABOVE ALL–HANDLE AN EXTENSION TIP WITH CARE! It is made of glass and ceramic materials. Use the same care you would normally use for glass or ceramic household objects in your own home!

- If the mounting surface you have selected is conductive and not at Earth Ground potential, insulate the Reimaging Lens or Extension Tip (or its mounting facility) from this surface.

⚠ CAUTION ⚠

1. Handle the Extension tip with care. The glass rod and its ceramic tube can be fractured by rough handling.
2. Avoid abrupt temperature changes (e.g. quickly withdrawing the Extension Tip from a hot oven into ambient air --- or particularly subjecting the hot glass rod to a cold water spray!) This could cause the glass rod to shatter. If possible, perform maintenance on the Extension Tip as part of an overall System maintenance routine --- when the heating source itself is cooled down for maintenance.

⚠ WARNING ⚠

Refer to Page 2F-10 to evaluate possible electrical safety hazards regarding the mounting of the Reimaging Lens or Extension Tip.

Section 2F — Fiber Optic SENSORS

2F.4b DIRECT MOUNTING

A Reimaging Lens or an Extension T ip may be mounted directly into a 7/8-inch diameter hole in a bulkhead, panel or other mounting support. If the hole is threaded (7/8 –20 UNEF thread), no additional components are required. If unthreaded, the two retaining nuts supplied with the sensor are required.

Procedure

IMPORTANT! Be sure your mounting location will provide target alignment, and focusing for Reimaging Lens, see Section 2F.1c, 2F.1d, and 7.

1. Remove the plastic cap from the protective window of a Reimaging Lens or the glass rod of an Extension Tip.

2. If mounting in a 7/8 –20 threaded hole, simply screw the Reimaging Lens or Extension Tip into the hole until secure.

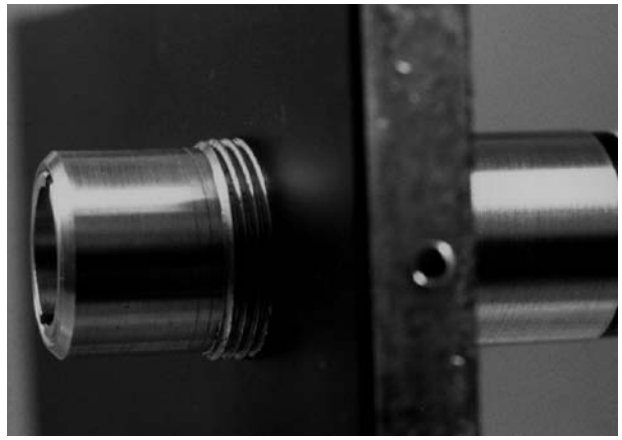
3. For an unthreaded 7/8-inch hole, screw one of the retaining nuts onto the threaded section of the Reimaging Lens or Extension Tip and insert through the hole. Then attach the other retaining nut to secure the assembly as in Fig. 2F.13.

4. *Reimaging Lens Only.* If a Model AA-5 Air Purge (Fig. 2F.14) or an AAQ-1 Quick Release Air Purge is included in the installation, secure the mounting thread of the air purge to the panel or bulkhead as in Step 2 or 3 above. Then attach the air line and screw the Reimaging Lens mounting thread into the air purge.

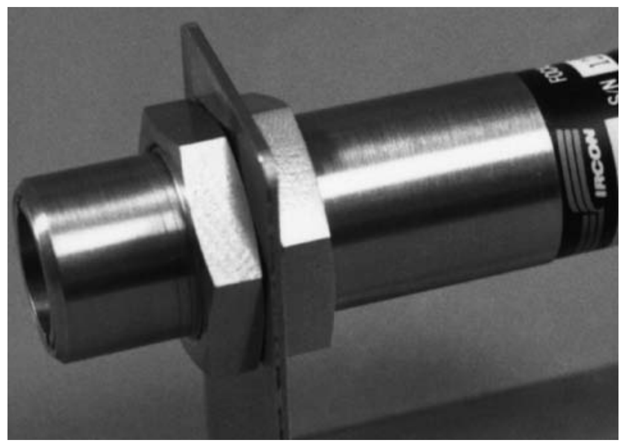
Assembly Notes

1. Make sure the Fiber Optic Coupler at the rear of the Reimaging Lens or Extension T ip is accessible.

2. For a Reimaging Lens, make sure the Lens Position Locking Screw is accessible.



Direct Mounting in 7/8–20 Threaded Hole



Mounting in 7/8" Hole Using Two Retaining Nuts

FIG. 2F.13 – DIRECT MOUNTING OF REIMAGING LENS
(Procedure Identical for Extension Tip)

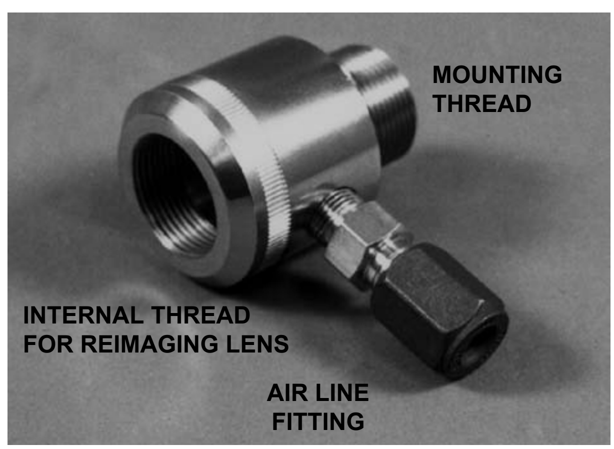


FIG. 2F.14 – MODEL AA-5 AIR PURGE

2F.4c MODEL MB-5 ANGLE MOUNTING BRACKET

The Model MB-5 Angle Mounting Bracket provides a base that may be bolted to a mounting surface. The Reimaging Lens or Extension T ip is then mounted into the hole on the vertical section of the bracket.

Procedure

IMPORTANT! Be sure your mounting location provides target alignment, and focusing for Reimaging Lens, see Section 2F.1c, 2F.1d, and 7.

1. Bolt the base of the Angle Mounting Bracket to the desired mounting surface. Check the grounding requirements in Fig. 3.14.

2. Remove the plastic cap from the protective window of a Reimaging Lens or the glass rod of an Extension Tip.

3. Screw one of the retaining nuts onto the threaded section of the Reimaging Lens or Extension Tip. Then insert through the hole in the vertical section of the bracket and attach the other retaining nut to secure the assembly as in Fig. 2F.15.

4. *Reimaging Lens Only.* If a Model AA-5 Air Purge or an AAQ-1 Quick Release Air Purge is included in the installation, secure the mounting thread of the air purge to the mounting bracket as in Step 3 and attach the air line. Then screw the Reimaging Lens mounting thread into the air purge, as in Fig. 2F.16.

Assembly Notes

1. Make sure the Fiber Optic Coupler at the rear of the Reimaging Lens or Extension T ip is accessible.

2. For a Reimaging Lens, make sure the Lens Position Locking Screw is accessible.

   IMPORTANT! Be sure your bracket mounting follows the grounding instructions in Fig. 3-14 of Section 3.

FIG. 2F.15–MOUNTING A REIMAGING LENS IN THE MB-5 ANGLE MOUNTING BRACKET
(Procedure Identical for Extension Tip)

FIG. 2F.16 – TYPICAL MOUNTING OF REIMAGING LENS WITH MODEL AA-5 AIR PURGE

Section 2F — Fiber Optic SENSORS

2F.4d MODEL MC-5 MOUNTING CLAMP OR SB-5 SWIVEL BASE

The MC-5 Mounting Clamp adapts a Reimaging Lens or an Extension Tip for attachment to a mounting surface by means of a 1/4–20 bolt. It can also attach to the 1/4–20 bolt of a TM-6 Tripod.

The same mounting clamp is included as part of a Model SB-5 Swivel Mounting Base.

Procedure

IMPORTANT! Be sure your mounting location provides target alignment and focusing for the Reimaging Lens, see Section 2F.1c, 2F.1d and 7.

1. For direct attachment to a mounting surface, insert a 1/4–20 bolt through a hole in the mounting surface and screw it into the Mounting Clamp (Fig. 2F.17).

   Note: Maximum depth of mounting hole in bottom of clamp is 0.41 in. (10.4 mm).

   If the clamp is part of an SB-5 Swivel Mounting Base (Fig. 2F.18), mount the swivel base to the desired mounting surface.

   For use with a Model TM-6 Tripod, thread the captive screw of the tripod pedestal into the Mounting Clamp.

2. Remove the plastic cover from the protective window of the Reimaging Lens or the tip of the glass rod of the Extension Tip.

3. Slide the Reimaging Lens or Extension Tip into the mounting collar of the Mounting Clamp and tighten the mounting screw to secure the assembly.

Assembly Notes

1. An MC-5 Mounting Clamp alone allows a panning motion that may be useful in aiming the Reimaging Lens or Extension Tip on the target. (The mounting screw can be tightened to lock the position when properly positioned.)

2. An SB-5 Swivel Mounting Base or TM-6 Tripod allows complete panning and tilting motions for optical adjustment. Loosen the large hex nut on the Swivel Mounting Base or the tilt and pan arms on the Tripod to permit alignment. Then tighten them to secure the position.

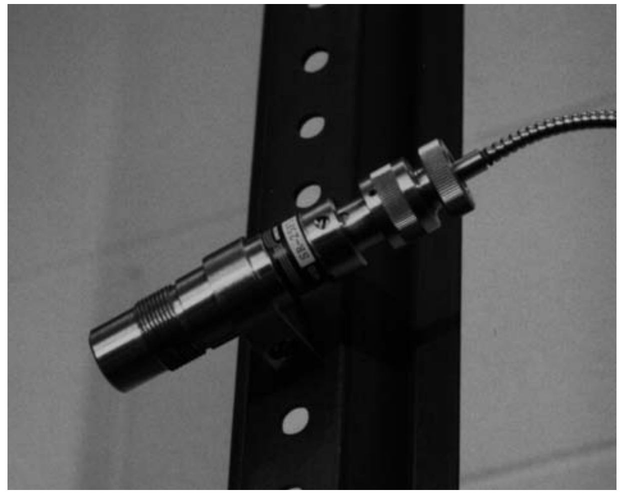


FIG. 2F.17 – TYPICAL MOUNTING ARRANGEMENT WITH MODEL MC-5 MOUNTING CLAMP
(Procedure Identical for Extension Tip)

FIG. 2F.18 – MOUNTING ARRANGEMENT IN MC-5 MOUNTING CLAMP AS PART OF MODEL SB-5 SWIVEL MOUNTING BASE
(Procedure Identical for Extension Tip)

3. A Model AA-5 Air Purge may be screwed onto the threaded section of a Reimaging Lens after the lens has been mounted in either arrangement (Fig. 2F.16 or 2F.17).

2F.4e MODEL AP-5 ADAPTER PLATE

This accessory adapts a Focusable Reimaging Lens for flange mounting. This plate screws onto the mounting thread of the Reimaging Lens as shown in Fig. 2F .19. The bolt holes in the AP-5 align with those of other flange mount accessories to permit mounting.

The AP-5 also accepts the thread of a Model AA-5 Air Purge or an AAQ-1 Quick Release Air Purge mounted on the front flange of the Reimaging Lens as shown in Fig. 2F.18.

Procedure

IMPORTANT! Be sure your mounting location provides target alignment and focusing for the Reimaging Lens, see Section 2F.1c.

1. Remove the plastic cap from the protective window of the Reimaging Lens, and any protective coating that may cover the threaded section.

2. Screw the mounting thread of the Reimaging Lens into the threaded hole of the Adapter Plate (from recessed side) as shown in Fig. 2F.19.

   If an AA-5 Air Purge is included in the installation, screw the thread of the Air Purge into the threaded hole of the Adapter Plate, then screw the thread of the Reimaging Lens into the Air Purge as in Fig. 2F.19.

3. Insert the three screws provided with the AP-5 through the unthreaded holes, from the recessed side, to bolt the Adapter Plate to its mounting support or other flange mount accessories. Refer to the accessory installation instructions for details of any installation procedures.

Note: A Reimaging Lens Spot Check, to verify the assembly, is shown in Section 7.15.

Assembly Notes

1. Make sure the Fiber Optic Coupler at the rear of the Reimaging Lens is accessible.

2. Make sure the Lens Position Locking Screw of the Reimaging Lens is accessible.

FIG. 2F.19 – REIMAGING LENS INSTALLED IN AP-5 ADAPTER PLATE DIRECTLY (TOP) AND WITH MODEL AA-5 AIR PURGE (BOTTOM)

Section 2F — Fiber Optic SENSORS

2F.5 INSTALLING THE FIBER OPTIC CABLE

When coupling a Sensor to a Reimaging Lens or Extension Tip with a Fiber Optic Cable, observe these cautions and warnings, before starting the procedure.

CAUTION

Ambient temperature limits of the Fiber Optic Cable are 0 to 400 °F (0 to 200 °C), except for models with ambient temperature restrictions in Section 1.5.

IMPORTANT! Do not overly flex a Fiber Optic Cable. Bends in the Fiber Optic Cable must have a radius of at least 3 inches (76 mm).

Fiber Optic Cable must not be immersed in water or subjected to liquid spray. Liquid seeping through armor sheath can erode and damage glass fibers inside.

WARNING

Refer to Page 2F-10 to evaluate possible electrical safety hazards in routing and mounting the Fiber Optic Cable.

Use care in handling the electrically conductive armor sheath of the Fiber Optic Cable in areas where electrical power is present.

IRCON can provide an Insulating Sleeve Kit (L120KT2) as an aid in insulating the Fiber Optic Cable sheath. Contact IRCON Technical Service Department for further information.

Procedure

1. Remove the Fiber Optic Cable from its protective bag, and check the model number and serial number on the tag. Make sure they are the same as the model number and serial number on the backplate of the Sensor and on the barrel of the Reimaging Lens or Extension Tip.
2. Remove the plastic caps from each coupler of the Fiber Optic Cable. Notice each coupler has a different type keyway, see Fig. 2F.20.
3. Route the respective ends of the Fiber Optic Cable to the Sensor and the Reimaging Lens or Extension Tip.

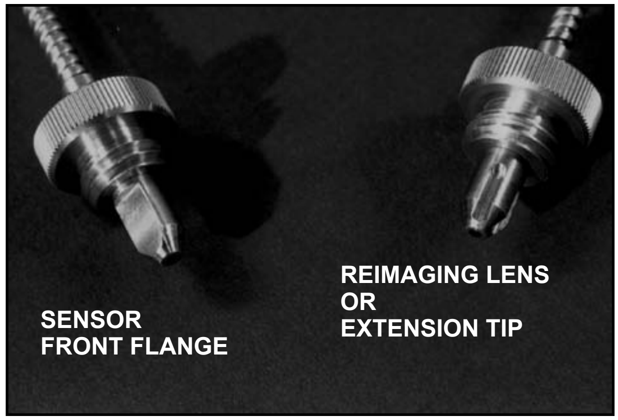


FIG. 2F.20 – KEYED COUPLERS ON FIBER OPTIC CABLE

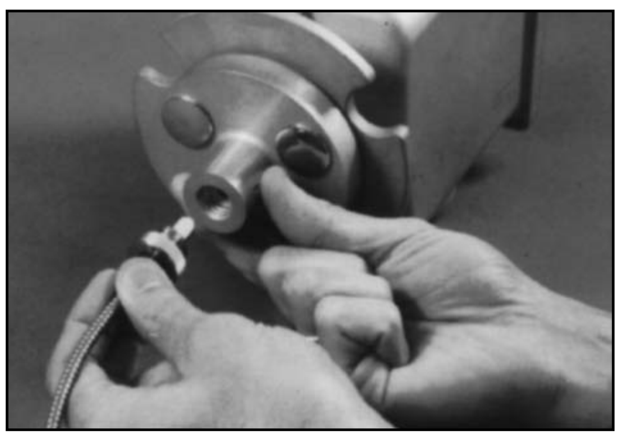


FIG. 2F.21–COUPLING THE FIBER OPTIC CABLE TO A REIMAGING LENS OR EXTENSION TIP *(top)* **and TO THE SENSOR FLANGE** *(bottom)*

4. Insert the couplers into the corresponding coupler sockets on the Reimaging Lens or Extension Tip, as shown in Fig. 2F.21. Then, couple the cable to the Sensor Flange Fixture. Rotate the knurled locking nut to seal the coupling.

2F.6 INSTALLING THE SIGNAL CABLE

The Signal Cable is the link between the Sensor and the Indicator/Processor. It is a 12 foot (4m) shielded cable with insulation overall.

Signal Cables up to a maximum of 1000 feet (300m) can be ordered from IRCON, Inc. in pre-assembled or unassembled bulk form.

If you have ordered a preassembled cable, you will receive the cable with the Sensor connector attached and the Indicator / Processor leads prepared for connection to the terminals. All that is necessary is to plug the cable connector into the matching connector on the Sensor backplate and tighten the locking ring. Then route the other end of the cable to the Indicator / Processor. Section 3 describes the connection to the Indicator / Processor terminals.

If you have ordered bulk, unassembled cable, prepare the cable and install the connector according to the instructions on the cable pages attached to Section 9 as an Addendum. When you have completed the assembly, plug the cable connector into the matching connector on the Sensor backplate and tighten the locking ring, then route the other end of the cable to the Indicator / Processor. Section 3 describes the connection to the Indicator / Processor terminals.

Signal Cable Routing

To avoid physical damage, the Sensor signal cable must be routed through areas free from plant traffic. The Signal Cable should be routed in a conduit by itself or with other signal carrying cables. Do not route the cable along ac power lines, relay wires, or other possible sources of interference. Avoid running the cable near strong magnetic fields such as those around large transformers, inductors, or saturable core reactors.

Local Electrical Codes

Use the wiring methods prescribed for your cabling carrying local low voltage sensor signals.

⚠ CAUTION ⚠

Do NOT route the cable across hot ovens or other hot surfaces. Maximum operating ambient temperature of the cable is 220 °F (100°C) for PVC covered cable or 400°F (200°C) for Silicone Rubber covered cable.

Section 2F — Fiber Optic SENSORS

2F.7 INSTALLATION CHECK LIST

To assure accurate, reliable and trouble-free operation, check your installation for the following:

- ❑ Sensor Housing is mounted securely, out of the way of any plant traffic or other possible sources of damage.
- ❑ Reimaging Lens or Extension Tip is aligned on target. If possible, target size is at least twice the spot size of the Reimaging Lens or Extension Tip at the viewing distance.
- ❑ Reimaging Lens is protected by air purge and clean purge air if atmosphere is dirty, oily, corrosive, or excessively humid.
- ❑ The serial numbers of the Fiber Optic Cable, the Reimaging Lens or the Extension Tip have been calibrated together at the factory and the numbers must match.
- ❑ Sensor, Fiber Optic Cable, and Reimaging Lens or Extension Tip are all operating within rated ambient temperature limits.
- ❑ Mounting surface is not above earth ground potential. If it is - then, insulate the casting from the surface as suggested in Section 2F.3 and Section 3 - Fig.3.14, if necessary.
- ❑ Bends in the Fiber Optic Cable must have a radius of at least 3 inches (76 mm).
- ❑ Fiber Optic Cable is NOT immersed in water or subjected to liquid spray. Liquid seeping through the armor sheath can erode and damage the glass fibers inside.
- ❑ Signal Cable is NOT routed over any surface that exceeds 200°F (100°C) for PVC covered cable or 400°F (200°C) for Silicone Rubber covered cable.
- ❑ Signal Cable is not routed along ac power line or other sources of electrical interference.
- ❑ Fiber Optic Cable is not being subjected to static discharge. If insulating the sheath is required, IRCON can provide an Insulating Sleeve Kit (L120KT2).

When you have completed all installation procedures, and checked them to your satisfaction, proceed with the Indicator/Processor installation as described in Section 3.

CAUTION

Fiber Optic Cables, Reimaging Lenses, and Extension Tips have very high ambient temperature ratings. They may become extremely hot in normal operation. Exercise all plant safety practices for handling materials in high temperature zones if you must touch them for adjustment, maintenance, or any other reason once they have heated. If need be, handle them only after normal cooldown of the heating system!

TYPICAL MAXIMUM OPERATING TEMPERATURES
Fiber Optic Cable and Reimaging Lens: 400°F (200°C)
Extension Tip: 575°F (300°C)

Section 3 — INDICATOR/PROCESSOR

This section provides the information you will need to install the MODLINE 3 Indicator/Processor. General installation requirements are explained, and instructions are given for physically mounting the enclosure. Wiring details are provided for all standard and optional features.

Section 3 — INDICATOR/PROCESSOR

3.1 DESCRIPTION

The Indicator / Processor is the core of the MODLINE 3 System. In its basic form it is a self-contained unit with all facilities to monitor the output of the temperature Sensor and provide a display of the measured temperature. A selection of analog outputs or a RS-485 Digital Communications Interface are available. The analog output signal is linearly proportional to measured temperature and is available for a variety of user supplied indicators, recorders, computers, etc.

The Indicator / Processor can be ordered with an On-Off or PID Controller option. The On-Off Controller provides relay switching at two adjustable temperature levels to permit process control, alarming, and other functions. With a PID Controller, the System provides control of your process temperature.

Fig. 3.1 shows the Indicator / Processor Front Panel. All the controls, the temperature display and the function display are located on the front panel of the enclosure. All the Indicator / Processor components and subassemblies are housed in an aluminum extrusion enclosure that has a NEMA 4 rating.

YOUR SYSTEM

The standard functions for the System are described in this section. If your system includes one of the controller options, such as; On-Off Controllers — you will use this section and refer to Section 3C for the On-Off Controller wiring connection information. Use this section and Section 3P to install the PID Controller wiring connections information.

Before proceeding with this installation, it is a good idea to consider the factors in Section 3.2 Pre-installation Notes.

You will want to use this section as a step-by-step training aid. The section shows you ways to mount the unit, wire in the controls, what functions to select for a basic Indicator / Processor System.

IN THIS SECTION

In this section you learn to install the Indicator / Processor in a panel. You connect the Sensor Signal Cable, the required power cable, and any related equipment cables to user supplied devices. You are shown the appropriate options, the requirements, the selectable functions and the communications abilities of the MODLINE 3 System that broaden your process control.

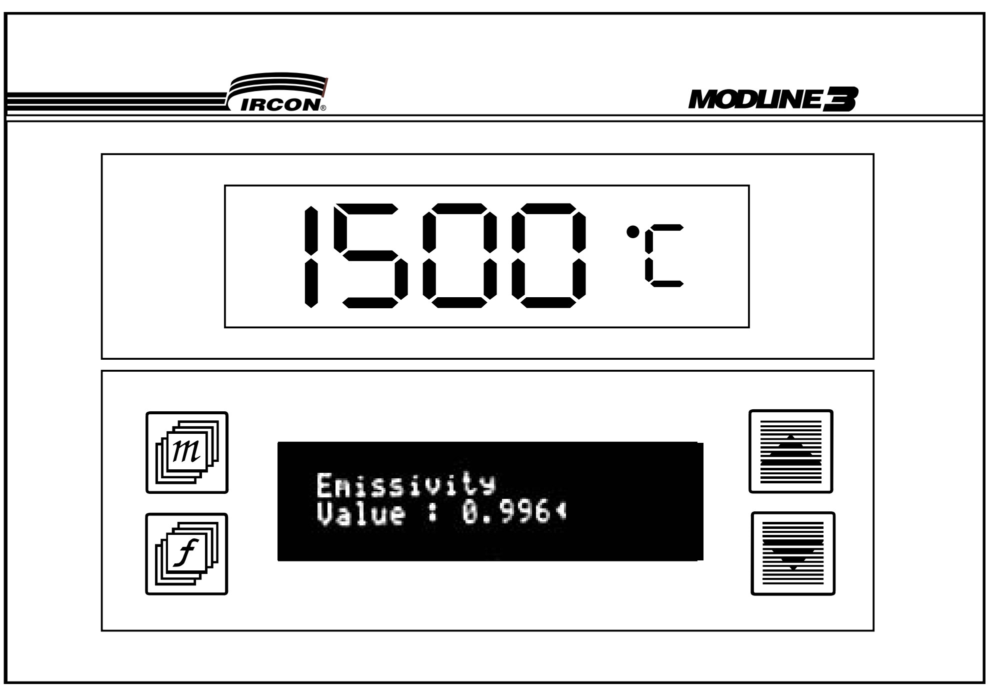


FIG. 3.1 - MODLINE 3 INDICATOR / PROCESSOR FRONT PANEL

Section 3 — INDICATOR/PROCESSOR

3.2 PRE-INSTALLATION NOTES

The following guidelines will help in planning the installation of your Indicator/Processor.

PHYSICAL MOUNTING

The Indicator / Processor is intended to be panel mounted by means of the mounting hardware supplied. Select a location protected from heavy plant traffic and physical abuse. Avoid mounting the enclosure in areas of heavy magnetic fields, or in proximity to strong ac currents. Dimensions of the Indicator / Processor enclosure and the panel cutout are given in Fig. 3.2.

ENVIRONMENTAL CONDITIONS

Ambient operating temperature for the Indicator / Processor is 32 to 122 °F (0 to 50 °C). Make sure the temperature at the mounting location does not exceed these limits.

NEMA SAFEGUARDS

The enclosure is NEMA 4 rated and designed to provide a degree of protection against dust and rain, splashing water and even short duration of hose directed water.

The enclosure maintains NEMA 4 integrity when all the cable entry ports are sealed. Grounding Strain Reliefs are a typical method of sealing a cable entry port. When properly installed, as in Section 3.7, they form a dust-tight and water-tight seal for the cable. DO NOT simply run individual wires or bare cable through an open port.

ELECTRICAL POWER

The power consumption of the unit is 40 VA maximum. The instrument requires mains that supply 90 to 250 Vac, 50/60 Hz, with the third wire earth ground. If the third wire earth ground is not available, you must supply a separate earth ground as explained in Sections 3.14 and 3.15.

The wiring insulation must be suitable for single fault condition (600V, 105 °C). Follow all local electrical codes and standard plant practices in planning your wiring.

Use a clean power line such as a separate instrument power line, see Section 3.15 Power Wiring Practices. Avoid power lines serving noisy electrical equipment such as brush motors, phase angle fired SCR power supplies, etc. Install a line conditioner, if necessary.

A two-pole power shutoff or safety switch must be incorporated within the main power line for this MODLINE 3 System. This switch should be in close proximity to the operator. The switch should be clearly marked as the cutoff or power shutoff for the equipment. The switch (and all circuit breakers) should comply with IEC 947 requirements given in Section 3.15 Power Wiring Practices. Installation is given in Section 3.16 AC Power Connections.

GROUNDING AND ISOLATION

Good grounding and proper installation of signal leads are essential for trouble free operation. Recommended methods of wiring are described in the individual wiring instructions that follow. Proper grounding and isolation procedures for the overall system are summarized in Section 3.14.

AUXILIARY EQUIPMENT

Before interfacing any auxiliary equipment to the System, consider the operating specifications and cable requirements for each device, defined in the wiring instructions for each cable connection.

RFI AND EMI INTERFERENCE

The MODLINE 3 is designed and tested to meet CE standards: In order to retain the standard all signal cables must be 360° grounded to the enclosure as in section 3.5.

⚠ WARNING ⚠

Risk of Personal Injury

When this instrument is being used in a critical process that could cause property damage and personal injury, the user should provide a redundant device or system that will initiate a safe process shut-down in the event that this instrument should fail. The user should follow the NEMA safety guidelines in Appendix A of Section 9 of this manual.

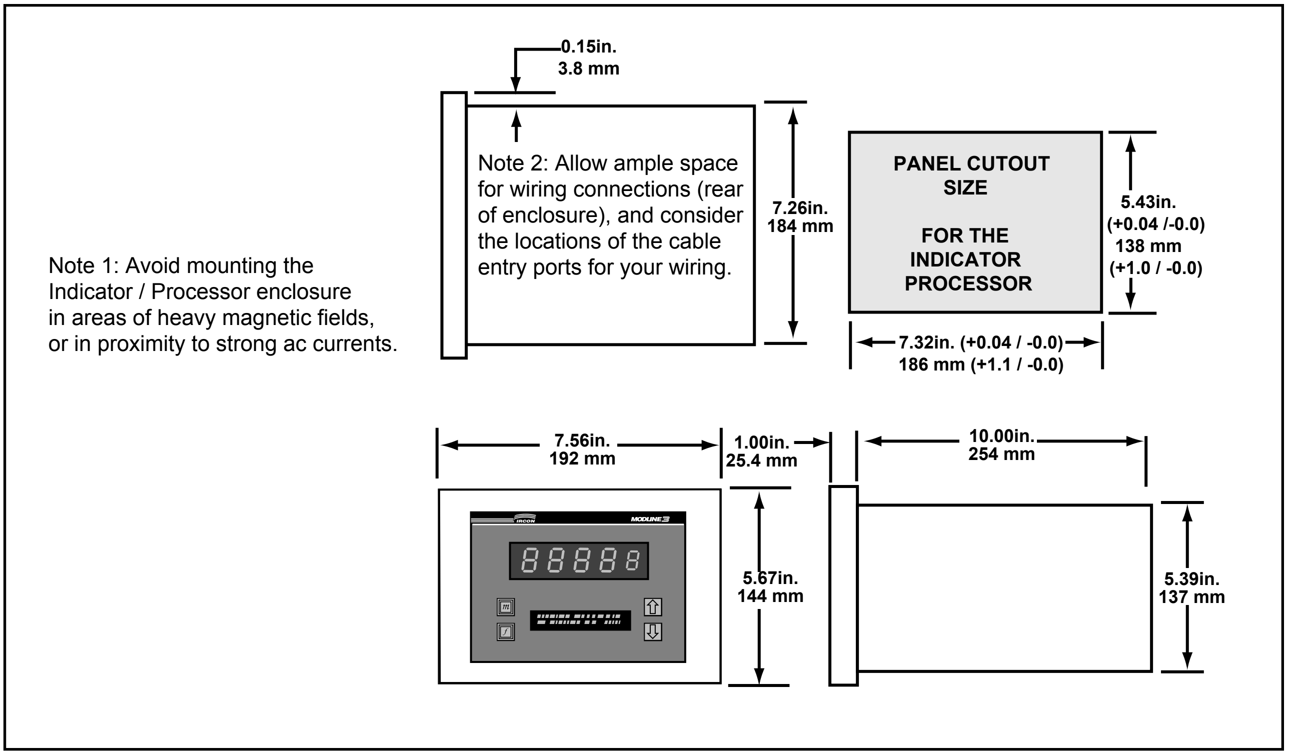


FIG. 3.2 - DIMENSIONS OF MODLINE 3 INDICATOR / PROCESSOR ENCLOSURE

3.3 PANEL MOUNTING PROCEDURE

The MODLINE 3 Indicator / Processor is designed for mounting in a user-supplied panel.

Prepare your panel, as follows:

1. Prepare a cutout in a panel (8 to 14 gauge 1.6 to 3.3mm thick). Use the Panel Cutout Size dimensions shown in Fig. 3.2.

2. Follow the Section 3.2 Pre-installation Notes about Environmental Conditions and Physical Mounting.

3. Follow the Fig. 3.2 precaution procedure notes about mounting space and magnetic field proximity.

Section 3 — INDICATOR/PROCESSOR

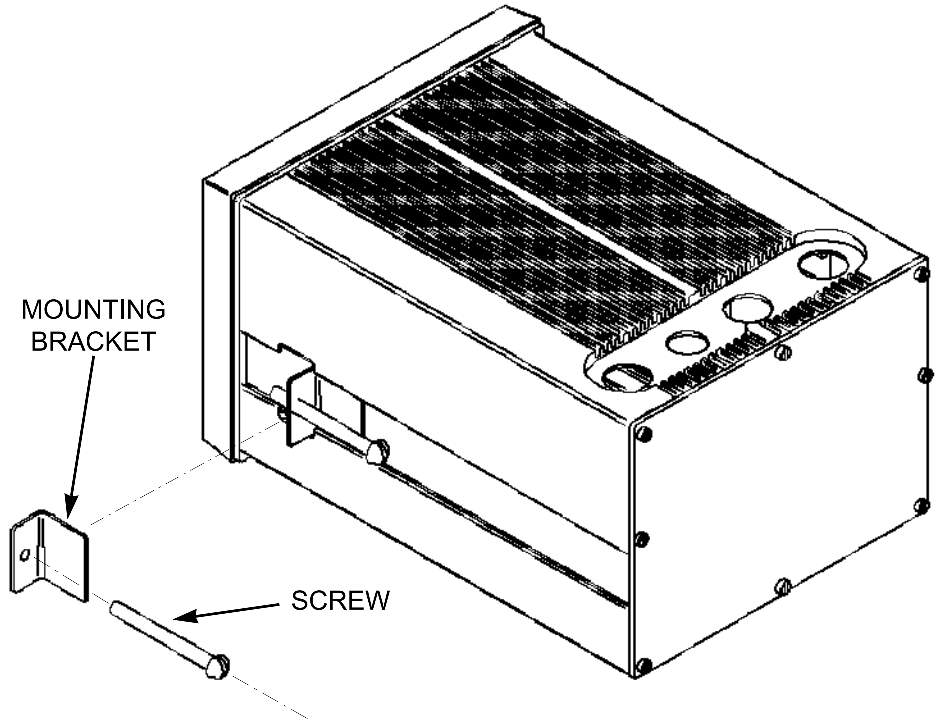


FIG. 3.3b – HARDWARE MOUNTING PROCEDURE

3.3 Continued

Mount your Indicator / Processor, in your prepared panel, as follows:

1. Slide the Indicator / Processor enclosure in from the front of the panel until the front flange is seated against the panel, taking care to center the enclosure in the panel cutout, as shown in Fig. 3.3b.

2. Insert the brackets, one at a time into the mounting slots on each side of the enclosure as shown in FIG.3.3b.

3. Tighten the screws, so that the brackets secure the enclosure to the panel.

4. If you are going to wire the rear panel, you may want to temporarily leave the rear panel cover off.

5. When all wiring has been completed, you must reinstall the rear panel cover with the seal intact and the eight screws to retain CE compliance and the environmental rating of this unit.

Side by Side Indicator / Processors

The enclosure size allows mounting of two Indicator / Processors side-by-side in a 19 inch rack.

3.4 SENSOR CABLE CONNECTION

SENSOR CABLE GROUNDING CONNECTION

Fig. 3.4 shows typical cable routing layout at four of the ports.

Any of the six cable ports may be used for routing the various signal and power cables. Two smaller entry ports are provided for the smaller reliefs. Install them as described in Section 3.5.

1. To gain access to the wiring area: loosen all eight captive screws and remove the rear panel cover, shown in Fig 3.3b. When all wiring has been completed, you must reinstall the rear panel cover, to retain CE compliance and the environmental rating of this unit, shown in Fig 3.17.

2 Each cable port is sealed by a cap, an o-ring and a nut. Remove the cap and nut from the port you wish to use.

3. Pass the Sensor Signal Cable leads and fit - tings through the port and into the enclosure.

4. Make sure the grommet is centered in the opening.

5. Hold the cable firmly, so that the cable does not twist in the fitting, as you screw the nut onto the fitting. Tighten all fittings to make a water-tight seal.

Section 3.6 describes how to install the cable leads. All terminals on the rear panel are clearly labeled, as seen in Fig 3.7, to simplify the cable and wire connection.

CAUTION

Using non-CE-approved components may result in the system not maintaining compliance with the CE directives.

INPUT/OUTPUT CABLE ROUTING

All cables coming to the Indicator / Processor must be routed through areas free from plant traffic.

BULK SENSOR SIGNAL CABLE

If you have ordered bulk, unassembled cable, you will have to assemble the connectors on the cable.

Diagrams and instructions for building the three types of bulk cables are shown in Section 9 Addendum of this manual. The cables are:

- PVC Signal Cable,
- Silicone Rubber Signal Cable, and
- Silicone Extension Cable with a PVC Extension Cable.

Note: You may want to pull the bulk cable through your conduit before affixing connectors. Then insert the color-coded leads into the terminal lugs of the 8-pin connector of the Indicator / Processor, as in Fig. 3.5.

GROUNDING SHIELDED CABLE IN CONDUIT

The shielded cable running in a conduit, must have a liquid-tight o-ring seal. Attach the drain wire to the grounding screw on the conduit nut as an earth ground.

Uncomb and drape the cable braided shield wires over the conduit nut as shown in Fig. 3.4.

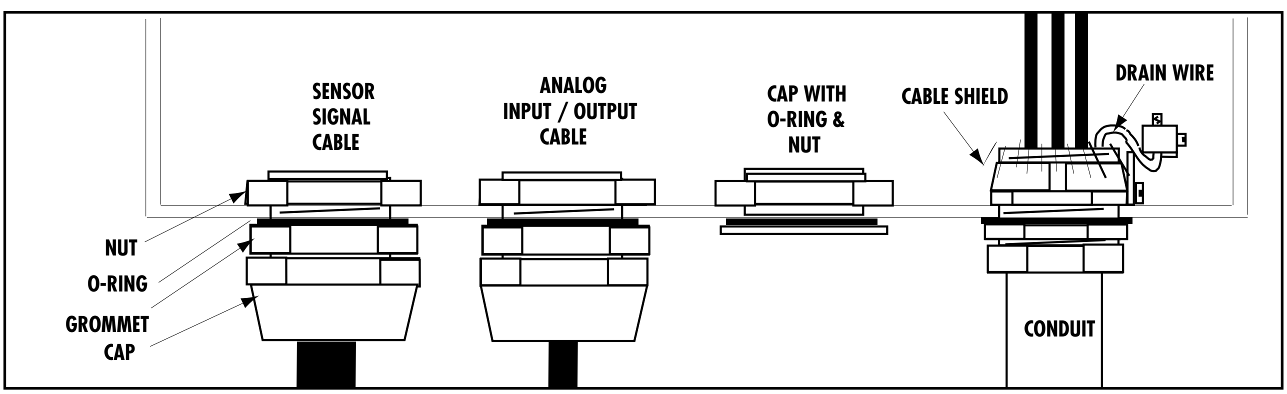


FIG. 3.4 – TYPICAL CABLE ROUTING LAYOUT

Section 3 — INDICATOR/PROCESSOR

3.4 SENSOR CABLE CONNECTION — Continued

SENSOR SIGNAL CABLE

To make the wiring installation a little easier, you can use your fingers to remove and remount the 8-terminal Sensor Connector plug shown in Fig. 3.5 from the Sensor Connector on the rear panel, shown in 3.6.

Insert the color-coded leads into the terminal lugs of the 8-pin connector, as in Fig. 3.5. Each wire must be captured in a terminal lug and the terminal screw tightened securely. Reinsert the 8-pin connector in the Rear Panel Connector.

Note: If you have ordered extension cable, join the in-line connectors of the cables shown in Fig.3.5, as described in Section 9. Tighten the in-line connectors securely.

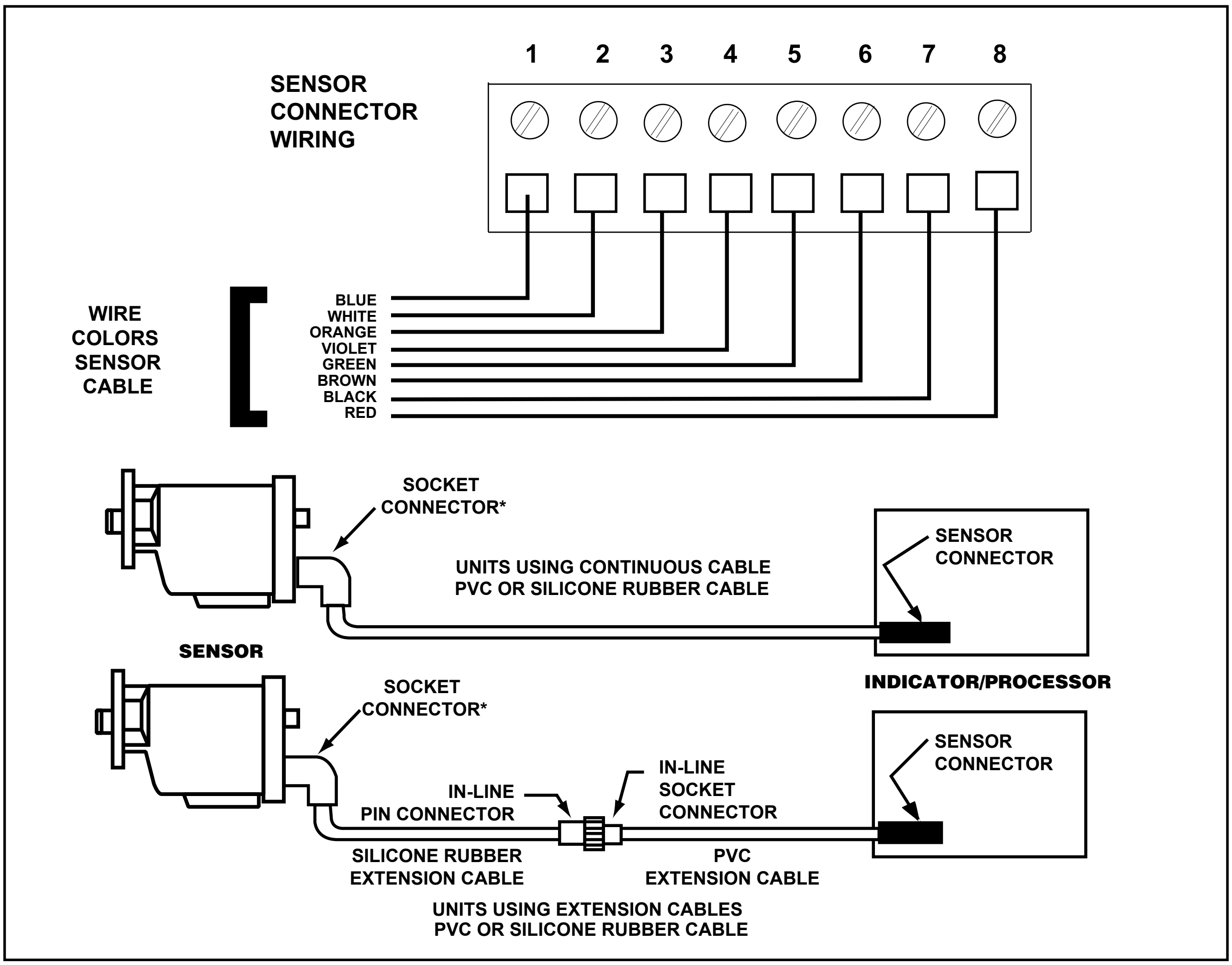


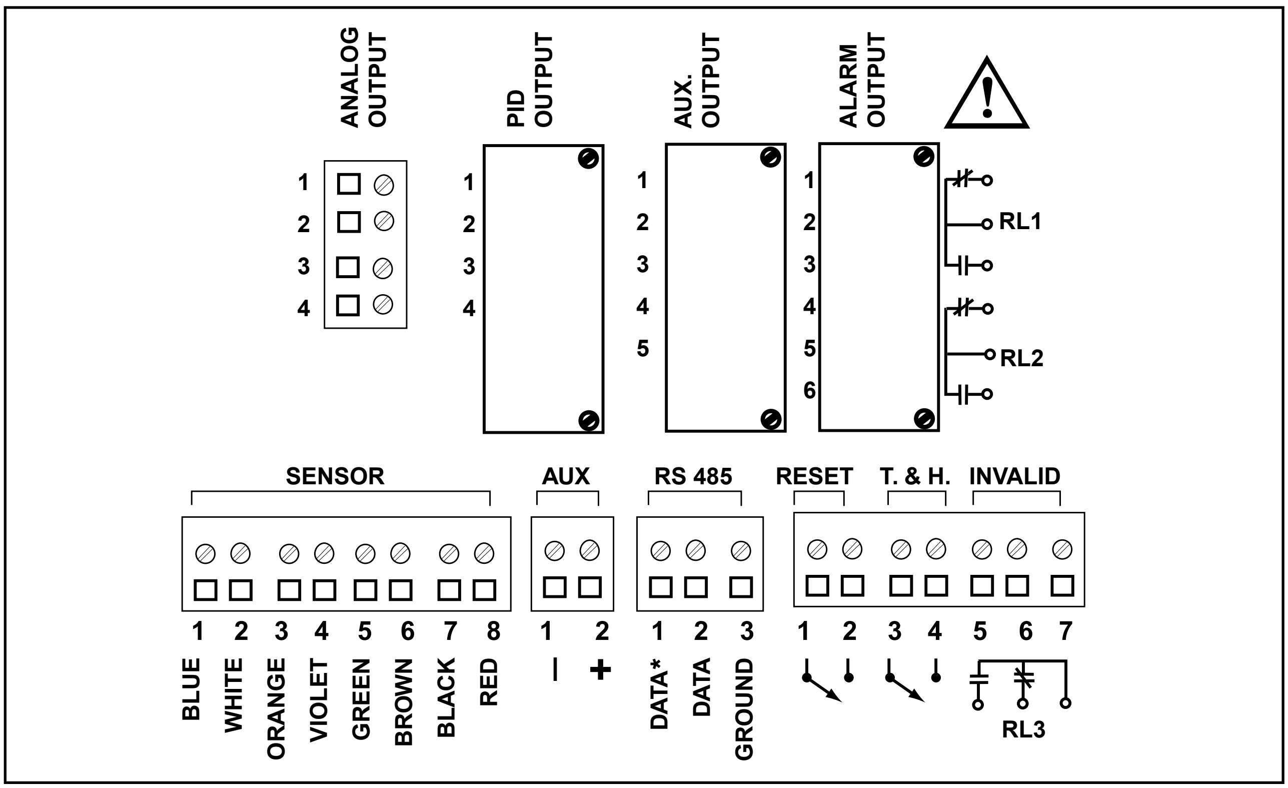
FIG. 3.5 - SIGNAL CABLE CONNECTIONS BETWEEN SENSOR AND INDICATOR/PROCESSOR

3.5 WIRING INDICATOR / PROCESSOR

The procedures for wiring of the rear panel for the Indicator / Processor are described in the following Sections:

Section 3.6 Auxiliary Cable Preparation.
Section 3.7 Shield Grounding.
Section 3.8 Analog Output cable.
Section 3.9 Aux Input cable.
Section 3.10 RS-485 Digital Interface cable
Section 3.11 Reset Peak Picker cable.
Section 3.12 T. & H. Control cable
Section 3.13 Invalid Alarm cable.

Fig. 3.6 shows the names of the connectors and terminal numbers. They are clearly labeled to sim - plify wiring. The lower portion of Fig. 3.6 details the wire names.



SENSOR	AUX	RS 485	RESET	T&H	INVALID	ANALOG OUTPUT	PID OUTPUT	AUX OUTPUT	ALARM OUTPUT
1 BLUE	1 - SIGNAL	1 DATA*	1 +	3+	5 NO	1 +	1 +	1 NONE	1 RLY 1 NC
2 WHITE	2 + RETURN	2 DATA	2 GND	4 GND	6 NC	2 -	2 -	2 NONE	2 RLY 1 COM
3 ORANGE		3 GND			7 COM	3	3	3 NONE	3 RLY 1 NO
4 VIOLET						4	4	4 NONE	4 RLY 2 NC
5 GREEN								5 NONE	5 RLY 2 COM
6 BROWN									6 RLY 2 NO
7 BLACK									
8 RED									

FIG. 3.6 – REAR PANEL WIRING FOR NO CONTROLLER

Section 3 — INDICATOR/PROCESSOR

3.6 AUXILIARY CABLE PREPARATION

CABLES FOR AUXILIARY EQUIPMENT

You supply:

- Shielded Cables for analog outputs, reset or control inputs, and relay outputs.
- Shielded Cable for RS-485 Digital Interface Communications.
- If more Grounding Strain Relief Fittings are needed, see Section 9 for ordering information.

All user supplied shielded cables routed to the Indicator / Processor must be routed through the Grounding Strain Relief fittings. The dressing of 2, 3, 4, and 5 wire shielded cables for the auxiliary equipment is similar to that of the PVC shielded cable. Exceptions for cables supplied by Ircon, Inc. are noted in the text.

DRESSING PVC CABLES

Before you make any cable connections to the Indicator / Processor the auxiliary cables will require dressing and cutting.

Dress the cable before installing it in the Grounding Strain Relief fittings. This example covers all types of PVC Cable:

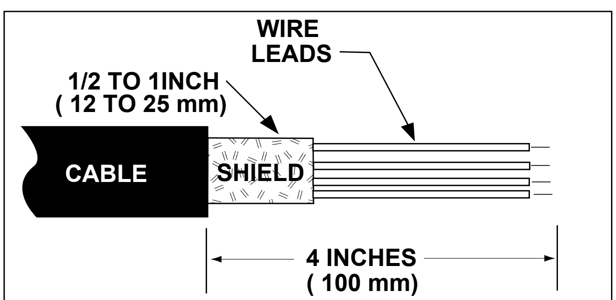
a. Strip off 4 to 5 inches (100 to 125mm) of the outer cable insulation.

b. Remove 3.5 to 4 inches (75 to 100mm) of the outer braided shield. Leave one inch (25mm) of shield exposed.

c. Remove the drain wire.

d. Remove the exposed inner foil and the foil just under the braided shield.)

e. Strip all colored wires 5 / 16 inch (8 mm). Do not tin wire ends.



DRESSING SILCONE CABLES

IRCON supplies a Silicone Cable that has two added braided drain wires and an added yellow wire. Dress the cable before installing it in the Grounding Strain Relief fittings:

a. Strip off 4 inches (100mm) of the outer cable insulation.

b. Remove 3 to 3.5 inches (75 mm) of the outer braided shield. Leave one inch (25mm) of shield exposed.

c. There are two inner braided wire drains that are not used in this installation. Trim them back and leave them isolated.

d. There is a yellow wire that is not used. Trim it back and leave it isolated.

e. There are two inner areas of foil shielding that are not used in this installation. Trim both the inner foil shield and the foil just under the braided shield.

f. Strip all colored wires 5 / 16 inch (8 mm). Do not tin wire ends.

GROUNDING STRAIN RELIEFS

To maintain RFI immunity, all signal cables must be grounded to the Indicator / Processor enclosure chassis using Grounding Strain Relief fittings.

IRCON supplies: two Grounding Strain Reliefs or three if the system is ordered with a controller. The larger is for the Sensor Signal Cable. The smaller Grounding Strain Relief is for smaller shielded cables. They are specially designed to ground the shielded cables and provide a liquid-tight seal.

Note: Do not attempt to improvise by making the cable thicker to fit the Strain Relief. Use the proper size Grounding Strain Relief.

3.7 SHIELD GROUNDING

For maximum RFI immunity all cable shields must be grounded by a grounding strain relief as they enter or leave the Indicator / Processor and at the user supplied accessory.

IMPORTANT: If the ground potentials, between the MODLINE 3 and the accessory, are substantially different excessive ground currents will result. Therefore, you may not be able to ground the cable shield at the accessory end. In such a case RFI immunity will be degraded.

1. Figure 3.7 illustrates how a braided wire shielded cable is grounded when using either the large or small Grounding Strain Relief fittings.

2. Check that you are using the proper size grounding strain relief. Slip the cap and the compression assembly onto the cable, as in Fig. 3.7. Pay attention to their order, position and direction.

3. Unbraid and comb out the shield wires. Flare the combed shield wires evenly around, down, and over the compression assembly.

   If an inner foil is used in the cable, check that no inner foil drapes over the shield wires, trim it if necessary.

4. It is very important that the compression assembly rest on the unstripped portion of the outer cable insulation to make a proper seal.

5. Position the grommet into one of the holes in the enclosure. The o-ring on the grommet must seal against the enclosure. Slip the locking nut onto the grommet and tighten.

6. Trim the shield wires to a spot just past the o-ring on the compression assembly, as in Figure 3.7.

7. Pass the cable leads through the grommet and into the enclosure.

8. Push the compression assembly, all the way, into the grommet.

9. Hold the cable firmly, so that the cable does not twist in the fitting, as you screw the cap onto the grommet to make a water-tight seal.

The procedures for wiring the rear panel of the Indicator / Processor are listed in Section 3.5.

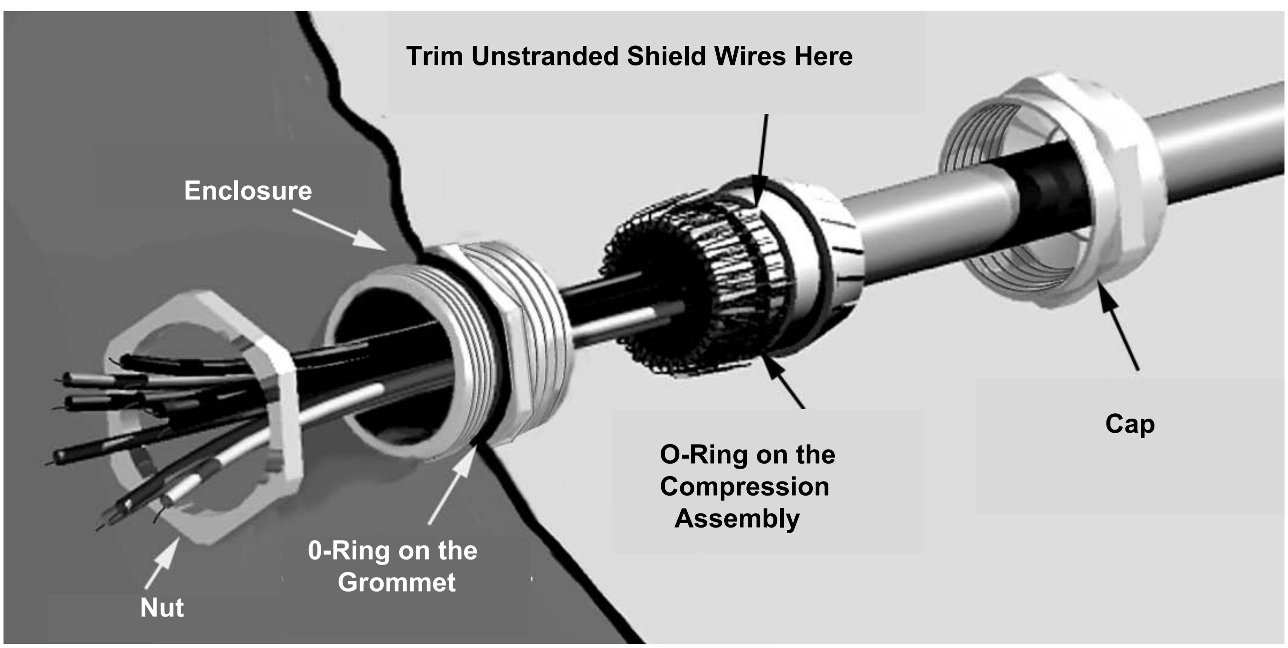


FIG 3.7. - GROUNDING STRAIN RELIEF FITTINGS

Section 3 — INDICATOR/PROCESSOR

3.8 ANALOG OUTPUT CONNECTION (to remote analog indicators, recorders, etc.)

DESCRIPTION

Selection of either 0 to 20 mAdc, 4 to 20 mAdc, or 5μA per degree outputs is available if Model Block D = 0.

The Analog Output signal is 0 to 10 Vdc if Model Block D = 1. Use of this output requires using 0 to 20 mAdc configuring. See Sections 4.15 and 4.21 for selecting and using the Output signals.

INSTALLATION NOTES

Operating specifications and cable requirements must conform to the following Notes:

- For 0 to 20 mAdc and 4 to 20 mAdc signals, the **maximum** load resistance is 1000 Ohms. The 0 to 10 Vdc output **minimum** load resistance is 3000 Ohms.

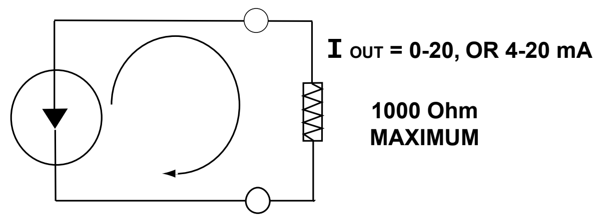
0 to 20 mAdc, 4 to 20 mAdc, or 10 Vdc CONNECTION

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.7. Shield grounding is required for all cables entering the Indicator / Processor.

Note: The Analog Output signals are isolated from chassis ground.

Insert the cable leads into Terminals 1 and 2 of the four-pin connector, as in Fig. 3.8. To make the wiring a little easier, you can use your fingers to remove and remount the connectors.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the connector marked "Analog Output" on the rear panel.



- Shielded cable must be used for these connections. Ground the cable shield as described in Section 3.7.
- Check the wiring to your device being certain to observe correct polarity. Terminal 1 (+) positive is the Signal output. Check that Terminal 2 is a Return.

CAUTION

For safety, the maximum differential between Earth Ground and Isolated Optional Outputs must range 40 volts peak or less. The best way to do this is to connect the (–) to Earth Ground at the load.

If the loads are referenced to some voltage other than Earth Ground, that voltage should be isolated from the Mains Supply by a Isolation Transformer, as in Fig. 3.14.

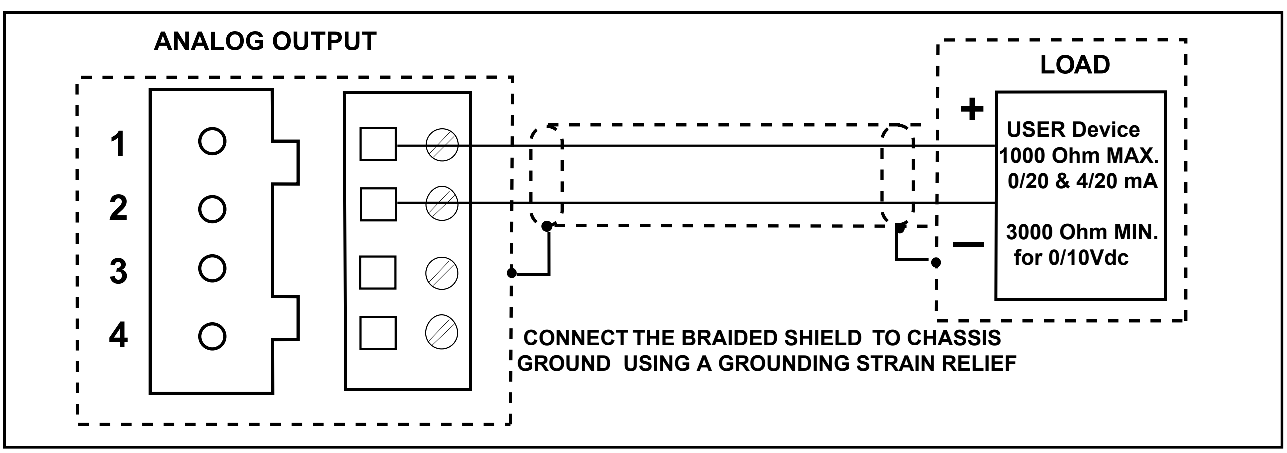


FIG.3.8 - 0 to 20 mAdc or 4 to 20 mAdc or 0 to 10 Vdc ANALOG OUTPUT CONNECTION

3.8 Continued

DESCRIPTION for 5µA per degree

You may select 5µ Amperes per degree as an Analog Output signal.

The Analog Output signal provides temperature indications to remote analog indicators, recorders, etc., see Section 4.15 and 4.21 for details on selecting the desired Analog Output signal.

CONNECTION for 5µA per degree

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.7. Shield grounding is required for all cables entering the Indicator / Processor. To make the wiring a little easier, you can use your fingers to remove and remount the ANALOG OUT connector.

Note: The Analog Output signals are isolated from chassis ground.

For a 5µA per degree signal, attach a 200 Ohm @ 0.1% tolerance resistor to Terminals 1 and 2 of the four-pin connector, to create a millivolt per degree output. Insert the cable leads into Terminals 1 and 2 of the four-pin connector, as in Fig. 3.9.

Note: The maximum output for this configuration corresponds to 4000 degrees Fahrenheit or Celsius.

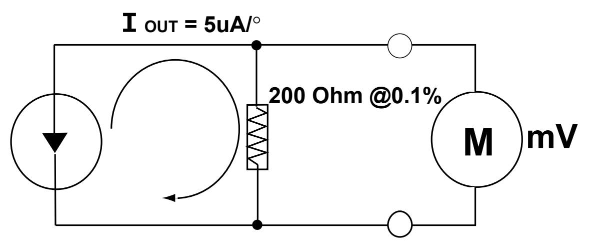
Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the connector marked "Analog Output" on the rear panel.

INSTALLATION NOTES

Operating specifications and cable requirements must confirm to these Installation Notes:

- Using a 200 Ohm load resistor will convert the 5µA per degree output signal to a 1 millivolt per degree output, see Section 4.21 for details.

  The tolerance of the resistor can alter the accuracy of the indication on the meter. Use a resistor with a tolerance of 0.1% or better. IRCON can supply a 200 ohm @ 0.1% tolerance resistor, Part Number 514692.



- Shielded cable must be used for these connections. The Indicator / Processor chassis provides the ground for the cable shield, as described in Section 3.7.

- Check the wiring to your device being certain to observe correct polarity. Terminal 1 (+) positive is the Signal output. Check that Terminal 2 (-) ground is a Return.

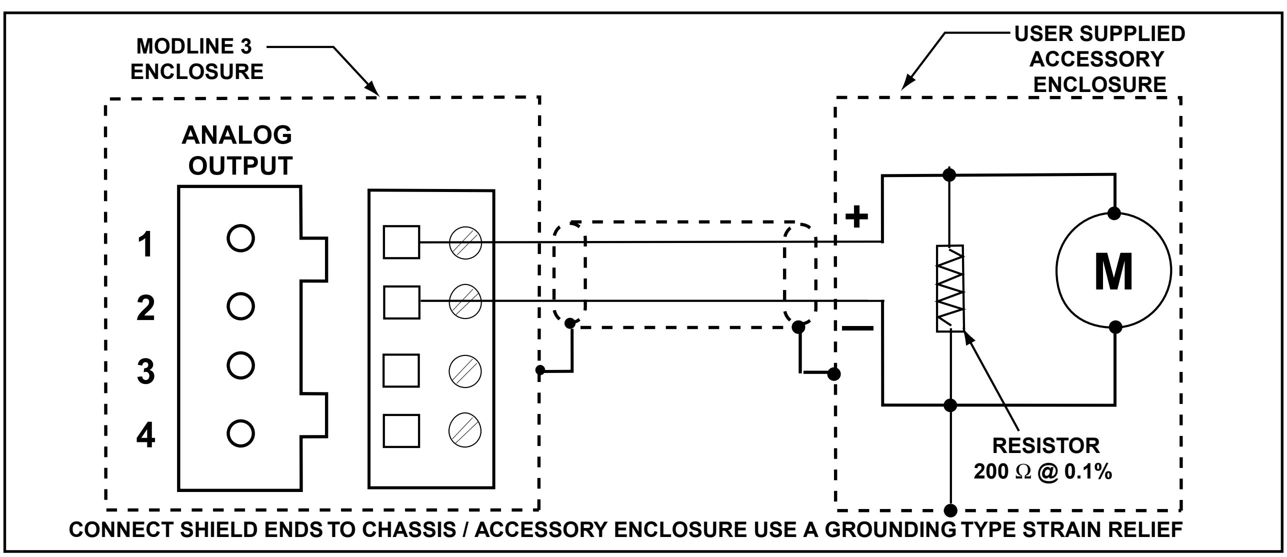


FIG.3.9 - MILLIVOLT PER DEGREE ANALOG OUTPUT CONNECTION

Section 3 — INDICATOR/PROCESSOR

3.9 AUX INPUT

DESCRIPTION

The Auxiliary Signal Input is a MODLINE 3 feature that allows you to manipulate the Emissivity, the E-Slope, or the Set Point 1 value from an external or remote control device using a scaled input signal of 4 to 20 mAdc to the AUX terminals.

Use the System Configuration menu, shown in Section 4.15, to select what values will be established by an Auxiliary Input signal. For details:

"Aux In : Emissivity", for Sensors Series 200, 340, 600, 700, 800, 3G, 3W, and 3V, see Sections 4.8 & 7.2.

"Aux In : E-Slope", for Series 3L or 3R Sensors, see Sections 4.9 & 7.3.

"Aux In : Set Point 1 for a two-point On / Off Controller, see Sections 3C and 4C. For Set Point to a PID Controller, see Sections 3P and 4P.

"Aux In : None", see Sections 4.15. None must be selected if you are not using an auxiliary signal input.

CONNECTION

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.7. Shield grounding is required for all cables entering the Indicator / Processor.

Insert the cable leads into terminals 1 and 2 of the two-pin connector, as in Fig. 3.10. To make the wiring a little easier, you can use your fingers to remove and remount the connector.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the two-pin connector marked "AUX" on the rear panel.

AUXILIARY INPUT RELATIONSHIPS

Example for Emissivity

A 4 mAdc signal corresponds to an emissivity setting of 0.100. A 20 mAdc corresponds to an emissivity of 1.000. The relationship for the values in between is linear.

Example for E-Slope

For the E-Slope settings the 4 to 20 mAdc signals correspond to a settings of 0.850 to 1.150. The relationship for the values in between is linear.

Example for Set Point 1

When setting Set Point 1 from with a remote signal you must know your sensor 's range. For this example, use a range of 500 to 1100 °. A mid-range current signal of 8 mA sets a scale temperature of 650°. A 4 mAdc signal would set 500 and a 20 mAdc signal would set 1100. There is a linear relationship for the temperature values in between. See Section 4.21 for more details.

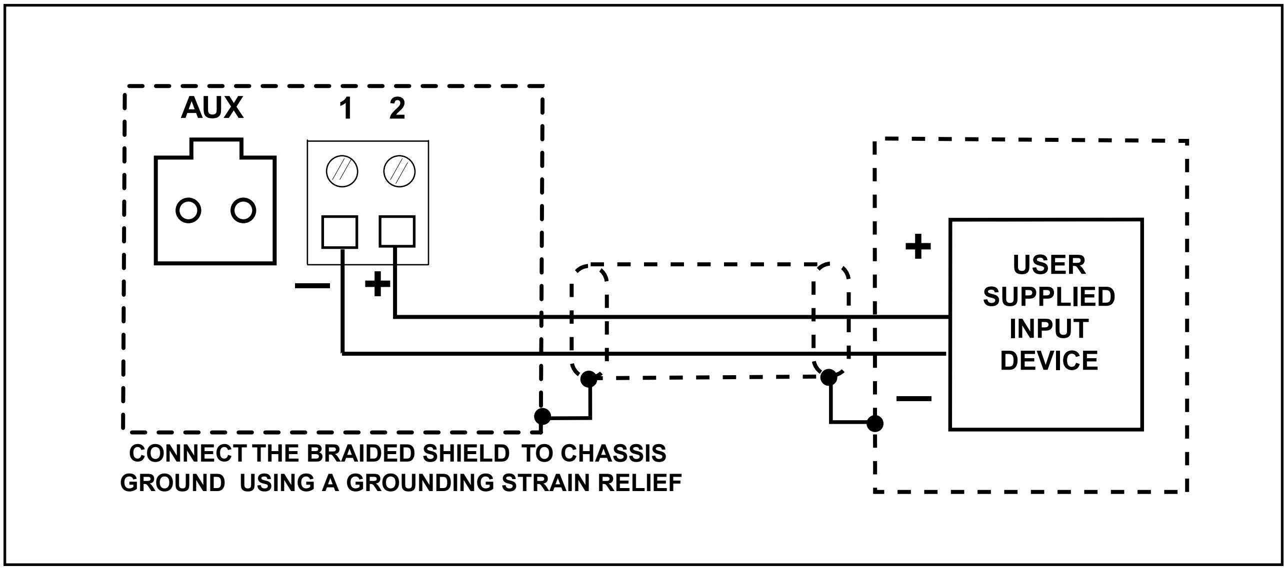


FIG.3.10 - AUX INPUT CONNECTIONS

3.10 RS-485 DIGITAL INTERFACE

DESCRIPTION

The RS 485 Digital Communications Interface communicates in half-duplex to a computer or other device equipped for RS-485 Message Format, as described in Section 8.2.

