Kurz Instruments, Inc.

Model 452FT
Insertion Flow Transmitter User Guide
360170 Rev. A

May 1997

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Table of Contents

Title Page i

Publication Notices .... ii-iii

Copyright ii

Trademarks ii

Publication Notice .... ii-iii

Warranty iv

Table of Contents .... v-ix

Introduction .... x-xi

Duct Velocity Profile Correction xi

Sensor Insertion Location xi

Duct Area xi

Field Calibration xi

Sensor Pitch or Orientation to the Flow xi

Medium to be Measured xi

KURZ 452FT Brochure (DCN 367029) 1-8

Installation 9-25

Mounting 9

Field Wiring 10

Safety 10

Table of Contents (Continued)

Table 1 Typical Wiring Diagrams 11

24 VDC Powered Flow Transmitters 12

AC Powered Units 12

Analog Output 12-13

Transmitter Separate (TS) Configurations 13-14

Optional Power-On Surge Check 14

Figure 1 Model 452FT Installation with Compression Fitting 15

Figure 2 Typical Hook-Up for A.C. Powered Model 452FT with Nonisolated Self-Powered 4-20mA Output 16

Figure 3 Typical 3-Wire Hook-Up for 24 VDC Powered Model 452FT with Nonisolated Self-Powered 4-20mA Output 17

Figure 4 Typical 4-Wire Hook-Up for 24 VDC Powered Model 452FT with Nonisolated Self-Powered 4-20mA Output 18

Figure 5 Typical Hook-Up for A.C. Powered Model 452FT with Loop-Powered 4-20mA Output 19

Figure 6 Typical 3-Wire Hook-Up for 24 VDC Powered Model 452FT with Non-Isolated Loop-Powered 4-20mA Output 20

Figure 7 Typical 4-Wire Hook-Up for 24 VDC Powered Model 452FT with Loop-Powered 4-20mA Output 21

Wiring Diagram, Field, Single-Point Mass Flow Transmitter, CE Series (DCN 342014) 22-23

Wiring Diagram, 465/438/AC PWR, Mass Flow Transmitter, CE Series (DCN 342016) 24-25

Table of Contents (Continued)

Insertion Flow Transmitter Calibration 26-30

Factory Calibration Method 26

User Zero and Span Calibration 26-27

Figure 8 Typical Input Calibration Sheet (DCN 180117) 28

Figure 9 Typical calibration Curve 29

Figure 10 Typical Output calibration Sheet 30

Maintenance and Troubleshooting 31-36

Maintenance 31

Flow Issues 32

Sensor Element 32

Linearizer and Bridge Electronics 33

Table 2 Troubleshooting Chart 33-36

Return Shipment 37-38

RMA # (Return Material Authorization #) 37

Cleaning of Material to be Returned 37

Shipping Material to be Returned 38

Appendix A Thermal Anemometer Measurements A1-A9

Mass Rate A1

Mass Flow Equations A1-A3

Table of Contents (Continued)

Reynolds Number A1-A2

Standard Velocity A2

Standard Volumetric Flow A2

Mass Flow A3-A4

Gas Property Induced Errors A4

Pressure Changes A4

Temperature Changes A4

Temperature Profiles A4

Low Flow Free Convective forces A4

Flow Profiles A5

Low Velocity Laminar Profile A5

High Velocity Turbulent Profile A5

Correction Factors A6

Use of the Flow Equations in the KURZ Mass Flow Meter A6-A7

Single Point Insertion Flow Elements A6

Multi-Point Insertion Flow Elements A7

Inline Flow Elements A7

Problems A8

Major Points to Remember (Fill-In) A9

Table of Contents (Continued)

Appendix B Declarations of Compliance B1-B2

Models 452/502/522-UHP/532 Declaration of CE Compliance (DCN 430007) B1

452FT/502Ft Declartion of Safety Compliance (DCN 430018) B2

Appendix C Recommended Sensor Placement Criteria and Sensor Flow Blockage Correction Factors for Series 450 Single-Point Mass Flow Elements (DCN 364002) C1-C5

I. Introduction C2

II. Recommended Sensor Placement Criteria C3

III. Sensor Blockage Correction Factors C4-C5

Table 1, Series 450 Sensor Blockage Correction Factors C5

INTRODUCTION

The Kurz Instruments 452FT series of insertion mass flow transmitters are point velocity sensing devices. The flow element is a constant temperature thermal anemometer which intrinsically measures the process fluid Reynolds number. The net meter response is mass rate per unit area. The engineering output may be scaled to represent standard velocity, standard volumetric flow or mass rate. Density changes are automatically accounted for negating the need for pressure and temperature compensation. A complete description of how and what the thermal anemometer measures can be found in Appendix A. The units must be calibrated in the gas type to be measured or may be correlated from Air calibrations if available.

The 452FT is a 3, 4 or 5-wire device whose 4- 20 mA output current is directly proportional to the flow rate. The unit is available as 24 VDC, 115 VAC @ 50 to 60 Hz, or 230 VAC @ 50 to 60 Hz powered. The 4-20 mA output can be nonisolated self-powered or isolated loop-powered. The typical configuration has all the electronics in one enclosure, known as the TA configuration, or with just the sensor and a terminal wiring board in a separate enclosure from the electronics in the TS configuration. Both cases are shown in the field wiring diagrams. The TS configuration is used where the sensor enclosure ambient temperature is expected to exceed 60 °C, allowing the electronics to be mounted separated in a cooler place.

Additional product description, specifications, outline drawings and explanation of part numbers can be found in the product brochure at the end of this section.

Important Issues for Accurate Flow Measurements

- Duct Velocity Profile Correction:
  - Does velocity profile change with dampers, fans, valves, etc. where the sensor is measuring?
- Sensor Insertion Location:
  - What part of the profile is to be measured?
- Duct Area:
  - Sensor blockage, reducing the effective area.
- Field Calibration:
  - With the FT, field calibration is limited to a Zero and Span adjustment. Changing the calibration as a function of velocity to account for velocity profiles is not available on the FT model, see model 155 for these features.
- Sensor Pitch or Orientation to the Flow:
  - Is the flow arrow pointing in the same direction as the flow?
- Medium to be Measured:
  - Was the unit calibrated in the medium to be measured?
  - Is the medium composition highly variable?
  - Does the medium change phase?
  - Can material build up on the sensor?

Answers to many of these question can be found in this manual or its appendices. Kurz customer service may also be contacted for assistance (408-646-5911 or FAX 408-646-1033). This user manual covers installation, operation, calibration and maintenance information.

INSTALLATION

WARNING: Your warranty will be voided if your unit is not installed in accordance with this user guide. Make sure you read and thoroughly understand the installation portion of this guide before you attempt to install your unit. If you have any questions, contact your Kurz customer service representative before attempting installation.

Mounting

The 452 insertion flow transmitter is generally mounted with a compression fitting into a duct or on a flange (See Figure 1). See the product brochure (DCN 367029) for Kurz mounting accessories. It is important for the mounting design to consider the force that will be exerted on the probe support or flange when the process fluid is under pressure. The insertion depth depends on the duct size and sensor size. Our recommended placement criteria are also in the brochure. The sensor blockage, used to establish the duct area where the measurement is made is specified in DCN 364002 included in Appendix C.

For transmitter separate versions (TS) there are two enclosures. The one with the sensor mounts as described above and contains just a sensor wire terminal board. The second enclosure contains the bridge electronics and is mounted via its conduit ports or a mounting bracket. This bracket has four 1/4" holes with 2.50" square spacing (see the brochure). It is important to know that the sensor serial number must be matched with the bridge board and its linearizer. These three parts are not interchangeable unless recalibrated.

Things to watch out for:

- If the process being monitored has moving valves or other flow profile disturbances you should keep your distance from them to obtain the best performance. About 30 duct diameters are needed to have the profile within about 1% of a long run velocity profile.

- When the dew point is close to your operation temperature, and/or you have a saturated gas in un-insulated ducting and condensation occurs on the walls, do not mount the sensor pointing in a downward angle. Pointing the sensor up or at the least horizontal will prevent condensation from reaching the sensor element and causing false high flow readings as the heated element evaporates the condensate.

Field Wiring

There are up to four issues for the proper wiring installation of the Kurz 452FT:

- Safety Grounding and Explosion Proof enclosure connections.
- DC or AC power requirements and connection.
- Analog Output configuration and wiring of the 4-20 mA signal.
- Sensor wiring for transmitter remote (TS) units.

Please read the complete text of the sections and study the wiring diagrams which are relevant to your model before performing the installation.

Safety

To ensure compliance with General Safety requirements the metal enclosures must be grounded to minimize the chance of electrical shock. For Explosive Atmospheres, proper grounding minimizes the chance of sparks occurring (ignition sources) outside an enclosure at its mechanical interfaces if a fault current was to flow. Both internal and external grounds are available, see the wiring diagrams at the end of this section. Units which are 24 VDC powered are wired according to DCN 342014 and those which are 115/230 VAC 50/60 Hz are wired according to DCN 342016.

For hazardous gas areas, wiring going into and out of the explosion proof enclosures must be done through a conduit seal or cable gland rated for explosion proof applications (Class 1 Div. 1 or Zone 1) attached directly to the enclosure. These seals are not needed for nonincendive designs (Class 1 Div. 2 or Zone 2).

For hazardous areas it is important to not connect or disconnect any wiring when the circuit is energized, the resulting spark could cause ignition.

Typical Hook-Up Wiring Diagrams

For both the AC & DC powered versions of the 452FT, typical summarized wiring diagrams for most applications are available as defined in Table 1.

TABLE 1

Typical Wiring Diagrams

4-20 mA Analog Output Configuration	Input Power	Interconnection Wiring Configuration	See Figure#
Nonisolated Only Self-Powered	115 VAC or 230 VAC 50 Hz - 60 Hz	Separate Shielded 3-Wire Power and Shielded 2-Wire Signal Out Cables	Figure# 2
Nonisolated Only Self-Powered	24 VDC	Single Shielded 3-Wire Power and Signal Out Cable	Figure# 3
Nonisolated Only Self-Powered	24 VDC	Separate Shielded 2-Wire Power and Shielded 2-Wire Signal Out Cables	Figure# 4
Nonisolated or Isolated Loop-Powered	115 VAC or 230 VAC 50 Hz - 60 Hz	Separate Shielded 3-Wire Power and Shielded 2-Wire Signal Out Cables	Figure# 5
Nonisolated or Isolated Loop-Powered	24 VDC	Single Shielded 3-Wire Power and Signal Out Cable	Figure# 6
Nonisolated or Isolated Loop-Powered	24 VDC	Separate Shielded 2-Wire Power and Shielded 2-Wire Signal Out Cables	Figure# 7

24 VDC Powered Flow Transmitters

The 24 VDC power is a nominal voltage since all circuits have a regulated supply and will work between 18 and 28 VDC. You may also use an unregulated power supply with 50 to 60 Hz ripple as long as the instantaneous voltage is between 18 and 28 VDC. Surge currents during sensor warm up could require up to 660 mA and will fall off after it warms up in about 30 seconds. At no flow the current will be about 0.2 A and about 0.5 A for high flow rates (12,000 SFPM). The power is protected against reverse polarity so if no current flows or there is no output signal you may want to check the polarity against the wiring diagram, DCN 342014.

The flow transmitter is isolated from ground to avoid ground loop currents. However, the 24 VDC power and 4-20 mA signal have MOVs (metal oxide varistors) to clamp voltage spikes going into the unit. These are 39 V nominal (voltage level at 1 mA) and do not conduct significant current below about +/- 30 VDC relative to ground. Consequently, it is a good idea to have the 24 VDC power grounded to prevent leakage currents on the MOVs, which can cause an error in the flow measurement if occurring on the 4-20 mA signal.

AC Powered Units

The 115 VAC @ 50 to 60 Hz and the 230 VAC @ 50 to 60 Hz units are factory wired to the voltage range ordered. The transformer jumpers and fuse may be changed as required. See the field wiring diagram DCN 342016 for the details. The voltage must be nominal +10/ -20 % for proper operation. The 115 V unit requires a 0.3 A connection and uses a slow blow fuse of the same rating. The 230 V unit is half this. All wiring to the AC power supply interface board must be routed through the holes provided in the PCB before connection to the terminal strips to prevent the wires from catching in the threads of the explosion proof lid. The internal ground can be made via the AC power plug or a 10-32 stud on the PCB. There is no power disconnect means for this unit.

Analog Output

The 4-20 mA linear output of the 452FT is jumper selectable for a self powered, nonisolated only signal or a loop powered nonisolated or isolated signal. The positive output terminal is diode protected against reverse voltage. The jumper settings for the 4-20 mA mode are found on the linearizer board which is found in the opposite enclosure chamber to that of the power and signal hook up terminals.

A self powered, nonisolated output is the factory setting. To use it in this mode, the receiving current should be sensed with an isolated input to avoid ground loop currents. This isolated input is often just a differential mode receiver. The 4-20 mA circuit has a 7 V compliance at the full 20 mA current. The internal voltage supply which powers the loop current limits the maximum load resistance to 500 Ω or a 10 V load. In this mode, the negative lead of the 4-20 mA circuit is internally connected to the 24 VDC negative lead. So, it is possible to wire the unit in three wire mode (See Figure 3). That is to use the negative power lead also for the 4-20 mA return lead.

As a loop powered 4-20 mA output (See Figures 5, 6, & 7), the jumper setting on the linearizer board must be changed. This configuration is useful when nonisolated current sensing is used or larger load resistance is needed. For example, with a 24 V power supply, you can drive 800 Ω. Do not exceed 30 VDC on the loop powered interface or you may have leakage current from the protective MOVs causing an error in the measurement. In summary, a loop powered configuration places a customer provided DC power source, the 452FT output and load resistance(s) all in series.

