

**Sierra Series 600/640
Accu-Flo™ and Steel-Trak™
Insertion Mass Flow Meters**

Instruction Manual

Part Number IM-60-600
03/96 Revision C



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Caution messages (preceded by **CAUTION!** in the text) appear before procedures which, if not observed, could result in damage to equipment.

CAUTIONS

CAUTION! For all installations of flow meters, standard industrial wiring practices apply. Local codes may require the use of conduit. In general, the use of conduit is recommended as good wiring practice.

CAUTION! Be sure that your flow meter is equipped for the correct input power by checking the label on the outside of the unit.

CAUTION! The flow meter is not a 24V, 4-20 mA loop powered transmitter. The meter requires four wiring connections, two for power and two for signal.

CAUTION! Terminal strips for field wiring are located inside the enclosure. Refer to APPENDIX C5 for wiring instructions.

CAUTION! Before powering up for the first time, check all wiring to ensure it is in compliance with APPENDIX C section of this manual.

CAUTION! Adjustments to VR1, VR2 VR6 and VR7 affect the calibration of your flow meter and should only be attempted by qualified personnel with the proper flow standards.

CAUTION! The electronics, sensors and interconnect wires supplied by Sierra Instruments, Inc. are calibrated as a single precision mass flow meter. Interchanging sensors will impair the accuracy of the flow meter.

WARNINGS

Warning messages (preceded by “**WARNING!**” in the text) indicate that when a specific procedure or practice is not followed correctly, personal injury could result.

WARNING! Although a specially designed Series 640 Flow Meter has been approved by Factory Mutual Research Corporation, Sierra does not have approval by any agency for use of the standard 600 or 640 flow meter in a hazardous location. Sierra Instruments, Inc. neither recommends nor offers the Series 600/640 Flow Meters for use in a hazardous location. For use in classified areas, use the 640 FM which has an NEC Code Class I, Divisions 1 and 2, Groups B, C and D with a T-3 Rating and Class II, Divisions 1 and 2, Groups E and F with a T-3 Rating. For applications that require maximum safety, the meter must be properly installed using metal conduit and fittings for all wiring, both power and signal, with the desired safety rating.

WARNING! All installation procedures must be performed with the power OFF.

WARNING! Before attempting any maintenance make sure there is no pressure in the line.

WARNING! Gas leaks are possible during probe maintenance. If there is toxic or combustible gas in the line, be sure the lines are completely purged before removing the probe.

WARNING! All maintenance operations must be carried out with the power off.

WARNING! Calibration must be performed by qualified personnel. Sierra Instruments, Inc. strongly recommends that you return your 600/640 Flow Meter to the factory for calibration. Refer to Section 6, TROUBLESHOOTING, for shipping instructions.

(Refer to Section 2, INSTALLATION, for detailed instructions)

QUICK INSTRUCTIONS

Installation

1. Check the label on the flow meter for system pressure, temperature, gas composition, power input, and signal output.
2. Check the sensor element orientation so that flow passes through sensor “window” and over the shorter sensor element first.
3. Check the installation. Install the flow meter four-fifths of the length along the longest straight section of pipe available. Proper operation dictates using 20 pipe diameters straight run upstream minimum, 5 pipe diameters straight run downstream. If possible, provide 20 diameters upstream and 10 diameters downstream to provide maximum accuracy.
4. Check for correct insertion depth (normally centered in pipeline).
5. Check system for anomalies: leaks, valves which might drastically change flow rate unexpectedly or cause turbulence, heaters which might cause rapid excursions in temperature, etc.
6. The flow meter is not a loop powered transmitter. The meter must be externally powered requiring separate wiring for power and signal. Refer to the wiring guides in this manual.
7. Ensure that all plumbing and electrical hook-ups are in accordance with OSHA, NFPA, and all other safety requirements.

Operation

1. Supply power to flow meter.
2. If RS 485 interface is used, query Probe to read back identification and diagnostic data.
3. Allow for a two minute warm up.
4. If possible, verify zero output signal at zero flow.
5. Verify output signal is present at a nominal flow rate.
6. Verify optional features such as local display, alarm operation, etc.

This manual contains information about Sierra 600/640 Series Insertion Mass Flow Meters. Within the text we will use the terms mass flow meter or flow meter interchangeably.

1 INTRODUCTION

Caution messages (preceded by “**CAUTION!**” in the text) appear before procedures which, if not observed, could result in damage to equipment.

Warning messages (preceded by “**WARNING!**” in the text) indicate that when a specific procedure or practice is not followed correctly, personal injury could result.

This manual contains eight sections plus appendices. Section 1, this section, gives a general introduction to the flow meter and describes the important flow meter parts. Sections 2 and 3 comprise the main informational sections of the manual for actual operation of the flow meter. Sections 4, 5 and 6 cover maintenance, calibration and trouble-shooting. Sections 7 and 8 cover general aspects of flow monitoring. The appendices contain reference drawings and tables.

The Sierra Instruments, Inc. Applications and Service Engineers may be reached at (800) 866-0200 or Fax (408) 373-4402. In Europe you can reach our Applications and Service Engineers at Sierra Instruments b.v., 31(0)20-614580 or Fax 31(0)20-6145815.

Service Number

When your Sierra flow meter is received, carefully check the outside packing carton for damage incurred during shipment. If the packing carton is damaged, notify the local carrier. Submit a report to: Customer Service, Sierra Instruments, Inc., 5 Harris Court, Building L, Monterey, CA 93940 or Customer Service, Sierra Instruments b.v., Bolstoen 30A, 1046 AV Amsterdam, The Netherlands. Remove the packing slip from its envelope and check that the carton contains all parts listed. Make sure any spare parts or accessories are not discarded with the packing material. In case of shortages, contact Customer Service at one of the addresses below, or call (800) 866-0200 or 31(0)20-6145810 and ask for Customer Service.

1.1 Receipt of Your Mass Flow Meter

Do not return any equipment without a Return Material Authorization obtainable from the Customer Service Department. Please include information describing the problem, corrective action or work to be accomplished at the factory, the purchase order number under which the equipment was purchased, and the name and phone number of the person at your company to contact. Return shipping address:

Return Material
Authorization

USA HEADQUARTERS
Sierra Instruments, Inc.
5 Harris Court, Building L
Monterey, CA 93940
ATTN: SERVICE DEPT.

EUROPEAN HEADQUARTERS
Sierra Instruments b.v.
Bolstoen 30A
1046 AV Amsterdam
The Netherlands
ATTN: SERVICE DEPT.

NOTE: Equipment returned for repair that is found to be completely operational will be subject to the current “no problem found” billing rate.

1.2 Product Coverage

This instruction manual covers the installation and operation of all standard Series 600/640 Mass Flow Meters. This manual applies to the following model numbers:

Mass Flow Meters

600-(*)Accu-Flo™ Insertion Velocity and Mass Flow Meters; all options are covered by this manual.

640-(*)Steel-Trak™ Industrial Insertion Velocity and Mass Flow Meters; all options are covered by this manual.

**Descriptive text to specify gas and range within parentheses, options outside parentheses.*

1.2.1 General Description

Sierra's Series 600 and 640 Insertion Mass Flow Meters monitor the mass flow rate of air and process gases in any full scale range from 0-100 and 0-15,000 SFPM† and 0-0.5 to 0-75 SMPS†. The mass flow probe is inserted into the gas flow and delivers a 0-1 VDC, 0-5 VDC, 0-10 VDC, or 4-20 mA analog output signal proportional to total gas mass flow rate, without requiring the temperature and pressure corrections necessary in Pitot-tube, orifice-plate, or turbine devices. An RS 485 serialized output signal is optionally available. Instrument performance is superior: 1% of full scale +0.5% of reading accuracy; 0.2% of full scale repeatability; and 0.2 second (Accu-Flo™) flow time response.

†SFPM = Standard Feet Per Minute; SMPS = Standard Meters Per Second

1.2.2 Options

Many options are available to satisfy every flow monitoring application: input power choices of 15-18 VDC, 24 VDC, 100 VAC, 115 VAC, and 230 VAC; digital LCD readout of flow rate; high and low flow rate alarms; electronics mounted directly on the probe or remote mounted up to fifty feet away; NEMA 2 or explosion proof enclosures; HT2 high-temperature operation up to 450°F (232°C); and a wide selection of probe mounting options, including compression fittings, flanges, brackets, and “hot-tap” models.

1.3 Principle of Operation

Sierra's unique Accu-Flo and Steel-Trak probes are responsible for the unsurpassed accuracy, ruggedness, and reliability of Sierra flow meters. Each probe has two sensors; a velocity sensor and a temperature sensor that automatically correct for temperature changes. Both sensors are reference-grade platinum resistance temperature detectors (RTD's). The platinum RTD wire is wound on a rugged ceramic mandrel for strength and stability. In the case of the Accu-Flo sensor, the assembly is glass-coated. Steel-Trak sensors are clad in a rugged, sealed 316 stainless steel encasement, or thermowell.

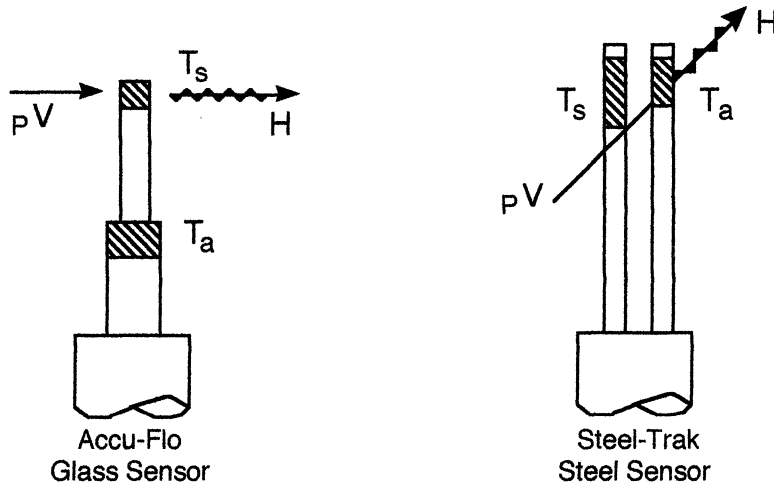


Figure 1.1
The Sierra Thermal
Principle

The circuit heats the velocity sensor at a temperature differential, $T_s - T_a$, above ambient and measures the cooling effect of the gas flow. The resulting output provides unsurpassed low-speed sensitivity and a rangeability of 1000:1. Velocities as low as 10 SFPM or .046 normal meters per second (NMPS) and as high as 15,000 SFPM (70.73 NMPS) are easily resolved. Since the heat is carried away by the molecules in the gas, the heated sensor directly measures gas mass velocity, ρV (SFPM or NMPS), referenced to standard conditions of 70°F (21.1°C) and atmosphere. In the case of duct flows, the Sierra flow meters monitor the mass velocity, which, when multiplied by the cross-section area, gives the total mass flow rate in SCFM (NCMH).

2 INSTALLATION

WARNING! Although a specially designed Series 640 Flow Meter has been approved by Factory Mutual Research Corporation, Sierra does not have approval by any agency for use of the standard 600 or 640 flow meter in a hazardous location. Sierra Instruments, Inc. neither recommends nor offers the Series 600/640 Flow Meters for use in a hazardous location. For use in classified areas, use the 640 FM which has an NEC Code Class I, Divisions 1 and 2, Groups B, C and D with a T-3 Rating and Class II, Divisions 1 and 2, Groups E and F with a T-3 Rating. For applications that require maximum safety, the meter must be properly installed using metal conduit and fittings for all wiring, both power and signal, with the desired safety rating.

WARNING! All installation procedures must be performed with the power OFF.

CAUTION! For all installations of flow meters, standard industrial wiring practices apply. Local codes may require the use of conduit. In general, the use of conduit is recommended as good wiring practice.

Refer to the QUICK INSTRUCTIONS at the beginning of this manual for a summary of the installation procedure.

Although the sensing elements are rugged, take care not to damage them upon installation.

For measuring low flows it is important that the probe be mounted securely to assure accurate results.

Check label on flow meter against system pressure, temperature, gas composition, power input, and signal output.

After all installation steps are completed for your flow meter, proceed to Section 3, OPERATING INSTRUCTIONS, particularly Section 3.1, GENERAL DESCRIPTION, and Section 3.2, POWER-UP.

2.1 Mounting of Probe and Electronics Enclosures

A common method of mounting the probe through a wall or duct is with a compression fitting. Flange mounting is optionally available. Contact Sierra Instruments directly to order the proper fitting for your flow meter.

For dimensional drawings of probe and electronics enclosure mountings, refer to APPENDIX B.

Check the sensor element orientation so that flow passes through the probe "window" in the correct direction. Mount the probe so that the plane of the window is perpendicular to the axis of the pipe or ducts within a $\pm 5^\circ$ azimuthal angle and a $\pm 5^\circ$ yaw angle.

A flow direction indication label is attached to each meter. While the meter will indicate flow in the opposite direction, it is calibrated with flow in the direction indicated on the label.

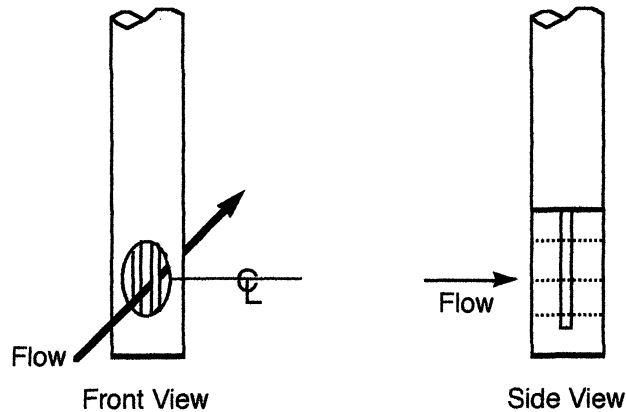


Figure 2-1
Probe Orientation

Check the installation; 20 pipe diameters straight run upstream, 5 pipe diameters straight run downstream, provides reasonable accuracy.

Check for correct insertion depth; usually the sensing point is located on the center line of the pipe or duct.

Check system for anomalies: leaks, valves which might drastically change flow rate unexpectedly or cause turbulence, heaters which might cause rapid excursions in temperature, etc.

Field wiring for Series 600/640 Flow Meters is either via terminal strips within an integral wiring compartment or via a connector mounted on the enclosure.

All Series 600/640 Flow Meters supplied in an explosion proof enclosure have an integral wiring compartment. This includes flow meters with any of the following options: explosion proof, 115/230 VAC power, 24 VDC power, or any display options.

Flow meters not supplied in the explosion proof enclosure are supplied in a smaller NEMA 2 enclosure. Field wiring for this enclosure is via a connector mounted on the enclosure.

