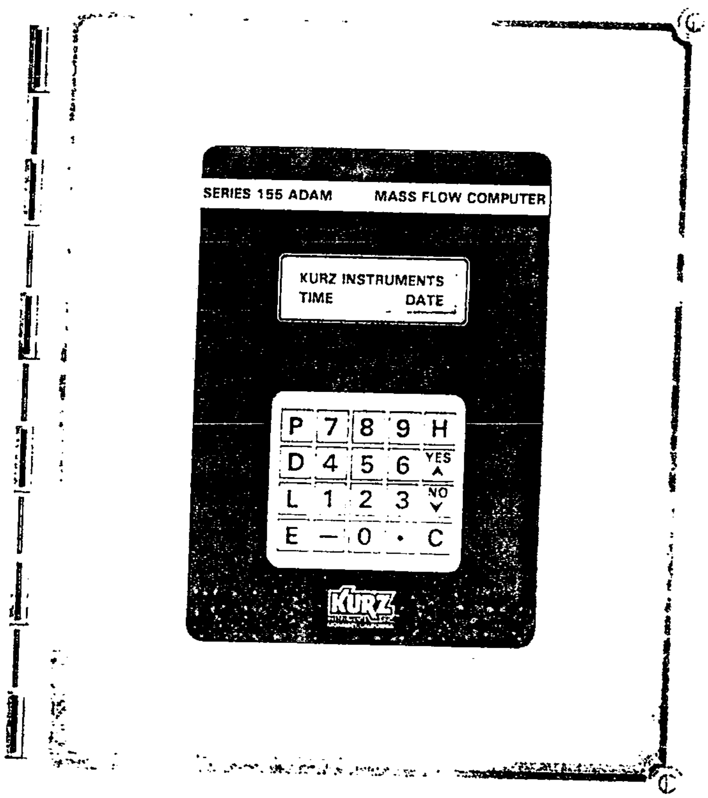
Kurz Instruments, Inc.
ADAM Series 155
Models A and B



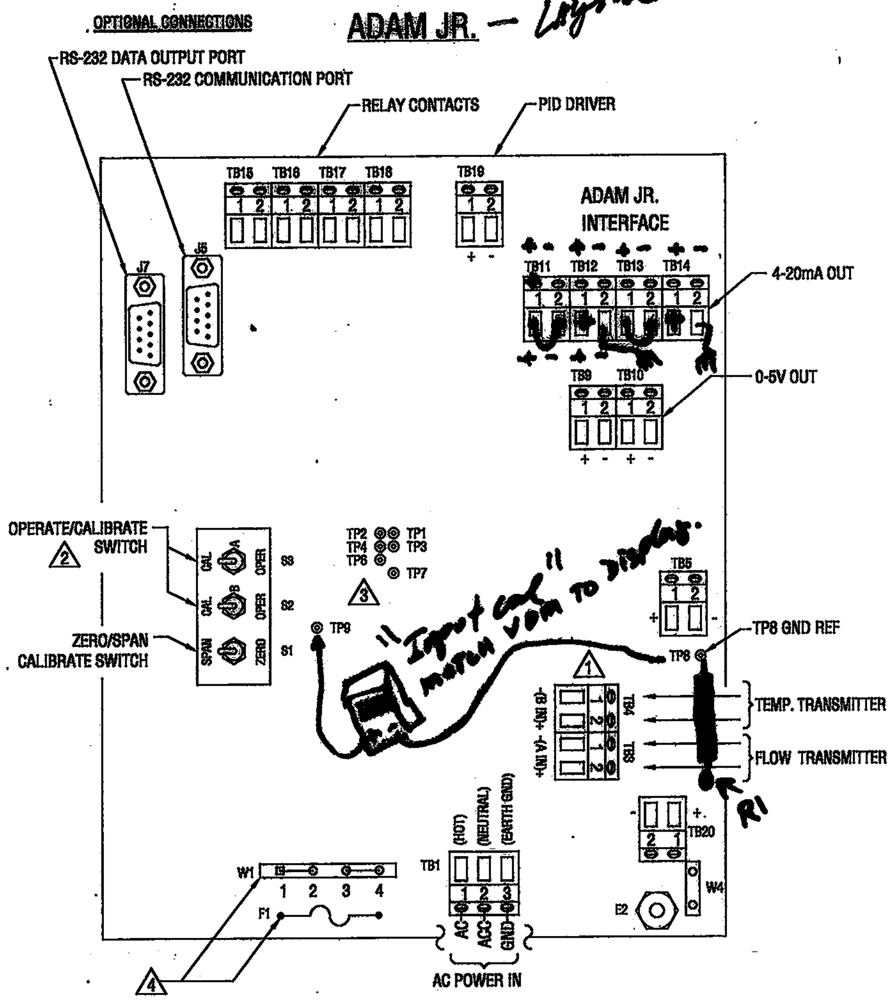
ADDENDUM

Table of Contents

Figure List

Document Title: Adam Series 155 Mass Flow Computer/Transmitter Addendum
Document Number: 360157, Revision A
Publication Date: July 26, 1994

ADAM JR. — Layout



⚠1 TB3-1 THRU TB4-1 (CHANNEL A THRU B) INPUTS 0-5 VDC MAX. TB3-2 THRU TB4-2 (CHANNEL A THRU B) OUTPUTS 18 TO 24 VDC.