<u>Transmitter Separate (TS) Configurations</u>

The wiring of the TS configuration has a few more constraints since you must wire up the 5 sensor wires too. The most important thing about the TS wiring configurations (see sheet two of DCN 342014 and sheet two of DCN 342016) is keeping the 5 wires going to the proper terminals. The second most important thing is to make sure the linearizer PCB is plugged into the bridge board with both rows of pins properly mated. When connecting the 5 wires to the lower bridge board for the sensor, the terminals must be tight. Over torquing the connectors can damage them or components' surface mounted on the bridge board. When the linearizer is reinstalled, its two pin 4-20 mA connector must be above the same type two pin connector on the bridge.

The 5-wire sensor connection must use quality wire whose resistance per lead is less than 1 Ω. Each wire must match the resistance of the other wires within 0.01Ω so the lead length correction will work properly. This procedure is needed to ensure the factory calibration and temperature compensation holds up in the field. If the individual wires do not meet the matching specification, their length must be trimmed or extended until they match. The terminal strips for the bridge board are limited to 14 AWG wire which limits the TS configuration to about 400 ft between sensor and electronics (see wiring diagram). Longer lengths would need a wire splice from the larger wire size to 14 AWG to fit the bridge terminals. Again to get access to the bridge terminals, the linearizer PCB must be unplugged from the bridge. Be careful when reinstalling the linearizer that the plug-in connector pins mate properly.

To maintain the CE compliance of the product when in the TS configuration one must maintain a good shield around the 5 wires. This can be done with ridged conduit between the sensor junction box and the sensor electronics enclosure. Conduits that seal directly to the enclosure are still needed to meet the explosion proof ratings. Or a braided shield multiconductor cable between the two enclosures. Peripherally bonded shielded cable glands are required for cable connections. Hawk, makes a whole line of cable glands for shielded cable, some have explosion proof ratings too. Please contact Kurz Instruments, Inc. Customer Service if you need information in this area or other aspects of the installation.

Optional Power-On Surge Check

Once the mechanical and electrical installation is complete and checked you may safely apply power. Buy monitoring the 4-20 mA signal during power on you can get a rough idea if the unit is working properly. A fast chart recorder, scroll mode digital storage scope or fast milliampere meter should be connected to the 4-20 mA signal. When power is first applied, you will typically see the signal go to a very high value, hold for up to a few seconds then exponentially decay to the present flow value in about 20 seconds. This occurs because the heated velocity sensing element is initially cold and is warming up. After it warms up, momentarily cycling the power will not produce a turn on surge as large as when it has been off for 5 minutes or longer.