2.2 Access to Field Wiring

2.2.1 Explosion Proof Enclosures

Explosion proof enclosures have an integral wiring compartment that contains terminal strips for field wiring. To expose the wiring compartment, locate the two threaded dome lids, one on each side of the enclosure. The wiring compartment is inside the smaller dome lid.

Locate and loosen the small set screw that locks the dome lid in place. Carefully unthread the small dome lid by screwing it counterclockwise. Inside you will find a terminal strip labeled TB1. Positions on these strips are labeled 1-15. See APPENDICES C1-C5 for a description of these fifteen positions.

The explosion proof enclosure has two $\frac{3}{4}$ " NPT conduit entries. To maintain separation between input power and signal wiring, it is recommended that separate conduit connections be utilized. This is especially important if 115V or 230V power is utilized.

Power supplied to the meter will be either 115 V/230 VAC, 24 VDC or 15 VDC. Refer to the serial number label and the wiring hook-up guide.

2.2.2 NEMA 2 Enclosure

NEMA 2 enclosures have an integral circular connector mounted on the enclosure. There are two versions of the connector, depending on whether the optional RS 485 interface is used. Refer to APPENDIX C7 AND C8 for a picture of the connector and pin out. The NEMA 2 enclosure is only available with 15 VDC input power.

2.3 Power Supply Wiring

The following sections describe connecting power to a Series 600/640 Flow Meter. Power wiring at the flow meter is either via a terminal barrier or a circular connector mounted on the enclosure.

CAUTION! Be sure that your flow meter is equipped for the correct input power by checking the label on the outside of the unit.

2.3.1 100/115/230 VAC, 50/60 Hz Input Power

All flow meters with 115 or 230 VAC power have an integral wiring compartment. Refer to Section 2.2, ACCESS TO FIELD WIRING, for instructions on access to the wiring compartment.

Two positions on terminal strip TB1 are used for AC power hook-up. A copper lug is attached to the chassis for attachment of the AC power ground wire. Refer to APPENDIX C1.

The load represented by an AC powered flow meter is 15 VA max.

CAUTION! The flow meter is not a 24V, 4-20 mA loop powered transmitter. The meter requires four wiring connections, two for power and two for signal.

**2.3.2
24 VDC Input Power**

All Series 600/640 Flow Meters with 24 VDC power options have an integral wiring compartment that contain terminal strips for field wiring.

Refer to Section 2.2, ACCESS TO FIELD WIRING, for instructions on locating the field wiring terminals.

A fifteen position terminal strip is located within the wiring compartment. Refer to APPENDIX C1 for wiring instructions.

The load represented by a 24 VDC flow meter is about 500 mA max.

Series 600/640 Flow Meters with 15 VDC power options are supplied in either an explosion proof enclosure with an integral wiring compartment or in a rectangular NEMA 2 enclosure with a wiring connector. There are two versions of this connector, depending on whether the RS 485 output is utilized. Refer to APPENDICES C7 & C8 for wiring connections.

**2.3.3
15 VDC Input Power**

CAUTION! Terminal strips for field wiring are located inside the enclosure. Refer to APPENDIX C5 for wiring instructions.

**2.4
Remote Electrical
Enclosures**

The following sections describe connecting signal wiring to a Series 600/640 Flow Meter. Signal wiring at the flow meter is either via a terminal strip or circular connector. Refer to TABLE 2.5 for a general description of the signal wiring for the Series 600/640 meters. (Depending on model, your flow meter might not use all the signals listed).

**2.5
Signal Wiring**

For all flow meters, standard industrial wiring practices apply. Local codes might require the use of conduit. In general, the use of conduit is recommended as good wiring practice.

2.5.1 0-5 VDC and 4-20 mA Output Signals

All flow meters are equipped with either a 0-5 VDC or a 4-20 mA output signal. This signal represents 0-100% of full-scale and may or may not be linear. Check the label on the outside of the flow meter for output signal, type of gas, and full scale value.

The 0-5 VDC signal can drive a minimum load of 1,000 ohms and is output from "0-5V/4-20mA Output" and "Signal Ground".

The meter will provide a 4-20 mA signal through a load resistance of 50 to 400 ohms to ground. The meter is not a loop powered device. 4-20 mA output signal must be referenced to ground. Refer to APPENDIX C2.

If the meter utilizes 115 or 230 VAC power, the 4-20 mA output signal will be electrically isolated. Note, however, that connecting any of the output terminals to earth ground will violate the isolation.

Regardless of the analog output signal the flow meter uses, be sure to use "Signal Ground" for the signal return. Refer to Appendix C2 for E2/E3/E4 wiring detail and APPENDIX C7 & C8 for E0 and E1 wiring detail.

*Table 2.5
Signal Wiring
Series 600/640*

Signal Name	Description
Relay 1 Relay 2	Form C Contact Closure
Signal Ground	Analog Ground of 0-5 VDC or 4-20 mA
0-5V/4-20 mA Output	Analog Output of 0-5 VDC or 4-20 mA
Sensor Black Sensor White Sensor Orange Shield Sensor Red Sensor Green	Remote Sensor Wiring

NOTE: The model of your flow meter determines which signals are used.

2.5.2 RS 485 Option

Flow meters equipped with microprocessor electronics use an EIA standard RS 485 serial bi-directional interface. This interface allows up to thirty flow meters to be daisy chained on a single twisted pair plus shield. Maximum length of the daisy chain is 4,000 feet (1,200 meters) using twenty-four gauge wire.

If your system includes a Collector-Box, the RS 485 interface is transparent and all the details of interface protocol are handled by the Collector-Box.

There are three main configurations for Sierra Series 600/640 Flow Meters:

- **Flow Meter Alone.** An analog output signal, either 0-5 VDC or 4-20 mA, represents the flow value. Refer to SECTION 3.2, POWER UP, SECTION 3.3, 0-5 AND 4-20 MA OUTPUT SIGNALS, and SECTION 3.5, DISPLAY OPTIONS.
- **Flow Meter with PC Compatible Computer.** An RS 485 output signal connected to a PC compatible computer represents the flow value. The computer must have a RS 485 interface card installed as COM1: or COM2:. Refer to SECTION 3.4, RS 485 OPTION.
- **Flow Meter with Sierra's System Electronics (Single-Channel, Dual-Channel or 1 to 5 Channel Microprocessor-Based Flo-Box™ Electronics).** Sierra Instruments can provide the systems electronics which provide power, display with optional totalizer and alarms. The bench mounted electronics can be rack mounted or panel mounted if required. The system electronics can support up to five flow meters. If your flow meter is supplied with Sierra's system electronics, refer to the separate instruction manual covering the electronics.

CAUTION! Before powering up for the first time, check all wiring to ensure it is in compliance with APPENDIX C section of this manual.

When power is first applied to a flow meter, the output will momentarily go high. It is normal for this condition to persist for a few seconds the velocity sensor is heated. After completion of warm up, the flow indication will rapidly approach a zero value (or the value of flow, if present). Within minutes, the flow meter is operational.

The flow meter may be turned on or off with flow present without damaging the meter.

All flow meters are equipped with either a 0-5 VDC or a 4-20 mA output signal. This signal represents 0-100% of full scale.

Check the label on the outside of the flow meter for full scale value and calibration gas for your flow meter.

For linear models, the output signal represents a linear proportional analog of flow ranging from zero (0 VDC or 4 mA) to the full scale value (5 VDC or 20 mA), as indicated on the label.

For non-linear models, a graph, table, or mathematical equation (polynomial) is supplied with the meter to convert the electrical signal to the flow value. Zero flow is always represented by either 0 VDC or 4 mA and full scale flow by either 5 VDC or 20 mA. Between zero and full scale the signal is not proportional to flow and you must perform a conversion using the supplied data.

3 OPERATING INSTRUCTIONS

3.1 General Description

3.2 Power Up

3.3 0-5 VDC and 4-20 mA Output Signals

3.4 RS 485 Option

A RS 485 output is an option available with the flow meter. The following description of the Sierra RS 485 protocol is provided mainly for reference.

There is one “master” transceiver (Collector-Box™ or PC-compatible computer) and up to thirty “slave” transceivers (flow meters). The data format is eleven bits: one start bit, eight data bits (MSB first), a tenth programmable bit (not parity), and a stop bit. The data rate is 9600 baud.

There are two types of bytes: address bytes and data bytes. The tenth bit would normally be the parity bit; however, in this application it is not used for parity. It signals which type of byte is being sent. When the tenth bit is one, the byte is an address byte. When it is zero, it is a data byte. Normally, the master sends address bytes and the slaves respond with an address byte echo followed by data bytes.

The following code is written from the point of view of the master transceiver (PC-compatible computer) wishing to read a slave transceiver. Included are code examples written in C using Turbo-C and Greenleaf ComLib software.

```
/* Enable RS 485 transmitter, disable receiver. Set for “parity” equal to
space, i.e., bit 8=1. Transmit address byte. */
if      (comport ==0)
        outportb ( 0 x 3ff, 2);          /* COM1: enable xmitter */
else
        outportb (0x2ff, 2);             /* COM2: enable xmitter */
/* Wait for transmission done before turning around interface to receive.
Enable RS 485 receiver, disable trasmitter. */
do { /* check UART directly */
        rxbyte = bioscom (3, address, comport);
        } while (! (rxbyte>=0));
/* enable RS-485 receiver, disable xmitter */
if      (comport ==0)
        outportb (0x3ff,1);
else
        outportb (0x2ff, 1);
delay (150); /* wait 150 milliseconds for returned characters. */
```

Wait 150 milliseconds for returned characters. All characters sent in a stream during this time interval correspond to the RS 485 description in Table 3-4.

To initiate a data exchange, the master transmits an *address byte* composed of an address (1-30) with the tenth bit equal to one. At all other times, the tenth bit is zero. This generates a real time interrupt in all flow meters. They then inspect the received address to see if it matches their own address. If it doesn't, no action is taken and normal processing is resumed. If a match is detected, then the flow meter responds with a transmission that occurs within the next 150 milliseconds.

Table 3-4

Number	Description
1	Flow Meter Address Echo; Value: 1-30
2	Flow Meter Type; Value: 1 = Single Point, 2 = Multi-Point
3,4	Flow Meter Software Version; Value: 0-65,535 100 = Version 1.00, 250 = Version 2.50, etc.
5	Number of Points; Value: 1 = 1 Point, 2 = 2 Points, etc.
6	Units English/Metric; Value: 1 = SFPM/°F, 0 = MPS/°C
7, 8	Full Scale Value; Value: 0-65,535; 0-65,535 MPS or SFPM depending on units above
9, 10	Low Alarm Setpoint; Local (Flow Meter Only) Low Alarm; Value: 0-65,535
11, 12	High Alarm Setpoint; Local (Flow Meter Only) High Alarm, Value: 0-65,535
13	Flow Meter Supply Voltage; Value: 0-255 = 0-25.5 volts
14	Speed of Response; Proportional to response speed of output signal from Flow Meter; Value: 1-255; 1 = fast, 255 = slow
15, 16	Alarm Status Flags; LSB bit = 0 for low alarm, LSB bit = 1 for high alarm
17, 18	Fault Status Flags; LSB bit = 0 signifies bridge fault. MSB bit = 0 signifies RAM failure, MSB bit = 1 signifies A/D failure
19, 20	Temperature Value; Value: 0-65,535
21, 22	Flow Value; Value: 0-65,535
23-38	Individual Point Flow Value Point 1-8, each reading; Value: 0-65,535; Unused points value: 0
39-48	Spare; All bytes Value: 0
49, 50	Checksum; Binary sum of all transmitted bytes including address, module 16 bits; Value: 0-65,535

NOTE: All numbers transmitted represent unsigned binary numbers unless noted. For two byte numbers, transmission is MSB first, then LSB. Contact Sierra Instruments, Inc., Applications Engineers for latest release version.

The following section answers some of the questions frequently asked by our customers:

Q: What baud rate should I use?

A: The flow meter is programmed internally to work at 9600 baud.

Q: Why doesn't the program I wrote work, if all of my wires are hooked up correctly?

A: You must use an interrupt driven com library rather than a polled mode. The polled mode may not "stay on the line" long enough to receive all of the data. Also remember that you must enable the RS 485 transmitter and disable the receiver when you send information from the Series 640. You must reverse the process to receive information. It is easy to forget that the RS 485 is bidirectional.

Q: Why doesn't Sierra require termination resistors to balance the lines?

A: Since the RS 485 has the capability to run at one mega baud and we are only using it at 9600 baud, the "reflections" in the line at 9600 baud are virtually non-existent. Therefore, there is no need to balance the lines.

Q: Why does Sierra send all the data on each query? Why doesn't Sierra only send the flow value?

A: We do this because all of our systems operate the same way. You, the user, are given the option to use the data you choose. Note that the entire "stream" is sent in 150 milli-seconds.

Q: How do I calculate the flow?

A: Obtain full scale flow from bytes 7, 8 and flow value from bytes 21, 22. Flow = (flow value) • full scale

1020

3.4.1 RS 485 Option Response Time Adjustment

Microprocessor equipped flow meters have a "response" potentiometer that determines the speed of response of the meter. In the fast setting, the response is primarily governed by the speed of the sensor itself, on the order of 200 milliseconds for Accu-Flo (600 Series) and one second for Steel-Trak (640 Series). Flow meters are shipped from Sierra Instruments, Inc. with fast response.

At the slowest setting, the time response of the flow meter is several seconds.

3.5 Display Options

Display options include flow rate readout, totalized (mass) flow readout, and front panel LED status indicators.

The front panel status LEDs include power, high alarm, low alarm, sensor fault, and RS 485 fault.

- **Power:** This LED glows when power is applied to the flow meter.
- **High and Low Alarms:** These LEDs glow when the measured flow is above/below the preset alarm setpoints, respectively. Refer to Section 3.6, ALARM OPTIONS, for adjusting the alarm setpoints.
- **Sensor Fault:** This LED glows when a problem is detected in the flow measuring circuit. The flow meter is not functioning properly. Refer to Section 4, MAINTENANCE. The flow meter may have to be returned to Sierra Instruments for repair. Sensor fault detection is only available on meters with the microprocessor option.
- **RS 485 Fault:** The RS 485 Fault LED indicates the RS 485 interface bus is not functioning properly. If you are using the interface bus, you probably will not be able to read the flow meter. The flow meter may have to be returned to Sierra Instruments for repair.