⚠2 SWITCH POSITION
- CHANNEL CALIBRATE
- OPERATE MODE

⚠3 TP1 +2.500 REF
TP2 +5V
TP3 -9V
TP4 +10V
TP6 +12V
TP7 +15V
TP8 GND REF
TP9 INPUT CAL

⚠4 1 2 3 4
115VAC (STD.)
F1 IS ~~.315~~ AMP
0.5 SB

1 2 3 4
230VAC (OPT.)
~~F1 IS 0.16 AMP~~

5. CONNECT INPUT/OUTPUT SHIELDS TO CONDUIT HUB BUS BAR GROUND STUDS (NOT SHOWN).

6. EXTERNAL INPUT OPTION
TB20-1 INPUT A (+ EXT.)
TB20-2 INPUT A (- EXT.)
TB5-1 INPUT B (+ EXT.)
TB5-2 INPUT B (- EXT.)

Rev. P

(SEE DWG 340155-29 IN MANUAL FOR MORE DETAIL)

LABEL P/N 170134-P

INTRODUCTION

This Addendum is the result of Kurz Instruments, Inc. commitment to provide the best possible product improvements for our customers. Use of the built in calibrator, input calibration, output calibration, setup of linearizers including Velocity/Temperature Mapping (VTM), and implementation of the zero and span drift check verification feature for Series 155, Models A and B Mass Flow Computers are presented in this document.

BUILT-IN FIELD CALIBRATOR

The Field Calibrator verifies system calibration by allowing the user or technician to insert the Current Sense Voltages listed in the *Calibration Data and Certification Document* through the use of an on board switch and variable resistor and the ADAM® software.

A calibrated digital voltmeter (DVM) with 4½ digits or better and ±0.1% accuracy is required for this procedure along with the appropriate *Calibration Data and Certification Document* for the instrument under test.

The *Calibration Data and Certification Document* lists the Current Sense Voltages in the column labelled "CSV VDC" (Current Sense Voltage Volts DC) for each calibration point. Corresponding velocity or mass flow values for each calibration point are listed in the column labelled "Velocity SFPM". The first calibration point indicates a no-flow condition.

Before starting any procedure contained in this document, the following items should be noted or verified.

☆ Performance of this procedure requires knowledge of user or technician level security codes. To obtain these codes, contact Kurz Instruments, Inc. Customer Service.

☆ All wiring is properly connected.

☆ Input power is available and instrument is energized.

☆ These procedures are performed with power applied to the instrument; appropriate steps must be taken to prevent contact with potentially dangerous electrical energy or serious damage to personnel and/or equipment may result.

☆ When switch SW2 is placed in the "Calibrate" position, the unit is no longer monitoring actual flow rates. Verify that removal of this equipment from service will not compromise personnel or equipment safety. Switch SW2 must be placed in the "Operate" position when returning the instrument to service.