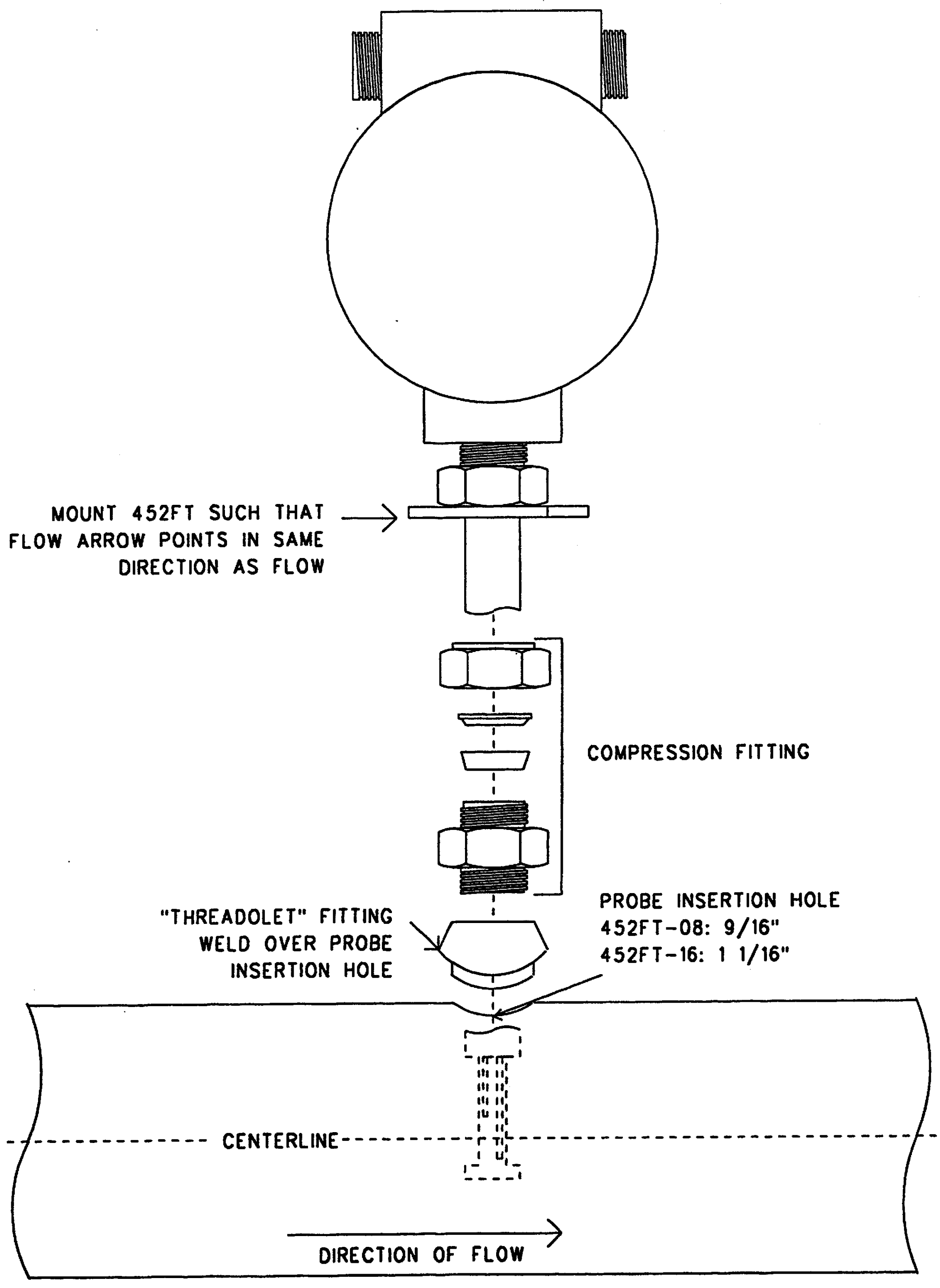


FIGURE 1 MODEL 452FT INSTALLATION WITH COMPRESSION FITTING

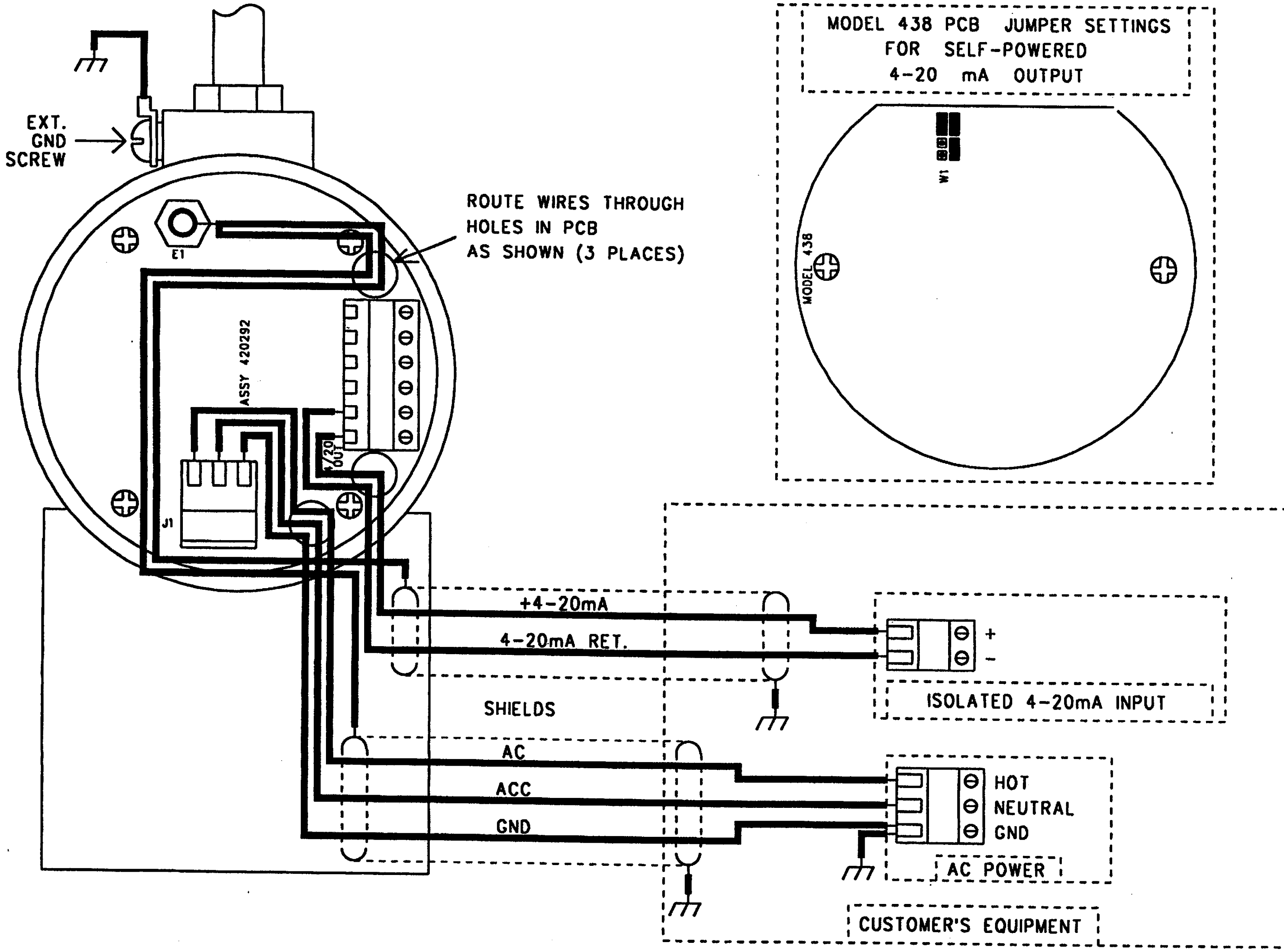


FIGURE 2 TYPICAL HOOK-UP FOR A.C. POWERED MODEL 452FT WITH NON-ISOLATED SELF-POWERED 4-20mA OUTPUT

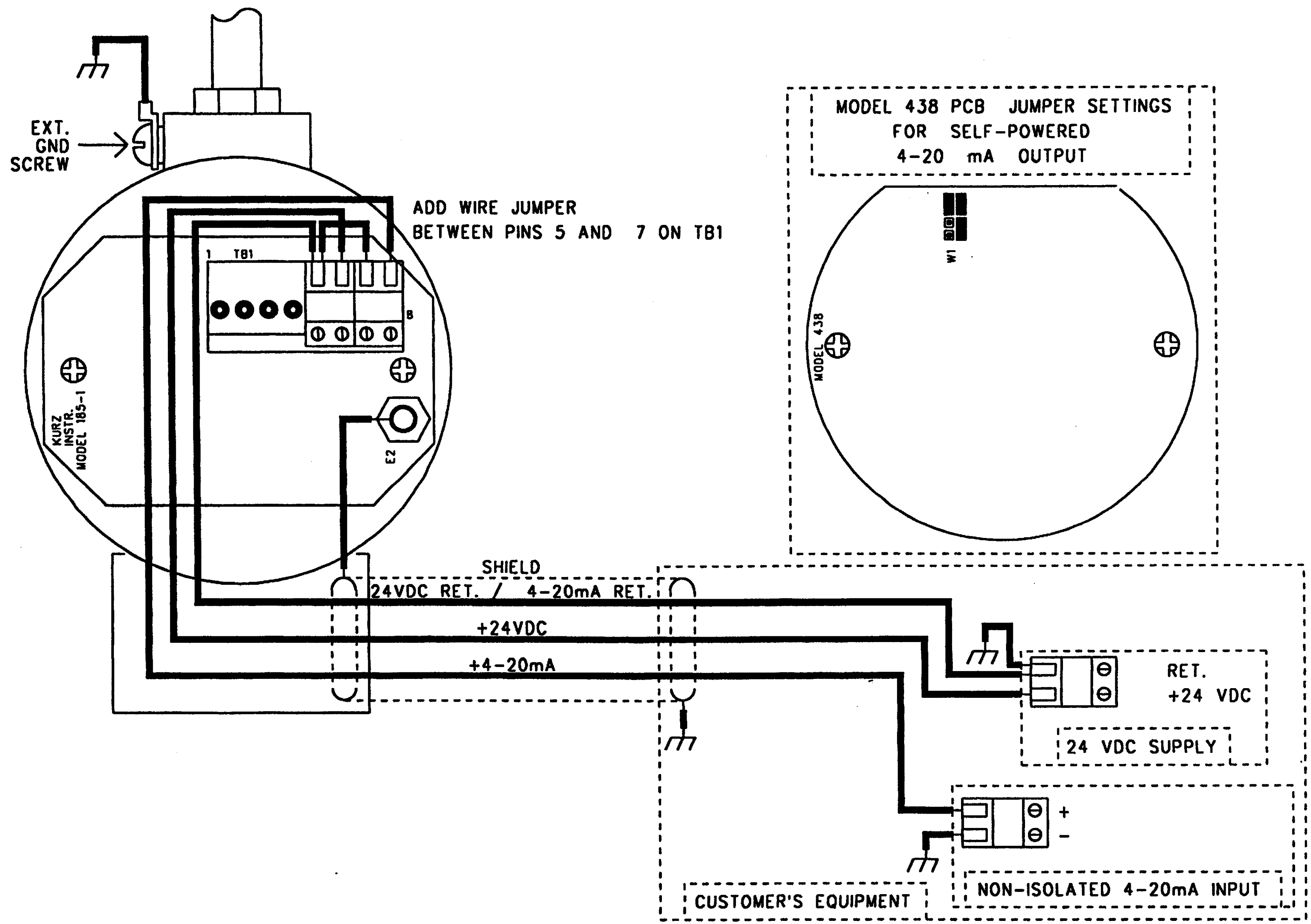


FIGURE 3 TYPICAL 3-WIRE HOOK-UP FOR 24 VDC POWERED MODEL 452FT WITH NON-ISOLATED SELF-POWERED 4-20mA OUTPUT

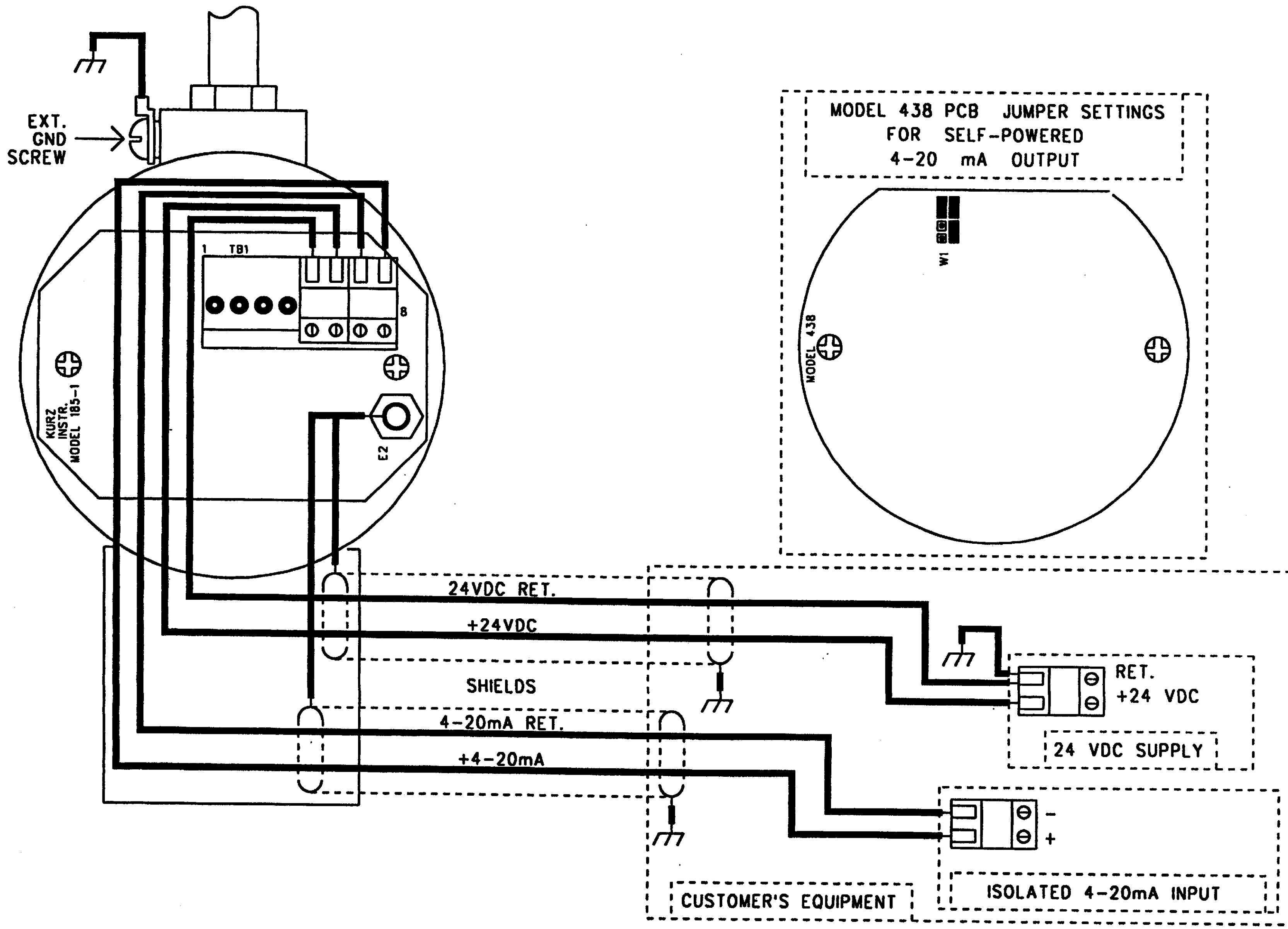


FIGURE 4 TYPICAL 4-WIRE HOOK-UP FOR 24 VDC POWERED MODEL 452FT WITH NON-ISOLATED SELF-POWERED 4-20mA OUTPUT

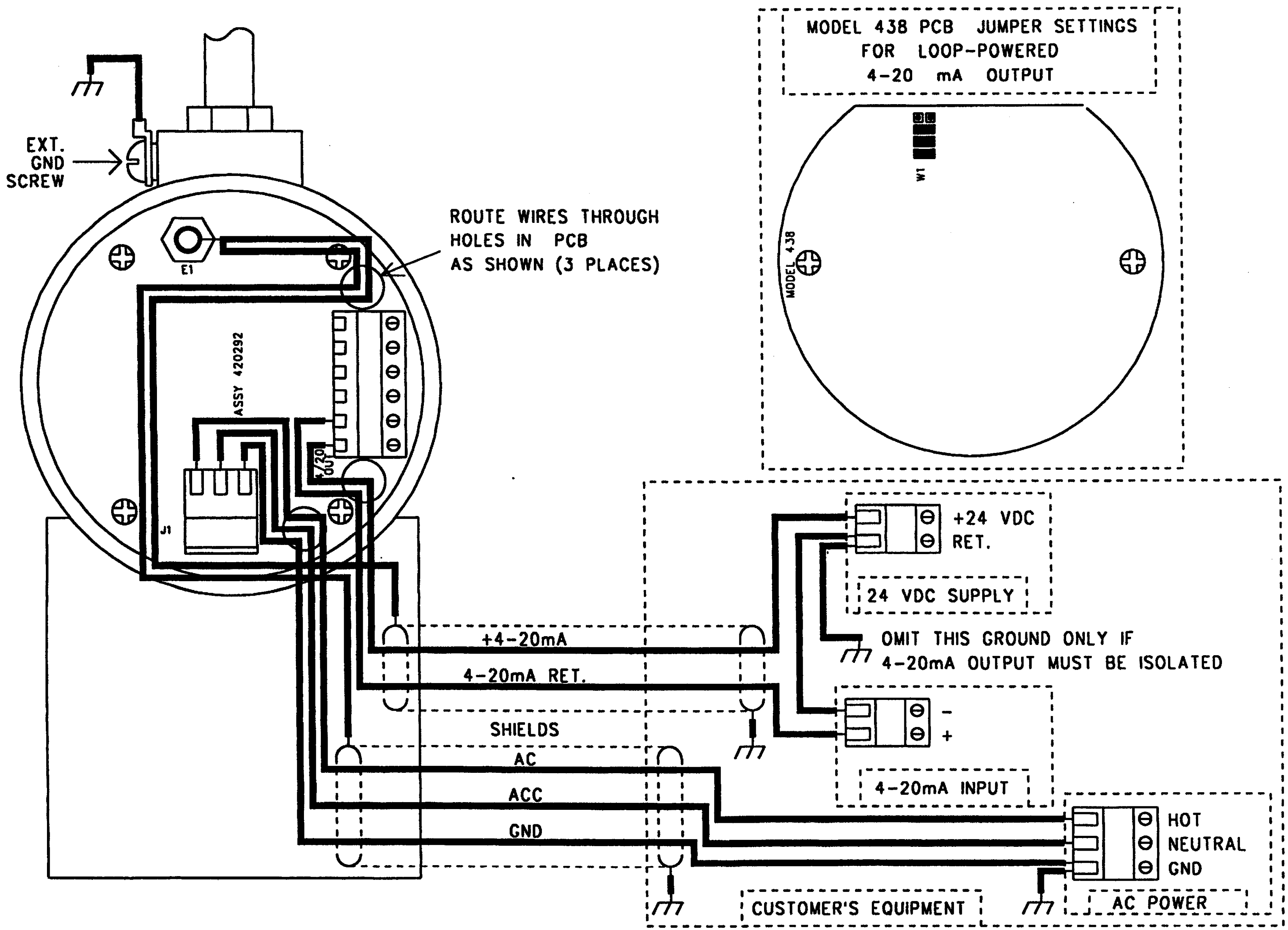


FIGURE 5 TYPICAL HOOK-UP FOR A.C. POWERED MODEL 452FT WITH LOOP-POWERED 4-20 mA OUTPUT

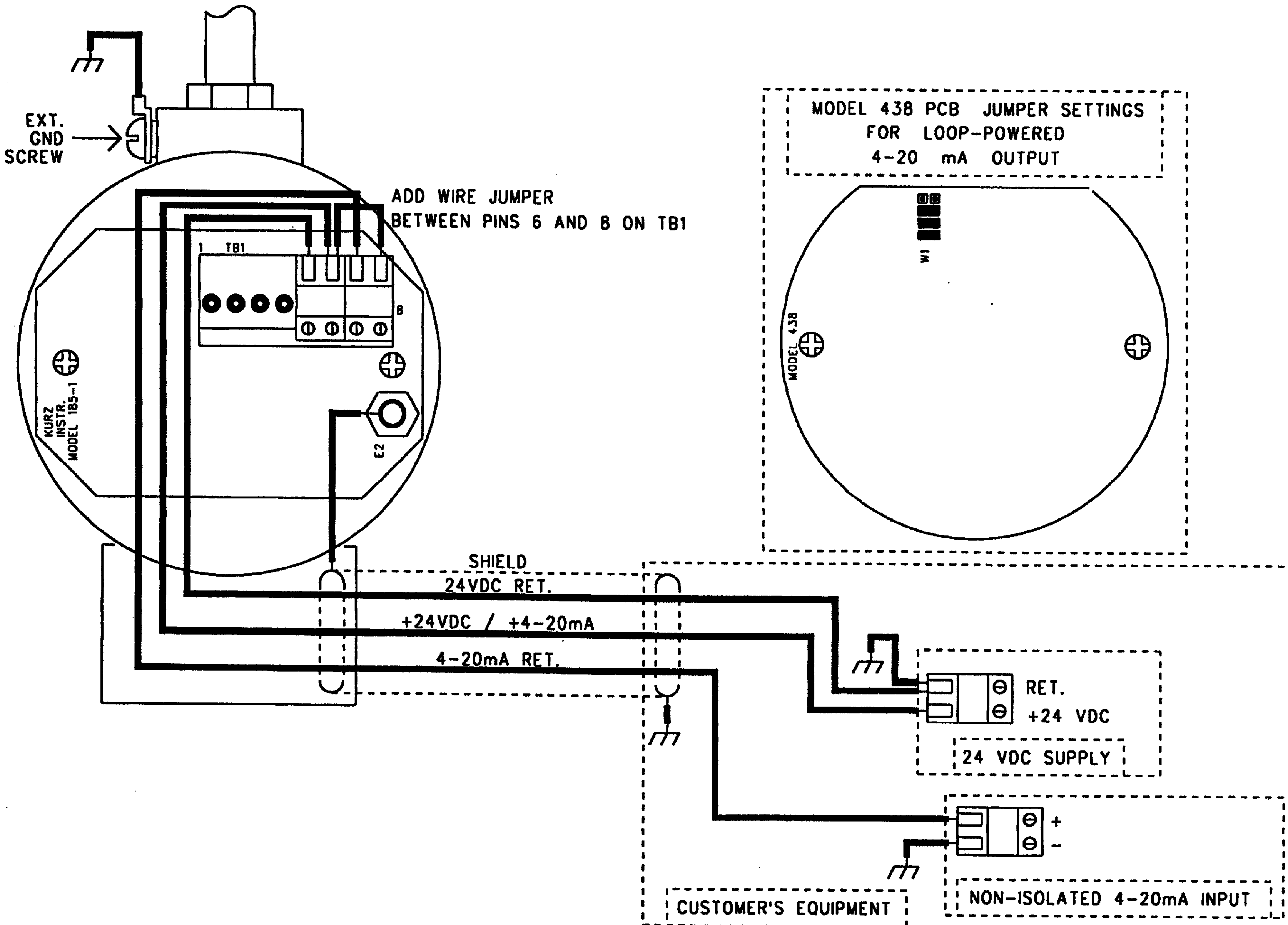


FIGURE 6 TYPICAL 3-WIRE HOOK-UP FOR 24 VDC POWERED MODEL 452FT WITH NON-ISOLATED LOOP-POWERED 4-20mA OUTPUT

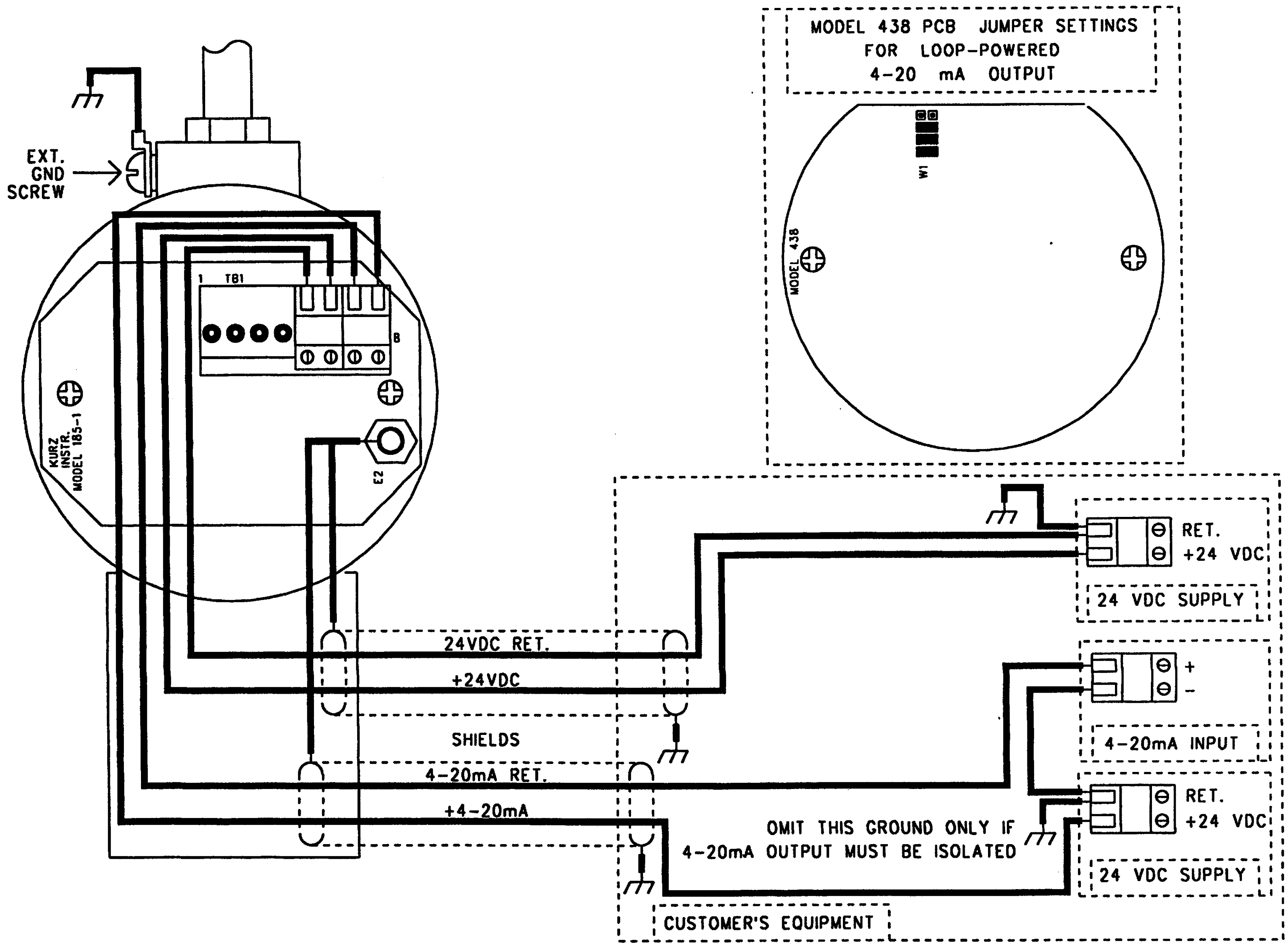


FIGURE 7 TYPICAL 4-WIRE HOOK-UP FOR 24 VDC POWERED MODEL 452FT WITH LOOP-POWERED 4-20mA OUTPUT

REV	DESCRIPTION	BY	CHKD	APPVD	DATE
A	RELEASED PER DRF #490043	ADK	GF	GF	6-21-96
B	REVISED PER ECO #B47398	ADK	BBB	BBB	4-8-97

NOTES: UNLESS OTHERWISE SPECIFIED

1. REFERENCE DESIGNATORS AND TERMINAL NO. ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON COMPONENTS.

2. KURZ SENSOR SERIAL NO. TO BE SCRIBED APPROX WHERE SHOWN.

3. FOUR CONDUCTOR WITH SHIELD (OR TWISTED CABLE WITH SHIELD) AND METAL CONDUIT BY CUSTOMER.

4.5Ω MAXIMUM PER WIRE (Cu)

AWG	MAX. LENGTH (FT)
28	69
24	175
20	443
16	1120

4. RIGID CONDUIT WITH EXPLOSION PROOF SEALS DIRECTLY TO EACH ENCLOSURE ARE REQUIRED TO MAINTAIN SAFETY AND CE RATING. ALTERNATELY, BRAIDED SHIELD CABLE WITH FLAMEPROOF (EEx D) BRAIDED SHIELD CABLE GLANDS AT EACH ENCLOSURE ARE REQUIRED TO MAINTAIN SAFETY AND CE RATING. MINIMUM CABLE LENGTH IS (1) METER TO MAINTAIN SAFETY RATING. 5-WIRE CABLE FOR FLOW ELEMENT MUST HAVE MATCHED RESISTANCE ON EACH WIRE SO THE SENSOR BRIDGE CIRCUIT CAN COMPENSATE FOR THE SENSOR LEAD RESISTANCE.