3.5.1 Front Panel Status LEDs Option

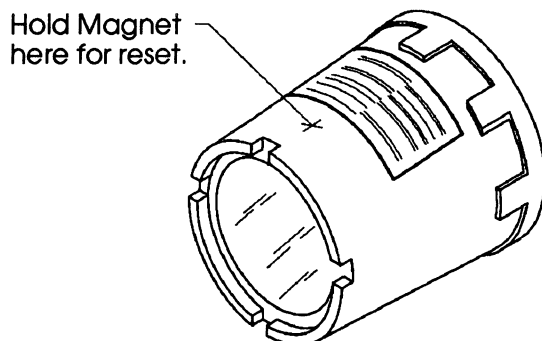
The flow rate readout is a 3½ digit LCD display which normally reads out engineering units directly (e.g. SCFM, NCMH, LBS/HR). If the full scale rating of the meter exceeds the 3½ digit display, a multiplier of ten will be used. Check the label on the meter and front panel for information concerning the readout units.

3.5.2 Flow Rate Readout Option

The totalizer readout shows accumulated (total) mass flow and is displayed on its own 6-digit LCD readout. The totalizer normally reads out directly in engineering units (e.g. cubic feet, grams, pounds, etc.). Check the label on the meter and front panel for information concerning the totalizer units.

3.5.3 Totalizer Readout Option

You can reset the totalizer to a reading of 000000 by holding the supplied reset magnet (or any suitable magnet) to the spot indicated in the sketch below. The magnet must be held in this location for several seconds. This activates a magnetic sensing reset circuit within the enclosure. Note that the power must be on to reset the totalizer.



3.6 Alarm Options

All Series 600 flow meter alarm outputs are open collector. They sink current to ground when active (“on”) and are open circuit when inactive (“off”). Because they sink current, they must pull a positive voltage (maximum 30 VDC) to ground potential. They are nominally rated at 100 mA maximum with a resistive load (such as a computer input or lamp). If an inductive load is used (such as a buzzer), connect a diode in parallel with the load, the cathode of the diode to the power supply side of the load and the anode of the diode to the flow meter alarm side of the load. A 1N4002, 1N4003, or 1N4004 diode is satisfactory.

All 640 Series Flow Meters feature Form C contact relay outputs. The LED indicators provided on the terminal board inside the wiring dome make setting e alarms easy. There is also an optional sensor fault alarm.

ALARM SETPOINT

The M52-0092 has dual alarm outputs (optional) configured as HIGH and LOW alarm. Each alarm setpoint is user adjustable by a multi-turn potentiometer. Refer to APPENDIX D3, for the location of the circuit board, test points and adjustment potentiometers. Each alarm has a built in hysteresis of 2% to avoid “chattering”. The Sensor Fault Alarm is nonadjustable.

3.6.1 Adjusting the Setpoint

Locate potentiometer VR4 (High alarm set) or VR5 (Low alarm set) and the associated Tests Points on the M52-0092 printed circuit assembly. To adjust the alarm setpoint, use one of the following two methods.

DYNAMIC ADJUSTMENT

Set the flow rate to the point where the alarm must activate. Monitor the alarm output while adjusting VR4 (High) or VR5 (Low) to find the alarm actuation point. When the alarm activates, rotate the adjustment screw back and forth a few times to ensure that the setting is correct.

STATIC ADJUSTMENT

Locate the alarm adjustment test points (see Table 1) on the M52-0092 PCB. Connect a voltmeter’s positive lead to the TP6 (High) or TP7 (Low) and the negative lead to TP10 (Ground). As you rotate VR4 (High) or VR5 (Low), the voltmeter will sweep between 0 and 5 volts which

Table 1 Test Points	
TP1	Bvv
TP2	Bridge Amp – Input
TP3	Bridge Amp + Input
TP4	Sub. Cal Volts
TP5	0-5 VDC Non-Linear
TP6	High Alarm Set
TP7	Low Alarm Set
TP8	Sensor Fault
TP9	VGND
TP10	Ground

Table 2 Adjustment Potentiometers	
VR1	Zero (0-5 VDC Output)
VR2	Span (0-5 VDC Output)
VR3	Cal Pot
VR4	High Alarm Set
VR5	Low Alarm Set
VR6	4 mA Adjust
VR7	20 mA Adjust
VR8	Bridge Offset (Factory Adjustment)

represents an alarm setpoint between zero and full scale flow. Adjust VR4 or VR5 to the desired value. Linear Output Models may be adjusted by using a simple multiplier to convert volts to the desired engineering units.

Example:

Linear Output Models:

Full scale = 400 SCFM, alarm point ll= 1200 SCFM, find the voltage required to trigger the alarm at 1200 SCFM.

$(1200/4000) \times 5 = 1.50 \text{ VDC}$

Following the access procedure in reverse, install the enclosure over the electronics PCBs. This completes the alarm setpoint adjustment

CAL POT: Moving J1 from the NORM position to the CAL position disconnects the flow sensor bridge circuit from the signal conditioning circuitry and enables the static calibration pot VR3. The static calibration pot provides a substitute Bridge Voltage signal. This allows you to check the operation of all of the output circuits, including the 0-5 VDC output, 4-20 m A Output, High Alarm, Low Alarm and Sensor Fault Monitor without actually running flow past the sensor.

To use Cal Pot, you need to refer to the current calibration sheet that came with your flow meter. Find the table listing Bridge Voltage versus Flow. (NOTE: Some sheets may list non-linear 0-5 VDC data versus flow. Alternate methods for this will be listed in parentheses.)

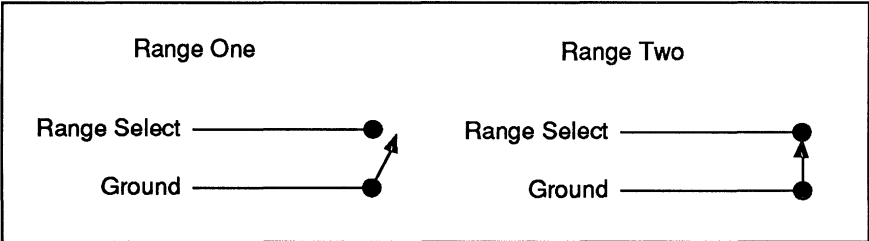
Connect the Voltmeter's negative lead to TP10 (Gnd) and the positive lead to TP4 (TP5 for non-linear 0-5 VDC). Adjust VR3, Cal Pot, for the flow reading of interest. This could be Zero Flow, Full Scale Flow, an Alarm Point, etc. Once VR3 is set, move the positive lead of the Voltmeter to the output being tested to read.

CAUTION! Adjustments to VR1, VR2, VR6 and VR7 affect the calibration of your flow meter and should only be attempted by qualified personnel with the proper flow standards.

IMPORTANT: Replace jumper J1 in the NORM position when you are finished checking outputs or adjusting alarms.

3.7
Dual Range
Flow Options

Series 600 and 640 flow meters can be calibrated for two flow ranges. This option requires the use of a stationary switch. When the range select is shorted to ground (switch closed) the unit is in the second flow range and when the range select is not shorted to ground (switch open) the unit is in the first flow range. See APPENDIX C3 for E2/E3/E4 wiring detail and APPENDIX C7 for E0/E1 wiring detail. The output voltage, or current, will then be scaled to the selected range.



WARNING! Before attempting any maintenance make sure there is no pressure in the line.

WARNING! Gas leaks are possible during probe maintenance. If there is toxic or combustible gas in the line, be sure the lines are completely purged before removing the probe.

Refer to Section 6, TROUBLESHOOTING, if you need to return your flow meter to Sierra Instruments, Inc. for repair.

WARNING! All maintenance operations must be carried out with the power off.

The explosion proof enclosure contains electronics PCAs within the larger round dome lid. To gain access to the electronics PCAs, including adjustment potentiometers, locate and loosen the small set screw which locks the dome lid in place, then carefully unthread the large round dome lid and slide it away from the flow meter.

To access the electronics PCAs within the NEMA 2 enclosure remove the small screws holding the extruded enclosure to the base of the flow meter. Orient the top cover to allow the extruded enclosure to slide over the circuit boards and carefully slide it away from the base. Keep in mind that the enclosure is attached to the flow meter via the wires connecting the PCAs to the connector. There is enough slack to allow access to all the internal components.

The totalizer back-up battery normally lasts six years. To replace the battery the flow meter must be returned to Sierra Instruments, Inc. Refer to Section 6.1, CUSTOMER SERVICE AND SHIPPING INSTRUCTIONS.

Both the Accu-Flo and Steel-Trak probes are insensitive to small amounts of contamination or dirt, so a little contamination or discoloration will not cause accuracy errors.

Even though the Accu-Flo probe is insensitive to small amounts of contamination, continued use in dirty air or stacks will necessitate periodic cleaning. To inspect the sensor element, remove the probe from the pipe or duct, exposing the Accu-Flo probe sensor element (ceramic mandrel with tip diameter of about .040 in. (1.0 mm)). If it is visibly dirty, clean it with water or alcohol (ethanol) and an artist's brush until it appears clean again. Even though the sensor element is rugged and breakage resistant, avoid touching it with any solid object and *use a light touch while cleaning it.*

4 MAINTENANCE

4.1 Access to Electronics PCAs

4.1.1 Totalizer Back-Up Battery

4.2 Probe Cleaning

4.2.1 Accu-Flo Probe Cleaning

4.2.2 Steel-Trak Probe Cleaning

The Steel-Trak probe is even less sensitive than the Accu-Flo probe to contamination or build-up of particulates. To inspect the sensor elements, remove the probe from the pipe or duct, exposing the sensor elements (two stainless steel encasements, or thermowells). If they are visibly dirty, clean them with water or alcohol (ethanol) and an artist's brush until they appear clean again. Even though the sensor elements are rugged and breakage resistant, avoid touching them with any solid object and *use a light touch while cleaning them.*

4.3 Breakage or Damage of Probe

If the sensors are broken or damaged, the probe and electronics must be returned to the factory. A new sensor assembly will be installed and calibrated. Refer to Section 6.1, CUSTOMER SERVICE AND SHIPPING INSTRUCTIONS.

To insure the continuing high accuracy of your Series 600/640 Flow Meter, Sierra Instruments, Inc. maintains a fully equipped, quality controlled Flow Calibration Metrology Laboratory for recalibration. If the probe or electronics have been damaged, or you simply want to have the flow meter recalibrated, please refer to Section 6, TROUBLESHOOTING, for information regarding contacting customer service and shipping instructions.

The data is non-linear. If you have a linear unit, the calibration sheet shows the mathematical formula which the linearizer uses to produce the linear output. All accuracy specifications are per the system specifications unless other wise noted.

WARNING! Calibration must be performed by qualified personnel. Sierra Instruments, Inc. strongly recommends that you return your 600/640 Flow Meter to the factory for calibration. Refer to Section 6, TROUBLESHOOTING, for shipping instructions.

To calibrate the mass flow meter you must generate a precisely known velocity, preferably with a low-noise wind tunnel with a flat velocity profile. You must use the original calibration gas. Insert the probe into the wind tunnel with its axis either vertical or oriented as it is located in your installation. Sierra Instruments uses an in-house NIST-traceable laser doppler anemometer as a primary standard for calibration of our transfer standards and for calibration at high pressures or temperatures. It is also used at velocities below 500 FPM (2.54 MPS). An NIST-traceable Pitot-tube can be used for higher velocities. The sensor must be at or near the same location as the Pitot-tube. Mutual flow disturbances should be avoided. For lower velocities, less than approximately 1000 FPM (5.08 MPS), a high-accuracy flow meter, such as a laminar flow element, may be put in the line to measure the total flow rate. If the velocity profile at the measurement point is perfectly flat, the calibration velocity is the flow rate divided by the effective cross-sectional area.

To set the calibration refer to APPENDIX D3 for the location of the calibration-adjustment potentiometers. Insert the probe in the wind tunnel. Allow several minutes for the probe to stabilize. Adjust the zero potentiometer until the readout shows zero. The flow meter is now zeroed.

Next, select a suitable calibration point for the range, either nearest to full scale or the typical operating point for your application. Generate this velocity in the wind tunnel. Allow one minute for stabilization, and adjust the "span" potentiometer until the readout shows the correct value. The velocity range is now properly spanned.

Next, take data for multiple equally spaced values to create a data chart that gives you indicated versus actual flows.

5 CALIBRATION

5.1 Calibration at Sierra Instruments, Inc.

5.2 How to Calibrate the Series 600/640 Yourself

For linear mass flow meters, Sierra uses an EPROM look-up table for linearization. You will not be able to modify this table. If you need to change your gas or full scale flow range you will need to return the flow meter to Sierra Instruments for recalibration. Alternatively, you may elect to obtain the non-linear data and supply this data to Sierra Instruments to burn an EPROM with the proper transfer function matching your calibration data. Sierra would then send you the EPROM. You would install the new EPROM and then perform the final span calibration. The new EPROM table will be as accurate as the data you took. Call our Customer Service Department for assistance at (800) 866-0200. In Europe call our Customer Service Department at 31(0)20-6145810.

6 TROUBLE- SHOOTING

CAUTION! The electronics, sensors and interconnect wires supplied by Sierra Instruments, Inc. are calibrated as a single precision mass flow meter. Interchanging sensors will impair the accuracy of the flow meter.

If you experience any problem with your Series 600/640 flow meter call Sierra's Customer Service Department, Technical Assistance, at (800) 866-0200 or in Europe call 30(0)20-6145810.

Table 6.1
Troubleshooting

Problem	Possible Cause	Action
Velocity measurement seems low	a) Probe not oriented properly	a) Orient probe with respect to flow
	b) sensors dirty	b) Refer to Section 4, Maintenance, for information on cleaning the sensors
Velocity measurement is erratic or fluctuating	a) Very turbulent flow	a) Try to find less turbulent area to measure velocity
	b) Sensor dirty	b) Refer to Section 4, Maintenance, for information on cleaning sensor
	c) Sensor broken	c) Refer to Shipping Instructions, to return flow meter to Sierra for repair
	d) Probe not mounted securely	d) Probe must be mounted securely without vibration
	e) Malfunction in flow meter	e) Refer to Shipping Instructions, to return flow meter to Sierra for repair
Reading won't zero	a) Out of calibration	a) Refer to Section 5, Calibration
	b) Sensor broken	b) Refer to Shipping Instructions, to return flow meter to Sierra for repair
4-20 mA output not indicating 4 mA at zero flow	a) Excessive current loop resistance. Loop resistance must be between 50 and 400 ohms	a) Use larger gauge wire or change load resistance

6.1 Customer Service and Shipping Instructions

The Sierra Instruments, Inc. Customer Service Department can be reached at (800) 866-0200. The European Customer Service Department can be reached at 31(0)21-6145810. Please have your model number and serial number available when you call.