RS-485 Command Code signaling is used in the following categories:

- Temperature Request
- Setting Adjustments
- System Status Information
- System Configuration
- On/Off Control Functions
- Service Functions
- PID Controller Functions
- On/Off Controller Functions

The RS-485 three-terminal connection on the rear panel accepts a braided metal shielded 3-wire cable and serves as the communications port, as shown in Fig. 3.11.

CABLE LENGTHS

You supply the shielded 3-wire RS-485 cable. The maximum accumulative length of RS-485 cable for a system is 4000 feet (1220 meters).

Ground the cable shield at the Indicator / Processor and the Host device.

CONNECTION

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.7. Shield grounding is required for all cables entering the Indicator / Processor.

Insert the cable leads into Terminals 1, 2 and 3 of the connector, as in Fig. 3.11. To make the wiring a little easier, you can use your fingers to remove and remount the connectors.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the connector marked "RS-485" on the rear panel.

Check the wiring to your Indicator / Processor being certain it is correct. Recheck:

- Terminal 1 is Data*,
- Terminal 2 is Data, and
- Terminal 3 Ground.

Note: The Terminal 3 Ground connector should only be needed when connecting to an isolated RS-485 port.

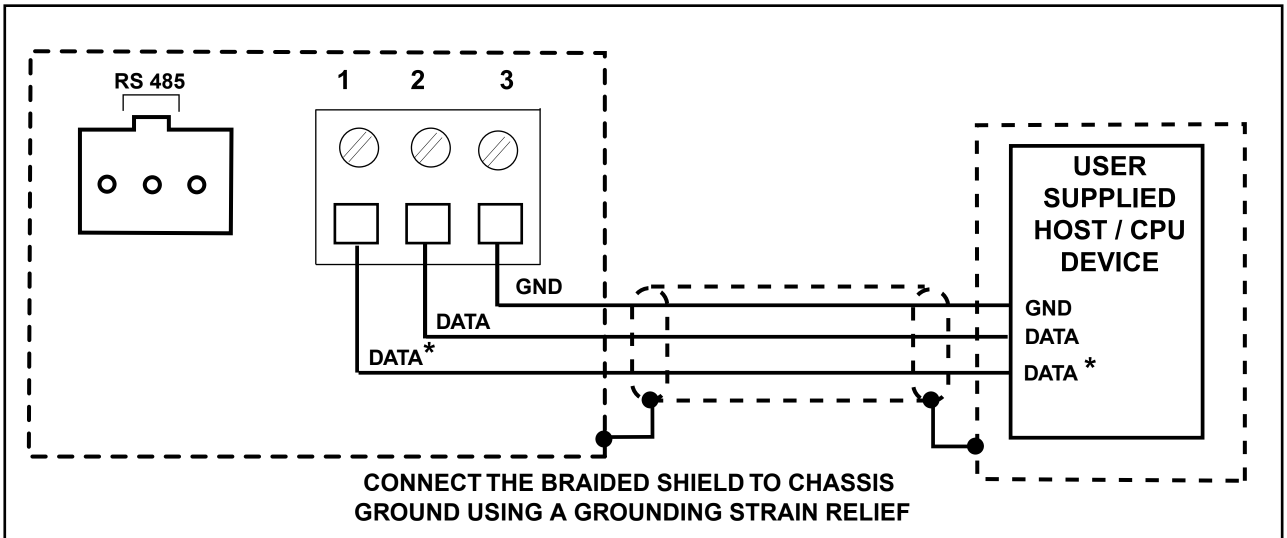


FIG. 3.11 - RS-485 CABLE CONFIGURATION

Section 3 — INDICATOR/PROCESSOR

3.11 REMOTE RESET FOR PEAK PICKER

For external control of the Peak Picker, use a normally open momentary SPST switch. Sections 4.11 and 4.19 details how to turn Peak Picker off and on, set the decay rate, select auto reset, and establish a reset below value.

Switch action for External Peak Picker control:

- Momentary closure (>0.005 second) of the switch immediately resets the Peak Picker. If the switch is continuously closed, the Temperature Display will show direct readings without any Peak Picker conditioning
- The switch may be manually operated or it may be a contact on a timer, relay, or any other process operated switch.

CONNECTION

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.7. Shield grounding is required for all cables entering the Indicator / Processor. To make the wiring a little easier, you can use your fingers to remove and remount the connector.

Insert the cable leads to terminals 1 and 2 to the RESET terminals of the seven-pin connector, as in Fig. 3.12. Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the seven-pin connector marked “RESET” on the rear panel.

3.12 REMOTE CONTROL OF TRACK AND HOLD

For external control of the Tracking or Holding modes of operation, connect an external switch to the T. & H. terminals. See Section 4.12 for how to select Track and Hold from the menu.

Switch action for Track and Hold control:

- With the switch open the temperature tracking continues, as described in Section 4.22.
- With the switch closed the displayed temperature will hold.
- The switch may be manually operated or it may be a contact on a timer, relay, or any other process operated switch.

CONNECTION

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.5. Shield grounding is required for all cables entering the Indicator / Processor. To make the wiring a little easier, you can use your fingers to remove and remount the connector.

Insert the cable leads to terminals 3 and 4 of the seven-pin connector, as in Fig. 3.12. Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the seven-pin connector marked “T & H” on the rear panel.

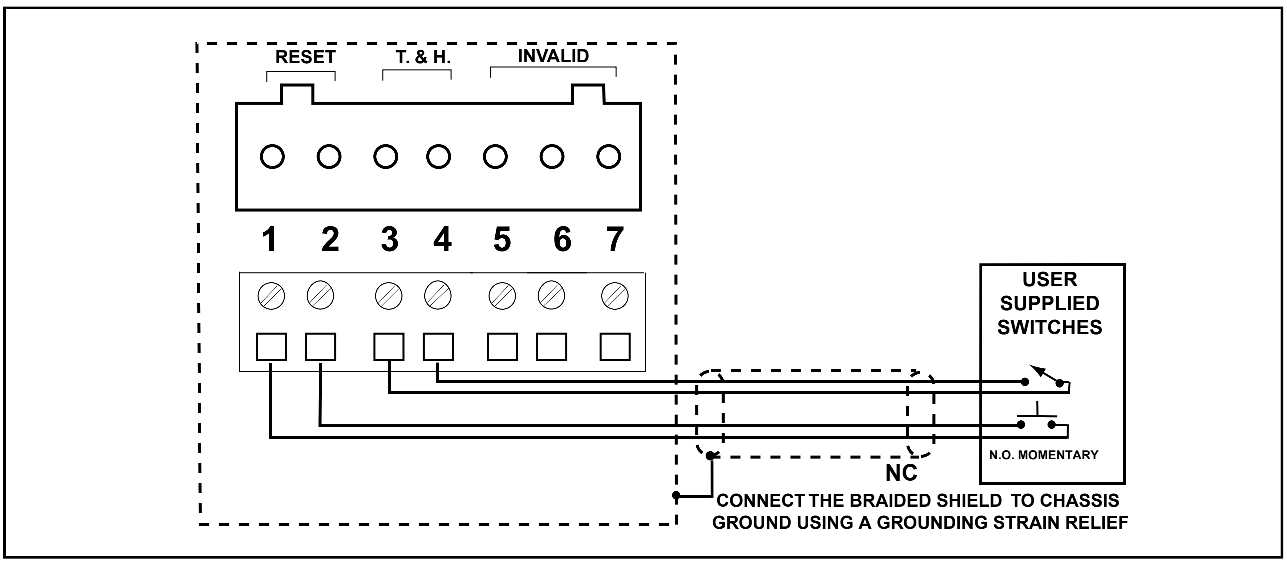


FIG.3.12 - PEAK PICKER REMOTE RESET CONNECTIONS AND TRACK AND HOLD SELECT CONTROL CONNECTIONS

3.13 INVALID ALARM

(Series 3L and 3R Sensors)

DESCRIPTION

MODLINE 3 Systems that include sensor Series 3L or 3R will have an Invalid Alarm feature. Under certain operating conditions the Invalid Alarm will activate and give a visual alarm on the temperature display of MODLINE 3 and at the same time provide contact closure from a Form C relay output.

The conditions that cause the Invalid Alarm to operate are described in Section 4.18.

Visual Invalid Alarm output is described in Section 4.2 Displays and Controls.

The Form C relay output has contacts that are rated for switching 24 Volts AC or DC and that are capable of handling currents of up to 1 Amperes for both inductive and resisting loads.

The relay contacts may be used to operate external *(customer supplied)* alarm devices.

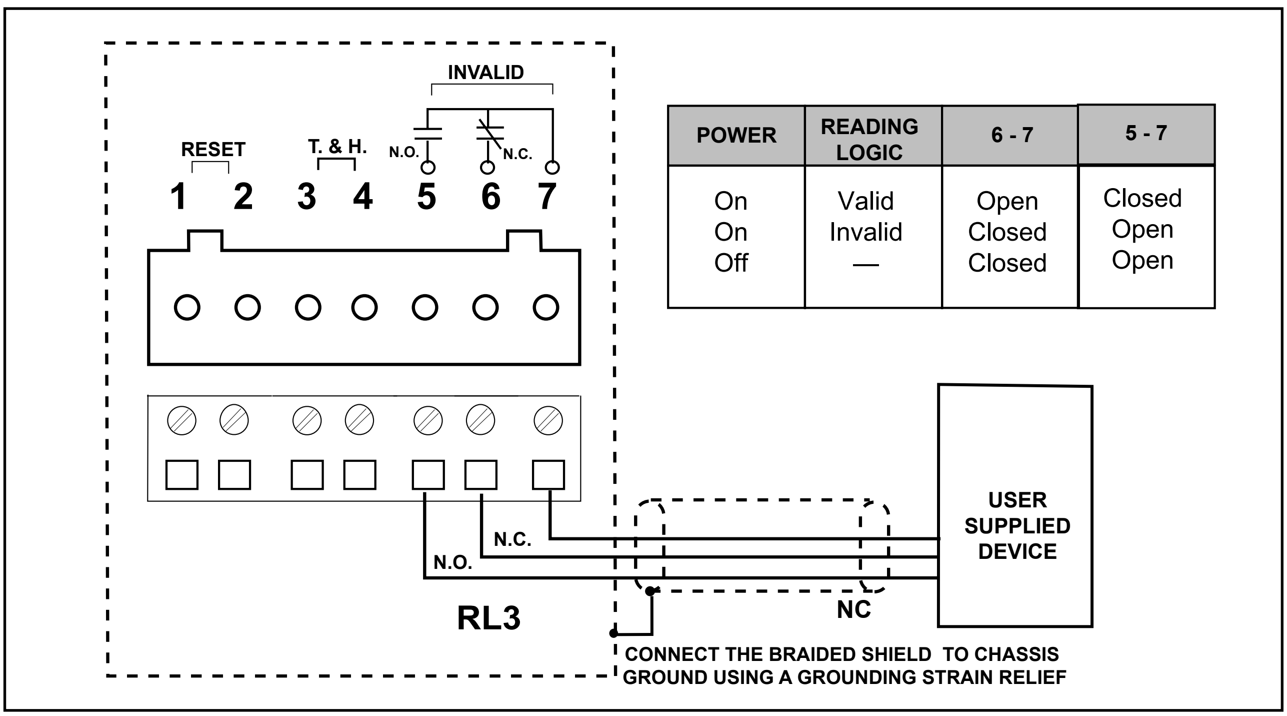
CONNECTION

Install the grounding strain relief and user supplied shielded cable in an entry port, as outlined in Section 3.7.

Note: Shield grounding is required for all cables entering the Indicator / Processor.

Using Fig 3.13 determine from the table of relay contact states whether to use normally open contacts, terminals (5 & 7) or normally closed contacts, terminals (6 & 7). To make wiring a little easier, terminal 5, 6 and 7 are mounted on a removable connector. Remove connector using your hand and insert wires into the terminal lugs. Tighten terminal lug-screw to secure the wires and replace the connector into mating connector marked "INVALID".

Note: Do not allow a load operated by the Invalid Alarm to exceed the contact ratings of relay output.



POWER	READING LOGIC	6 - 7	5 - 7
On	Valid	Open	Closed
On	Invalid	Closed	Open
Off	—	Closed	Open

FIG. 3.13 - INVALID ALARM RELAY CONNECTIONS

Section 3 — INDICATOR/PROCESSOR

3.14 GROUNDING AND ISOLATION

The ideal solution is to power the MODLINE 3 from a separate ac line, independent of all interference producing equipment. If this is not practical, consider using a line conditioner or isolation transformer, as in Fig.3.14.

The MODLINE 3 power supply has an internal ac line filter. But, please avoid a line shared with brush motors, SCR supplies, saturable reactors, or other "noisy" devices. Voltage pulses (line transients) can enter and cause the instrument to malfunction and/or fail.

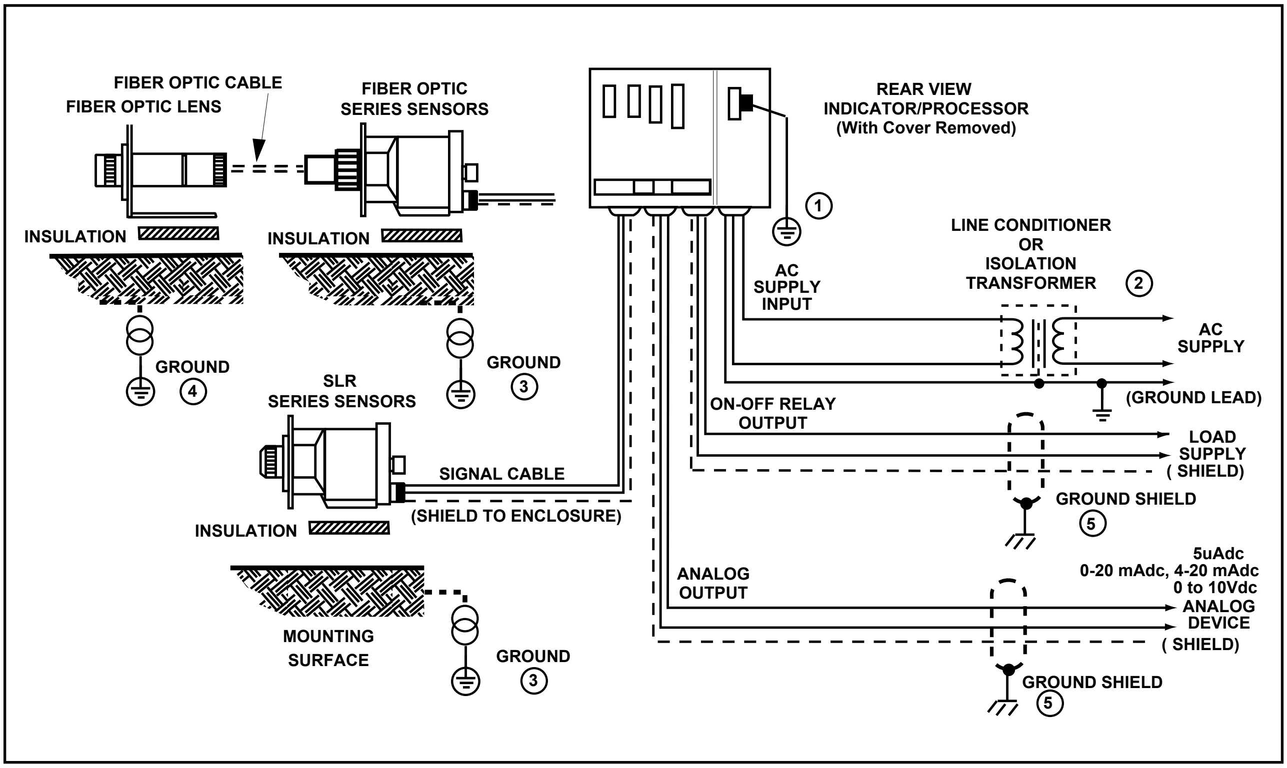


FIG. 3.14 – SUMMARY OF GROUNDING AND ISOLATION

NOTES:

1. ⏚ This symbol designates an Earth Ground (or a protective ground conductor terminal.) You must provide an Earth Ground to ground terminal screw on the Indicator / Processor rear panel as shown in Section 3.16.

2. If you use a line conditioner or isolation transformer, connect per manufacturer 's instructions. Observe grounding instructions and make sure earth ground is supplied to Ground terminal of AC Power input terminal strip. The power requirement of the MODLINE 3 System is shown in Section 1.4.

3. If the mounting surface of the Sensor is not at earth ground potential you must insulate the Sensor from surface as shown in Fig 3.14. The Sensor is connected to the ground shield of the Signal Cable and the Signal Cable shield is connect to the Indicator / Processor enclosure. The enclosure earth ground is described in Note 1.

4. Reimaging Lens or Extension Tips are held at the same electrical potential as the sensor housing by a metal shield of the fiber optic cable. If the mounting surface is not at earth ground. Insulate the Reimaging Lens, Extension Tips and Fiber Optic Cable, as shown in Fig 3.14.

5. Shielded cable is required for each Analog Input and Output used. Ground the shield at the Indicator / Processor enclosure. Follow Shield Grounding instructions provided in Sections 3.4 and 3.5.

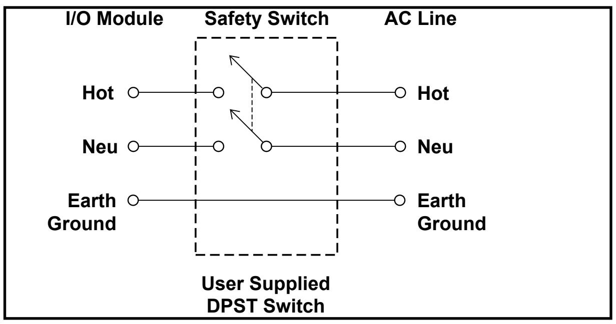
3.15 POWER WIRING PRACTICES

POWER SWITCH REQUIREMENTS

The MODLINE 3 Indicator/Processor does not include a power switch. You must supply a switch for 90 Vac to 250 Vac at 50 to 60 Hz. The power consumption of the unit is 40 VA maximum.

The two-pole switch (and all circuit breakers) should comply with IEC 947 standard. Switches and circuit breakers that carry the markings of TUV, VDE or other European Agencies do meet the IEC 947 standard. Other switches and circuit breakers may not meet the IEC standard. Proper installation is given in Section 3.16.

Your power shutoff or safety switch should be incorporated within the main power line that powers the IRCON equipment. This switch should be in close proximity to the operator. The switch should be clearly marked as the power shutoff for the equipment.



WARNING

THE MODLINE 3 SYSTEM REQUIRES A THREE-WIRE AC SUPPLY

- If your line does not include a third wire ground, connect a ground wire from the PROTECTIVE CONDUCTOR TERMINAL of the Earth Ground Screw. The ground wire must be as large or larger than the L1 /L2 wires. See section 9.4 for mm sizes.
- Failure to make this connection can cause a shock hazard and erratic operation or damage.
- Follow all local electrical codes related to grounding of electrical equipment.

CABLE REQUIREMENTS

Power cables are NOT supplied by IRCON. They should meet European and American standards for Main Voltage Safety with the insulation suitable for single fault condition (600V, 105 °C). Strain relief for the power cable must also comply with European and American standards as dictated by the power cable selected.

SAFETY REQUIREMENTS

The IRCON equipment should be installed safely within the user's facility. Improper electrical installation of the MODLINE 3 can result in ground currents and exposure to high voltage transients. These are potential trouble sources, which can cause erratic operation, and some cases may be severe enough to destroy circuit components.

GROUNDING PRACTICES

You must provide an Earth Ground for the MODLINE 3 Indicator / Processor. This will normally be the third wire of a grounded single phase system.

Connect the earth ground wire to the Earth Ground Screw, as shown in the Fig. 3.16. The ground wire must be at least as large as the L1/L2 wires, but never smaller than 14 AWG, see section 9.4 for mm wire sizes.

Be sure to observe your Local Electrical Codes in selecting the grounding method.

CAUTION

- Use a "clean" power line such as a separate instrument power line. Avoid power lines serving noisy electrical equipment such as brush motors, phase angle fired SCR power supplies, etc. Install a line conditioner if necessary. This condition can be avoided by using a separate instrument power line.
- Follow all local electrical codes related to Earth Ground and the grounding of electrical equipment.

Section 3 - INDICATOR/PROCESSOR

3.16 AC POWER LINE CONNECTIONS

DESCRIPTION

The MODLINE 3 Indicator/Processor does not include a power switch.

You supply a switch that meets the requirements specified in Sections 3.2 and 3.15.

WARNING

To prevent personal injury, make sure the power is off at the main power service entrance before proceeding with the power connections.

The wiring insulation must be suitable for single fault condition (600V, 105°C). Follow all local electrical codes and standard plant practices in planning your wiring.

CONNECTION

You are now ready to wire in the main power. The Power Wiring is shown in Fig. 3.15. The Power Connector is shown in Fig. 3.16.

1. Conduit is required for power cables entering the Indicator / Processor. A power cable or individual discrete wires may run in the conduit.

2a. Connect the Earth Ground wire to the Earth Ground Terminal. Shape the wire into a “hook” shape. Position the wire under the cup washer and above the star washer. Then, tighten the Earth Ground screw.

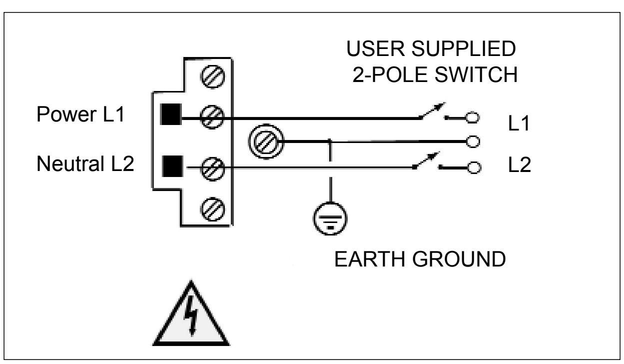


FIG. 3.15 - POWER WIRING

Note: If you are using a three wire power cord, the Earth Ground wire should be slightly longer than the two other wires. It should not act as a strain relief. The other wires must pull free first if the cord is accidently pulled free of the enclosure.

2b. If a two wire supply is used, you must supply an Earth Ground as described in Section 3.15 Grounding Practices. Failure to make this connection can cause a shock hazard and erratic operation or damage to the equipment.

3a. For easy access to the terminals, you may remove the two wire connector by loosening two screws above and below Terminal L1/ Terminal L2 screws as shown in Fig. 3.15 and 3.16. Then, pull the two wire connector free of the rear panel.

3b. Insert power wire into Terminal L1. Insert neutral wire into L2. Each wire must be captured in a terminal lug. Each terminal screw must be tightened securely on the side of the connector.

4. If you removed the two terminal connectors, reinsert them into the 2-pin connector on the rear panel and tighten each screw securely.

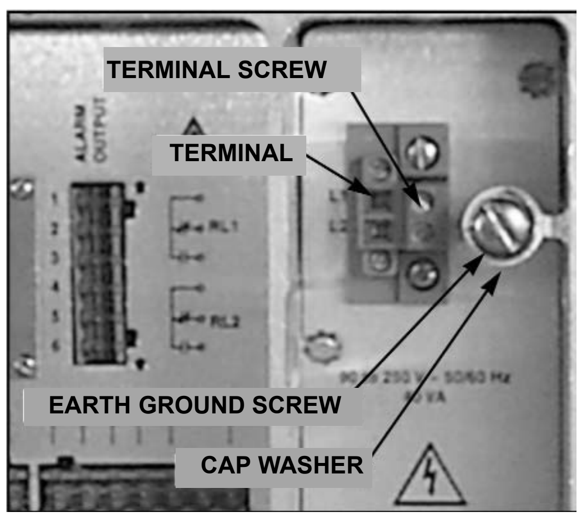


FIG. 3.16 - POWER CONNECTOR

3.17 REAR PANEL COVER

DESCRIPTION

Reinstall the rear panel cover to retain the CE mark compliance and the environmental rating for the MODLINE 3 Indicator / Processor.

1. Check the condition of the rear seal.

2. Install and tighten all eight screws as in Fig. 3.17.

3. Do the Installation check on the following page.

FIG. 3.17 - REAR PANEL COVER

Section 3 — INDICATOR/PROCESSOR

3.18 INSTALLATION CHECKLIST

Before proceeding, check the installation against the following check list:

❑ Check the routing of all leads to avoid unwanted pickup of stray signals in low-level signal circuits.

❑ Make sure all wires are captured by the terminal lugs and secured by screws.

❑ Make sure you have observed all grounding requirements.

❑ If the ac supply line is subject to "noise pulses", install ac isolation transformer or line conditioner in sup ply line.

❑ Make sure all cable ports of the enclosure are sealed with approved fittings. Unused cable ports must be sealed by supplied caps.

❑ Make sure the Signal Cable shield is connected to the Indicator / Processor enclosure.

For a standard MODLINE 3 System, this completes the Installation. Attach the back cover over the terminals at the rear of the enclosure. Proceed to Section 4 for Function Selection and Operational Checkout.

Section 3C — INDICATOR/PROCESSOR (On-Off Controller)

This section provides the information you will need to install the MODLINE 3 On-Off Controller. It is supplementary to the general procedures for all MODLINE 3 Indicator / Processors, as described in Section 3. Perform the procedures in Section 3C after you have completed all appropriate procedures in Section 3.

Section **Page**

Section 3C — INDICATOR/PROCESSOR (On-Off Controller)

3C.1 DESCRIPTION

The Indicator / Processor is the core of the MODLINE 3 System. It can be ordered with an On-Off or PID Controller option or no controller at all.

The On-Off Controller provides relay switching at two adjustable temperature levels to permit process control, alarming, and other functions.

Fig. 3C.1 shows the Indicator/Processor Front Panel. All the controls, the temperature display and the function display are located on the front panel of the enclosure. All the Indicator / Processor components and subassemblies are housed in an aluminum extrusion enclosure that has a NEMA 4 rating.

YOUR SYSTEM
The standard functions for the System are described in Section 3. If your system includes an On-Off Controller — use this section and refer to Section 3 for wiring and connection information.

Before going on with this installation, it is a good idea to consider the factors in Section 3.2. Preinstallation Notes.

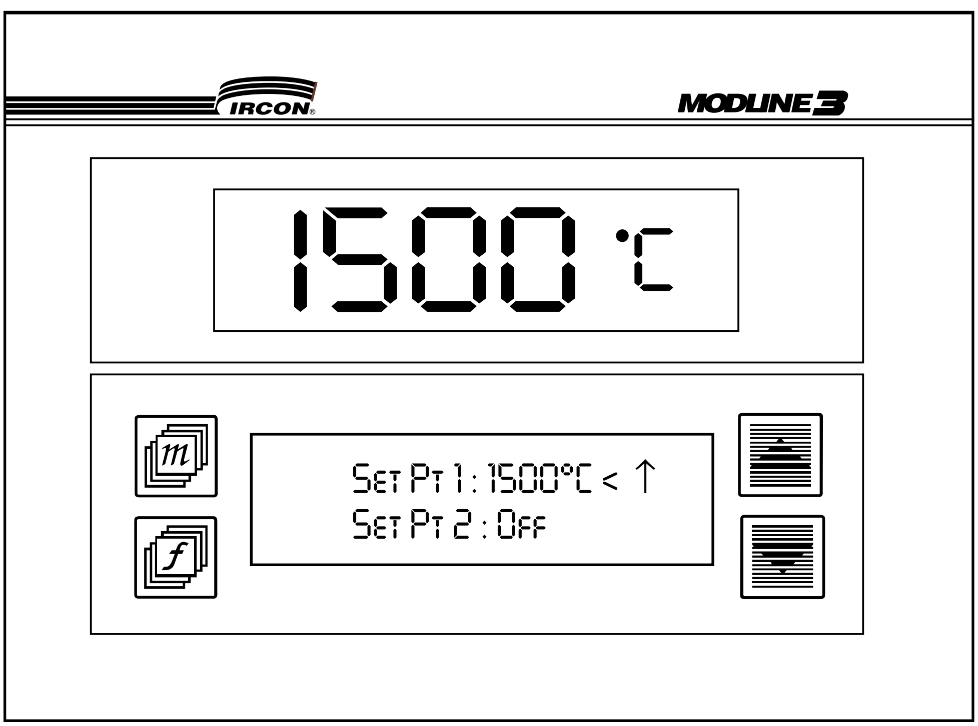


FIG. 3C.1 - MODLINE 3 INDICATOR/PROCESSOR FRONT PANEL

Section 3C — INDICATOR/PROCESSOR (On-Off Controller)

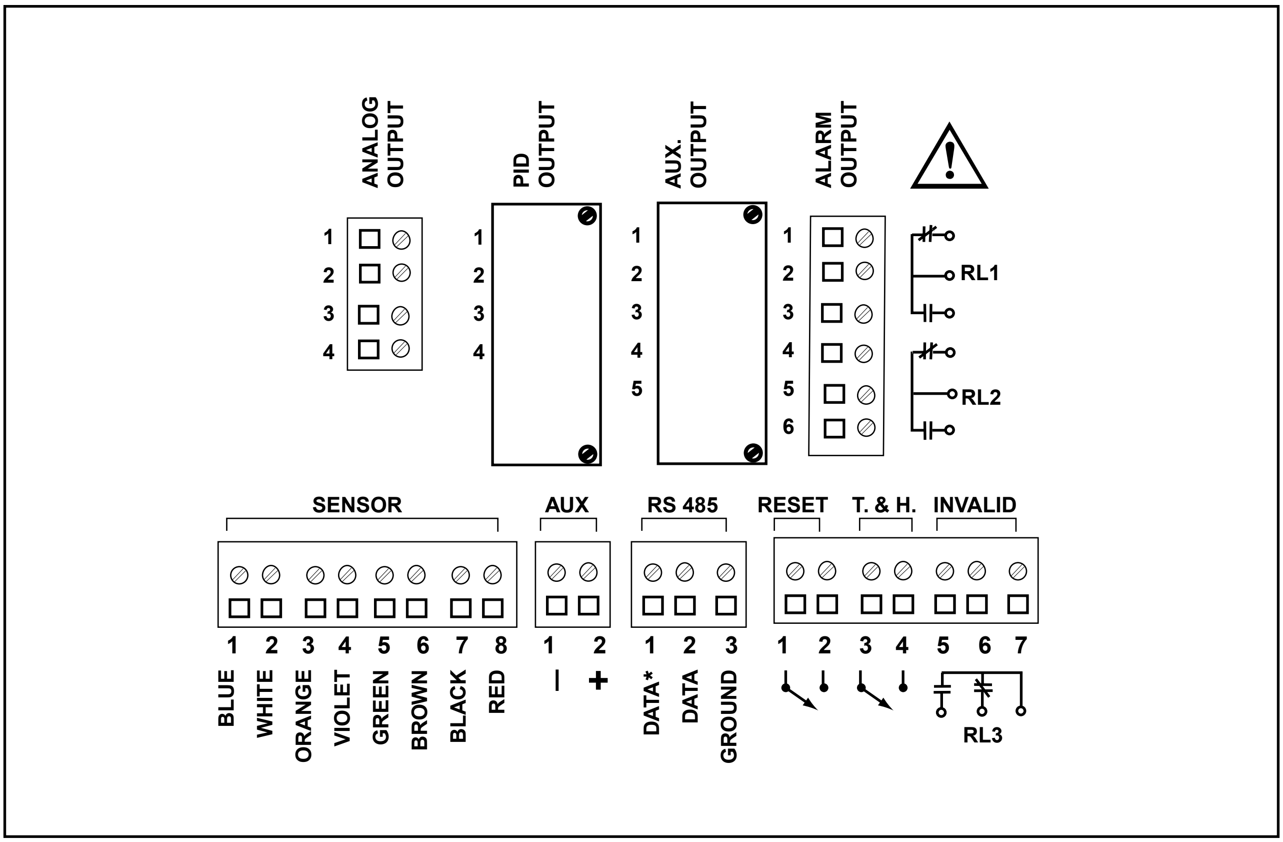
3C.2 WIRING INDICATOR/PROCESSOR

The procedures for wiring of the rear panel for the Indicator / Processor with a On-Off Controller are described in the following Sections:

Section 3C.3 Aux Input.
Section 3C.4 On-Off Control Relays.

Fig. 3C.2 shows the names of the connectors and terminal numbers. They are clearly labeled to sim - plify wiring. The lower portion of Fig. 3C.2 details the wire names.

The PID OUTPUT and the AUX OUTPUT openings on the rear panel will be covered with plates, if you ordered a On-Off Controller.



SENSOR	AUX	RS 485	RESET	T&H	INVALID	ANALOG OUTPUT	PID OUTPUT	AUX OUTPUT	ALARM OUTPUT
1 BLUE	1 - SIGNAL	1 DATA*	1 +	3+	5 NO	1 +	1 +	1 NONE	1 RLY 1 NC
2 WHITE	2 + RETURN	2 DATA	2 GND	4 GND	6 NC	2 -	2 -	2 NONE	2 RLY 1 COM
3 ORANGE		3 GND			7 COM	3	3	3 NONE	3 RLY 1 NO
4 VIOLET						4	4	4 NONE	4 RLY 2 NC
5 GREEN								5 NONE	5 RLY 2 COM
6 BROWN									6 RLY 2 NO
7 BLACK									
8 RED									

FIG. 3C.2 – REAR PANEL WIRING FOR AN ON-OFF CONTROLLER

3C.3 AUX SIGNAL ANALOG INPUT

DESCRIPTION
The Auxiliary Signal Input is a MODLINE 3 feature that allows you to manipulate the Set Point 1 value from an external or remote control device using a scaled input signal of 4 to 20 mAdc to the AUX terminals.

Use the System Configuration menu, shown in Section 4.15, to select what values will be established by an Auxiliary Input signal. For details:

> “Aux In : Set Point 1 for a two-point On / Off Controller, see Section 4C.

CONNECTION
Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.5. Shield grounding is required for all cables entering the Indicator / Processor.

Insert the cable leads into terminals 1 and 2 of the two-pin connector, as in Fig. 3C.3. To make the wiring a little easier, you can use your fingers to remove and remount the connectors.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the two-pin connector marked “AUX” on the rear panel.

AUXILIARY INPUT RELATIONSHIPS

Example for Set Point 1
When setting Set Point 1 from with a remote signal you must know your sensor ’s range. For this example, use a range of 500 to 1100 °. A mid-range current signal of 8 mA sets a scale temperature of 650°. A 4 mAdc signal would set 500 and a 20 mAdc signal would set 1100. There is a linear relationship for the temperature values in between. See Section 4.21 for more details.

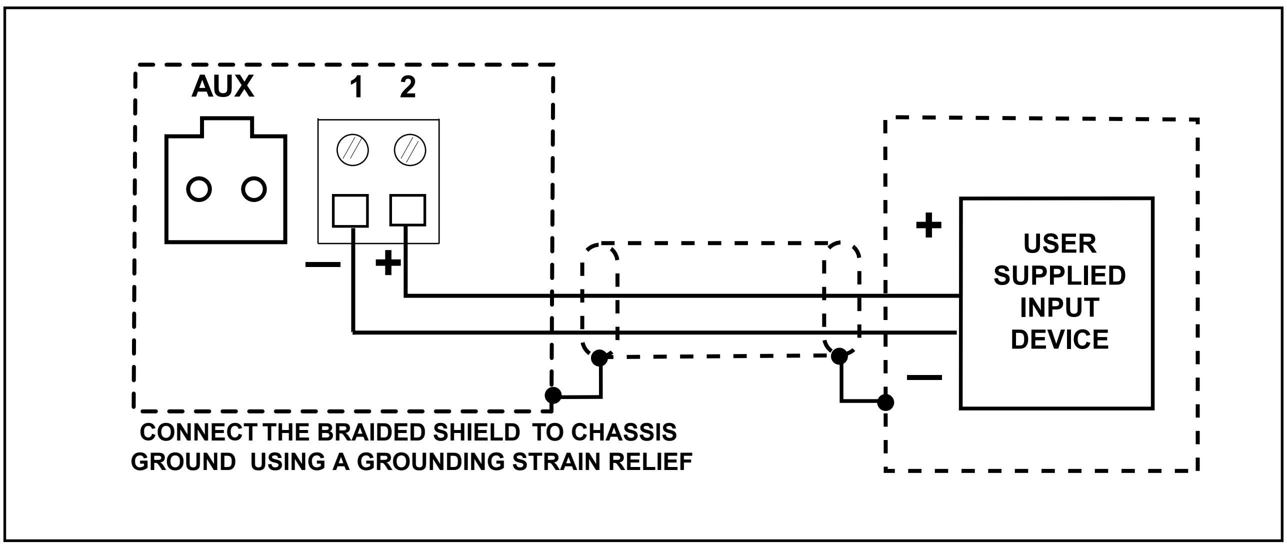


FIG.3C.3 - AUX INPUT CONNECTIONS

Section 3C — INDICATOR/PROCESSOR (On-Off Controller)

3C.4 ON-OFF CONTROLLER RELAYS

DESCRIPTION

These instructions apply only to a MODLINE 3 Indicator / Processor equipped with an On-Off Controller. The On-Off Controller provides relay switching when a measured temperature reaches a preset value or set point, see Section 4C for operation details.

These relay controlled terminals can be used for a variety of functions:

- Turn a heater on and off to control process temperature.
- Operate alarms when measured temperature exceeds or falls below the set point level.
- Operate sorting equipment to sort hot and cool workpieces.
- Activate process cycles according to the temperature of the material being processed.
- Trigger a Programmable Controller.

ON-OFF CONTROLLER FUNCTIONS

You may allow these two relays to provide switching at two independent temperature levels: Set Point 1 and Set point 2.

CAUTION

RELAY RATINGS

Make sure the load power requirements do not exceed the relay ratings for inductive or restrictive loads: The two Form C relay outputs are rated at 24 V AC/DC; @1 Ampere.

SET POINT 1 CONTROLS

Relay 1 provides contact switching for Set Point 1.

- Set Point 1 may adjusted manually from the Function Display. You select a temperature from over full temperature span of the sensor, see Sections 4C for details.
- Set Point 1 may be controlled by an External Input Signal of 4 to 20 mA, daisy chain compatible. You must select: a Configuration menu function of "Aux. Input for set point, see Sections 3C.1, 4C and Section 4.
- Set Point 1 may be controlled by an RS-485 Command Code, see Section 8.5 for On-Off Control Function Code OA .
- You may turn the function off, see Section 4C.

SET POINT 2 CONTROLS

Relay 2 provides contact switching for Set Point 2.

- You may be manually select the temperature at which the relay contacts switch or you may turn the function off, see Section 4C.
- Set Point 2 may be adjusted manually from the Function Display. You select a temperature from over full temperature span of the sensor, see Section 4C for details.

  Note: Set Point 2 is NOT controlled by an Aux. Input of 4 to 20 mA, as is Set Point 1.
- Set Point 2 may be controlled by an RS-485 Command Code, see Section 8.5 for On / Off Control Function Code OB.

MODLINE 3 POWER	MEASURED TEMPERATURE	RELAY 1		RELAY 2	
		1 - 2	2 - 3	4 - 5	5 - 6
Off	—	Closed	Open	Closed	Open
On	Above Set Point	Closed	Open	Closed	Open
On	Below Set Point	Open	Closed	Open	Closed
On	Controller Off	Closed	Open	Closed	Open

TABLE 3C.1 ON-OFF ALARM RELAY STATES

3C.4 ON-OFF CONTROLLER RELAYS (Continued)

CONTROL OF RELAYS

The relay contact positions are shown in Fig. 3C.4. The contacts are shown with the relays de-energized. This state exists (a) when the power is off or (b) when power is on and measured temperature is above the set point. The relays energize when measured temperature is below the set point. The contact states are summarized in Table 3C.1.

Determine the type of load control you need (load energized above or below set point), and connect the load and load supply to the Relay Output terminals as shown in Fig. 3C.4.

The two Form C relay outputs are rated at 24 V AC/DC; @1 Ampere. Make sure the load power requirements do not exceed the relay ratings.

WARNING

1. Observe all local electrical codes regarding load switching.
2. Consider the effect of a power failure or any other condition that will cause the relays to de-energize. The N.C. contacts of Fig. 3C.4 will close and any equipment controlled by these contacts will be turned on until power is restored. This action can be used to trigger a "power failure alarm," but be sure the contact closure will not harm any other equipment.

CONNECTION

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.7. Shield grounding is required for all cables entering the Indicator / Processor.

Insert the cable leads into the desired terminals of the six-pin connector, as in Fig. 3C.4. To make the wiring a little easier, you can use your fingers to remove and remount the connectors.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the connector marked "ALARM OUTPUT" on the rear panel.

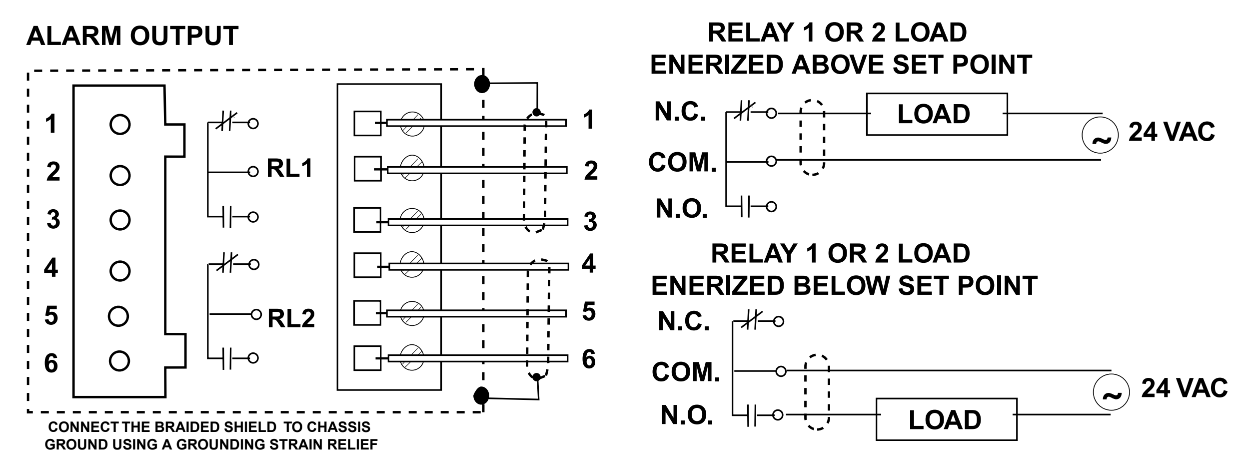


FIG. 3C.4 - ON-OFF RELAY CONNECTIONS

NOTES:

Section 3P — INDICATOR/PROCESSOR With PID CONTROLLER OPTION

This section provides the information you will need to prepare the MODLINE 3 PID Controller Option for operation. It is supplementary to the general procedures for all MODLINE 3 Indicator/Processors, as described in Section 3. Perform the procedures in Section 3P after you have completed all appropriate procedures in Section 3.

Section **Page**

Section 3P — INDICATOR / PROCESSOR PID CONTROLLER OPTION

3P.1 DESCRIPTION

The Indicator / Processor is the core of the MODLINE 3 System. It can be ordered with a PID or On-Off Controller option or no controller at all.

With a PID Controller, the System provides accurate control of your process temperature.

This section provides the information you will need to prepare the MODLINE 3 PID Controller Option for operation. It is supplementary to the general procedures for all MODLINE 3 Indicator / Processors, as described in Section 3. Perform the procedures in Section 3P after you have completed all appropriate procedures in Section 3.

Fig. 3P.1 shows the Indicator/Processor Front Panel. All the controls, the temperature display and the function display are located on the front panel of the enclosure.

Before going on with this installation, it is a good idea to consider the factors in Section 3.2. Preinstallation Notes.

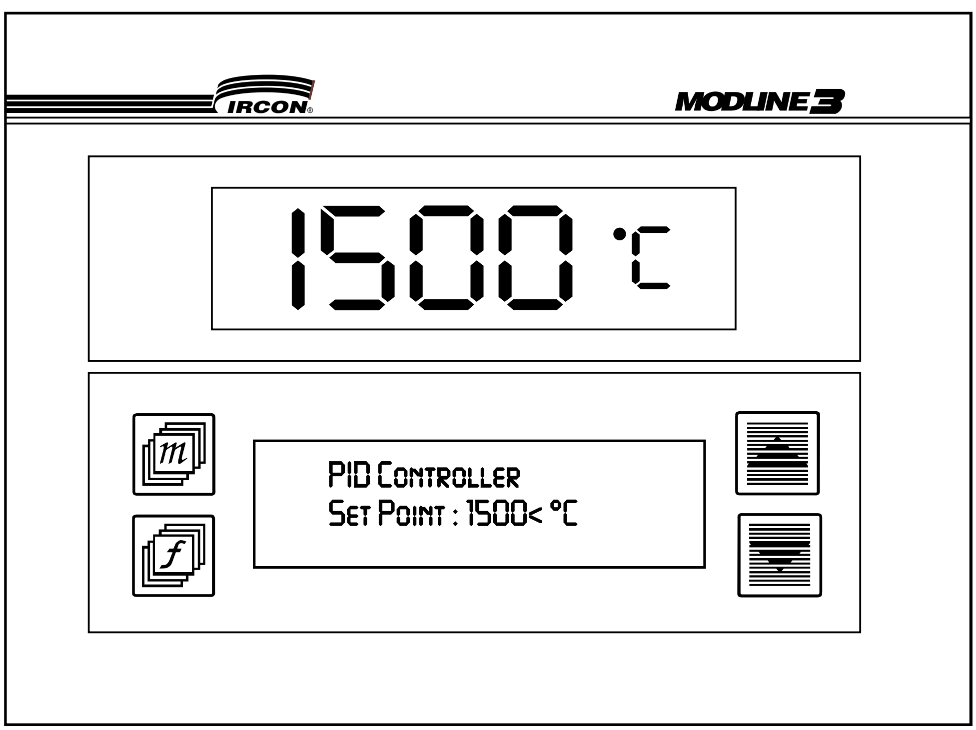


FIG. 3P.1 - MODLINE 3 INDICATOR / PROCESSOR FRONT PANEL

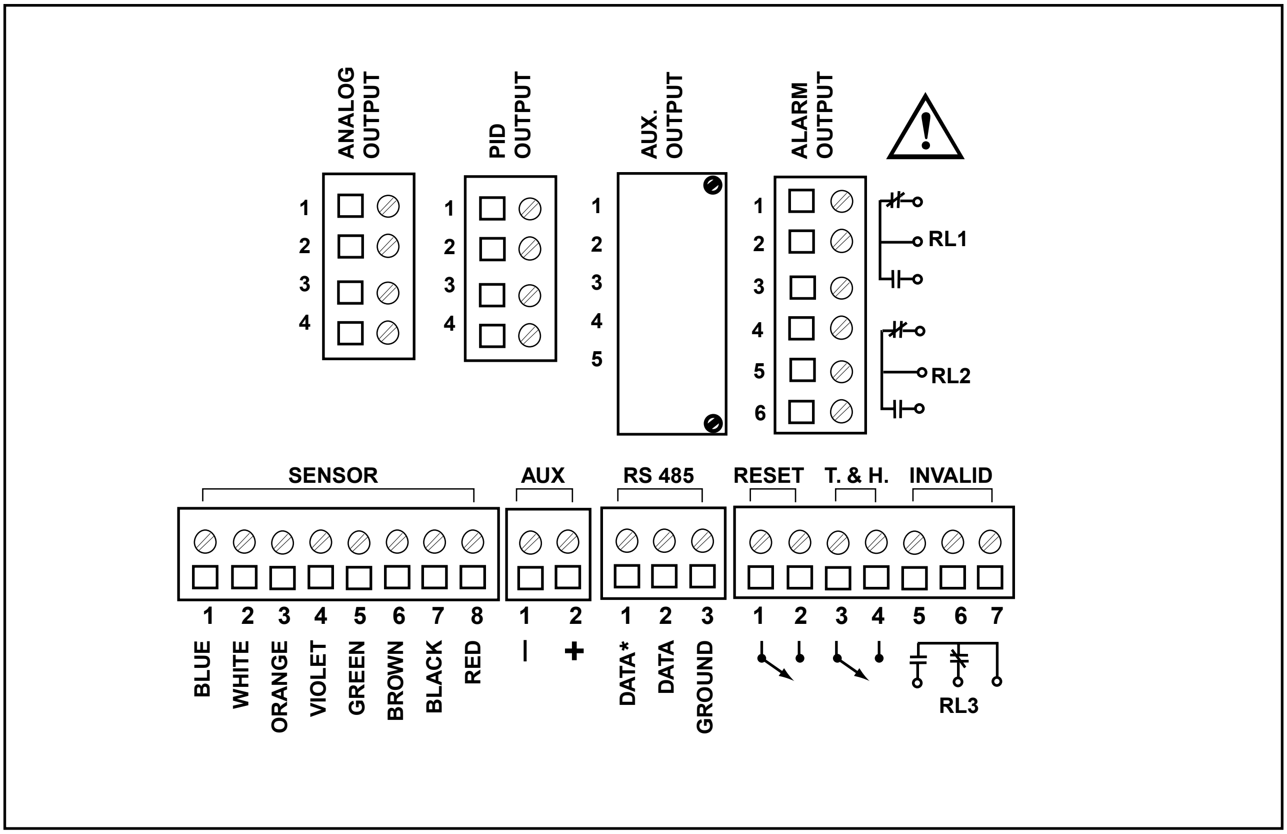
Section 3P — INDICATOR / PROCESSOR With PID CONTROLLER OPTION

3P.2 WIRING INDICATOR/PROCESSOR

The procedures for wiring of the rear panel for the Indicator / Processor are described in the following Sections:

Section 3P.3 PID Output cable.
Section 3P.4 Aux Signal cable.
Section 3P.5 Deviation Alarm cable.

Fig. 3P.2 shows the names of the connectors and terminal numbers. They are clearly labeled to simplify wiring. The lower portion of Fig.3P.2 details the wire names.



SENSOR	AUX	RS 485	RESET	T&H	INVALID	ANALOG OUTPUT	PID OUTPUT	AUX OUTPUT	ALARM OUTPUT
1 BLUE	1 - SIGNAL	1 DATA*	1 +	3+	5 NO	1 +	1 +	1 NONE	1 RLY 1 NC
2 WHITE	2 + RETURN	2 DATA	2 GND	4 GND	6 NC	2 -	2 -	2 NONE	2 RLY 1 COM
3 ORANGE		3 GND			7 COM	3	3	3 NONE	3 RLY 1 NO
4 VIOLET						4	4	4 NONE	4 RLY 2 NC
5 GREEN								5 NONE	5 RLY 2 COM
6 BROWN									6 RLY 2 NO
7 BLACK									
8 RED									

FIG. 3P.2 – REAR PANEL WIRING FOR A PID CONTROLLER

Section 3P — INDICATOR / PROCESSOR With PID CONTROLLER OPTION

3P.3 PID OUTPUT

DESCRIPTION
The Proportional Controller provides a control output proportional to the deviation between process temperature and set point temperature. The output from this controller is 4 to 20 mA current and it is suitable for control of an SCR Controller, Saturable-core Reactor, or other such devices.

The PID Controller is also equipped with HI and LO Deviation Alarms which provide relay outputs suitable for switching external alarms.

CONNECTION
Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.7. Shield grounding is required for all cables entering the Indicator / Processor.

Insert the cable leads into terminals 1 and 2 of the four-pin connector, as in Fig. 3P.3. To make the wiring a little easier, you can use your fingers to remove and remount the connectors.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the connector marked "PID OUTPUT" on the rear panel.

Connect the other end of the cable to your process control device, see Section 4P.5 Process Control details. Be certain to observe correct polarity. The load on the PID Output should not exceed 1000 Ohms. This output is isolated from earth ground.

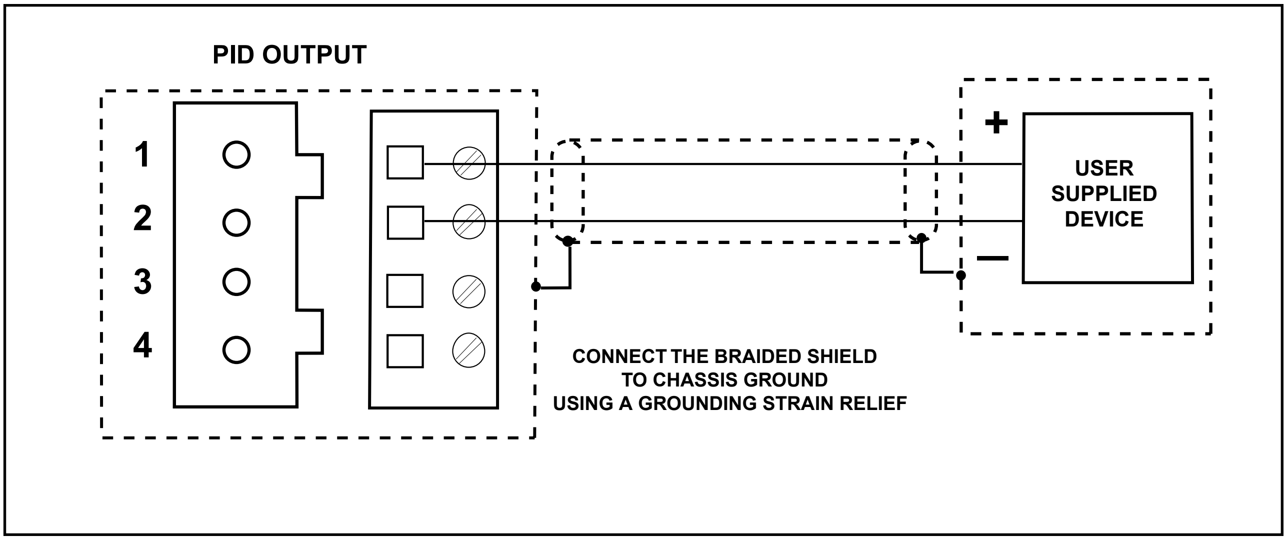


FIG. 3P.3 - PID OUTPUT CONNECTIONS

Section 3P — INDICATOR / PROCESSOR With PID CONTROLLER OPTION

3P.4 AUX SIGNAL ANALOG INPUT

DESCRIPTION
The Auxiliary Signal Input is a MODLINE 3 feature that allows you to manipulate the Set Point value for the PID Controller from an external or remote control device using a scaled input signal of 4 to 20 mAdc to the AUX terminals.

Use the System Configuration menu, shown in Section 4.15, to select what values will be established by an Auxiliary Input signal. For details:

"Aux In : for Set Point to a PID Controller, see Section 4P.

CONNECTION
Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.5. Shield grounding is required for all cables entering the Indicator / Processor.

Insert the cable leads into terminals 1 and 2 of the two-pin connector, as in Fig. 3P.4. To make the wiring a little easier, you can use your fingers to remove and remount the connectors.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the two-pin connector marked "AUX" on the rear panel.

AUXILIARY INPUT RELATIONSHIPS

Example for Set Point
When setting Set Point from with a remote signal you must know your sensor 's range. For this example, use a range of 500 to 1100 °. A mid-range current signal of 8 mA sets a scale temperature of 650°. A 4 mAdc signal would set 500 and a 20 mAdc signal would set 1100. Three is a linear relationship for the temperature values in between. See Section 4.21 for more details.

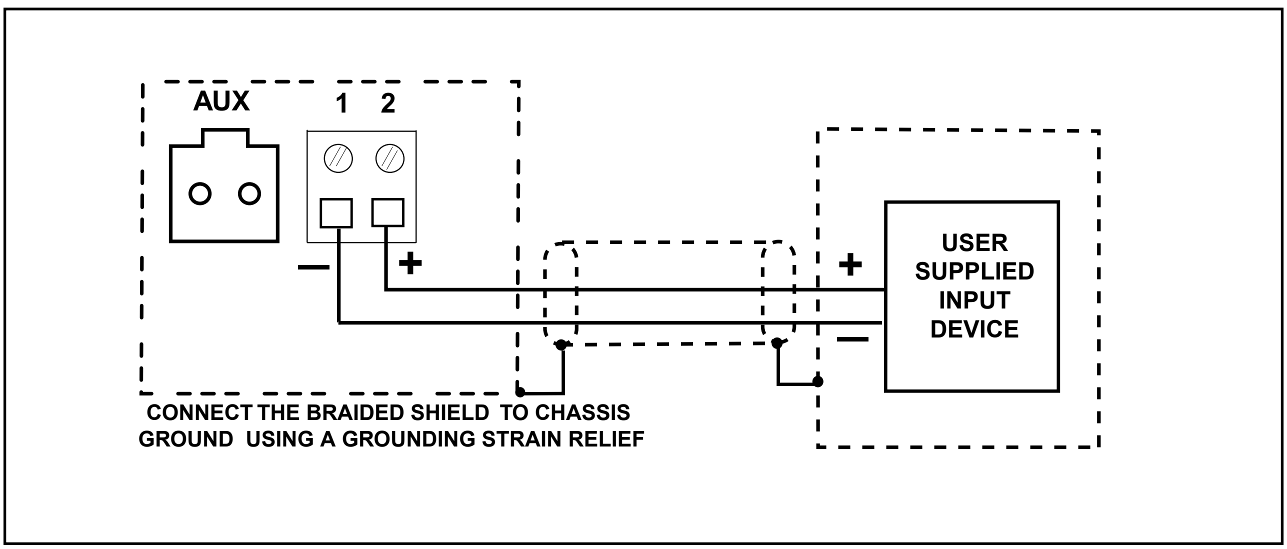


FIG.3P.4 - AUX OUTPUT CONNECTIONS

Section 3P — INDICATOR / PROCESSOR With PID CONTROLLER OPTION

3P.5 DEVIATION ALARMS

DESCRIPTION
The Deviation Alarm circuit wiring uses the RL1 and RL2 relays, shown in Fig. 3P.5. Relay 1 is the HI Alarm and uses Terminals 1, 2 and 3. Relay 2 is the LO Alarm and uses Terminals 4, 5 and 6. The relay contact states for various alarm conditions are summarized in Table 3P.1.

CONNECTION
You may connect these relays to alarm circuits, lights or other loads of your choice.

Install the grounding strain relief and user supplied shielded cable in an entry port, as in Section 3.5.

CAUTION

RELAY RATINGS
Make sure the load power requirements do not exceed the relay ratings for inductive or restrictive loads: The two Form C relay outputs are rated at 24 V AC/DC; @1 Ampere.

Shield grounding is required for all cables entering the Indicator / Processor.

Insert the cable leads into desired terminals of the connector, as in Fig. 3P.5. To make the wiring a little easier, you can use your fingers to remove and remount the connectors.

Each wire must be captured in a terminal lug and the terminal screw tightened securely. Remount the connector into the connector marked "ALARM OUTPUT" on the rear panel.

WARNING

1. Observe all local electrical codes regarding load switching.

2. Consider the effect of a power failure or any other condition that will cause the relays to de-energize. Be sure that any contact closure will not harm any other equipment.

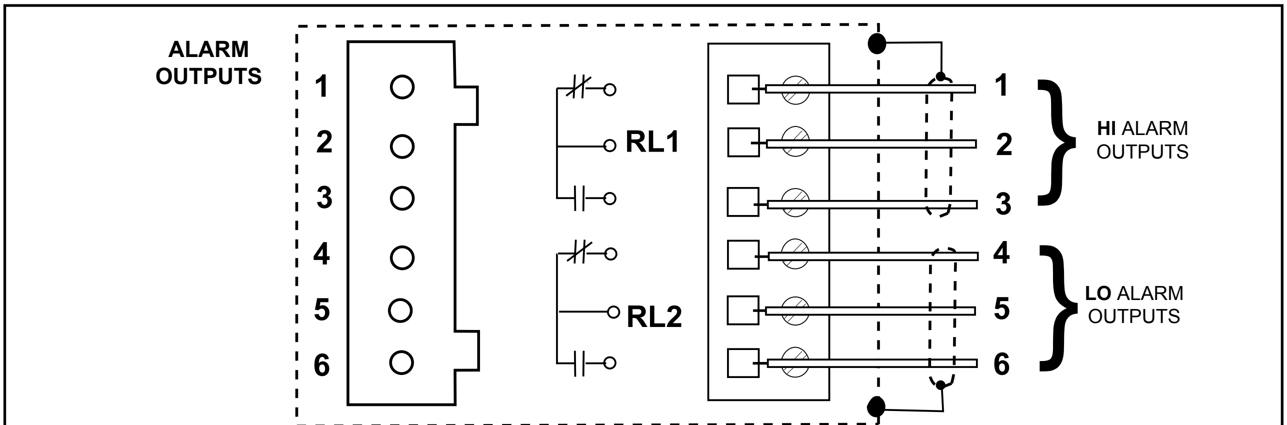


FIG. 3P.5 - DEVIATION ALARM RELAY CONNECTIONS

MODLINE 3 POWER	ALARM STATUS	RELAY RL1		RELAY RL2	
		1 - 2	2 - 3	4 - 5	5 - 6
Off	—	Closed	Open	Closed	Open
On	NO ALARMS	Open	Closed	Open	Closed
On	HI ALARM	Closed	Open	Open	Closed
On	LO ALARM	Open	Closed	Closed	Open

TABLE 3P.1 DEVIATION ALARM RELAY STATES

NOTES:

Section 4 — OPERATION (NO CONTROLLER)

This section describes the setup and operating procedures for your MODLINE 3 instruments. It includes descriptions of all controls and displays on the front panel of the Indicator/Processor, with step-by-step procedures for selecting the functions and placing the instrument in operation.

NOTE: The operating procedures in this section are common to all MODLINE 3 instruments. If your Indicator/Processor is equipped with an On-Off or PID Controller, the additional operating procedures for these options are added as supplementary sections.

4.1 DESCRIPTION

The standard functions for the System are described in this section. If your system includes one of the controller options, such as; On-Off Controllers — you will use this section and refer to Section 4C for the On-Off Controller functions. Use this section and Section 4P for the PID Controller functions.

Before you apply power to the Indicator / Processor, take the time to familiarize yourself with the displays, the controls, the menus and the functions they all perform, as described in Section 4.2 Displays and Controls.

You will use Section 4.3 Menus and Functions as a step-by-step training aid. The section shows you ways to practice at the controls. Then, it goes on to set up and describe the function and value choices in a standard system with no controller options installed.

Your Process

If the System is connected to your process, be aware that these instructions will alter some function selections and adjustments. Make note of the predetermined values your process requires.

Power

Use the Shutoff Switch you installed in Section 3.16, to turn the power on.

When you apply power to the System both front displays light and the words "MODLINE 3 IRCON INC" appear in the lower display.

Factory Specifications

These instruments were thoroughly tested and calibrated to factory specifications before shipment, and should require no more than a brief check, some function selections and adjustments to meet the exact requirements for you process.

⚠ CAUTION ⚠

If you observe any signs of malfunctions smoke or overheating; complete lack of any indication; etc. - turn off power immediately. Recheck all wiring, and refer to Section 5 for troubleshooting.

4.2 DISPLAYS AND CONTROLS

A MODLINE 3 Front Panel has a Temperature Display, a Function Display and a four button touch panel, as shown in Fig. 4.1.

Temperature Display

The display at the top center of the front panel displays measured temperature and the units of temperature calibration. It's referred to as the "Temperature Display."

The Temperature Display has four tall digits dedicated to displaying temperature and some alarm conditions. A degree character (°) shows the unit of instrument temperature calibration. The letter "F" refers to Fahrenheit and letter "C" to Celsius.

Examples: The following temperature displays will be seen on all models, the meanings are:

1500° F	= Temperature readings °F
1500° C	= Temperature readings °C
-LO-°C	= Below zero scale temperature
-H I-°C	= Above full scale temperature

The temperature displays for sensor series 3L and 3R will differ from the described above displays in the following manner:

Certain process and /or operating conditions may cause the Invalid Alarm to activate. When this occurs Temperature Display will begin to flash and alternate between displaying temperature readings for example: (1500 °C) and dashed lines (– – – – °C) and depending on Response Time control settings or Peak Picker rate of decay settings, ultimately begin to display zero scale temperature alarm (-LO -C °) and dashed lines (––––°C).

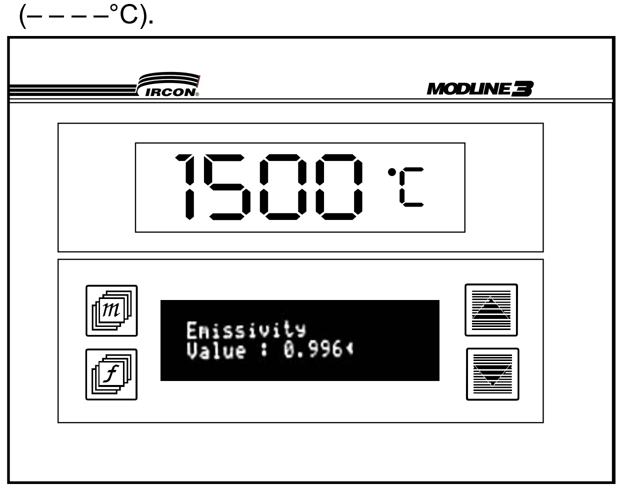


FIG. 4.1 - MODLINE 3 FRONT PANEL

Section 4 — OPERATION

Function Display Example

The Function Display has two 20 character lines to

display menus of function controls and function value selections. The Function Display location is shown in Fig. 4.1.

Display Saver

The Display Saver dims the Function Display after five minutes of inactivity. The display brightens and functions become selectable after any button is pressed.

Control Buttons

There are four touch buttons on the front panel. The button labeled " *m* " and called "menu" serves to search and index through the menus shown in the Function Display.

The button labeled " *f* " is called the "function" button. It serves to index or toggle the functions seen on the second line of the menus.

The buttons labeled **" ▲** and **▼ " (**or up and down arrow) serve to index through function choices or to increment/decrement the function values.

4.3 MENUS AND FUNCTIONS

This section takes you through a series of steps that show you how-to-select and use your system's menus from the Function Display and ultimately how-to set-up your System.

The word "menu" refers to a group of functions and/or features. A menu may contain a single function or a group of functions.

Menu titles always appear on the first line of the Function Display, while the functions associated with the menu appear on the second line . There are a few menus where the functions take both lines of the display.

The menus that are available and the sequence in which they appear depends on the System Model or the System Options.

The Systems are shipped from the factory with menus appearing in the English language. In addition, menus written in the French language or German language can be selected during the system set-up and/or configuration.

A Close Look at Menus

- Available menus are the function of the instrument model and/or the purchased options.
- Menu sequence is model/ option dependent.
- To see what menus are available for your instrument you may elect to do the following:

  a. Scroll - Press and hold the "m" button.

  b. Index - by pressing the "m" button once, a new menu appears.
- Each menu is comprised of a single function or a group of functions.
- For a menu that contains a group of functions the *"f"* button is used. To see what additional functions are available for your instrument you may elect to do the following:

  a. Scroll - Press and hold the *"f"* button to scroll through the functions.

  b. Index - by pressing the *"f"* button once for each new function.

A Close Look at Functions

- A function variable is expressed as a word or as a number.
- A function variable may be changed from State A to State B or from a higher numerical value to a lower value by using the up and down arrows.
- A Function Display menu flowchart is shown in Section 4.16 .

4.4 USING THE " *m* " BUTTON

Use the " *m* " button to select a new menu on the Function Display.