CONSTRAINTS:
MAXIMUM WIRE LENGTH FOR 1Ω PER WIRE

AWG	MAX. LENGTH (FT)
18	157
16	249
14	396
12	630

IE: $|WIRE(R_{ph}) - WIRE(R_{pl})| < 0.01\Omega$, ΔR 0.01Ω MAX.

5. SENSOR LEAD COLOR CHART

SENSOR WIRE DESCRIPTION	TFL/TFZ WIRE COLOR	TFL CABLE WIRE COLOR
Rp SENSE LEAD, Rp(S)	RED	WHITE/RED
Rp LOW SIDE, Rp(L)	RED	WHITE/GREEN
Rp HIGH SIDE, Rp(H)	YELLOW	WHITE/ORANGE
Rtc LOW SIDE, Rtc(L)	WHITE	WHITE
Rtc HIGH SIDE, Rtc(H)	WHITE	WHITE/BLUE
GROUND	N/A	BRAIDED SHIELD

6. 438 PCB JUMPERS AND TEST POINTS:

6.1 4 TO 20mA OUTPUT (TB1)

W1 LOOP POWERED CONFIG. (ISOLATED)
7V COMPLIANCE (800Ω MAX @ 24V LOAD)

W1 SELF POWERED CONFIG. (NON-ISOLATED)
500Ω MAX LOAD

6.2 VRB/CAL SELECT

W2 VRB OUTPUT TO ZERO/SPAN STAGE AND TP1

W2 CAL OUTPUT TO ZERO/SPAN STAGE AND TP1
CAL VOLTAGE ADJUSTED WITH R7 TO SIMULATE VRB
ADJUST R11 FOR ZERO AT TP2
ADJUST R13 FOR SPAN (5V) AT TP2

6.3 ENG OUT/CAL SELECT

W3 ENGINEERING UNITS OUT TO 4 TO 20mA CIRCUIT
ADJUST R51 FOR 4mA OUTPUT AT TB1
ADJUST R46 FOR 20mA OUTPUT AT TB1

W3 OPTIONAL CAL OUTPUT TO 4 TO 20mA CIRCUIT
ADJUST R51 FOR 4mA OUTPUT AT TB1
ADJUST R48 FOR 20mA OUTPUT AT TB1

6.4 TEST POINTS

TP1 VRB OR CAL VOLTAGE TEST POINT
TP2 0 TO 5V NON-LINEAR OUTPUT TEST POINT
TP3 0 TO 5V LINEAR OUTPUT TEST POINT
TP4 GROUND

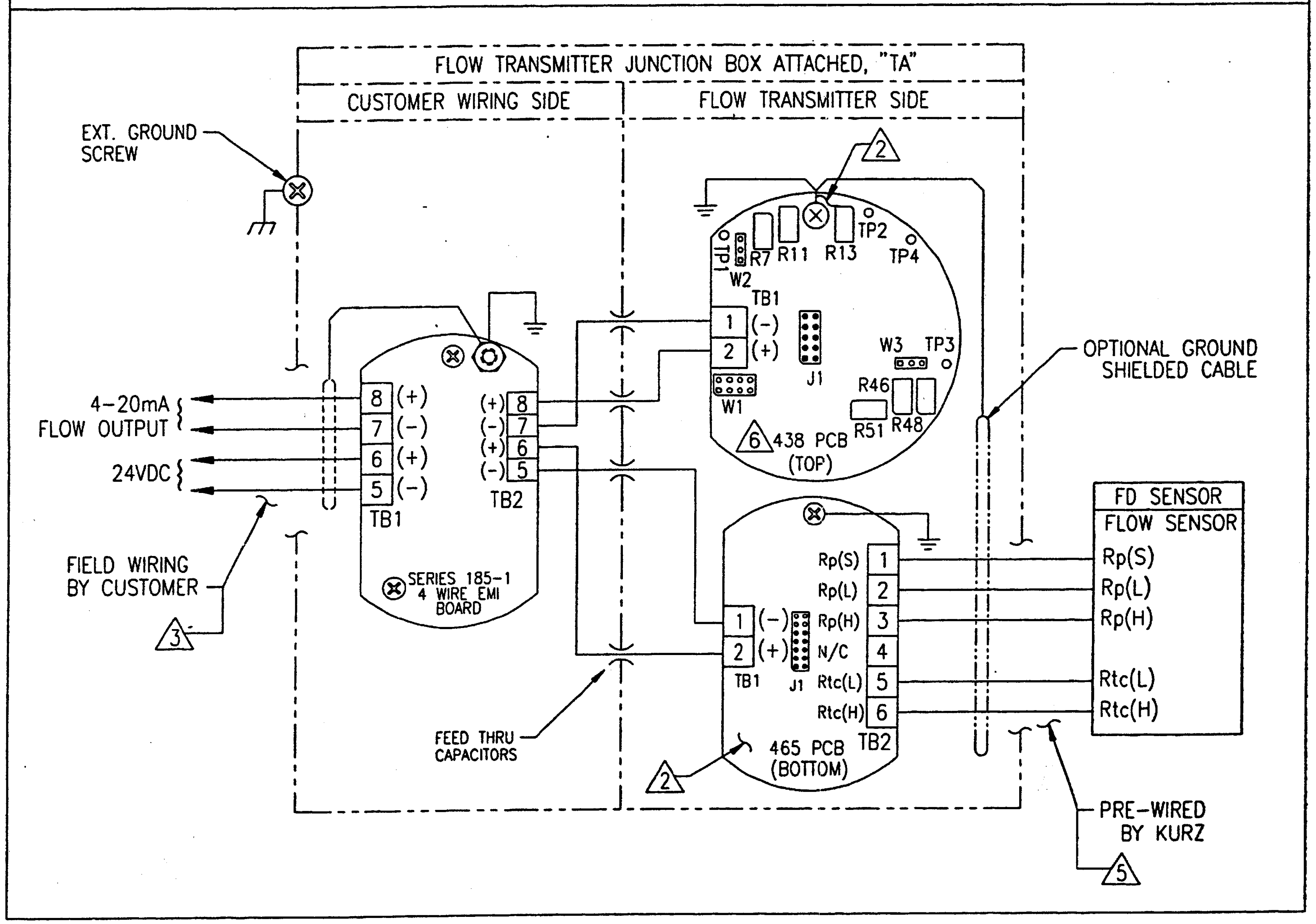
6.5 J1 SIGNALS FROM THE MODEL 465-R8

J1-1 V+ (+24V)
J1-2 V- (RETURN)
J1-3 VCC
J1-4 VCH
J1-5 GROUND
J1-6 RTCL
J1-7 BV
J1-8 VPH
J1-9 VLL
J1-10 VDD (-6V)

6.6 PCB INTERCONNECTION

438 (J1) INTO 465 (J1)

FLOW TRANSMITTER JUNCTION BOX ATTACHED, "TA"



SERIES 502FT	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ± 1/32; ANGLES ± 0°-30'; DECIMALS .X ± 0.1, .XX ± 0.01, .XXX ± 0.005, .XXXX ± 0.0010	APPROVALS: DRAWN BY A. KAMIMORI, DATE 4/23/96; CHECKED BY G. FOSTER, DATE 6-21-96; APPROVED G. FOSTER, DATE 6-21-96
SERIES 452FT	ORIG. RELEASE DATE	
NEXT ASSEMBLY		

KURZ INSTRUMENTS, INC.