If you find it necessary to return a Series 600/640 Mass Flow Meter to Sierra Instruments, Inc., obtain a Return Material Authorization from the Customer Service Department.

Unless specifically instructed to do otherwise, you must return the entire flow meter, including *all* electronics.

Please include information describing the difficulties experienced, purchase order number under which the equipment was purchased, and a contact name and phone number.

Be sure to include **complete** return shipping instructions. **We cannot deliver to post office boxes.** Ship to one of the following addresses:

USA HEADQUARTERS

Sierra Instruments, Inc.
5 Harris Court, Building L
Monterey, CA 93940
ATTN: SERVICE DEPT.

EUROPEAN HEADQUARTERS

Sierra Instruments b.v.
Bolstoen 30A
1046 AV Amsterdam
The Netherlands
ATTN: SERVICE DEPT.

MONITORING FLOW RATE

General Relationships

The Sierra Series 640 Flow Meter has two major applications:

- measuring free air velocity in open spaces
- monitoring the total flow rate of gases in pipes, ducts, and stacks.

The first application is relatively easy because the flow meter directly monitors the parameter of interest – velocity, or flow within a nozzle of infinite diameter.

In the latter case, however, the total standard volumetric flow rate Q_s (SCFM or Sm^3/hr), in the pipe or duct, is the quantity of direct interest. The total standard volumetric flow rate is determined by the following relationship:

$$Q_s = V_s A \quad (1)$$

where:

V_s = the average standard mass velocity over the cross-sectional area of the pipe or duct (SFPM or SMPS) and

A = the cross-sectional area of the pipe or duct (ft^2 or m^2). See Section 8, CALCULATING ACTUAL FLOW RATE, for an explanation of Equation (1) and the relationship between standard and actual flow rates.

The Sierra flow meter monitors the standard mass velocity at a single point in the cross section. Usually, the mass flow sensor is located at the center line of the pipe or duct and measures the standard center line mass velocity $V_{s,c}$. The flow meter does not directly measure the average velocity, V_s . The total standard volumetric flow rate is then determined by the following relationship:

$$Q_s = K V_{s,c} A \quad (2)$$

where:

$$K = V_s / V_{s,c}$$

If the velocity profile in the pipe or duct is perfectly flat, or uniform, then $K = 1$, and the flow meter directly monitors the average mass velocity. Unfortunately, in most applications, the velocity profile is not uniform. The flow in pipes, ducts and stacks is almost always turbulent and has a non-uniform profile. The velocity decreases as the gas approaches the pipe's wall (gas velocity is zero at the wall's surface). In a straight run of pipe or duct twenty to thirty diameters in length, the velocity profile will be fully developed at the downstream end of the pipe. This is a desirable place to locate the flow meter because the profile is predictable and the flow is unidirectional down the pipe's axis. In some cases, due to extreme mounting constraints, the flow meter

must be located downstream of an elbow in which case the velocity profile is greatly skewed. The gas's momentum speeds up the flow along the outer radius of the elbow. Secondary vortex flows also are created in elbows.

Due to the flow distribution, K generally does not equal one. Fortunately, K usually is essentially constant over a flow range, or Reynold's number range, of 4:1 to 10:1. This means the normalized shape of velocity profiles is essentially constant over a wide turn-down ratio. Because this is true, we can determine K by the traversal method. In this method, we divide the cross-sectional area at the monitoring location into equal areas, maintain a constant flow rate in the middle of the range of interest, and insert or traverse the flow meter into the pipe so that the mass flow sensor measures the local mass velocity at the geometric center of each equal area.

Divide the cross section into four equal areas. Via traversing, measure each area's velocity as $V_{s,1}$, $V_{s,2}$, $V_{s,3}$, and $V_{s,4}$ and the center-line velocity as $V_{s,c}$. The average velocity and K are:

$$V_s = 1/4 (V_{s,1} + V_{s,2} + V_{s,3} + V_{s,4})$$

$$K = (1/4 V_{s,c}) (V_{s,1} + V_{s,2} + V_{s,3} + V_{s,4})$$

If we divide the cross-section into n equal areas, then K is expressed as:

$$V_s = (1/n) \sum_{i=1}^n V_{s,i} \quad (5)$$

$$K = V_s / V_{s,c} \quad (6)$$

For fully developed turbulent flows, K varies from (0.8 to 0.95).

For large ducts or monitoring applications where the velocity is highly non-uniform, we recommend installing Sierra's Series 670 Flow Averaging Arrays for accurate flow averaging.

The remainder of this section describes methods for equal-area traversing of pipes, ducts, and stacks to obtain $V_{s,c}$ using Equation (5).

7.2 Equal Area Traversal Method

The "equal area method" is recommended for most flow measurement applications. Traversing in round ducts with diameters of six inches or less should be made as shown in Figure 7-1. The traverse should consist of a total of twelve readings taken along two diameters at 90° to each other and at centers of equal areas. Traversing in round ducts with a diameter larger than six inches should be made as shown in Figure 7-2. In this case, the traverse should consist of a total of twenty readings along two diameters at 90° to each other, at centers of equal areas.

Tube Markings From Wall		
1	" Dia. x 0.043 =	"
2	" Dia. x 0.146 =	"
3	" Dia. x 0.296 =	"
4	" Dia. x 0.704 =	"
5	" Dia. x 0.854 =	"
6	" Dia. x 0.957 =	"

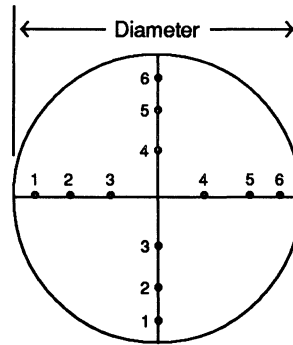


Figure 7-1
Equal Area Traverse for
Round Ducts, 6-Inch
Diameter or Less

Tube Markings From Wall		
1	" Dia. x 0.026 =	"
2	" Dia. x 0.082 =	"
3	" Dia. x 0.146 =	"
4	" Dia. x 0.226 =	"
5	" Dia. x 0.342 =	"
6	" Dia. x 0.658 =	"
7	" Dia. x 0.774 =	"
8	" Dia. x 0.854 =	"
9	" Dia. x 0.918 =	"
10	" Dia. x 0.974 =	"

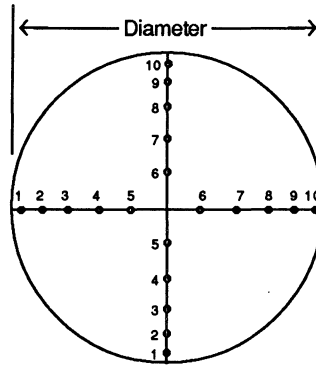


Figure 7-2
Equal Area Traverse
for Round Ducts
Larger than 6-Inch
Diameter

For rectangular ducts, the following procedure should be followed:

1. At least sixteen, but not more than sixty-four, readings should be taken at centers of equal area.
2. If fewer than sixty-four readings are taken, the traverse points should be no more than six inches center-to-center.
3. If sixty-four readings are taken, the traverse points may be over six inches center-to-center.

7.3 Stack and Flue Monitoring

For stack monitoring, the U.S. EPA Method 1 is usually specified. This method requires that: (1) the stack flow is not cyclonic or swirling; (2) the stack is at least twelve inches in diameter or 113 square inches in cross-sectional area; and (3) the measurement location is at least eight diameters downstream and at least two diameters upstream from the nearest flow disturbance. EPA allows for relaxation of these requirements.

The number of monitoring points specified by EPA Method 1 is given in Table 7-1, as follows:

*Table 7-1
Minimum Number of
EPA Method 1 Monitoring
Points*

Stack Diameter (or Equivalent Diameter)	Number of Monitoring Points
12-24 inches	8 (Circular stacks)
12-24 inches	9 (Rectangular stacks)
Over 24 inches	12 (Circular or rectangular)

After the number of monitoring points is determined, divide the stack's cross-section into equal areas. The flow meter's probe tip should be located in the center of each equal area. Table 7-2 gives EPA's recommendation for the size of each equal area for square or rectangular cross sections. The dimensions of each area can be modified provided the cross-sectional area is the same.

*Table 7-2
Size of Equal Areas for
Square and Rectangular
Stacks*

Number of Monitoring Points	Size of each Individual Equal Area
9	3 x 3
12	4 x 3
16	4 x 4
20	5 x 4
25	5 x 5
30	6 x 5
36	6 x 6
42	7 x 6
49	7 x 7

CALCULATING ACTUAL FLOW RATE

The mass flow meter measures the “standard” volumetric flow rate, Q_s , referenced to 70°F (21.1°C) and 1 atmosphere (760 mm of mercury). The units of measurement are standard cubic feet per minute (SCFM) or standard cubic meters per hour (Sm³/hr).

In most monitoring applications the mass flow (Q_s) is the quantity of direct interest. However, in some cases the actual volumetric flow rate Q is desired. This is obtained by applying a correction factor given by the following equation:

where:

$$Q = Q_s \left(\frac{\rho_s}{\rho} \right) = Q_s \left(\frac{P_s}{P} \right) \left(\frac{T}{T_s} \right) \quad (1)$$

where:

Q = “actual” volumetric flow rate at conditions of P and T
(m³/h, ACFM),

Q_s = “standard” volumetric flow rate referenced to standard conditions of P_s and T_s , (Sm³/hr, SCFM),

ρ = gas mass density at actual conditions, lb/ft³,

ρ_s = gas mass density at standard conditions
(0.0748 lb/ft³ for air at 70°F)

T = gas temperature at actual conditions, °R,

T_s = standard gas temperature = 70°F = 529.67°R,

P = gas pressure at actual conditions, mm of mercury (psia),

P_s = standard gas pressure = 760 mm of mercury (14.7 psia).

Example Calculation:

Your flow meter shows a reading of 800 SCFM. The gas temperature is 150°F. The gas pressure is 200 psig. From Equation 1, the actual volumetric flow rate Q is calculated as:

$$Q = 800 \left(\frac{14.7}{14.7 + 200} \right) \left(\frac{150 + 459.67}{529.67} \right) = 63.0 \text{ ACFM}$$

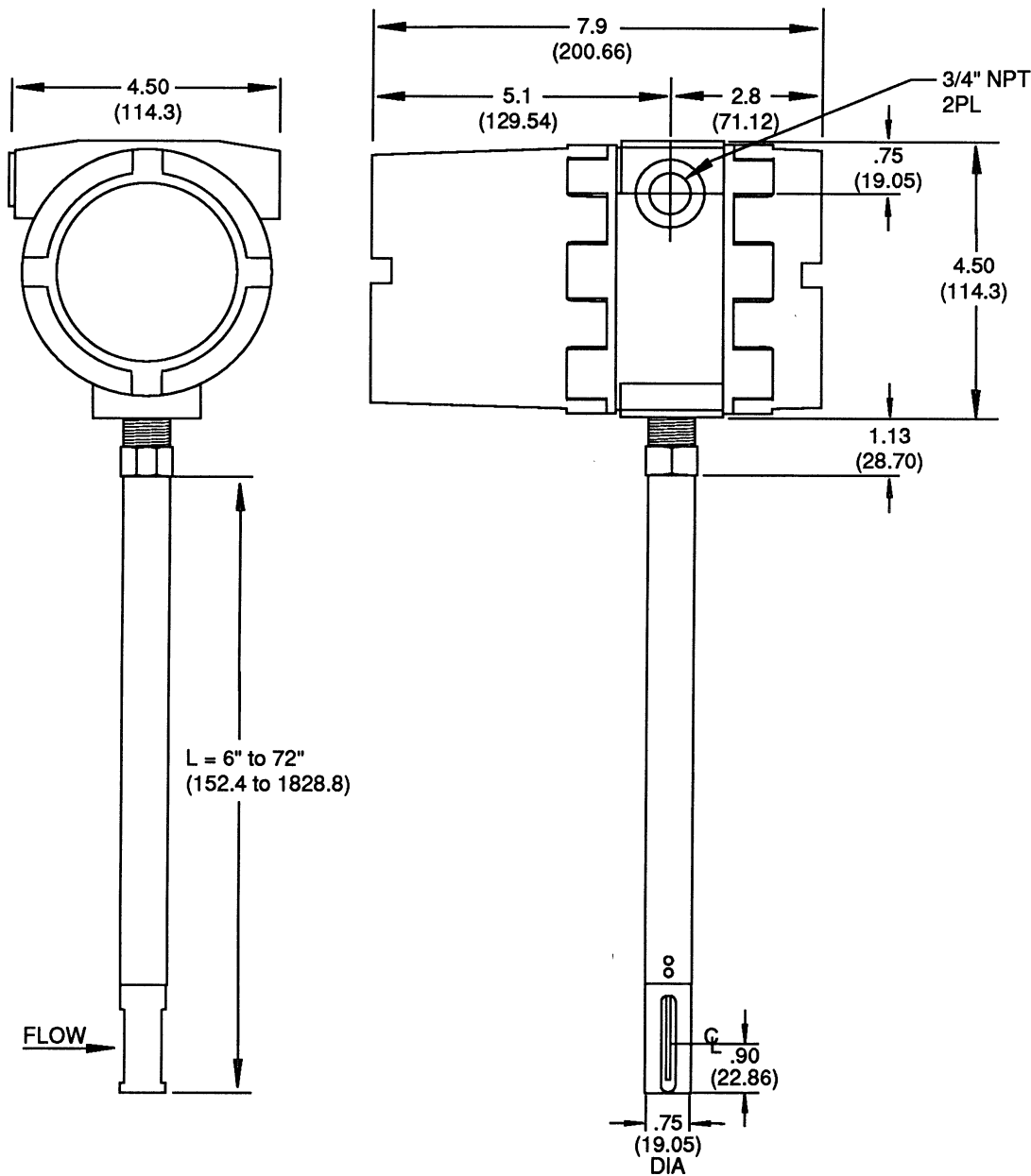
APPENDIX A.