Scrolling

Hold the button down and the menus will scroll by. The second line of the menu is blank while you are scrolling. The menus are:

Emissivity (or E-Slope)
Response Time
Peak Picker
Track and Hold
Calibration Check
Security Access
System Configuration

The above list of menus is for Systems with no controller options installed and for Systems with Sensor Series: 200, 340, 600, 700, 800, 3G, 3W and 3V. This list contains the Emissivity menu. If your system has a Sensor Series: 3R or 3L a different menu list appears. It contains the "E-Slope" menu; in place of the Emissivity menu.

Note: The Calibration Check menu appears for Systems having Sensor Series: 340, 600, 700, and 800.

Menu at a Time

Each time you press the " *m* " button; a new menu appears.

Use the " *m* " button to move to the "Emissivity" menu. The second line appears showing a function or a value.

EMISSIVITY
VALUE : 1.000<

Notice the blinking arrowhead pointing at the last character. It indicates this number is a variable and that it's value can be changed. If the " *m* " button is pressed once, the Function Display will display the next menu in the sequence.

RESPONSE TIME
VALUE : 0.01<s

This menu allows you to select the Response Time function. Notice the blinking arrowhead is again pointing at the variable value to indicate that it's value can be changed

A small "s" follows the arrowhead. That indicates that the units in which the function is expressed is seconds.

Press the " *m* " button once again. The Peak Picker menu appears:

PEAK PICKER
FUNCTION : ON< (OR) PEAK PICKER
FUNCTION : OFF<

Either the word " On" or "Off" will appear after the word "Function." Notice the blinking arrowhead is again pointing at the variable. This time the variable is a word not a number.

If you continue to press the " m " button again and again the menus change to:

TRACK AND HOLD
FUNCTION : ON < OR TRACK AND HOLD
FUNCTION : OFF<

SECURITY ACCESS
PANEL : OPEN <

CALIBRATION CHECK
CYCLE CAL. : <

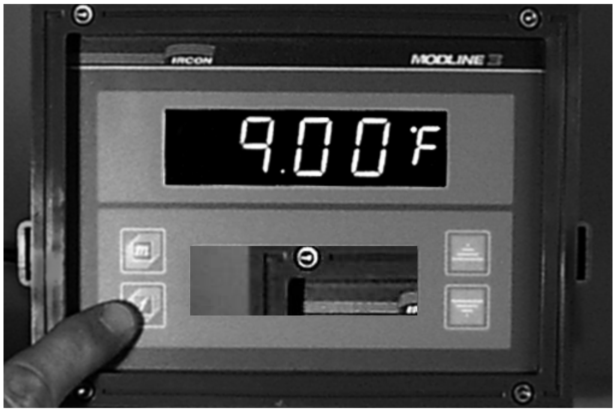
SYSTEM CONFIGURATION
MODEL : XX-XXXXX

You have reached the end of the menu list. However, if you press the " *m* " button once again the display will advance to i.e., "Emissivity."

Section 4 — OPERATION

4.5 USING THE " f " BUTTON

To scroll through the functions seen on the second line of the menus, press and hold down the " *f* " button. If you go past the desired function, continue to press it, to return to the desired function.



Or you may press the " *f* " button once, for a single action.

For this example, use the " *m* " button to reach the beginning of the Peak Picker menu.

PEAK PICKER
FUNCTION : ON< (OR) PEAK PICKER
FUNCTION : OFF<

Press the " *f* " button, once. The second line of the Peak Picker menu changes to show the next menu function.

PEAK PICKER
DECAY : 300 °F/s < (OR) PEAK PICKER
DECAY : 300 °C/s <

This example shows the Decay Rate function. It has a range of 0 to 300. You also see a degree symbol " ° " and letter "F" standing for Fahrenheit or "C" for Celsius. The forward slash " / " symbol indicates division per unit of time, i.e. The symbol "s" stands for seconds.

Press " *f* ". The second line of the Peak Picker menu changes to:

PEAK PICKER
MANUAL RESET : <

Press " *f* ". The second line changes to:

PEAK PICKER
AUTO RESET: ON < (OR OFF)

Press " *f* ". The second line changes to a numbered value:

PEAK PICKER
RST. BELOW : 6500 <°F (OR °C)

Press the " *f* " button again and the Peak Picker menu changes to another numbered value:

PEAK PICKER
PEAK DELAY : 0.015 s < (OR OFF)

Press the " *f* " button again and the Peak Picker menu selection returns to:

PEAK PICKER
FUNCTION : ON< (OR) PEAK PICKER
FUNCTION : OFF<

4.6 USING THE " ▲ AND ▼ " BUTTONS

To change a variable value, word or function on the second line of the menu, use an " ▲ or ▼ " button. (You may call them up and down arrows.)

Now, use the " *m* " button to change the menu to one showing "Emissivity":

EMISSIVITY
VALUE : 1.000<

The word "Value" is followed by a number. This number has a range of 0.100 to 1.000.

All values accessed through the front panel are retained in memory and are automatically reloaded, in the event of a power loss.

Practice with the “ ▲ and ▼ ” Buttons

Just for practice follow this sequence:

1. You still have the menu showing " Emissivity." Press the “ ▼ ” arrow button, once, and hold it down.

2. The value number changes — downward.

3. You are decrementing the number value. Press and hold down the “ ▼ ” arrow button.

   Emissivity
   Value : 1.000<
   Value : 0.999<
   Value : 0.998<
   v
   Value : 0.990<
   Value : 0.980<
   v
   Value : 0.900<
   Value : 0.800<
   Value : 0.700<
   Value : 0.600<
   v
   Value : 0.100<

   As long as the “ ▼ ” arrow button is held down: the value decreases by ones until it reaches ten, then it decreases by tens until it reaches hundreds, then it decreases by hundreds until it reaches the lowest possible number for that value. For Emissivity that number is 0.100.

4. When the button is released the display stops.

5. Press and hold down the “ ▲ ” arrow button.

6. The value number changes. You are incrementing the number value.

7. The value increases by ones until it reaches ten, then it increases by tens until it reaches hundreds, then it increases by hundreds until it reaches the highest possible number for that value. For Emissivity that number is 1.000.

   Emissivity
   Value : 1.000<

More Practice

If you need a little more practice, try to change the Emissivity value down to a value of 0.650.

1. Watch the value number.

2. Press and hold the “ ▼ ” button.

3. The number for the Emissivity variable begins to change, that is, get smaller.

4. The rate of change follows the decrements of 0.001s, 0.010s, and 0.100s.

5. Release the “ ▼ ” button. What number did you stop at?

6. If you have not reached 0.650, press the “ ▼ ” button again, carefully. Release it when you are close to 0.650.

7. You may have passed the number. If so, press either the “ ▲ or ▼ ” button to reach 0.650.

This little bit of practice, will be a big help the next time you go to adjust a value.

4.7 SELECTING FUNCTIONS

Changing a Function Variable

This section is not a step-by-step guide. The menu items are functions, such as Section 4.8 Emissivity Section 4.9 E-Slope. You are given the information about a function and then you make the proper selections.

You move from menu to menu and make the needed changes. Your changes take effect immediately.

Section 4 — OPERATION

Type of Controller Option

If your system includes one of the controller options, such as; On-Off Controller — you will use this section and refer to Section 4O for the On-Off Controller selections. Use Section 4P for PID Controller selections.

4.8 EMISSIVITY

One of the most important requirements for accurate temperature measurements is the Emissivity selection. With this selection, you effectively set your measurement circuits to the characteristics of the material you are measuring.

Use the " *m* " button, to reach the Emissivity Menu. The Function Display shows a numeric variable:

Emissivity
Value : 1.000<

The range for this function is 0.100 to 1.000. There are some models with Emissivity restrictions, see Section 1.5.

You adjust the value in “real time” by using the “ ▲ or ▼ ” buttons to change the numeric settings. You have already practiced setting this value while working in Section 4.6.

To get a true measure of temperature you must set the Emissivity value to match the characteristics of the material being measured.

1. Determine the Emissivity value of your target by referring to the instructions in Section 7.2.
2. Select the proper Emissivity value, from the Tables in Section 7 for the surface finish.

If the material changes characteristics or you change materials, you must redetermine the Emissivity value for the new material and adjust the Emissivity value menu.

Note: If you are viewing your target through a window, consider the effect of window transmission factor on the E-Factor, as described in Section 7.7

Exception: If you ordered a System with an optional window equipped lens (e.g., type PW-1 lens for Sensor Series 200, etc.), the Sensor has been calibrated with the window in place. No further compensation is necessary.

You may wish to read the IRCON publication “Spectrum Reprint SR100 - Product Temperature Solutions — Temperature Errors Caused by Changes in Emissivity.”

Auxiliary Input

You may make remote or external adjustments to the Emissivity value by sending a scaled input of 4 to 20 mAdc to the AUX terminals. The wiring connections and scaling relationships are shown in Section 3.9.

To enable the AUX terminals for Emissivity setting, select “Aux In : Emissivity ” from the System Configuration menu, shown in Section 4.15.

The word “Ext” will appear in front of Emissivity to show the system will accept an externally set value. The blinking arrowhead is not pointing at the variable value. This value can now only be changed from a remote or external input.

Ext. Emissivity
Value : 1.000

You may also adjust the Emissivity values by sending an EM Command from a remote host/PLC to the RS-485 terminals.

4.9 E-SLOPE

Systems having a Series 3L or 3R Sensor require E-Slope value selection for a system that will be measuring temperatures of non-greybody and greybody targets.

Use the " *m* " button to move to the E-Slope Menu.

The Function Display shows:

E-Slope
Value : 1.000<

You adjust or select the value in “real time” by using the “ ▲ or ▼ ” buttons to change the numeric settings. The selection of range for this function is 0.850 to 1.150.

To get a true measure of the temperature you must select the E-Slope values to match the material being measured.

- Determine the E-Slope value by referring to Section 7.4 and Tables 7.4 and 7-5.
- Select the proper E-Slope value from the function menu.

If you change materials or if the material characteristics change, you must redetermine the E-Slope of the material and readjust the E-Slope menu.

Note: If you are viewing your target through a window, consider the effect of window transmission as described in Section 7.7.

Exception: If you ordered an optional window-equipped lens (e.g., type AW-1 lens for Sensor Series 3R, etc.), the Sensor has been calibrated with the window in place. No further compensation is necessary.

Auxiliary Input

You may make remote or external adjustments to the E-Slope value by sending a scaled input of 4 to 20 mAdc to the AUX terminals. The wiring connections and scaling information are in Section 3.9.

To enable the AUX terminals for a remote E-Slope setting, select "Aux In : E-Slope " from the System Configuration menu, shown in Section 4.15.

The word "Ext" will appear in front of E-Slope to show the system will accept an externally set value. The blinking arrowhead is not pointing at the variable value. This value can now only be changed from a remote or external input.

Ext. E-Slope
Value : 1.000

You may also set the E-Slope value by sending an EM Command from a remote host / PLC to the RS-485 terminals.

4.10 RESPONSE TIME

You must select a Response Time that provides meaningful temperature information and eliminates the distracting "jitter" and temperature variations referred to in Section 4.17.

Use the " *m* " button, to reach the Response Time menu.

Response Time
Value : 0.01 <s

This menu allows you to select the Response Time, using the " ▲ and ▼ " buttons to select the seconds. Range is 0.01 to 60.00 seconds. See section 1.5 for range limitations.

Note: If you determine that your Response Time must be greater than 25 seconds, it is recommend that you trial your process. Longer Response Time selections will vary from actual time. Selections of 40 to 50 seconds may be 48 seconds in actual length. Selections of 55 to 60 seconds may be as long as 96 seconds in real time.

The Response Time selected affects the temperature signal input to Optional Controllers, Analog Outputs, Peak Picker functions and Track and Hold functions.

4.11 PEAK PICKER

You adjust Peak Picker to obtain the peak measured temperature value and ignore momentary decreases in measured temperature. Please take the time to familiarize yourself with the Peak Picker functions as explained in Section 4.19.

Peak Picker Function

Use the " *m* " button to reach the Peak Picker menu.

Peak Picker
Function : On< (or)

Peak Picker
Function : Off<

To select "word variables" such as; on and off, you use the " ▲ " or " ▼ " buttons to change the word.

If "Function : On" is displayed; press the " ▼ " button once. You just changed it to Off.

If "Function : Off" is displayed; press the " ▲ " button once. You just changed it to On.

If you select Peak Pick "Function : On "; you must select a Decay Rate to retain peak measured temperature value and ignore momentary decreases in measured temperature. This eliminates erratic measurements due to gaps in workpieces, bursts of smoke, or steam, etc. in the sight path of the sensing head.

Section 4 — OPERATION

Decay Rate

Press the " *f* " button to move down to the Decay Rate portion of this menu.

PEAK PICKER
DECAY : 300 °F/s<

The second line shows the "Decay" function followed by a numerical value. The range of Decay Rate is 0 to 300° F or 0 to 300° C per second.

You select a Decay Rate value by using the " ▲ and ▼ " buttons to select the desired numeric.

Decay Rate value is described in Section 4.19.

Manual Peak Picker Reset

Press the " *f* " button to move down to the Reset portion of this menu.

PEAK PICKER
MANUAL RESET : <

You use the " ▲ " button to perform a manual Peak Picker reset.

The Peak Picker Reset "clears" the stored peak information. The system begins tracking the measured temperature, in the Peak Picker mode after a manual reset.

Remote Momentary Peak Picker Reset Input

You may do a Peak Picker Remote Reset by sending a remote momentary switch closure to the "RESET" terminals of the Indicator / Processor. Refer to Section 3.11 for switch installation instructions.

If the "RESET" switch is held closed the Temperature Display will indicate the measured temperature without any peaking action taking place.

Auto Peak Picker Reset

Press the " *f* " button to move down to the Auto Reset portion of this menu.

PEAK PICKER
AUTO RESET : ON< OR

PEAK PICKER
AUTO RESET : OFF<

On the second line you see the " Auto Reset. You select On by pressing the " ▲ " up button or " ▼ " down button for Off.

With Peak Picker On the Auto Peak Picker Reset function will trigger, when the measured temperature matches the selected Reset Below temperature, and the Peak Picker is reset.

Reset Below

Press the " *f* " button to move down to the Reset Below function of this menu.

PEAK PICKER
RST. BELOW : 650<°F

On the second line you see the " Rst. Below" temperature. You use the " ▲ " or " ▼ " buttons to change the Reset Below temperature value.

The Automatic Reset temperature range matches the Temperature Span of the System being used.

With Peak Picker On and Auto Peak Picker Reset On, when the measured temperature matches the selected value of the Reset Below function, the Peak Picker Reset will take place.

The Reset Below function is effected by the Response Time, the Decay Rate, as well as the displayed temperature. It is possible for a slow response time and a long decay rate to delay a Peak Picker reset for a considerable time after the measured temperature falls below the selected Reset Below temperature.

The displayed measured temperature is followed linearly by the Analog Output Signal.

Peak Picker Delay

Use the " *f* " button, to bring yourself to the Peak Delay menu.

PEAK PICKER
PEAK DELAY : 0.01 <S (OR OFF)

This menu allows you to select the seconds for delay by using the " ▲ and ▼ " buttons.

With Peak Picker On , Auto Peak Picker Reset On, and a valid Reset Below Temperature selected for the process; the Peak Picker signal conditioning may be delayed.The Peak Picker Delay time is selectable in the range of 0.01 to 10.00 seconds. See Section 4.19 Peak Picker for a detailed description of Peak Picker Delay.

To get back at the main menu list; use the " *m* " button.

4.12 TRACK AND HOLD

Use the " *m* " button, to bring you to the Track and Hold menu.

TRACK AND HOLD
FUNCTION : ON< OR

TRACK AND HOLD
FUNCTION : OFF<

You change from Off to On with the **"** ▲ **"** button.

External Control for Track and Hold

After you select "Function : On ". You may control the Track and Hold through an external remote switch wired to the T&H terminals as described in Section 3.12.

The switch actions for the Track and Hold feature are described in Section 4.22.

Track and Hold Function Off

If you wish, you can change the selection from "On" to Off by pressing the **"** ▼ **"** arrow button. Changing from On to Off will reset the Track and Hold function and start the tracking of the measured temperature.

4.13 SECURITY ACCESS

You may use Panel Lock to secure the Function Display, if you wish. When the panel is "Closed" or "Locked":

- no accidental menu changes can be made manually.
- you may view the menus and functions but not change them.
- the lock does not interfere with the system process or control actions.
- the auxiliary inputs and the RS 485 Interface are operational.

IMPORTANT: You can not go from "Locked" directly to "Closed", or vice versa. You must first go to "Open."

Use the " *m* " button, to bring you to the Security Access Panel menu. The display shows one of the following:

SECURITY ACCESS
PANEL : LOCKED.<

or

SECURITY ACCESS
PANEL : CLOSED.<

or

SECURITY ACCESS
PANEL : OPEN.<

Note: The System is sent to you with the panel lock in the Open Mode.

Panel Lock

Follow these steps to lock the panel:

1. Press the " *f* " Button. Press the " ▲ " button and the second line shows a number:

   a. As long as the **"** ▲ **"** button is held down: the display increases until: it stops at the maximum number.

   b. If you release the button: the display stops.

   c. As long as the **"** ▼ **"** button is held down: the display decreases until: it stops at the lowest possible number.

2. Use the **"** ▲ and ▼ **"** buttons to increment or decrement the number until you reach: 967.

3. Press the " *f* " Button. The word "Locked" appears. It remains on the Security Access menu: until you change it.

   Note: The menu functions and menu values can be viewed but not changed.

Panel Open

Follow these steps to Open the panel:

1. Press the " *f* " Button. Press the " ▲ " button. The second line shows a number:

2. Use the " ▲ " button to increment the number and the " ▼ " button to decrement the number until you reach: 967. That's right it's the same number.

3. Press the " *f* " Button. The word "Open" appears. It remains on the Security Access menu: until you change it.

Open to Closed

Follow these steps to Close the panel:

1. When the panel is "Open". The display shows:

   SECURITY ACCESS
   PANEL : OPEN.<

2. Press the " ▲ " button and the second line shows a number "1".

   Note: With the "1" (or some other number) on the display, take care not to press the " *m* " button. The System will then remain in open, until you lock it.

3. Press the " *f* " Button. The word "Closed" appears and remains on the Security Access menu: until you change it.

Closed to Open

To move from "Closed" to "Open":

1. Press the " ▲ " button. A number "1" appears.

2. Press the " *f* " Button. The word "Open" appears. It remains on the Security Access menu: until you change it.

   Note: This action avoids having to use the " ▲ and ▼ " buttons to increment or decrement the number until you reach: 967.

Section 5.5 describes use of the Service Code for maintenance purposes.

4.14 CALIBRATION CHECK

A System Calibration Check may be tested at any time.

Only MODLINE 3 Systems with Sensor Series: 340, 600, 700 and 800 have this feature. A calibration bulb is turned on inside the Sensor. The Indicator / Processor measures the output of the Sensor during the "Calibration Check" and compensates for any changes in the expected output.

IMPORTANT: The Sensor must not be pointed at a hot target during the Calibration Check. The lens must be covered or blocked, as described in the Calibration Check.

A Calibration Check should only be performed off-line. That is, when the Sensor is not required to provide outputs to a control device or data acquisition system.

Disregard the Temperature Display readings during the Checking Calibration function. The Analog Output readings and control action will not be valid during the Checking Calibration function. If the Track and Hold feature is in the Hold Mode; the temperature readings prior to initiating the calibration check will be provided at the the analog output and as input to any controller option installed.

If the Peak Picker is on and a long Decay Date is selected; the temperature readings, prior to initiating the calibration check, will be seen at the analog output and as input to any controller option .

After initial installation the Calibration Check should be performed once per week for the first two weeks. It is best to do the Calibration check after the instrument has been operating for at least one hour in its operating ambient.

Thereafter, when the MODLINE 3 is in continuous operation the Calibration Check should be performed about once per month. If the MODLINE 3 is used only for intermittent operation the Calibration Check should be performed about once per week.

CALIBRATION CHECK PROCEDURE

1. Depress the " *m* " button until: "Calibration Check" appears

   CALIBRATION CHECK
   CYCLE CAL. : <

2. Block the Sensor len with an opaque cover that is well below the zero scale temperature but not hotter than 130 °F (55°C). ideally the lens cover should be at the same temperature as the Sensor.

For Sensor models that measure temperatures below 150°F (65°C), the lens cover must be at 80°F (27°C) ±10% to insure proper calibration. Ideally the Sensor should be at the same temperature as the lens cover.

3. Press the " ▲ " button.

   CALIBRATION CHECK
   CONFIRM LENS COVERED

   a. Reminder message to confirm the lens is blocked or covered.

   b. Press the " ▲ " button, again.

4. The phrase "Checking Calibration" appears and flashes on and off for about 17 seconds.

   CALIBRATION CHECK
   CHECKING CALIBRATION

   If for any reason you wish to stop the checking, use the " ▼ " button at any time.

5. At the end of this Calibration Check the phrase "Cycle Cal" appears as part of the second line, if the System passed the check.

   CALIBRATION CHECK
   CYCLE CAL. : <

   Uncover the lens and restart the System process.

6. If the phrase "Calibration Failed" appears, your System failed the check.

   CALIBRATION CHECK
   CALIBRATION FAILED

   You must press the " ▲ " button to acknowledge and clear any alarm. The system will revert to the previous valid calibration data

   If the Sensor was too hot or the lens was not covered adequately the Calibration Check will fail. You may want to recheck these items and redo the Calibration Check.

   If after, several checks the "Calibration Failed" phrase appears your System may need servicing. Refer to the troubleshooting in Section 5.10.

4.15 SYSTEM CONFIGURATION

Use the " *m* " button, to bring you to the menu heading for System Configuration. Use the " *f* " button to move to the desired menu functions.

Model

The System Configuration shows the series and model. *Note:* Sensor Model and System Series numbering is explained and shown in Section 1.4.

SYSTEM CONFIGURATION
MODEL: XX - XXXXX

The XX = Series. (An example is: 3L or 33.)
The x x x x x = Model. (An example is: 20F05.)

Model selection is part of the order code and is selected when the system is ordered. It can be reset in the field by trained service personnel using Section 5.6. A model or series change will change the default ranges and values of the system.

Text

You select a text language for the Function Display operation: English, French, or German. Use the " *f* " button to move to the Text menu.

SYSTEM CONFIGURATION
TEXT : ENGLISH

OR

SYSTEM CONFIGURATION
TEXT : FRANCAIS

OR

SYSTEM CONFIGURATION
TEXT : DEUTSCH

Use the **" ▲ and ▼ "** buttons to make a selection.

Auxiliary Input

Your external control device sends any value 4 to 20 mAdc signal to the AUX Terminals. You select how the Auxiliary Input signal is to be used. Use the " *f* " button, to reach the Auxiliary Input menu:

SYSTEM CONFIGURATION
AUX. IN : EMISS. < (OR E-SLOPE)
: SET PT.
: NONE

Section 4 — OPERATION

Use the " ▲ and ▼ " buttons to select: Emissivity, E-Slope, Set Point or None from the System Configuration Aux In menu. If your system has a Series 3L or 3R Sensor the word "E-Slope" replaces the word "Emiss."

"Aux In : None " must be selected if you are not using an auxiliary signal to set your Emissivity, E-Slope, or Set Point value.

Note: Auxiliary Input to Set Point is not used in a System Configured for No Controller functions.

Wiring the Auxiliary Input terminals is described in Section 3.9. The remote device may be manually operated or it may be a process operated device.

Analog Signal Output

Use the " *f* " button to move to the Ana. Out menu.

System Configuration
Ana. Out : 0 - 20mA **Select 0-20 mA for 0-10 Vdc Option**
: 4 - 20mA
: 5 uA / °F

You use the " ▲ and ▼ " buttons to select a signal to match your system output, see Section 1.5.

If Model Block D=0, a choice of 3 different analog current outputs is avilable. If Block D=1, the output is 0 to10 Vdc. See 4.21 for detailed information.

This signal is available at the Analog Output terminals on the rear plate of the Indicator / Processor. See Section 3.8 for wiring information.

Analog Zero Scale Adjustment

Use the " *f* " button to move down to the Analog Zero menu, set to zero scale at the factory.

System Configuration
Ana. 0% : 1000°F (or C)

Use the " ▲ and ▼ " buttons to select a Zero Scale temperature that establishes a smaller range for the scaling of the 0 to 20 mA or 4 to 20mA or 0 to 10 V zero scale analog output signal.

System Temperature Range Example: In a MODLINE 3 System having a Temperature Range of 500° to 2500° the Analog Zero Scale Value is 500°.

Re-assigned Zero Scale Example: With a temperature range of 500 ° to 2500°, you can choose a zero scale temperature within the range. Fig.4.2 shows an example of a reassigned Analog 0% zero scale of 1000°.

The System requires a 10 ° minimum span below the full scale range. Therefore with a setting of 2500 the System will stop the setting at 2490°.

Analog Full Scale Adjustment

Use the " *f* " button to move down to the Analog 100% menu.

System Configuration
Ana. 100% : 1800 °F (or C)

Use the " ▲ and ▼ " buttons to adjust the range of the Full Scale temperature. You are selecting the temperature and a smaller scaling range for the 0 to 20 mA or 4 to 20mA or 0 to 10 V full scale analog output signal.

System Temperature Range Example: In a MODLINE 3 System having a Temperature Range of 500° to 2500° the Analog Full Scale Value = 2500°

Re-assigned Full Scale Example: With a temperature range of 500 ° to 2500°, you can choose a full scale temperature within the range. Fig.4.2 shows an example of a reassigned Analog 100% full scale of 1800°.

The System requires a 10 ° minimum span above the zero scale range. If you set the analog zero scale to 500° the full scale output temperature can not be set below 510°.

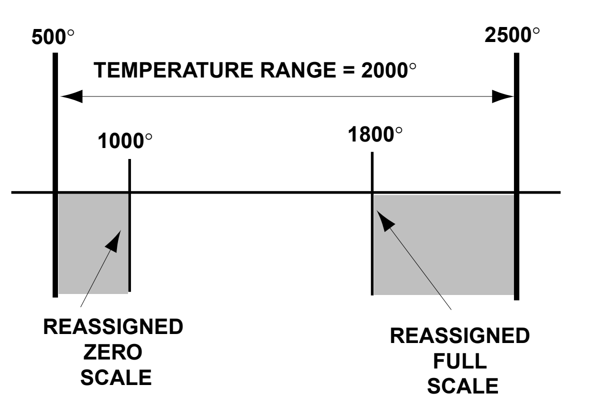


FIG. 4.2 - EFFECTS OF A REASSIGNED ZERO AND FULL SCALE ON THE RANGE

RS-485 Digital Communication Configuration

Select the "Read Only or Read Write " function operation for the RS 485 Interface:

RS 485 : Read - Only
: Read / Write

Make your selection by using the " ▼" for "Read Only" and the " ▲ " button for "Read / Write".

This signal is available at the RS 485 terminals on the rear plate of the Indicator / Processor. The cable specifications are described in Section 3.10. Refer to Section 8 for an explanation of the Command Codes and more detail on the RS-485 Digital Communications Interface.

Unit Address

The Unit Address is a single letter code. It ranges from a single numeric to an upper or lower case "A to Z ". Refer to Section 8 for the explanation of the Command Codes and the usage of the Unit Address Number.

Unit Address : 0 to 9 < (or a to z, A to Z)

This menu allows you to select the Unit ID character, using the " ▲ and ▼ " buttons. It must match the Unit Address used by your host/CPU.

Baud Rate

The Baud Rate must match the customer supplied communication devices. Use the " *f* " button to move to the Baud Rate menu.

System Configuration
Baud Rate: 19200< (or 9600 or 2400)

You may select the Baud Rate, using the " ▲ and ▼ " buttons. It must match the rate used by your host/CPU.

Version Information

All MODLINE 3 Indicator / Processors show a firmware version code. It contains a "V" for version; followed by a three character numeric for the firmware installed.

System Configuration
V 1.XX

Section 4 — OPERATION

4.16 FLOWCHART (Basic Functions)

The FLOWCHART shows the " *m* " and " *f* " button structure and it is not an exact function display replica. The ▲▼ buttons do a function selection.

More functions exist than are shown on this flowchart.

The ranges of the values are shown as an aid to the reader.

[M] Emissivity (or E-Slope 0.850 to 1.000)
(Ext.) Value : 0.100 to 1.000 ▲▼
[M] Response Time
Value : 0.01 to 60.00s ▲▼

[M] Peak Picker
[F] Function: On or Off ▲▼
[F] Decay : 0 to 300°F/s ▲▼
: 0 to 300°C/s
[F] Manual Reset : ▲▼
[F] Auto Reset: On or Off ▲▼
[F] Rst. Below : 50 to 6500°F ▲▼
: 0 to 3500°C
[F] Peak Delay : Off ▲▼
: 0 .01 to 10.00s

[M] Track and Hold
[F] Function : On or Off ▲▼

[M] Security Access
[F] Panel : Locked < ▲▼
or Open or Closed

[M] Calibration Check
[F] Cycle Cal : < ▲▼

[M] System Configuration
[F] Model: XX - XXXXX
XX = Series (Example is 3R or 36.)
x x x x x = Range (Example is 14C05.)

[F] Text : English ▲▼
: Francais or Deutsch

[F] Aux. In : Emiss. (or E-Slope) ▲▼
: None
: Set Pt .

[F] Ana. Out : 0 - 20mA ▲▼
: 4 - 20mA ▲▼
: 5µA / °F or °C ▲▼

[F] Ana. 0% : 0°/s F or C ▲▼

[F] Ana. 100% : 6500°/s F or C ▲▼

[F] RS 485 : Read - Only ▲
: Read / Write ▼

[F] Unit Address : 0 - 9, A - Z, a - z ▲▼

[F] Baud Rate: 19200< ▲▼
9600
2400

[F] V 1.00

4.17 RESPONSE TIME ADJUSTMENT

DESCRIPTION

Response Time is the length of time it takes for the displayed temperature and the output signals of the Indicator / Processor to reach approximately 95% of a step change in measured temperature. If the power is turned off or temporarily lost the Response Time Menu will display the last Response Time value selected.

Response Time in the MODLINE 3 System has an adjustable range from 10 ms to 60 seconds, depending on the model. See Section 1.5 for Response Time restrictions.

If you find that noise is interfering with you controller operation, you must increase the Response Time as required and then retest your parameter selection

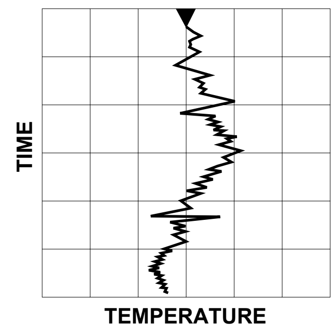
PROCEDURE

The Response Time is factory set for fastest response time. You may wish to select a slower response time, that is suitable for your process.

To follow temperature variations as they occur, select a fast response time. If you prefer to "filter out" temperature variations, select a slower response time. In most applications, the practical approach is to observe the temperature display and adjust the response time for the most meaningful temperature information without distracting variations on a Temperature Display, or your chart recorder. Fig. 4.3 illustrates the general effects of response times, as if plotted by a chart recorder.

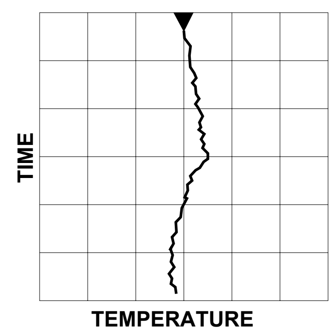
IMPORTANT: The combination of low target temperature and fast response time will cause unstable temperature indications. When measuring low target temperatures, adjust Response Time slowly to obtain stable temperature readings. Measurements below 400 °F or 200 °C may require a response time of one second or more. A Response Time setting of 30 msec usually provides good starting point for higher measured temperatures.

FAST RESPONSE



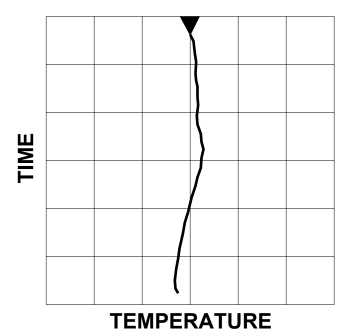
Temperature display (also output signals and controller action) follow temperature variations as fast as minimum response time of instrument.

MEDIUM RESPONSE



Rapid temperature variations are "filtered out" and system follows general trends in temperature, with small amounts of "ripple".

SLOW RESPONSE



System tracks slow variations in temperature, and effects of temperature spikes are eliminated.

FIG. 4.3 - EFFECT OF RESPONSE TIME ON TEMPERATURE SIGNAL

Section 4 — OPERATION

4.18 RESPONSE TIME 3L SENSORS

DESCRIPTION

The previous section describes how Response Time Adjustment is used to filter out process temperature variations. This section describes *3L Series Instrument Response Time*. If you have one of the following lower temperature 3L Series Models, Dynamic Response Time (DRT) must be considered when setting up your system: 3L05-05C, 3L05-10F, 3L10-07C, or 3L10-14F.

The 3L instrument response time is dependent on the sensing head response time as well as the indicator response time setting. The 3L sensing head normally has a 20msec response time but when signal levels are low it automatically increases it's internal response time. The effective instrument response time is the greater of the sensing head response time and the indicator response time.

DRT is an automatic function that becomes active when measured temperatures are below 840 °F (449°C) and are emanated from targets other than a blackbody source. During these conditions, DRT automatically calculates the response time based on the temperature signal levels. Relationship between response time and temperature-signal levels is inversely proportional such that the lower the signal level the higher the response time value. (Refer to graphs.)

The benefit of DRT is that it automatically provides the best combination for the fastest Instrument Response Time and minimum system noise.

YOUR MANUALLY ADJUSTED RESPONSE TIME IS OVERRIDDEN BY DRT

A Response Time Adjustment that was set on the potentiometer will be overridden by the automatic action of DRT if the computed Instrument Response Time is slower than the setting on the potentiometer.

For example, Fig. 4B.6b graphs the type of compensation expected at temperatures below 575 °F (302°C) with 100% resolved blackbody targets. Action of DRT will be about 200 msec even if the Response Time Adjustment is set to a faster setting. At temperatures above 575 °F (302°C), you can expect a response time as fast as 25 msec (assuming the potentiometer is set to the fastest setting). This happens because DRT negotiates the three contributing parameters, then, the microprocessor computes if there is a need for a slower response time. If so, DRT action automatically overrides Response Time Adjustment of the potentiometer and Instrument Response Time takes over.

Fig. 4B.6c graphs the type of automatic DRT compensation you can expect at temperatures below 840°F (449°C) with a 5% resolved blackbody target. At temperatures above 840°F (449°C), you can expect a response time of 25 msec, even with 95% of the signal reduced. Below 840 °F (449°C), Instrument Response Time becomes slower at the

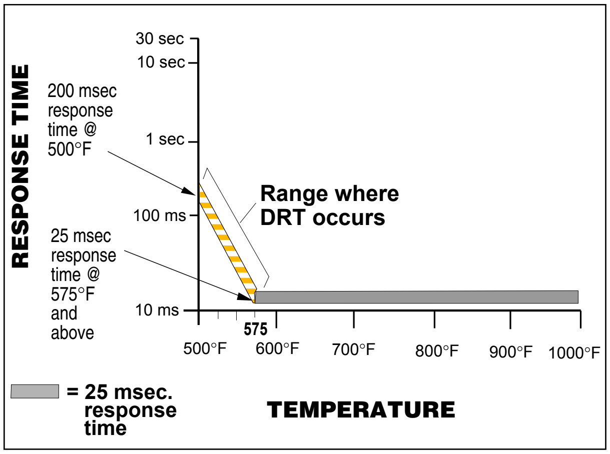


FIG. 4.4a – BELOW 575°F, ACTION OF DRT (WITH 100% RESOLVED BLACKBODY TARGET)

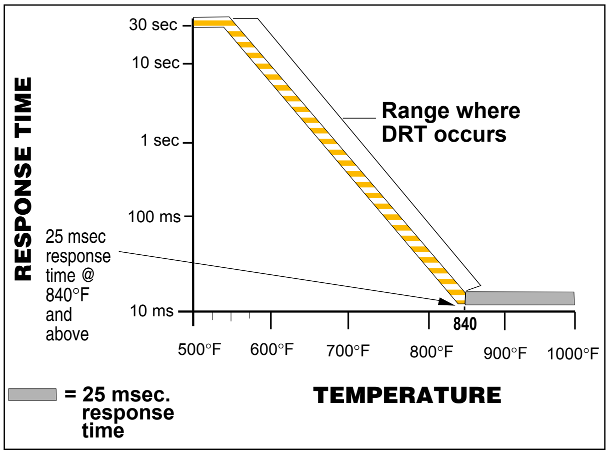


FIG. 4.4b – BELOW 840°F, ACTION OF DRT (WITH 5% RESOLVED BLACKBODY TARGET)

rate shown in the graph.

Fig. 4B.6d graphs the type of automatic DRT compensation you can expect at temperatures below 960°F (516°C) with a 5% resolved blackbody target. At temperatures above 960° (516°C), you can expect a response time of 25 msec, even with 95% of the signal reduced. Below 960 ° (516°C), response time action becomes slower at the rate shown in the graph. At 700 °F (371°C), you can expect a 10 second Instrument Response Time with DRT action overriding your potentiometer setting.

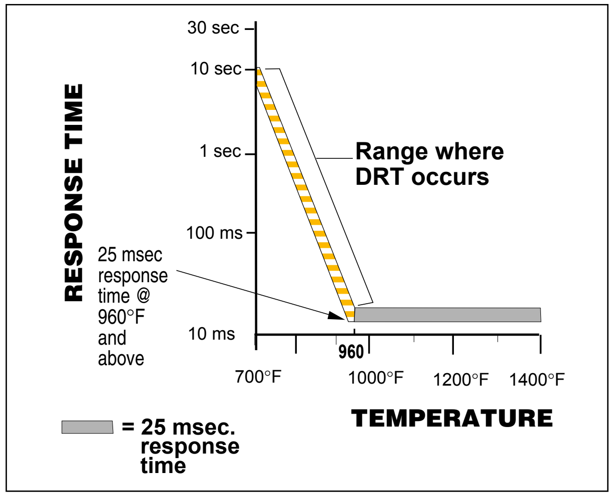


FIG. 4.4c – BELOW 960°F, ACTION OF DRT WITH 5% RESOLVED BLACKBODY TARGET

Section 4 — OPERATION

4.19 PEAK PICKER FEATURE

DESCRIPTION

You will want to learn how to use the Peak Picker function for certain measurement situations.

- If the workpiece you are measuring is moving and is in the field of view for only a brief period of time.
- If a succession of small parts is to be viewed with variable spacing between them.
- If the temperature of a moving work-piece varies because of slag, oxides, etc., but you wish to know the highest measured temperatures.
- If the line of sight between the instrument and the workpiece is momentarily or periodically interrupted, as by a moving piece of machinery or by bursts of steam or smoke.

Fig. 4.4 illustrates the Peak Picker action. The Peak Picker circuitry responds to the highest instantaneous value of temperature and holds this value even if the temperature source is interrupted by one of the conditions listed above.

The indicated temperature (solid line) rises almost instantly, depending on the selected response time, to follow the peaks in actual temperature (dashed line). The indicated temperature decays at a rate determined by the setting of the Peak Picker Decay Rate control. Fig. 4.4 shows the effect of changing the decay rate.

Note: The Peak Picker action affects the Analog and Digital Outputs, Track and Hold functions and if installed as an option the controller operation.

TURNING THE PEAKING FUNCTION ON AND OFF

The Peak Picker can be turned on and off by using the following:

1. From the Peak Picker function menu, selecting Peak Picker on or off.
2. Remotely using the PS Command Code on the RS 485 Digital Interface.
3. Once the Peak Picker function is turned on by using Step 1 or Step 2 above a continuous switch closure at the rear panel RESET terminals will turn the Peak Picker off. Opening the switch will provide Peaking Action.

The Peak Picker signal conditioning takes place with the Peak Picker on or enabled. The temperature readings may be returned to instantaneous values at any time by selecting the Peak Picker Off. The system then follows actual temperature variations as they occur.

Note: Both the Peak Picking actions and direct temperature indication are affected by the Response Time you have selected.

PEAK PICKER DECAY RATE

You can select the Peak Picker Decay Rate from the Peak Picker function menus or remotely from the PS Command Code on the RS 485 Digital Interface.

The fastest decay rate is 300 degrees per second. The slowest decay rate is 0.01 degrees per second. This slow decay rate will decay only 1 degree in 100 seconds.

You select a rate somewhere in between these extremes that will yield the decay you need for your particular measurement situation. Refer to Fig.4.4, for examples of fast and slow decays.

PEAK PICKER RESET

The Peak Picker can be reset automatically or manually by an external switch. Reset immediately removes any "Peaked" information stored in the Peak Picker. After the reset, the system will begin tracking measured temperature again and Peak Picker signal conditioning will continue.

The Peak Picker can be reset by any of the following actions:

- Manual reset of the function from the Peak Picker Function Display menu.
- Remotely reset by a momentary switch closure at the RESET Terminals on the rear panel.

- Automatic Reset using the Auto Peak Picker Reset function with the Auto Reset Below Temperature selection.
- Remotely resetting using the PS Command Code on the RS 485 Digital Interface.

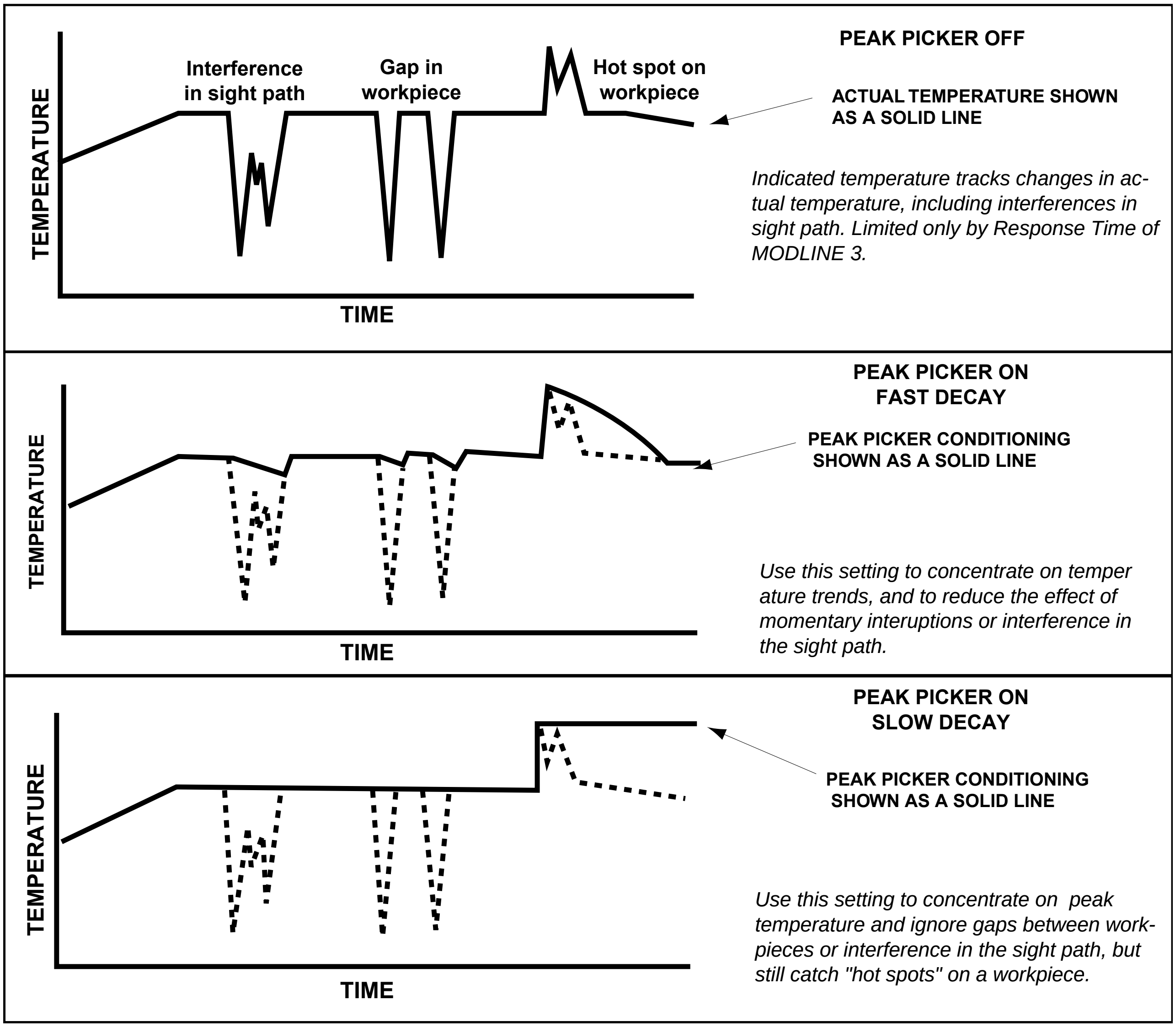


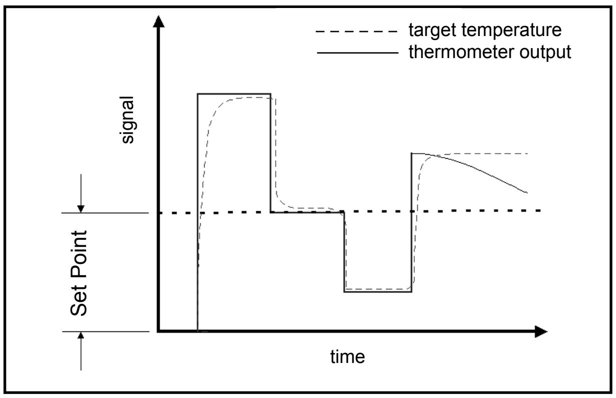
FIG. 4.5 – EFFECT OF PEAK PICKER ON TEMPERATURE INDICATION

AUTO PEAK PICKER RESET Using the PEAK PICKER RESET BELOW Temperature Selection

A reset can be accomplished automatically with the Auto Peak Reset function. This is accomplished when the Auto Reset function is turned on either by the function menu selection or by using the PS Command Code from the RS-485 Digital Interface.

This reset action is trigged when the measured temperature goes below the Reset Below selected temperature. The selection is made either through the Peak Picker Reset Below function menu or by using the PK Command Code from the RS-485 Digital Interface.

When the measured temperature is below the selected Reset Below temperature the displayed temperature will be the measured temperature unaffected by the Peak Picker signal conditioning action, subject to any Response Time selection that has been made.



PEAK PICKER WITH AUTO RESET

When the measured temperature is above the selected Peak Picker Reset Below temperature the displayed temperature will be the measured temperature with the Peak Picker signal conditioning action applied, subject to any Response Time selection that has been made.

The Auto Peak Picker Reset can effectively be used to turn ON the Peak Picker function only when the target is in view and to turn it OFF when the target is out of view.

IMPORTANT: The Reset Below temperature must be properly selected so as to provide the measurement conditions wanted. Too high of a selected temperature may cause the peaking action not to be activated, if the target is cooler. If the Reset Below temperature selected is too low Peak Picker action will continuously take place with higher background temperatures.

PEAK PICKER DELAY

The Peak Picker Delay function is used to delay the start of the peaking action for up to 10 seconds

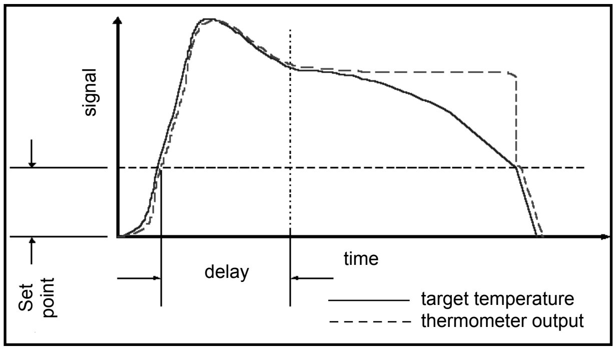


FIG. 4.6 – PEAK PICKER DELAY TIME

following the detection of the leading edge of a new target.

The Peak Picker Delay function must be used in conjunction with the Auto Peak Picker Reset and Reset Below temperature selection.

The Peak Picker Delay time-out will be not begin until a target whose temperature is above the selected Reset Below Temperature comes into view and remains in view. Fig. 4.6 shows the delay time in relation to the target temperature and the reset below temperature level. The Peak Picker action will begin after the selected delay time and will continue until the the actual measured temperature goes below the selected Reset Below temperature. The system will then return to direct temperature indication until a new target comes into view. The Decay Cycle will repeat as describe above.

Delaying the start of the peaking action allows peaked temperature measurement of targets with hot leading edges and cooler middle temperatures without peaking on the hotter leading edge. The delay time selected determines at what position or point on the target peaking action begins.

This function is affected by very slow Response Time. Slow response times may further delay the start of peaking action.

Example: Before a moving work piece enters the target viewing area, the System may be sensing a measured temperature below the selected Reset Below temperature. As the target comes into view, the hotter temperature is sensed and the Peak Picker Delay time-out begins. When the delay is completed, the system will begin peaking action on the measured temperature until the work piece passes the Sensor.

The delay time selection is made either through the Peak Picker Delay function menu or by using the PD Command Code from the RS-485 Digital Interface.

4.20 TRACK AND HOLD CONTROL

DESCRIPTION

Your MODLINE 3 System may include a control device for external Track or Hold, such as a normally open switch connected to the T. & H. terminals. The switch could come from a device that detects a workpiece as it enters or exits the target area.

Switch action for External Track and Hold control:

- With the switch open the measured temperature tracking continues.
- With the switch closed the displayed temperature will hold and the analog outputs will hold.
- The remote switch may be manually operated or it may be a contact on a timer, relay, or you may use the movement of a target or its' timing in the process to close the remote switch.
- The Track and Hold is affected by the Response Time setting and the Peak Picker selections.
- The Track and Hold operation affects controller operation as well as temperature indication.

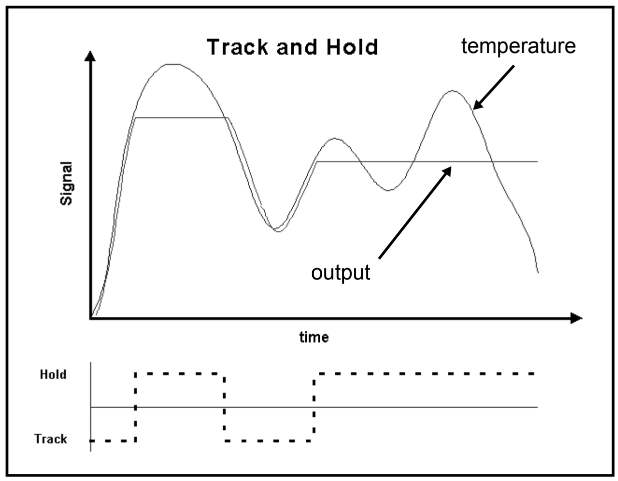
You must select "Function : On ", if you have an external or remote switch wired for the Remote T&H feature as described in Section 3.12.

Section 4.12 details how to set the Track and Hold menus for external control.

Section 8.5 details how to turn the Track and Hold on and off using the "TS" Command Code for the RS-485 Digital Communications Interface.

Example: you may want to scan the surface of a moving workpiece and hold the temperature reading at middle point on the workpiece, while ignoring the readings at the beginning and the end of the workpiece.

Another Example: the temperature tracking can be made to hold a temperature even after the temperature in the sighted area has dropped. It will hold the value without any decay until the switch is opened or the power is interrupted.



TRACK AND HOLD

Section 4 — OPERATION

4.21 ANALOG OUTPUTS

DESCRIPTION

If Model Block D=0 the choices of analog signal outputs are:

- 0 to 20 mAdc,
- 4 to 20 mAdc, or
- 5μA per degree Fahrenheit or Celsius

If Model Block D=1 the analog output is 0-10 Vdc. The signal varies linearly with the measured tem-perature. This output will drive remote devices scaled to make these analog signals meaningful.

You must learn to relate the signal values to temperature values. You may want to devise a temperature scale or prepare a signal-to-temperature conversion table for your auxiliary device. The signal varies linearly with temperature, so it is a simple matter to mark an auxiliary meter or recorder scale for equivalent values.

Example for 0 to 20 mAdc Output:
The temperature range of a MODLINE 3 series 32-16C30 system is 800 to 1600 °C (a span of 800°). Each milliamp on this 0 to 20 span represents 40°. A 10 mAdc reading on a meter connected to this output therefore represents 1200 °. A 15 mAdc reading is 1400°; and so on up to a 20 mAdc reading of 1600°C.

$$T = \left(\frac{I}{20} \times (T_{F.S.} - T_{Z.S.}) \right) + T_{Z.S.}$$

Example for 4 to 20 mAdc Output:
When you use any 4 to 20 mA analog indicator, it is a simple matter to convert current readings to the temperature readings they represent. A 4 mA reading will correspond to the zero scale temperature of the Sensor range, and a 20 mA reading will correspond to full scale temperature. Equal increments of current will correspond to equal increments of temperature between these range limits.

Expressed mathematically, the indicated temperature, T, at any point in the range is:

$$T = \left(\frac{I-4}{16} \times (T_{F.S.} - T_{Z.S.}) \right) + T_{Z.S.}$$

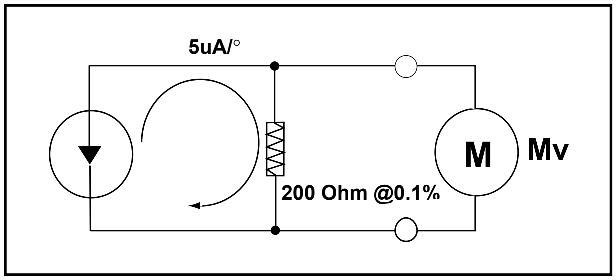


FIG. 4.7 – 1000 OHM RESISTOR

Example:
Assume the instrument range is 500 to 1100 °C. The current displayed by the 4 to 20 mA milliampmeter is 8 mA. To calculate temperature:

$$T = \left(\frac{8-4}{16} \times (1100 - 500) \right) + 500$$

$$= \frac{4}{16} \times 600 + 500$$

$$= 150 + 500$$

$$= 650°C$$

Resistor Example:
Use a 1000 Ohm resistor, as in Fig. 4.6 and Section 3.8 Analog Output.

Note: An example of the 5μA per degree Output, is shown on the next page.

LEGEND

T = Temperature in degrees

$T_{Z.S.}$ = Instrument zero scale temperature in degrees

$T_{F.S.}$ = Instrument full scale temperature in degrees

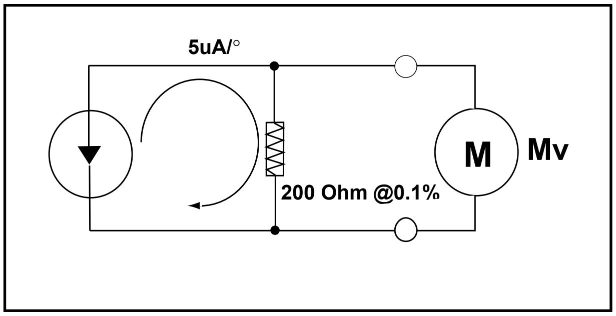


FIG. 4.8 – 200 OHM RESISTOR

Example for 5 uA per degree Output:
You have selected the 5 μA per degree Output, either Fahrenheit or Celsius, as an analog signal output. You will use a 200 Ohm @ 0.1% resistor, to create a millivolt per degree output, as in Fig. 4.7 and Section 3.8 Analog Output.

The 5μA per degree signal output has a ± 2° deviation from the displayed temperature and maximum millivolt range of 3999mV, hence can only be used with either Fahrenheit or Celsius temperatures up to 4000 °. The voltmeter you are using must be scaled the proper range. The accuracy of the meter you use will also effect the indication.

The tolerance of the resistor can alter the accuracy of the indication on the meter. Use a resistor with a tolerance of 0.1% or better. IRCON can supply a 200 Ohm @ 0.1% tolerance resistor, Part Number 514692.

Assume you are using a 32-24F10 System with a range of 1000 to 2400 °F (a span of 1400 °). The indicated temperature is 1200 °F. When you add a 200 Ohm load, as in the illustration, an output of 1200 millivolts may be used to drive a voltmeter.

Expressed mathematically:

μA out = 5μA · T

mV/° = μA out x 200 Ohm

mV/° = 1200mV

Note: The accuracy in this example is effected by the tolerance of the resistor used.

OPERATION NOTES:

1. Analog output range for the 0 to 20 mAdc, the 4 to 20 mAdc or 0 to 10 Vdc signal may be adjusted inside temperature span of a system. Use the Analog Zero and Analog Full menus to adjust the range, as in 4.15.

2. The Analog Signal Outputs are affected by the selected Response Time Value and by the Peak Picker and Track and Hold selections.

CHECKOUT OF OPERATION

1. Check the connection to the Analog Output Terminal 1 and 2. As described in Section 3.8. Check that the system power is on.

2. Turn on the Auxiliary Device that will track the Analog Output.

   Note: If you have watched the Auxiliary Device track the temperature and the Temperature Display track the temperature and if the readings do not match: you might check your paper work or do some troubleshooting.

3. Cover the lens. The output should go to 0 mA for the 0 to 20 mA output or to 4 mA for the 4 to 20 mA output or to 0 V for the 0-10V output.

   With the lens covered, the 5 μA per degree Output will go to a temperature that is 100 degrees below the zero scale temperature for the model sensing head being used. If however, 100 degrees below zero scale equals less than zero degrees the 5μA per degree Output will be set to 0μA.

4. Place a hot target in front of the lens and observe that the output tracks the temperature display.

Note: Any readjusting of the range adjustment for the Analog Zero scale and Analog Full scale menus, may effect these readings. Refer to section 4.15, if the ranges need to be reassigned.

Graphic Record
You may wish to make a Temperature Output graph on a piece of linear graph paper. That will give you a permanent graphic record of remote temperature readings.

Section 4 — OPERATION

4.22 AUXILIARY ANALOG INPUTS

DESCRIPTION

A user supplied control device may send an auxiliary analog 4 to 20 mAdc signal to the MODLINE 3 System AUX Terminals. The control device may be manually operated or it may be a process operated device.

Section 4.15 System Configuration details how to select: Emissivity, E-Slope, Set Point or None. Section 3.9 details how to wire the AUX Terminals.

Note: Auxiliary Input to Set Point is not used in a System Configured for No Controller functions.

4.23 SENSOR SERIES 3L AND 3R OPERATION

WARM-UP REQUIRED

Systems with either 3L or 3R Sensor series require warm-up time. The warm-up time is approximately 15 minutes for a sensor that is operating at 32 °F (0°C) ambient and somewhat shorter time for the sensor that is at a higher ambient temperature.

During the warm-up time, systems with 3R sensor Series will allow you to make temperature measurement, however, if accuracy is important measurement readings should be used after the warm-up period has expired.

Systems with 3L Sensor Series on the other hand will not allow you to make temperature measurement while the sensor is in warm-up period. During this time the 3L sensor will provide an Invalid Alarm causing all analog outputs to go below zero scale values and temperature display to flash alternately (--LO-- C°) and (----°C).

Similarly, if there is an occurrence of a brief power outage and is more than 1/4 second long, systems with 3L Sensor Series will go into warm-up mode as described above. However, the warm-up time in this case will only last for approximately 5 minutes. System with 3R Sensor Series will not be affected by the occurrence of a brief power outage.

After the warm-up period is over, you should observe from your system responses that are described below:

1. **WITHIN RANGE** — If the Sensor is viewing a temperature within the range of your system, the Indicator/ Processor will display a temperature value. Equivalent analog signals will be supplied to any devices you have connected to the analog outputs (e.g., recorder or remote indicator).

   NOTE: Because you have not yet adjusted the operating controls to match your process characteristics, the displayed temperature and analog outputs will not be a true representation of the target temperature.

2. **LO/HI ALARMS** — If measured temperature is below or above the range limits of your system, the LO and HI Alarms will be displayed on the temperature display (--LO-- C°) or (--HI--°C).

4. **INVALID** — An Invalid Alarm will activate for both sensor series 3R and 3L any time the infrared radiation reaching the sensor is considered to be inadequate for accurate temperature measurement.

   Additionally, sensor Series 3L will activate Invalid Alarm during the warm-up time, as mentioned earlier, and if the sensor is operated in an environment that causes the sensor to become overheated.

   if Invalid Alarm activates, all analog outputs will be forced to go below zero scale values and the Invalid Alarm relay output to trigger any external device you might have connected to the system.

   NOTE: During initial setup, because you have not yet tuned the system to your process, an Invalid Alarm is of no consequence.

4.24 SUMMARY NOTES

The setup procedure is complete, and the system should provide an accurate display of the temperature of any object in the Sensor's field of view. Any auxiliary equipment you have connected to the Indicator/Processor outputs will respond to the measured temperature values.

Review the following operating notes to familiarize yourself with the system operation.

1. The system should measure process temperatures viewed by the Sensor. Response changes in this temperature will depend on the Response Time you have selected. For the Peak Picker option, the rate of decrease of the indicated temperature is governed by the Decay Rate selected.

2. During start-up routines, observe measured temperature very closely to make sure you are getting the right action. If necessary, fine tune your adjustment range, and refer to Section 7 for applications guidance.

3. Always allow time for the display to settle when making your readings. Settling time depends on the Response Time you selected.

   Note: Response time also affects the input to a controller, if included in your instrument, and affects standard or optional outputs.

4. To maintain system accuracy, be sure to perform maintenance routines on a regular basis. For Series Sensors 340, 600, 700, and 800 sensors: check calibration at regular intervals. Refer to Section 5 for more maintenance information.

5. *IMPORTANT:* An Invalid Alarm condition (Sensor Series 3L and 3R only), causes the controller output to go to 0% output and the Invalid Alarm relay to de-energize. Situations such as smoke or steam blocking the optical path may result in enough signal reduction to trigger an Invalid Alarm condition.

! CAUTION !

During an invalid alarm condition, you must take special care to avoid overheating your process. Take advantage of the Invalid Alarm relay closure, described in Section 3.13, to avoid overheating your process.

If these observations are satisfactory, you may start selecting menu functions and setting values.

Section 4C — OPERATION (ON-OFF CONTROLLER)

This section describes the setup and operating procedures for a MODLINE 3 On-Off Controller. It is supplementary to the general set-up and operating procedures for all MODLINE 3 Indicator/Processors, as described in Section 4. Perform the procedures in Section 4C after you have completed all appropriate procedures in Section 4.

Section 4C — OPERATION (ON-OFF CONTROLLER)

4C.1 DESCRIPTION

This section describes the On-Off Controller system menus and function. It then goes on to explain the set up of an On-Off Controller.

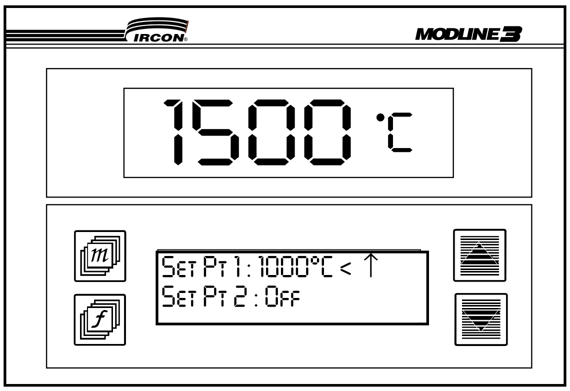


FIG.4C.1 - MODLINE 3 SYSTEM FRONT PANEL

Before you apply power to the Indicator / Processor or do any feature selection, take the time to familiarize yourself with Section 4 of this manual.

If you read Section 4, you have already learned how to make function and value selections from the menus. You can think of those as the standard system menus or the basic functions.

Secrtion 4C.2 takes you through the steps of how to set up and use the controller functions. Section 4C.3 shows you how to use the controller's Auxiliary Input, a feature that allows Set-Point #1 to be adjusted from an external source. Section 4C.4 provides a menu Flowchart for the On-Off controller.

4C.2 SELECTING THE ON-OFF CONTROLLER FUNCTIONS

Use the "m" button to reach the On-Off Controller menu. The words "On-Off Controller" are seen momentarily.

On/Off Controller

If no prior adjustements were made on the controller, display will show controller default settings:

Set Pt. 1: Off ◀
Set Pt. 2: Off

The words "Set Pt." stand for Set-Point and Numbers (1) and (2) refer to controller set point (#1) and set point (#2). The words "Off" appearing after set point 1 & 2 means that controller functions of both set points have been turned off. The flashing caret symbol (◀) is a pointer that shows which set point is currently selected for adjustment.

SET-POINT #1 ADJUSTMENT

The flashing caret symbol (◀) should be pointing at set point #1. If, however, it is pointing at set point #2, use the "f" button to move to set point #1. The "f" button is used to toggle between set point #1 and set point #2.

Use the increment/decrament keys "▼,▲" to select the temperature for your set point.

Set Pt. 1: 1000◀°C ↓
Set Pt. 2: Off

You will be able to adjust the set point temperature value anywhere within the instrument temperature span. (The temperature span and units of calibration is given by the instrument model number and is a default span of temperature adjustment for both set point #1 and set point #2.)

The downward facing arrow "↓" and the upward facing arrow "↑" are displayed as alert tags and are useful during set point temperature adjustment. The downward facing arrow "↓" appears if the indicated temperature is below the set point temperature value. See table 4C for details on switching conditions and relay actions.

The upward facing arrow "↑" appears, if the indicated temperature is above the set point temperature value. See section 4C for details on switching conditions and relay actions.

SELECTING SET POINT OFF

To select "Off", use the "▼" button to move to the lowest temperature allowed for the set point.

Set Pt 1: 1000◀°C ↑
Set Pt 2: 1000 °C ↑ (or) Set Pt 1: Off ↑
Set Pt 2: Off ↑

With the low temperature displayed; press the "▼" button once. The Set Point will go to "Off". Or just, hold down the "▼" button, until "Off" appears.

Section 4C — OPERATION (ON-OFF CONTROLLER)

If “Function : Off” is displayed; press the “ ▲ ” button once. You just changed it to “ On ” as the low temperature appears.

You may use an RS-485 OA or OB Command to turn Set Point 1 and 2 on and off.

SET POINT # 2 ADJUSTMENT

Use the “ *f* ” button to move to the set point #2. The blinking arrowhead moves to the second line to indicate Set Point #2 is capable of being changed.

Set Pt 1: 1000 ◀°C ↑
Set Pt 2: 1000 °C ↑

All other procedures for adjusting or using set point #2 are identical to the procedures that are outlined for set point #1.

4C.3 AUXILIARY OR EXTERNAL INPUT

You may adjust the Set Point #1 temperature value from an external source by sending a scaled current input signal of 4 to 20 mA to the AUX terminals or an RS-485 OA Command.

Use Section 4 to study how an Auxiliary or External Input signal can be used to set the Emissivity, E-Slope or a Set Point #1 value.

To enable the AUX terminals for Set Point setting, select “Aux In : Set Point” from the System Configuration menu, shown in Section 4.15.

Once you have selected external set point “Ext” appears in front of “Set Pt.” in the On/Off Controller menu.

AUX Connector Wiring

Instructions for wiring an external set point cable to the Indicator / Processor AUX Connector are given in Section 3C. The External Set Point control only acts on Set Point 1. Set Point 2 is always set manually from the Function Menu or RS-485.

Section 4C — OPERATION (ON-OFF CONTROLLER)

4C.4 FLOWCHART (On-Off Controller Menus)

The FLOWCHART shows the " *m* " and " *f* " button structure and it is not an exact function display replica.
The ▲ ▼ buttons do a function selection.