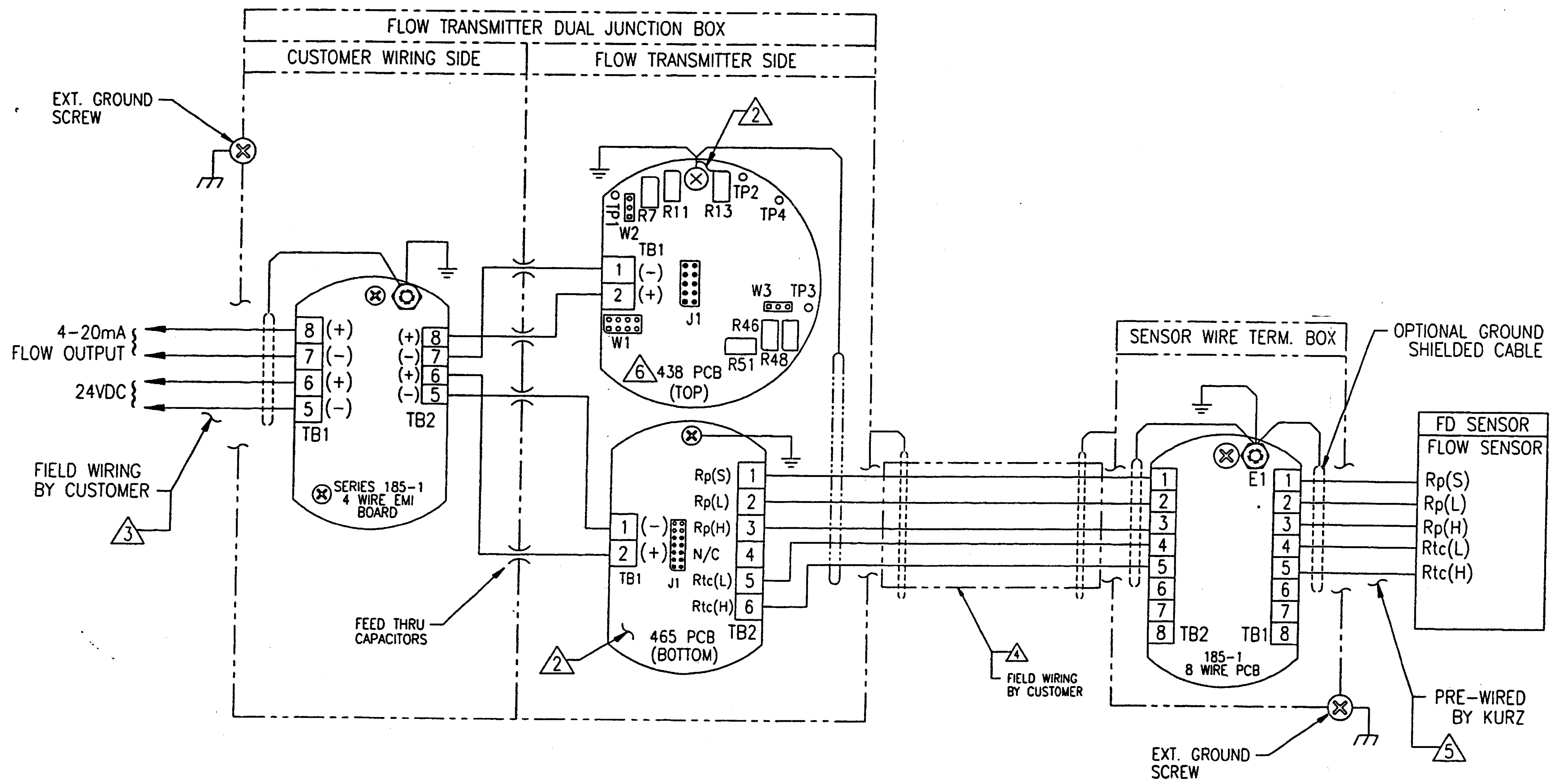
WIRING DIAGRAM, FIELD, SINGLE-POINT MASS FLOW TRANSMITTER, CE SERIES

DWG. SIZE D | DWG. NO. 342014 | REV. B | SCALE NONE | SHEET 1 OF 2

PLOT 1/1.25

NOTES: (SEE SHEET ONE)

FLOW TRANSMITTER JUNCTION BOX SEPARATE, "TS"



23

KURZ INSTRUMENTS, INC.		
WIRING DIAGRAM, FIELD, SINGLE-POINT MASS FLOW TRANSMITTER, CE SERIES		
DWG. SIZE D	DWG. NO. 342014	REV. B
SCALE NONE		SHEET 2 OF 2

PLOT 1/1.25

REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	RELEASE PER ECO #B47358	ADK	GF	GF	7-23-96
B	REVISED PER ECO #B47398	ADK	BBB	BBB	4-8-97
C	REVISED PER ECO #B47413	ADK			4-18-97

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1. REFERENCE DESIGNATORS AND TERMINAL NO. ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON COMPONENTS.

2. KURZ SENSOR SERIAL NO. TO BE SCRIBED APPROX WHERE SHOWN.

3. FIELD WIRING BY CUSTOMER. ALL HOOK-UP WIRES MUST BE ROUTED THRU THE WIRE FEED THRU HOLES PROVIDED ON AC PWR SUPPLY PCB, NEAR EACH TERMINAL BLOCK.

4. RIGID CONDUIT WITH EXPLOSION PROOF SEALS DIRECTLY TO EACH ENCLOSURE ARE REQUIRED TO MAINTAIN SAFETY AND CE RATING. ALTERNATELY, BRAIDED SHIELD CABLE WITH FLAMEPROOF (EEx D) BRAIDED SHIELD CABLE GLANDS AT EACH ENCLOSURE ARE REQUIRED TO MAINTAIN SAFETY AND CE RATING. MINIMUM CABLE LENGTH IS (1) METER TO MAINTAIN SAFETY RATING. 5-WIRE CABLE FOR FLOW ELEMENT MUST HAVE MATCHED RESISTANCE ON EACH WIRE SO THE SENSOR BRIDGE CIRCUIT CAN COMPENSATE FOR THE SENSOR LEAD RESISTANCE.

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AWG	MAX. LENGTH (FT)
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IE: $|WIRE(Rph) - WIRE(Rpl)| < 0.01\Omega$, ΔR 0.01Ω MAX.

5. SENSOR LEAD COLOR CHART

SENSOR WIRE DESCRIPTION	TFL/TFZ WIRE COLOR	TFL CABLE WIRE COLOR
Rp SENSE LEAD, Rp(S)	RED	WHITE/RED
Rp LOW SIDE, Rp(L)	RED	WHITE/GREEN
Rp HIGH SIDE, Rp(H)	YELLOW	WHITE/ORANGE
Rtc LOW SIDE, Rtc(L)	WHITE	WHITE
Rtc HIGH SIDE, Rtc(H)	WHITE	WHITE/BLUE
GROUND	N/A	BRAIDED SHIELD

6. 438 PCB JUMPERS AND TEST POINTS:

6.1 4 TO 20mA OUTPUT (TB1)
- W1 LOOP POWERED CONFIG. (ISOLATED) 7V COMPLIANCE (800Ω MAX @ 24V LOAD)
- W1 SELF POWERED CONFIG. (NON-ISOLATED) 500Ω MAX LOAD

6.2 VRB/CAL SELECT
- W2 VRB OUTPUT TO ZERO/SPAN STAGE AND TP1
- W2 CAL OUTPUT TO ZERO/SPAN STAGE AND TP1
  CAL VOLTAGE ADJUSTED WITH R7 TO SIMULATE VRB
  ADJUST R11 FOR ZERO AT TP2
  ADJUST R13 FOR SPAN (5V) AT TP2

6.3 ENG OUT/CAL SELECT
- W3 ENGINEERING UNITS OUT TO 4 TO 20mA CIRCUIT
  ADJUST R51 FOR 4mA OUTPUT AT TB1
  ADJUST R46 FOR 20mA OUTPUT AT TB1
- W3 OPTIONAL CAL OUTPUT TO 4 TO 20mA CIRCUIT
  ADJUST R51 FOR 4mA OUTPUT AT TB1
  ADJUST R48 FOR 20mA OUTPUT AT TB1

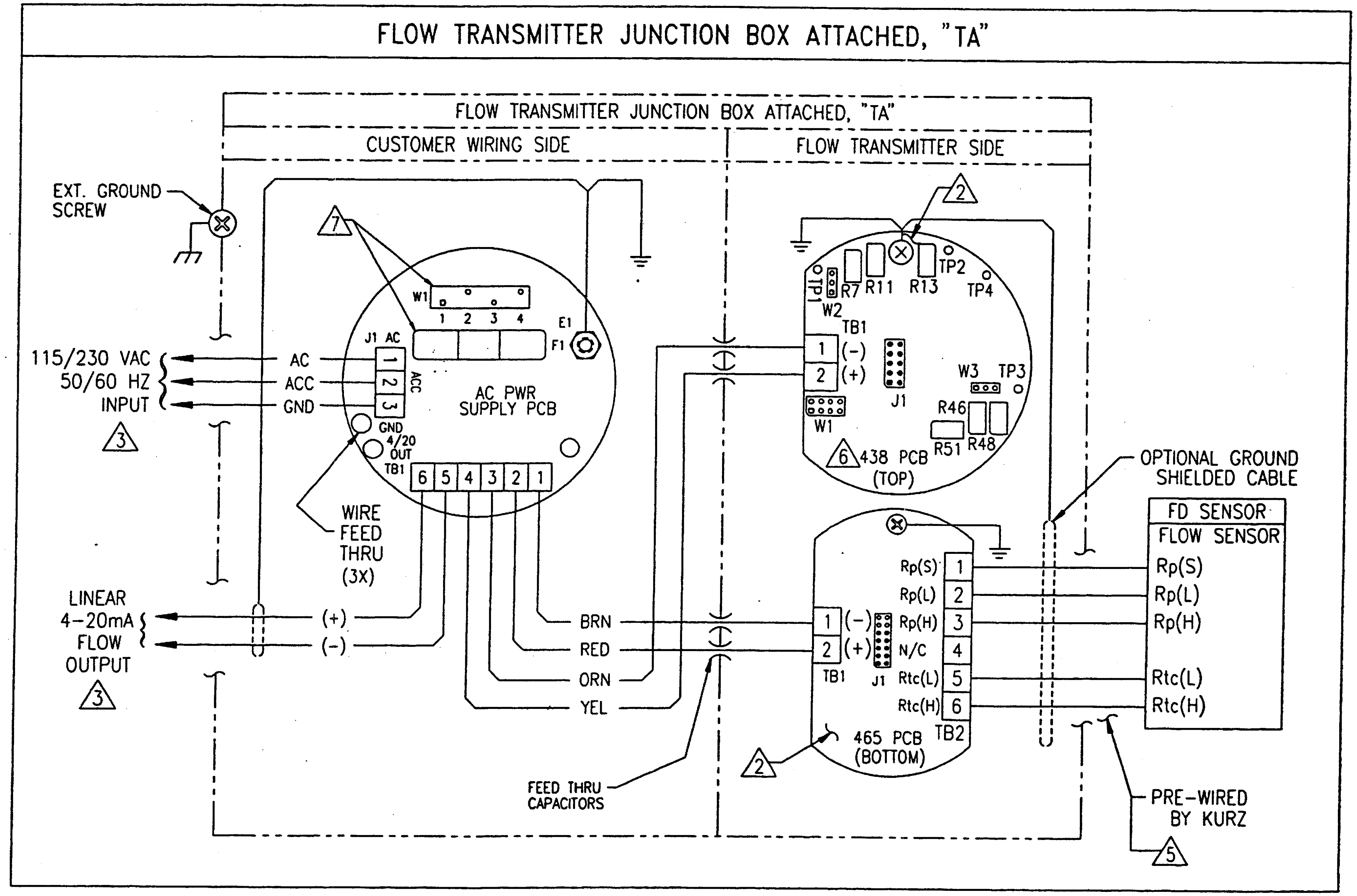
6.4 TEST POINTS
- TP1 VRB OR CAL VOLTAGE TEST POINT
- TP2 0 TO 5V NON-LINEAR OUTPUT TEST POINT
- TP3 0 TO 5V LINEAR OUTPUT TEST POINT
- TP4 GROUND

6.5 J1 SIGNALS FROM THE MODEL 465-R8

J1-1	V+ (+24V)	J1-6	RTCL
J1-2	V- (RETURN)	J1-7	BV
J1-3	VCC	J1-8	VPH
J1-4	VCH	J1-9	VLL
J1-5	GROUND	J1-10	VDD (-6V)

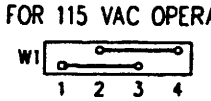
6.6 PCB INTERCONNECTION
438 (J1) INTO 465 (J1)

FLOW TRANSMITTER JUNCTION BOX ATTACHED, "TA"



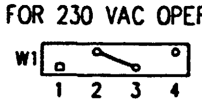
7. AC PWR SUPPLY PCB JUMPER/FUSE SET-UP:

7.1 FOR 115 VAC OPERATION.



F1 = 0.3 AMP 3AG SLO-BLO FUSE.

7.2 FOR 230 VAC OPERATION.



F1 = 0.15 AMP 3AG SLO-BLO FUSE.