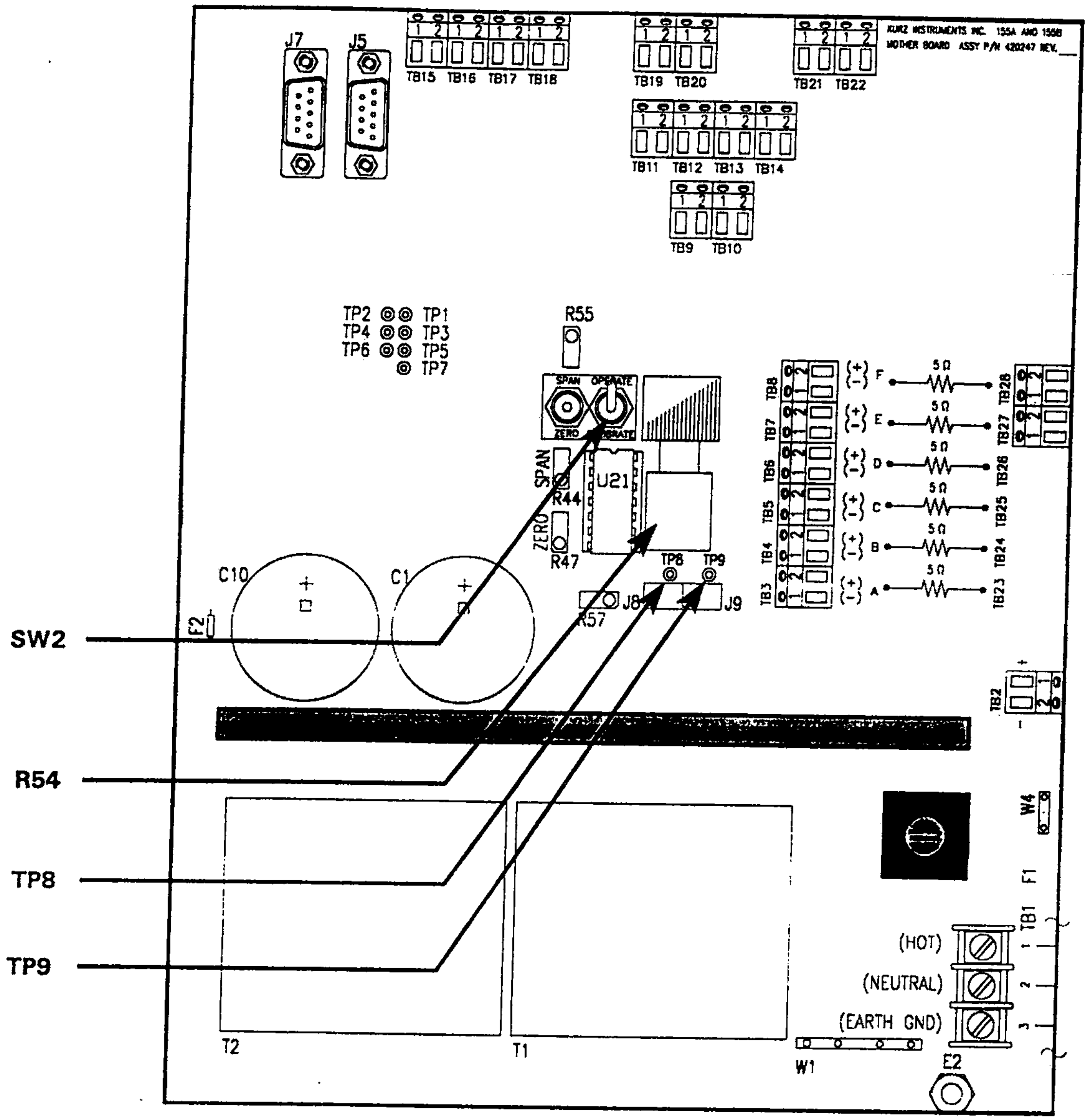


Figure 1. Mother Board, Models 155A and 155B, Component Location

INPUT CALIBRATION

Refer to Figure 2 for component location.

741953

1. Enter the Program Mode using technician level acess code.

2. Press [P] until the message "PRESS ENTER TO CALIBRATE" appears on the front panel LCD, then press [E].

3. Press the up (YES) or down (NO) arrow until the message "PRESS ENTER FOR INPUT CAL" appears on the front panel LCD, then press [E].

4. Press [P] until you see the "SET ZERO VOLTS..." prompt for the channel you wish to calibrate. If you inadvertently pass the desired channel, pressing [C] once will return you to step 3.

5. When you see the message "SET ZERO VOLTS..." for the channel you wish to calibrate, place switch SW2 in the "CALIBRATE" position.

6. Connect DVM to TP8 (+) and TP9 (-)

7. Adjust R54 until the DVM indicates 0.000 VDC.

8. Press the up (YES) or down (NO) arrow until the front panel LCD indicates 0.000 volts. Then press [E].

9. Adjust R54 until the DVM indicates 3.000 VDC.

10. Press the up (YES) or down (NO) arrow until the front panel LCD indicates 3.000 volts. Then press [E].

11. This completes the input calibration process for one channel.

    11.1 If you wish to continue for the other channels (up to 3 for a Model A or 6 for a Model B) return to step 4.

    11.2 If you wish to perform output calibration, press [C], then proceed to the section titled "SET OUTPUT CALIBRATION" of this addendum.