M Emissivity / E Slope
(Ext.) Value : 0.100 to 1.000 ▲▼
M Response Time
Value : 0.010 to 60 s ▲▼

M Peak Picker
F Function: On or Off ▲▼
F Decay : 0 to 1000 °F/s ▲▼
: 0 to 560 °C/s
F Manual Reset : ▲▼
F Auto Reset: On or Off ▲▼
F Rst. Below : 50 to 6500°F ▲▼
: 20 to 3500°C
F Peak Delay : Off ▲▼
: 0 .01 to 10.00s

M Track and Hold
F Function : On or Off ▲▼

M Security Access
F Panel : Locked< ▲▼
Open or Closed

M Calibration Check
F Cycle Cal : Off ▲▼

M On/Off Controller
F Set Pt1: 0 to 1000<°F ↑ ▲▼
Set Pt1: 0 to 560 °C ↑
Ext. SP1 : 1000
Set Pt1 : Off
F Set Pt2 : 0 to 1000<°F ↑ ▲▼
Set Pt2 : 0 to 560 °C ↑
Set Pt2 : Off

M System Configuration
F Model: XX - XXXXX

XX = Series (Example is 3R or 36.)
XXXXX = Model (Example is 14C05 .)

F Text : English ▲▼
: Francais or Deutsch

F Aux. In : Set Pt. ▲▼
: None
: Emiss. / E Slope

F Ana.Out : 0 - 20mA ▲▼
: 4 - 20mA ▲▼
: 5 uA / °F or °C ▲▼

F Ana. 0% : 50°/s F or C ▲▼

F Ana. 100% : 1000°/s F or C ▲▼

F RS 485 : Read - Only ▲
: Read / Write ▼

F Unit Address : 0 - 9, A - Z, A - Z ▲▼

F Baud Rate:
19200 ▲▼
9600
2400

F V 1.00

Section 4C — OPERATION (ON-OFF CONTROLLER)

4C.5 ON-OFF CONTROL

An On-Off Controller provides relay switching at some preset temperature. The temperature at which switching takes place is the Set Point. You control the switching temperature by adjusting the set point. This fundamental action is useful in just about any process that lends itself to "power-on and power-off" control modes.

The control relays can be used for a variety of functions, some examples are:

- Turn a heater on and off to control process temperature.
- Operate alarms when measured temperature reaches, exceeds or falls below the set point level.
- Operate sorting equipment to sort hot and cool workpieces.
- Activate process cycles according to the temperature of the material being processed.
- Activate equipment at selected temperatures in order to move workpieces in and out of heating zones.

The available Modline 3 On-Off Controller is a Two-Point controller. This type of controller provides independent contact switching at two different set points. For example, with a Two-Point controller, you can adjust one set point to provide the basic control action, and use the second set point as a low or high temperature alarm (in case measured temperature goes below or above the desired limits). Or you might use two set points to set up a temperature "window" with selected low and high limits. You rprocess equipment could move workpieces into a heating zone at one temperature (set point #1), hold them there until they reach a desired temperature (set point #2), then move them into the next zone. The range of applications is almost limitless!

4C.6 SWITCHING CHARACTERISTICS

The relay switching action is governed by two temperature limits or "rails" one degree above and below set point temperature. This two degree hysteresis band is designed into the controller to prevent relay chatter. Reason: If switching always occurred at a single level, the relay might continuously open and close, or "chatter", in some applications.

Fig. 4C.2 shows how the controller responds to measured process temperature variations. Process temperature is initially below set point, the relay is energized, and temperature is rising. When measured temperature reaches a point one degree above the Set Point temperature, the relay deenergizes and, for example, turns off a heater.

The process cools until the system senses that the temperature is one degree below the set point. Here the relay energizes again, the contacts close, and the heater turns on. This control action continues as long as the process is within the temperature range.

Conclusion: There is always approximately 2 °F or 2°C between the temperatures at which the relay energizes and deenergizes. This virtually eliminates any possibility of relay chatter.

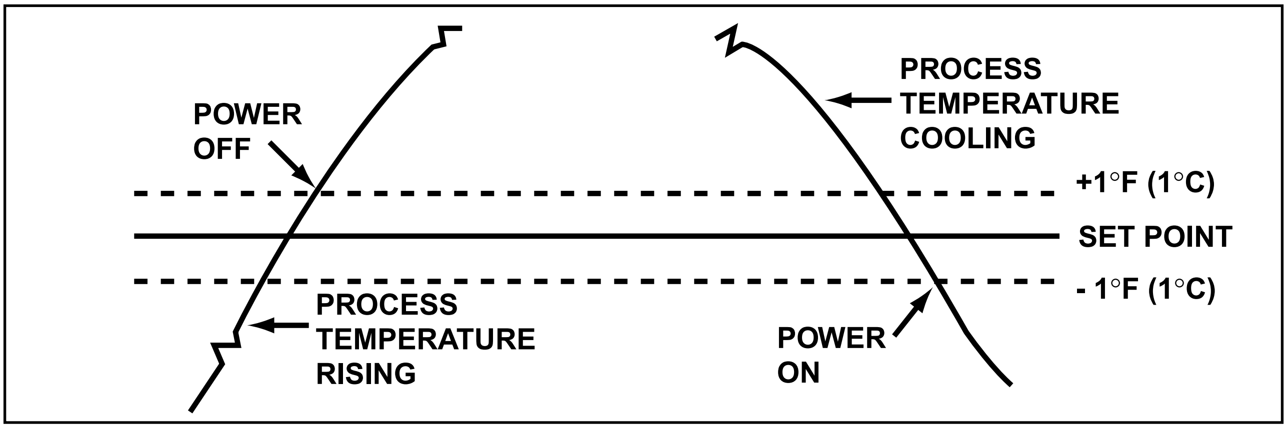


FIG. 4C.2 - ON-OFF CONTROLLER SWITCHING ACTION

4C.7 TEMPERATURE CONTROL

The On-Off Controller can be used to control the temperature of a heater. This type of temperature control is used primarily in lower power heaters, and in situations where the workpieces being heated can tolerate the heating and cooling cycles inherent in on-off controllers.

Fig. 4C.3 illustrates on-off control of a heater. The curves in this figure represent variations of process temperature as the controller turns the heater on and off.

Figs. 4C.3A and 4C.3B illustrate the cyclical nature of on-off temperature control. These curves also illustrate the "offset" between average process temperature (broken line) and set point temperature (solid line). If the power available is much greater than the power required to heat the workpiece to set point temperature, the average process temperature will be above set point as in Fig. 4C.3A. If the available power-to-required power ratio is low, it takes longer for the workpiece to reach set point and the average process temperature is below set point as in Fig.4C.3 B. Offset is minimized by scaling available power as nearly as possible to the process requirements.

4C.8 ON-OFF CONTROL SUMMARY

Assume that the Set Point 1 has been established, the power to the MODLINE 3 System is on, and the Sensor is viewing a cool target (i.e. below zero scale indication on temperature display).

The relays will be energized, so the contacts between Terminal 1 and Terminal 2 will be closed.

When the indicated temperature reaches a value one degree above the set point the relay will de-energize, contact 1-2 will open, contact 2-3 will close. Power will be removed from the load.

As the load cools the indicated temperature will decrease and as it reaches a point one degree below the set point the relay will re-energize, contact 1-3 will open, contact 1-2 will close and power will again be applied to the load.

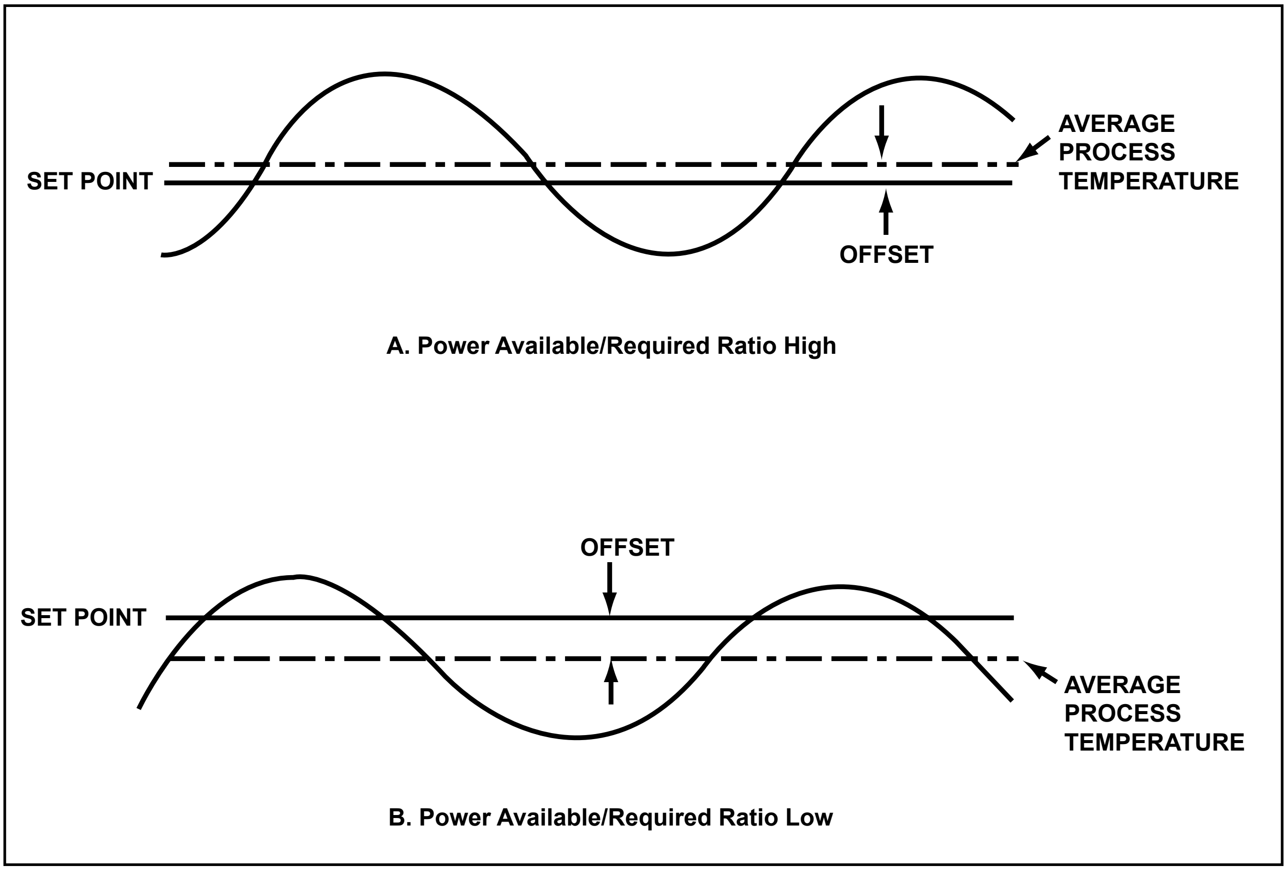


FIG. 4C.3 - ON-OFF CONTROL OF HEATER

Section 4C — OPERATION (ON-OFF CONTROLLER)

These basic actions are summarized in the Table 4C.1.

The relays are held in position by current conduction when the indicated temperature is below set point. If power to the controller or one of its components should fail, the relays will be released and they will remain in the over-temperature state, removing power from the load.

It you are operating on External Set Point 1 and your external circuit opens, then Set Point 1 will indicate over-temperature all the time and the " ↑" over-temperature indicator stays on the Function Display.

MODLINE 3 POWER	MEASURED TEMPERATURE	RELAY 1		RELAY 2	
		1 - 2	2 - 3	4 - 5	5 - 6
Off	—	Closed	Open	Closed	Open
On	Above Set Point	Closed	Open	Closed	Open
On	Below Set Point	Open	Closed	Open	Closed
On	Controller Off	Closed	Open	Closed	Open

TABLE 4C. 1 SUMMARY OF STANDARD MODLINE 3 ON-OFF CONTROL ACTION

4C.9 SUMMARY NOTES

Once you have adjusted the set points for your process requirements, the controller will compare measured temperatures with set point temperatures and provide relay switching based on these comparisons.

The following operating notes apply to the On-Off Controller.

1. The set point temperature can be displayed in the On-Off Controller menu by your using the " *m* " but ton and " *f* " button to select Set Point menu .

2. Controller action is affected by the Response Time selected, and by Peak Picker Decay Rate (if pre sent). It is also subject to special Indicator / Processor conditions, such as Out of Range (Digital Temperature Display) and Invalid Alarm (Sensor Series 3L and 3R only).

4. It is important to note that the controller simply turns the heater full-on or full-off according to the process temperature observed by the Sensor. How the process temperature will respond to this control action depends on the dynamics of the entire system (power available; etc.). This varies considerably from application to application, and will undoubtedly require careful observation when you place the system in operation.

5. See Section 3C for relay connection and the relay limits.

Section 4P — OPERATION (PID CONTROLLER)

This section describes the setup and operating procedures for a MODLINE 3 PID Controller. It is supplementary to the general set-up and operating procedures for all MODLINE 3 Indicator / Processors, as described in Section 4. Perform the procedures in Section 4P after you have completed all appropriate procedures in Section 4.

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Section 4P — OPERATION PID CONTROLLER

4P.1 GENERAL DESCRIPTION

The MODLINE 3 PID Controller is used to provide smooth efficient temperature control. It automatically seeks to overcome the effects of system upsets and to stabilize a process at a desired set point temperature. The MODLINE 3 Controller features and/or functions are displayed on the Function Display and are accessed through the front panel of Indicator / Processor as shown in Fig. 4P.1 or through a digital command as described in Section 8 Digital Communications.

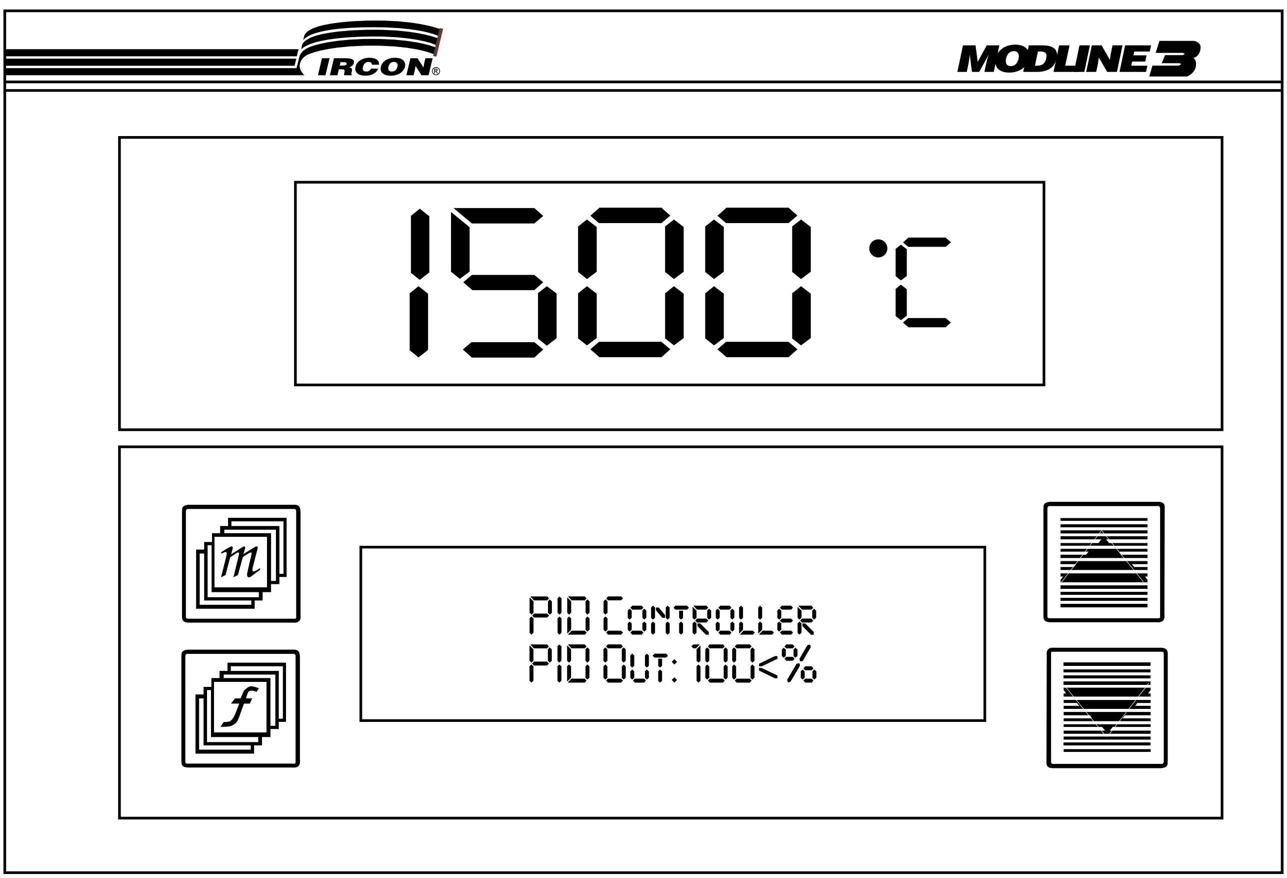


FIG.4P.1 - MODLINE 3 FRONT PANEL FOR PID CONTROLLERS

Section 4P — OPERATION PID CONTROLLER

4P.2 PROCESS CONTROL SYSTEM

A process control system as discussed in this manual is a complete Closed Loop Temperature Control System as illustrated in Fig. 4P.2. While closed loop systems may be discussed more generally, we will be concerned solely with the control of temperature utilizing the MODLINE 3 PID Controller.

The workpiece is viewed by a MODLINE 3 Sensor, and an electrical signal proportional to the temperature of the workpiece is generated. This Process Temperature Signal is sent to the input of the controller. A desired process temperature is set into the controller by the Set Point Function. The controller compares the process temperature signal to the Set Point Temperature signal, the difference between these values being the deviation.

An output current is developed in the controller proportional to this deviation. The current values are low and are in the range of 4 to 20 milliamperes. These controller output currents are used to control a high level Power Controller.

This Power Controller may be in the form of an SCR Controller, a Saturable Core Reactor, a Motor Speed Controller or the like. The essential feature of this controller is that from a very low input control current (5 mAdc) it varies great amounts of power, perhaps millions of watts. As an example an SCR power controller is able to vary power to the Controlled Element from 0 power to full scale power of 480 volts and 500 amperes.

The controlled element transforms this power into heat in the workpiece, raising its temperature. The controlled element may be an induction heater, calrod heaters, infrared lamps, a current transformer for resistance heating of the workpiece, or the like, depending upon the requirements of the process and the nature of the workpiece.

If disturbances occur anywhere in the closed loop they will be compensated for by the controller. As an example consider that the workpiece is heavier, requiring more power to keep it at Set Point Temperature. The Sensor will measure a decreasing temperature, the deviation will increase, the output of the controller will increase and the power controller will increase the current to the controlled element, raising the process temperature to Set Point Temperature.

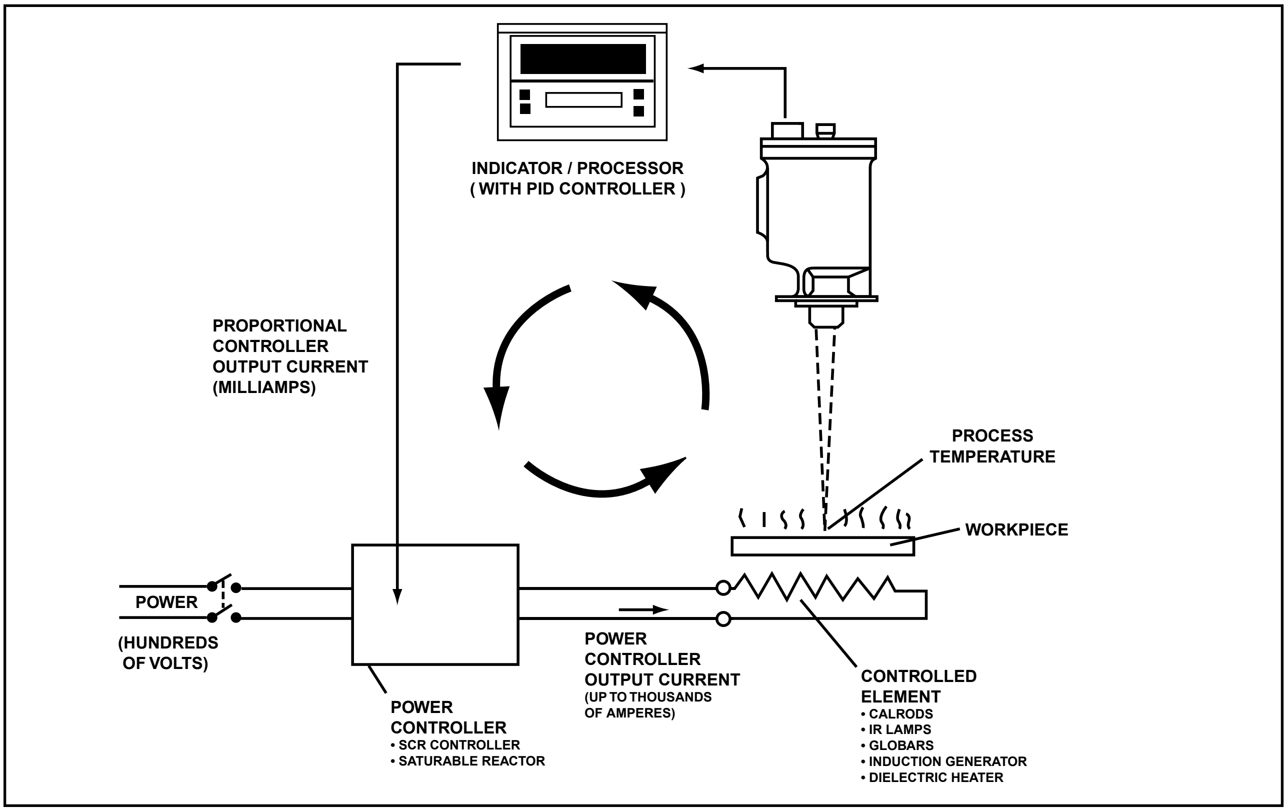


FIG. 4P.2 - CLOSED LOOP TEMPERATURE CONTROL SYSTEM

Similar disturbances might be changes in ambient temperature surrounding the workpiece, coupling of the controlled element to the workpiece, variations in power line voltage and the like. All disturbances within the loop will be removed by control action.

4P.3 CONTROLLER TYPE

MODLINE 3 Proportional Controller, as described , is a Current Adjusting Type **(CAT)** and since it is a controller with Proportional **(P)**, Reset **(I)** and Rate **(D)** actions it is also, as it is commonly called, 3 Mode PID Controller.

The PID Control Equation, describes the MODLINE 3 PID Controller:

The equation key:

$$m(t) = \overline{m} \cdot \frac{100}{PB} \cdot e(t) + \int \frac{RS \cdot 100}{PB} \cdot e(t)\, dt + \frac{RT \cdot 100}{PB} \cdot \frac{de(t)}{dt}$$

e(t)	=	Error in percent of band
m(t)	=	Controller Output
$\overline{m}$	=	Controller Output when e(t) = 0
PB	=	Proportional Band in percent
RS	=	Reset in repeats per minute
RT	=	Rate Time in minutes

4P.4 KEY FEATURES

Automatic and Manual Mode of Operation:

Automatic Mode

The MODLINE 3 PID Controller is normally operated in the Automatic Mode. In this mode, the controller through the action of (P), (I) and (D) control parameters, automatically and continuously adjusts its output to compensate for any process disturbances and maintains the process at desired set point temperature.

Manual Mode

Manual Mode on the other hand, provides a constant output that is only related to the manually adjusted value for the controller output. This feature is useful when for example a batch process under control is finished and you may want to idle your power controller at some reduced power level between parts. Another application for this feature would be on a process where little or no overshoot is allowed. In this case and in order to avoid a large swing in power by trying to control from cold to the set point temperature, process can be brought close to the set point using manual setting for the controller output and then to switch over to the Automatic Mode for the final control.

External Set Point Adjustment

Internal input for the controller set point temperature is provided by the Indicator / Processor and it is accessed through the MODLINE 3 front panel or through a digital command from an RS-485 interface.

Set point can also be adjusted from an external (4 to 20mAdc) current input. The current input is scaled such that a input of 4 mA adjusts the set point to the zero scale temperature while a input of 20mA adjusts the set point to the full scale temperature of MODLINE 3 system range. True linear relationship exists between current input and temperature throughout the span of the adjustment.

The default input for controller set point adjustment is “Internal”. External set point input can be selected, instead of Internal input, from the MODLINE 3 System Configuration Menu, see Section 4.15 for details. The 4 to 20mA input is applied at AUX. IN terminals 1 and 2 at the rear panel of Indicator / Processor, see Fig. 3.10.

Auto Tune

The Auto Tune feature from the MODLINE 3 PID Controller, automatically determines the (P), (I) and (D) control parameters. The controller performs this task by using a modified version of Ziegler - Nichols on-line controller tuning technique.

4P.4 KEY FEATURES (Continued)

The auto tuning technique basically forces the

Section 4P — OPERATION PID CONTROLLER

process under control to go 4 degrees above and 4 degrees below the selected set point temperature. Parameters (PB_μ) and (T_μ) are derived from the observed process cycle time and temperature overshoot.

The derived parameters (PB_μ) and (T_μ) are converted to the control parameters in the following manner:

Proportional Band	(P)	$= 3 \cdot (PB_\mu)$
Reset	(I)	$= 2 / (T_\mu)$
Rate Time	(D)	$= (T_\mu) / 3$

Once the tuning cycle is over, the established control parameters are inputted automatically into the controller and are used from there after in the automatic control of process temperature.

Anti-Reset Windup

The MODLINE 3 PID Controller has a built in Anti-Reset Windup. This is a feature that helps minimize temperature overshoot, normally experienced in temperature control during a process startup.

The Anti-Reset Windup delays the start of Reset action until the process temperature is close enough to the set point to initiate Proportional action and start reducing the output from 100 % level. This prevents Reset action from saturating the controller output and causing a gross temperature overshoot. A typical response out of a controller without this feature and on a process with slow warm-up time.

The Anti-Reset Windup will perform well in most controller applications and provide minimum amount of temperature overshoot. If, however, even relatively small startup overshoot cannot be tolerated, it is recommended that the process be brought manually very close to the set point temperature and then switched to Automatic mode of operation.

Bumpless Transfer

The Bumpless Transfer is a function that acts on the PID Controller output during its mode of operation transition: from Automatic to Manual.

When Bumpless Transfer function is enabled, the last PID Controller output value established while operating in controller Automatic Mode, will be transferred on to the controller output value operating in the Manual Mode.

The Bumpless Transfer function is useful for example on a batch process where you may like to maintain the same power level out of your heater in between workpieces and avoid overdriving the heater.

Deviation Alarms

This is a controller feature that provides alarm outputs, both visual and electrical. The alarm outputs can be used to announce that a process temperature has deviated from its control set point and in magnitude that is outside some allowed limits.

The visual alarms, representing appropriate alarm conditions, appear on the Function Display of the Indicator / Processor and are in a form of a flashing words: “HI ALARM” and “LO ALARM”.

The electrical alarms consist of two form C Relay Outputs. One relay output for the “HI ALARM” and one for the “LO ALARM”.

The Alarm Set Points are assigned directly in degrees temperature and in the desired magnitude above and below the controller set point temperature.

Example:
Set point temperature for the controller is 1300 °F, the HI alarm set point is set to 20 °F and LO alarm set point is set to 25°F, the following will take place at the alarm outputs.

If process temperature goes above1320 °F, HI alarm will activate.

If process temperature goes below 1275 °F, LO alarm will activate.

If process temperature is between 1275 and 1320°F, no alarms will be activated.

Controller Function Summary

All other features are described in the Table 4P.1 Controller Function Summary.

Table 4P.1. PID Controller Function Summary (Continued)

Controller Function	Function Variable	Controller Operation
Mode:	Off	Controller Output is Off, other controller parameters are available for selection, adjustment or review.
	Auto	Controller Output is On and it is proportional to the error signal and as it's influenced by the action of controller (P) parameter and if turned On, by the (I) and (D) parameters.
	Manual	Controller Output is On and can be manually varied from 0% to 100% of its range. *Note:* The controller output in this mode is only influenced by the manually selected % of output setting and not by the error signal or (P), (I) and (D) controller parameters.
Set Point:	XXXX < °F or C	Assigns controller Set Point Temperature from the front panel of Indicator / Processor or through digital command.
Ext. Set Pt:	XXXX °F or C	Assigns controller Set Point Temperature from an external analog input (4 to 20mAdc).
0% [[][][][][][][][][][]] 100% PID Out: 0.0 %	Controller Mode: Off	Percent of Controller Output Bar-Graph is not illuminated and PID Out: shows 0.0%.
0% [███[][][][][][][]]100% PID Out : 30< %	Controller Mode: Auto	Segments of Bar-Graph are illuminated proportionally to the value of Controller Output and the PID Out: shows that same value numerically.
0% [█████[][][][][]]100% PID Out : 50< %	Controller Mode: Manual	Segments of Bar-Graph are illuminated proportionally to the manually adjusted value of Controller Output and the PID Out: shows that same value numerically.

Section 4P — OPERATION PID CONTROLLER

Table 4P.1. PID Controller Function Summary (Continued)

Controller Function	Function Variable	Controller Operation
Bumpless Xfer:	On	Transfers controller output value obtained while operating controller in Automatic mode to the controller output value operating in Manual mode.
	Off	Disables the Bumpless transfer function.
(P) P. Band:	Adj. Range: 0.1 - 200.0<%	Proportional Band Parameter, expressed in percent of controller temperature span over which controller output has proportioning action.
(I) Rst:	Adj. Range: 0.1 - 99. 00<R/mn with Off position	Reset Parameter, expressed in repeats per minute is a signal that continuously integrates any droop that exists, and produces an output of amplitude and polarity that will cancel that droop automatically.
	Off	Disables the Reset Parameter
(D) Rate:	Adj. Range: 0. 00 - 9. 900<mn with Off position	Rate, a Derivative Parameter, expressed in minutes is a controller action that determines the rate at which any deviation in control is changing and predicts what the deviation will be one “Rate Time” later.
	Off	Disables the Reset Parameter
Load Demand:	Adj. Range: 0 - 100<%	Load Demand Parameter, expressed in percent of controller output, is the percentage of maximum controller output signal needed to maintain process at set point. Note: This parameter is typically used when 3 mode - PID Controller is operated as a 1 mode - PID Controller (Reset & Rate turned Off).

Table 4P.1. PID Controller Function Summary (Continued)		
Controller Function	**Function Variable**	**Controller Operation**
Auto Tune	On	Controller Parameters (P), (I) and (D) are automatically determined and set to use by starting a sequence that forces the process, under control, to cycle in a band that is 1% above and below the desired set point temperature. Appropriate parameter values for that process are then derived from the observed process cycle time, overshoot and through the usage of special algorithms.
	Off	Auto Tune Function is disabled or the "Auto Tuning Cycle" is completed and control parameters were determined and are set to use.
HI Alarm:	XXXX< °F or C with Off position	"HI Alarm" flashes and HI Alarm-Relay output (RL1) changes its state when high alarm set point is exceeded. High alarm set point is in degrees temperature and is set above the controller set point temperature.
LO Alarm:	XXXX< °F or C with Off position	"LO Alarm" flashes and LO Alarm-Relay output (RL2) changes its state when low alarm set point is exceeded. Low alarm set point is in degrees temperature and is set below the controller set point temperature.

Section 4P — OPERATION PID CONTROLLER

4P.5 GENERAL SYSTEM INSTALLATION CHECK

Before you begin to use the MODLINE 3 PID Controller for control of your process temperature, make certain that MODLINE 3 Thermometer System is installed properly. In particular, make certain that the Sensing Head is securely mounted to a permanent structure and that it has a full and uninterrupted view of the target and/or process area you intend to control.

Additionally, check and make sure that you have adjusted the MODLINE 3 Emissivity to a value appropriate for your process. Also, adjust the Response Time control so that the system response is slowed down enough to ignore sporadic process temperatures and yet, fast enough to follow process temperature trends.

4P.6 CONTROLLER OUTPUT PRELIMINARY TESTS

CAUTION

Before starting, make sure that the mains feeding your power controller are turned off or disconnected.

Perform these few tests to first, verify that wiring and the scaling between the MODLINE 3 Controller output and your power controller input is correct and functioning properly. And second, to verify that your system-power output is correctly matched for process you intend to control.

PREPARATION

Equipment required: Strip Chart Recorder, Digital Voltage / Current Meter.

Connect a strip chart recorder with a 0 to 20 mA dc or 4 to 20 mA dc input range to terminals 1 and 2 of the Analog Output connector located on the MODLINE 3 Indicator / Processor. Select a chart speed suitable for the response time of your process, and set up the recorder for operation.

Install a current meter in series to the MODLINE 3 PID Controller Output. The meter should be capable of reading current in the range of 4 to 20 mAdc.

4P. 7 Procedure 1 (MODLINE 3 PID Controller — Preliminary Settings)

The following procedure is for setting up MODLINE 3 with parameters that are related to temperature measurement, selection of input for controller set point and its value assignment, and selection of analog output suitable for driving a chart recorder that will be used later in the procedure.

START

PID Controller Mode : Off	use **“m”** button to scroll to **PID Controller Menu** use **Up Arrow** button to select **Off**
step 2 ↓	
Emissivity Value : 1.000	use **“m”** button to scroll to **Emissivity Menu** use **Up** or **Down Arrow** buttons to select **Emissivity Value** suitable for your process
step 3 ↓	
Response Time Value : 0.40 s	use **“m”** button to scroll to **Response Time Menu** use **Up** or **Down Arrow** buttons to select **Response Time Value** suitable for your process
step 4 ↓	
Peak Picker Function : Off	use **“m”** button to scroll to **Peak Picker Menu** use **Down Arrow** button to select **Off**
step 5 ↓	
Track and Hold Function : Off	use **“m”** button to scroll to **Track and Hold** use **Down Arrow** button to select **Off**
step 6 ↓	(if you plan on using external set point input)
System ConfiguratIon Aux. In : Set Pt.	use **“m”** button to scroll to **System Configuration** use **“f”** button to scroll to **Aux. In** use **Up** or **Down Arrow** buttons to select **Set Pt.**
step 7 ↓	
System Configuration Ana. Out :4 to 20 mA	use **" f "** button to scroll to **Ana. Out**: use **Up** or **Down Arrow** buttons to select **0 to 20** or **4 to 20mA**

Section 4P — OPERATION PID CONTROLLER

4P. 8 Procedure 2 (MODLINE 3 PID Controller — Test Settings)

The following procedure is for setting up parameters for MODLINE 3 PID Controller, prior to testing its operation.

START	
PID Controller Set Point : 1300	use **" m "** button to scroll to **PID Controller Menu** use **" f "** button to scroll to **Set Point** use **Up** and **Down Arrow** button to select desired **Set Point** temperature or if you are using External Set Point, input temperature equivalent 4 to 20 mA signal
step 2	
PID Controller Bumpless Xfer : Off	use **" f"** button to scroll to **Bumpless Xfer:** use **Down Arrow** button to select **Off**
step 3	
PID Controller (I) Rst : 0.01 R / mn	use **" f "** button to scroll to **(I) Rst:** use **Up Arrow** button to select any value other than **Off**
step 4	
PID Controller (D) Rate : 0.001mn	use **" f "** button to scroll to **(D) Rate:** use **Up Arrow** button to select any value other than **Off**
step 5	
HI Alarm : 20 LO Alarm : 20	use " f " button to scroll to **HI** and **LO Alarm Menu** use **Up** and **Down Arrow** button to first select **HI Alarm** value then to select **LO Alarm** value

4P. 9 Procedure 3 (MODLINE 3 PID Controller — Interface Test)

The following procedure is for verifying that wiring and scaling between MODLINE 3 PID Controller output and your power controller input is correct and functioning properly.

CAUTION

Before starting, make sure that the mains feeding your power controller are turned off or disconnected.

During this procedure you will manually and in several steps, adjust the output from MODLINE 3 PID Controller to the following values : 0, 50 and 100. These values represent percentage of controller overall output-span, i.e., 0% = 4 mA, 50% = 12 mA and 100% = 20 mA.

Each time you will be asked to observe the reading on your current meter or on the MODLINE 3 Function Display. Also, you will be asked to observe the reaction of your power controller to the input from the MODLINE 3 PID Controller.

If you have not already connected a current meter in series with the output of MODLINE 3 PID Controller and the interface card of your power controller, please connect it now.

We are now ready to begin.

START

Display	Action
PID Controller Mode : Manual	use **" m "** button to scroll to **PID Controller Menu** use **Down Arrow** button to select **Manual**
step 2 ↓	
0% [▯▯▯▯▯▯▯▯▯▯▯▯]100% PID Out : 0< %	use **" f "** button to scroll to **Controller Output Graphic** / **PID Out :** use **Down Arrow** button to select **PID Out : 0< %**

Step 3 is on the next page.

The current that you should be measuring at this point and from the output of MODLINE 3 PID Controller, is 4mA. Also, the controller output bar-graph should not have any segments illuminated and the PID Out: should indicate zero (0). Normal reaction of your power controller to this input should be to call for 0% of power output.

If you are reading something grossly different, make sure that you have adjusted the PID Out: to a value of zero (0). If this does not resolve the problem, turn off power and recheck your connections.

If your power controller is asking for more then 0% power output, check its 4 to 20 mA input scaling.

(Procedure 3 continues on the next page.)

Section 4P — OPERATION PID CONTROLLER

4P. 9 Procedure 3 - Continued

step 3

```
0% [█████[][][][][] ]100%
PID Out : 50< %
```

use **Up** and **Down Arrow** button to select **PID Out: 50< %**

If everything is functioning properly, MODLINE 3 PID Controller Output will be outputting 12 mA and the MODLINE 3 Function Display will show five (5) graph bars illuminated and PID OUT: will show 50%. More significantly, your power controller should be asking for 50 % of available power.

step 4

```
0% [██████████]100%
PID Out : 100< %
```

end

use **Up** and **Down Arrow** button to select **PID Out: 100< %**

Accordingly, MODLINE 3 PID Controller Output will be outputting 20 mA and the MODLINE 3 Function Display will show ten (10) graph bars illuminated and PID OUT: will show 100%. Your power controller should be asking for 100 % of available power.

Assuming that your observations are in agreement with the above outline, the procedure for verifying that the wiring and scaling between MODLINE 3 PID Controller and your power controller is correct and functioning properly, is now over. Using the Down Arrow button adjust down the PID Out : so that it reads 0% and you are ready go to the next step.

If however, there is some disagreement, the problem must be isolated and resolved before you go to the next step.

4P. 10 Procedure 4 (Establishing Process — Load Demand Characteristics)

The following procedure is for verifying that your systems power output is correctly matched to the process requirements and that it is capable of providing control that you expect.

During this procedure and once again, you will manually and in several steps, adjust the output from the MODLINE 3 PID Controller. This time, however, the mains supplying your power controller will be switched on.

You will observe and remark on the relationship between MODLINE 3 PID Controller output and the attained process temperature. From this data you will plot a curve that you will compare to the sample curves that are given in Fig. 4P.3 and determine how well your power output matches your process require - ments.

If you have not already connected a chart recorder to the Analog Output of MODLINE 3 System, please connect it now.

We are now ready to begin.

The MODLINE 3 PID Controller settings, if left undisturbed from previous step, should be in the Manual Mode of operation and PID Out: should be at 0%. Verify these settings and if you find that they are different, make changes using steps shown below.

START

Display	Action
PID Controller Mode : Manual	use **" m "** button to scroll to **PID Controller Menu** use **Down Arrow** button to select **Manual**

step 2

↓

Display	Action
0% [▯▯▯▯▯▯▯▯▯▯▯▯]100% PID Out : 0< %	use **" f "** button to scroll to Controller Output Graphic / PID Out: use **Down Arrow** button to select **PID Out : 0< %**

Step 3 of Procedure 4 Establishng Process is on the next page.

Section 4P — OPERATION PID CONTROLLER

CAUTION

You are about to switch on your power controller and ultimately, apply heat to your process. Be alert for any signs of malfunction and ready to switch it off if necessary.

4P.10 Procedure 4 (Continued)

3. Turn on the mains feeding your power controller.

4. Using the Up Arrow button, gradually increase the value of the " PID Out : ", until you see process temperature indication on the MODLINE 3 temperature display or on your chart recorder.

   Allow the temperature reading to stabilize, then record the % value of "PID Out : " and the attained process temperature reading.

5. Select two other values for "PID Out : ", one near midrange and one near the high end of the range. After temperature stabilizes at each setting, record % value of "PID Out :" and the attained process temperature.

6. Plot % value of "PID Out : " vs Process Temperature. This represents the Load Demand curve of your process. Sample Load Demand curves are shown in Fig. 4P.3.

   The significance of each curve shape is described. Compare your Load Demand curve with those shown, and take any steps necessary to improve it before proceeding to the control parameter settings.

   Note: If you make any changes, cool the process and repeat the test sequence.

   If the results are satisfactory, proceed with your control parameter settings.

4P.11 CONTROL PARAMETERS

Control parameters are required to varying degrees in different processes. For instance, every process requires a different amount of control power, has different thermal conductivity lags, etc.

The following brief descriptions will acquaint you with the these control parameters before you get into the adjustment procedures.

Proportional Band (P)

The percentage of controller temperature span over which the controlled output signal varies from 0% to 100% of its maximum value. Correct setting of this parameter allows the controller to line out at some average temperature that differs from set point temperature by minimum "droop".

Reset (I)

A signal which adds to or subtracts from set point to remove droop from the Proportional Band. In a Three-Mode Controller, a reset circuit continuously integrates any droop that exists, and produces an output of amplitude and polarity that will cancel the droop automatically.

Rate (D)

A derivative action in the Three-Mode Controller which determines the rate at which any deviation in control is changing and predicts what the deviation will be at one "rate time" later. This allows the controller to "plan ahead" and compensate for this projected value.

Load Demand

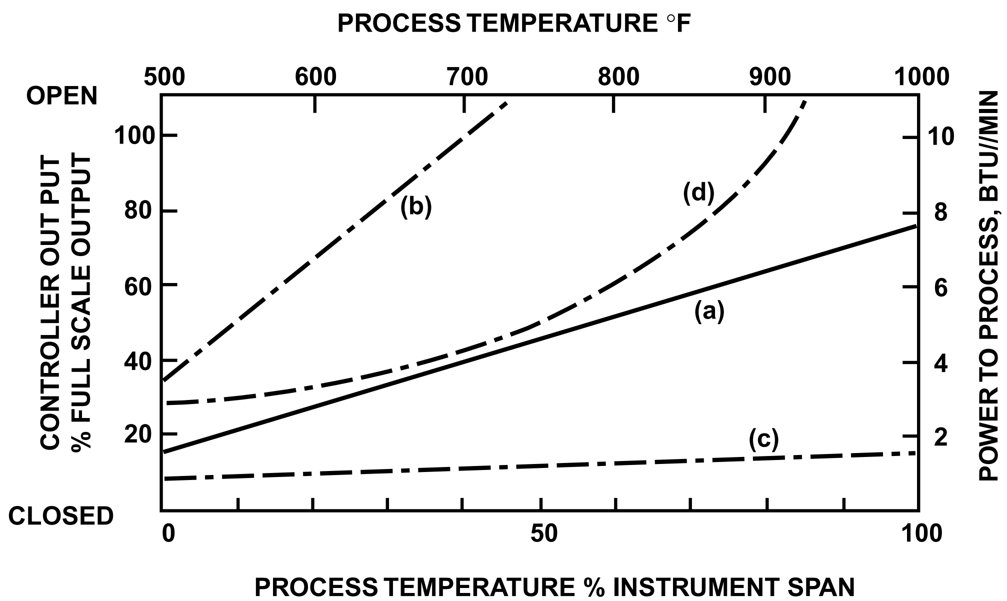
The percentage of maximum controller output signal needed to maintain process at set point. You will find it helpful to use this control parameter if you operate the MODLINE 3 PID Controller only as a Proportional Controller (Reset and Rate parameters turned off).

You will set up your controller in a series of steps that will allow you to take fullest advantage of any parameters it includes, and thus provide the smoothest, most efficient control possible. Follow the instructions carefully to prevent any over-adjustment or under-adjustment that will interfere with operation.

4P.12 LOAD DEMAND

Load Demand is the percentage of maximum controller output signal needed to maintain your process at set point. The Load Demand feature allows you to manually specify the Load demand of your process at the set point temperature. You will want to adjust this parameter as a first step in setting up your controller.

Note: Auto Tune mode does not assign a value to the Load Demand parameter; because, PID control uses Reset action to adjust for the Load Demand of the process. If the Reset action is not being used, and Reset Off is selected, it is particularly important to test your process and set the Load Demand for the appropriate value.



SIGNIFICATION OF LOAD DEMAND CURVE SHAPES

Load Demand Curve (a): The power to the system is well scaled. Response of Temperature versus Power is fairly linear and there is power in reserve for load or other external changes.

Load Demand Curve (b): The system is underpowered; even with full scale application of power you cannot achieve full scale temperature.

Make sure that your final controller is working properly. Perhaps one or more phases of a three phase controller are improperly connected, load coupling from an induction heater is improper, infrared heaters are misaligned, or the like.

It is also possible that you have low temperature indications from the workpiece because the Sensor is not correctly viewing the workpiece, there is a physical obstruction, the E Factor setting is incorrect, or some similar problem.

Load Demand Curve (c): The system is overpowered and it will be is difficult to achieve good control. Power to the power controller or controlled element should be reduced.

Load Demand Curve (d): The process is nonlinear. Control settings should be made at a temperature where the change in temperature with increase in power is high (system gain is high). It control constants are set at a temperature where system gain is low, and then set point is changed, instability may result.

FIG. 4P.3 - PROCESS LOAD DEMAND CHARACTERISTICS

4P.13 HOW TO OBTAIN CONTROL PARAMETERS

Control parameters that will produce desired control results for most process-control applications, can be acquired automatically by using the Auto Tune feature found on the MODLINE 3 PID Controller.

The Auto Tune, as described in Section 4P.1, automatically determines the (P), (I) and (D) control parameters. The controller performs this task by forcing the process which it controls, to cycle 1% above and 1% below the control set point temperature. It then determines the control parameters from the observed process cycle time, temperature overshoot and usage of special algorithms.

Once the tuning cycle is over, the established control parameters are inputted automatically into the controller and are from there on, used in the automatic control of your process temperature.

4P.14 USING THE AUTO TUNE

Before you begin using Auto Tune please take a note of the following:

- The Auto Tune function may be activated at any time, regardless of whether the process is hot or cool, or whether the Controller Mode of operation is Manual, Auto or even Off.
- Once the Auto Tune tests are finished, controller is automatically placed in the Auto control mode.
- The Auto Tune test cycle, can be aborted manually by turning the Auto Tune function Off.
- Aborting the Auto Tune while still in a test cycle, preserves the original (PID) control parameters.
- During Auto Tune test cycle, (PID) control parameters can not be changed.
- Once the Auto Tune test cycle is completed, the (PID) control parameters can be modified.

Auto Tune Procedure

Before you activate the Auto Tune function take a moment to recheck your settings for the Emissivity and Response Time parameters and make sure that they are appropriate for your process.

If you are using a Peak Picker or Track and Hold functions, disable them during the Auto Tune cycle. You may add these functions after the Auto Tune cycle, however, with full cognizance of what each function may do to the temperature indication and/or controller input.

The step-by-step Procedure for the Auto tune Procedure is on the next page.

4P.14 PROCEDURE 5 (MODLINE 3 PID Controller—Auto Tune)

START	Use **“ m ”** button to scroll to **PID Controller Menu.**
PID Controller Set Point : 1300	Use **“ f ”** button to scroll to **Set Point Menu.**
step 2	Use **Up** or **Down Arrow** buttons to select the desired Set Point temperature, if you are using External Set Point, input temperature equivalent 4 to 2O mA signal.
PID Controller Auto Tune : On	Use **“ f ”** button to scroll to **Auto Tune Menu.** Use the **Up Arrow** button to select “Auto Tune : On”.
step 3	The Auto Tune function is activated and will now begin to test your process. After some period, Auto Tune will determine optimum (PID) controller settings and begin to use them for control of your process. After the Auto Tune Cycle is completed the menu will display **“**Auto Tune : Off **”**. The length of time that Auto Tune takes to arrive at these settings is greatly dependent on the dynamics of your process. A process that heats and cools fast will have a short period of Auto Tuning and similarly, a process that heats or cools slowly, will require a longer period for Auto Tuning. Finally, the Auto Tune derived (P), (I) and (D) control parameters will in most process control applications, provide the best control performance possible. If; however, in your application these parameters prove to be inadequate, you may change them to fit your requirements.
PID Controller (P) P.Band : 0.1<%	If you wish, use **“ f ”** button to scroll to the **(P) P. Band : Menu** to view the automatically determined (P) control parameter. If you wish, use the **Up Arrow** button or the **Down Arrow** button to select any other value.
step 4	
PID Controller (I) Rst : 0.01R/mn	If you wish, use **“ f ”** button to scroll to the **(I) Rst : Menu** to view the automatically determined (I) control parameters. If you wish, use the **Up Arrow** button or the **Down Arrow** button to select any other value.
step 5	
PID Controller (D) Rate : 0.01R/mn	If you wish, use **“ f ”** button to scroll to the **(D) Rate : Menu** to view the automatically determined (D) control parameters. If you wish, use the **Up Arrow** button or the **Down Arrow** button to select any other value.
step 6	
End	Refer to Control Parameters section of this manual for additional help.

NOTES:

Section 5 — MAINTENANCE & SERVICE

This section provides information you will need to perform routine maintenance and service on your MODLINE 3 instrument. General maintenance requirements and basic service procedures are explained. Basic troubleshooting suggestions are also provided.

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Section 5 — MAINTENANCE & SERVICE

5.1 ROUTINE MAINTENANCE

Routine Maintenance is essential for reliable, trouble-free operation. It consists of a thorough inspection at regular intervals to keep the instrument working efficiently and to head off problems *before they occur.*

Most "service problems" are caused by control misadjustment, improper Sensor positioning, improper Fiber Optic component positioning, dirty optics, and other conditions that will be caught and corrected by an orderly maintenance program.

The following checklist will help you develop a maintenance routine suitable for your installation:

❒ Check Indicator/Processor control settings. Make sure controls are set correctly for process being measured.

❒ Check Sensor for proper alignment and focus. Make sure there are no obstructions in the optical path between Sensor and target.

❒ Check Sensor lens and clean if necessary. Refer to cleaning instructions.

❒ Make sure Sensor is not overheated. If water cooling and/or air purge accessories are used, make sure there is adequate flow of cooling water and/or clean, dry air.

❒ Make sure all connections are secure.

❒ Check signal cable for any signs of mechanical damage or overheating.

❒ For Series 340, 600, 700, and 800 Sensors: Check Sensor calibration as instructed.

❒ *For fiber optic devices,* Check for proper alignment of Reimaging Lens or the glass rod for the Extension Tip. Make sure it is accurately sighted on the target surface.

❒ *For fiber optic devices,* Check, the glass rod of the Extension Tip, for debris. Clean the tip with a softcloth moistened with acetone or laboratory grade isopropyl alchohol.

IMPORTANT: Avoid abrupt temperature changes (e.g., quickly withdrawing the extension tip from a hot oven into ambient air - this could cause the tip to shatter). If possible, perform maintenance on fiber optic devices when the heating source is cooled down.

⚠ WARNING ⚠

Risk of Personal Injury

When this instrument is being used in a critical process that could cause property damage and personal injury, the user should provide a redundant device or system that will initiate a safe process shut-down in the event that this instrument should fail.

Follow the NEMA safety guidelines in Appendix A.

⚠ WARNING ⚠

Risk of Personal Injury

Fiber Optic Cable, Reimaging Lens and Extension Tip may become very hot during normal operation. Exercise all plant safety practices for handling materials in high temperature zones, if you must touch them for adjustment, maintenance or other reason once they are heated. If need be, handle them only after a normal cooldown of the heating system! The MAXIMUM OPERATING TEMPERATURES for the Fiber Optic Cables, Reimaging Lens are: 400 °F (200°C) and Extension Tips are: 575°F (300°C)

Section 5 — MAINTENANCE & SERVICE

5.2 SLR SENSOR LENS CLEANING

Inspect the lens on a routine schedule and clean it of any dust or residue that may have accumulated. If this requires dismounting the Sensor , make sure you note the mounting alignment and lens focus position so you will be able to restore the Sensor to its correct operating position.

Refer to Table 5.1 for cleaning instructions that apply to your Series Sensor.

CAUTION

Treat the lens and any protective window with care. Scratches or harmful solvents can destroy the lens

The frequency of the lens cleaning will depend on the environment at the point of installation. Air purging will reduce the necessity of frequent cleaning in dusty, dirty areas.

Clean the front surface of the lens as often as necessary, and also remove the lens tube and clean the back of the lens and the front surface of the window behind the lens tube every six months, or more often in a dirty or oily atmosphere.

RESTORING THE SENSOR TO OPERATION

Always re-install the Sensor in its original position if you remove it from its mount. Refocus the lens as stated in Section 2. (It you have marked the proper focus position on the lens tube, return the lens tube to the marked position.) Lock the lens by tightening the lens position locking screw.

Place the dust cap on the viewing telescope on the back plate, and go through any operational checks that may be necessary to make sure the instrument is functioning properly.

5.3 FIBER OPTIC LENS CLEANING

The lens of a Reimaging Lens assembly is sealed by a protective window at the front of the lens cylinder. The lens itself is not accessible for normal field maintenance. It is normally shielded from any dust or other debris by its protective window.

Routine maintenance consists of inspecting and cleaning the exposed surface of the protective window.

CAUTION

Treat the window with care. Scratches or harmful solvents can damage the window and prevent it from allowing infrared radiation to reach the lens.

The frequency and extent of cleaning will depend on the environment at the point of installation. Air purging will reduce the necessity of frequent cleaning in dusty, dirty areas.

If necessary, remove the Reimaging Lens from its mounting facility for window cleaning. This may involve separation of air lines if an air purge is used. Be very careful to note the mounting orientation so that the Reimaging Lens (and any mounting fixture) is restored to its correct target viewing position when service is completed.

Note: Depending on how you have installed the Fiber Optic Cable, you may want to uncouple this cable from the Reimaging Lens for cleaning routines.

Clean the window with a soft, dry cloth or swab, moistened with laboratory-grade isopropyl alcohol if necessary. Wipe clean to remove any residue.

Inspect the body of the Reimaging Lens assembly for any buildup of debris, and clean as necessary. Reinstall the Reimaging Lens in its mounting fixture, and go through the alignment and focusing procedures of Section 2F.1c.

5.4 LENS TUBE REMOVAL

The procedure for lens tube removal is as follows:

1. Mark the position of the lens tube, then loosen the lens position locking screw adjacent to the top fin on the Sensor. (Fig. 5.1 A)

2. Turn the Sensor upside down and locate the recessed hex head lens-retaining set screw. Loosen and back this set screw off about two turns with a 3/32" hex wrench. (Fig. 5.1 B)

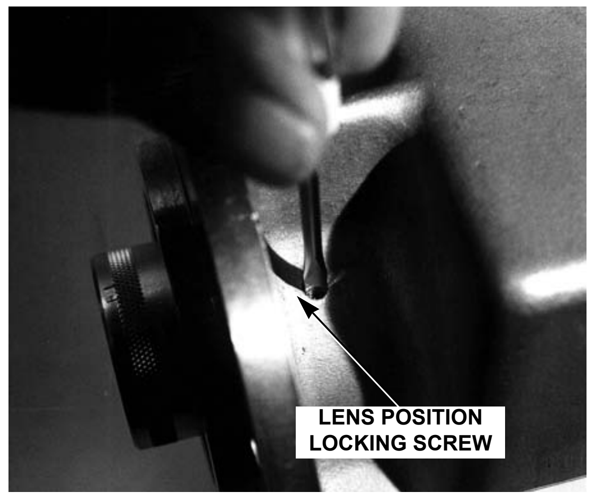
3. Slide the lens tube out of the Sensor and clean the lens and the window (Fig. 5.1 C) in the manner already described.

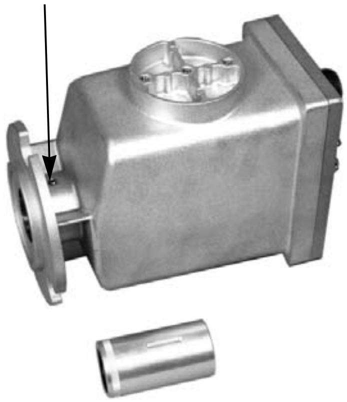
4. Reinstall the lens tube in the Sensor housing. Make sure the slot on one side of the lens tube is aligned with the hex head set screw.

5. Tighten the set screw, making sure that it goes into the lens tube slot. Back of f about one-half turn on the screw (until lens tube will slide freely).

6. Move the lens back to the marked position or refocus the lens back on the target. Fix it in place.

A. Mark proper focus position on lens tube. Loosen lens position locking screw.





B. Loosen set screw on underside of Sensor about two turns and slide lens tube out of casting.

C. With lens tube removed, window is accessible for cleaning.

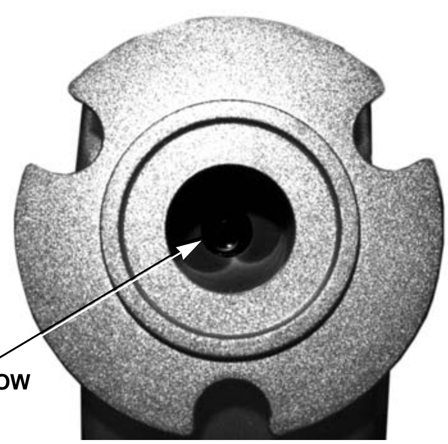


FIG. 5.1 – SLR LENS TUBE REMOVAL

Section 5 — MAINTENANCE & SERVICE

TABLE 5.1 - MODLINE 3 LENS CHARACTERISTICS

Instrument Series	Lens Material	Window Material	Recommended Cleaning Agent	Comments
200, 600, 3G, 3W & 3V.	Crown Glass	Crown Glass	Soft, dry cloth or swab moistened with acetone or high grade alcohol* if necessary	Wipe gently to remove any residue. Inspect and rewipe as necessary to remove any film.
340 700	Calcium Fluoride (CaF_2)	Calcium Fluoride (CaF_2)	Soft, dry cloth or swab moistened with acetone or high grade alcohol* if necessary	Wipe gently to remove any residue.
3L & 3R	Fused Quartz	Fused Quartz	Soft, dry cloth or swab moistened with acetone or high grade alcohol* if necessary	Wipe gently to remove any residue.
800	Cleartrean (ZnS)	Cleartrean (ZnS)	Soft, dry cloth or swab moistened with acetone or high grade alcohol* if necessary	Wipe gently to remove any residue.

* Laboratory grade isopropyl alcohol is recommended

CAUTION

Lenses are slightly soluble in water and other liquids. Do not soak any lens in water or any other liquid for long periods of time.

5.5 CALIBRATION CHECK

Only MODLINE 3 Systems with Sensor Series: 340, 600, 700 and 800 have this feature. A calibration bulb is turned on inside the Sensor. The Indicator / Processor measures the output of the Sensor during the "Calibration Check" and compensates for any changes in the expected output.

> IMPORTANT: The Sensor must not be pointed at a hot target during the Calibration Check. The lens must be covered or blocked, as described in the Calibration Check.

A Calibration Check should only be performed off-line. That is, when the Sensor is not required to provide outputs to a control device or data acquisition system.

Disregard the Temperature Display readings during the Checking Calibration function. The Analog Output readings and control action will not be valid during the Checking Calibration function. If the Track and Hold feature is in the Hold Mode; the temperature readings prior to initiating the calibration check will be provided at the the analog output and as input to any controller option installed.

If the Peak Picker is on and a long Decay Rate is selected; the temperature readings prior to initiating the calibration check will be provided at the analog output and as input to any option installed.

After initial installation the Calibration Check should be performed once per week for the first two weeks. It is best to do the Calibration check after the instrument has been operating for at least one hour in its operating ambient.

Thereafter, when the MODLINE 3 is in continuous operation the Calibration Check should be performed about once per month. If the MODLINE 3 is only for intermittent operation the Calibration Check should be performed about once per week.

CALIBRATION CHECK PROCEDURE

1. Depress the " *m* " button until: "Calibration Check" appears

    CALIBRATION CHECK
    CYCLE CAL. : <

2. Block the Sensor lens with an opaque cover that is well below the zero scale temperature but not hotter than 130 °F (55°C). ideally the lens cover should be at the same temperature as the Sensor.

    For Sensor models that measure temperatures below 150°F (65°C), the lens cover <u>must</u> be at 80°F (27°C) ±10% to insure proper calibration. Ideally the Sensor should be at the same temperature as the lens cover.

3. Press the " ▲ " button.

    CALIBRATION CHECK
    CONFIRM LENS COVERED

    a. Reminder message to confirm the lens is blocked or covered.

    b. Press the " ▲ " button, again.

4. The phrase "Checking Calibration" appears and flashes on and off for about 17 seconds.

    CALIBRATION CHECK
    CHECKING CALIBRATION

    If for any reason you wish to stop the checking, use the " ▼ " button at any time.

5. At the end of this Calibration Check the phrase "Cycle Cal" appears as part of the second line, if the System passed the check.

    CALIBRATION CHECK
    CYCLE CAL. : <

    Uncover the lens and restart the System process.

6. If the phrase "Calibration Failed" appears, your System failed the check.

    CALIBRATION CHECK
    CALIBRATION FAILED

    You must press the " ▲ " button to acknowledge and clear any alarm. The system will revert to the previous valid calibration data

    If the Sensor was too hot or the lens was not covered adequately the Calibration Check will fail. You may want to recheck these items and redo the Calibration Check.

Section 5 — MAINTENANCE & SERVICE

If after, several checks the "Calibration Failed" phrase appears your System may need servicing. Refer to the troubleshooting in Section 5.10.

5.6 SERVICE ACCESS

Certain functions are available for use by service personnel. These functions include changing the MODLINE 3 model configuration and monitoring the sensing head output voltages. An access code is required to access these functions.

Entering Service Access Mode

1. Depress the "m" button until "Security Access" appears.

   SECURITY ACCESS
   PANEL : LOCKED.<

2. Depress the "▲" or "▼" button until the service access code of 5151 is displayed.

   SECURITY ACCESS
   PANEL : 5151<

3. Press the " f " button and the word "Service" will appear. The instrument is now in the service access mode.

   SECURITY ACCESS
   PANEL : ! SERVICE !<

The word "SERVICE" remains on the Security Access menu: until you change it.

Changing the System Model Selection

The configuration of the MODLINE 3 indicator can changed to match any standard MODLINE 3 sensing head model. The Indicator / Processor model must be configured to match the sensing head model number.

WARNING

IMPORTANT: Do not operate your process while the Indicator / Processor is in the "SERVICE" mode. It is possible to destroy the Indicator / Processor calibration. Also, some measured temperature, indications will be incorrect.

Determine the model number of the sensing head that the indicator will be programmed to match. The sensing head model number can be found on the rear of the sensing head above the eyepiece assembly. The 5th digit of the model number is either an F or C and signifies a °F or a °C model.

1. Press and hold the " m " button until "System Configuration" menu appears.

2. Press and hold the " f " button until "°F/C Models" appears.

   SYSTEM CONFIGURATION
   °F/ C MODELS : °F< OR

   SYSTEM CONFIGURATION
   F/ C MODELS : °C

Note: This is not an F or C conversion feature. The model number on the sensor must be matched exactly, as in the steps below.

3. Use the "▲" or "▼" button to select F or C. This must match the F or C in the 5th digit of the sensing head model number.

4. Press and hold the " m " button until "System Configuration" appears.

5. Press and hold the " f " button until the sensing head model number appears.

   SYSTEM CONFIGURATION
   MODEL : 36-14F15

   Only the °F models appear after " F " is selected and only °C models will appear if " C " was selected. Sensor Model and System Series numbering is explained in Section 1.5.

6. Use the "▲" button to select the model that matches your sensing head model. If your Model does not appear, be sure that you have correctly selected °F or °C.

   If you have a Special Model Sensor, see the section "Non-standard Sensor Model" on the following page.

7. Once the matched model number appears on the menu. Exit the Service Mode.

CAUTION

The “Model : SH-mVolt” is intended for factory use only. If the “SH-mVolt” code appears on the function display during model selection, press the “ f ” button, immediately. Never have this model selected — improper action could change the basic Indicator / Processor.

Leaving Service Access Mode

1. Depress the “ m ” button until “Security Access” appears.

2. Press the “ ▲ ” button until the second line shows the number “1”.

3. Press the “ f ” button and the Security Access should be changed to “closed”.

4. If you want to change the Security Access to “open”, press the “ ▲ ”once more to display the number “ 1 ” and then repress the “ f ” key. The Security Access should now be “open”.

If you have installed or are planning to install a new model sensor in your IRCON MODLINE 3 System, Section 4 describes the methods, you will need to access the related functions menus of the MODLINE 3 System.

Non-standard Sensor Models

The Indicator / Processor ordered with an “SP” special sensor code will have information to match the the Sensor

Note: An “SP” number on the sensing head serial tag identifies a non-standard sensing head. An indicator with programming for non-standard models will have models in the menu beginning with the designation SP.

System Configuration
Model : SP-60C02

Non-standard sensor models are not included in this manual.

5.7 INSTRUMENT CALIBRATION SERVICE

Instruments are calibrated against precision laboratory standards and are "burned in" for 24 hours before shipment to ensure accurate temperature measurements throughout the operating range.

To preserve this accuracy, each instrument should be recalibrated periodically on a Blackbody standard. We recommend recalibration of this type on a yearly basis.

You can have your instruments calibrated at our Service Center. An available option is calibration traceable to the National Institute of Standards and Technology (NIST).

Each Fiber Optic System consists of a Sensor, a Fiber Optic Cable, and a Reimaging Lens or Extension Tip. These items have matching serial numbers and are calibrated together as a set. The System should be recalibrated on a blackbody if the Fiber Optic Cable is replaced.

5.8 SPARE PARTS

A supply of spare parts can be used to minimize costly downtime in case of System malfunctions. Malfunctioning parts can be returned to IRCON's service center for warranty or out-of-warranty repairs.

Since the MODLINE 3 Indicator / Processor can be user programmed for any standard model, just one Indicator / Processor can be purchased as a spare for several different MODLINE 3 models. Sensor models cannot be changed, so a spare for each different model is needed.

Recommended Replacement Modules

Specify instrument model and serial number.

MODLINE 3 Indicator / Processor
MODLINE 3 Sensor
Lens Assembly
Sensor Signal Cable

Section 5 — MAINTENANCE & SERVICE

5.9 MAINTENANCE TRAINING

IRCON can provide maintenance training for your personnel, either in your plant or in our Service Center.

Field Service Agreements geared to your requirements are also available. Options include Periodic Maintenance (with provisions for guaranteed emergency service rates) and Field Maintenance with emergency service and parts replacement.

Details on these services are available for IRCON Technical Services.

5.10 FACTORY ASSISTED SERVICE ACCESS

CAUTION

IMPORTANT: The Indicator / Processor must be in the "!Service!" mode. The Sensor must not be pointed at a hot target during the Calibration Check. The lens must be covered or blocked, as described in the Calibration Check. The Indicator / Processor Model Selection must match — the Sensor Model. Never leave the Indicator / Processor in the SERVICE Mode during normal operation.

Never select the "Model : SH-volt". Escape with the " f " button.

The internal Sensor Cal Lamp may be manually activated on Series 340, 600, 700 and 800. Service personnel may use this function as a troubleshooting aid.