24

SERIES 502FT (AC PWR)	
SERIES 452FT (AC PWR)	
NEXT ASSEMBLY	

APPROVALS: DRAWN BY A. KAMIMORI, DATE 7/18/96; CHECKED BY G. FOSTER, DATE 7-23-96; APPROVED G. FOSTER, DATE 7-23-96

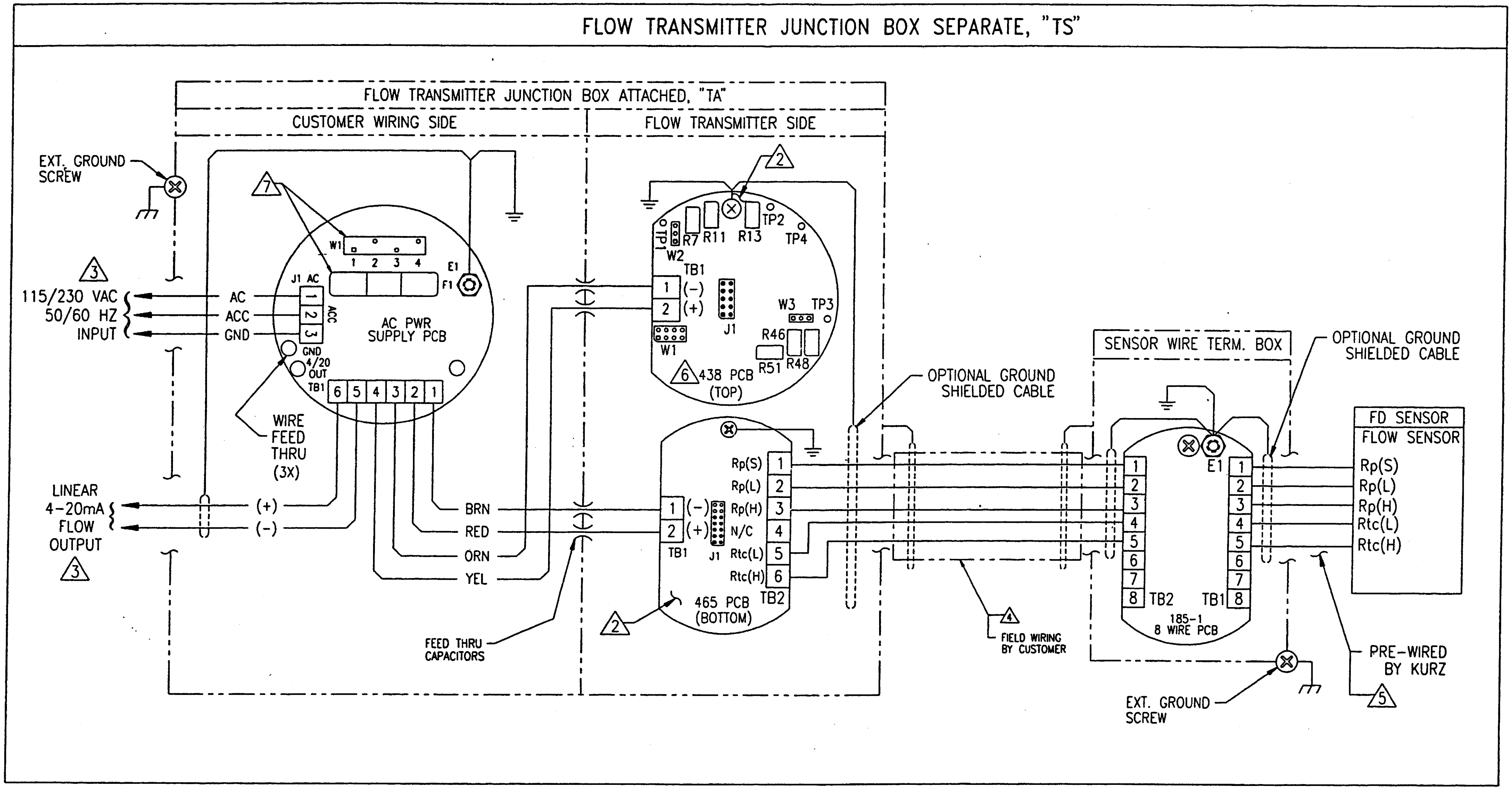
KURZ INSTRUMENTS, INC.

WIRING DIAGRAM, 465/438/AC PWR, MASS FLOW TRANSMITTER, CE SERIES

DWG SIZE D | DWG NO. 342016 | REV. C | SCALE NONE | SHEET 1 OF 2

PLOT 1/1.25 1

NOTES: (SEE SHEET ONE)



KURZ INSTRUMENTS, INC.	
WIRING DIAGRAM, 465/438/AC PWR, MASS FLOW TRANSMITTER, CE SERIES	
DWG. SIZE D	DWG. NO. 342016 REV. C
SCALE NONE	SHEET 2 OF 2

PLOT 1/1.25

Insertion Flow Transmitter Calibration

Factory Calibration Method

Two methods of velocity calibration are used depending on the gas type to be calibrated. For air calibrations and gas correlations a transfer standard is used where the unit under calibration and the standard are in the same plane perpendicular to the flow. The wind tunnel has a relatively flat velocity profile and locating them in the same sensing plane automatically accounts for sensor blockage. For other gases, a special ducted section on a mass flow calibration system is used. Here the sensor blockage and effective area of the calibration section are used to convert the mass flow to mass flow per unit area or Standard Velocity. These mass flow calibrations are generally performed at room temperature and pressure but can be performed at elevated pressures to account for pressure dependent viscosity induced errors. Figures 8 and 9 show a typical calibration data sheet and graph of the sensor response versus standard velocity.

The nonlinear nature of the sensor output is shown in Figure 9. The linearizer converts this signal to a linearly proportional one. This conversion is a factory operation whose tracking accuracy is documented on a data sheet as shown in Figure 10.

User Zero and Span Calibration

The 452FT can be field adjusted for its Zero and Span Calibration. There are two linear output calibration scales in this unit selected by jumper W3. The first is the factory adjusted Standard Velocity scale which uses R51 for the Zero adjust and R48 for the Span adjustment. The user will typically set W3 for the engineering units output (standard volumetric or mass flow type units) where the same Zero adjustment is use but the Span is set with R46.

The nonlinear zero and span adjustments (R11 and R13) should not be used unless instructed by Kurz Customer Service personnel or you have knowledge of this type of linearizer and its adjustment.

If Field Calibration data are available on the process, the Zero and Span adjustments can be simply set to those numbers. Many of the issues for obtaining accurate flow or mass rate readings from an insertion unit are covered in Appendix A. Another method of field calibration using the factory calibrated standard velocity signal can be used to help establish the volumetric or mass flow calibration.

The sequence goes as follows:

1. Set W3 to the "optional" output position.
2. Use the provided data sheet (see figure 8) to convert the 4-20 mA signal to standard velocity.
3. Knowing the velocity profile, establishes the correction factor (CF) between the sensor's velocity (SFPM) and duct average velocity near the nominal operating point.
4. Next compute the standard volumetric flow rate (SCFM) using the sensor and probe support blockage and duct area.
   SCFM = (SFPM * CF) / (Area - Blockage)
5. Use this SCFM value to scale the engineering output to read the desired 4-20 mA current scale (for example, 5,000 SCFM = 20 mA)

Kurz Instruments offers insitu flow calibrations which account for all the profile issues etc. Both flow profile traversing and tracer gas calibrations are available through the customer service department.

CALIBRATION DATA AND CERTIFICATION DOCUMENT

KURZ INSTRUMENTS, INC.
2411 GARDEN ROAD
MONTEREY, CALIFORNIA. 93940
1-(800)-424-7356 (408)-646-5911 FAX (408)-646-8901

Kurz Model 400D Wind Tunnel Calibration System

FLOW ELEMENT CALIBRATION REFERENCE
Model no: 450-08-AT-12, Serial no: DLI7384F
NIST Calibration Due Date: 11-30-1996

DATA ACQUISITION SYSTEM
Model no: LSDAS-16
Serial no: 9513-0017

---> Sensor Calibration Data <---

Serial no/Filename : FD9999A/FD9999A.WTC
Date : 11/1/96
Customer Code/Name : 999999/XYZ_CO.
Purchase Order No : _
Model No : 452FT-08-12
PART No : 452FT-08-12
MAPICS Item NO :
Flow Units : SFPM
Reference Fluid : AIR
Standard Conditions : 77 °F and 29.92 inHg.

Point No.	Velocity SFPM	Velocity SMPS	CSV VDC
1	0.0	0.000	0.789
2	306.2	1.555	1.275
3	603.6	3.066	1.415
4	1039.7	5.281	1.548
5	2062.5	10.477	1.737
6	3061.4	15.551	1.862
7	4037.8	20.511	1.955
8	6015.8	30.559	2.096
9	9033.8	45.889	2.265

This instrument was calibrated with NIST traceable equipment having a rated total system uncertainty of ±1.03% at 12000 SFPM, ±1.17% at 6000 SFPM, ±.85% at 1000 SFPM and ±1.37% at 100 SFPM. Refer to Kurz 400D Calibration System Error Analysis, Kurz Doc. No. 28019, for details. This calibration is traceable to National Institute of Standards and Technology Test No.836/256043-95 Purchase Order No. P16641 and meets the requirements of ISO 10012-1 and ANSI/NCSL Z540-1. This calibration was performed per Kurz Doc. No. 760017.

WIND TUNNEL OPERATOR: John Doe DATE : 11-1-96

QUALITY CONTROL: Jane Doe DATE : 11-12-96

Form Number 180117 REV. C Sheet 1 of 1

Figure 8 Typical input calibration sheet

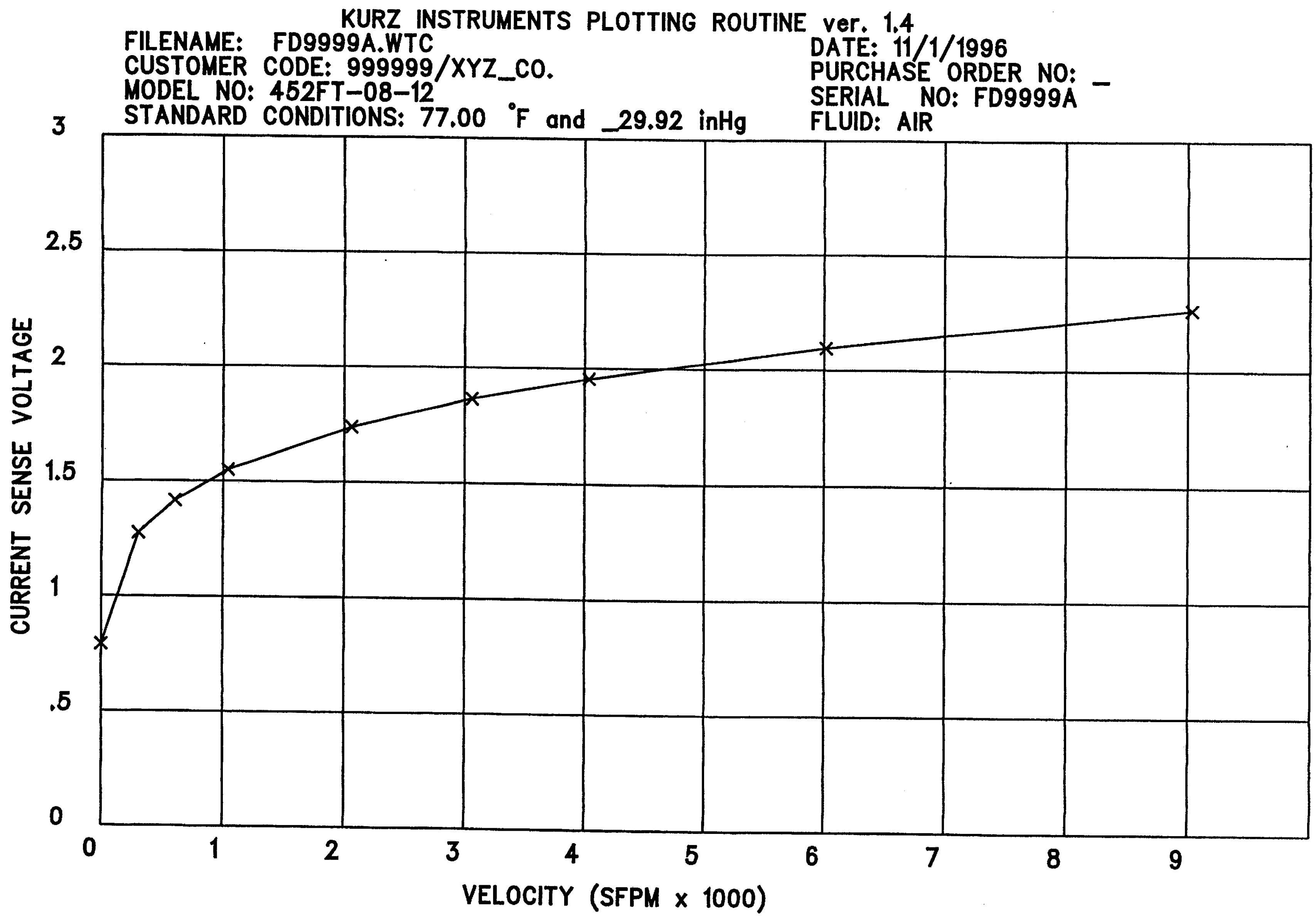


FIGURE 9 TYPICAL CALIBRATION CURVE

CALIBRATION DATA AND CERTIFICATION DOCUMENT
KURZ INSTRUMENTS INC.
2411 GARDEN RD.
MONTEREY, CA. 93940
1-800-424-7356 408-646-5911 FAX 408-646-8901

CUSTOMER CODE	:	_999999
CUSTOMER NAME	:	_XYZ_CO.
P.O. NUMBER	:	__
MAPICS ITEM NO	:	_
MODEL NO	:	_452FT-08-12
PART NO	:	_452FT-08-12
SERIAL NO/FILENAME	:	_FD9999A/FD9999A.WTC
STD. CONDITIONS	:	_77.00 °F and_29.92 inHg
CALIBRATED FLOW RANGE	:	0 - 9033.775 _SFPM
4 - 20 mA SCALE	:	0 - 9000.0000 _SFPM

PT NO.	FLOW	4-20mA SCALE	ACTUAL_Iout
1	0.0000	0.0000	4.000
2	306.1900	306.1900	4.652
3	603.6120	603.6120	5.068
4	1039.7010	1039.7010	5.894
5	2062.5071	2062.5071	7.735
6	3061.3999	3061.3999	9.497
7	4037.7590	4057.7590	11.318
8	6015.7500	6015.7500	14.407
	9000.0000	9000.0000	20.000
9	9033.7754	9033.7754	

NIST Traceable Calibration Instruments

FLOW REF. S/N:	BLJ 7384 J	CAL. DUE DATE:	11-30-06
DVM S/N :	2017	CAL. DUE DATE:	7-2-97
THERMO S/N :	181027	CAL. DUE DATE:	4-3-97
BAROMETER S/N:	7135900Y2081	CAL. DUE DATE:	12-8-96

Technician: John Doe Date: 11-4-96

Quality Control: Jane Doe Date: 11-12-96

Sheet 1 of 1

Figure 10 Typical output calibration sheet

Maintenance and Troubleshooting

Maintenance

The thermal anemometer has no moving parts so there is not too much to the maintenance except cleaning and inspection for corrosion and environmental damage. When an application is first started or changes the sensor should be inspected for dirt build up and a cleaning schedule established as required. There are two approaches to sensor dirt which is used will depend on the type of dirt.