Specifications

Specifications	Series 600 Accu-Flo™ Meters	Series 640 Steel-Trak™ Meters
FLOW RANGE	Each flow meter is individually calibrated in Sierra's wind tunnels for the type of gas and maximum flow range Any full scale flow range can be selected over the range of 100 SFPM (.47 NMPS) to 15,000 SFPM (70.73 NMPS)	Each flow meter is individually calibrated in Sierra's wind tunnels for the type of gas and maximum flow range Any full scale flow range can be selected over the range of 100 SFPM (.47 NMPS) to 20,000 SFPM (94.3 NMPS)
GASES	Air, nitrogen; consult factory for other non-combustible, non-corrosive gases	Air, nitrogen; argon, helium, hydrogen, natural gas; consult factory for others
FLOW OUTPUT SIGNALS	Choice of one of four analog output signals linearly or non-linearly proportional to mass flow rate or velocity: 0-5 VDC standard, 1000 ohms min. load resistance; 4-20mA optional, 250 ohms max. loop resistance; 0-1 VDC optional, 200 ohms min. load resistance; or 10 VDC optional, 2000 ohms min. load resistance RS 485 serial output standard for microprocessor electronics: 2-wire cable, 4,000 feet (1,200 m) max. length Other output signals available on special order	Choice of one of four analog output signals linearly or non-linearly proportional to mass flow rate or velocity: 0-5 VDC standard, 1000 ohms min. load resistance; 4-20mA optional, 400 ohms max. loop resistance; 0-1 VDC optional, 200 ohms min. load resistance; or 10 VDC optional, 2000 ohms min. load resistance RS 485 serial output standard for microprocessor electronics: 2-wire cable, 4,000 feet (1,200 m) max. length Other output signals available on special order
TOTALIZER	6-digit LCD display (optional), for explosion proof electronics enclosure only	6-digit LCD display (optional), for explosion proof electronics enclosure only
ALARMS	Standard electronics: high or low alarms; microprocessor electronics: high, low, or "window" alarms; open collector outputs; specify levels (optional)	Standard electronics: high or low alarms; microprocessor electronics: high, low, or "window" alarms; Form C relay outputs; specify levels (optional)
DIGITAL READOUT	For explosion proof electronics enclosure only: for mass flow or velocity in any engineering units; 3-1/2 digit LCD display; also available in remote Dual-Channel or Flo-Box™ Electronics; stand-alone digital panel meter optional, operates on two wires	For explosion proof electronics enclosure only: for mass flow or velocity in any engineering units; 3-1/2 digit LCD display; also available in remote Dual-Channel or Flo-Box™ Electronics; stand-alone digital panel meter optional, operates on two wires
LED INDICATORS	For microprocessor electronics only; power-on, RS 485 transmission fault alarms, and sensor fault	
INPUT POWER REQUIRED	NEMA 2 enclosure: 15-18 VDC, 300 mA max. Explosion proof Electronics: 15-18 VDC, 350 mA max.; 20-26 VDC, 350 mA max.; 100 ± 10% VAC, 50 Hz, 10 watts; 115 ± 10% VAC, 60 Hz, 10 watts; or 230 ± 10% VAC, 50 Hz, 10 watts Remote Electronics: 115 ± 10% VAC, 60 Hz, 10 watts standard; 100 ± 10% VAC, 50 Hz, 10 watts optional; or 230 ± 10% VAC, 50 Hz, 10 watts optional	NEMA 2 Enclosure: 15-18 VDC, 300 mA max. Explosion proof Electronics: 15-18 VDC, 350 mA max.; 20-26 VDC, 350 mA max.; 100 ± 10% VAC, 50 Hz, 10 watts; 115 ± 10% VAC, 60 Hz, 10 watts; or 230 ± 10% VAC, 50 Hz, 10 watts Remote Electronics: 115 ± 10% VAC, 60 Hz, 10 watts standard; 100 ± 10% VAC, 50 Hz, 10 watts optional; or 230 ± 10% VAC, 50 Hz, 10 watts optional
NUMBER OF POINT VELOCITIES	One	One
ACCURACY IN POINT VELOCITY	1% FS + 0.5% R over 32 to 122°F (0 to 50°C) and 5 to 30 psia (0.35 to 2 kg/cm²)	±2% of reading from 10-100% of calibrated range. ±0.5% of full scale below 10% of calibrated range.

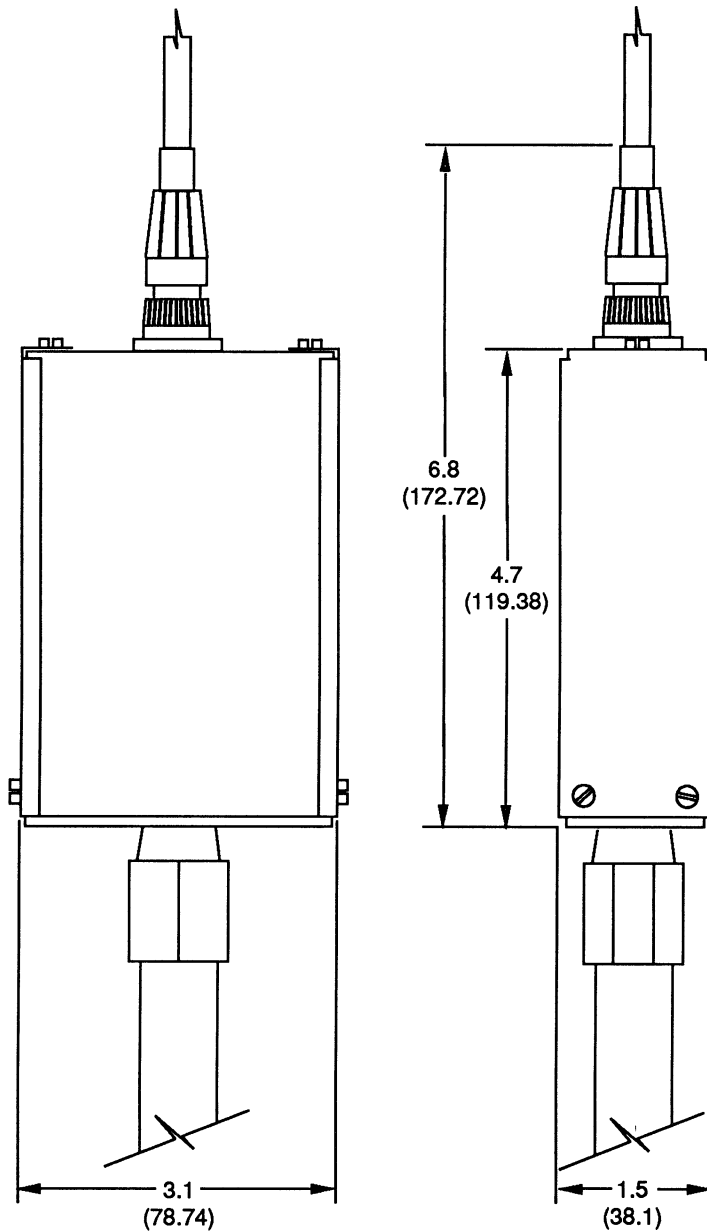
Specifications	Series 600 Accu-Flo™ Meters	Series 640 Steel-Trak™ Meters
REPEATABILITY	0.2% FS	0.2% FS
TIME RESPONSE	0.2 seconds to 63% of final velocity value for microprocessor electronics; analog output signal and display time response variable from 0.5 to 5 seconds	1 second to 63% of final velocity reading; analog output signal and display time response variable from 0.5 to 5 seconds
GAS PRESSURE	150 psig (10 kg/cm ² G) max.	–5 to 200 psig optimum. 500 psig maximum (Design pressure; 1000 psig maximum)
GAS TEMPERATURE	Standard: 14 to 176°F (-10 to 80°C)	Standard: 14 to 176°F (-10 to 80°C); "HT2" option: 32 to 450°F (0 to 230°C)
ELECTRONICS OPERATING TEMPERATURE	32 to 122°F (0 to 50°C)	32 to 122°F (0 to 50°C)
ELECTRONICS STORAGE TEMPERATURE	32 to 158°F (0 to 70°C)	32 to 158°F (0 to 70°C)
WETTED MATERIALS	304 SS probe: glass-coated sensor; epoxy	Standard and "HT2" temperature option: 316 SS probe, 316 SS sensors. Viton® "O"-Rings
PROBE MOUNTING OPTIONS	316 SS 1/4-inch tube x 1/4-inch male NPT compression fitting; flat duct mounting bracket; curved duct mounting bracket (specify O.D.)	316 SS 3/4-inch tube x 1-inch male NPT compression fitting (1-inch female NPT Weldolet optional); flat duct mounting bracket; curved duct mounting bracket (specify O.D.); 150 lb. 1-inch NPT ASA raised flange; or high (1000 psig max.) and low (100 psig max.) pressure "hot-tap" models, 1-1/4-inch male NPT
ELECTRONICS ENCLOSURES	Anodized aluminum NEMA 2 enclosure; or painted aluminum NEMA 4 and explosion proof enclosure—complies with NEC Code: Class I, Groups B, C & D, Division 1 & 2 and Class II, Groups E, F & G, Divisions 1 & 2—viewing window optional Remote electronics: single-channel electronics, dual-channel electronics, 1 to 5 channel microprocessor-based Flo-Box™ electronics, or power supply	FM and CSA approved explosion proof for Class I, Division 1, Groups B, C, D. EEX Certification EEx'd IIC T6...T2 Electronics housing explosion proof Non Destructive Test (NDT) Certificates Material Certificates
PROBE DIMENSIONS	0.250 in. (6.35 mm) O.D.: lengths; 3.75, 6, 13 (standard), 18 or 24 in. (9.5, 15, 33 or 61 cm)—other lengths optional. distance from tip of probe to mass flow sensing point: 0.30 in. (7.6mm)	0.750 in. (19.05 mm) O.D.: lengths; 6, 13 (standard), 18, 24, 36, 48, or 72 in. (15, 33, 46, 61 or 91 cm)—other lengths optional. Distance from tip of probe to mass flow sensing point; .90 in (22.86 mm)
REMOTE PROBE CABLE	Standard: vinyl; 15 ft. (5 m) standard	Standard: vinyl; "HT2" option: Teflon™
NET WEIGHTS	Probe: 0.2 lb. (0.1 kg) per ft. (per 30 cm): NEMA 2 enclosure; 0.3 lb. (0.1 kg); explosion proof enclosure; 10 lb. (5 kg)	Probe: 0.6 lb. (0.3 kg) per ft. (per 30 cm): NEMA 2 enclosure; 0.3 lb. (0.1 kg); explosion proof enclosure; 10 lb. (5 kg)

APPENDIX B1
Dimensional Drawings
for Explosion Proof
Enclosure



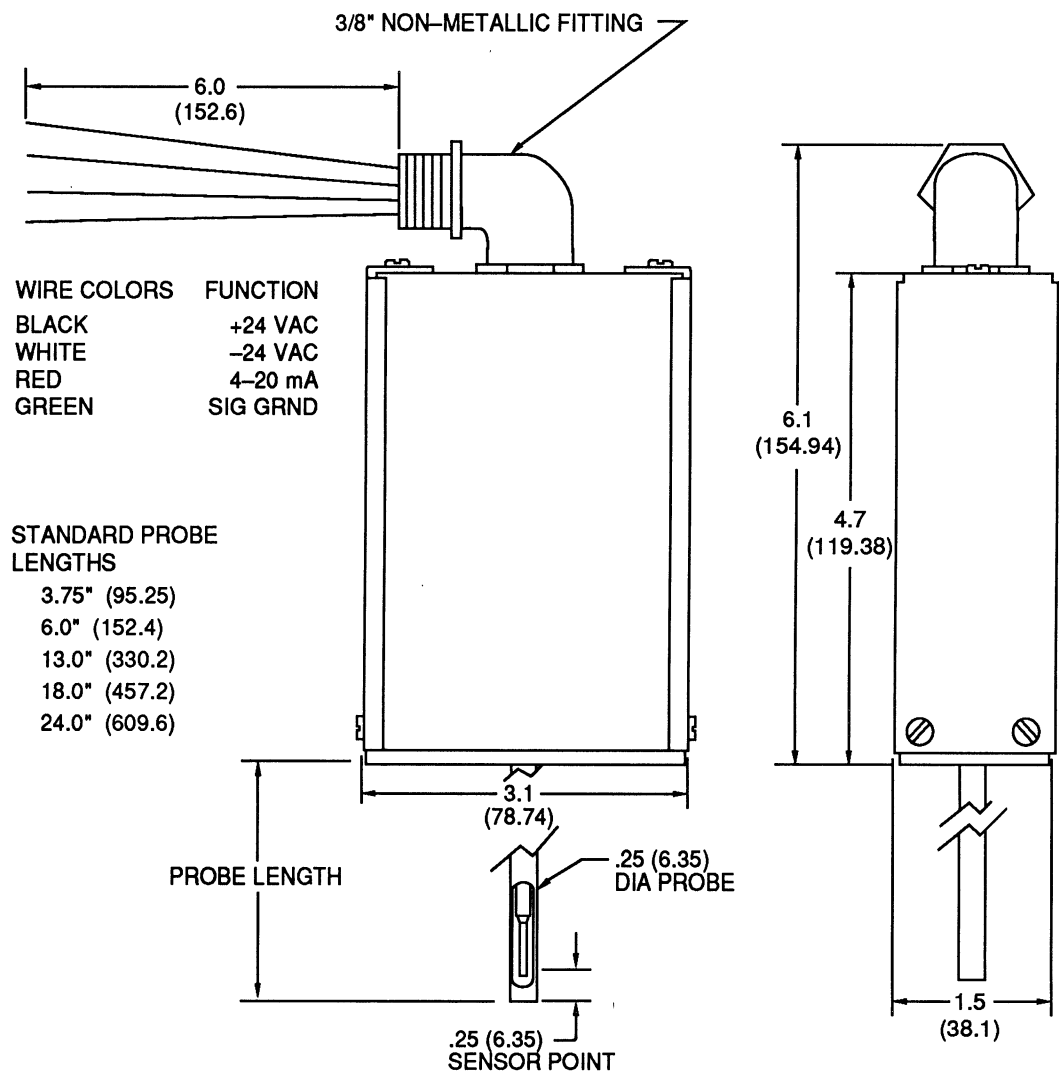
DIMENSIONS IN INCHES
(DIMENSIONS IN MILLIMETERS IN PARENTHESES)

APPENDIX B2
Dimensional Drawings
for NEMA 2 Enclosure



DIMENSIONS IN INCHES
(DIMENSIONS IN MILLIMETERS IN PARENTHESES)