Cal Bulb Activation

1. Depress the " m " button until "Calibration Check is displayed.

CALIBRATION CHECK
CAL BULB : <

2. Depress the " f " button. "Cal. Bulb : Off" is displayed.

CALIBRATION CHECK
CAL BULB : OFF

3. Depress the " ▲ " button. "Cal. Bulb : On " is displayed.

CALIBRATION CHECK
CAL BULB : ON

4. Press the " f " button. CH1 and CH2. appears. Record the values in millivolts. Exit as follows.

CALIBRATION CHECK
CH1 : 155 : CH2 : 0

Note: The sensing head output may be monitored with the cal bulb on or off by pressing the " f " button one more time. The second line displays the input voltage from the Sensor:

5. Depress the " f " button. "Cycle Cal" is displayed.

CALIBRATION CHECK
CYCLE CAL : <

6. Depress the " f " button. "Cal. Bulb : On" is displayed. Press the " ▼ " button to turn the lamp to " Off ".

CALIBRATION CHECK
CAL BULB : ON< TO CALIBRATION CHECK
CAL BULB : OFF<

7. Depress the " m " button. The Security Access menu appears. Leave the "!Service!" mode.

Leaving Service Access Mode

1. With "Security Access" displayed. Press the " ▲ " button until the second line shows the number "1".

3. Press the " f " button and the Security Access should be changed to "closed".

4. If you want to change the Security Access to "open", press the " ▲ "once more to display the number "1 " and then repress the "f" key. The Security Access should now be "open".

Note: If you have selected a new model sensor . Return to Section 4, you will need to access the related function menus of the MODLINE 3 System and recheck and readjust the Function Values.

5.11 TROUBLESHOOTING

If troubles develop in the initial installation or after periods of normal operation, the troubleshooting suggestions in Table 5.2 may help you to identify certain trouble symptoms and possibly correct the problem. If trouble persists, call IRCON Technical Services for help.

TABLE 5.2 – TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE / CORRECTIVE ACTION
• Completely inoperative. • No display of any kind. • No Optional Output or Control action (if included in system).	1. Check your power line voltage supply. Check external line switch or circuit breaker at alteration current source. 2. Check power line voltage supply connections on rear panel. 3. Check any line fuse or circuit breaker, you may have installed. Replace if necessary. No user accessible line fuses or circuit breakers exist in the Indicator / Processor.
• No temperature indication or incorrect temperature indication. (Target temperature known to be within system temperature range.) • Under-range or Over-range indication displayed. • For Sensor Series 3L and 3R instruments, Invalid indication displayed.	1. Check Sensor model number must match the selected System Configuration. 2. Check Sensor sighting and focusing. Make sure lens cap is removed from front of Sensor. 3. Check for obstruction in sight path. 4. Check for background interference. 5. Check lens and clean if necessary. (If system includes window or mirror, check and clean.) 6. Check Sensor signal cable and connections. A short to ground on any of the power or motor drive leads can cause permanent damage to the Indicator / Processor. 7. Check ambient temperature of Sensor. If water cooling is used, make sure coolant is flowing at recommended rate. 8. Check all control settings, particularly Emissivity (or E-Slope for Sensor Series 3L and 3R instruments). 9. Check Calibration in Section 5.6. 10. Perform the Illuminator Check for Fiber Optic Sensors, as described in Section 7.15.

Section 5 — MAINTENANCE & SERVICE

TABLE 5.2 - TROUBLESHOOTING (CONTINUED)

SYMPTOM	POSSIBLE CAUSE / CORRECTIVE ACTION
No Output, or incorrect Output. Accurate temperature displayed on front panel.	1. Check wiring between the rear panel terminals and external devices. 2. Review manufacturer's instructions for external devices. Make sure device is connected and adjusted correctly, and is compatible with MODLINE 3 specifications. 3. For Control option, check set point adjustments. 4. For Analog Full or Zero scale adjustment, see Section 4.15 for how to select a proper analog signal range.
Erratic display and outputs. *(Target temperature known to be stable.)* If the trouble persists: vary the Response Time to see if the symptom changes. If so, adjust the System to eliminate the problem.	1. Check Sensor signal cable connections. Also, check the signal cable shield connection at the Grounded Strain Relief Fitting. A shorted motor drive signal would cause wrong or erratic readings on a 340, 700, or 800 Series Sensor. 2. Check for proper grounding of all system components. 3. Check cable routing. Signal cables must not run in the same conduit as the power wiring. 4. Check for recurrent interruptions in sight path (e.g. bursts of smoke or steam, moving equipment). Check the oper ation in Peaking mode with suitable decay rate may allevi ate condition. 5. Check ambient temperature of Sensor Add water cooling and/or heat shielding to Sensor, if necessary.
System continuously resets.	1. Cause is excessive noise on the power lines. An line con ditioner is recommended. 2. Line transients greater than 2Kv may cause malfunction.
Temperature display normal, but Analog Output or Control operation (if included) erratic.	1. Check wiring and connections between MODLINE 3 terminal and external devices 2. Check wiring, adjustment and operation of external device per manufacturer's instructions. Make sure device is operating from clean power line and is properly grounded. 3. For RS-485 Digital Interface Output, make sure external device is compatible with MODLINE 3 System interface. Make sure cabling is correct and communications program is fully compatible.

TABLE 5.2 - TROUBLESHOOTING (CONTINUED)

SYMPTOM	POSSIBLE CAUSE / CORRECTIVE ACTION
The display is: **-LO- °C** or **-HI- °C**	1. The display shows LO when the measured temperature is below the zero scale value (range of the sensor). 2. The display shows HI when the measured temperature is above the full scale value (range of the sensor) by even a few degrees. 3. The display remains LO or HI as long as the measured temperature is out-of-range .
Temperature Display is flashing and alternately displaying temperature and four dashed lines or below zero scale alarm and four dashed lines. For example: **1500°C** and **---- °C** or **– LO –** and **---- °C**	For Sensor series 3R and 3L.This is an Invalid Alarm display. It is displayed, if the infrared energy reaching the Sensor is too weak to provide reliable temperature measurements or if Sensor 3L is overheated.
Function Display goes dim.	This is the normal action for the Screen Saver Mode. The display dims after 5 minutes of inactivity.
The display is: Calibration Failed.	1. The lens is not properly covered during the Calibration Check. 2. Check the Sensor Signal cable for damage. 3. Check that the cable connections are tight. 4. Overheated Sensor head. 5. Malfunctioning Sensor. 6. Incorrect selection of the System Configuration Sensor Series Model Number.

NOTES:

Section 6 — OPTIONAL ACCESSORIES

IRCON provides a variety of optional accessories for the Modline 3 System with Fiber Optic (FO) Sensors and Single Lens Reflex (SLR) Sensors to simplify mounting and to protect the Sensors from hostile environment. The common accessories are described in this section.

SPECIALIZED ACCESSORIES

Sight tubes (open and closed end), safety shutters, furnace mount assemblies, and other optional accessories are also available. All IRCON accessories are described in Product Bulletin PB0070, available on request.

Section 6 — OPTIONAL ACCESSORIES

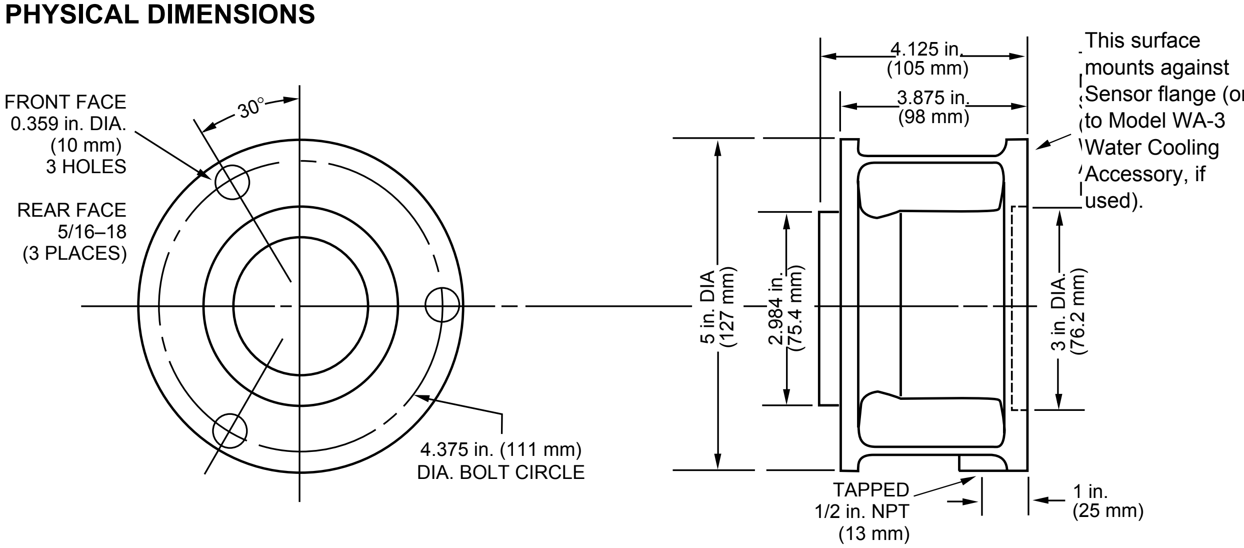
6.1 MODEL AA-3 AIR PURGE

(For SLR Sensors)

The Model AA-3 Air Purge provides a stream of clean air to prevent smoke, particles, steam, etc. from collecting on the lens. This accessory bolts to the front flange of the Sensor and can be used in combination with other accessories such as a Model WA-3 Water Cooling Accessory.

A 0.5-inch NPT tapped hole is provided for air intake. Air flow of about 6 ft^3/min (0.17 m^3/min) is suitable for most applications.

PHYSICAL DIMENSIONS



THREE HOLES FRONT AND REAR FLANGE, ALL ALIGNED, SPACED 120° ON 4.375 in. DIA. (111.1 mm) BOLT CIRCLE.

FRONT SIDE 0.359 in. DIA. (9.5 mm)

REAR SIDE 5/16–18 TAPPED HOLES

Section 6 — OPTIONAL ACCESSORIES

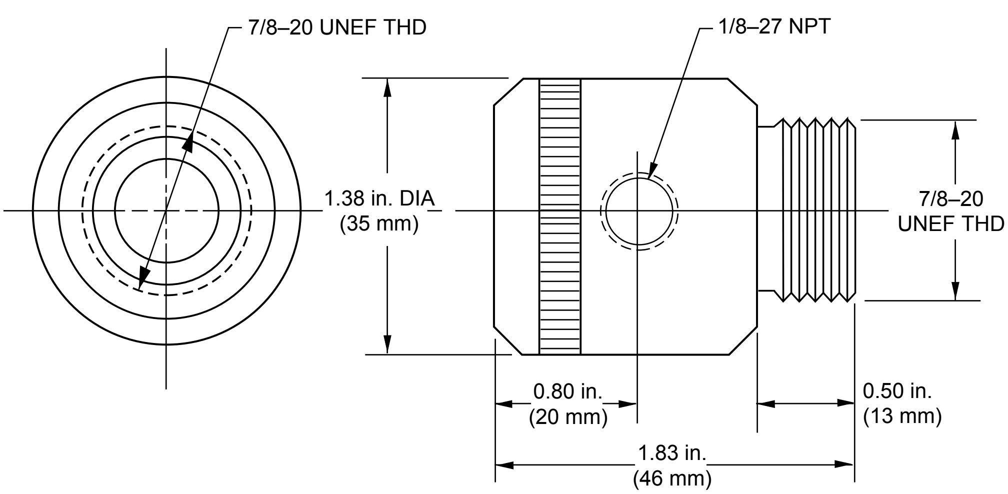
6.2 MODEL AA-5 AIR PURGE

(For Fiber Optic Sensor Reimaging Lens)

The Model AA-5 Air Purge provides a stream of clean air to prevent smoke, particles, steam, etc. from collecting on the lens of a Focusable Reimaging Lens assembly. This accessory screws onto the threaded front section of the Focusable Reimaging Lens assembly. A 7/8 –20 threaded forward section can be used to mount the entire unit in a panel cutout, into a Model AP-5 Adapter Plate, or into a Model MB-5 Angle Mounting Bracket with the use of the retaining nuts supplied with the Focusable Reimaging Lens assembly.

A 1/8–27 NPT fitting is provided for air intake. Air flow of about 1 ft ^{3}/min (0.03 m^3/min) is suitable for most applications.

PHYSICAL DIMENSIONS



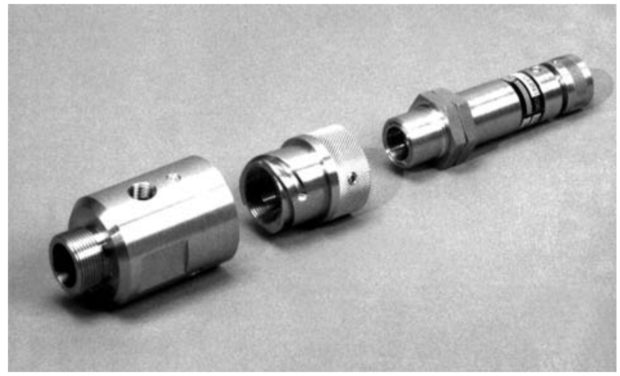
ASSEMBLY NOTES: The AA-5 may be used in direct mounting, mounting in the MB-5 Angle Mounting Bracket, or mounting in a Reimaging Lens secured in a MC-5 Mounting Clamp or SB-5 Swivel Base. Detailed instructions and illustrations are given in Sections 2F.

6.3 MODEL AAQ-1 QUICK-RELEASE AIR PURGE ASSEMBLY

(For Fiber Optic Sensor Reimaging Lens)

The Model AAQ-1 Quick-Release Air Purge Assembly provides a stream of clean air to prevent smoke, particles, steam, etc. from collecting on the optical elements of the Focusable Reimaging Lens. Additionally, it allows quick and easy access for checking the cleanliness of the Reimaging Lens. It is constructed of stainless steel and is designed to operate at 400°F (200°C).

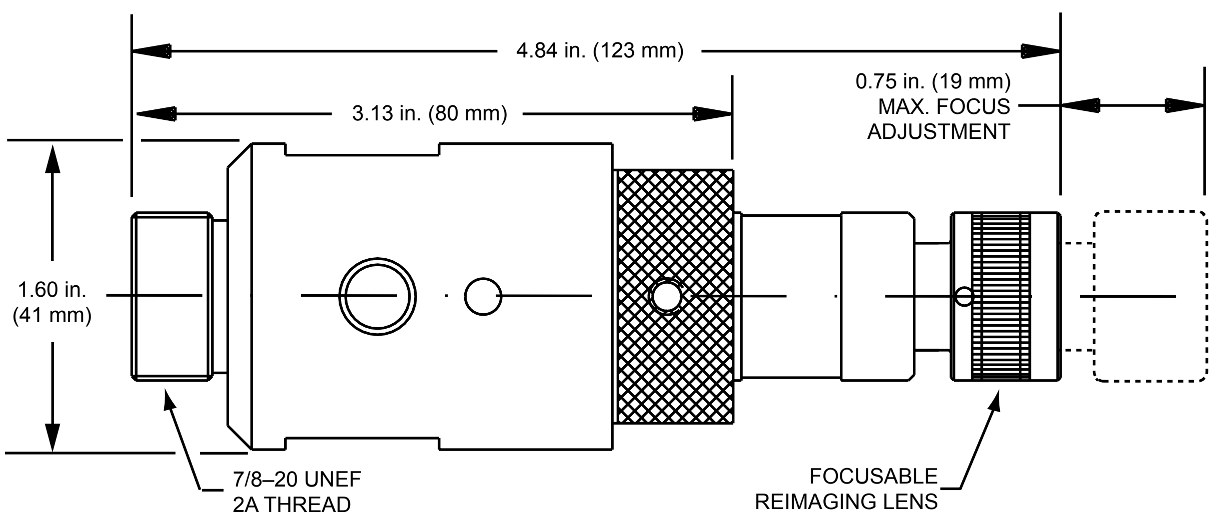
A 1/8–27 NPT fitting is provided for air intake. Air flow of about 1 ft ^{3}/min (0.03 m^3/min) is suitable for most applications.



(FROM LEFT TO RIGHT) QUICK-RELEASE AIR PURGE, REIMAGING LENS ADAPTER, AND REIMAGING LENS

AAQ-1 ASSEMBLED WITH REIMAGING LENS

PHYSICAL DIMENSIONS



Section 6 — OPTIONAL ACCESSORIES

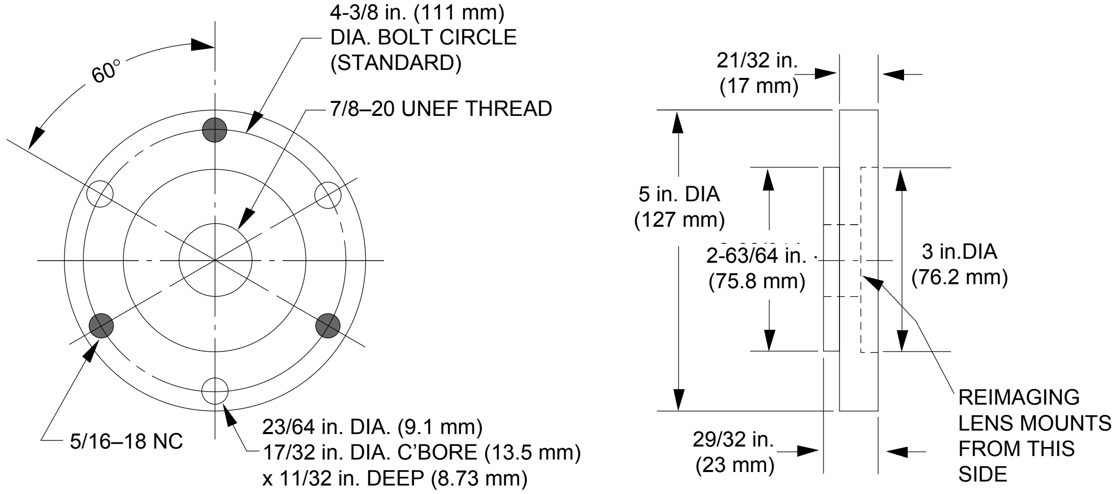
6.4 MODEL AP-5 ADAPTER PLATE

(For Fiber Optic Sensor Reimaging Lens)

The Model AP-5 Adapter Plate adapts the Focusable Reimaging Lens of a Fiber Optic Sensor for flange mounting.

A threaded aperture in the center of the plate screws onto the mounting thread of the Reimaging Lens, Model AAQ-1 Quick-Release Air Purge Assembly, or a Model AA-5 Air Purge. The holes in the rim of the AP-5 may then be used to bolt the complete assembly to other flange mount accessories.

PHYSICAL DIMENSIONS



6.5 MODEL IL-5 FIBER OPTIC ILLUMINATOR

(For Fiber Optic Sensor Reimaging Lens)

This compact, hand-held illuminator is designed to transmit a bright light through the Fiber Optic cable and Focusable Reimaging Lens to aid in aligning and focusing the lens on a target object. The light that falls on the target is an accurate indication of the image area that will be picked up by the fiber optic system during operation. Thus, it is an accurate means of determining spot size and spot position during installation or maintenance routines.

Light is produced by a rechargeable battery-powered quartz halogen lamp with variable intensity control. A battery recharging accessory is supplied with the illuminator.

Units are available with battery rechargers designed for operation on either 115 Vac or 220 Vac sources:

- Model IL-5-0 for 115 Vac 50/60 Hz
- Model IL-5-1 for 220 Vac 50 Hz

6.6 MODEL TM-6 TRIPOD

The Model TM-6 Tripod provides a versatile, adjustable, and quickly assembled platform for general laboratory or engineering use.

Friction-grip adjustable legs and a geared elevation crank permit elevation adjustments from 2 ft to over a maximum practical elevation of 5.5 ft. Friction pan and tilt adjustments add to adjustment ease. All adjustments lock securely when optical alignment is complete.

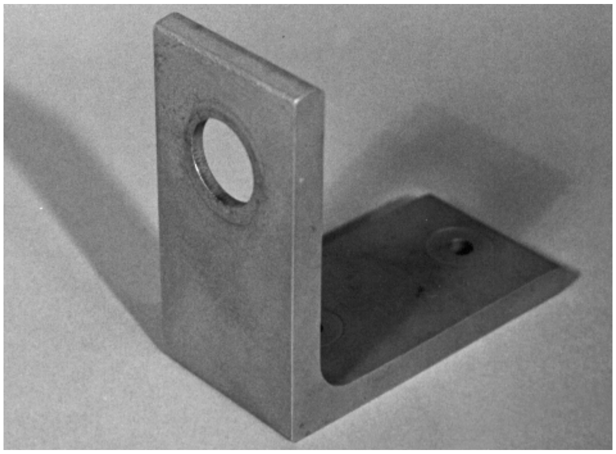
A captive screw with locking mechanism attaches the base of the Sensor to the tripod platform.

Section 6 — OPTIONAL ACCESSORIES

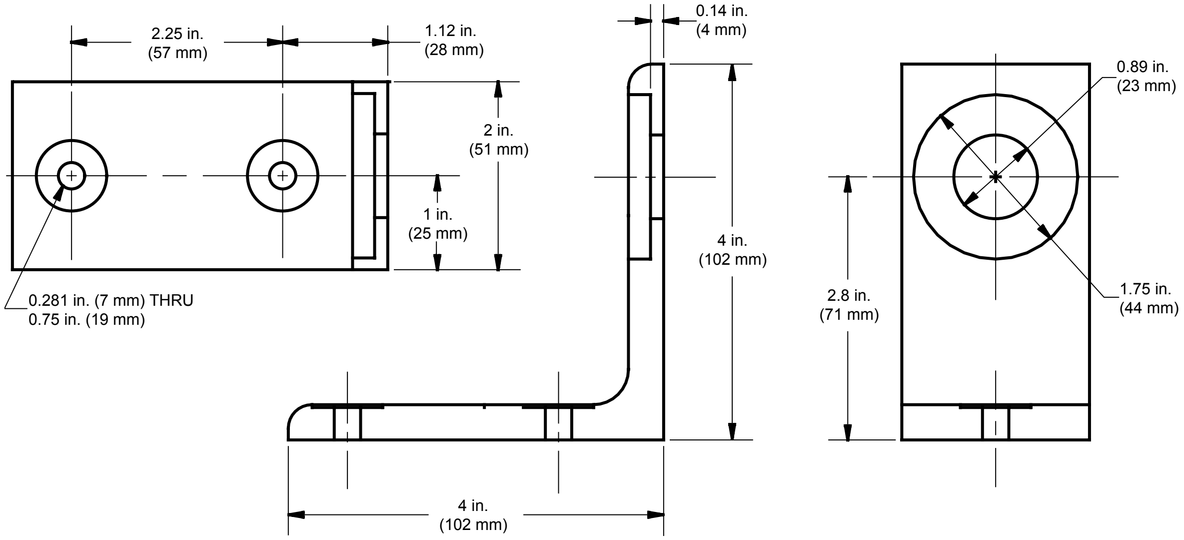
6.7 MODEL MB-2 ANGLE MOUNTING BRACKET

(For Fiber Optic Sensor Reimaging Lens)

The Model MB-2 Angle Mounting Bracket forms a mounting base for the Focusable Reimaging Lens. This bracket can be bolted to any desired surface for fixed mounting. This heavy-duty bracket is designed to support a Reimaging Lens and Fiber Optic Sight Tube assembly and to hold it firmly in place. In general, it provides a drift-free and sturdy mount for applications in which lens sighting is critical.



PHYSICAL DIMENSIONS



6.8 MODEL MB-3 ADJUSTABLE ANGLE MOUNTING BRACKET

For Fiber Optic Sensor Reimaging Lens

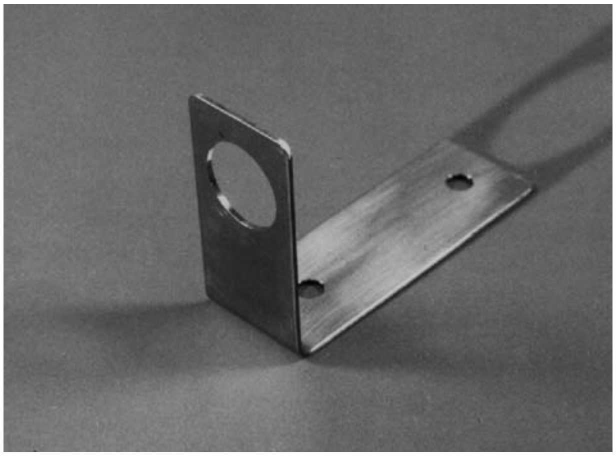
Note: The MB-3 Bracket is obsolete and no longer available.

Section 6 — OPTIONAL ACCESSORIES

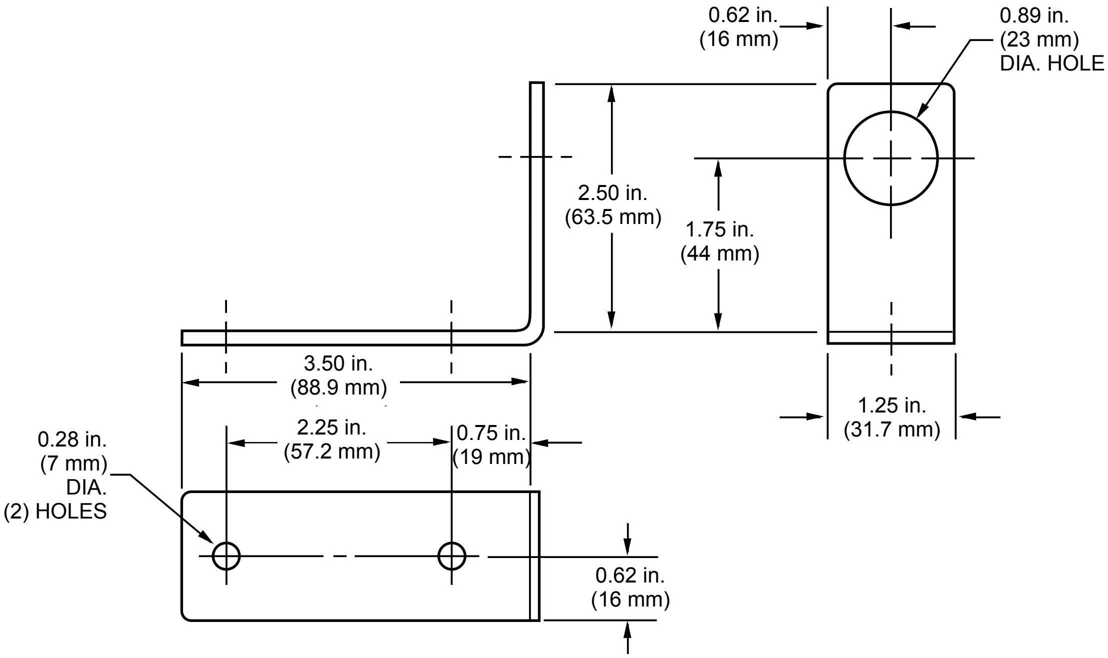
6.9 MODEL MB-5 ANGLE MOUNTING BRACKET

(For Fiber Optic Sensor Reimaging Lens)

The Model MB-5 Angle Mounting Bracket forms a mounting base for a Focusable Reimaging Lens or Extension Tip. This bracket can be bolted to any desired surface for fixed mounting.



PHYSICAL DIMENSIONS



6.10 MODEL MC-5 MOUNTING CLAMP

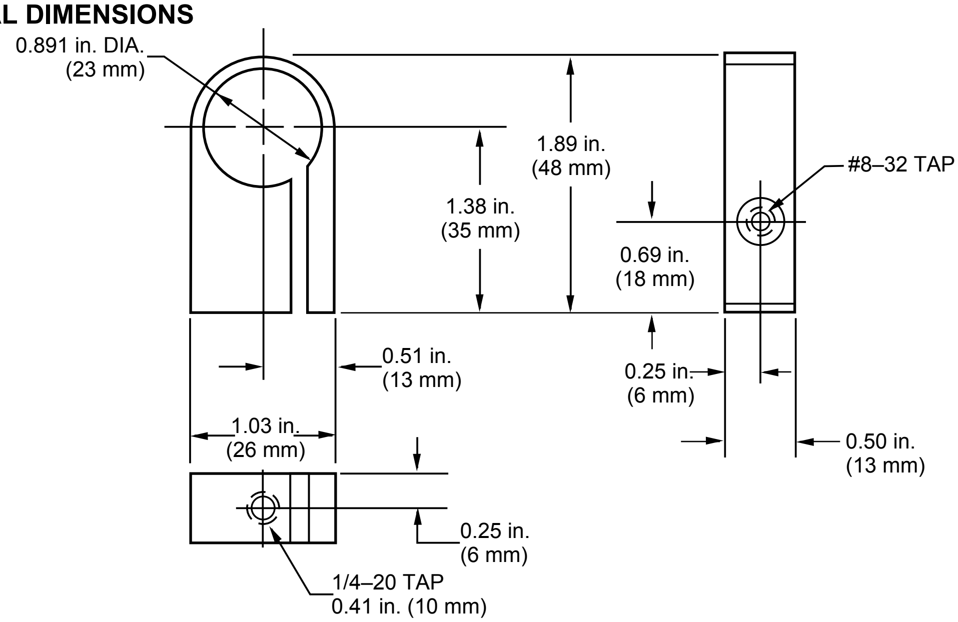
(For Fiber Optic Sensor Reimaging Lens)

The Model MC-5 Mounting Clamp is a sturdy mounting support for either a Focusable Reimaging Lens or Extension Tip assembly. It can be attached to a vertical or horizontal member by means of a 1/4 –20 mounting screw inserted in its bottom surface. (NOTE: Maximum depth is 0.41 in. [10 mm]). The Focusable Reimaging Lens or Extension Tip slides into the mounting collar, which is then tightened to hold the assembly.

The Mounting Clamp can be panned to align the Focusable Reimaging Lens or Extension Tip on the target, then tightened in place by means of its mounting screw when alignment is complete.

Note: This clamp is a companion to Model SB-5 Swivel Mounting Base. The hole in the base also accepts the captive screw of Model TM-6 Tripod.

PHYSICAL DIMENSIONS



ASSEMBLY NOTES: Slide the Reimaging Lens or Extension Tip into the collar of the clamp. Then tighten the mounting screw to secure the assembly. The procedure is described and illustrated in Section 2F. If desired, a Model AA-5 Air Purge can be screwed onto the front of a Reimaging Lens.

Section 6 — OPTIONAL ACCESSORIES

6.11 MODELS PM-1 AND PM-2 PIPE MOUNTS

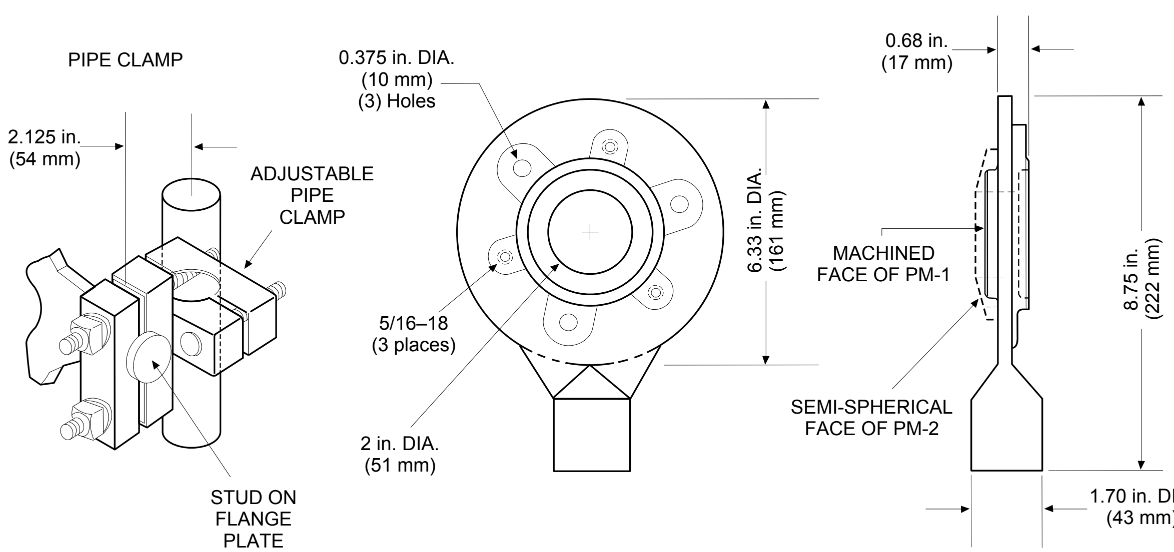
Note: The PM-1 machined plate is obsolete and no longer available.

The PM-2 Pipe Mount is ideal for flange mounting a Sensor to a pipe or stanchion, allowing two degrees of freedom for alignment of the Sensor on its target.

The Pipe Mount Assembly consists of a set of right-angle connected clamps and one flange plate. One clamp holds the flange plate, and the other clamp grips a user-supplied supporting pipe between 1.625 and 2.5 in. in diameter. The standard six-hole bolt circle connects to the Sensor front flange or to a flange-mount accessory in between.

The PM-2 flange plate is machined on one side, the opposite having a cast semi-spherical face which accepts the special ring clamp required in mounting STSC, or STA sight or target tubes.

PHYSICAL DIMENSIONS



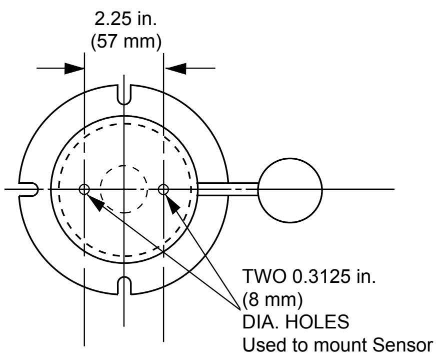
6.12 MODELS SB-1 AND SB-3 SWIVEL MOUNTING BASES

Note: the SB-3, in photo below, is obsolete. Use the SB-1 in all Applications.

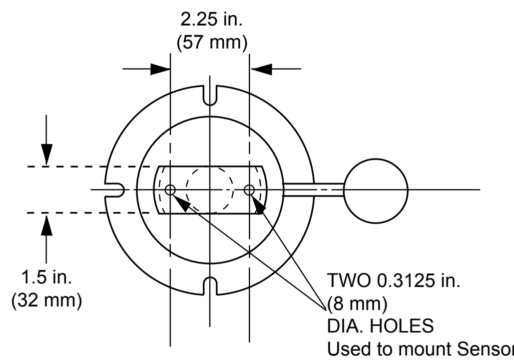
The Model SB-1 Swivel Mounting Base may be used for installations requiring good line-of-sight adjustment capability. The devices permit tilting and panning motions and may be locked firmly in place when optical alignment is complete.

IMPORTANT: This base CANNOT be used to support a Model WJ-5 Water Cooling Jacket.

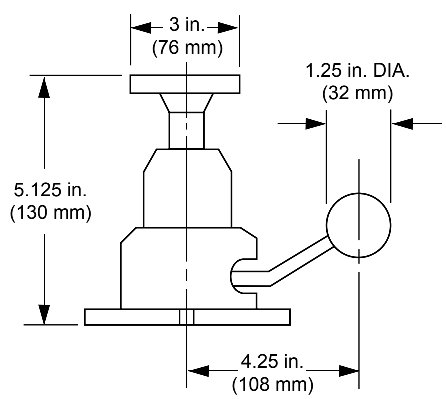
PHYSICAL DIMENSIONS



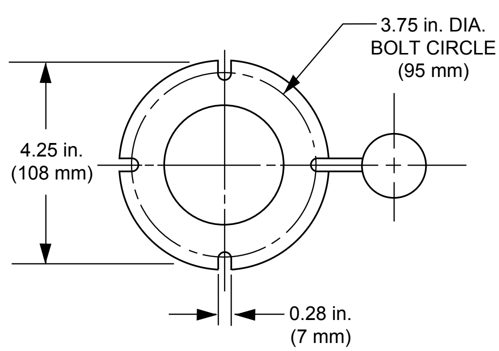
TOP VIEW FOR SB-1



TOP VIEW FOR SB-3 (Obsolete)



SIDE VIEW FOR SB-1



BASE VIEW FOR SB-1

ASSEMBLY NOTES: Three 1/4 x 20 NC hex-head bolts and 0.25 in. split-ring lockwashers are supplied (two each required; one each spare). Insert two bolts with lockwashers through mounting plate holes into corresponding threaded holes on Sensor base. Tighten bolts.

Attach base to desired mounting surface using customer-supplied mounting hardware. Refer to the grounding information in Section 3.14.

Section 6 — OPTIONAL ACCESSORIES

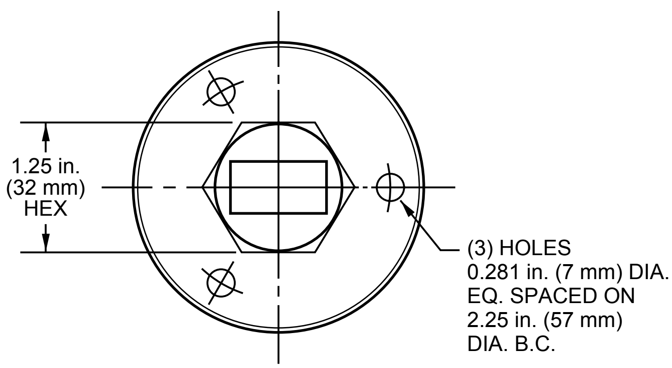
6.13 MODEL SB-5 SWIVEL MOUNTING BASE

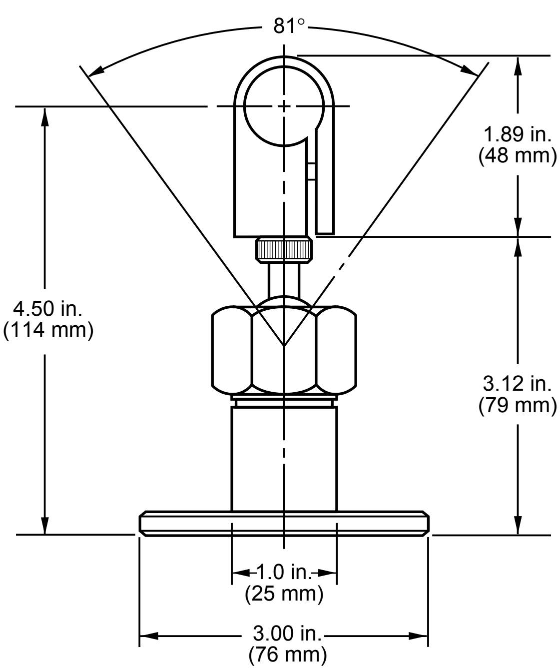
(For Fiber Optic Sensor Reimaging Lens)

The Model SB-5 Swivel Mounting Base may be used when the Focusable Reimaging Lens requires good line-of-sight adjustment capability. This device permits both tilting and panning motions and may be locked firmly in place when adjustment of the Focusable Reimaging Lens is completed.

Note: A Model MC-5 Mounting Clamp is supplied with this accessory for attachment to the Focusable Reimaging Lens.

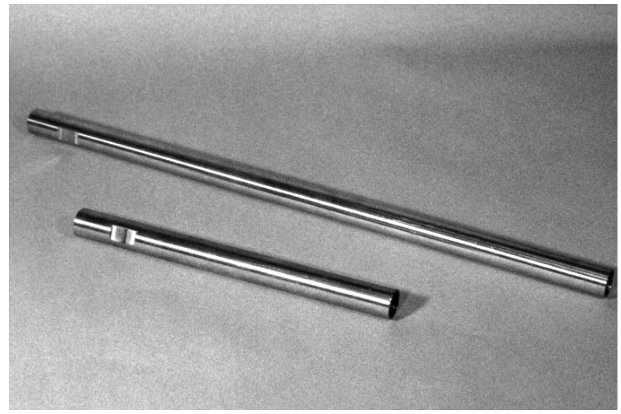
PHYSICAL DIMENSIONS





6.14 MODELS SI-12 AND SI-24 INCONEL SIGHT TUBES

(For Fiber Optic Sensor Reimaging Lens)

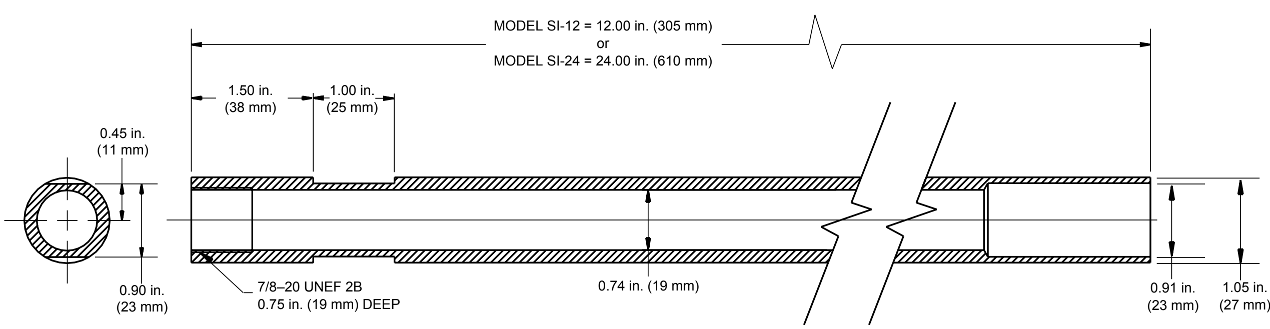


Model SI-12 and Model SI-24 Sight Tubes are used to shield the sight path of a Reimaging Lens. Made of inconel, the sight tubes may be used at temperatures of up to 2000 °F (1093°C). If no cooling is involved, care must be taken to ensure that the sight tube 's conducted heat does not exceed the temperature limit of any attached component.

Both models have an outside diameter of 1.05 in. (26.7 mm) and, except for the ends, a general inside diameter of 0.74 in. (18.8 mm). Model SI-12 has a length of 12 in. (305 mm). Model SI-24 has a length of 24 in. (610 mm) and allows a resolution of D/60 only.

Note: The Reimaging Lens must have an unobstructed path while it is "looking" through a Sight Tube. This can be achieved by pre-focusing the lens for a distance that equals the length of the Sight Tube.

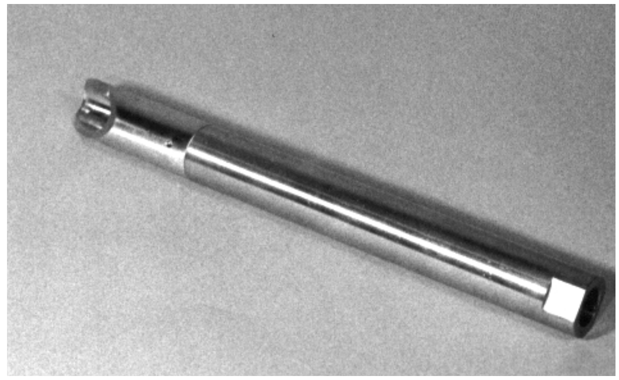
PHYSICAL DIMENSIONS



Section 6 — OPTIONAL ACCESSORIES

6.15 MODEL SS-14 STAINLESS STEEL SIGHT TUBE

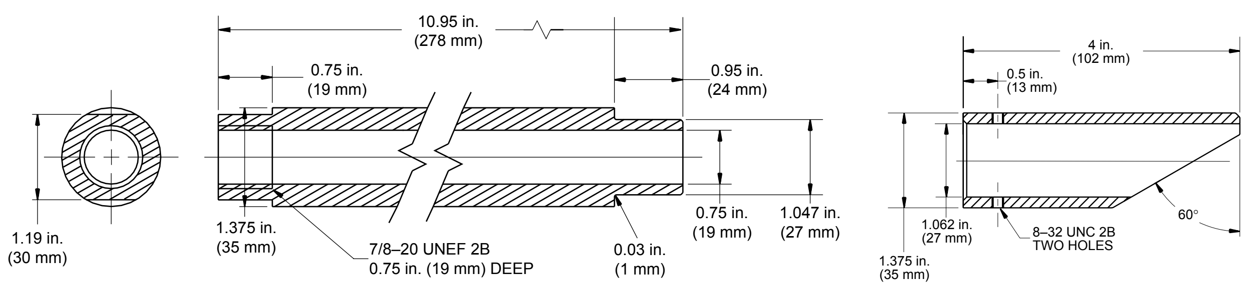
(For Fiber Optic Sensor Reimaging Lens)



The Model SS-14 Sight Tube is used to shield Reimaging Lens sight paths. It is composed of two parts: the tip and the sight tube. The angled and adjustable tip aids in preventing debris from falling into the tube. The 14-inch (355 mm) Model SS-14 is made of stainless steel. It may be used at temperatures of up to 1000 °F (538°C). If no cooling is involved, care must be taken to ensure that the sight tube's conducted heat does not exceed the temperature limit of any attached component. It has an outside diameter of 1.375 in. (34.93 mm) and an inside diameter of 0.75 in. (19.05 mm). The SS-14 allows a resolution of D/60 only.

Note: The Reimaging Lens must have an unobstructed path while it is "looking" through a Sight Tube. This can be achieved by pre-focusing the lens for a distance that equals the length of the Sight Tube.

PHYSICAL DIMENSIONS



6.16 MODEL WA-3 WATER COOLING ACCESSORY

(For SLR Sensor)

The Model WA-3 Water Cooling Accessory is recommended where ambient temperatures are expected to exceed the maximum rating of the Sensor. Nominal water flow of 10 gal./hr (38 liter/hr) at water temperatures below 90°F (32°C) is suitable for most applications. Water cooling effectively raises the maximum ambient temperature limit by about 35°F (19°C) in most applications.

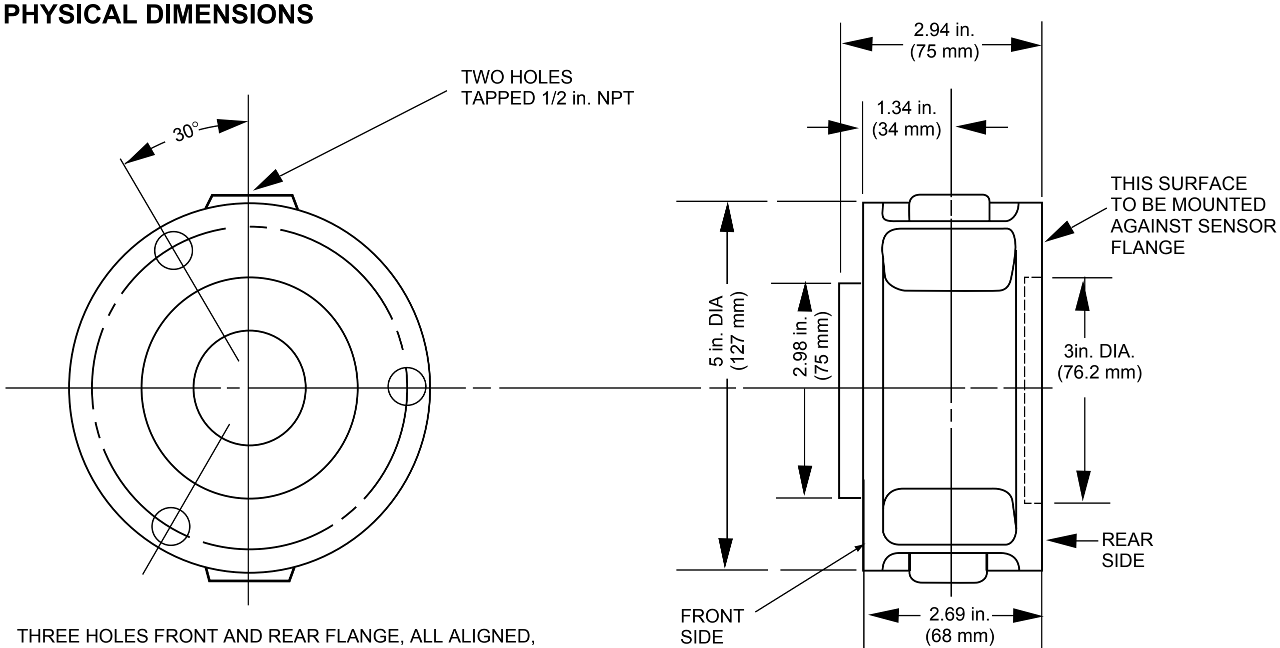
Two 0.5-inch NPT tapped holes accept water intake and outlet pipes. Machined flanges permit bolting to the Sensor front flange and to other standard accessories.

Where high ambients and moist atmospheres are encountered, using a Model AA-3 Air Purge Accessory with a Model WA-3 Water Cooling Accessory prevents moisture condensation on the Sensor lens.

CAUTION

For continued acceptable performance, use only cooling water that is compatible with aluminum alloy #319 found in this accessory.

PHYSICAL DIMENSIONS

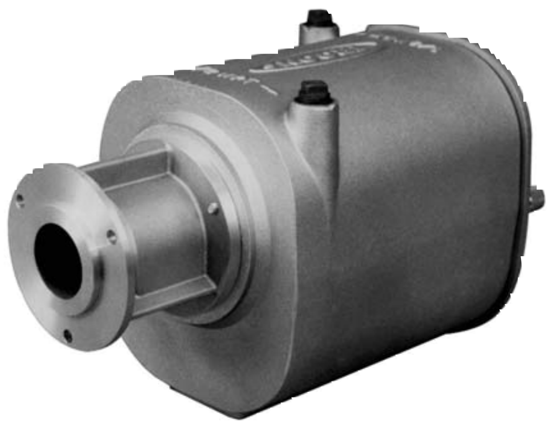


THREE HOLES FRONT AND REAR FLANGE, ALL ALIGNED, SPACED 120° ON 4.375 in. DIA. (111 mm) BOLT CIRCLE.
FRONT SIDE 23/64 in. DIA. (10 mm)
REAR SIDE 5/16in.–18 TAPPED HOLES

Section 6 — OPTIONAL ACCESSORIES

6.17 MODEL WJ-5 WATER COOLING JACKET

(For SLR Sensor)



The Model WJ-5 Water Cooling Jacket may be used to protect the Sensor in ambient temperatures up to 400 °F (200°C). The jacket provides cooling via water circulating through a stainless steel coiled pipe embedded in the jacket walls. High-temperature insulation material attached to the back door opening insulates and seals the opening. An air purge is attached to the front plate to protect the Sensor lens from dirt, steam, and water.

APPLICATION

Two 0.5-inch NPT threaded holes in the top of the jacket accept water inlet and outlet pipes or tubing. The water should have a flow rate of 20 gal./hr (75 liter/hr) and a temperature of 90 °F (32°C) or less. Water pressure shall be less than 100 psi (6.8 bar).

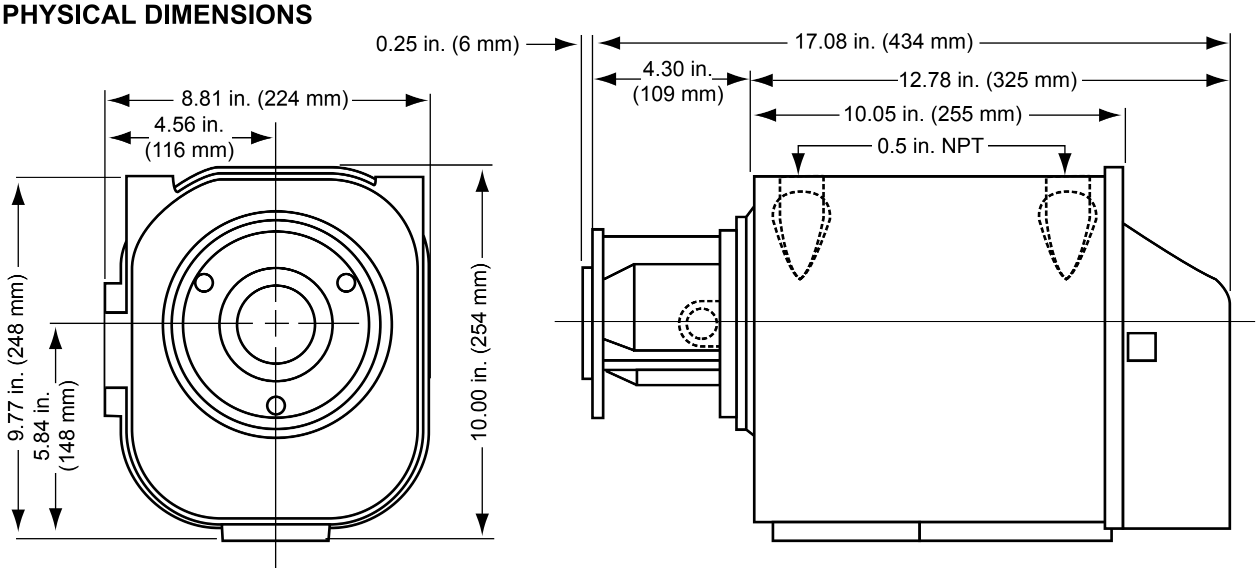
A 0.5-inch NPT threaded air inlet on the air purge is provided for a pipe or tube fitting. The purge air should be clean, dry, and have a flow rate of about 6 ft^3/min (0.17 m^3/min).

Four 1/4–20 tapped holes are provided in the base for mounting purposes. The front flange of the air purge can serve as a mounting flange for other accessories. Maximum weight of the assembly (filled with water, Sensor installed) is 35 lb (15.8 kg).

CAUTION

For continued acceptable performance, only use cooling water that is compatible with the chemical content that is compatible with the 316 Stainless Steel Cooling Coil found in this accessory.

PHYSICAL DIMENSIONS



Section 7 — APPLICATIONS GUIDE

This section provides information about specific infrared concepts and gives practical applications advice. We suggest you review all material in this section and concentrate on those sections related to your own applications.

Section 7 — APPLICATIONS GUIDE

7.1 INTRODUCTION

The MODLINE 3 System is a precision measuring instrument built for rugged service and ease of operation. When installed and maintained with reasonable care, it will give you reliable service in a wide variety of applications.

In this section we offer some guidelines to further assure accuracy and reliability. Although it is impossible to cover every application in detail, the general information can be adapted to most situations.

Please, review this information to make sure your system gives you the results it is capable of. Start with Emissivity; what is it? What is an Emissivity Setting? What are the Practical Limits on Emissivity? How does it differ from the E-Slope Setting for two color sensor.

7.2 EMISSIVITY

An ideal infrared radiator, called a *blackbody*, emits the maximum amount of infrared energy possible at each given temperature. It has an Emissivity (*E*) equals 1.0, as in Fig. 7.1. The targets you deal with in practice, however, are *non-blackbodies*. Their emissivity values are less than 1.0, which means they emit a fraction of the infrared energy a blackbody would emit at a given temperature.

All MODLINE 3 Sensors are factory calibrated using blackbody standards. For accurate measurements you must compensate for the difference between the emissivity of your target and that of a blackbody radiator.

For all MODLINE 3 Series Sensors, except 3L and 3R as described in Section 7.4, this involves setting the Emissivity value to match the emissivity of your target material—at a value less than 1.0. Methods of determining emissivity are described in Section 7.2a.

7.2a EMISSIVITY SETTING

Note: This information applies to all MODLINE 3 Series except 3L and 3R. For Series 3L and 3R Sensors, refer to Section 7.4.

Using Emissivity Tables

One way to determine an approximate Emissivity setting is to refer to a set of emissivity tables.

WE WANT TO HELP!

We describe some of the common measurement situations and the things to watch for in dealing with them. If you run into these or other situations that may cause problems, consult IRCON Applications Engineering. Our many years of experience in facing and solving temperature measurement problems can be of great benefit!

Tables 7.1, 7.2, and 7.3 are provided for this purpose. Emissivity values in the tables are based on actual tests on samples of the materials.

Because the emissivity of most materials changes with wavelength, a separate column of emissivity values is provided for each Sensor series. To use the tables, locate your target material and obtain a value from the column for the Sensor series you are using. Adjust the Emissivity value setting to this value.

Most table values are in the form of ranges. This is because the details of an object's form and characteristics affect its reflectance (R) and transmittance (T). These factors in turn reduce the emissivity (E) value , as shown in the following general equation relating the three characteristics:

$$E = 1 - R - T$$

Fig. 7.1 shows how a target's surface characteristics affect its reflective properties, hence its emissivity. It is assumed in the figure that each sample of Material A is thick enough to be completely opaque (T = 0). Notice that a cavity in an opaque object comes very close to having blackbody characteristics; E = 1 when both R = 0 and T = 0.

From Fig. 7.1, you can see why the lower value of a given range represents a flat, highly polished sample of the material. The upper value represents a sample of the material that has a flat surface that is as rough as might be expected when in its “crude” or “unfinished” form.

A few entries in Table 7.3 are marked with asterisks (*) to signify that the range of values results from more than just the target's reflective characteristics. These materials, in their specified forms, are partially transparent to infrared radiation. In spectral regions where the materials transmit energy, the emissivity typically increases with target thickness.

Follow the guidelines in the tables to estimate the emissivity of your target. Even a rough estimation can significantly improve the accuracy of your measurements over only using "averaged" values. Note that table entries having a single value represent targets in forms that are clearly specified.

You may wish to read the IRCON publication "Spectrum Reprint SR100 - Product Temperature Solutions — Temperature Errors Caused by Changes in Emissivity."

Using Emissivity Thermocouple Test

If your material is not listed in the table, or if you want to verify the emissivity value being used, you can test the emissivity of a target sample in the following lab setup:

1. Embed a thermocouple (30 or 36-gauge wire recommended) just under the surface to be viewed and heat the target to the desired temperature range. Allow the temperature indication from the thermocouple to stabilize.

2. Aim the thermometer sensor at the surface of the target sample (close to where the thermocouple is installed). Observe the temperature indication and adjust the Emissivity value setting so that this temperature indication matches the thermocouple reading. The value of the setting is the target emissivity.

Using Relative Readings

True temperature readings are not always necessary. Relative temperature readings may suffice in applications where temperature variations, rather than precise temperature values, are of interest. It is not necessary to know the target's emissivity for relative temperatures. Meaningful relative temperatures can be obtained if (a) the Emissivity value setting is kept constant and (b) the target objects to be viewed are of similar form and composition.

For relative readings we suggest an Emissivity setting of 1.000.

The more times reflected radiation "bounces" on a surface, the less reflective the target. This is because the surface absorbs more of the radiation at each "bounce", leaving less and less radiation to be reflected away from the surface.

Since targets that are less reflective have higher emissivities, the rough surface and the cavity, illustrated below, represent increasingly higher emissivity values —even though they are made from the same material as the polished surface.

It is best to measure targets with high emissivity values. High reflectance of f or transmittance through the target introduces the possibility of measurement error due to background interference. Be sure to follow the precautions in Section 7.2 b when measuring targets with emissivities less than about 0.8.

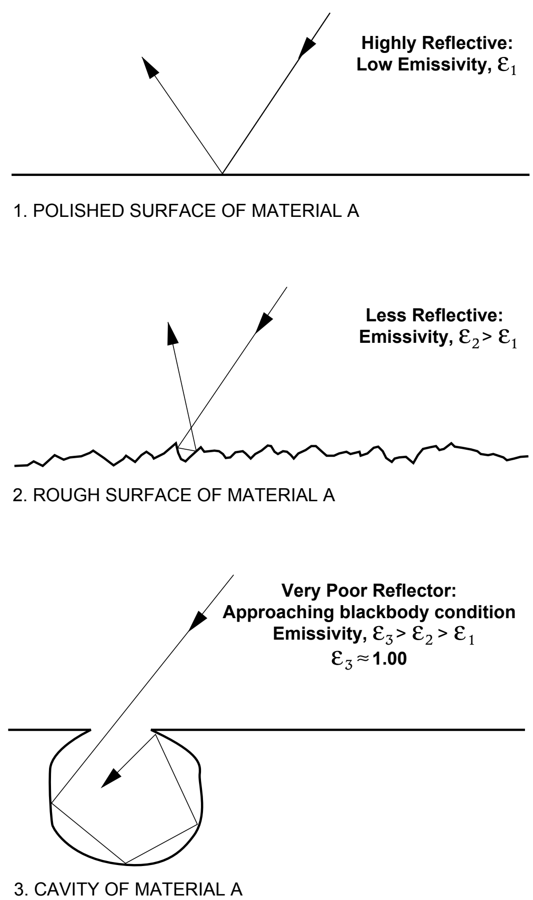


FIG. 7.1 – REFLECTED RADIATION

7.2b – PRACTICAL LIMITS ON EMISSIVITY

While all MODLINE 3 instruments are capable of emissivity settings of 0.100 to 1.000 it is not always advisable to use the lower emissivity settings.

Potential interference and temperature measurement errors in any given measurement situation are aggravated by a combination of decreasing target emissivity and decreasing target temperature with respect to surrounding temperatures.

For example in Fig. 7.2 the diagram illustrates target emissivity-vs-target temperature combinations to be avoided for the MODLINE 3 Series Sensors.

- In Fig. 7.2 the Series 600 Sensor; avoid measurements below 300 °F Target Temperature with an Emissivity of 0.3.
- In Fig. 7.2 the Series 800 Sensor; avoid measurements below 300 °F Target Temperature with an Emissivity of 0.45.
- In Fig. 7.2 the Series 340 and 700 Sensors; avoid measurements below 300 °F Target Temperature with an Emissivity of 0.6.

It is not to say that measurements cannot be made under these conditions, but special precautions will undoubtedly be necessary and measurement problems may be anticipated. If you are operating under these conditions and encounter measurement problems please call IRCON for advice, see Section 5.9 for a phone number.

Refer to Section 7.3 for further guidelines on practical emissivity limits specific to Series 3W and 3V Sensors.

Section 7.9 shows the guidelines on practical ambient temperature limits for the MODLINE 3 Series Sensors.

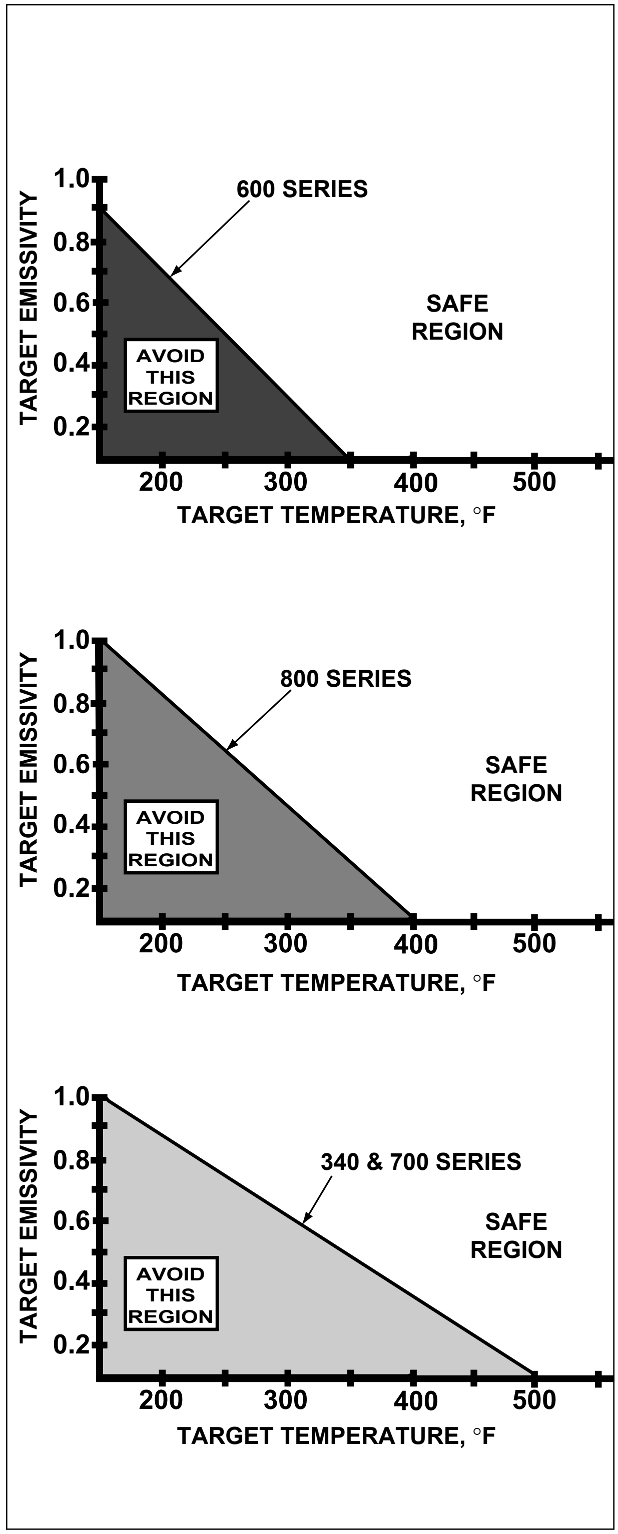


FIG. 7.2 – PRACTICAL LIMITS ON EMISSIVITY

TABLE 7.1 - EMISSIVITY VALUES of METALS AND ALLOYS (Flat, Unoxidized Surfaces)

- Emissivity ranges shown represent differences in surface finish: mirror quality finish to dull, mill finish
- Values for low-emissivity entries can be significantly greater than shown if surfaces are even slightly contaminated

MATERIAL	EMISSIVITY RANGE BY SENSOR SERIES					
	200, 3W & 3 V	3G	600	340	700	800
Alumel	0.40-0.60	0.35-0.50	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Aluminum	0.05-0.20	0.04-0.16	0.03-0.15	0.03-0.15	0.03-0.15	0.03-0.15
Brass	0.15-0.30	0.10-0.25	0.08-0.20	0.05-0.20	0.05-0.15	0.03-0.15
Bronze	0.20-0.40	0.15-0.30	0.10-0.25	0.08-0.20	0.08-0.20	0.05-0.20
Chromel	0.40-0.60	0.35-0.50	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Chromium	0.40-0.60	0.35-0.50	0.30-0.45	0.25-0.35	0.20-0.30	0.10-0.2
Cobalt	0.25-0.40	0.20-0.35	0.15-0.25	—	—	—
Constantan	0.25-0.40	0.20-0.35	0.15-0.25	—	—	—
Copper	0.05-0.20	0.04-0.16	0.03-0.15	0.03-0.15	0.03-0.15	0.03-0.15
Gold	0.05-0.20	0.04-0.16	0.03-0.15	0.02-0.15	0.02-0.15	0.02-0.15
Inconel	0.40-0.60	0.35-0.50	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Iron	0.35-0.50	0.25-0.40	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Iron, Cast	0.35-0.50	0.25-0.40	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Lead	0.25-0.40	0.15-0.25	0.10-0.20	—	—	—
Molybdenum	0.35-0.50	0.25-0.40	0.20-0.35	0.15-0.30	0.10-0.25	0.10-0.25
Monel	0.40-0.60	0.35-0.50	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Nichrome	0.40-0.60	0.35-0.50	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Nickel	0.30-0.50	0.25-0.40	0.15-0.30	0.10-0.25	0.05-0.25	0.05-0.20
Platinum	0.25-0.35	0.20-0.30	0.15-0.25	—	—	—
Silver	0.05-0.20	0.04-0.16	0.03-0.15	0.03-0.15	0.03-0.15	0.03-0.15
Steel, Carbon	0.35-0.50	0.35-0.40	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Steel , Stainless	0.40-0.60	0.35-0.50	0.20-0.35	0.15-0.25	0.10-0.25	0.10-0.25
Tantalum	0.20-0.60	0.15-0.30	0.10-0.30	0.08-0.20	0.08-0.20	0.05-0.15
Titanium	0.40-0.60	0.30-0.50	0.20-0.35	—	—	—
Tungsten	0.35-0.50	0.25-0.40	0.10-0.25	0.05-0.20	0.05-0.20	0.05-0.20
Vanadium	0.35-0.50	0.30-0.40	0.25-0.35	0.20-0.30	0.15-0.25	0.15-0.25
Zinc, molten	0.20-0.40	0.15-0.30	0.10-0.25	—	—	—

TABLE 7.2 - EMISSIVITY VALUES of OXIDIZED METALS AND ALLOYS (Flat Surfaces)

- Emissivity ranges shown represent differences in surface finish: smooth finish to rough, grainy finish
- Oxide film assumed to be sufficiently thick to avoid thin film interference effects

MATERIAL	EMISSIVITY RANGE BY SENSOR SERIES					
	200, 3W & 3 V	3G	600	340	700	800
Alumel , oxidized	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85
Aluminum , anodized	—	—	—	0.40-0.80	0.20-0.80	0.20-0.55
Brass, oxidized	0.50-0.80	0.50-0.80	0.50-0.80	—	—	—
Bronze, oxidized	0.50-0.80	0.50-0.80	0.50-0.80	—	—	—
Chromel , oxidized	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85
Chromium, oxidized	0.40-0.80	0.40-0.80	0.40-0.80	—	—	
Cobalt , oxidized	0.40-0.80	0.40-0.85	0.40-0.80	—	—	—
Constantan, oxidized	0.60-0.85	0.60-0.85	0.60-0.85	—	—	—
Copper , oxidized	0.40-0.80	0.04-0.80	0.40-0.80	0.40-0.80	0.40-0.80	0.40-0.80
Inconel , oxidized	0.80-0.90	0.80-0.90	0.80-0.90	0.80-0.90	0.80-0.90	0.80-0.90
Iron , oxidized	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95
Iron, Cast , oxidized	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.10-0.95
Molybdenum, oxidized	0.50-0.80	0.50-0.80	0.50-0.80	—	—	—
Monel , oxidized	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85
Nichrome , oxidized	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85	0.60-0.85
Nickel , oxidized	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95
Steel, Carbon, oxidized	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95
Steel , Stainless, oxidized	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95	0.80-0.95
Tantalum , oxidized	0.40-0.80	0.40-0.80	0.40-0.80	—	—	—
Titanium , oxidized	0.50-0.80	0.50-0.80	0.50-0.80	—	—	—

TABLE 7.3 - EMISSIVITY VALUES of MISCELLANEOUS MATERIALS (Bulk, Normal Form)

- Unless otherwise noted, these materials have no transmittance in their normal form
- Emissivity ranges shown for opaque materials represent differences in surface finish: smooth, polished finish to rough, uneven finish
- Emissivities of partially transparent materials (*) will also increase with sample thickness

MATERIAL	EMISSIVITY RANGE BY SENSOR SERIES						
	200 & 3W	3V	3G	600	340	700	800
Asphalt, Tar, Pitch	—	—	—	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00
Carbon, Graphite	0.75-0.90	0.75-0.90	0.70-0.85	0.65-0.80	0.60-0.80	0.50-0.75	0.45-0.70
Cinders, Slag, Cinkers	0.85-0.95	0.85-0.95	0.85-0.95	0.85-0.95	0.85-0.95	0.85-0.95	0.85-0.95
Coke	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00
Firebrick[1], ~2" thick[1]							
high purity alumina*	<0.20	<0.50	<0.20	<0.20	<0.20	0.80-0.90	0.95-1.00
high purity aluminum* silicate (Mullite)*	<0.20	<0.20	<0.20	0.20-0.50	0.30-0.70	0.95-1.00	0.95-1.00
Foods, bulk (fruits, vegetables, oils meats, bakery goods, etc.)	—	—	—	—	0.95-1.00	0.85-1.00	0.95-1.00
Gallium Arsenide solid polished, 0.5 mm-thick wafer	—	0.70	—	—	—	—	—
Glass, commercial soda-lime[1]							
0.05" thick*	<0.05	—	<0.05	0.05-0.10	0.40-0.60	0.95-1.00	0.98-1.00
> 4" thick	0.95-1.00	—	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00	0.98-1.00
Oil, animal or vegetable 0.040"	—	—	—	—	0.95-1.00	0.75-0.90	0.95-1.00
Oil, mineral 0.040"	—	—	—	—	0.95-1.00	0.20-0.30	0.95-1.00
Paints, oil or water base[2]							
on metal*	—	—	—	—	0.85-1.00	0.10-0.40	0.90-1.00
on plastic or wood*	—	—	—	—	0.85-1.00	0.70-0.90	0.90-1.00
Paper, Cardboard	0.20-0.40	0.15-0.30	0.10-0.25	—	0.90-1.00	0.40-0.70	0.90-1.00

[1] Highly variable. Values for low emissivity entries can be significantly greater than shown if even small amounts of impurities are present.