For dry powdered dirt, the sensor will reach a steady state dust load and should be field calibrated with this level of dirt on the sensor. For sticky dirt that just builds up over time, periodic cleaning is needed for the best results. Calibration strategies vary depending on the cleaning schedule of the sensor(is the sensor clean, have a typical dirt load, or maximum dirt load just prior to cleaning). This establishes the bounds on the calibration errors and/or provides the data to compensate for the dirt over time. The addition of most dirt to a thermal anemometer is to reduce the reading for the same flow rate. The best way to know the impact of the dirt is to check the calibration against some known reference (second unit or method). Despite the above, it is the tolerance for dirt, in contrast to turbines or pitot tubes is one of the significant reasons the thermal anemometer is a great industrial product.

When cleaning, a stiff hair brush with soap is recommended to clean the sensor. More aggressive cleaners are used at your own risk. Be careful not to bend the sensor elements as this can change the calibration or damage the unit. Corrosion of the sensor probe or probe support will eventually cause contamination to get into the sensor or electronics and the unit will fail shortly thereafter.

Flow issues

The most common problem with an insertion flow element is that it measures the point mass rate at the sensor, not the duct average. Ignoring this issue can cause a 40% error at low flow that diminishes at higher flow rates. Unless you have invested the time in field calibrations, only relative measurements can be made. Accuracy requires field calibration. To avoid this field calibration issue, the Kurz 502FT line will provide an accurate "out of the box" calibration. You must follow the guide lines to avoid flow disruptions from being too close to the element.

For either in line or insertion flow transmitters, locating a sensor close to a valve (up or down stream) will give different readings (up to 20% for in line and much more for insertion) depending on the position of the valve even at the same average flow rate. Uninsulated pipe/duct can have a temperature profile which will make the sensor reading too high or low depending on the sensor location and the duct's radial temperature gradient. A unit inserted with the velocity element in the center or on the insertion side of center will read lower for ducts with a hot core and colder walls than the same duct with no thermal gradient. Conversely, It will read high if the duct core is cold and the walls hot. A unit inserted beyond center or the far side of the duct will have the opposite drift from that described above for the same thermal gradient.

Sensor Element

There are 5 sensor wires for the two RTDs. The two white leads connect to a 300 Ω ± 1% @ 0 °C platinum element. The two red leads connect to one side of a 9 Ω ± 3%@ 0 °C element whose other side is the yellow lead. The two red leads should measure below 2 Ω measured between them including any extra wire from a transmitter separate configuration.

Sensor leakage resistance between elements or to ground should be 1 MΩ or higher as measured with a 10 V or larger test voltage. Do not use a standard DVM because its ohm meter test voltage is too low to work with the electrochemical cell voltage from contamination. We typically use the 24 VDC supply applied between the elements (one white lead to the yellow) an make sure the leakage current is less than 24 μA. Next we check the white to sensor case then the yellow to sensor case to ensure its leakage is less than 24 μA. The leakage and resistance test should be made at normal process operation temperatures.

Linearizer and Bridge Electronics

Both the linearizer and bridge board are conformal coated so measurements will require scraping or punching through the insulation which should be easy since we use silicon rubber. Verify the positive and negative power supplies on the linearizer using test point 4 for the volt meter reference. Using a resistor lead or small solid wire as a probe, measure at the test/interface connector J1-1 for the +24 VDC signal (lower if you do not have a 24 VDC supply) then J1-10 for the - 6 VDC +/- 1 V.
The sensor output can be measured on TP 1 which is typically 0.8 V at zero flow. This signal should go up and down proportionally with flow. If this looks normal, then the sensor, bridge and some of the front end of the linearizer are working properly.
When shunt W2 is in the top position, the signal at TP2 and TP3 should be near 0 V at zero flow and will be 5 V at the full scale velocity value for this unit. The nonlinear signal is at TP2 and linearized at TP3.

TABLE 2

TROUBLESHOOTING CHART

Symptom	Possible Reasons
No 4-20 mA signal	Loss of power Reversed polarity on power or 4-20 mA leads Jumpers on linearizer incorrectly set Self powered 4-20 mA units may have no power from the user's supply. Linearizer not plugged into bridge correctly Linearizer Board Defective
Output Signal "motor boating"	Sensor has too much leakage current, corrosion or water damage Defective Bridge Board

4-20 mA does not change with flow	Jumpers on linearizer not set to operate mode. Defective Sensor, Bridge or Linearizer Is sensor cover removed?
Unit does not read zero at zero flow	The gas type or pressure may be different than when calibrated. Defective Linearizer, Bridge or Sensor.
Unit saturates before reaching full scale.	Unit calibrated for a lower flow rate at the factory Unit calibrated for the wrong gas. Defective bridge board or linearizer.
Calibration is too low.	Is the sensor orientated to the flow correctly? Was the unit calibrated for the gas type in use Has the unit been set up for the ducts velocity profile? (See appendices A & C) Is there a temperature profile near the sensor? (e.g. hot duct center, cold outside) Dirt will generally cause the reading to fall off from proper calibration.

Calibration is too high.	Have sensor blockage & flow profile effects been accounted for? This is a significant factor in ducts measuring less than $1ft^2$. Is the sensor orientated to the flow correctly? Was the unit calibrated for the gas type in use? Is there a temperature profile near the sensor? (e.g. hot duct center, cold outside) Is there condensation on the sensor? Is there pulsating flow noise ? (e.g. from a pump inlet or exhaust)
Calibration does not track with temperature.	Unit measures (density x velocity) or mass rate per unit area. (See appendices A & C for info on converting to actual velocity). Is there a temperature profile near the sensor? (e.g. hot duct center, cold outside) If you think it still is not tracking it may be a defective sensor or bridge board.
4-20mA output is "noisy".	Missing ground. (See Figures 2-7). Poor electrical contact. Make sure all electrical connections are clean and tight.

"Cross talk" between Isolated 4-20mA outputs.	"Isolated" 4-20mA outputs may be tied to unnecessary grounds or the 438 PCBs are jumpered in the self powered instead of the loop powered 4-20mA output configuration causing them to be nonisolated. (See Figures 5 and 7).

Return Shipment

RMA # (Return Material Authorization #)

If you believe your unit is not working properly, contact the Kurz Customer Service Department at phone # (408) 646-5911. Please have the following information ready to give to the Kurz Customer Service Representative :

Defective unit's model # and serial #

Detailed description of application and type of environment unit is being used in

Detailed description of perceived problem

Type of gas, Flow range, and standard conditions unit is to be recalibrated at

Any special QA requirements (nuclear or military application, oxygen service, special calibration or certification etc).

Technical contact's name and phone #

Billing contact's name and phone #

Complete shipping address

Complete billing address

You will then be issued an RMA #. **Kurz personnel will refuse to accept return material shipments if an RMA # is not visible on the outside surface of the shipping container.**

Cleaning of Material to be Returned

Thoroughly clean all material to be returned to Kurz. Because we serve a diverse customer base, there is a risk of receiving contaminated returned material from our customers. **When uncleaned material is received at Kurz, the customer will be contacted to arrange at their expense for the material to be picked up from Kurz and cleaned before Kurz personnel handle the equipment.**

Shipping Material to be Returned

Securely package cleaned material **(When uncleaned material is received at Kurz, the customer will be contacted to arrange at their expense for the material to be picked up from Kurz and cleaned before Kurz personnel handle the equipment)** along with a packing slip referencing the RMA #, model # and serial # in a sturdy container with the return address and RMA # clearly marked on the outside surface of the container. **Kurz personnel will refuse to accept return material shipments if an RMA # is not visible on the outside surface of the shipping container.**

Ship pre-paid to the following address:

KURZ INSTRUMENTS INC
CUSTOMER SERVICE DEPT
2411 GARDEN RD
MONTEREY CA 93940-5394
USA

Appendix A

Thermal Anemometer Measurements

The KURZ thermal anemometers use two RTDS, one heated 50 to 100 °C above the ambient, the other monitors the ambient. The current required to keep the velocity element heated is the parameter calibrated in our wind tunnels.

Mass Rate

What does a thermal flow sensor measure? Because of the equations of forced convective heat transfer, the output of any thermal anemometer is proportional to the sensor's Reynolds number (Re). Looking at the Reynolds number we can see how it measures **mass rate** per unit area, NOT volumetric flow rate. Therefore, the thermal anemometer automatically compensates for density.

Because a thermal anemometer measures the unit-area mass flow, it can be said to measure **mass rate.** In other words, it measures the true velocity, weighted by the **density** of the flowing gas. If the mass rate is normalized by a known density, it has velocity units, a term know as **standard velocity**. The next section helps explain where these ideas come from.

Mass Flow Equations

Reynolds Number

Lets look at the Reynolds number since it is proportional to the sensor's power or current when heated X degrees above the ambient:

$$Re = \rho\frac{vd}{\mu}$$

where

ρ = actual density
v= actual velocity
d = sensor's diameter
μ = gas viscosity

It is the density and velocity (ρv) product that makes the thermal anemometer a mass flow meter. Density (ρ) has units of mass/volume and velocity (v) has units of length/time. So the ρv product has units of (mass/time)/area or mass rate per unit area.

For example:

ρ is kg/m^3, v is m/s

so ρv is (kg/s)/m^2

The sensor is sensitive to the energy that the gas molecules hitting it take away in the form of heat. This energy is proportional to the size and number of molecules that hit the sensor. It does not know about density and velocity. Small light gas molecules like hydrogen (H_2) having a large surface area to mass ratio, are more efficient at transferring the vibrational heat energy of the sensor surface than large heavy molecules like Argon (Ar) having a small surface area to mass ratio.

Standard Velocity is the ρv product normalized to a standard density

Standard Velocity = $\rho v/\rho_s$

where ρ_s is the standard gas density. For air this is 0.07387 lb/ft^3 at 25 °C and 29.92 in Hg.

Note the density units cancel and you are left with velocity (m/s). Typical units are: Standard Feet Per Minute (SFPM) or Standard Meters Per Second (SMPS). If the gas density doubled (you went from 15 PSIA to 30 PSIA) at the same actual velocity, the standard velocity would double. This also means that if the process gas is at the same temperature and pressure as the standard condition or the same density, the standard velocity and actual velocity are identical.

Standard Volumetric Flow is the ρv product multiplied by an area (like a pipe cross section), normalized to a standard density

Standard Volumetric Flow $= \text{Area x (Standard Velocity)}$
$= A\rho v/\rho_s$

where A is the area

The units here are volume/time (m^3/s)
Typical Displayed units are:
SCFM, Standard Cubic Feet per Minute
SCMM, Standard Cubic Meters per Minute
SCFH, Standard Cubic Feet per Hour
SCMH, Standard Cubic Meters per Hour

Mass Flow is obtained by simply multiplying the Standard Volumetric Flow by the Standard Density.

MASS Flow $= \text{(Standard Volumetric Flow) x } \rho_s$
$=A\rho v$

The units here are mass/time (kg/s)
Typical units are:
PPH, Pounds per Hour
KGH, Kilograms per Hour

Different gases have different standard densities. This is often described as a reference density (air) multiplied by a specific gravity (sg).

$$\rho_s=\rho_{air}sg$$

Then

Mass Flow $= \text{(Standard Volumetric Flow) x } \rho_{air}sg$
$= A(v\rho/\rho_s)\ \rho_{air}sg$

Conversion of Standard Velocity or Standard Volumetric Flow to actual requires only scaling the result for the gas density according to the ideal gas law.

$$V_a = V_s\,(P_s/P_a)(T_a/T_s)$$

or

$$F_a = F_s\,(P_s/P_a)(T_a/T_s)$$

where V_a is actual velocity, V_s is standard velocity
F_a is actual volumetric flow, F_s is standard volumetric flow
P_s is the standard pressure in absolute units
P_a is the actual pressure in absolute units
T_a is the actual temperature in absolute units (Kelvin or Rankin)
T_s is the standard temperature in absolute units (Kelvin or Rankin)
Note °K = °C + 273.16, °R = °F + 459.67

Gas Property Induced Errors

There are secondary effects which cause mistracking of the idea thermal anemometer.

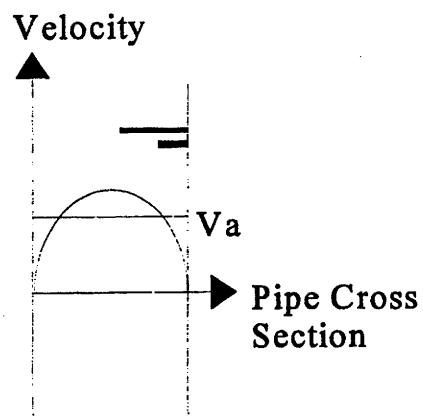
- **Pressure changes** will affect the calibration for some gasses. For example, N_2 has a large 2.5% /100 psi shift in its viscosity which changes its mass flow reading the same amount. Buy contrast He has nearly no viscosity change with pressure.

- **Temperature changes** will affect the gas thermal conductivity and viscosity so the calibration will drift. This is typically 2.5% /100 °C. The minimum drift occurs near 3000 SFPM where the dynamic temperature compensation is performed.

- **Temperature profiles** in the pipe will produce flow errors. This is caused by using uninsulated pipe upstream of the sensor where the gas is above or below the ambient temperature.