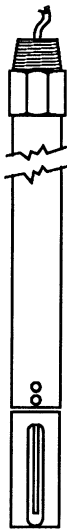
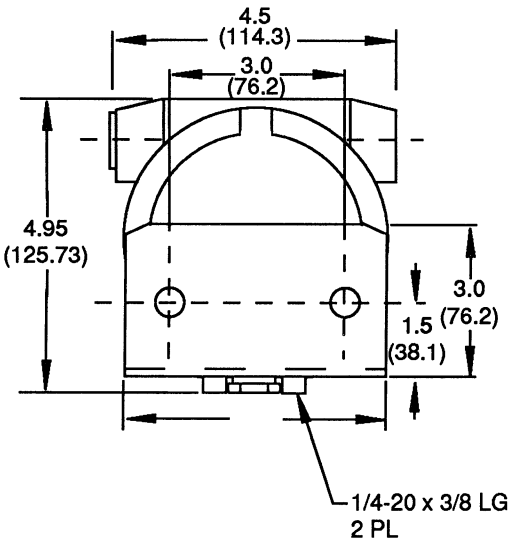
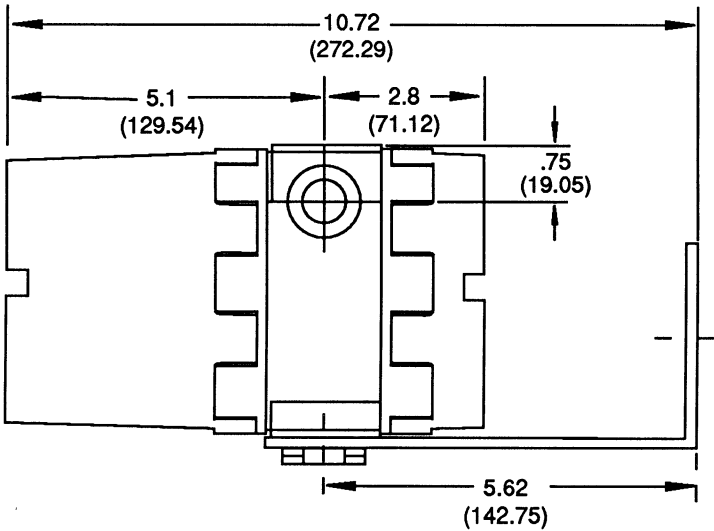
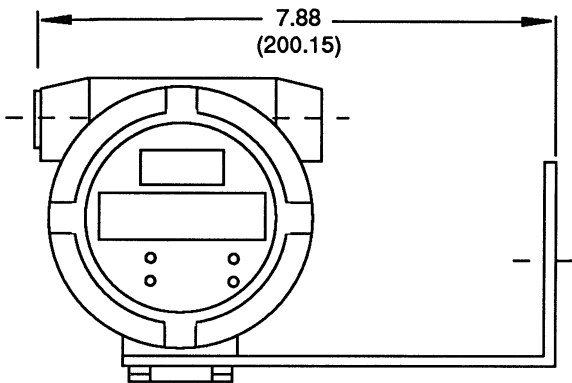
APPENDIX B3
Dimensional Drawings
for NEMA 2 Enclosure
(HVAC Units Only)



DIMENSIONS IN INCHES
(DIMENSIONS IN MILLIMETERS IN PARENTHESES)

APPENDIX B4

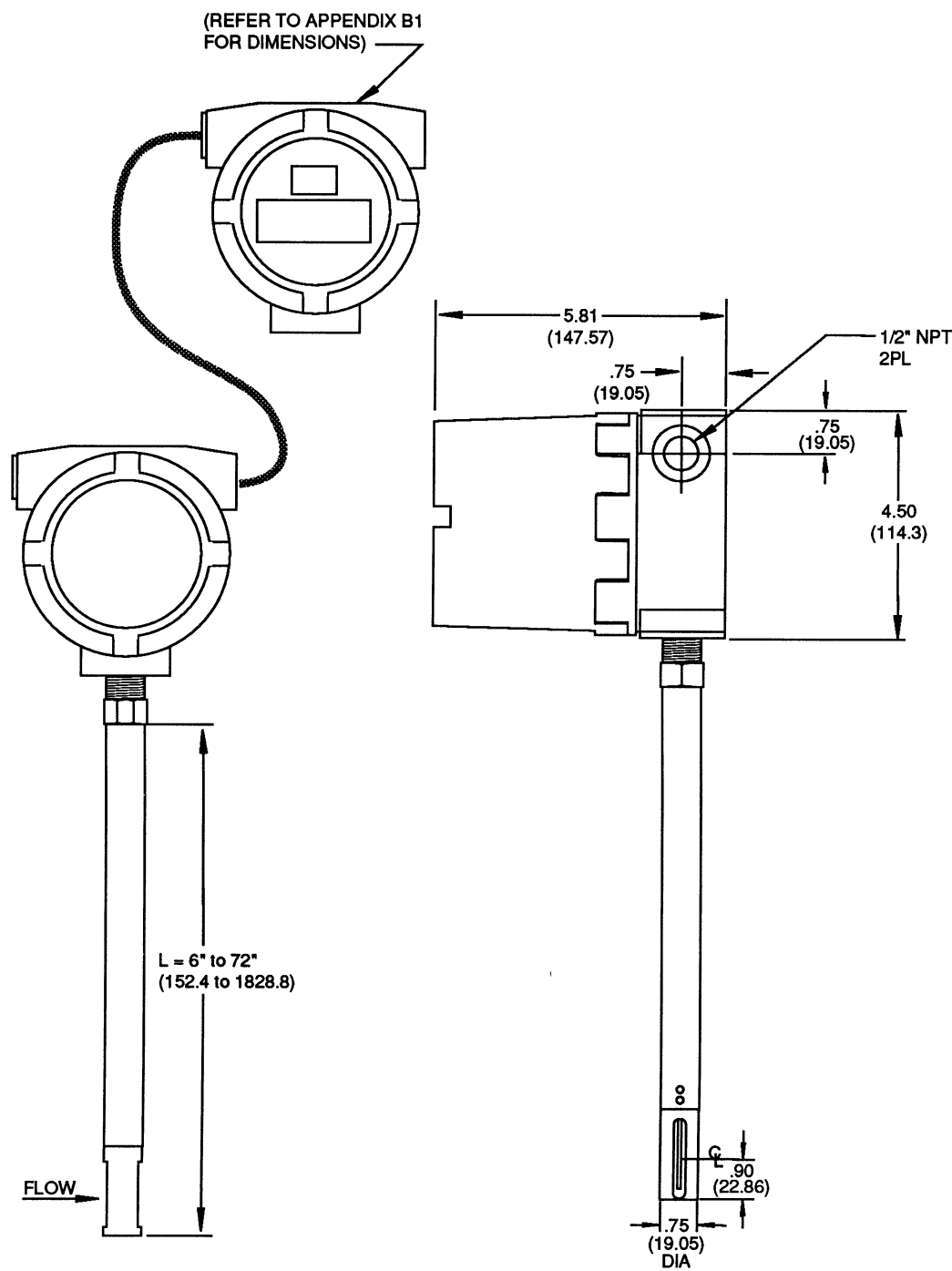
**Dimensional Drawings
for Remote Electronics
(E3 Option)**



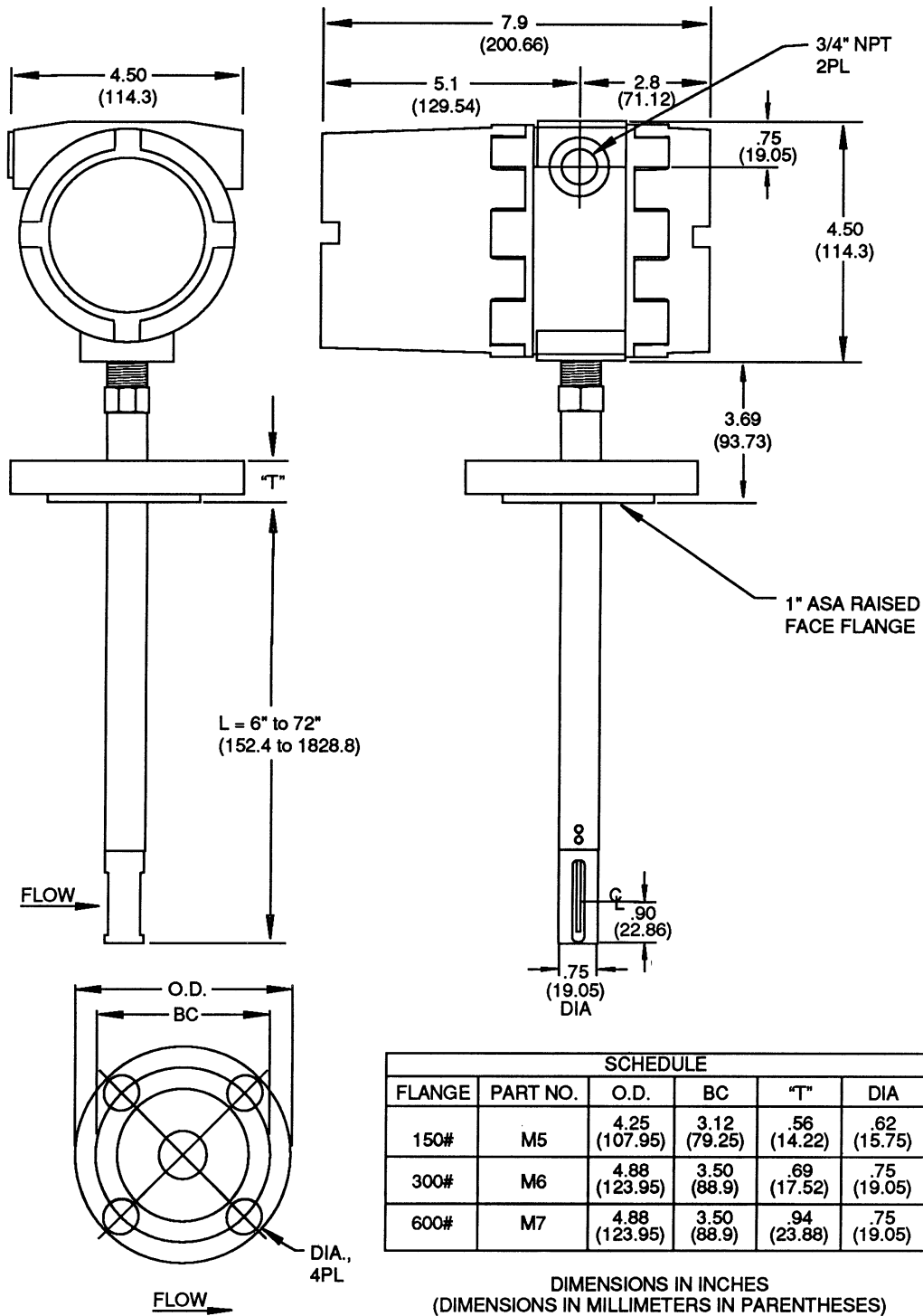
DIMENSIONS IN INCHES
(DIMENSIONS IN MILLIMETERS IN PARENTHESES)

APPENDIX B5

Remote
Explosion Proof
Enclosure (E4 Option)



APPENDIX B6 **Explosion Proof** **Enclosure Mounting;** **Raised Face Flange**



APPENDIX C

Understanding Your Options

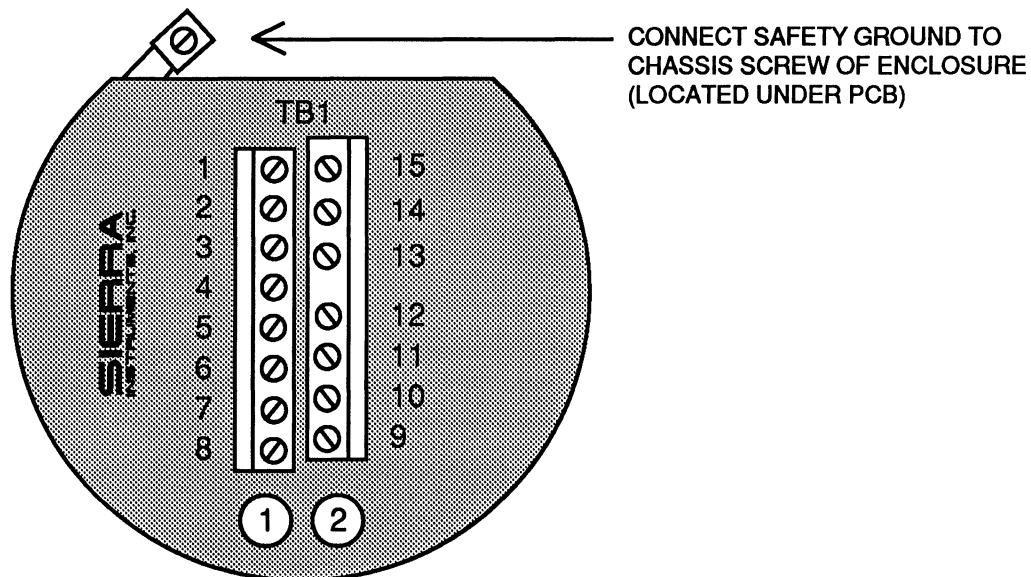
Model 600 and 640 flow meters can be manufactured with a variety of options. These options normally result in differences in power supply, output, and alarm wiring.

APPENDICES C1 through C5 are applicable to 600 and 640 Series units which use the red Adalet NEMA 4 enclosure.

For those with the NEMA 4 enclosure: APPENDIX C1, POWER INPUT WIRING will be applicable to all, as will APPENDIX C2, OUTPUT SIGNAL WIRING. APPENDIX C3, ALARM AND DUAL RANGE WIRING will apply if you have either of those features. If you are using a Sierra® 900 Series Control Box, please consult APPENDIX C4, 900 SERIES TO 600/640/760 INTERFACE WIRING and APPENDIX C6, WIRING GUIDE SERIES 900 BOX. Finally, anyone using an E3 or E4 remote hookup will need to refer to APPENDIX C5 for both REMOTE SENSOR WIRING and REMOTE ENCLOSURE WIRING.

For those with the NEMA 2 enclosure: Please refer to APPENDIX C7 and C8 for FIELD WIRING.