[2] Paints with metallic pigments may have much lower emissivities.

TABLE 7.3 - EMISSIVITY VALUES of MISCELLANEOUS MATERIALS (Continued)

MATERIAL	EMISSIVITY RANGE BY SENSOR SERIES 200 & 3W	3V	3G	600	340	700	800
Plastics							
all≥ 1/8" thick	—	—	—	0.90-1.00	0.60-0.80	0.50-0.75	0.45-0.70
polyester film (mylar) 0.0002" thick*	—	—	—	~0.10	~0.35	~0.20	0.90-1.00
polyethylene film, 0.0002" thick*	—	—	—	~0.10	0.95-1.00	~0.05	~0.05
Rubber	—	—	—	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00
Salt Baths	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00	—	—	—
Silicon, solid polished 0.5 mm-thick wafer	(Series W only) 0.68	0.68	—	—	—	—	—
Silicon, molten	0.30	0.30	0.30	—	—	—	—
Silicon, Carbide	0.80-0.85	0.80-0.85	0.80-0.85	0.80-0.85	0.80-0.85	0.80-0.85	0.80-0.85
Textiles, Fabrics							
Carpet (cotton, wool, synthetic)	—	—	—	—	0.95-1.00	0.85-1.00	0.95-1.00
Fabrics, close weave (cotton, wool, synthetic) *3	—	—	—	—	0.85-1.00	0.40-0.80	0.85-1.00
Leather	—	—	—	—	0.95-1.00	0.95-1.00	0.95-1.00
Water, 0.0002" film4	—	—	—	—	0.95-1.00	0.80-0.90	0.95-1.00
Wood	—	—	—	—	0.85-1.00	0.70-0.90	0.90-1.00

[3] Emissivity values may be significantly lower than shown for very sheer materials.

[4] Note that objects with even a very thin coating of water have very high emissivities.

Section 7 — APPLICATIONS GUIDE

7.3 SPECIAL PRECAUTIONS FOR SERIES 3W AND 3V SENSORS

Practical Limits on Emissivity

The 3W Series and 3V Series Sensors are sensitive to low levels of infrared radiation and therefore operate at extremely low signal levels. Adhering to the following guidelines will ensure that there is sufficient signal to maintain the instrument's specified accuracy:

For target temperatures in lower 20% of instrument's range:
minimum emissivity setting = 0.4

For target temperatures in upper 80% of instrument's range:
minimum emissivity setting = 0.1

Avoiding Background Interferences

As described in Section 7.5, the temperature measurement is susceptible to errors caused by background interferences whenever the target emissivity is less than one. Due to the fact that 3W and 3V Series Sensors are extremely sensitive, they are particularly susceptible to these interferences. As the target temperatures drop relative to the surrounding temperatures, the background interference becomes increasingly significant. Therefore, you must take special precautions to ensure that background radiation does not interfere with your measurements.

A good method of doing this is to experiment with your measurement setup. Use your 3W Series or 3V Series instrument to measure your target. One by one, shield or eliminate each potential interference source, noting for each if there is any variation in the measured temperature. If there is, you will have to rearrange the viewing geometry or make sure that source is eliminated or blocked with a cool, opaque shield during future measurements.

Some examples of possible sources of background interference are:

- Bare tungsten filament bulbs
- Fluorescent lights
- Sunlight
- Other objects of comparable temperature or higher temperature than the target.

Note that for test purposes, the shield may be simply a sheet of plywood, cardboard, or sheet metal. Then a permanent solution may be devised.

Fluorescent lights cause much less interference than tungsten filament bulbs, so whenever possible you should switch from tungsten filament to fluorescent lighting.

Optical spillage is also something that may be of importance to these relatively sensitive instruments. Although the reticle seen in the viewing telescope defines where nearly all the detected radiation comes from, a very small percentage of radiation from outside the reticle is also detected. This is called optical spillage or "size of source effect." It is a characteristic of all optical systems.

Spillage can be a problem, if there is a much higher temperature source such as a heater, present near the target. If this source is not completely blocked, the sensor may detect some of it's radiation - even though it lies outside the cone of vision.

When extraneous radiation is detected, even though the radiation thermometer is sensitive to only a very small percentage of it, it can still have an overwhelming ef fect on the indicated temperature. The following example refers to Fig. 7.3, which shows the graphs of relative detector signal vs. target temperature for both the W Series and the V Series spectral regions.

EXAMPLE:

A 3V Series Sensor views a 400 °C opaque target that is heated by a 1000 °C coil located behind it. Although the target completely fills the reticle, a total of 0.10% of the heater radiance is still detected along with the target radiance. This occurs as a result of optical spillage and pickup of unblocked, stray heater radiation bouncing of f nearby reflective surfaces.

The indicated temperature will be greater than 500°C because of this error . True target temperature is 400°C.

From Fig. 7.3, a 1000 °C object produces a relative signal level of about 40,000 units in a 3V Series instrument, as compared with the relative signal of about 1 for a 400 °C object. Assuming only 0.10% of the 1000°C heater radiance is detected, the portion of the signal produced by the heater radiance is:

40,000 X 0.0010 = 40 units

Thus the small percentage of detected heater radiance still produces a signal that is 40 times larger than the signal produced by the target. Referring back to Fig. 7.3, this translates into an indicated temperature error of more then 100°C.

The indicated temperature will be greater than 500°C, because of this error the true target temperature is 400°C

From this example it can be seen that even less than 1% of background interference can produce a large error in the indicated temperature. Be sure to follow the suggestions given earlier in this Section to insure that background radiance will not interfere with your measurements!

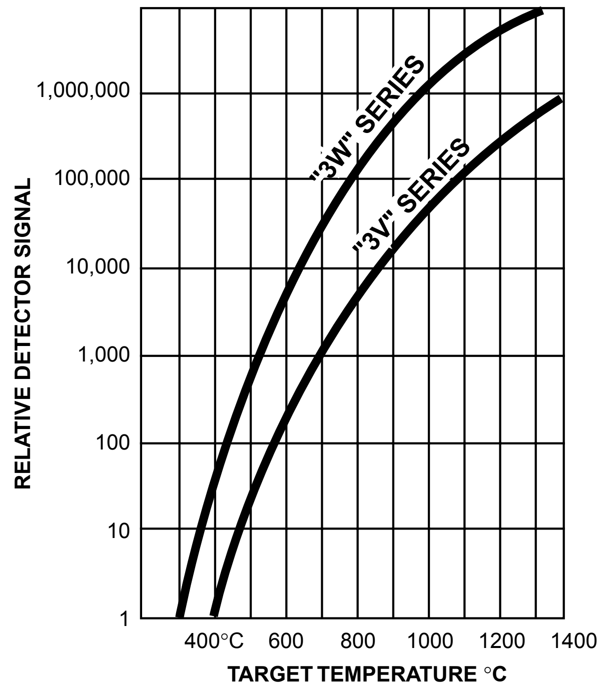


FIG 7.3 - RELATIVE DETECTOR SIGNAL VS. TARGET TEMPERATURE FOR 3W SERIES AND 3V SERIES SPECTRAL REGIONS

Section 7 — APPLICATIONS GUIDE

7.4 E-SLOPE SETTING

Note: This information applies only to Series 3L and 3R Dual W avelength Sensors. For any other MODLINE 3 Series, refer to Section 7.2 Emissivity.

Modline 3 Series 3L and 3R Sensors measure temperature by comparing the relative infrared radiance at two dif ferent wavelengths and com - puting the ratio of the two.

When using a Series 3L or 3R Sensor you must determine the proper selection of the E-slope value. An E-Slope adjustment is provided to allow you to calibrate the MODLINE 3 to measure the temperature of the target material accurately.

Series 3L and 3R Sensors are commonly used for applications involving materials in one of two main classifications, which are:

1. Greybody materials that have emissivities that are the same at both detected wavelengths.

2. Materials with emissivities that exhibit a slope (emissivities that are not the same at both detected wavelengths).

The first of these, the class of greybody materials, contains those materials which have emissivities that are the same at both detected wavelengths. For 3L and 3R Series, T able 7.4 lists the most common greybody materials. When your target is made from any of these materials and are oxi - dized, set the E-Slope Control of your 3L or 3R Series Sensor to a value of 1.00.

The second main classification is a family of metals with emissivity which exhibit a non-linearity (or slope) of approximately 1.06 and 1.03. Materials in this classification are listed in Table 7.5.

TABLE 7.4 – MATERIALS WHICH REQUIRE AN E-SLOPE SETTING OF 1.00

- Blackbody calibration standard
- Cavities in any opaque, isothermal body
- The following metals when worked in air and are subject to oxidizing:

Iron	Cobalt
Steel	Nickel
Stainless Steel	

To measure any of the metals in this class, set the E-Slope control to 1.06 Series 3R Sensors or 1.03 Series 3L Sensors. *Note:* For this setting to be valid, be sure that your viewing surface is clean, smooth, and unoxidized.

If the materials in your process do not fall into either of these categories, you will have to test your product to find the appropriate E-Slope setting. To do this, sight the instrument on a sample target having a temperature which you have accurately determined by some other means (such as a reliable thermocouple). For best accuracy, select a temperature near the center of the instrument's range, or better still, carry out the test at several points throughout its range.

Adjust the E-Slope Setting until the indicated temperature matches the value you have previously determined. Set the E-Slope control to this value whenever measuring this type of target. If you use several tests, average the results and use this value as your E-Slope setting.

TABLE 7.5 – MATERIALS WHICH REQUIRE A 1.06 or 1.03 E-SLOPE SETTING

3R SERIES: E-SLOPE SETTING OF ≈1.06

- Clean, smooth, unoxidized surfaces of the following metals:

Iron	Molybdenum
Molten Grey Iron	Platinum
Cobalt	Rhodium
Nickel	Steel
Tungsten	Stainless Steel
Tantalum	

3L SERIES: E-SLOPE SETTING OF ≈1.03

- Clean, smooth, unoxidized surfaces of the following metals:

  Iron
  Steel
  Stainless Steel

7.5 AVOIDING COMMON MEASUREMENT PROBLEMS

VIEWING ANGLE LIMITATIONS

Acute viewing angles can present problems of reduced emissivity values, particularly if you are dealing with smooth target surfaces.

Fig. 7.4 shows the permissible angles (for all Sensor Series) when viewing smooth surfaced objects such as metals, glass or plastics. Angles up to 45° from the perpendicular usually will not appreciably affect the measurement, although the smaller the angle from the perpendicular the better. In general, angles greater than 45° should be avoided. An increase in reflectance occurs when smooth surfaces are viewed at large angles, and consequently the target emissivity decreases.

BACKGROUND INTERFERENCES

Under ideal circumstances, the radiant energy being measured should be from the target only. This is why you must center the Cone of Vision on the target and make sure that its cross-section (spot size) is smaller than the target. That way the sensor can't "see" past the target into the background. Although the Sensor Series 3L and 3R have somewhat looser restrictions on filling the field of view, it is still affected by background interference if significant sources of background radiation are present.

Significant background radiation comes from comparably hot or hotter objects in the target's surroundings. This background radiation may be reflected off or transmitted through the target, adding to the radiant energy detected by the instrument and resulting in error in the indicated temperature. For all MODLINE 3 Sensor Series except the Series 3L and 3R, this extra radiation, if detected, causes a temperature indication that is higher than the target's true temperature.

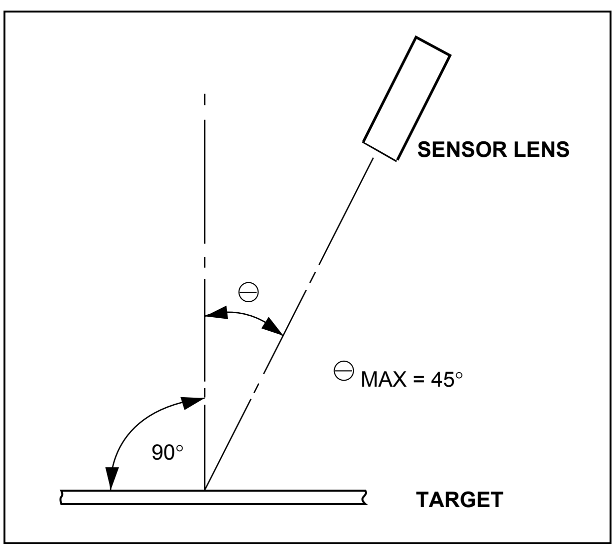


FIG. 7.4 – VIEWING ANGLE LIMITATIONS FOR SMOOTH TARGET SURFACES

For Series 3L and 3R Sensors, background interferences that are slightly cooler than the target result in temperature indications that are too low. When the background temperature is much lower than that of the target, however, the indicated temperature is unaffected. If the interfering background sources are hotter than the target, the indicated temperature is too high. There is no error in the indicated temperature, with a Series 3L and 3R Sensors, when the background temperature matches the target temperature.

Whenever you operate your instrument in an environment where unfiltered background light or heat sources are present, select a viewing arrangement which minimizes these problems.

In general, the higher the target's emissivity, the less susceptible the measurement is to errors. This is because Emissivity (E), Reflectance (R), and Transmission (T) are related as follows:

$$E = 1 - T - R$$

Maximum accuracy is possible when E = 1.0 (blackbody condition). In this condition there is no reflection and no transmission of background energy to cause measurement errors.

As emissivity decreases it is harder to get accurate readings because reflectance and/or transmittance become more pronounced. Use caution when attempting to measure materials with emissivity values known to be 0.8 or less. When using Series 3W or 3V Sensors, special precautions against background interference are usually necessary. Refer to Section 7.3 if you are using either of these two Sensor series.

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Avoiding Transmission Effects

If the target has some transmission at the operating wavelength, it can act as a window for infrared emission from objects behind it (e.g. an oven wall or heating element). Such problems can sometimes be corrected by changing the viewing angle so that the background source is not directly behind the target, by selecting a different measurement point away from the background source, or by inserting a cooled shield behind the workpiece. See Fig. 7.5 for examples. These considerations apply to all Sensor series.

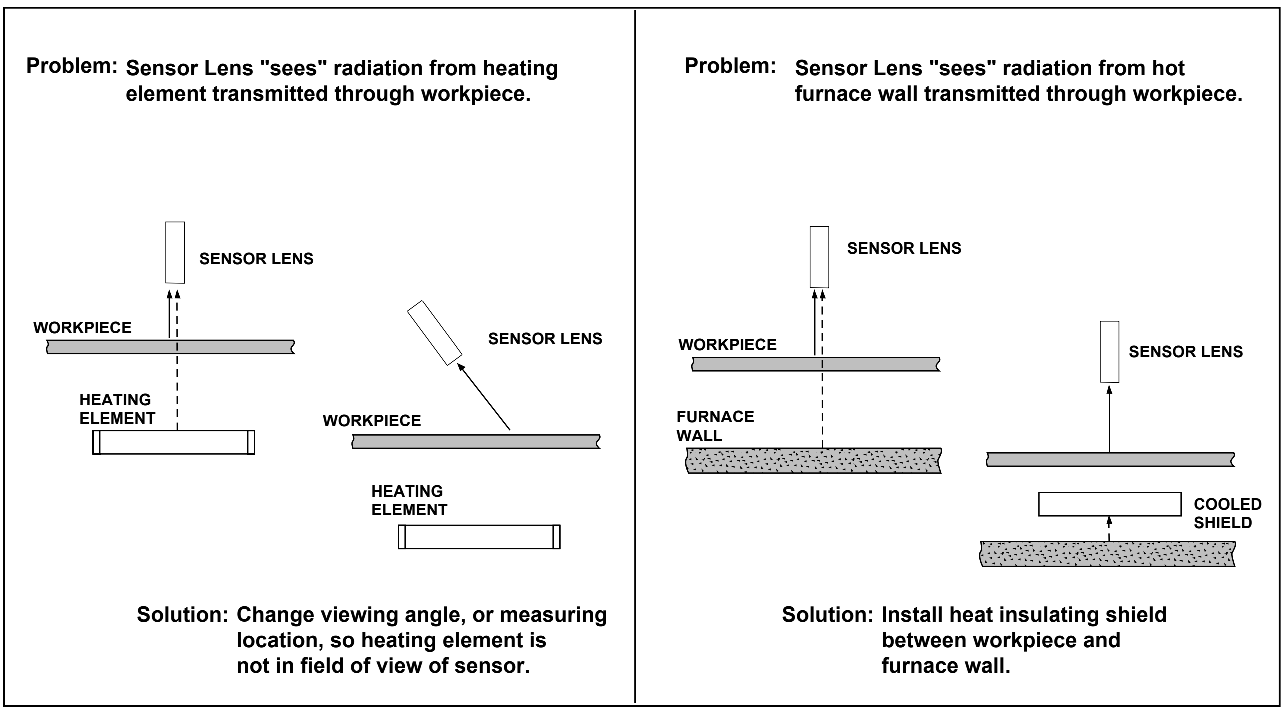

FIG. 7.5 – SOLVING COMMON TRANSMISSION PROBLEMS

Avoiding Reflectance Effects

If the target has some reflectance, it acts as a mirror and reflects infrared energy generated by other sources (e.g. a furnace wall or heating element). If the Sensor picks up the reflection, measurement errors will result. Reflectance depends on the target material and the condition of its surface. Flat, smooth surfaces tend to have larger reflectance values than roughened surfaces of the same material. Reflectance problems may be reduced by changing the viewing angle so that the reflection is not picked up by the Sensor, or by the use of sight tubes or some other form of shielding. (See Fig. 7.6 for examples.) These considerations apply to all Sensor Series.

Transmission Path

Materials in the transmission path may absorb infrared radiation, reducing the amount of radiant energy an instrument receives. This is less of a problem for Series 3L and 3R Sensors, as long as the radiance at both detected wavelengths is reduced equally. For any other Sensor Series, a poor transmission path causes the indicated temperature to be lower than the target's true temperature. These problems may be minimized by keeping the System's optical components clean, and by selecting a sight path for which the entire optical cone between the target and the instrument is free of solid objects, dust, smoke, and evaporates. Sight tubes, shown in Fig. 7.6, can be used for this purpose. For information on the use of windows, refer to Section 7.7.

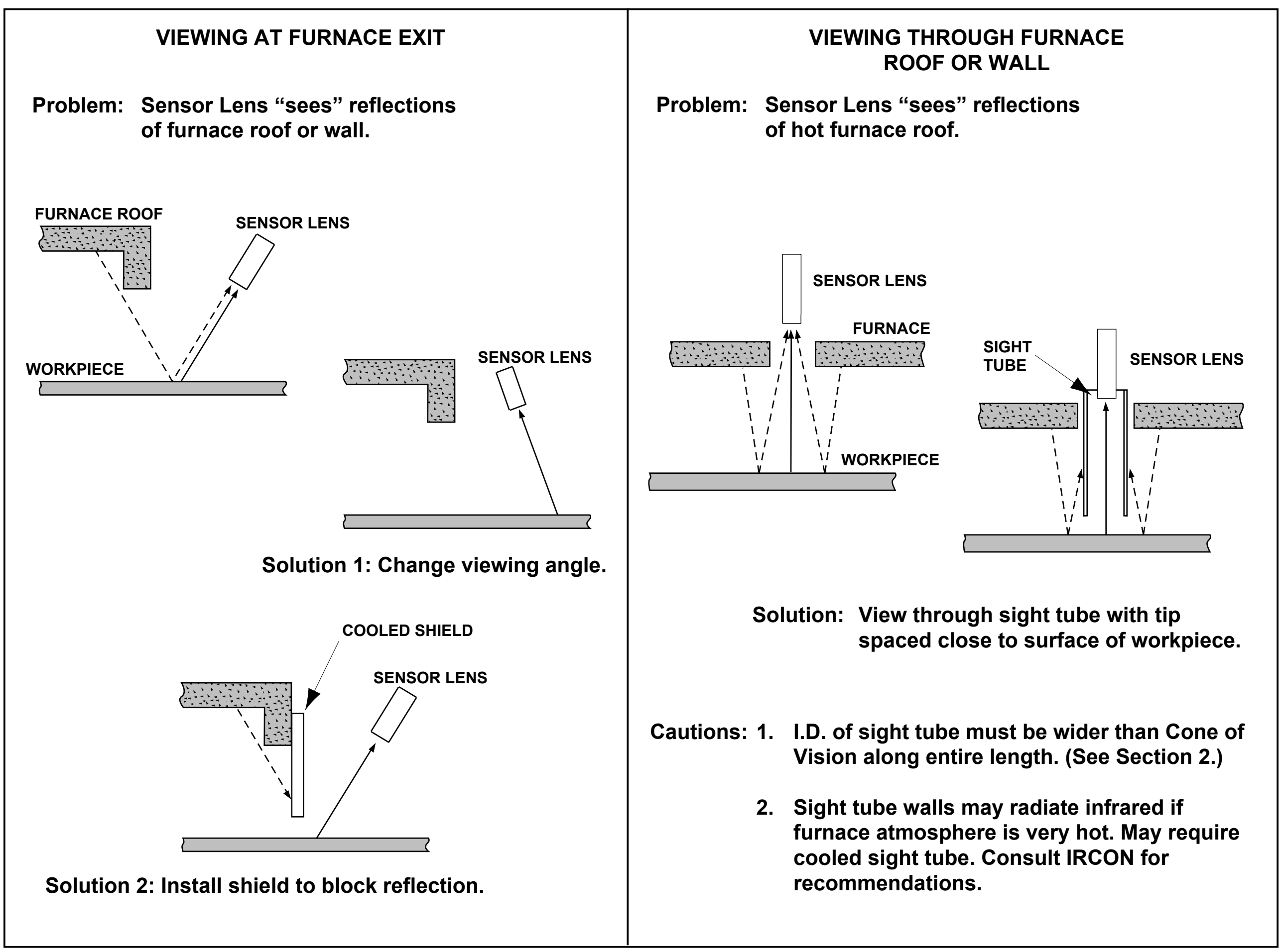

FIG. 7.6 – SOLVING COMMON REFLECTANCE PROBLEMS

Section 7 — APPLICATIONS GUIDE

7.6 INDIRECT VIEWING

In rare situations it may be difficult, if not impossible, to position the Sensor for a direct view of the desired target surface. You may then find it necessary to view the target indirectly by means of a mirror.

Mirror material, surface area and alignment are critical in this application. In all cases the mirror must be a first surfaced (front surfaced) mirror, and ideally it should be a perfect reflector at the operating wavelength of the Sensor.

A first surfaced, flat, aluminized or gold mirror may be used for all standard Sensor Series except Series 3L and 3R. This type of mirror is readily available from optical supply houses. For Series 3L and 3R Sensors only, the mirror must be a front surfaced, gold coated mirror. (Aluminum coated mirrors show a small coloring effect in the Series 3L and 3R spectrum, causing the instrument to read low. This low reading error may be corrected by the E-Slope adjustment, but a gold mirror is preferred.)

As indicated in Fig. 7.8, the Cone of Vision extends from Sensor-to-mirror-to-target. The mirror effectively bends the cone but does not change its shape.

There are two spot sizes to consider in Fig. 7.7: spot size d1 at the mirror surface (distance D_1) and spot size d2 at the target surface (distance D_2). Mirror and target areas must be at least twice the cone diameter at their respective distances.

The mirror must be positioned (and angled) so that the axis of the reflected target image coincides with the optical axis of the Sensor. You should be able to accomplish the alignment without difficulty by sighting through the viewing telescope.

Be sure to lock the mirror firmly in position, and check the alignment on a regular basis. Also, inspect and clean the mirror (in manner recommended by the manufacturer) as part of your regular maintenance routine.

If you have any trouble in obtaining an appropriate mirror or in erecting your system, please contact IRCON for recommendations.

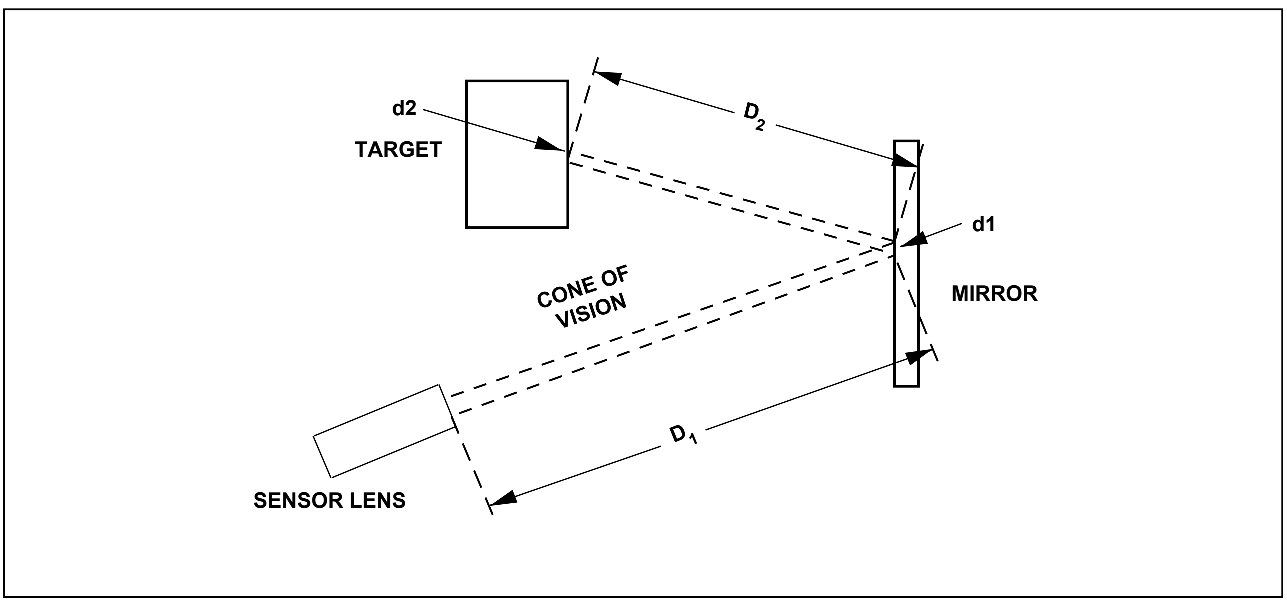

FIG. 7.7 – EFFECT OF MIRROR ON OPTICAL CONE

7.7 USE OF WINDOWS

If it is desirable to view an object in an inert atmosphere or vacuum, you must use an infrared-transmitting window. Selection of an appropriate window material will depend on the Sensor's spectral response. Some suggested window materials for various Modline 3 Sensor Series are listed in the Window Selection Guide (Table 7.6).

It is good practice to make a window at least twice the diameter of the Cone of Vision at the point where the window is to be installed. Note that the dimensions of the Cone of Vision can be changed by focusing the optics. It is essential for all Sensor Series except Series 3L or 3R that you never allow any part of the Cone of Vision to be obstructed, as illustrated in Fig. 7.8. Also keep the window clean, or low temperature indications will result.

For all Sensor series, except: Series 3L or 3R. The window material must be highly transparent in the Sensor's infrared spectral region. Yet there is always some signal loss due to reflection or absorption when using a window. To compensate for this loss, first multiply the emissivity of the target object by the window's transmission factor (T) shown in the Window Selection Guide. Then adjust the emissivity setting to this value.

EXAMPLE:

Emissivity of object = 0.8
Transmission factor of window = 0.92
Emissivity setting = 0.8 X 0.92 = 0.74

The window specifications given at the top of the chart are suitable for most applications. However, high pressure applications may require windows that are thicker than 1/8" (3 mm). Be aware that transmission of thicker windows may be significantly degraded.

SPECIAL CONSIDERATION FOR SERIES 3L and 3R SENSORS

Because Series 3L or 3R Sensors compare the radiation detected at two separate wavelengths, the best windows for these units have the same transmission value at both wavelengths. All acceptable Series 3L or 3R windows specified in the Guide have this characteristic. No additional E Slope adjustment is required when these windows are used.

Note that certain materials which seem transparent to the human eye can cause serious measurement errors when you use a Series 3L or 3R Sensor. For instance, it almost always causes problems if any of soda-lime plate glass, "PLEXIGLAS ™", water, or "PYREX™" glass lies between the Sensor and the target during a measurement. Similarly, if you need to reflect your target's radiation in order to measure it with a Series 3L or 3R Sensor, use a front surface gold mirror, not a mirror with an aluminum reflecting surface.

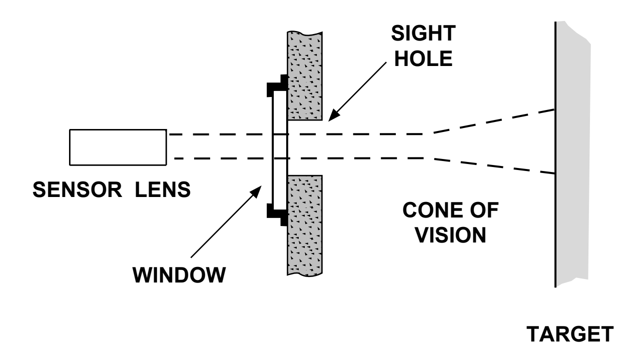

FIG. 7.8 – VIEWING A TARGET THROUGH A SIGHT HOLE AND WINDOW

Section 7 — APPLICATIONS GUIDE

The materials listed in the Guide are not all common optical materials and you may have some difficulty locating a source for windows. If you do, here are some suggestions.

Adolph Meller Optics
P.O. Box 6001
Providence, Rhode Island 02940
401-331-3717

Karl Lambrecht Corp.
4204 Lincoln Ave.
Chicago, Illinois 60618
773-472-5442

Janos Technology Inc.
Route 35
Townshend, Vermont 05353
802-365-7714

TABLE 7.6 – WINDOW SELECTION GUIDE
Showing Window Suitability and Transmission Factor T

AVAILABLE WINDOWS (Specifications: Optical Grade, 1/8 inch thick, Polished to "Plate Glass" Finish)					
Series	PYREX #7740	FUSED QUARTZ (G.E.#124 or eqiv.)	SYNTHETIC SAPPHIRE	CALCIUM FLORIDE	CLEARTRAN (ZnS)
200 3G, 3V, 3W	SUITABLE T = 0.92	RECOMMENDED T = 0.94	SUITABLE T = 0.85	SUITABLE T = 0.94	SUITABLE T = 0.94
3L, 3R	NO	RECOMMENDED T = 0.94	SUITABLE T = 0.85	SUITABLE T = 0.94	SUITABLE T = 0.94
600	NO	RECOMMENDED T = 0.94	SUITABLE T = 0.85	SUITABLE T = 0.94	SUITABLE T = 0.94
340	NO	NO	RECOMMENDED T = 0.88	SUITABLE T = 0.94	SUITABLE T = 0.94
700	NO	NO	NO	RECOMMENDED T = 0.94	SUITABLE T = 0.94
800	NO	NO	NO	SUITABLE T = 0.94	RECOMMENDED T = 0.94

7.8 SPECIAL FOCUSING REQUIREMENTS

(For SLR Sensors)

Should the focusing ranges of the standard Sensor Lens system prove to be inadequate for your needs, optional lens assemblies are available for these Sensors to permit viewing smaller targets. These lens assemblies are interchangeable with - out any need for recalibration of the instrument.

Table 7.7 shows approximate values for the minimum spot size and permissible focusing distances for each lens type. Also shown are the formulas for computing the approximate spot size, given the focusing distance and instrument resolution.

In Table 7.7, D represents the distance range from the front of the mounting flange to the target surface; d is the diameter of the circular area being measured; F is the optical resolution of your instrument.

The Models R-1, A-1, T -1, U-1, and LA-1 are the standard lens assemblies which are normally supplied with their associated sensors. Any other lens assembly must be specially requested.

TABLE 7.7 LENS CHARACTERISTICS FOR SLR TYPE SENSORS

Series or Model	Objective Lens Assembly	Approx.† Working Distance Range		Spot Size at Shortest Working Distance		General Relationship d=D/F
		D (Inches)	D (mm)	D (Inches)	D (mm)	
37-XXX05 33-XXX05	R-1* R-2 R-3	13 - INF. 5 - 8 3 - 4	326 - INF. 127 - 208 76 - 104	0.26 0.10 0.060	6.6 2.54 1.52	D/50 D/45 D/50
37-XXX10 33-XXX10	T-1* T-2 T-3 T-4 T-5	40 - INF. 15 - 27 10 - 12 FIXED AT 6.4 FIXED AT 4.2	1016 - INF. 381- 27 250 - 308 FIXED AT 162 FIXED AT 106	0.40 0.15 0.10 0.06 0.04	10.16 3.81 2.54 1.62 1.06	D/100 D/100 D/100 — —
38-XXX02	U-1* U-2	20 - INF. 10 - 16	508 - INF. 254 - 406	1.00 0.50	25.4 12.7	D/20 D/20
3R-XXX05	A-1* A-2	15 - INF. 9 -15	381 - INF. 229 - 381	0.30 0.18	7.62 4.57	D/50 D/50
3R-XXX10	A-1* A-2	15 - INF. 9 -15	381 - INF. 229 - 381	0.15 0.09	3.81 2.29	D/100 D/100
3R-XXX15	A-1* A-2	15 - INF. 9 -15	381 - INF. 229 - 381	0.10 0.06	2.54 1.52	D/150 D/150
3L-XXX05	LA-1* LA-2	15 - INF. 9 -15	381 - INF. 229 - 381	0.30 0.18	7.62 4.57	D/50 D/50
3L-XXX10	LA-1* LA-2	15 -INF. 9 -15	381 - INF. 229 - 381	0.15 0.09	3.81 2.29	D/100 D/100

* Standard lens type supplied with sensor.
† Tolerance of Working Distance Range is ±10%.
Note: Characteristics are identical for equivalent lens ordered with protective window (i.e.,PW-1 lens characteristics are identical with P-1 characteristics.)

TABLE 7.7 IS CONTINUED ON THE NEXT PAGE

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TABLE 7.7 LENS CHARACTERISTICS FOR SLR TYPE SENSORS (Continued)

Series or Model	Objective Lens Assembly	Approx.† Working Distance Range		Spot Size at Shortest Working Distance		General Relationship d=D/F
		D (Inches)	D (mm)	D (Inches)	D (mm)	
32-XXX02 3W-XXX02 3V-XXX02	P-1* P-2 P-3 P-4 T-5	18 - INF. 7 - 20 4 -7 FIXED AT 2	487 - INF. 177- 508 127 - 203 FIXED AT 50.8	0.90 0.39 0.27 0.18	22.80 9.90 6.85 4.57	D/20 D/18 D/15 —
32-XXX05 3W-XXX05 3V-XXX05	P-1* P-2 P-3 P-4	18 - INF. 7 - 20 4 - 7 FIXED AT 2	487 - INF. 177- 508 127 - 203 FIXED AT 50.8	0.36 0.16 0.10 0.80	22.80 4.06 2.54 20.32	D/50 D/45 D/40 —
32-XXX10 3W-XXX10 3V-XXX10	P-1* P-2 P-3 P-4	18 - INF. 7 - 20 4 - 7 FIXED AT 2	487 - INF. 177- 508 127 - 203 FIXED AT 50.8	0.18 .077 .050 .040	4.30 19.56 12.70 10.20	D/100 D/90 D/80 —
32-XXX20 3W-XXX20 3V-XXX20	P-1* P-2 P-3 P-4 T-5	18 - INF. 7 - 20 4 - 7 FIXED AT 2	487 - INF. 177- 508 127 - 203 FIXED AT 50.8	0.90 .039 .025 .020	22.80 9.90 6.35 5.10	D/200 D/180 D/160 —
32-XXX30 3W-XXX30	P-1* P-2 P-3 P-4	18-INF. 7-20 4 - 7 FIXED AT 2	487 - INF. 177- 508 127 - 203 FIXED AT 50.8	0.60 0.026 0.017 0.012	15.20 0.66 0.43 0.30	D/300 D/270 D/240 —
3G-XXX05	P-1* P-2 P-3 P-4	20 -INF. 10 -40 5 - 8 FIXED AT 1.7	508 - INF. 254- 1016 127 - 203 FIXED AT 43	0.40 0.20 0.125 0.057	10.00 5.08 3.18 1.45	D/50 D/50 D/40 —
3G-XXX15	P-1* P-2 P-3 P-4	20 -INF. 10 -40 5 - 8 FIXED AT 1.7	508 - INF. 254- 1016 127 - 203 FIXED AT 43	0.133 0.074 0.050 0.021	3.38 1.88 1.27 0.51	D/150 D/135 D/100 —
36-XXX15	P-1* P-2 P-3 P-4	18 - INF. 7 - 20 4 - 7 FIXED AT 2	487 - INF. 177- 508 127 - 203 FIXED AT 50.8	0.12 0.052 0.035 0.025	3.04 1.32 0.89 0.64	D/150 D/135 D/115 —

* Standard lens type supplied with sensor.
† Tolerance of Working Distance Range is ±10%.
Note: Characteristics are identical for equivalent lens ordered with protective window (i.e.,PW-1 lens characteristics are identical with P-1 characteristics.)

Examples of Spot Size calculation. Note: Sensor Model 32-20F05 selected for purpose of illustration. Target Distance (within Focusing Range of P-1 or P-2 lens) selected arbitrarily:

Using standard P-1 lens
Sensor Model: 32-20F05 (F = 50)
Target Distance: 60” (D = 60)
Spot Size: d = D/F = 60/50 = 1.2”

Using standard P-2 lens
Sensor Model: 32-20F05 (F = 45)
Target Distance: 60” (D =15)
Spot Size: d = 15/45 = 0.33”

INSTALLATION NOTES

7.9 AMBIENT TEMPERATURE LIMITS

These guidelines describe the Ambient Sensing Head Temperature to Source Temperature for specific Sensors Series: 340, 600, 700, 800, and 3V.

Fig. 7.9 shows some combinations to be avoided. Examples are given, such as:

> Series 700 Sensors can operate in an ambient temperature up to 130°F (55°C).
>
> Series 3V Sensors has an ambient temperature range of 50 to 113°F (10 to 45°C).

When the target temperature is below 300 °F, it is not advisable to operate these Sensors in high ambient temperatures.

The infrared thermometer necessarily views a small portion of its own internal case structure which, like all other materials, emits according to its own temperature. The radiant contribution to the signal reaching the detector is negligible compared to the radiant energy from the target as long as the case temperature is significantly less than that of the target.

Consequently, to avoid measurement errors for low temperature targets the case temperature should not exceed the levels shown in Fig 7.9. This is readily accomplished, even in severe ambients, by using the Model W A-3 Water Cooled Accessory described in Section 6.16. A void using the W A-3 in humid ambients - condensation droplets or a film of water may form on the lens and reduce the reading.

Section 1.5 shows Sensor Series Ambient Temperature Restrictions, as part of the Model Identification Notes. T ables 2.2 and 2F .1 give the Sensor Series Ambient T emperature Ranges as part of the Pre-installation Notes.

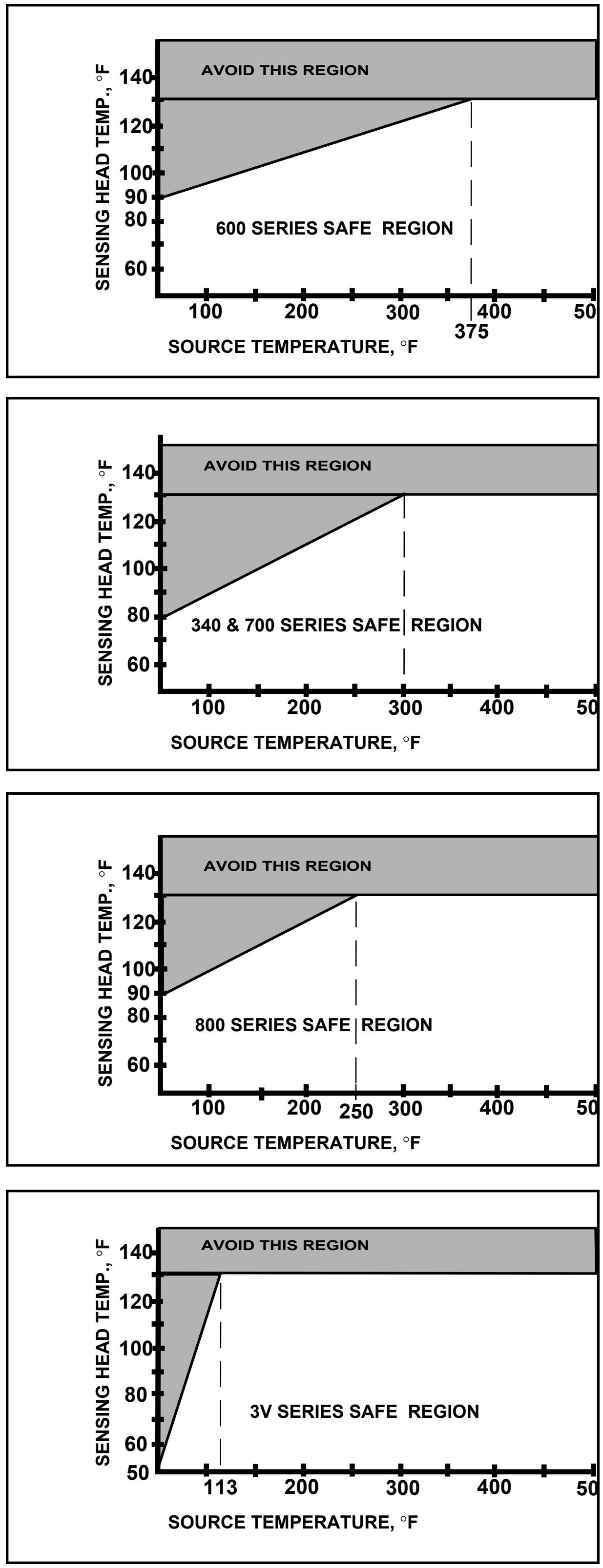


FIG. 7.9 – PRACTICAL LIMITS FOR SENSING HEAD TEMPERATURES

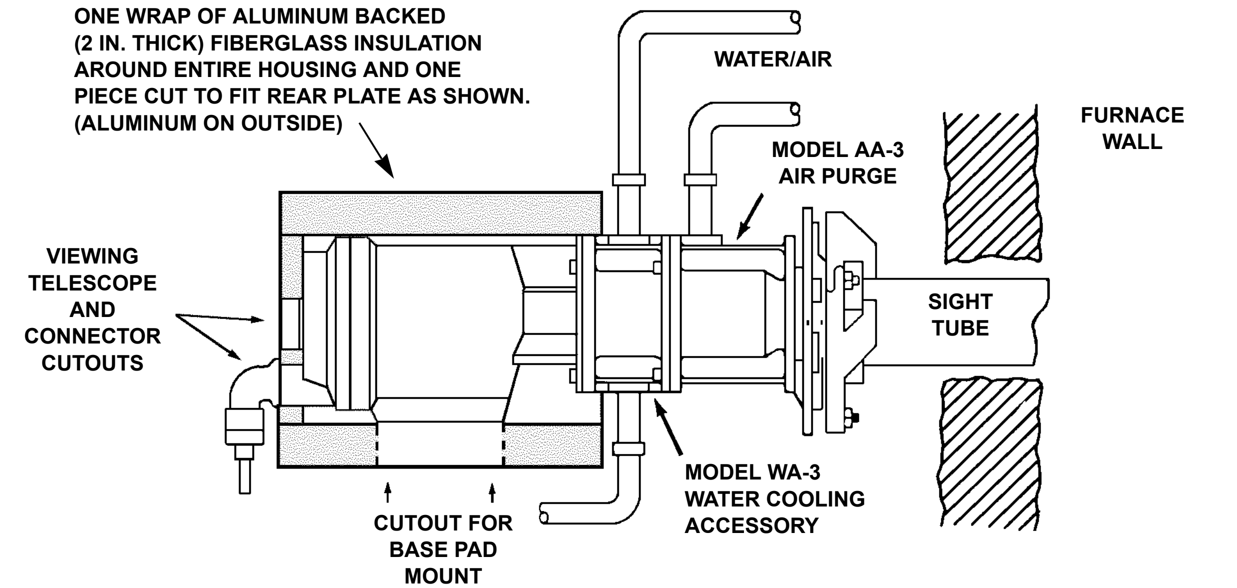


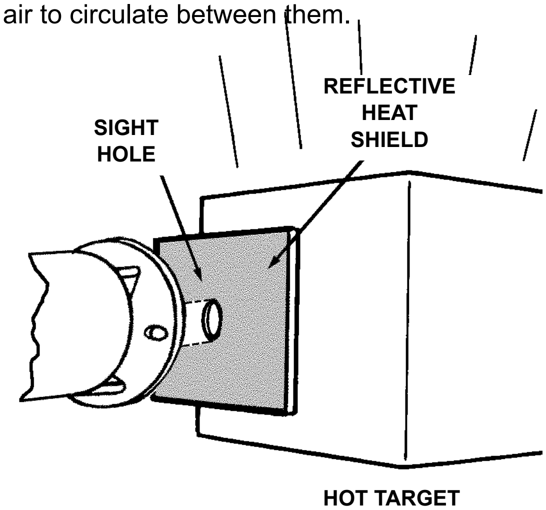
FIG. 7.10 – SUGGESTED INSULATING SHIELD FOR SENSOR

7.10 HEAT SHIELDING

It may be necessary to provide insulation and reflective shielding for some degree of protection from extreme ambient temperature and radiated heat. Sensor housing temperature must not exceed maximum temperature specifications. A Model WJ-5 W ater Cooling Jacket provides this type of protection. It is also possible to provide some degree of protection by using materials available at the installation site.

Fig. 7.10 shows one means of providing insulation protection. In this example a Sensor is mounted at a sight hole cut in a furnace wall. The Sensor is protected from the atmosphere within the furnace by a Model W A-3 Water Cooling Accessory , and is insulated from the atmosphere in the vicinity of the wall by aluminum-backed insulation.

A radiant heat shield can be any reflective metal shield in the path between the heat source and the Sensor, as in Fig. 7.1 1. It should be close enough to the Sensor to block random reflected radiation, but with a space between it and the unit to allow air to circulate between them.



Note: Sight hole must be large enough so heat shield does not obstruct sight path. (See Section 2). Also, Sensor must not contact heat shield.

FIG. 7.11 – PROTECTION BY MEANS OF A REFLECTIVE HEAT SHIELD

Section 7 — APPLICATIONS GUIDE

7.11 FIBER OPTIC LENS POSITIONING

Positioning a Reimaging Lens or Extension Tip

The Reimaging Lens or Extension Tip is the "eye" of the Fiber Optic System. The infrared image it sees is coupled by the Fiber Optic Cable to the infrared detector in the Sensor, which converts the infrared energy to an electrical signal analogous to target temperature.

To measure temperature accurately, the Reimaging Lens or Extension Tip must have a good view of the target object—and *only* the target object. If there are other objects in the field of view, the "eye" will see a combination of images and the detector will read them all to come up with a false temperature signal.

Note: The 3L and 3R Series Sensors are exceptions to this rule. They ignore foreign objects that are *cooler* than the target object. But it is best to strive for an unimpeded view even with the 3L and 3R Series Sensors.

This section offers some simple yet important guidelines that may help you recognize possible problems and avoid them in your installation.

Spot Size vs. Target Size

As shown in Fig. 7.12, a "cone of vision" extends into space from the protective window of a Reimaging Lens or from the tip of the glass rod of an Extension Tip. The circular area of this cone at any distance is the area that will be measured by your instrument.

Reimaging Lens

A Reimaging Lens gives you control of the cone of vision. As shown in Fig 7.12, you can focus the lens to control the cone area, or spot size, at the focus distance. For example, Fig. 7.12 shows a Reimaging Lens with a resolution of D/60 focused at a distance of 30 inches (760mm). The spot size at this distance is 0.5 inch (12 to 13mm). If you move this same lens closer to the target and refocus at a distance of 12 inches (302mm), the spot size is reduced to only 0.2 inch (5mm).

The important thing in setting up your system is to make sure the spot size is *smaller* than the target size. If the spot is larger than the target, the instrument will measure a combination of target temperature and the temperature of the background behind the target.

For large target surfaces this is not likely to present a problem. Simply aim the Reimaging Lens so its spot is centered on the target. But for small targets, try to get the Reimaging Lens as close to the target as possible, so you can focus to a small spot size as shown in Fig. 7.12.

In general, we recommend that target size should be at least twice spot size for reliable measurements.

Extension Tip

An Extension Tip does not have any focus capability. Its cone of vision expands at a fixed rate (resolution of D/3) with distance from the tip of the glass rod. For example, Fig 7.12 shows that the Extension Tip will view a circular area with a diameter of about 1 inch (25mm) at a distance of 3 inches (76mm); a diameter of about 3 inches (76mm)at a distance of about 9 inches (140mm); and so on.

Extension Tips are designed primarily for viewing large target surfaces at short viewing distances. In these cases the D/3 resolution does not create any problems. However, keep the tip-to-target distance as short as possible to avoid any possibility of the spot size extending beyond the edges of the target. The Extension Tip would then see objects beyond the target, and include them in the measurement!

Note: This same reasoning applies if there are foreign objects ahead of your target. The cone could fan out to include these objects before it reaches the target.

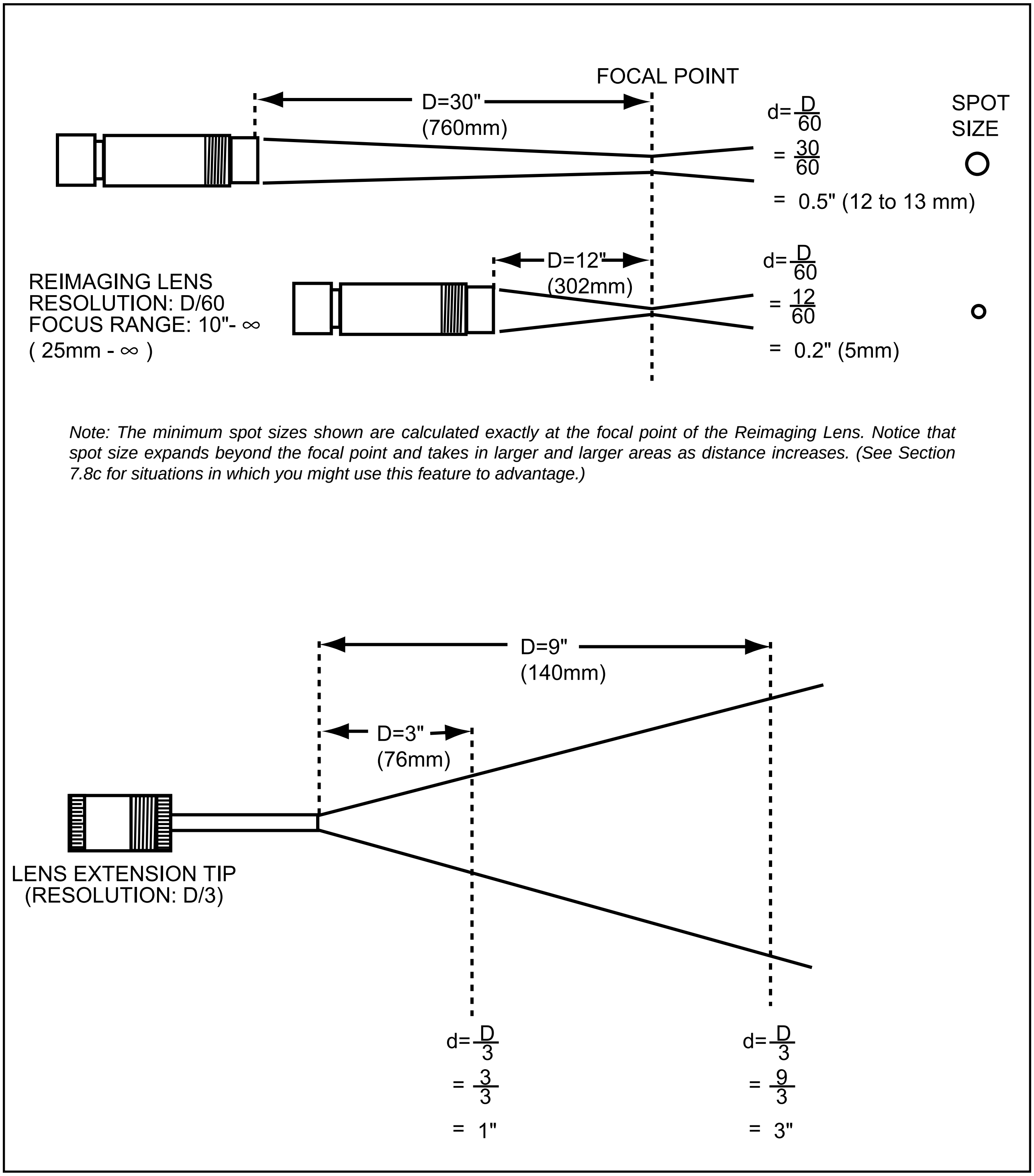


FIG. 7.12 – VIEWING DISTANCE/SPOT SIZE RELATIONSHIPS FOR REIMAGING LENS (Top) AND EXTENSION TIP (Bottom)

Section 7 — APPLICATIONS GUIDE

7.12 GUIDELINES FOR SMALL TARGET SURFACES

Spot size becomes very critical if you are measuring temperature of small target objects. An example of the problem is illustrated in Fig. 7.13. Here a Reimaging Lens is focused on a thin rod, but the cone of vision at the surface of the rod extends well beyond its edges. The cone expands beyond the target and strikes the background behind it. A measurement in this case would include the target *plus* the background.

SOLUTION: Move the Reimaging Lens closer to the target and refocus so the entire spot falls on the target surface.

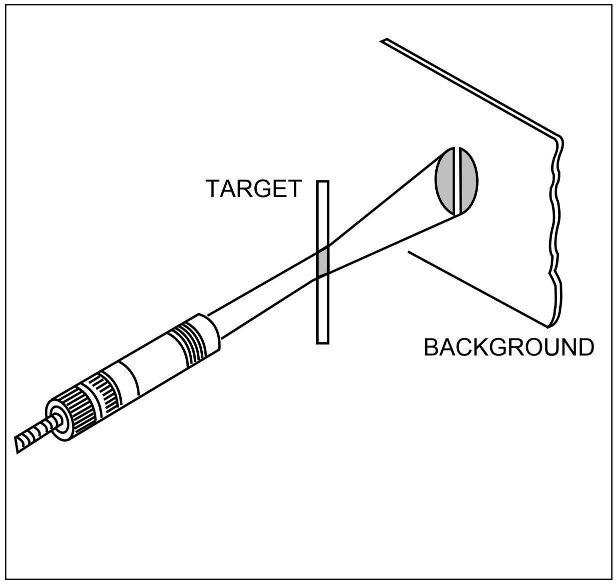


FIG. 7.13 – BACKGROUND PROBLEM IN MEASURING A SMALL TARGET

Fig. 7.14 shows the advantage of a Reimaging Lens with the unique D/30 x D/150 resolution. This lens has D/30 resolution in its long dimension, and D/150 resolution in its short dimension. Thus its spot size is in the form of a rectangle ideal for measuring rods or thin bars, or for threading through narrow areas (e.g. furnace ports) as shown in Fig. 7.14.

CAUTION: If you are using this type of Reimaging Lens, be sure to position the lens so its spot plane conforms to the target plane!

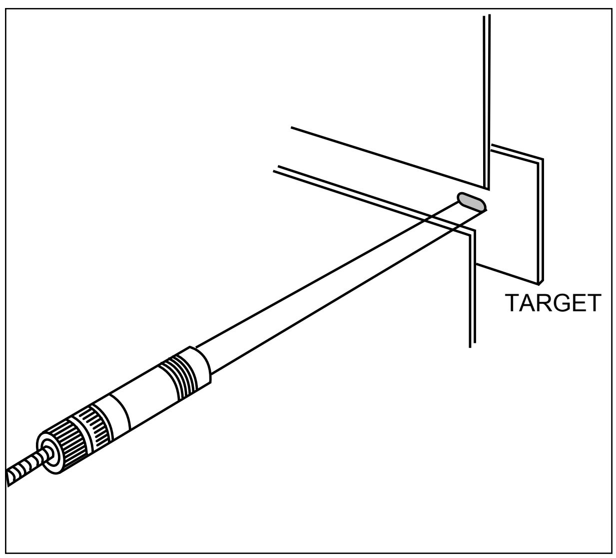


FIG 7.14 – USING THE D/30 x D/150 REIMAGING LENS TO MEASURE THROUGH A NARROW GAP

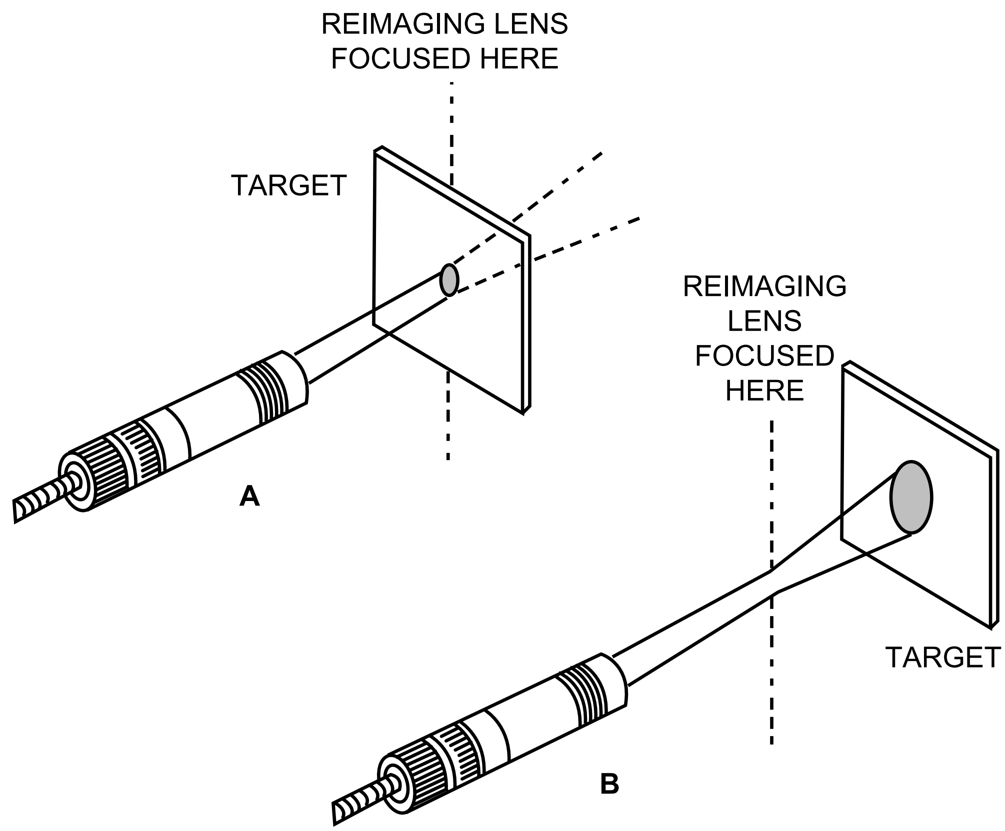


FIG. 7.15 – EFFECT OF REIMAGING LENS FOCUS ON SPOT SIZE

7.13 DEFOCUSING A REIMAGING LENS

In most applications it is desirable to focus a Reimaging Lens at the target surface to get minimum spot size. However , focus is not a requirement for reading temperature. A "defocused" spot will read just as accurately as a "focused" spot.

Fig. 7.15 Area A shows a Reimaging Lens focused on a target surface so it provides minimum spot size. In Fig. 7.15 Area B the Reimaging Lens is focused ahead of the target, so the lens is defocused at the target surface. *Note*: the cone of vision narrows down to the focus distance, then spreads out beyond this distance. The instrument therefore measures a larger area on the target surface.

This can be desirable if you want to measure overall target temperature and avoid hot spots or cool spots that would bias the measurement if a small spot size were used.

7.14 THE IMPORTANCE OF AIMING

If you are dealing with small target surfaces, be very careful in sighting or aiming the Reimaging Lens or Extension T ip when you set up your system. Try to align the optical axis of the lens or glass rod with the center of the target. Make sure your mounting arrangement is secured so that it will not vibrate out of position during operation.

Fig 7.15 shows what happens if you sight at the edge of a target. The cone of vision is in such a position that the left side falls on the target, and the right side extends on to some background object. Your instrument will measure part target and part background and give you a false temperature value.

Note: The same problem would crop up if the "background" in Fig. 7.16 were the "target", and vice versa. Y ou would then be measuring some interfering object ahead of your target, and the measurement accuracy would suffer!

CONCLUSION: Always aim your Reimaging Lens or Extension T ip so its optical axis is centered on the target, and make sure it is secure in this position so it will not drift out of the viewing area.

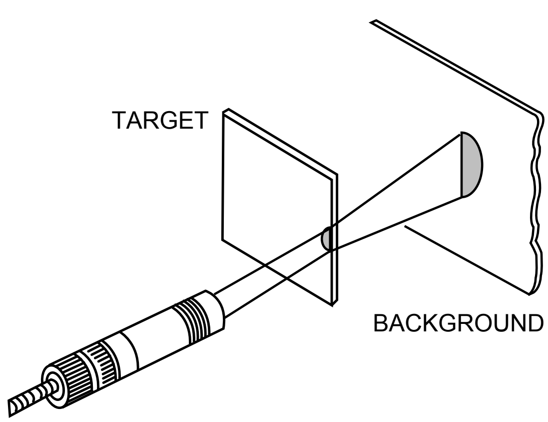


FIG 7.16 – MISALIGNMENT OF REIMAGING LENS WITH TARGET SURFACE

7.15 REIMAGING LENS SPOT CHECK

A spot check on the target surface, using the IRCON Model IL-5 Illuminator or other high intensity light source, is advisable at periodic intervals, especially if you are viewing small targets.

Simply remove the Fiber Optic Cable from the Sensor flange fixture and couple the IL-5 (or other source) to this end of the Fiber Optic Cable, as shown in Fig. 7.17.

Typical spot projections are shown in Fig. 7.18. Observe the spot on the target surface and make any alignment or focus adjustments in case the Reimaging Lens has vibrated or otherwise shifted from its normal viewing position. Spot size requirements vary by application as explained throughout Section 7.

For example, if you are viewing a large target surface you may deliberately defocus the lens to provide a large measurement area. For small targets you may require precise focus to reduce spot size. Fig. 7.18 shows an example of these spot characteristics.

A spot check also serves as a quick inspection routine that can alert you to broken fiber strands in the Fiber Optic Cable. WIth the Reimaging Lens focused precisely on a target that displays a clear image of the spot, and a high-intensity light such as the IL-5 attached to the Sensor end of the Fiber Optic Cable, you will actually see an image of the fibers on the target surface. Fig. 7.18 shows an examples of this type of image.

If a considerable number of fibers are damaged, they will not be visible in the image. Broken fibers will reduce the amount of infrared energy transmitted from target to the detector in the Sensor during normal measurement. A large number of such damaged fibers can reduce the energy transfer to a point where the readings are completely inaccurate.

After you complete the spot check: remove the light source and couple the Fiber Optic Cable to the Sensor flange fixture.

7.15 REIMAGING LENS SPOT CHECK (Continued)

Perform the Illuminator setup, as described in Fig. 7.17.

To perform the spot check, you will need a high-intensity light source such as the IRCON Model IL-5 Fiber Optic Illuminator or equivalent. More information about the IL-5 Fiber Optic Illuminator is provided in Section 6.