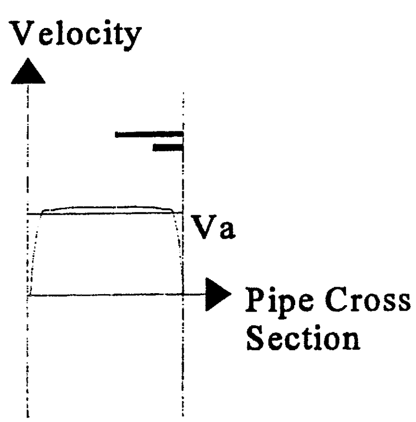
- **Low flow free convective** heat transfer forces compete with forced convective and conductive heat transfer forces for power. This causes measurable errors (depending on gas type, temperature, pressure, and orientation of sensor to both flow and gravity) starting at about 300 SFPM and becomes significant down at about 100 SFPM.

Flow Profiles And Correction Factors.



Low Velocity (Reynolds Number) Laminar Profile

At low velocity, a laminar velocity profile develops across the pipe cross section as shown in the figure. Note that the peak velocity is about 30% higher than the velocity average (Va).



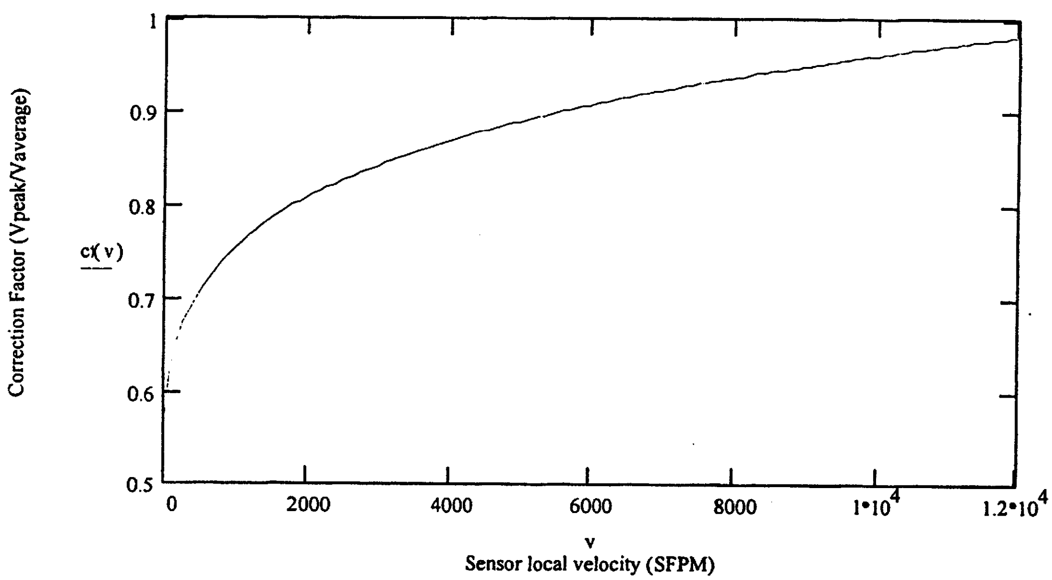
High Velocity (Reynolds Number) Turbulent Profile

At higher flow rates, a flatter velocity profile develops where the peak velocity is closer to the average. So depending on where the sensor is located, it will read a different fraction of the average velocity. It is the average velocity multiplied by the cross sectional area that will obtain the total flow.

Correction Factors

The use of a velocity dependent correction factor can convert the local velocity measurement to average velocity.

$$Flow = V_{local} * Area * CF(V_{local})$$



The above correction factor curve was measured from a 4" ID pipe with a ½" welded support, triple sting CD sensor. For other sized ducts, the data can be scaled by the Reynolds Number.

Use Of The Flow Equations In The KURZ Mass Flow Computer

Single Point Insertion Flow Elements like the 410, 450, 452 are calibrated as velocity devices in gas X. You can display standard velocity or with application specific information you can display standard volumetric flow and mass flow:

Area,
Sensor and probe support blockage
Correction factor (velocity profile)
Gas specific gravity when reading mass flow

Multi point Insertion Flow Elements (KBar) are also calibrated as a velocity devices in gas X. You can display standard velocity or with application specific information you can display standard volumetric flow and mass flow:

Area,
Sensor and probe support blockage
Correction factor (velocity profile). This tends to be automatic since the velocity is measured across the duct at equal area locations.
Gas specific gravity, when reading mass flow.

In-line Flow Elements (510, 502, 522UHP, 532) are calibrated as standard volumetric flow devices in gas X. You can display standard volumetric flow or with application specific information it will display standard velocity or mass flow:

Area,
Sensor and probe support blockage
Correction factor (velocity profile)
Gas specific gravity when reading mass flow

To maintain the factory calibration on in-line units requires adherence to the recommended L/D upstream and downstream criteria. This ensures the long pipe run velocity profile when used in the field.

Example L/D criteria: Model 502-16

L/D is from the heated sensor to the disturbance	90 ° Elbow at x L/D	Calibration Error
	10	11 %
	20	2.5 %
	30	< 0.5 %

Problems:

Air flow of 100,000 lb/hr through a 3' x 3' square duct, 90°F, 20 PSIG

What is mass flow in SCFM ______________________

What is velocity in SFPM ______________________

The actual velocity is ______________________

What range does Kurz calibrate to ______________________

Nitrogen flow of 10 ACFM through a 3" Schedule 40 pipe, 110°F, 50 PSIG

What is the area ______________________

What is the flow rate in SCFM ______________________

The velocity in SFPM is ______________________

The calibration max. range is ______________________

Major Points to Remember

KURZ INSTRUMENTS INC.

2411 GARDEN ROAD
MONTEREY, CA 93940 U.S.A.
800-424-7356
TEL 408-646-5911
FAX 408-646-8901
SERVICE FAX 408-646-1033

Models 452/502/522-UHP/532 Declaration of CE Compliance

This is to declare, in accordance with Directive 89/336/EEC for Industrial, Scientific and Medical (ISM) equipment; that Kurz Instruments Model series 452, 502, 522-UHP, 532 Mass Flow Elements and 452FT, 502FT Mass Flow Transmitters have been designed and manufactured in accordance with the EN 50081-1 light industrial emissions standard and the EN 50082-2 heavy industrial immunity standard. Units must be installed per the field wiring diagrams 342003, 342014 or 342016 to ensure CE compliance. The test record for this declaration is Kurz document 430006. This declaration is made on the basis that the above equipment has been designed and manufactured according to the electrical safety principles embodied in the Low Voltage Directive (73/23/EEC) and uses good engineering practice where other aspects of safety are concerned.

Signed: [signature]
Date: 10/24/96

Name: JEROME L. KURZ
Position: PRESIDENT / OWNER

Document Number 430007, Revision B.

THE LEADER IN MASS FLOW TECHNOLOGY FOR PROCESS AND ENVIRONMENTAL MEASUREMENTS

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452FT/502FT Declaration of Safety Compliance

This is to declare, in accordance with the references listed below, that the Mass Flow Transmitters:

Model 452FT-a

a = Probe Support Diameter 08 or 16.

Model 502FT-a

a = Flow Body Diameter 6A through 64.

have been designed and manufactured in accordance with the listed specifications.

Standard	Markings	Type
IEC 79-1	Exd IIC T3	Flameproof
EN50018	EExd IIC T3	Flameproof
IEC 79-15	Ex nA IIC T5 (24VAC) Ex nA IIC T4 (115/230VAC 50/60Hz)	Nonincendive Nonincendive

These products have been designed for operation from -40 to +60 degrees Celsius with rated input voltage of 115/230VAC, 50/60Hz or 24VDC. The maximum process pressure is 300 psi. This declaration is made on the basis that the above equipment has been designed and manufactured according to the electrical safety principles embodied in the 73/23 E.E.C Low Voltage Directive and uses good engineering practices where other aspects of safety are concerned.

Signature: [signature] Date: 5-27-97

Print Name: JEROME L. KURZ Position: PRESIDENT

Appendix C

RECOMMENDED SENSOR PLACEMENT CRITERIA AND SENSOR FLOW BLOCKAGE CORRECTION FACTORS FOR SERIES 450 SINGLE-POINT MASS FLOW ELEMENTS

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12-12-95

DCN 364002 REV.B

I. INTRODUCTION

The purpose of this technical note is to assist our customers to use our products in the most advantageous manner in the interests of accuracy, cost, maintenance and reliability.

For several years most suppliers, including Kurz, have recommended placing the centerline of the thermal sensor at the center of circular pipes. However, the velocity profile of a pipe is never flat, and generally has the highest velocity at the center of the pipe, such that the output of the mass flow element usually reads high! A truly laminar velocity profile could have a centerline velocity of about 30% higher than the average velocity; even a fully developed turbulent velocity profile can be 10-12% higher than the average velocity. Somewhere between the wall and the pipe centerline is the location of the average velocity. We have concluded that it is much better to place the sensor centerline at the equal area radial location such as is used for velocity traverses in ducts and pipes. Since this location is only about 15% of the pipe diameter from the inner wall of the pipe, the sensor support need not be very long for even large pipes. For example, if a Series 450 were used in a 60" pipe, the insertion dimension needs to only be about 9", instead of 30" if it were placed at the pipe centerline. This means that:

A) The flow element is less costly,

B) There is less flow blockage,

C) The stress on the sensor support is less,

D) The sensor support has a higher natural frequency so that it can be used in higher vibration, shock environments,

E) Less space is needed to insert the probe into the pipe,

F) A far smaller and more convenient ball valve retractor/restraint system may be used.

Since most user's don't know what the actual velocity profile is before installing a Series 450, and field tests are normally made to "dial" in the system accuracy, the sensor location is usually not critical. In addition, the correction for flow blockage is usually much smaller, especially in 2 ½ to 6" pipe because the sensor shield with its open slot (window) has a much lower flow blockage area than the sensor support. Therefore, we think that our new sensor placement criteria is a "win-win" situation.

II. RECOMMENDED SENSOR PLACEMENT CRITERIA:

A) For small pipes use the 0.5-inch diameter sensor support to reduce flow blockage and installation costs. Use the 1-inch diameter sensor support for larger pipes, or in which strength or very dirty air is encountered. For small pipes, or when higher accuracy is required, a Kurz In-Line Mass Flow Element is recommended.

B) For pipes having an inside diameter of 2.50 inches to 3.0 inches, place the centerline of the sensor at 1.50 inches from the inner wall of the pipe.

C) For pipes having an inside diameter of 3.0 inches to 12 inches, place the centerline of the sensor at 1.80 inches from the inner wall of the pipe.

D) For pipes having an inside diameter greater than 12 inches, position the centerline of the sensor at a distance equal to 15% of the pipe inside diameter from the inner wall of the pipe. This is the equal area location for a single sensor, which follows standard velocity traverse procedures.

E) The sensor support must also extend outward from the pipe to allow convenient mounting and to ensure that the surface temperature of the attached electronics enclosure does not exceed 60°C. If the pipe is properly insulated, this can generally be accomplished by ordering a longer support so that the enclosure is 12 inches or more from the pipe. If this is not possible, then a remote sensor electronics enclosure configuration (TS) should be used. (See Feature 4 of the Brochure).

F) If a welded flange connection is used, see the directions following Feature 8 of the Brochure to determine the appropriate "L" dimension. The temperature considerations above also apply to the flanged connections. See the drawings on the Series 450 Brochures.

G) If a Ball Valve Retractor/Restraint assembly is used, see the drawings to determine the proper sensor support length and mounting information.

H) If stress, natural frequency or vortex shedding calculations are required, consult Kurz.

III. SENSOR BLOCKAGE CORRECTION FACTORS:

This section provides equations to enable the user to calculate a Sensor Blockage Correction Factor (SBCF) that may easily be entered into the Series 155 Mass Flow Computer. The effect of the frontal area of the sensor on the indicated velocity in a small pipe is to increase the average velocity within the pipe. Our experiments indicate that using the pipe flow area minus the frontal area of the sensor shield, sensor sting and sensor support gives a very good correction. It needs to be mentioned that this correction only is useful to correct for the reduced area and does not correct for an unusual velocity profile. This must be done using a field test using a reliable Reference Method (RM) such as EPA Method II or a Tracer Gas Method. When using the Series 155 Mass Flow Computer, select the VCF Correction Factor and enter the sensor blockage correction factor. Since the SBCF, is the same for all velocities, only one data point is necessary and any corresponding velocity may be used. If experimental mass flow data is obtained, the SBCF data should be removed (or VCF set to 1.00) during the test. The new VCF data will account for all effects, including flow blockage. The table below gives the appropriate coefficients for the SBCF equation for the three sensor/sensor support geometries of the Series 450. It should be noted that these corrections apply only when using the recommended sensor placement criteria described in Section II, above.

$$SBCF = \frac{D^2 + A \times D + B}{D^2}$$

Corrected Flow Rate = (SBCF) x Indicated Flow Rate

Where: D = Inside diameter of pipe (inches)
And: A, B are listed in the accompanying Table I

TABLE I, SERIES 450 SENSOR BLOCKAGE CORRECTION FACTORS						
Pipe I.D. D	450-08, 452-08, etc. (½" support, FD Sensor)		450-16, 452-16, etc. (1" support, FD Sensor)		450T-16, 450PT-16, etc. (1" support, FDT Sensor)	
	A	B	A	B	A	B
2.5-3"	0	-.894	0	-1.356	0	-1.414
3" - 12"	0	-.944	0	-1.587	0	-1.688
12"-up	-.096	+.202	-.191	+.704	-.191	+.604

Example I:

The application is for a Model 452-16-MT in a 6" Sch. 40 pipe. The I.D. of the pipe D = 6.065 inches. From the table:

A = 0
B = -1.587

$$SBCF = \frac{D^2 - 1.587}{D^2} = \frac{36.784 - 1.587}{36.784} = 0.957$$

Example II:

Assume that a ½" sensor support is used, Model 452-08-MT, instead of the 1" sensor support of Example I:

D = 6.065
A = 0
B = -.944
SBCF = 0.974