APPENDIX C1
Power Input Wiring
for E2/E3/E4
Enclosure Option



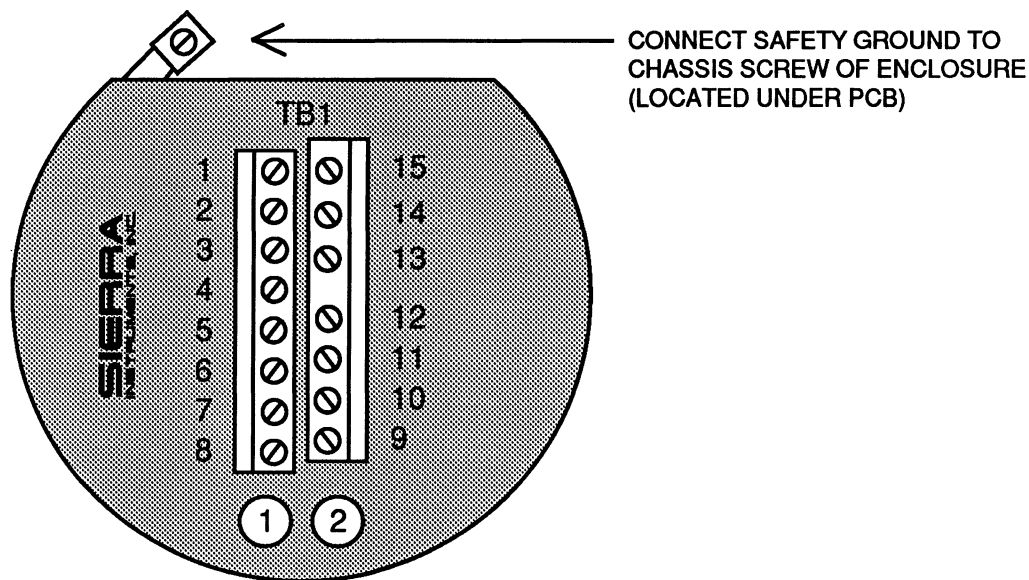
AC POWER WIRING (PS/PE/PJ)

TERMINAL BOARD CONNECTION	FUNCTION
TB1-14	VAC NEUTRAL (WHITE)
TB1-15	VAC HOT (BLACK)
CHASSIS SCREW (LOCATED UNDER PCB)	EARTH GROUND

DC POWER WIRING (PV1/PV2)

TERMINAL BOARD CONNECTION	FUNCTION
TB1-14	DC POWER COMMON
TB1-15	+15VDC / +24VDC

APPENDIX C2
Output Signal Wiring
for E2/E3/E4
Enclosure Options



OUTPUT SIGNAL WIRING (V1/V4)

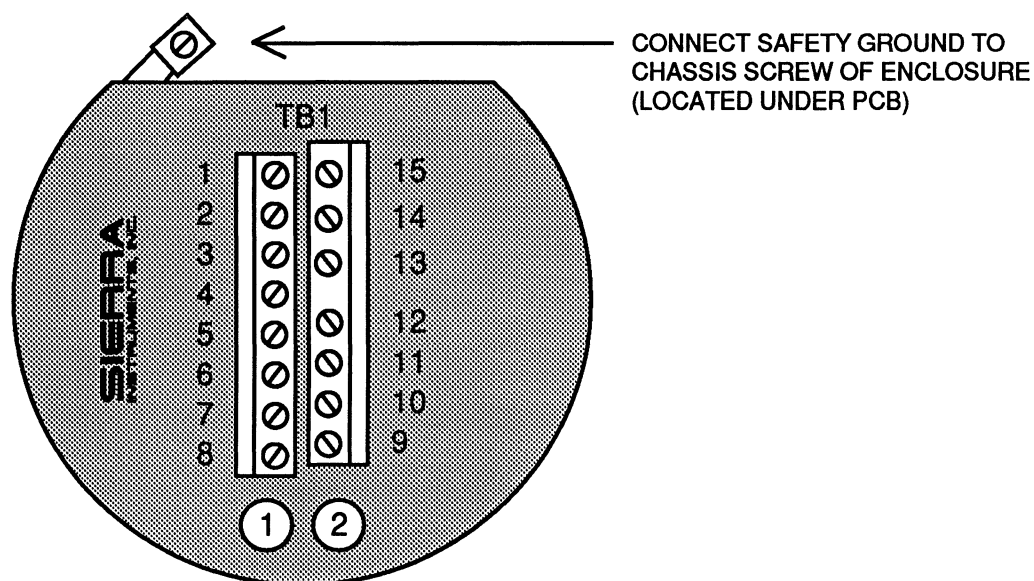
TERMINAL BOARD CONNECTION	FUNCTION
TB1-1	SIGNAL GROUND
TB1-2	0-5 VDC / 4-20 MA OUTPUT SIGNAL

RS-485 OUTPUT SIGNAL WIRING (RS)

TERMINAL BOARD CONNECTION	FUNCTION
TB1-7	RS-485 +
TB1-8	RS-485 -

APPENDIX C3

Alarm & Dual Range Wiring for E2/E3/E4 Enclosure Options



ALARM WIRING (AL)

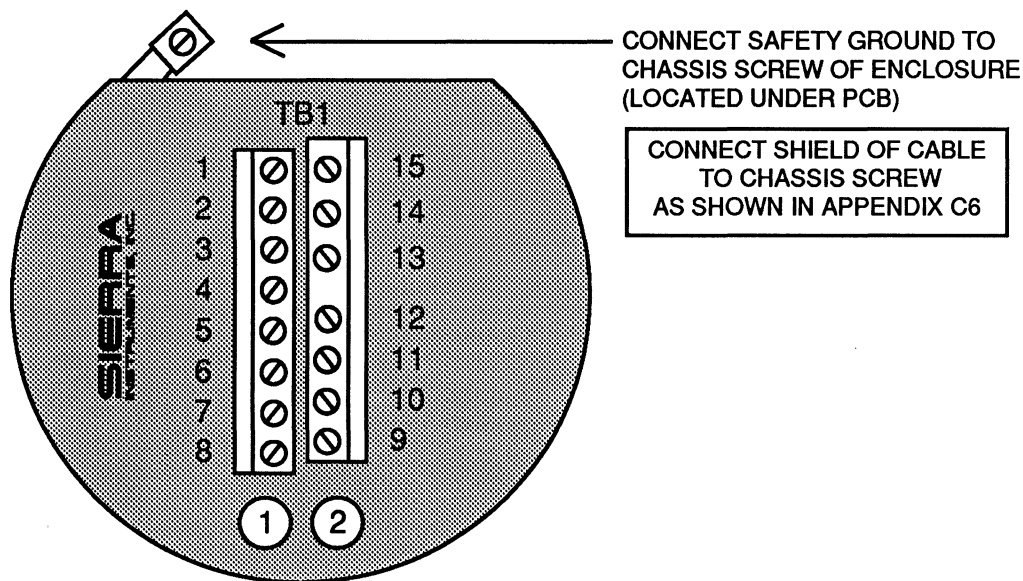
TERMINAL BOARD CONNECTION	FUNCTION
TB1-7	RELAY C (LOW ALARM)
TB1-8	RELAY NC (LOW ALARM)
TB1-9	RELAY NO (LOW ALARM)
TB1-10	RELAY 2 C (HIGH ALARM)
TB1-11	RELAY 2 NC (HIGH ALARM)
TB1-12	RELAY 2 C (HIGH ALARM)

*See also Appendix D for relay options.

DUAL RANGE WIRING (DF)

TERMINAL BOARD CONNECTION	FUNCTION
TB1-7	RANGE SELECT
TB1-9	RANGE SELECT COMMON

APPENDIX C4
900 Series to
600/640/760 Interface
Wiring for E2/E3/E4
Enclosure Options

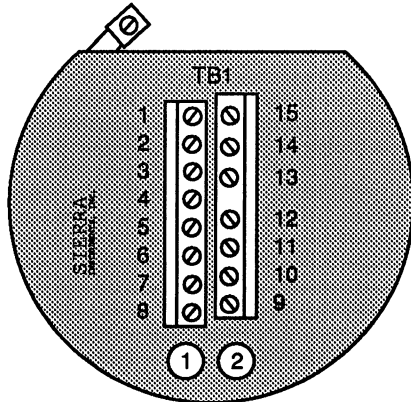


900 SERIES INTERFACE WIRING

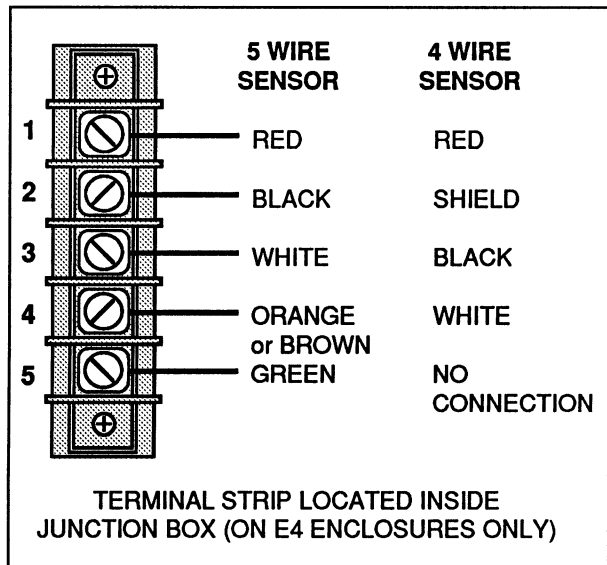
TERMINAL BOARD CONNECTION	FUNCTION	20-PIN BOX CONNECTOR
TB1-1	SIGNAL GROUND	PIN 2
TB1-2	OUTPUT SIGNAL	PIN 3
TB1-7	RANGE SELECT (FOR DUAL RANGE ONLY)	PIN A (FOR DUAL RANGE ONLY)
TB1-14	DC POWER COMMON	PIN B
TB1-15	+15 VDC	PIN 4

APPENDIX C5

Remote Sensor Wiring for E3/E4 Enclosure Options



TERMINAL STRIP LOCATED INSIDE
FLOW METER ENCLOSURE



REMOTE 5 WIRE SENSOR WIRING

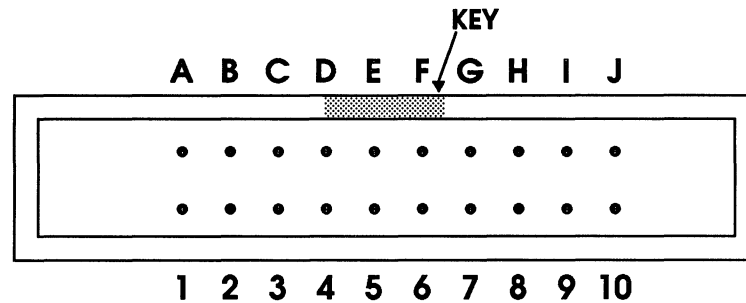
TERMINAL BOARD CONNECTION	FUNCTION	SENSOR WIRE COLOR (INTERNAL)	CABLE WIRE COLOR (EXTERNAL)
TB1-3	REMOTE TEMP SENSOR	BLACK	ORANGE or BROWN
TB1-4	REMOTE TEMP SENSOR	BLACK	GREEN
TB1-5	REMOTE VELOCITY SENSOR	RED	RED
TB1-6	REMOTE VELOCITY SENSOR	BLACK	BLACK
TB1-11	REMOTE VELOCITY SENSOR	WHITE	WHITE
TB1-13	SHIELD	SHIELD	SHIELD

REMOTE 4 WIRE SENSOR WIRING

TERMINAL BOARD CONNECTION	FUNCTION	SENSOR WIRE COLOR (INTERNAL)
TB1-3	REMOTE TEMP SENSOR	BLACK
TB1-4	REMOTE TEMP SENSOR	WHITE
TB1-5	REMOTE VELOCITY SENSOR	RED
TB1-6	REMOTE VELOCITY SENSOR	SHIELD

APPENDIX C6

Wiring Guide Series 900 Box



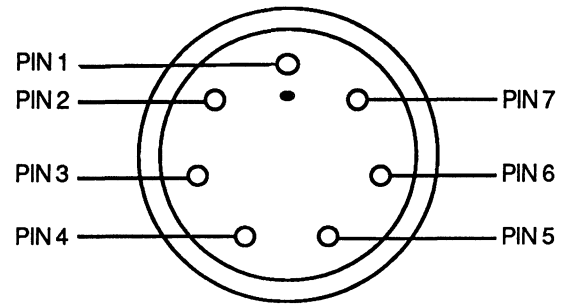
PIN NO.	FUNCTION	PIN NO.	FUNCTION
A	Setpoint Output to Controllers	1	Chassis Ground
B	Common	2	Common
C	Common	3	0-5 Volt Signal from Transducer
D	Valve Test Point (Avail. I/O Connector)	4	+15 VDC Supply from System Electronics to Transducers
E	RED Connection (Factory Use Only)	5	BLACK Connection (Factory Use Only)
F	-15 VDC supply from System Electronics to Transducers	6	No Connection
G	No Connection	7	No Connection
H	High Alarm Output (Avail. I/O Connector)	8	+15 VDC Supply from System Electronics to Transducers
I	Low Alarm Output (Avail. I/O Connector)	9	4-20 mA Signal from Transducer
J	Valve Off (Avail. I/O Connector)	10	Common

Standard Conxall Wiring 640/760	
Conxall Connection (Female)	Function
1	Signal ground
2	Output signal
3	+15 VDC
4	*Low alarm output
5	*High alarm output
6	Power ground
7	Factory test point (BV)
*Alarms are optional.	

Dual Range Conxall Wiring 640/760	
Conxall Connection (Female)	Function
1	Signal ground
2	Output signal
3	+15 VDC
4	No connection
5	Range select
6	Power ground
7	Factory test point (BV)

APPENDIX C7

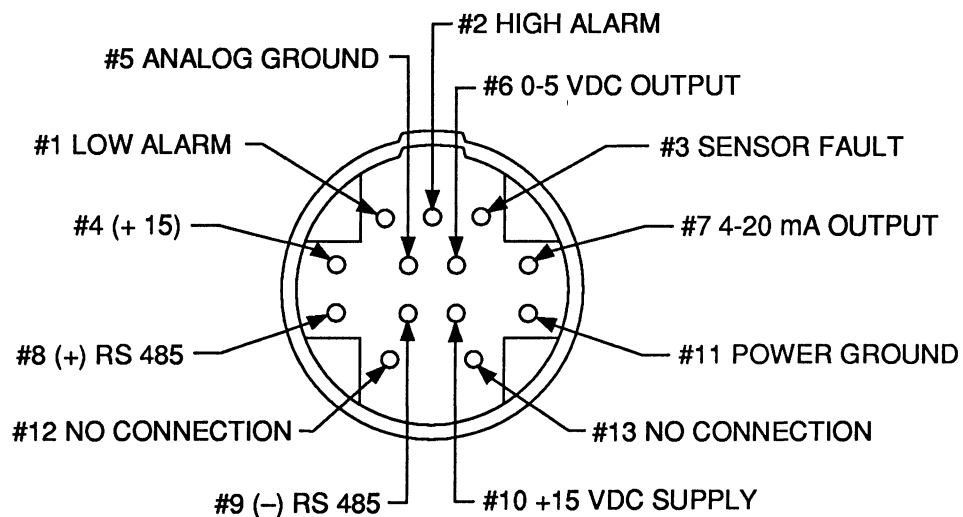
Field Wiring for 7 Circuit Connector for NEMA 2 Enclosure (Female Connector Solder Side)



NOTE: For HVAC Units, refer to Appendix B2-B for wiring detail.