- IMPORTANT! Do not continuously flex a fiber optic cable.
- Bends in the Fiber Optic Cable must have a radius of at least 3 inches (76 mm).
- Fiber Optic Cable must not be immersed in water or subjected to liquid spray. Liquid seeping through the armor sheath can erode and damage the glass fibers inside.

1. Couple one end of the Fiber Optic Cable to the Reimaging Lens. (Observe the keying on the coupler, and rotate it so it mates with the keyway in the Reimaging Lens coupler.) Tighten the locking nut.

2. If you have a Model IL-5 Fiber Optic Illuminator, insert the free end of the Fiber Optic Cable into the Illuminator and secure the coupling. (For any other light source, devise a suitable coupling method.)

3. Loosen the Lens Position Locking Screw on the Reimaging Lens about 1/4 turn to permit focusing. DO NOT remove the screw or loosen it to the extent that the two cylinders of the Reimaging Lens will disengage!

4. Aim the Reimaging Lens at a surface within its focal range, as indicated on the model number label. Turn on the illuminator and observe the light spot on the target surface. If you have a Model IL-5 Illuminator, adjust the light intensity to a comfortable level.

5. Slowly move the rear lens cylinder in and out of the forward cylinder.

FIG 7.17 – ILLUMINATOR CHECK

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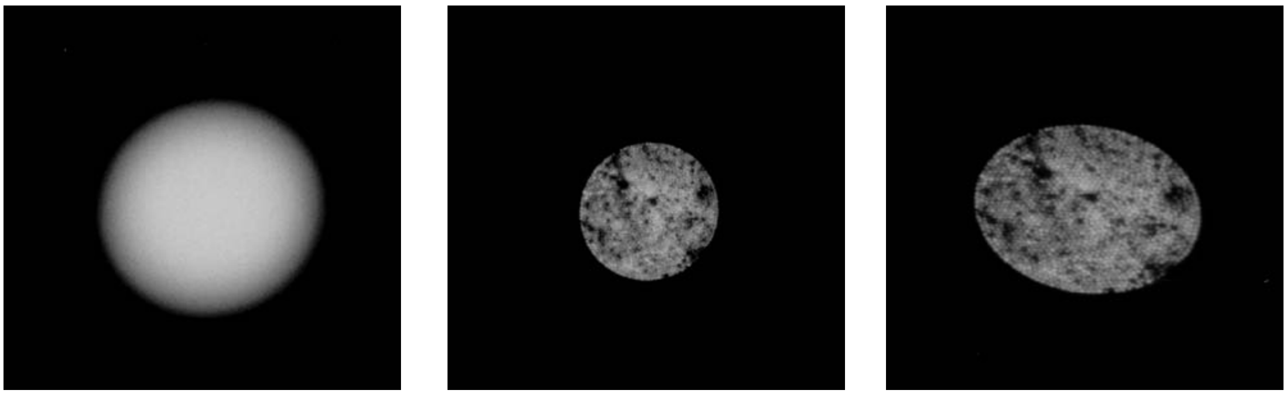
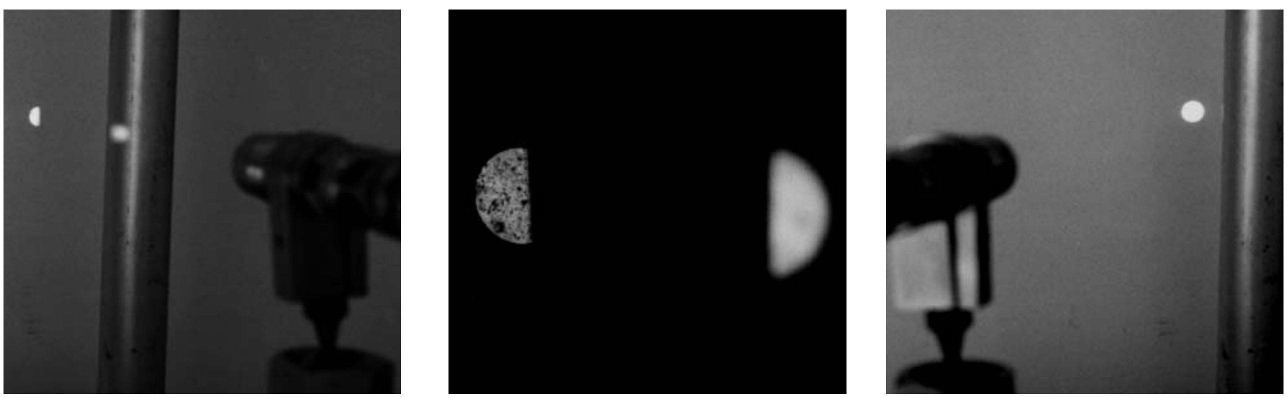
7.15 REIMAGING LENS SPOT CHECK (Continued)

Aiming and refocusing a Reimaging Lens can be difficult if you are dealing with small targets or if you must sight between or around objects in order for the Reimaging Lens to get an unimpeded view.

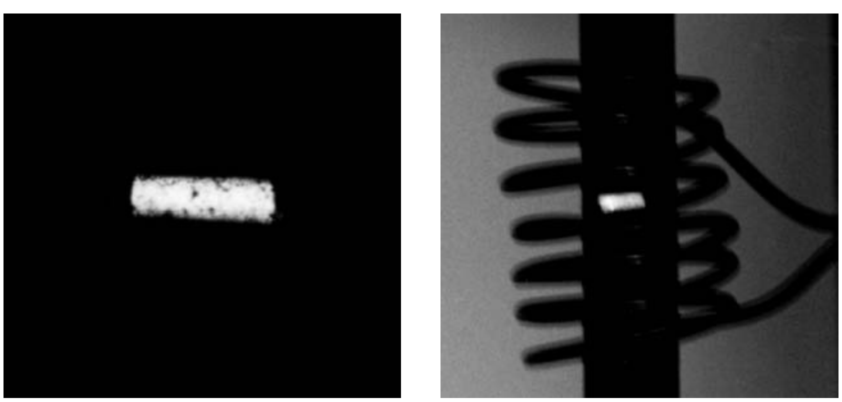
Each sample spot projection, shown in Fig. 7.18, is a spot check showing the exact location and size of the viewing area. Essential details are given in the text below the photos.



Appearance of spot on target surface. *Left:* Spot out of focus. *Center:* With Reimaging Lens focused, fibers (light spots) are clearly visible. (*NOTE:* Dark spaces are spaces between fibers in Fiber Optic Cable.) *Right:* Elongation of spot caused by not viewing at right angle.



Left: Result of interfering object between target and Reimaging Lens. *Center:* Closeup of "two spots" shows two areas that will be viewed by instrument. *Right:* Selecting another view point to avoid interfering object.



Left: Unique rectangular spot provided by instrument with D/30 x D/150 Resolution. *Right:* Using the rectangular spot to measure temperature of bar inside induction heating coil, while avoiding interference from coil turns.

FIG 7.18 – SAMPLE SPOT CHECK RESULTS

Section 8 — DIGITAL COMMUNICATIONS

This section provides information about your MODLINE 3 System RS-485 Digital Communications Interface.

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Section 8 — DIGITAL COMMUNICATIONS

8.1 DIGITAL COMMUNICATIONS

The MODLINE 3 System permits signal interchange with an external device by means of the RS-485 Digital Communications port. The MODLINE 3 System operates using a half-duplex two-wire interface. The System does not support simultaneous transmit and receive.

The Digital Communications message format is described in Section 8.4. Command code descriptions that pertains to programming an external device for communication with the MODLINE 3 System is described in Section 8.5. Section 8.6 lists all command codes by their function groups.

The shielded communications cable required to link the MODLINE 3 System to the external device is not supplied with the system. Specifications for RS-485 Digital Interface Cable are in Section 3.10.

8.2 RS-485 DIGITAL INTERFACE

The interface permits interchange of binary coded information between the MODLINE 3 System and a host computer, PLC (Programmable Logic Controller), or any other RS-485 device.

COMMUNICATIONS FORMAT
Communications are asynchronous with a serial character format of 1 start bit, 7 data bits, 1 parity bit and 1 stop bit forming a 10-unit frame. Data characters are standard ASCII code characters with *even parity*.

BAUD RATE
The Baud Rate selected needs to be either: 19200, 9600, or 2400 to match your RS-485 Device. For details see, Section 4.16 System configuration.

8.3 DIGITAL COMMUNICATIONS OPERATION

It is assumed that all required control and data lines are interconnected, and operating parameters have been selected as described in Section 8.2 to permit orderly message transfer.

The RS-485 Digital Communications interface allows an external device to communicate directly using a half-duplex interface for two-way communication — not only can the external device obtain information from the System, but it can also program the System with new values and modify System settings.

The external device must communicate with the System by sending messages it can understand. Any messages the System sends back will also be in its own “language”. The messages are based on a list of commands described in this section. Any values included in the messages are in decimal form.

Although the specifics of each implementation can differ, you must always set up your external device so that it can send and/or interpret received messages. Whenever there is a need to change a System parameter or a need to obtain information from the System, the external device must send a properly coded message. If there is any error, the System will ignore the message.

In turn, when the System transmits information back to your external device, the response message will be in a standard message format. Your device must be able to interpret the response message.

You can use the Digital Communications command codes as Read-only commands to obtain response readings of current values. Any read only command messages sent from the external device (host/PLC) causes the System to automatically send a status message.

For example, if the external device (host/PLC) sends a read only command to the System to check the emissivity; the System sends a response message containing the current emissivity setting.

All read / write command messages sent from the external device (host/PLC) that change System parameters and automatically echo back with a status message.

For example, if the external device (host/PLC) sends a command to the System to change the emissivity to 0.999; the System change the setting and sends a response message containing the new emissivity setting.

8.4 MESSAGE FORMAT

Table 8.1 shows six areas of the format used for all messages sent to and from the System. Any number of spaces between the command code characters and values is acceptable.

CHARACTER

Area 1 — The # character is the start of the message indicator.

UNIT ADDRESS

Area 2 — The Unit Address is a one-digit entry. The Address generally is left at 0 (zero), which is the factory-default setting. The acceptable addresses are: 0 to 9, a to z and A to Z. The wild card address of ‘ ? ‘ will be accepted by the MODLINE 3 regardless of which address it is set for.

CHANNEL NUMBER

Area 3 — This one-digit entry value is not used in the MODLINE 3 but should be set to 0 (zero) for future compatibility.

COMMAND CODE

Area 4 — The Command Code is two-letter code. All the commands are detailed in Section 8.5.

VALUE

Area 5 — The range of acceptable input value is given for each command code in Section 8.5.

The values entry is optional. If the value is omitted, execution of the instruction will return the present value of the parameter involved. If a value is included, however, execution of the instruction will assign the specified value to the parameter.

Area 6 —All messages are concluded with a carriage return (Enter or Return from a keyboard).

SYSTEM RESPONSE MESSAGE

The System response message format is very similar to the Command format:

Area 1 — Start of response message indicator.

Area 2 — Unit Address is the address of the System to which the response applies.

Area 3 —Channel Number generally is left at 0 (zero).

Note: Any alpha-numeric character may appear in this area.

Area 4 — Command Code identifies which command the System is responding to.

Area 5 — Value represents the numerical value requested by the command.

Area 6 — The response message also concludes with a carriage return (Enter or Return from a keyboard).

8.5 COMMAND DESCRIPTIONS

The command code descriptions in this Section are in the following categories:

- Temperature Request
- Setting Adjustments
- System Status Information
- System Configuration
- PID Controller Functions
- On/Off Controller Functions

TABLE 8.1 COMMAND CODE FORMAT

<#>	<Unit Address>	<Channel Number>	<Command Code>	[<Value>]	<cr>
1	2	3	4	5	6

TEMPERATURE REQUEST

Temperature – **TT**

When the MODLINE 3 System receives a Temperature request, it gives a response of the temperature being measured The temperature resolution is 1 °F or °C. This command is a Read Only command.

Range: From low end of System temperature range to high end of System temperature range.

Example if you send: #00**TT**<cr>.
The Response is #00**TT**1007F<cr>. The response indicates that the temperature is currently 1007°F. The Temperature Display may be showing 1008°F, its' logic sees the temperature in fractions and rounds to the next highest number.

For an invalid or undefined condition, the response is: #00**TT -**32256 (8200_{16}).

SETTING ADJUSTMENTS

Emissivity – **EM**

The Emissivity command allows you to set the emissivity value. This command is a Read / Write command.

Range: 100 to 1000 (representing emissivity values from 0.100 to 1.000)

Note: Input values are 1000 times the actual values.

Example if you send: #00**EM**820<cr>. The System sets the emissivity value to 0.820 and responds with #00**EM**820

If you send: #00**EM**<cr> a response of #00**EM**820 contains the current setting.

Note: If the external device (host/PLC) sends a command to the MODLINE 3 System to change the emissivity to 0.00, which is not a valid value for this parameter. The System would set the emissivity to the minimum value of 0.100 and send a response containing that value. The host/PLC should verify a new value, by checking the response message.

E-Slope – **ES**

The E-Slope command allows you to set the E-Slope value. This command is a Read / Write command.

Range: 850 to 1150 (representing E-Slope values from 0.850 to 1.150). *Note:* Input values are 1000 times the actual values.

Example if you send: #00**ES**1060<cr>. The System sets the E-Slope value to 1.060 and responds with #00**ES**1060.

If you send: #00**ES**<cr> a response of #00**ES**1060 contains the current setting.

Note: EM and ES are interchangeable. For convenience you may use EM even with ratio systems, but the value still must be between 850 and 1150.

Response Time – **RT**

The Response Time command allows you to set the response time. This command is a Read/Write command.

Range: 0.01 to 60 seconds (scaled 1 to 6000).

Note: The scaled input values are 100 times the actual values. Only two digits of resolution should be used for front panel compatibility.

Example if you send: #00**RT**30<cr> the System sets the response time to 300 milliseconds and responses with #00**RT**30.

If you send: #00**RT**<cr> a response of #00**RT**30 contains the current setting.

Decay Rate – **DR**

The Decay Rate command allows you to set the Peak Picker decay rate. This command is a Read/Write command.

Range is: 0.00 to 300 ° per second (scaled 0 to 30000), regardless of temperature units (F or C).

Note: The scaled input values are 100 times the actual values. Only two digits of resolution should be used for front panel compatibility.

Section 8 — DIGITAL COMMUNICATIONS

Example if you send: #00**DR**980<cr>. The System sets the decay rate to 9.80° per second and responses with #00**DR**980.

If you send: #00**DR**<cr> the System responds with #00**DR**20000 the reply contains the current setting of 200.00 degrees.

<u>Analog Zero Scale – **AZ**</u>

The Analog Zero scale command allows you to choose the temperature that will produce a zero scale analog output signal. This command is a Read / Write command.

Example if you send: #00**AZ**1500<cr> the System sets the analog output to its zero scale value when the measured temperature is at 1500° and responses with #00**AZ**1500.

If you send: #00**AZ**<cr> the System responds with #00**AZ**1500 the reply contains the current setting

Re-assigned Zero Scale: The Analog Zero Scale Value must be at least 10 ° less than the Analog Full Scale value or the system will assign one.

<u>Analog Full Scale – **AF**</u>

The Analog Full Scale command (e.g. #00AF<cr>) allows you to choose the temperature that will produce a full scale analog output signal. This command is a Read / Write command.

Example if you send: #00**AF**2500<cr>. The System sets the analog output to its full scale value when the measured temperature is at 2500° and responses with #00**AF**2500.

If you send: #00**AF**<cr> the System responds with #00**AF**2500 the reply contains the current setting .

Re-assigned Full Scale: The Analog Full Scale Value must be at least 10° greater than the Analog Zero Scale value.

<u>Peak Picker Modes and Reset – **PS**</u>

The Peak Picker functions are selected by sending a PS command (e.g. #00PS<cr>) with one of the following values.

Value:
0 — Peak Picker Off and Auto Reset Off.
1 — Peak Picker On.
2 — Peak Picker On and Auto Reset On.
3 — Peak Picker Reset.

This command is a Read / Write command.

Example if you send: #00**PS1**<cr>. The system initiates Peak Picker On, the stored information is dumped and response is #00**PS**1.

If you send: #00**PS**<cr> a response of #00**PS**1 contains the current settings.

<u>Peak Picker Reset Below – **PK**</u>

The Peak Picker Reset Below command (e.g. #00PK<cr>) allows you to choose a temperature, that will automatically reset the MODLINE 3 System when the measured temperature reaches or goes below, the selected temperature. This command is a read / write command.

Range: Any temperature within the System's Temperature Range.

Example if you send: #00**PK**100<cr> the System sets the reset to occur at 100 degrees and responses with #00**PK**100.

If you send: #00**PK**<cr> a response of #00**PK**100 contains the current setting.

<u>Peak Delay – **PD**</u>

The Peak Delay command allows you to select up to ten seconds delay. This is a delay, of peak picker signal conditioning. See Section 4.11 for more information. This command is a Read / Write command.

Range: 0.010 to 10 seconds real time (scaled 0 to 10000).

Note: The scaled input values are 1000 times the actual value.

Example if you send: #00**PD**1000<cr> the system sets the delay to one second.

If you send: #00**PD**0<cr> the system turns off the function.
If you send: #00**PD**<cr> a response of #00**PD**1000 contains the current setting.

Track and Hold Mode – **TS**

The Track and Hold function is selected by sending a TS command (e.g. #00TS<cr>) with one of the following values.

Value:
0 — Track and Hold Off. See Section 3.12 for details on External Track and Hold Control.
1 — Track and Hold On

This command is a Read / Write command.

Example if you send: #00**TS0**<cr> the system turns off the Track and Hold function.

If you send: #00**TS**<cr> a response of #00**TS**0 contains the current setting.

SYSTEM STATUS INFORMATION

System Alarm Status – **ST**

When the MODLINE 3 System receives this request (e.g. #00ST<cr>), it returns a message indicating the current status or alarm condition. The System Alarm Status command is a Read Only instruction.

Values:
0 — no faults
1 — low / under temperature range
2 — high / over temperature range
3 — invalid
4 — calibration failed

Example if you send: #00**ST**<cr> the System responds with #00**ST**0<cr>. This response indicates that the System has detected no faults.

SYSTEM CONFIGURATION

Version Number – **VR**

When the System receives this request, it returns the version number of the System's internal software. Version Number is a Read Only instruction.

Example if you send: #00**VR**<cr> the System responds with #00**VR**V1.14 this indicates the System has Version 1.14 software.

Model – **MD**

Returns the Model number of the Sensor. This command is a Read Only command.

Example if you send: #00**MD**<cr> the System responds with #00MD3604F15 this represents a 600 Series Sensor.

Controller Type – **TP**

When this command is received, it returns a one digit code specifying the type of control capabilities it has. This command is a Read Only command.

Values:
0 — No control
1 — On / Off Controller
2 — PID Controller

Example if you send: #00TP<cr> the System responds with #00TP2<cr> this indicates that the MODLINE 3 System is equipped with a PID Controller.

PID CONTROL FUNCTIONS

PID Set Point – **SP**

The PID Set Point function allows you to enter the value of the PID Set Point for the selected PID Indicator / Processor. This command is a Read / Write command.

Range: From low end of System 's span to high end of System 's span.

Example If you send: #00**SP**2800<cr> the System establishes 2800° as the set point and responds with #00**SP**2800.

If you send: #00**SP**<cr> a response of #00**SP**2800 contains the current setting.

Proportional Band – **KP**

Proportional Band Command allows you to adjust the value of the PID Proportional Band Parameter. This command is a Read / Write command.

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Range: From 0 to 2000 corresponding to 0 to 200 percent of the temperature span.

Example if you send: #00**KP**500<cr> the System sets the PID Proportional Band to 50.0% and responds with *#00***KP**500.

If you send: #00**KP**<cr> a response of #00**KP**500 contains the current setting.

Reset Rate (Integral) – **KI**

The Reset Rate function allows you to adjust the value of the PID reset parameter. Or you may send a value of 0 (zero) to turn off the integral action. This command is a Read / Write command.

Values:
0 — turns off the integral action.
— number of repeats per minute.

Range: From 0 to 9900 corresponds to 00.00 to 99.00 repeats per minute.

Example if you send: #00**KI**250<cr> the System assigns a value of 2.5 repeats per minute to the reset parameter and responds with *#00***KI**250.

If you send: #00**KI**<cr> a response of #00**KI**250 indicates a setting of 2.50 repeats per minute.

Rate Time (Derivative) – **KD**

The Rate Time function allows you to adjust the value of the PID rate parameter. Or you may send a value of 0 (zero) to turn off the derivative action. This command is a Read / Write command.

Values:
0 — turns off the action.
— number of minutes.

Range: From 0 to 9900 corresponds to 0 to 9.900 minutes.

Example if you send: #00**KD**78<cr> the System assigns a value of 0.078 minutes to the rate parameter (at D Rate menu) and responds with *#00***KD**78.

If you send: #00**KD**<cr> a response of *#00***KD**78 indicates a setting of 0.078.

Load Demand – **KL**

The Load Demand command allows you to set the value of the PID load demand parameter. This command is a Read / Write command.

Range: From 0 to 99 % of the output power.

Example if you send: #00**KL**55<cr> the System sets the load demand to 55 % of the maximum output power and responds with *#00***KL**55.

Sending #00**KL**0<cr> sets the load demand to 0% it does not turn off the function. The response is #00KL0.

If you send: #00**KL**<cr>a response of *#00***KL**55 indicates the setting.

Auto Tune – **AT**

The Auto Tune command automatically selects and programs the optimum PID parameters for your temperature control system. This command is a Read / Write command.

Note: You must have previously entered the desired PID set point: manually or with a #00SP####<cr>.

Values:
0 — Aborts or turns Auto Tune off.
1 — Initiates Auto Tune; it will respond with this value while completing Auto Tune.

Example if you send: #00**AT**1<cr> the system initiates the Auto Tune function. Any number above a 1 is treated as a 1.

If you send: #00**AT**<cr> a response of #00**AT**0 indicates Auto Tune off. Do not send #00**AT**<cr> while Auto Tune is functioning.

PID Auto Manual – **AM**

This command allows you to select either Auto or Manual mode for the PID Output. You can also terminate Auto Tune by selecting the Manual Mode. This command is a Read / Write command.

Values:
0 — Off.
1 — Manual Mode Control On.
2 — Automatic Mode Control On.

Example if you send: #00**AM1**<cr>. The System sets the PID Output to Manual Mode Control and responds with #00**AM1**.

If you send: #00**AM**<cr> a response of #00AM1 indicates a Manual Mode on.

PID Controller Output – **CP**

After the MODLINE 3 System receives this request, it send back a response containing the percentage value of the PID Output. This command is a Read / Write command.

Note: The system must be set to Manual Mode Control (#00AM1<cr>) before the CP command is sent.

Range: From 0 to 1000 representing 0 to 100 of the maximum output power.

Example if you send: #00**CP**<cr> the System response is #00CP21<cr>. The response indicates the MODLINE 3 System is at 2.1% of its maximum value.

If you send: #00**CP22**<cr> the System response is #00CP22<cr>. The response indicates the MODLINE 3 System is at 2.2% of its maximum value.

If you send: #00**CP0**<cr> you are setting the PID Output to 0% or 4 milliamperes.

Bumpless Transfer – **BP**

The Bumpless Transfer function controls the PID Output signal level during the transition from Auto Mode Control to Manual Mode Control. This command is a Read / Write command.

Values:
0 — Bumpless Transfer Off.
1 — Bumpless Transfer On.

Example if you send: #00**BP1**<cr> the System sets Bumpless Transfer On and responds with #00**BP1**.

If you send: #00**BP**<cr> a response of #00BP1 indicates the Bumpless Transfer mode on. Any number above a 1 is treated as a 1.

When On the last PID Output value established while in Auto Mode is transferred on as the output value for the Manual Mode Control, see Section 4P-8.

When the Bumpless Transfer function is Off the PID Output level jumps, to the Manual PID Out power setting, during the Auto Mode to Manual Mode transition.

High Deviation Alarm (PID) – **OA**

Changes the High Deviation Alarm value and responds with the new value.
This command is a Read / Write command.

Values:
0 — turns off the High Deviation Alarm.
— set the High Deviation Alarm value.

Range: From 0 to 100 degrees.

Example: #00**OA**50<cr> sets the high set point to 50°. *If you send:* #00OA0<cr> the 0 (zero) turns the High Deviation Alarm off. *If you send:* #00**OA**<cr> the response indicates the status.

Low Deviation Alarm (PID) – **OB**

Changes or reads the Low Deviation Alarm value. This command is a Read / Write command.

Values:
0 — turns off the Low Deviation Alarm.
— set the set point value.

Range: From 0 to 100 degrees.

Example: #00**OB**50<cr> sets the low set point to 50°. *If you send:* #00**OB**0<cr> the 0 (zero) turns the Low Deviation Alarm off. *If you send:* #00**OB**<cr> the response indicates the status.

ON /OFF CONTROL FUNCTIONS

On/Off Set Point 1 – **OA**

Changes or reads the On / Off Set Point 1. This command is a Read / Write command.

Range: Any value within the System's temperature range.

Example if you send: #00**OA**550<cr> the System sets the Set Point 1 to 550°.

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If you send: #00**OA**<cr> with Set Point 1 On, the response is #00**OA###**, the Set Point 1 temperature setting.

If you send: #00**OA0**<cr> it turns Set Point 1 Off. With Set Point 1 OFF, the response is #00**OA###**, a temperature of one degree below zero scale.

<u>On/Off Set Point 2 – **OB**</u>

Changes or reads On / Off Set Point 2. This command is a Read / Write command.

Range: Any value within the System 's temperature range.

Example: #00**OB**1500<cr> sets the Set Point 2 to 1500°.

If you send: #00**OB**<cr> with Set Point 2 On, the response is #00**OB###,** the Set Point 2 temperature setting.

If you send: #00**OB0**<cr> it turns Set Point 2 Off.

If you send: #00**OB**<cr> with Set Point 2 Off, the response is #00**OA###** a temperature of one degree below zero scale.

8.6 COMMAND CODE SUMMARY

TEMPERATURE REQUEST

TT Temperature - R/O

SETTING ADJUSTMENTS

AF Analog Full Scale - R/W
AZ Analog Zero Scale - R/W
DR Decay Rate - R/W
EM Emissivity - R/W
ES E Slope - R/W
PS Peak Picker Modes and Reset - R/W
PK Peak Picker Reset Below - R/W
PD Peak Delay - R/W
RT Response Time - R/W
TS Track and Hold Modes - R/W

SYSTEM STATUS

ST System Alarm Status - R/O

SYSTEM CONFIGURATION

MD Model - R/O
TP Controller Type - R/O
VR Version N - R/O

PID CONTROLLER FUNCTIONS

AM PID Auto / Manual - R/W
AT Auto Tune - R/W
BP Bumpless Transfer - R/W
CP PID Controller Power - R/W
KD Rate - R/W
KI Reset - R/W
KL Load Demand - R/W
KP Proportional Band - R/W
SP PID Set point - R/W
OA High Deviation Alarm - R/W
OB Low Deviation Alarm - R/W

ON/OFF CONTROLLER FUNCTIONS

OA On/Off Set Point 1 - R/W
OB On/Off Set Point 2 - R/W

Section 9 - ADDENDUM

This section includes selected information that applies to your System and its components. Instructions are given on Sensor Signal Cable assembly and other data to help you in installing, using, and ordering components for your MODLINE 3 instrument.

Sections **Page**

Cable Kit Information (Attached as an Addendum)

Appendix A

Appendix B

Section 9 — ADDENDUM

9.1 GROUNDING STRAIN RELIEFS

GROUNDING STRAIN RELIEF FITTINGS		
SIZE	CABLE DIAMETER	THREAD TYPE
Large grip	0.28 inch to 0.47 inch	European PG16 thread type.
576332	(6.4 mm to 12.7 mm)	CD 16 AA-BE, CD 16 AR-BE
576342	Locking Nut for Item 576332	NP 16 BE (Separate Order Item)
Small grip	0.11 inch to 0.28 inch	European PG11 thread type.
576352	(2.6 mm to 6.4 mm)	CD 11 AA-BE, CD 11 AR-BE
576362	Locking Nut for Item 576332	NP 11 BE (Separate Order Item)

Note: The names “Sealcon EMI-Proof” or “Hummel” may appear on the strain relief fittings.

9.2 BULK CABLE

BULK CABLE	
PART NO.	DESCRIPTION
560242	Cable Silcone Rubber , 9 Conductor, cut length per order (Separate Order Item)
560692	Cable PVC, 8 Conductor, cut length per order (Separate Order Item)

9.3 INTERCONNECT KITS

INTERCONNECT KIT FITTINGS	
PART NO.	DESCRIPTION
LM3 CBXI	**Standard Interconnect Kit (Sensor to Indicator / Processor)**
575522	Socket Connector Assembly
575542	Connector Clamp Assembly
#8 & #10	Tubing
----------	Shrink Tubing
LM3 CBSE	**Silcone Cable Extension Kit (Sensor to Indicator / Processor)**
571472	90° Socket Connector Assembly
572472	Connector Clamp Assembly
572462	Connector Clamp Assembly
#8 & #10	Tubing
----------	Shrink Tubing
LM3 CBPE	**PVC Cable Extension Kit (Sensor to Indicator / Processor)**
572482	Connector Clamp Assembly
575812	Connector Clamp Assembly
#8 & #10	Tubing
----------	Shrink Tubing

Section 9 — ADDENDUM

9.4 AWG AMERICAN WIRE GAUGE CONVERSION TABLE

GAUGE	DECIMALS	MILLIMETERS
20 AWG	0.032	0.081
18 AWG	0.040	1.02
16 AWG	0.050	1.29
14 AWG	0.064	1.63
12 AWG	0.080	2.05
10 AWG	0.101	2.59
8 AWG	0.128	3.26
6 AWG	0.162	4.12

The appropriate stipulations for the wire are as follows: Terminal Blocks must permit clamping without special wire preparation of the conductor in order to strengthen the wire.

The term "without special preparation" includes soldering and the use of wire eyes, etc. but not straightening the conductor prior to insertion in to the terminal or twisting together a multi-strand conductor prior to insertion in to the terminal.

9.5 ALUMINUM SHEET THICKNESS CONVERSION TABLE

GAUGE	DECIMALS	MILLIMETERS
14 AWG	0.0641	1.6
13 AWG	0.0720	1.8
12 AWG	0.0808	2.1
11 AWG	0.0907	2.3
10 AWG	0.1019	2.6
9 AWG	0.1144	2.9
8 AWG	0.1285	3.3

These stipulations are for the mounting panel material, described in Section 3.

9.6 FRACTION-DECIMAL-MILLIMETER CONVERSION TABLE

FRACTIONS	DECIMALS	MILLIMETERS
1/64	.0156	0.3969
1/32	0.313	0.7938
3/64	.0469	1.1906
1/16	.0625	1.5875
5/64	.0781	1.9844
3/32	.0938	2.3813
7/64	.1094	2.7781
1/8	.125	3.1750
9/64	.1406	3.5719
5/32	.1563	3.9688
11/64	.1719	4.3656
3/16	.1875	4.7625
13/64	.2031	5.1594
7/32	.2188	5.5563
15/64	.2344	5.9531
1/4	.250	6.3500
17/64	.2656	6.7469
9/32	.2813	7.1438
19/64	.2969	7.5406
5/16	.3125	7.9375
21/64	.3281	8.3344
11/32	.3438	8.7313
23/64	.3594	9.1281
3/8	.375	9.5250
25/64	.3906	9.9219
13/32	.4063	10.3188
27/64	.4219	10.7156
7/16	.4375	11.1125
29/64	.4531	11.5094
15/32	.4688	11.9063
31/64	.4844	12.3031
1/2	.500	12.7000

FRACTIONS	DECIMALS	MILLIMETERS
33/64	.5156	13.0969
17/32	.5313	13.4938
35/64	.5469	13.8906
9/16	.5625	14.2875
37/64	.5781	14.6844
19/32	.5938	15.0813
39/64	.6094	15.4781
5/8	.625	15.8750
41/64	.6406	16.2719
21/32	.6563	16.6688
43/64	.6719	17.0656
11/16	.6875	17.4625
45/64	.7031	17.8594
23/32	.7188	18.2563
47/64	.7344	18.6531
3/4	.750	19.0500
49/64	.7656	19.4469
25/32	.7813	19.8438
51/64	.7969	20.2406
13/16	.8125	20.6375
53/64	.8281	21.0344
27/32	.8438	21.4313
55/64	.8594	21.8281
7/8	.875	22.2250
57/64	.8906	22.6219
29/32	.9063	23.0188
59/64	.9219	23.4156
15/16	.9375	23.8125
61/64	.9531	24.2094
31/32	.9688	24.6063
63/64	.9844	25.0031
1	1.000	25.4000

Section 9 — ADDENDUM

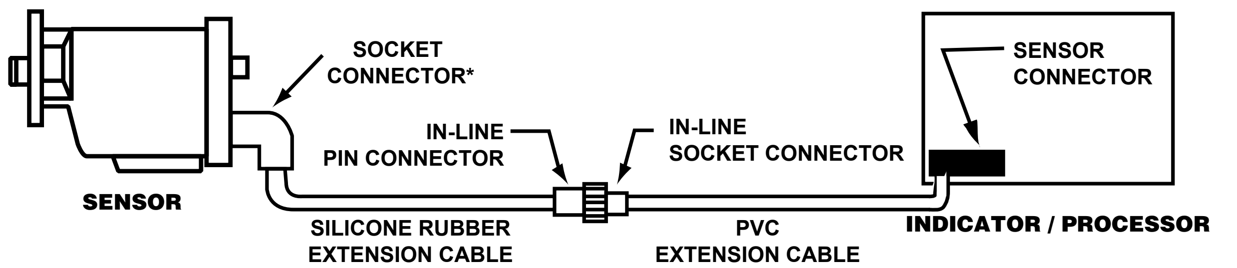
NOTES:

ASSEMBLY INSTRUCTIONS

ASY: LM3 CBSE & LM3 CBPE

IRCON

SHIELDED EXTENSION SIGNAL CABLES PVC or SILICONE RUBBER
MODLINE 3™ Series Sensor to Indicator / Processor



* 90° Socket Connector shown; Series 200 Sensors use an In-Line Socket Connector.

DETAIL A. UNITS USING EXTENSION CABLES (HIGH TEMPERATURE TO STANDARD)

DESCRIPTION

Extension cables are recommended where the Sensor end of the signal cable is in a high temperature zone, but the rest of the cable is in a low temperature zone. The purpose is to use the high temperature silicone cable only where it is needed, and link it to a section of PVC cable through cable connectors as shown above.

The PVC insulation of the standard cable permits safe operation in ambient temperatures up to 220°F (100 °C). The silicone rubber insulation of the high temperature cable permits safe operation in ambient temperatures up to 400°F (200°C).

These kits provide all the parts required to assemble the two cables. Examine the parts and check them against the parts lists, on page 2, to make sure you have received all parts.

IMPORTANT! The parts for each cable kit are packaged separately . Keep these parts separated for the individual cables.

PRE-ASSEMBLY NOTES

1. If the cable will be routed through conduit, consider pulling the cable before preparing the end that will be pulled.

2. Review these instructions carefully before you start the assembly. If you have any questions, contact our Technical Service Department.

KIT LM3CBSE — SILICONE RUBBER CABLE PARTS LIST

ITEM	PART NO.	QTY	DESCRIPTION
1	560242	1	Cable, Silicone Rubber — length per order
2	575522	1	Socket Connector Assembly, RFI Backshell Size 18
			2A Strain Relief End Cap
			2B Ferrule
			2C Rubber Grommet
			2D Outer Ground Ring with O-ring
			2E Inner Ground Ring
			2F Backshell
			2G Backshell Adapter
3	575542	1	Connector Circular Assembly, STR Plug 18-8
			3A Connector
			3B Connector Ring Rubber Grommet (Discard this Rubber Grommet.)
4		1	Tubing, No. 10 PVC, Clear : Cut into 10 pieces, 3/8 in. (10 mm) long
5		1	Tubing, No. 8 PVC, Clear: Cut into 2 pieces, 3/8 in. (10 mm) long
6			Not used in this configuration
7			Not used in this configuration
8			Not used in this configuration
9	576392	1	Socket Connector Assembly, STR Plug 18-8
10	575992	1	Socket Connector Assembly, RFI Backshell Size 18
			10A Strain Relief End Cap
			10B Ferrule
			10C Rubber Grommet
			10D Outer Ring with O-ring
			10E Inner Ground Ring
			10F Backshell Adapter
	052271	1	Assembly Instructions

KIT LM3CBPE — PVC CABLE PARTS LIST

ITEM	PART NO.	QTY	DESCRIPTION
1	560692	1	Cable, PVC — length per order
2	575992	1	Socket Connector Assembly, RFI Backshell Size 18
			2A Strain Relief End Cap
			2B Ferrule
			2C Rubber Grommet
			2D Outer Ground Ring with O-ring
			2E Inner Ground Ring
			2F Backshell Adapter
3	575542	1	Connector Circular Assembly, STR Plug 18-8
			3A Connector
			3B Connector Ring, Rubber Grommet (Discard Rubber Grommet.)
4		5	Tubing, No. 10 PVC, Clear : Cut into 10 pieces, 3/8 in. (10 mm) long
5		1	Tubing, No. 8 PVC, Clear: Cut into 2 pieces, 3/8 in. (10 mm) long
6			Not used in this configuration
7			Not used in this configuration
8			Not used in this configuration
9	576332	1	Liquid Tight Cord Grip Assembly (Grounding Strain Relief Fittings)
			9A Compression Nut
			9B Compression Fitting
			9C Body
10	576342	1	Nut, Locking (Grounding Strain Relief Fitting)
	052271	1	Assembly Instructions.

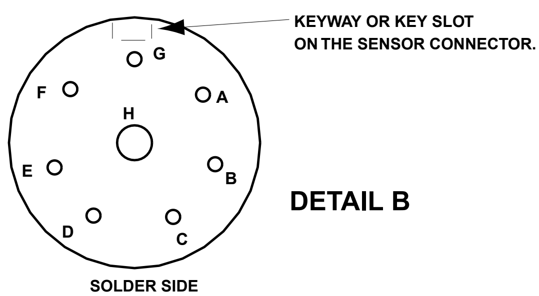
TABLE A WIRE COLORS AND CONNECTION LOCATIONS

Use Table A as a reference during the cable assembly. Some wires and braided drains are not used for the final cable. These wires are listed in Table A below and described in the Assembly Instructions.

Table B lists and describes the wires that are used in the Assembly Instructions.

TABLE A WIRES NOT USED IN CABLE		
CABLE JACKET	COLOR	AWG
SILICONE RUBBER	YELLOW	18 AWG
	INNER BUNDLE DRAIN WIRE	20 AWG
	OUTER BUNDLE DRAIN WIRE	20 AWG
PVC	DRAIN WIRE	20 AWG

TABLE B TERMINAL, COLOR, AND SIZE		SILICONE CABLE	PVC CABLE
TERMINAL	COLOR	AWG	AWG
A	ORANGE	18 AWG	18 AWG
B	BROWN	20 AWG	18 AWG
C	BLUE	20 AWG	18 AWG
D	WHITE	20 AWG	18 AWG
E	RED	20 AWG	20 AWG
F	BLACK	20 AWG	20 AWG
G	VIOLET	18 AWG	18 AWG
H	GREEN	18 AWG	18 AWG



DETAIL B

The rear view of the connector layout, in Detail B, is used for all these cables. The solder points are given alpha markings. These solder points are called out as terminal connections in the Assembly Instructions.

SILICONE EXTENSION CABLE - SENSOR END

The instructions that follow are for assembly, of the 90° SOCKET CONNECTOR END, of the cable. Review these instructions carefully before you start the assembly. Use kit (LM3CBSE).

1. Slide Items 2A, 2B, 2C and 2D onto the cable, in sequence shown in Detail C on the next page.

   NOTE: If necessary, use wire pulling grease for rubber grommet 2C.

2. Strip cable insulation jacket back 2.5 in. (64 mm).

   CAUTION: Use care to avoid cutting the braided wire inside!

3. Trim the braided shield to 1 in. (26 mm) from end of cable insulation. Trim foil shields back to cable jacket insulation edge.
4. Trim both of the braided drain wires back to braid.
5. Trim the Yellow wire back to braid.
6. Strip all colored wires 5/16 in. (8 mm) and tin wire ends.
7. Slide Items 2E, 2F , 2G and the 3B connector ring onto the cable in the sequence shown in diagram, on next page.
8. Items 3A & 3B come with an eight hole Rubber Grommet. Discard the Rubber Grommet (excess part, no item number).
9. Insert tubing (4) onto all wires, except the green wire.
10. Insert tubing (5) onto the green wire.
11. Solder wires to solder cups of 3A connector. See Detail B on page 3, for terminal identification.
12. Slide tubing (4 & 5) over each solder joint (8 places).
13. Slide the Sensor Connector Ring Item 3B over Connector Item 3A. Attach Adapter (2G) and 90° Right Angle Backshell (2F) to Connector (3A) and tighten all parts firmly.

    DO NOT twist the cable when tightening the parts.

14. Comb out the cable drain wire and the braided shield.
15. Slide the Inner Ground Ring (2E) into place. See Detail C-1.
16. Spread the combed wires over and all around the grommet. See Detail C-2.
17. Slide Grommet (2D) into place. See Detail C-3. Trim braid to back edge of the Grommet.
18. Slide 2E & 2D into 2F. Move Rubber Grommet 2C, Ferrule 2B, and the End Cap 2A into place.
19. Tighten all parts firmly.

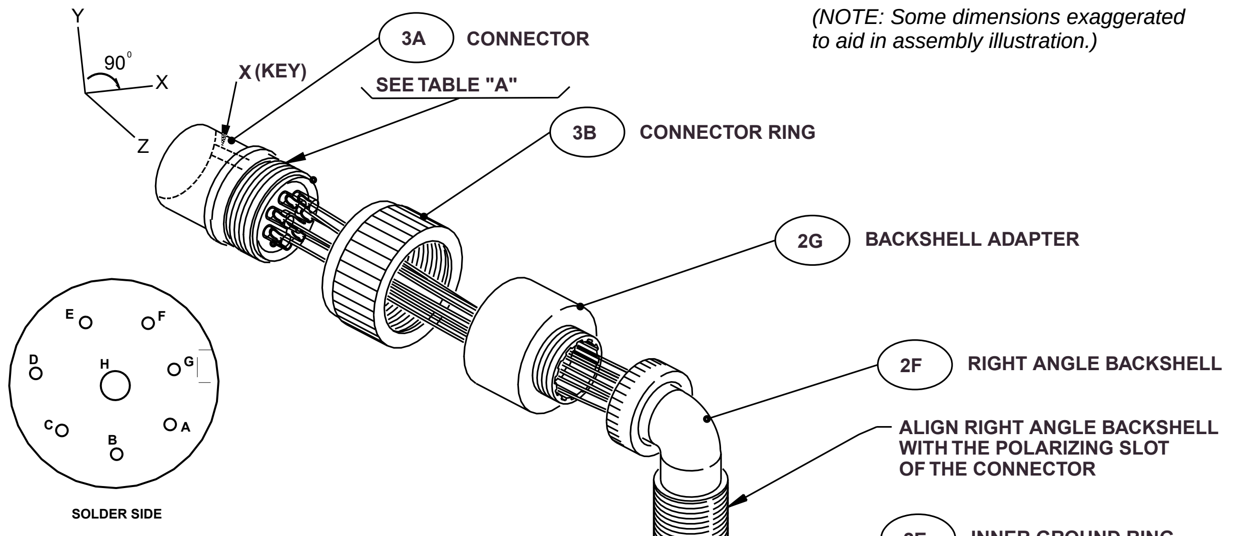
You have now completed the 90° connector end of the cable assembly.

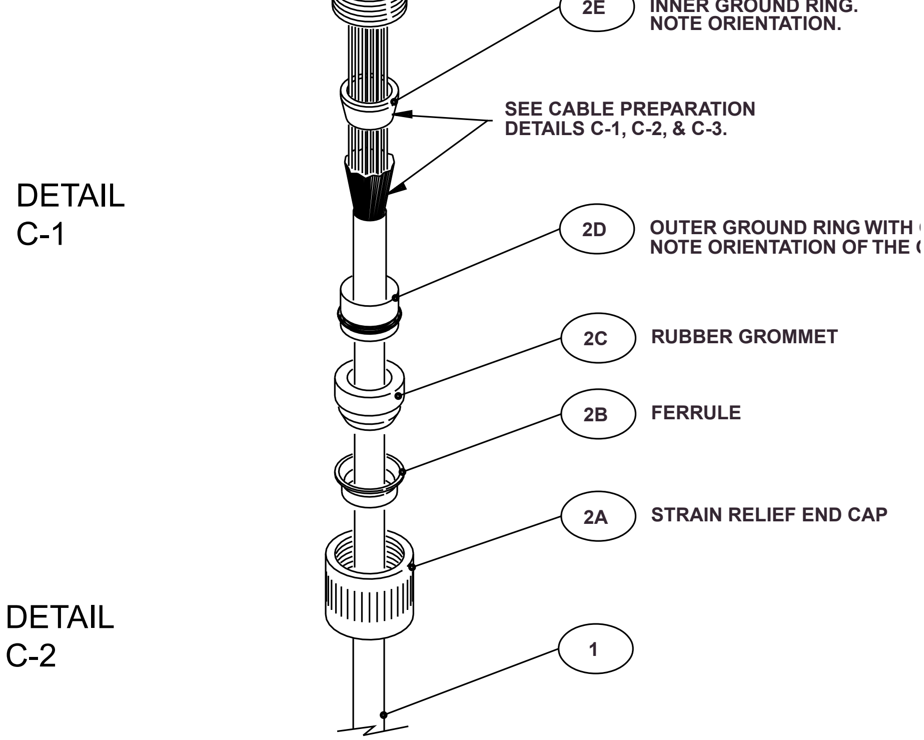
20. The Sensor Connector Ring (3B) is used to fasten the cable to the Sensor. See the Sensor Section of the MODLINE 3 Installation manual for how to install the cable.

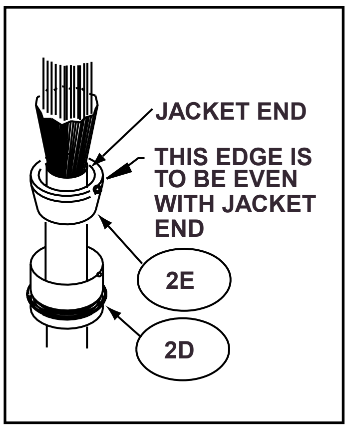
NOTE: Locktite is recommended, for use on the threads of the cable parts to prevent these assemblies from loosening.

THE LM3CBSE AT THE 90° SOCKET CONNECTOR END OF THE CABLE

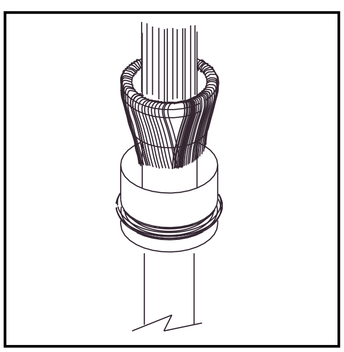
DETAIL C CONNECTOR TERMINAL IDENTIFICATION



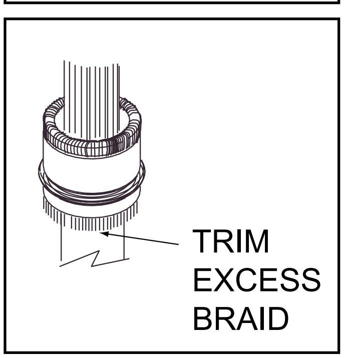




DETAIL
C-1



DETAIL
C-2



DETAIL
C-3

SEE INDICATOR / PROCESSOR END CABLE
PREPARATION ON THE PAGE 6.

SILICONE EXTENSION CABLE
SENSOR END

SILICONE EXTENSION CABLE - INDICATOR END

The instructions that follow are for assembly of the STRAIGHT SOCKET CONNECTOR END. Review these instructions carefully before you start the assembly.

1. Slide (10A) through (10D) onto the cable, as in Detail D.

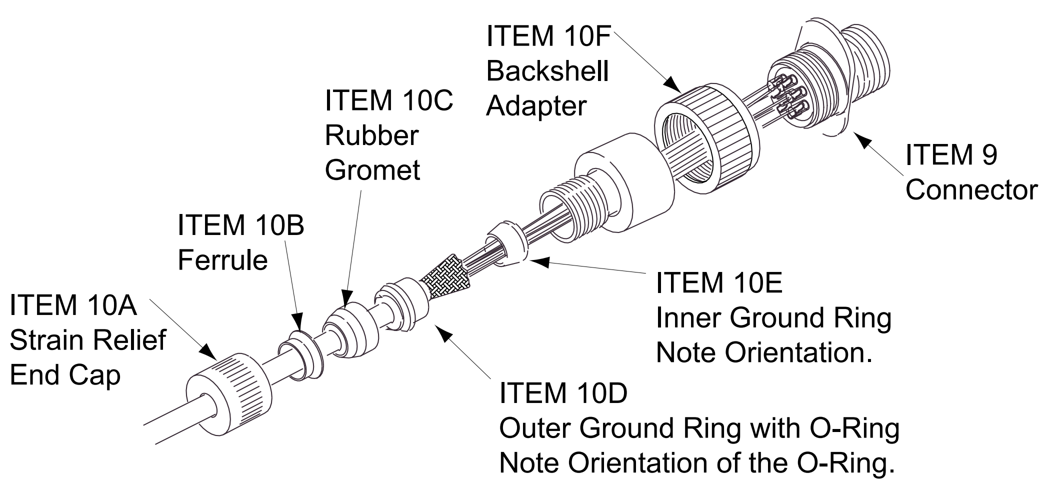
   NOTE: If necessary, use wire pulling grease for rubber grommet (10C).

2. Strip cable insulation jacket back 2 ½in (64mm).

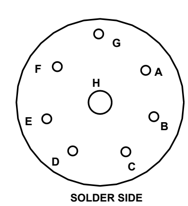
   CAUTION: Use care to avoid cutting the braided wire inside!

3. Trim the braided shield to 1 in. (26 mm) from end of cable insulation. Trim foil shields back to cable jacket insulation edge.
4. Trim both of the braided drain wires back to cable braid.
5. Trim the Yellow wire back to the end of cable braid.
6. Strip Yellow wire back to cable insulation and strip all other colored wires 5⁄16 in. (8 mm) and tin wire ends.
7. Slide (10E) and (10F) of connector clamp onto the cable in the sequence shown in Detail D.
8. Insert tubing (4) onto all wires, except the green wire.
9. Insert tubing (5) onto the green wire.
10. Solder wires to solder cups of (9) Connector (no keyway). See Detail D-1 for terminal identification.
11. Slide tubing (4 & 5) over each solder joint (8 places).
12. Thread the Backshell Adapter 10F onto 9 Connector and tighten all parts firmly. **DO NOT** twist the cable when tightening the parts.
13. Comb out the cable drain wire, yellow wire, and the braided shield.
14. Slide the Inner Ground Ring (10E) into place, as in Detail C-1.
15. Spread the combed wires over and all around the Inner Ground Ring (10E), as in Detail C-2.
16. Slide Grommet (10D) into place. See Detail C-3. Trim braid to back edge of the Grommet, as in Detail C-3.
17. Press (10D) into (10F) capturing the braid wire between (10E) and (10D).
18. Tighten all parts firmly. *You have now completed the straight connector end of the sensor cable assembly.*

NOTE: Locktite is recommended, for use on the threads of the cable parts to prevent these assemblies from loosening.



DETAIL D. STRAIGHT CONNECTOR END OF THE CABLE



DETAIL D-1

PVC EXTENSION CABLE - SENSOR END

These instructions are for assembly of the LM3CBPE Cable. Review these instructions carefully before you start the assembly.

1. Slide (2A) through (2D) onto the cable, approximately 5 in. (127 mm) from the end of the cable jacket as in Detail E.

   NOTE: Pulling grease may be used when sliding rubber grommet 2C onto cable.

2. Strip 2-1/2 in. (64 mm) of cable jacket from end of cable. T rim the braid shield back to 1 in. (26 mm) from cable jacket.

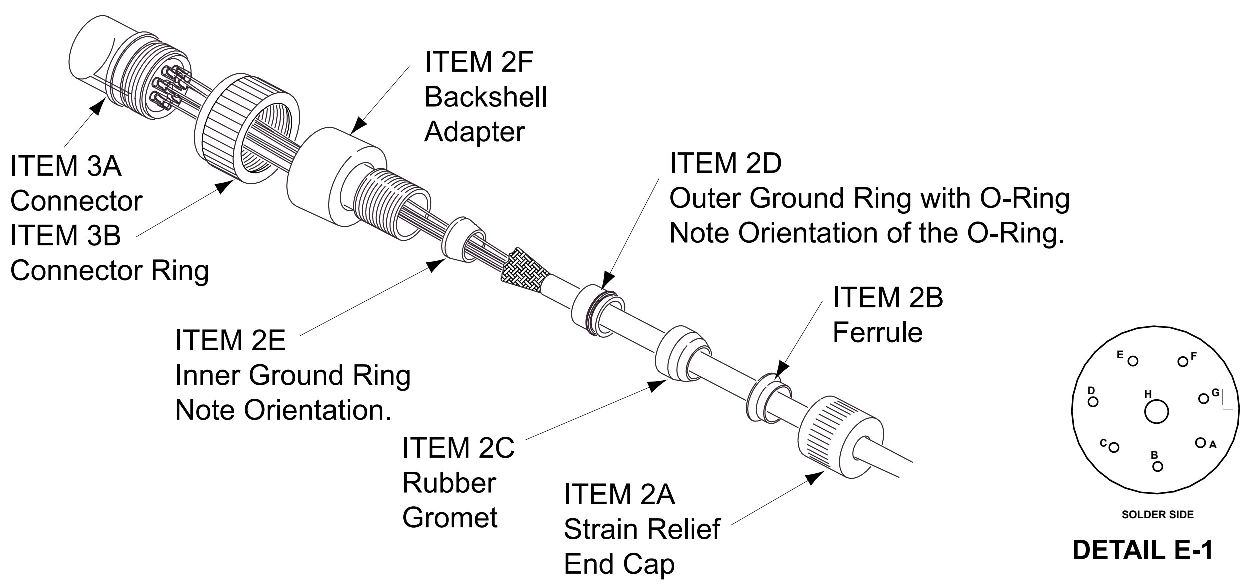
CAUTION: Use care to avoid cutting the braided wire inside!

3. Trim the drain wire back to cable braid.
4. Strip all colored wires ⁵⁄₁₆ in. (8 mm) and tin wire ends.
5. Item 3 comes with an eight hole Rubber Grommet. Discard the Rubber Grommet (excess part, no item number).
6. Slide (2E), (2F) of connector clamp and the 3B connector ring onto the cable in the sequence shown in Detail E.
7. Insert tubing (4) onto all wires, except the green wire.
8. Insert tubing (5) onto the green wire.
9. Solder wires to solder cups of connector , see Detail E for terminal identification.
11. Slide tubing (4 & 5) over each solder joint.
12. Slide the Sensor Connector Ring (3B) over Connector Item 3A. Attach Backshell Adapter (2F) to Connector Item 3A.

    DO NOT twist the cable when tightening the parts.

13. Comb out the cable drain wire and the braided shield.
14. Slide the Ground Ring (2E) into place, as in Detail C-1.
15. Spread the combed wires over and all around the grommet, as in Detail C-2.
16. Slide Outer Grommet Ring (2D) over the cable braid and the Ground Ring (2E). See Detail C-3. Trim braid to back edge of the Grommet, as in Detail C-3.
17. Press (2D) into (2F) capturing the braid wire between (2E) and (2D).
18. Tighten all parts firmly.

NOTE: Locktite is recommended for use on the threads of the cable parts to prevent these assemblies from loosening.



DETAIL E-1

DETAIL E. CONNECTOR END OF THE CABLE

PVC EXTENSION CABLE - INDICATOR / PROCESSOR END

CABLE END PREPARATION

Before you make any cable connections to the Indicator / Processor the cables will require dressing and cutting, as in Detail F The PVC covered cable is the standard extension cable.

DRESSING A PVC CABLE
Dress the cable before installing it in the Grounding Strain Relief fittings:

a. If the cable is to enter the Indicator / Processor from the top, strip off 4½ in. (114mm) of the outer jacket.

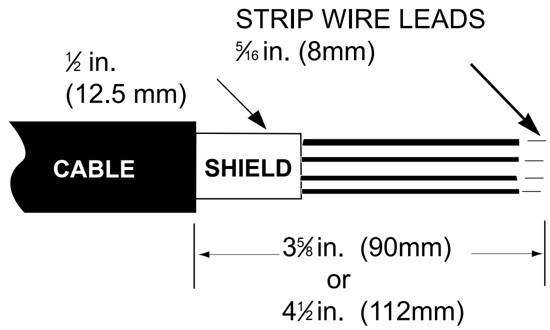
   If the cable is to enter the Indicator / Processor from the bottom, strip off 3 ⅝ in. (90mm) of the outer jacket.

b. Remove the outer braided shield. Leave ½ in. (13mm) of shield exposed.

c. Trim the drain wire(s) back to the end of the braid.

d. Trim both the inner foil and the foil just under the braided shield back.

e. Strip all colored wires 5/16 in. (8 mm) and TIN wire ends.



DETAIL F. CABLE END PREPARATION

THE LM3CBPE AT THE INDICATOR / PROCESSOR END OF THE CABLE

All signal cables shielding must be grounded to the Indicator / Processor enclosure, by a grounding strain relief, as they enter or leave the Indicator / Processor.

1. Detail G, illustrates how a braided wire shielded cable is grounded when using the Grounding Strain Relief fittings. Check that you are using the proper size grounding strain relief, for your cable.

2. Slip the Compression Nut (9A) and the Compression Assembly (9B) onto the cable, as in Detail G. Pay attention to their order , position and direction of each part shown.

3. Unbraid and comb out the braided shield wires and the stranded drain wires. Flare all the combed wires evenly all around, down, and over the Compression Fitting (9B).

   If an inner foil is used in the cable, check that no inner foil drapes over the shield wires, trim it if necessary.

4. It is very important that the compression assembly rest on the unstripped portion of the outer cable jacket to make a proper seal.

5. Push the Compression Fitting (9C), all the way, into the Grommet (9B).

6. Trim the shield wires to a spot just past the o-ring on the compression fitting, as in Detail G

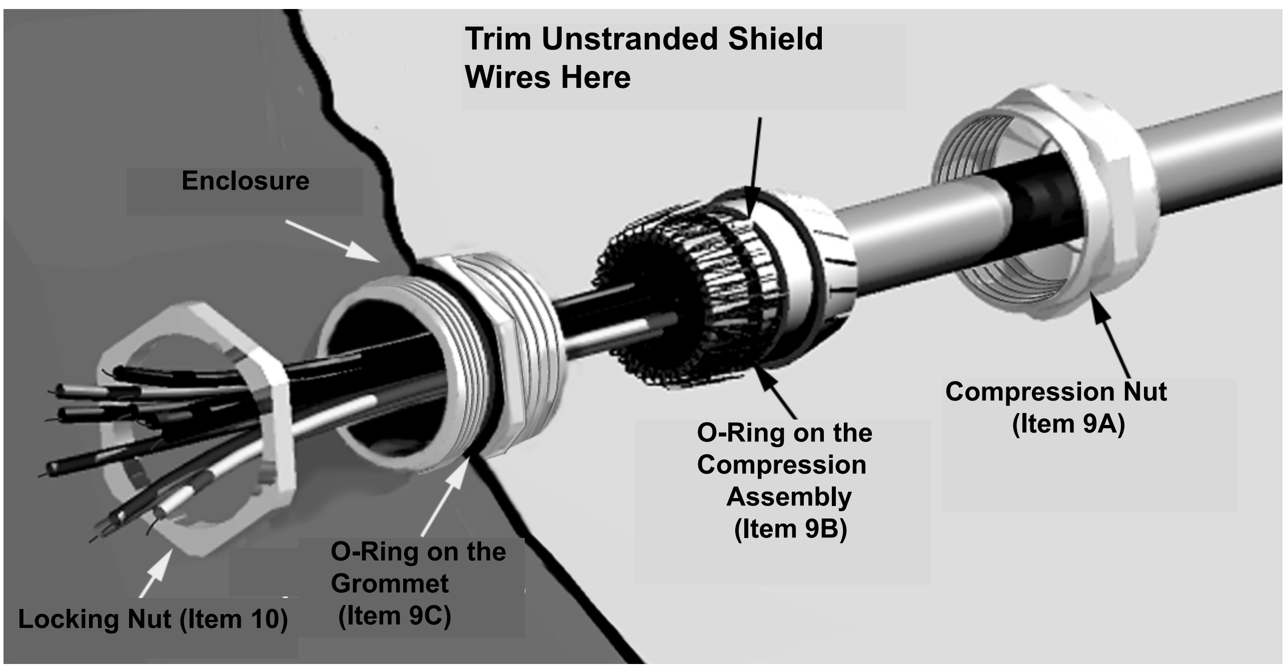
7. Hold the cable firmly , so that the cable does not twist in the fitting, as you screw the Compression Nut (9A) onto the Grommet to make a water-tight seal.

8. Tighten all parts firmly.

NOTE: The Locking Nut (10) is used to fasten this extension cable to the Indicator / Processor Enclosure. See the Indicator / Processor Section of the MODLINE 3 Installation Manual for how to install the cable leads.

Part of the PVC CABLE PARTS LIST (Repeated from page 2)

ITEM	PART NO.	QTY	DESCRIPTION
9	576332	1	Liquid Tight Cord Grip Assembly (Grounding Strain Relief Fittings) 9A Compression Nut 9B Compression Fitting 9C Body
10	576342	1	Nut, Locking (Grounding Strain Relief Fitting)



DETAIL G. GROUNDING STRAIN RELIEF

ASSEMBLY CHECKLIST

❏ After assembly, check continuity of each lead from connector socket to the wire ends.

❏ Check insulation resistance between all pairs of terminals.
Resistance should be 50 megohms or greater.

❏ Check closely for any wire strands, etc. that could cause shorting.

❏ Refer to Section 3 of MODLINE 3 System manual for instructions on installing the assembled cable.

If you have any questions about cable assembly , contact our Technical Service Department or the Applications Engineering Department for further information.

ASSEMBLY INSTRUCTIONS

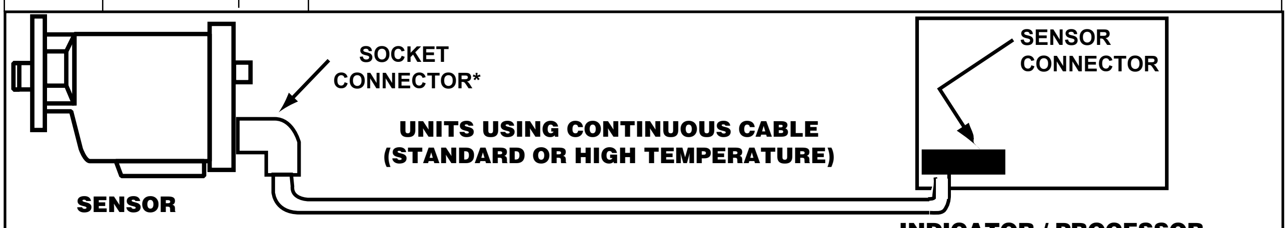
ASY: LM3 CBXI

IRCON

SHIELDED SIGNAL CABLE PVC or SILICONE RUBBER MODLINE 3™ Series Sensor to Indicator / Processor

PARTS LIST

ITEM	PART NO.	QTY	DESCRIPTION
1	560692	1	Cable, PVC, length per order
	560242	1	Cable, Silicone Rubber, length per order
2	575522	1	90° Socket Connector Assembly, RFI Backshell, Size 18
			2A Strain Relief End Cap
			2B Ferrule
			2C Rubber Grommet
			2D Outer Ground Ring with O-ring
			2E Inner Ground Ring
			2F Backshell
			2G Backshell Adapter
3	575542	1	Connector Circular Assembly, STR Plug 18-8
			3A Connector
			3B Connector Ring and Rubber Grommet (Discard Rubber Grommet.)
4		7	Tubing, No. 10 PVC, Clear, 3/8 in. (10 mm) long
5		1	Tubing, No. 8 PVC, Clear, 3/8 in. (10 mm) long
6			Not used in this configuration
7			Not used in this configuration
8			Not used in this configuration
9	576332	1	Liquid Tight Cord Grip Assembly (Grounding Strain Relief Fittings)
			9A Compression Nut
			9B Compression Fitting
			9C Body
10	576342	1	Nut Locking for Cord Grip Assembly (Grounding Strain Relief Fitting)
	052272	1	Assembly Instructions.



* 90° Socket Connector shown; Series 200 Sensors use an In-Line Socket Connector.

DETAIL A. PVC OR SILICONE RUBBER CABLE

DESCRIPTION

The Signal Cable links the MODLINE 3 Sensor and Indicator / Processor. It is a braided shielded cable with insulation overall.

The PVC insulation of the standard cable permits safe operation in ambient temperatures up to a maximum of 220 °F (100°C). The silicone rubber insulation of the high temperature cable permits operation in ambient temperatures up to a maximum of 400°F (200°C).

This kit provides all the parts required to assemble the cable. Examine these parts and check them against the Parts List above to make sure you have received all necessary parts.

PRE-ASSEMBLY NOTES

1. If the cable will be routed through conduit, consider pulling the cable before preparing the end that will be pulled.

2. Review these instructions carefully before you start the assembly. If you have any questions, contact our Technical Service Department.

90° SOCKET CONNECTOR END OF THE CABLE

The instructions that follow are for assembly , of the 90° SOCKET CONNECTOR END, of the cable. Review these instructions carefully before you start the assembly.

1. Slide parts 2A, 2B, 2C and 2D of Connector Backshell onto the cable in the sequence shown in Detail C.

   NOTE: If necessary, use wire pulling grease for rubber grommet 2C.

2. Strip cable insulation jacket to 2.5 in. (64 mm).

   CAUTION: Use care to avoid cutting the braided wire inside!
3. Trim the braided shield to 1 in. (26 mm) from end of cable insulation. Trim foil shields back to cable jacket insulation edge.
4. Trim the drain wire(s) back to the end of the braid.
5. For Silicone Rubber Cables Only , trim the Yellow wire back to the end of cable jacket.
6. Strip all colored wires 5/16 in. (8 mm) and tin wire ends.
7. Item 3 comes with an eight hole Rubber Grommet. Discard this Rubber Grommet
8. Slide parts 2E, 2F , 2G of connector and the 3B connector ring onto the cable in the sequence shown in Detail C.
9. Insert tubing (Item 4) onto all wires, except the green wire.
10. Insert tubing (Item 5) onto the green wire.
11. Solder wires to solder cups of connector . See Detail B for terminal identification.
12. Slide tubing (Items 4 & 5) over each solder joint (8 places).
13. Slide the Sensor Connector Ring Item 3B over Connector Item 3A. Attach Adapter (Item 2G) and 90° Right Angle Backshell (Item 2F) to Connector Item 3A.

    DO NOT twist the cable when tightening the parts.
14. Comb out the cable drain wire and the braided shield.
15. Slide the Ground Ring (Item 2E) into place. See Detail C-1.
16. Spread the combed wires over and all around the Ground Ring. See Detail C-2.
17. Slide Grommet (Item 2D) into place. See Detail C-3. Trim braid to back edge of the Grommet.
18. Slide Items 2E & 2D into 2F . Move Rubber Grommet 2C, Ferrule 2B, and the End Cap 2A into place.

NOTE: Thread locker is recommended, for use on the threads for items 2F and 3A, to prevent these assemblies from untreading.