APPENDIX C8

Field Wiring for 13 Circuit Connector for NEMA 2 Enclosure (For RS option) (Female Connector Solder Side)



APPENDIX D1

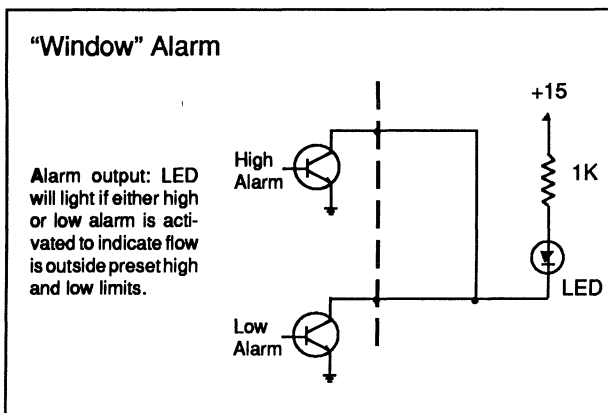
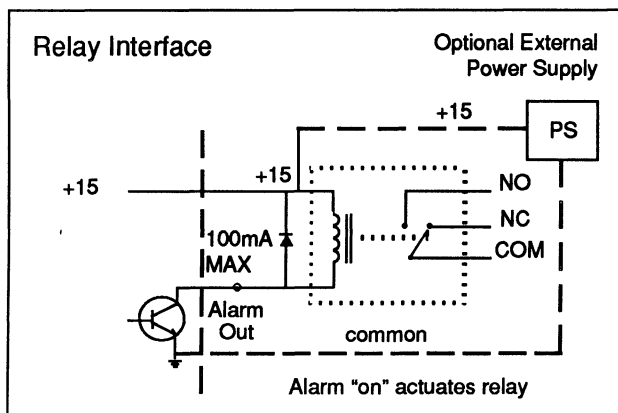
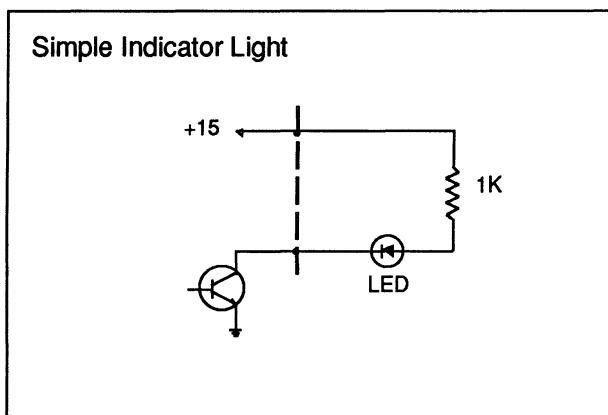
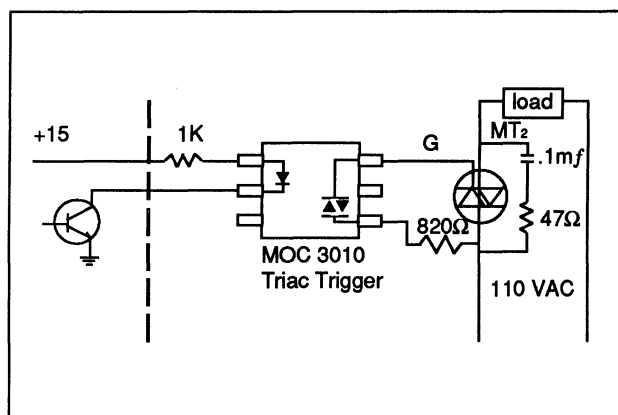
Alarms for Series 600 Mass Flow Meters

The alarms are open collector transistor outputs; that is, a transistor is used as a switch to ground. A “high” alarms means that if the flow signal is higher than the alarm trip setting, the transistor will be turned on. Conversely, a “low” alarm activates the transistor when the flow signal is lower than the alarm trip setting. Sierra products usually incorporate a means of configuring the output as either a high alarm or low alarm.

It is necessary to limit the current flow through the transistor to 100 mA maximum to provide reliable operation. The standoff voltage is 30 VDC. This means that the transistor can safely withstand 30 VDC on its collector while in the off state. Voltages greater than this may cause failure of the transistor.

NOTE: All alarms have built in hysteresis, providing a dead band of approximately 2% around the trip point. The alarm’s ON point will be slightly different than the OFF point, in order to avoid “chattering”, a rapid switching on and off of the alarm which can occur if the flow signal is slow moving or stable at the alarm trip point for a period of time.

Following are several examples of commonly used alarm circuits:



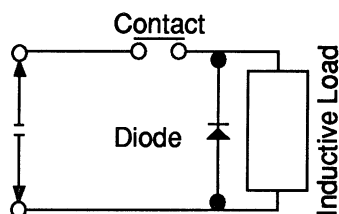
The 640 Series Flow Meter is equipped with one or two power relays. The relays are rated for 7 amps, 30 VDC or 7 amps, 250 VAC.

Typical contact protection circuits are shown below for your information. The circuit you are planning to use should be thoroughly checked.

APPENDIX D2

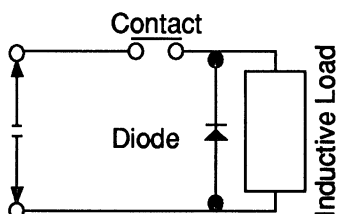
Alarms (Relay Outputs) for Series 640 Mass Flow Meters

DIODE AND ZENER DIODE CIRCUIT



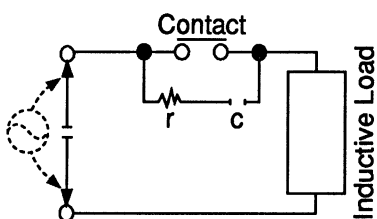
- DC applications only.
- Utilize when diode circuit causes too long release time.
- Use zener diode with zener voltage about equal to power supply voltage

DIODE CIRCUIT

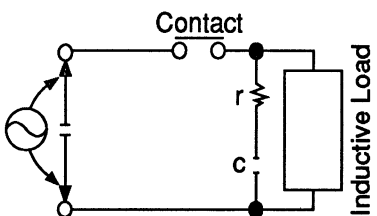


- DC applications only.
- Compared to RC type, circuit delays release time (2 to 5 × stated in catalog).
- For larger voltages, use diode with reverse breakdown ten times circuit voltage and forward load circuit.
- For smaller voltages, use reverse breakdown V of 2 to 3 × power supply voltage.

RC CIRCUITS

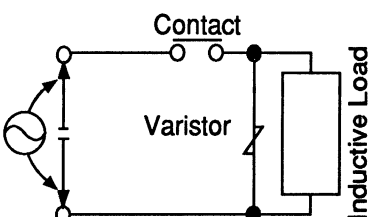


- Circuit A is suitable for AC or DC applications, but if used with AC voltage, impedance of the load should be smaller than the RC circuit's. Do not utilize for timer loads, as leakage current can cause faulty operation.



- Circuit B is suitable for AC or DC applications. If the load is a relay or solenoid, release times lengthen. Effective when connected to both contacts, power supply voltage across the load is 100 to 200V.

VARISTOR CIRCUIT

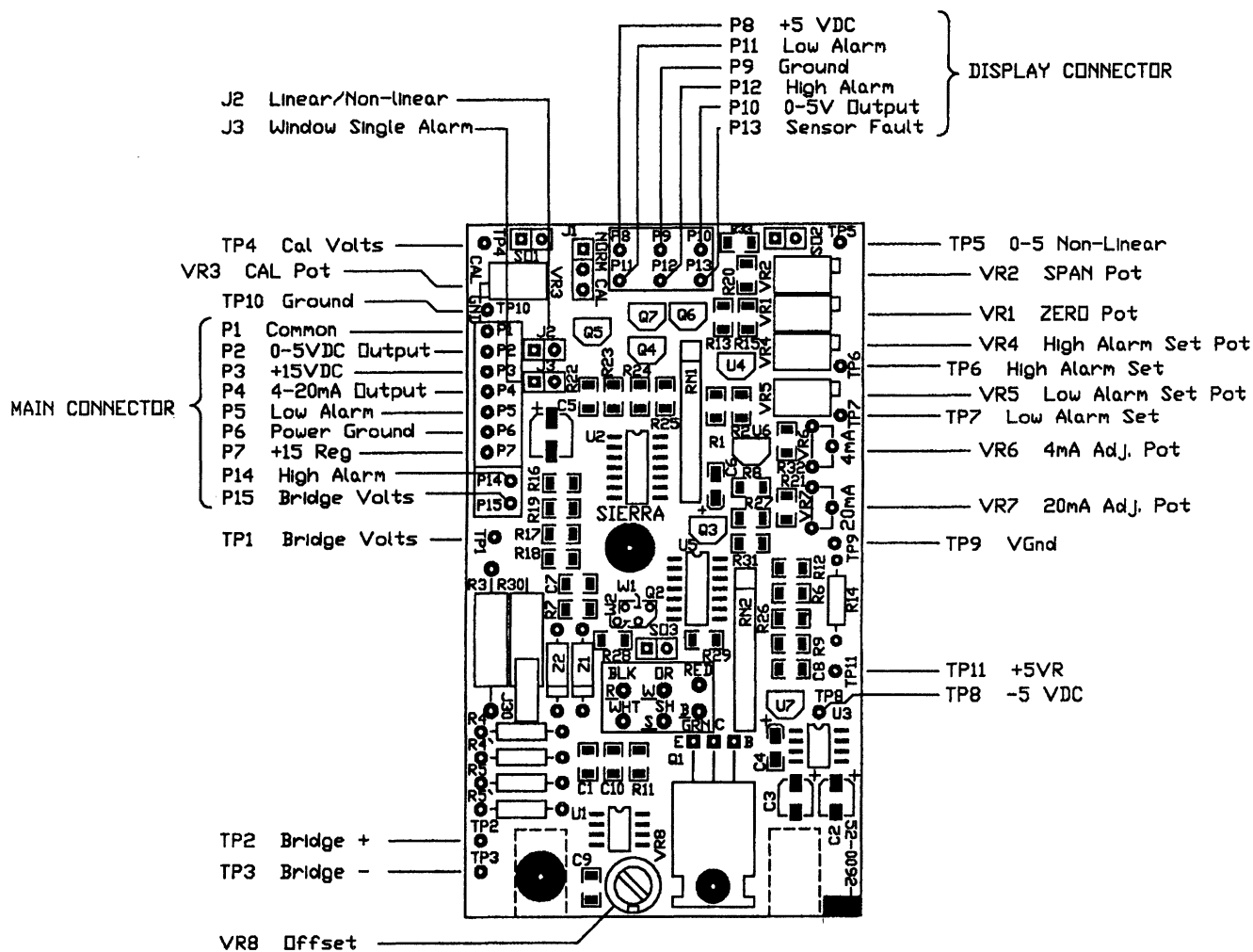


- Effective for AC or DC applications.
- Circuit slightly delays release time. Effective when connected to both contacts, power supply voltage across the load is 100 to 200V.

APPENDIX D3

737 PCB (0-5 V and 4-20 mA)

Sierra Part Number: M52-0092



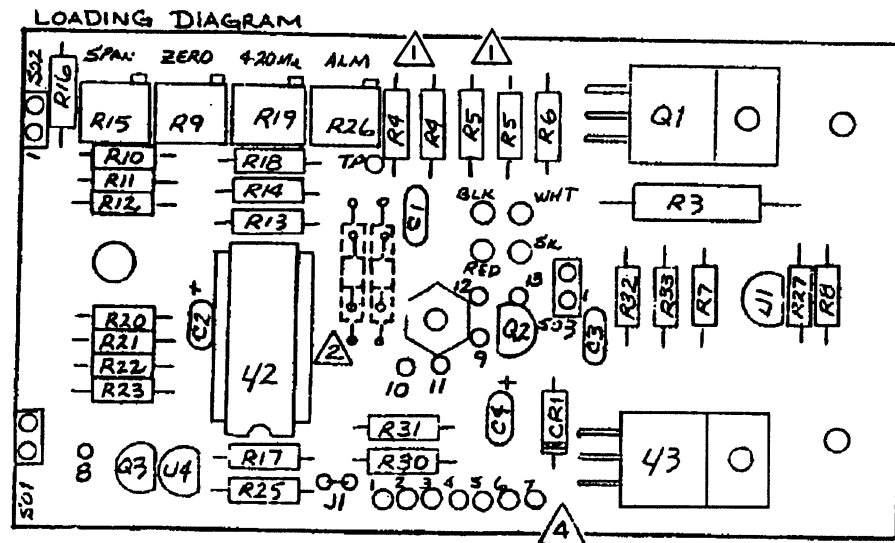
CRITICAL COMPONENT PLACEMENT

737LX REV A

M52-0092 10-3-94 44-0093

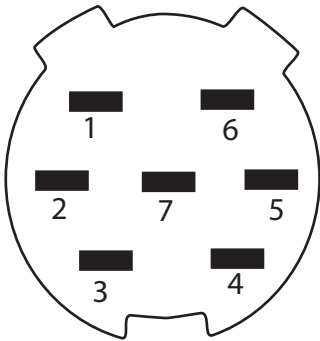
APPENDIX D4

737 Loading Diagram for Series 600 M52-0007 Rev. J



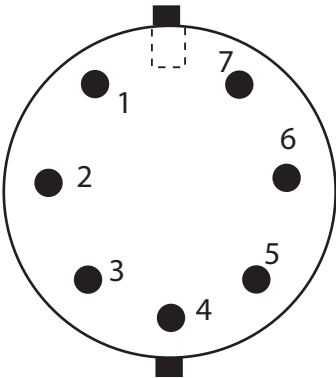
600 WIRING CONNECTIONS

No#.	Color	Signal
1	Black	Sig. Ground
2	White	Signal
3	Red	DC input Power
4	N/C	
5	N/C	
6	Green	Power Ground
7	(Brown or Orange)	(Bridge)



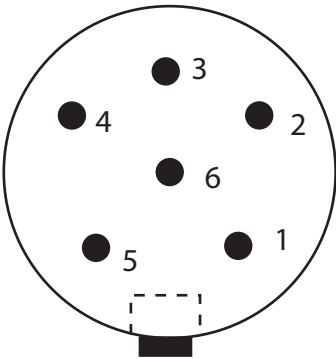
Blue Hi Rose Connector
Female Mating Connector
Solder Side

No#.	Color	Signal
1	Black	Sig. Ground
2	White	Signal
3	Red	DC input Power
4	N/C	
5	N/C	
6	Green	Power Ground
7	(Brown or Orange)	(Bridge)



Black Connector
Female Mating Connector
Solder Side

No#.	Color	Signal
1	Red	DC input Power
2	White	Signal
3	Black	Sig. Ground
4	(Brown or Orange)	(Bridge)
5	Green	Power Ground
6		



Silver Connector
Female Mating Connector
Solder Side