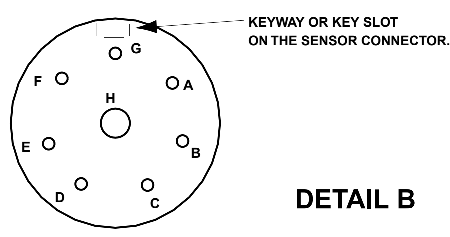
19. Tighten all parts firmly.

You have now completed the 90° connector end of the cable assembly.

NOTE: The Sensor Connector Ring Item 3B is used to fasten the cable to the Sensor . See the Sensor Section of the MODLINE 3 Installation manual for how to install the cable.

TABLE A WIRES NOT USED IN CABLE		
CABLE JACKET	COLOR	AWG
SILICONE RUBBER	YELLOW	18 AWG
	INNER BUNDLE DRAIN WIRE	20 AWG
	OUTER BUNDLE DRAIN WIRE	20 AWG
PVC	DRAIN WIRE	20 AWG

TABLE B TERMINAL, COLOR, AND SIZE		SILICONE CABLE	PVC CABLE
TERMINAL	COLOR	AWG	AWG
A	ORANGE	18 AWG	18 AWG
B	BROWN	20 AWG	18 AWG
C	BLUE	20 AWG	18 AWG
D	WHITE	20 AWG	18 AWG
E	RED	20 AWG	20 AWG
F	BLACK	20 AWG	20 AWG
G	VIOLET	18 AWG	18 AWG
H	GREEN	18 AWG	18 AWG

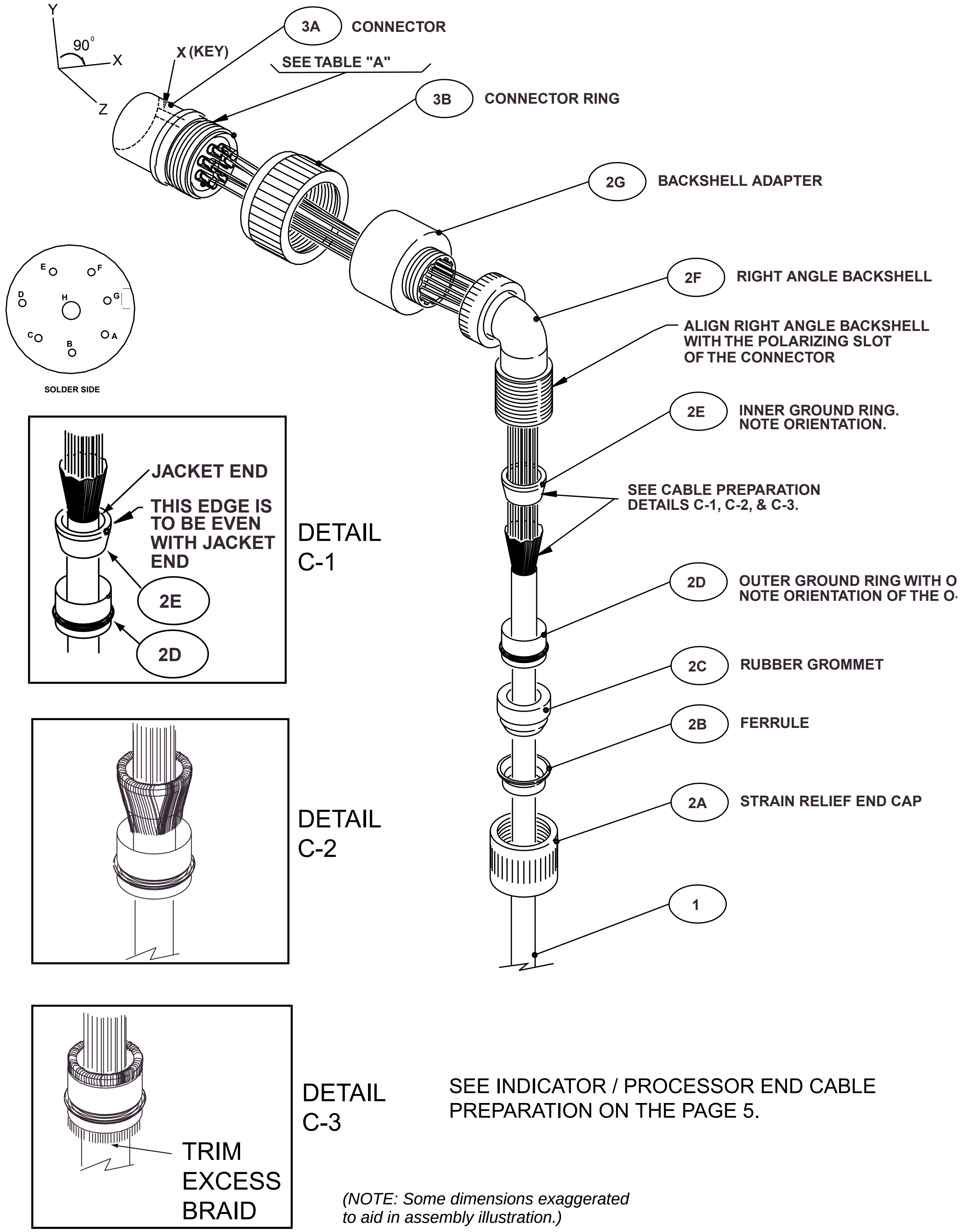


DETAIL B

These solder connections are seen from the solder cup side. Markings may appear on both the front and rear of the connector.

90° SOCKET CONNECTOR END OF THE CABLE

DETAIL C CONNECTOR TERMINAL IDENTIFICATION



SEE INDICATOR / PROCESSOR END CABLE PREPARATION ON THE PAGE 5.

(NOTE: Some dimensions exaggerated to aid in assembly illustration.)

THE INDICATOR / PROCESSOR END OF THE CABLE

CABLE PREPARATION

Before you make any cable connections to the Indicator / Processor the cables will require dressing and cutting.

IRCON supplies two types of specially designed shielded cable with the MODLINE 3 System. The PVC covered cable is the standard cable. The Silicone Rubber covered high temperature cable is special order only.

DRESSING SILICONE RUBBER CABLES

When IRCON supplies a Silicone Rubber Cable it must be configured as described in the following instructions.

a. If the cable is to enter the Indicator / Processor from the top, strip off 4-½ in. (114 mm) of the outer jacket.

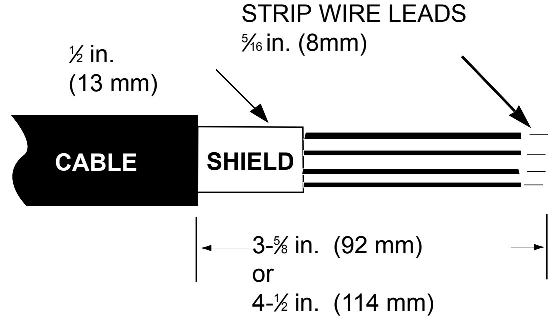
   If the cable is to enter the Indicator / Processor from the bottom, strip off 3-⅝ in. (92mm) of the outer jacket.

b. Remove the outer braided shield. Leave ½ in. (13mm) of shield exposed.

c. Trim the drain wire(s) back to the end of the braid.

d. There is a yellow wire that is not used. Trim it back and leave it isolated.

e. Strip all colored wires 5/16 in. (8 mm) and TIN wire ends.



DETAIL D. CABLE PREPARATION

DRESSING PVC CABLES

Dress the cable before installing it in the Grounding Strain Relief fittings. This example covers all types of PVC Cable:

a. If the cable is to enter the Indicator / Processor from the top, strip off 4-½ in. (114 mm) of the outer jacket.

   If the cable is to enter the Indicator / Processor from the bottom, strip off 3-⅝ in. (92mm) of the outer jacket.

b. Remove the outer braided shield. Leave one-half in. (13 mm) of shield exposed.

c. Trim the drain wire(s) back to the end of the braid.

d. Strip all colored wires 5/16 in. (8 mm) and Tin wire ends.

THE INDICATOR / PROCESSOR END OF THE CABLE

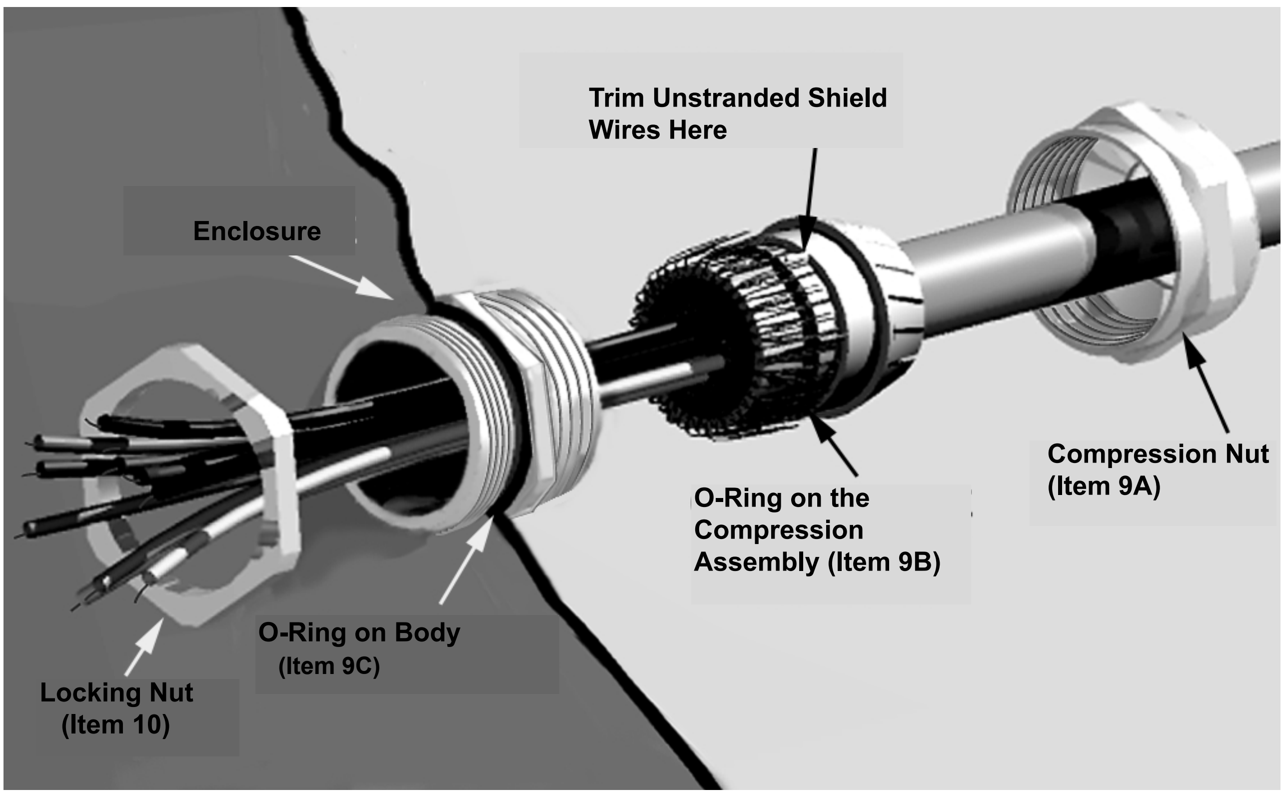
All signal cable shielding must be grounded to the Indicator / Processor enclosure, by a grounding strain relief, as they enter or leave the Indicator / Processor.

1. See Detail E, illustrates how a braided wire shielded cable is grounded when using either the large or small Grounding Strain Relief fittings.
2. Check that you are using the proper size grounding strain relief. Slip the Compression Nut (Item 9A) and the Compression Assembly (Item 9B) onto the cable, as in Detail E. Pay attention to their order , position and direction of each part shown.
3. Unbraid and comb out the braided shield wires and the stranded drain wires. Flare all the combed wires evenly all around, down, and over the Compression Fitting (Item 9B).

   If an inner foil is used in the cable, check that no inner foil drapes over the shield wires, trim it if necessary.
4. It is very important that the compression assembly rest on the unstripped portion of the outer cable jacket to make a proper seal.
5. Push the Compression Body(Item 9C), all the way, into the Compression Fitting (Item 9B).
6. Trim the shield wires to a spot just past the o-ring on the compression fitting, as in Detail E.
7. Hold the cable firmly , so that the cable does not twist in the fitting, as you screw the Compression Nut (Item 9A) onto the Compression Fitting to make a water-tight seal.
8. Check or tighten all parts firmly.

You have now completed the indicator connector end of the cable assembly.

NOTE: The Locking Nut (Item 10) is used to fasten the cable to the Indicator / Processor . See the Indicator / Processor Section of the MODLINE 3 Installation Manual for how to install the cable.



DETAIL E. GROUNDING STRAIN RELIEF

ASSEMBLY CHECKLIST

❏ After assembly, check continuity of each lead from connector socket to the wire ends.

❏ Check insulation resistance between all pairs of terminals.
Resistance should be 50 megohms or greater.

❏ Check closely for any wire strands, etc. that could cause shorting.

❏ Refer to Section 3 of MODLINE 3 System manual for instructions on installing the assembled cable.

If you have any questions about cable assembly, contact our Technical Service Department or the Applications Engineering Department for further information.

Appendix A — NEMA Safety Guidelines

The purpose of this section is to acquaint you with the ***NEMA Safety Guidelines*** *for Application, Installation and Maintenance of Solid State Control.*

Section **Page**

NEMA SAFETY GUIDELINES FOR APPLICATION, INSTALLATION AND MAINTENANCE OF SOLID STATE CONTROL

NEMA SAFETY GUIDELINES FOR THE APPLICATION, INSTALLATION, AND MAINTENANCE OF SOLID STATE CONTROL

Section 1: DEFINITIONS

(This section is classified as NEMA Standard 11-15-1984.)

Electrical Noise—Unwanted electrical energy which has the possibility of producing undesirable effects in the control, its circuits, and system.

Electrical Noise Immunity—The extent to which the control is protected from a stated electrical noise.

Off-State Current—The current that flows in a solid state device in the off-state condition.

Off-State Condition—The conditions of a solid state device where no control signal is applied.

On-State Condition—The condition of a solid state device when conducting.

Surge Current—A current exceeding the steady state current for a short time duration, normally described by its peak amplitude and time duration.

Transient Overvoltage—The peak voltage in excess of steady state voltage for a short time during the transient conditions (e.g., resulting from the operations of a switching device).

Section 2: GENERAL

(Sections 2 through 5 are classified as Authorized Engineering Information 11-15-1984.)

Solid State and electro-mechanical controls can perform similar control functions, but there are certain unique characteristics of solid state controls which must be understood.

In the application, installation and maintenance of solid state control, special consideration should be given to the characteristics described in 2.1 through 2.7.

2.1 AMBIENT TEMPERATURE

Care should be taken not to exceed the ambient temperature range specified by the manufacturer.

2.2 ELECTRICAL NOISE

Performance of solid state controls can be affected by electrical noise. In general, complete systems are designed with a degree of noise immunity. Noise immunity can be determined with tests such as described in 3.4.2. Manufacturer recommended installation practices for reducing the effect of noise should be followed.

2.3 OFF-STATE CURRENT

Solid state controls generally exhibit a small amount of current flow when in the off-state condition. Precautions must be exercised to ensure proper circuit performance and personnel safety. The value of this current is available from the manufacturer.

2.4 POLARITY

Incorrect polarity of applied voltages may damage solid state controls. The correct polarity of solid state controls should be observed.

2.5 RATE OF RISE–VOLTAGE OR CURRENT (DV/DT or DI/DT)

Solid state controls can be affected by rapid changes of voltage or current if the rate of rise (DV/DT and/or DI/DT) is greater than the maximum permissible value specified by the manufacturer.

2.6 SURGE CURRENT

Current of a value greater than that specified by the manufacturer can affect the solid state control. Current limiting means may be required.

2.7 TRANSIENT OVERVOLTAGE

Solid state controls may be affected by transient over-voltages which are in excess of those specified by the manufacturer. Voltage limiting means should be considered and may be required.

Appendix

Section 3: APPLICATION GUIDELINES

3.1 GENERAL APPLICATION PRECAUTIONS

3.1.1 Circuit Considerations

The consequences of some malfunctions such as those caused by shorted output devices, alteration, loss of memory, or failure of isolation within components or logic devices require that the user be concerned with the safety of personnel and the protection of the electronics.

It is recommended that circuits which the user considers to be critical to personnel safety, such as "end of travel" circuits and "emergency stop" circuits, should directly control their appropriate functions through an electromechanical device independent of the solid state logic. Such circuits should initiate the stop function through deenergization rather than energization of the control device. This provides a means of circuit control that is independent of system failure.

3.1.2 Power Up/Power Down Considerations

Consideration should be given to system design so that unsafe operation does not occur under these conditions since solid state outputs may operate erratically for a short period of time after applying or removing power.

3.1.3 Redundancy and Monitoring

When solid state devices are being used to control operations, which the user determines to be critical, it is strongly recommended that redundancy and some form of checking be included in the system. Monitoring circuits should check that actual machine or process operation is identical to controller commands; and in the event of failure in the machine, process, or the monitoring system, the monitoring circuits should initiate a safe shutdown sequence.

3.1.4 Overcurrent Protection

To protect triacs and transistors from shorted loads, a closely matched short circuit protective device (SCPD) is often incorporated. These SCPD's should be replaced only with devices recommended by the manufacturer.

3.1.5 Overvoltage Protection

To protect triacs, SCR's and transistors from overvoltages, it may be advisable to consider incorporating peak voltage clamping devices such as varistors, zener diodes, or snubber networks in circuits incorporating these devices.

3.2 CIRCUIT ISOLATION REQUIREMENTS

3.2.1 Separating Voltages

Solid state logic uses low level voltage (e.g., less than 32 volts dc) circuits. In contrast, the inputs and outputs are often high level (e.g., 120 volts ac) voltages. Proper design of the interface protects against an unwanted interaction between the low level and high level circuits; such an interaction can result in a failure of the low voltage circuitry. This is potentially dangerous. An input and output circuitry incorporating effective isolation techniques (which may include limiting impedance or Class 2 supplied circuitry) should be selected.

3.2.2 Isolation Techniques

The most important function of isolation components is to separate high level circuits from low level circuits in order to protect against the transfer of a fault from one level to the other.

Isolation transformers, pulse transformers, reed relays, or optical couplers are typical means to transmit low level logic signals to power devices in the high level circuit. Isolation impedance means also are used to transmit logic signals to power devices.

3.3 SPECIAL APPLICATION CONSIDERATIONS

3.3.1 Converting Ladder Diagrams

Converting a ladder diagram originally designed for electromechanical systems to one using solid state control must account for the differences between electromechanical and solid state devices. Simply replacing each contact in the ladder diagram with a corresponding solid state "contact" will not always produce the desired logic functions or fault detection and response. For example, in electromechanical systems, a relay having a mechanically linked normally open (NO) and normally closed (NC) contact can be wired to check itself. Solid state components do not have a mutually exclusive NO-NC arrangement. However, external circuitry can be employed to sample the input and "contact" state and compare to determine if the system is functioning properly.

3.3.2 Polarity and Phase Sequence

Input power and control signals should be applied with polarity and phase sequence as specified by the manufacturer. Solid state devices can be damaged by the application of reverse polarity or incorrect phase sequence.

3.4 PLANNING ELECTRICAL NOISE REJECTION

The low energy levels of solid state controls may cause them to be vulnerable to electrical noise. This should be considered in the planning stages.

3.4.1 Assessing Electrical Environment

Sources of noise are those pieces of equipment that have large, fast changing voltages or currents when they are energized or de-energized, such as motor starters, welding equipment, SCR type, adjustable speed devices, and other inductive devices. These devices, as well as the more common control relays and their associated wiring, all have the capability of inducing serious current and voltage transients on their respective power lines. It is these transients which nearby solid state controls must withstand and for which noise immunity should be provided.

An examination of the proposed installation site of the solid state control should identify equipment that could contaminate power lines. All power lines that will be tapped by the proposed solid state control should be examined for the presence, severity, and frequency of noise occurrences. If found, system plans should provide for the control of such noise.

3.4.2 Selecting Devices to Provide Noise Immunity

Installation planning is not complete without examination of the noise immunity characteristics of the system devices under consideration. Results of tests to determine relative immunity to electrical noise may be required from the manufacturer. Two such standardized tests are the ANSI (C37.90a-1974) *Surge Withstand Capability Test* and the NEMA (ICS 1-1983) noise test referred to as *The Showering Arc Test.* These are applied where direct connection of solid state control to other electromechanical control circuits is intended. Circuits involving analog regulating systems or high speed logic are generally more sensitive to electrical noise; therefore, isolation and separation of these circuits is more critical.

Further information on electrical noise and evaluation of the severity of noise may be found in ANSI/IEEE Publication No. 518-1982.

Where severe power line transients are anticipated or noted, appropriate filters such as commercially available line filter, isolation transformers, or voltage limiting varistors, should be considered.

All inductive components associated with the system should be examined for the need for noise suppression.

3.4.3 Design of Wiring for Maximum Protection

Once the installation site and power conductors have been examined, the system wiring plans that will provide noise suppression should be considered.

Conducted noise enters solid state control at the points where the control is connected to input lines, output lines, and power supply wires.

Input circuits are the circuits most vulnerable to noise. Noise may be introduced capacitatively through wire to wire proximity or magnetically from nearby lines carrying large currents. In most installations, signal lines and power lines should be separate. Further, signal lines should be appropriately routed and shielded according to the manufacturer's recommendations.

When planning system layout, care must be given to appropriate grounding practice. Because design differences may call for different grounding, the control manufacturer's recommendations should be followed.

3.5 COUNTERING THE EFFECTS OF OFF-STATE CURRENT

3.5.1 Off-State Current

Solid state components, such as triacs, transistors, and thyristors, inherently have in the off-state a small current flow called "off-state current".

Off-state current may also be contributed by devices used to protect these components, such as RC snubbers.

3.5.2 Off-State Current Precautions

Off-state currents in a device in the off-state may present a hazard of electrical shock and the device should be disconnected from the power source before working on the circuit or load.

Appendix

Precautions should be taken to prevent the off-state current of an output device which is in the off-state from energizing an input device.

3.6 AVOIDING ADVERSE ENVIRONMENTAL CONDITIONS

3.6.1 Temperature

Solid state devices should only be operated within the temperature ranges specified by the manufacturer. Because such devices generate heat, care should be taken to see that the ambient temperature at the device does not exceed the temperature range specified by the manufacturer.

The main source of heat in a solid state system is the energy dissipated in the power devices. Since the life of the equipment can be increased by reducing operating temperature, it is important to observe the manufacturer's "maximum/minimum ambient temperature" guidelines, where ambient refers to the temperature of the air providing the cooling. The solid state equipment must be allowed to stabilize to within the manufacturer's recommended operating temperature range before energizing control functions.

When evaluating a system design, other sources of heat in the enclosure which might raise the ambient temperature should not be overlooked. For example, power supplies, transformers, radiated heat, sunlight, furnaces, incandescent lamps, and so forth should be evaluated.

In instances where a system will have to exist in a very hot ambient environment, special cooling methods may have to be employed. Techniques that are employed include cooling fans (with adequate filtering), vortex coolers, heat exchanges, and air conditioned rooms.

Over-temperature sensors are recommended for systems where special cooling is employed. Use of air conditioning should include means for prevention of condensing moisture.

3.6.2 Contaminants

Moisture, corrosive gases and liquids, and conductive dust can all have adverse effects on a system that is not adequately protected against atmospheric contaminants.

If these contaminants are allowed to collect on printed circuit boards, bridging between the conductors may result in malfunction of the circuit. This could lead to noisy, erratic control operation or, at worst, a permanent malfunction. A thick coating of dust could also prevent adequate cooling on the board or heat sink, causing malfunction. A dust coating on heat sinks reduces their thermal efficiency.

Preventive measures include a specially conditioned room or a properly specified enclosure for the system.

3.6.3 Shock and Vibration

Excessive shock or vibration may cause damage to solid state equipment. Special mounting provisions may be required to minimize damage.

3.7 THE NEED FOR SAFETY–KNOWLEDGE LEADS TO SAFETY

Planning for an effective solid state circuit requires enough knowledge to make basic decisions that will render the system safe as well as effective.

Everyone who works with a solid state control should be educated in its capabilities and limitations. This includes in-plant installers, operators, service personnel, and system designers.

Section 4: APPLICATION GUIDELINES

4.1 INSTALLATION AND WIRING PRACTICE

4.1.1 Proper installation and field wiring practices are of prime importance to the application of solid state controls. Proper wiring practice will minimize the influence of electrical noise, which may cause malfunction of equipment.

Users and installers should familiarize themselves with and follow installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards. The manufacturer of the device or component in question should be consulted whenever conditions arise that are not covered by the manufacturer's instructions.

4.1.2 Electrical noise is a very important consideration in any installation of solid state control. While wiring practices may vary from situation to situation, the following are basic to minimizing electrical noise:

1. Sufficient physical separation should be maintained between electrical noise sources and sensitive equipment to assure that the noise will not cause malfunctioning or unintended actuation of the control.
2. Physical separation should be maintained between sensitive signal wires and electrical power and control conductors. This separation can be accomplished by conduits, wiring trays, or as otherwise recommended by the manufacturer.
3. Twisted-pair wiring should be used in critical signal circuits and noise producing circuits to minimize magnetic interference.
4. Shielded wire should be used to reduce the magnitude of the noise coupled into the low level signal circuit by electrostatic or magnetic coupling.
5. Provisions of the 1984 *National Electrical Code* with respect to grounding should be followed. Additional grounding precautions may be required to minimize electrical noise. These precautions generally deal with ground loop currents arising from multiple ground paths. The manufacturer's recommendations should be followed.

4.2 ENCLOSURES (COOLING AND VENTILATING)

Suitable enclosures and control of the maximum operating temperature, both of which are environmental variables, may be needed to prevent malfunction of solid state control.

The manufacturer's recommendations should be followed for the selection of enclosures, ventilation, air filtering (if required), and ambient temperature. These recommendations may vary from installation to installation, even within the same facility.

4.3 SPECIAL HANDLING OF ELECTROSTATIC SENSITIVE DEVICES

Some devices may be damaged by electrostatic charges. These devices are identified and should be handled in the special manner specified by the manufacturer.

NOTE: Plastic wrapping materials used to ship these devices may be conductive and should not be used as insulating material.

4.4 COMPATIBILITY OF DEVICES WITH APPLIED VOLTAGES AND FREQUENCIES

Prior to energization, users and installers should verify that the applied voltage and frequency agree with the rated voltage and frequency specified by the manufacturer.

NOTE: Incorrect voltage or frequency may cause a malfunction of, or damage to, the control.

4.5 TESTING PRECAUTIONS

When testing solid state control, the procedures and recommendations set forth by the manufacturer should be followed.

When applicable, instrumentation and test equipment should be electrically equivalent to that recommended by the manufacturer for the test procedure. A low impedance voltage tester should not be used.

High voltage insulation tests and dielectric tests should never be used to test solid state devices. If high voltage insulation of field wiring is required, solid state devices should be disconnected. Ohmmeters should only be used when and as recommended by the equipment manufacturer.

Testing equipment should be grounded; if it is not, special precautions should be taken.

4.6 STARTUP PROCEDURES

Checks and tests prior to startup and startup procedures recommended by the manufacturer should be followed.

Appendix

Section 5: PREVENTIVE MAINTENANCE AND REPAIR GUIDELINES

5.1 GENERAL

A well-planned and -executed maintenance program is essential to the satisfactory operation of solid state electrical equipment. The kind and frequency of the maintenance operation will vary with the kind and complexity of the equipment as well as with the nature of the operating conditions. Maintenance recommendations of the manufacturer or appropriate product standards should be followed.

Useful reference publications for setting up a maintenance program are NFPA 70B-1983, *Maintenance of Electrical Equipment*, and NFPA 70E-1983, *Electrical Safety Requirements for Employee Workplaces.*

5.2 PREVENTIVE MAINTENANCE

The following factors should be considered when formulating a maintenance program:

1. Maintenance must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the control.
2. Maintenance should be performed with the control out of operation and disconnected from all sources of power. If maintenance must be performed while the control is energized, the safety related practices of NFPA 70E should be followed.
3. Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.
4. Ventilation passages should be kept open. If the equipment depends upon auxiliary cooling, e.g., air, water, or oil, periodic inspection (with filter replacement when necessary) should be made of these systems.
5. The means employed for grounding or insulating the equipment from ground should be checked to assure its integrity (see 4.5).
6. Accumulations of dust and dirt on all parts, including on semiconductor heat sinks, should be removed according to the manufacturer's instructions, if provided; otherwise, the manufacturer should be consulted. Care must be taken to avoid damaging any delicate components and to avoid displacing dust, dirt, or debris in a way that permits it to enter or settle into parts of the control equipment.
7. Enclosures should be inspected for evidence of deterioration. Accumulated dust and dirt should be removed from the top of the enclosures before opening doors or removing covers.
8. Certain hazardous materials removed as part of maintenance or repair procedure (e.g., polychlorinated biphenyls (PCB) found in some liquid filled capacitors) must be disposed of as described in Federal regulations.

5.3 REPAIR

If equipment condition indicates repair or replacement, the manufacturer's instruction manual should be followed carefully. Diagnostic information within such a manual should be used to identify the probable source of the problem, and to formulate a repair plan. The level of field repair recommended by the manufacturer should be followed.

When solid state equipment is repaired, it is important that any replacement part be in accordance with the recommendations of the equipment manufacturer. Care should be taken to avoid the use of parts which are no longer compatible with other changes in the equipment. Also, replacement parts should be inspected for deterioration due to "shelf life" and for signs of rework or wear which may involve factors critical to safety.

After repair, proper start-up procedures should be followed. Special precautions should be taken to protect personnel from hazards during start-up.

5.4 SAFETY RECOMMENDATIONS FOR MAINTENANCE PERSONNEL

All maintenance work should be done by qualified personnel familiar with the construction, operation, and hazards involved with the equipment. The appropriate work practices of NFPA 70E should be followed.

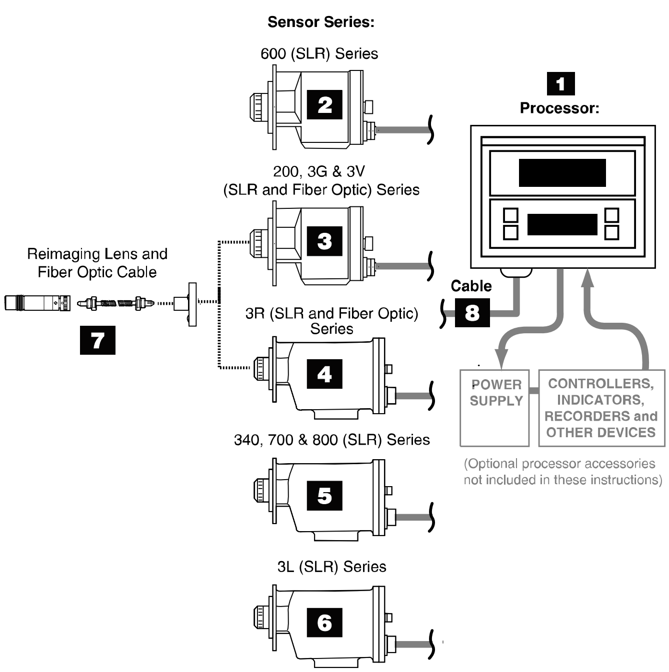
DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES

Following are the disassembly instructions for the Ircon Modline 3 product series, including most optional accessories, in accordance to guidelines of the European Union Waste Electric and Electronic Equipment (WEEE) Directive 2002/96/EC.

This product includes the following materials to be dispensed of properly:

Zinc	Sensor Casings
Aluminum	AA-3 Air Purge, WA-3 Water Jacket Casings, Lens Housings WJ-R Cooling Jacket, Modline 3 Processor Casing, various nuts and mounting brackets
Brass	WJ-5 Cooling Jacket Tubing and Connectors
Steel	Fiber Optic Cable and Reimaging lens, cable connectors, screws nuts and mounting brackets, AAQ-1 Quick Release
Glass	Lenses
Electronic Circuit Board	Within processor and sensor housings
Plastic	Processor casing, cable coating
Silicone	Cable coating
Copper	Various wires
Inconel	SI-12 and SI-14 sight tube

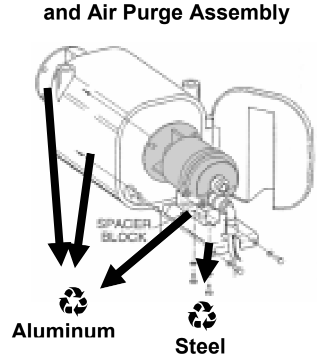
Fully Assembled View:
Below are diagrams illustrating the fully-assembled core Ircon Modline 3 system components, consisting of a Processor Module and six Sensor modules. Disassembly instructions for the Modline 3 system are shown on the following pages. These instructions account for all Modline 3 models (and often-used accessories), as the variation between models affecting recycling is minimal.



Round Style Sensor Accessories:

Sensor with AA-3 Air Purge and WA-3 Water Cooling Accessory

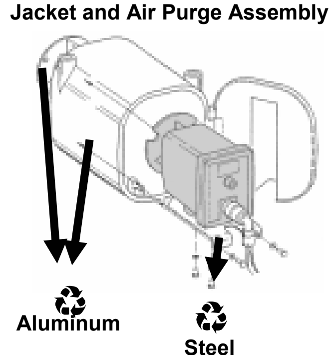
Sensor with WJ5 Cooling Jacket and Air Purge Assembly



Square Style Sensor Accessories:

Sensor with AA-3 Air Purge and WA-3 Water Cooling Accessory

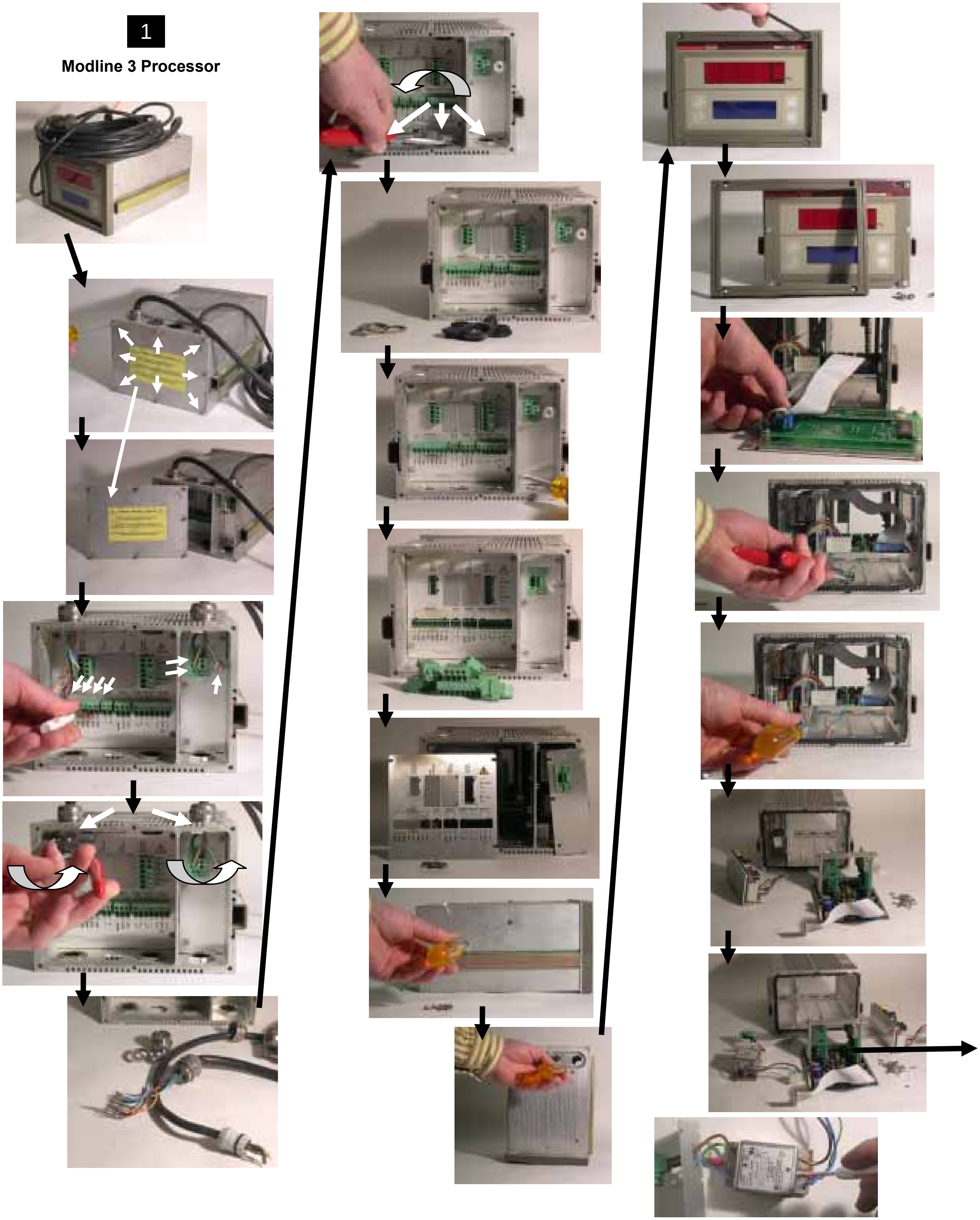
Sensor with WJ5 Cooling Jacket and Air Purge Assembly



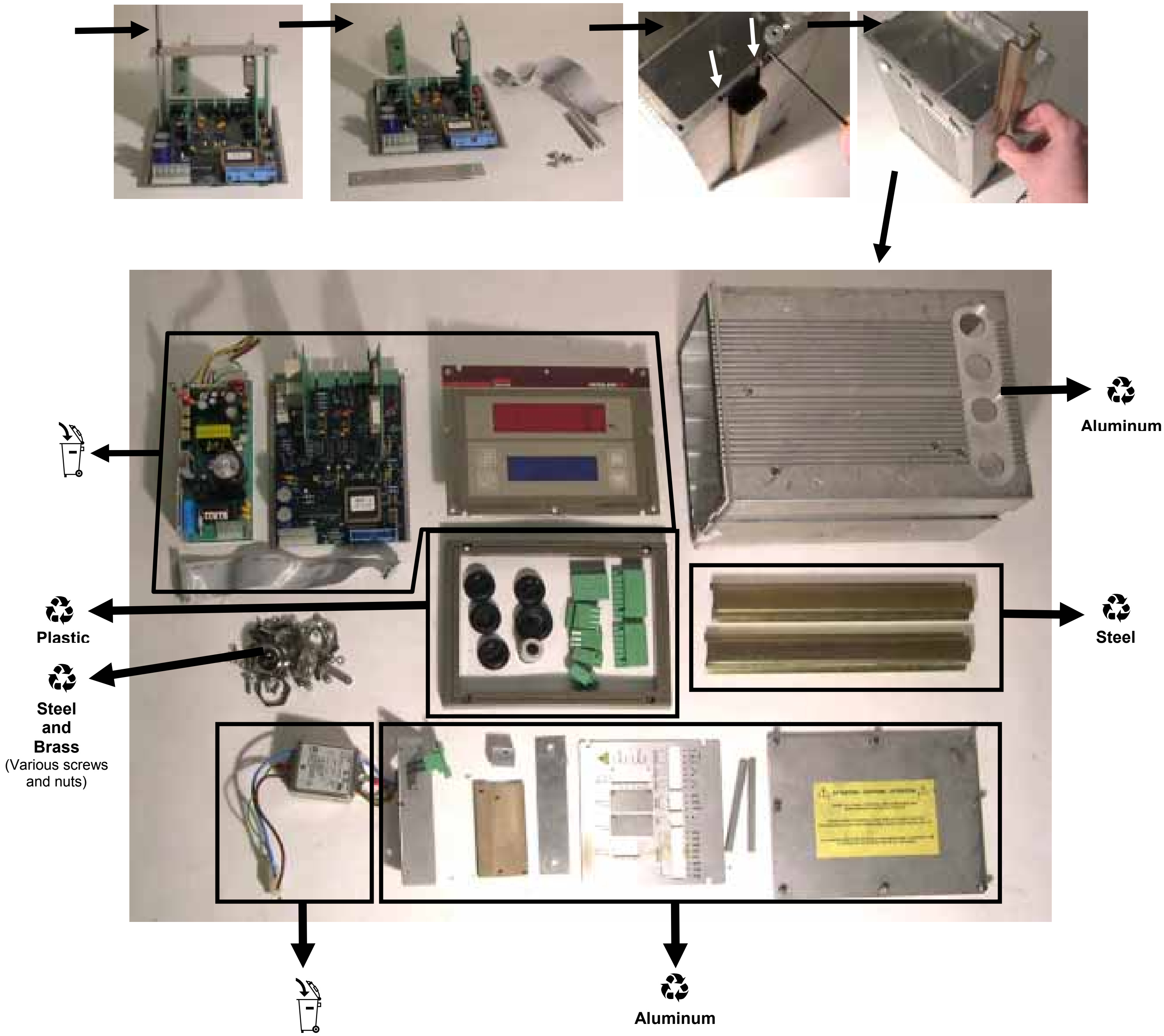
DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES

1

Modline 3 Processor



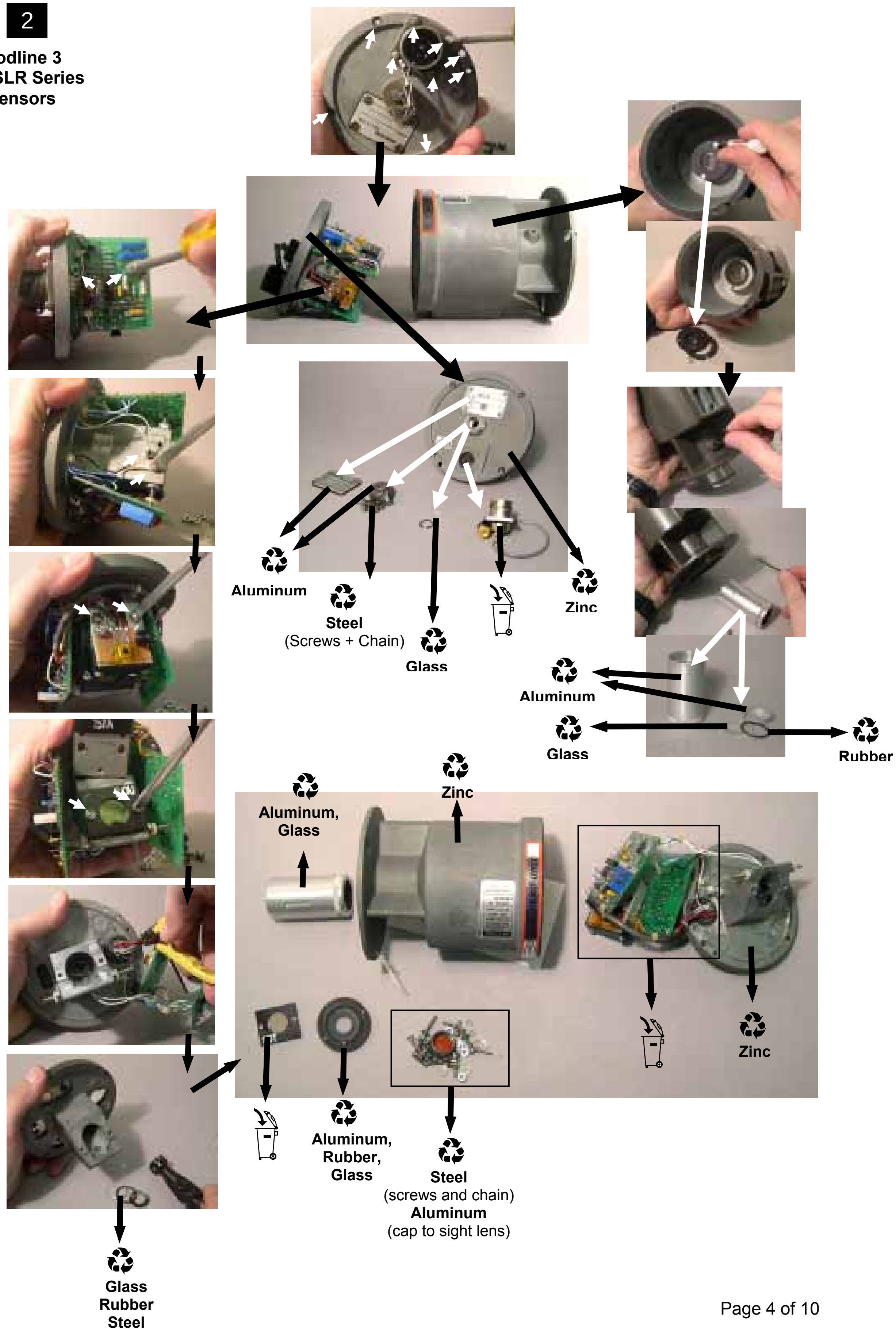
DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES



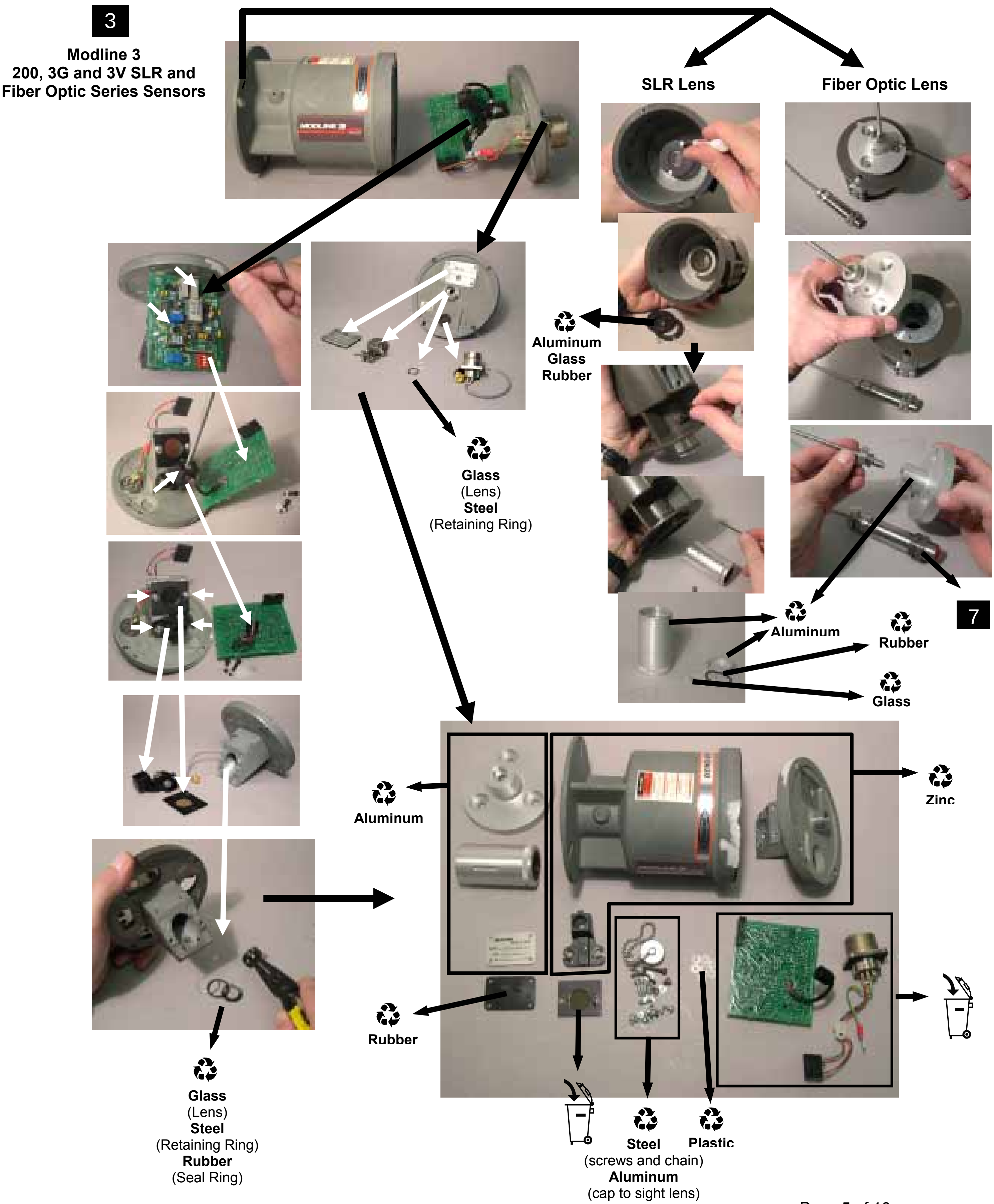
DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES

2

**Modline 3
600 SLR Series
Sensors**



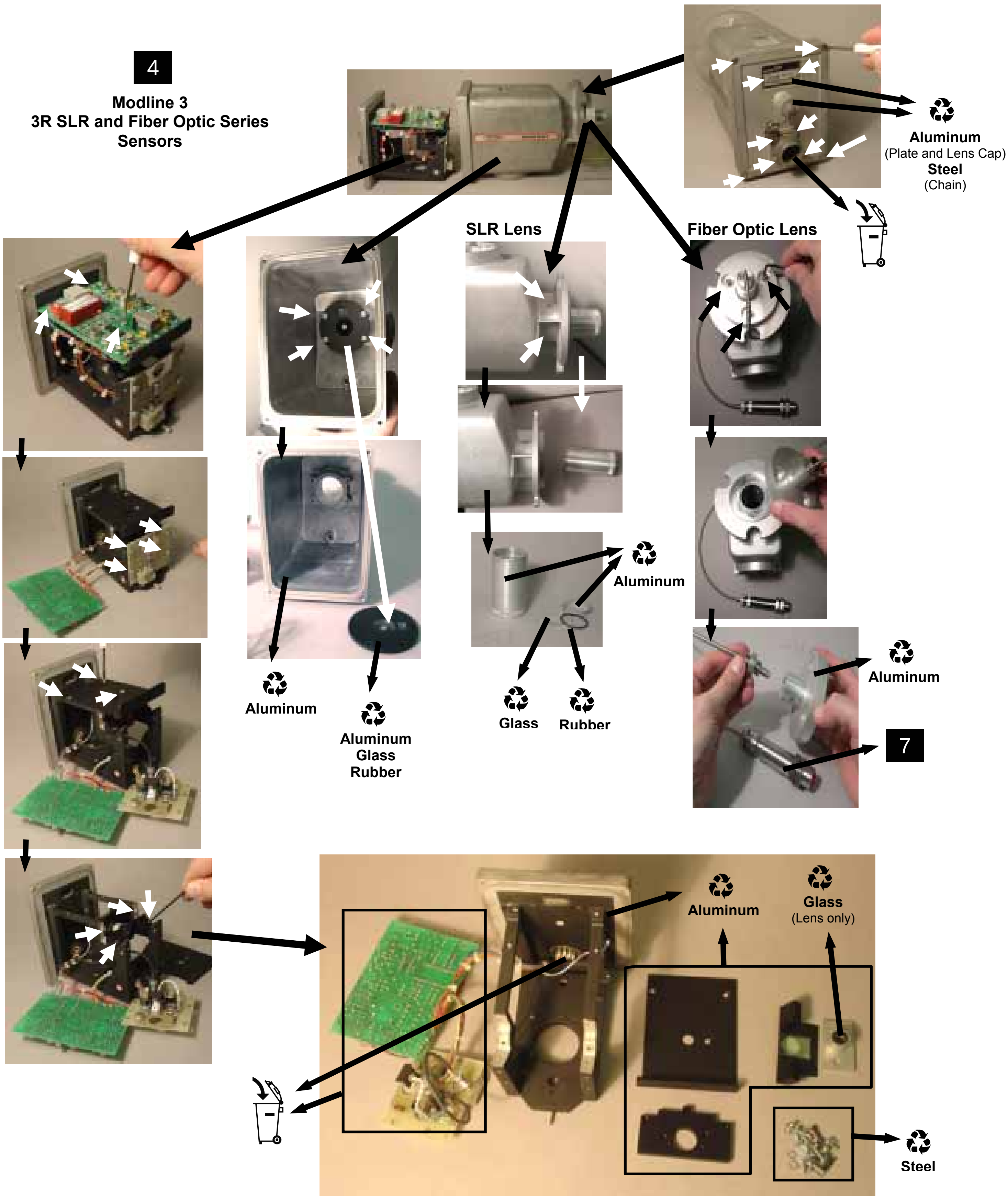
DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES



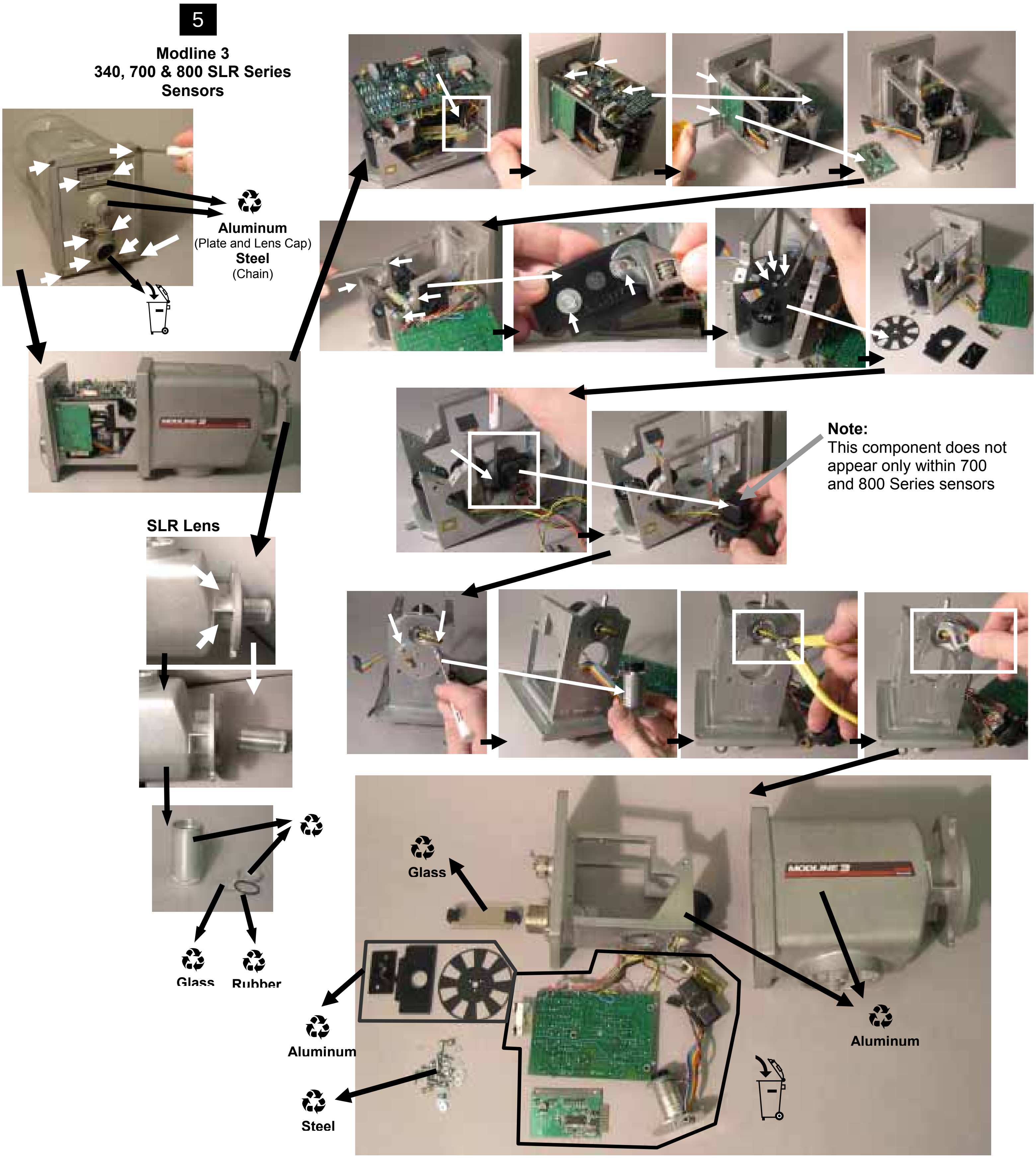
DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES

4

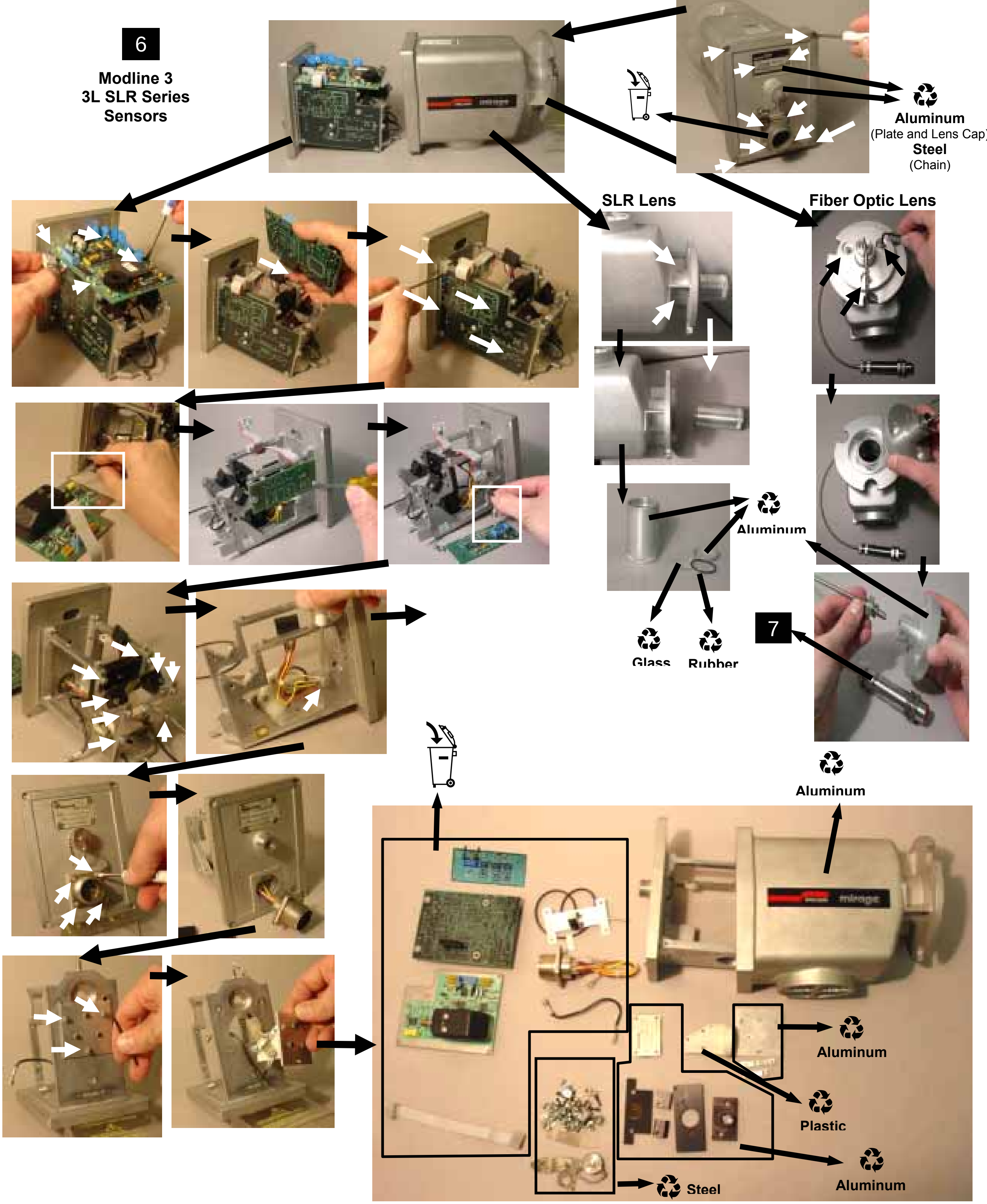
Modline 3
3R SLR and Fiber Optic Series
Sensors



DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES



DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES

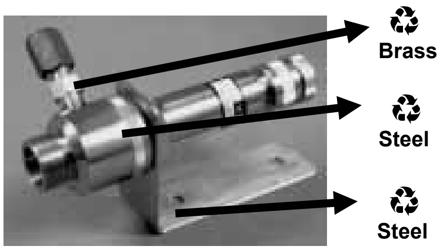


DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES

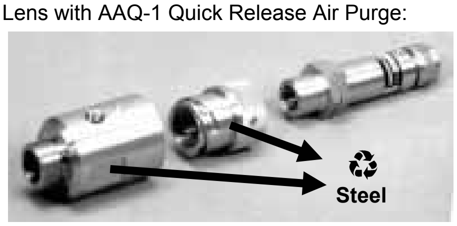
7 Mirage Fiber Optic Assembly Disassembly Instructions

Sensor Accessory Configurations:

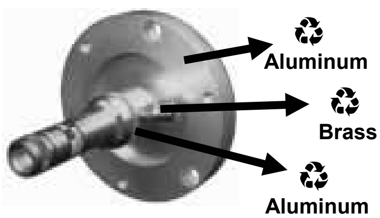
Lens with AA-5 Air Purge and MB-5 Bracket:

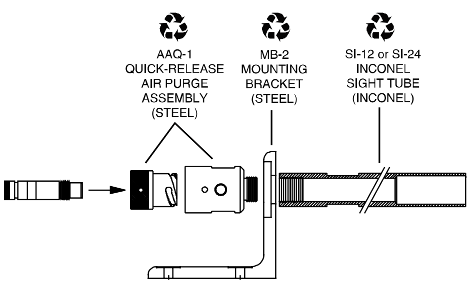


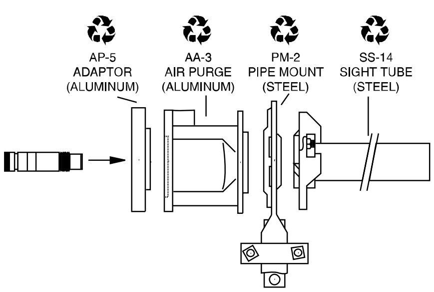
Lens with AAQ-1 Quick Release Air Purge:

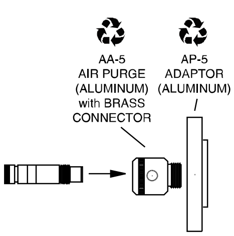


Lens with AP-1 Adapter Plate and AA-3 Air Purge:

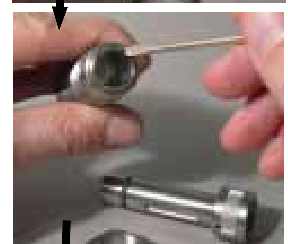


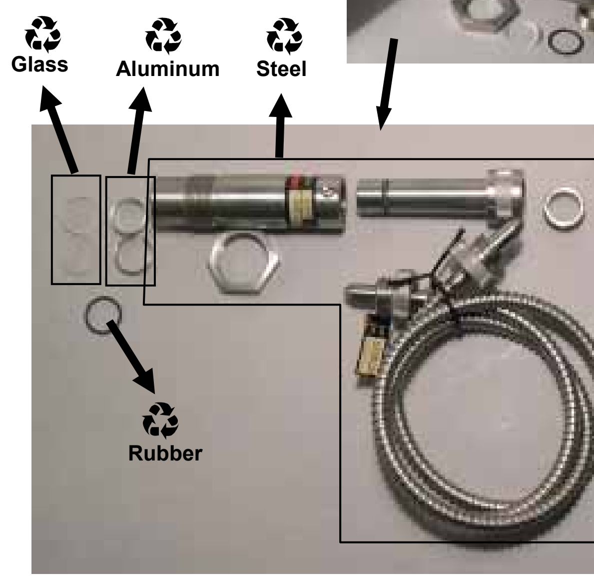






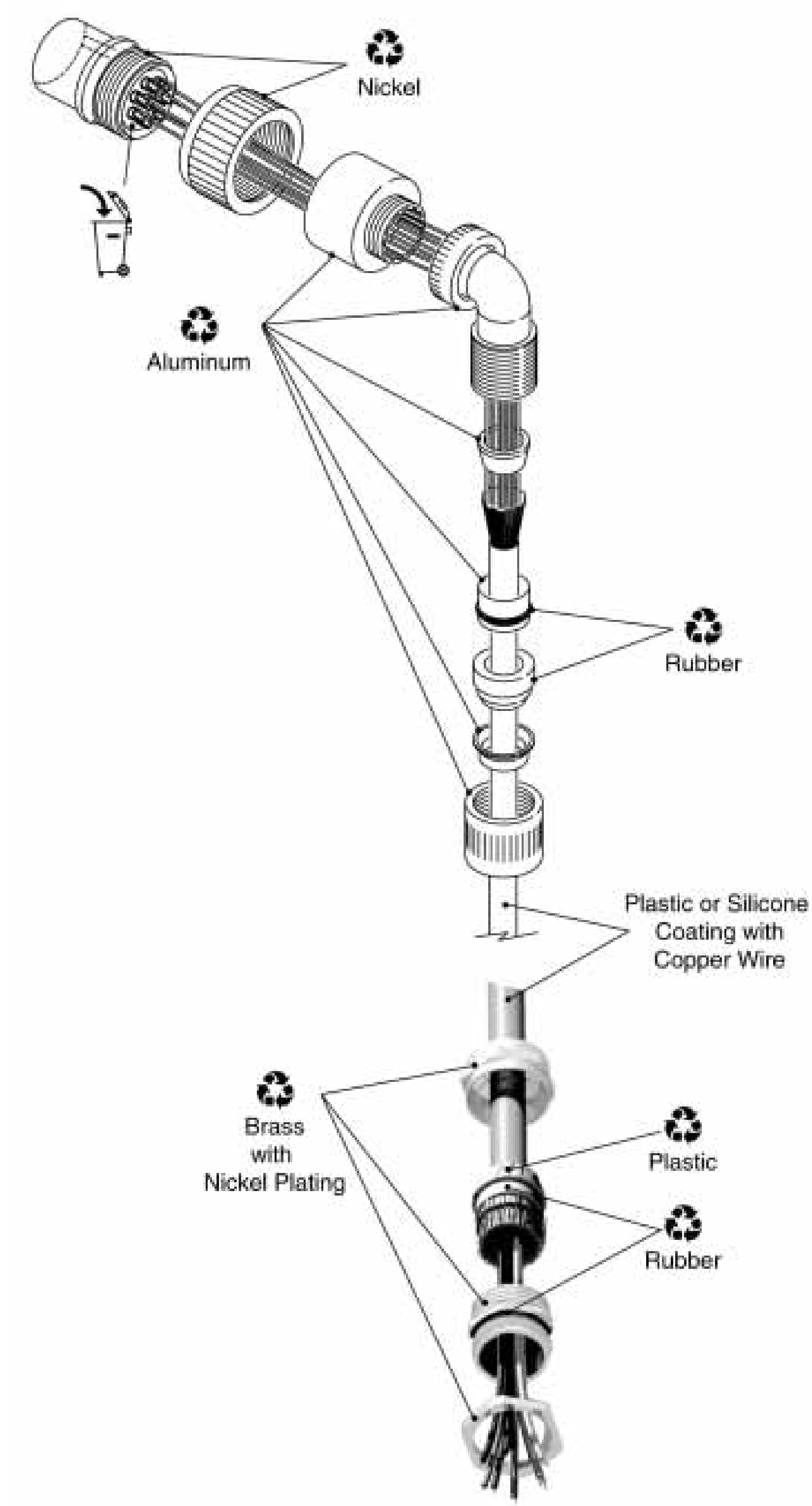
Reimaging Lens with Fiber Optic Cable





DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING:
IRCON MODLINE 3 PRODUCT AND ACCESSORIES

8 **Sensor Cable Assembly Disassembly Instructions**



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