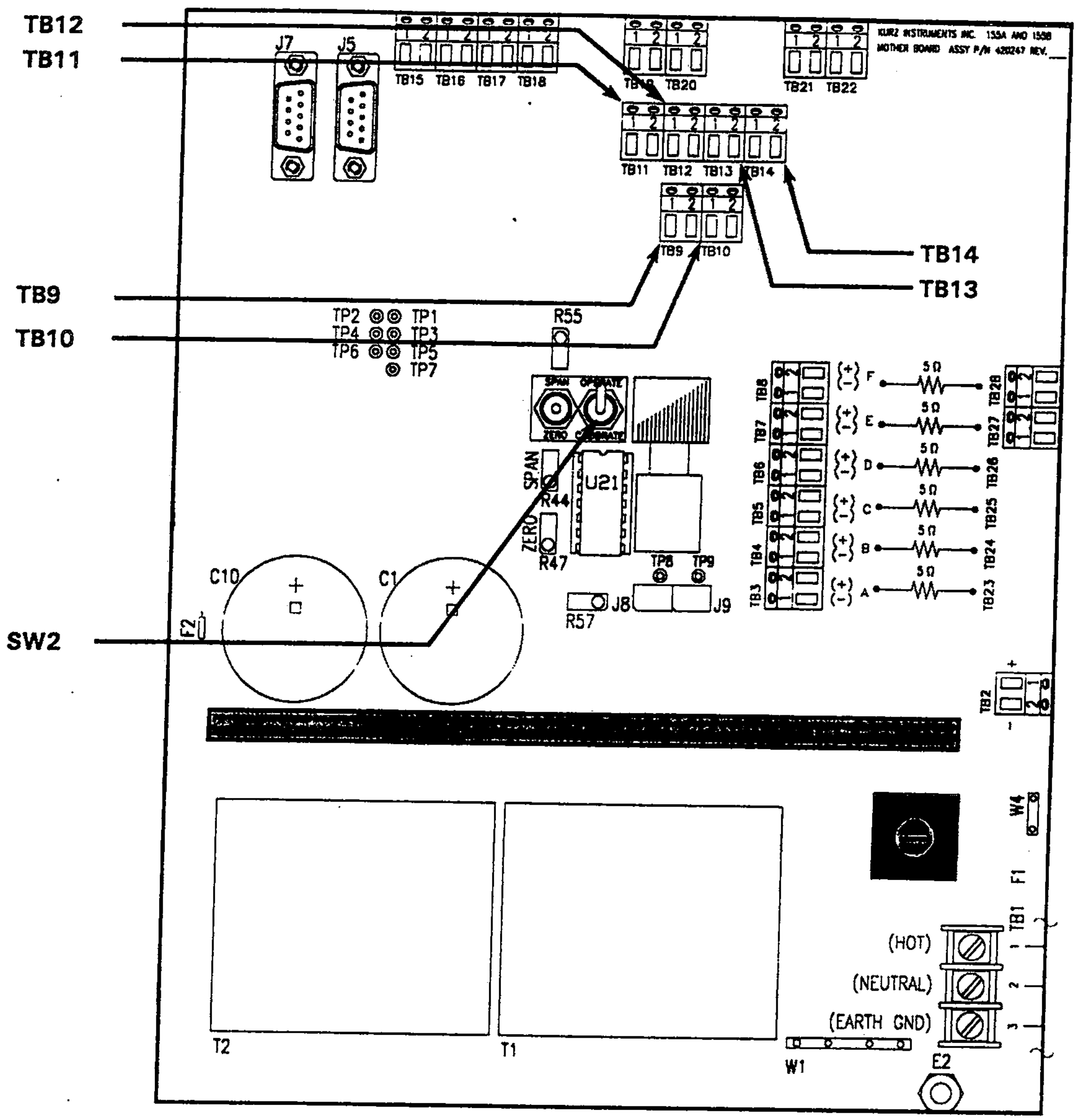


Figure 3. Mother Board, Models 155A and 155B, Output Calibration

BRAD TORR

842 3?

Kurz Instruments Inc.

155 JR

155JR

Calibration:

Output and Input circuits must be matched to real voltage and currents which are done with these menus. See the subsequent section for a detailed description of how this is done for the 0-5 V or 4-20 mA output.

The input calibration uses various methods of substituting a zero or span voltage to the input channels of each 155 unit. See the field wiring diagram for identification of the switches used for this purpose. Generally, there is a calibrate/operate switch. When in calibration there is another switch which selects zero or span. The span voltage must be measured with a 4 ½ digit multimeter with 0.1% basic DC accuracy to calibrate the inputs. As input voltages are raised to about the 4th power to convert the raw input to a flow or velocity, this process is critical and must be performed by a competent operator with an accurate voltage standard.

QUICK CHECK

A_ comect V.O.M. across R1 (TP8) = is grd)

B_ Press "D" (approx. 9 times) To the screen reads =

A= XXXX SFPM

INPUT = X.XXXX V

C_ The voltage across "R1" and the Display must match, if not follow the procedure...

FIELD CALIBRATION

Refer to Figure 1 for component location.

1. Place switch SW2 in the **CALIBRATE** position.

2. Connect DVM to TP8(+) and TP9(-). The DVM monitors the adjustable input voltage to the Model 155 A or B.

3. Enter the Program Mode.

4. Press [P] until the message "PRESS ENTER TO SEE INPUT VOLTS" appears on the front panel LCD.

5. Press [E] to see the channel A flow and input voltage values.

6. Using the DC Voltage Current-Sense column of the *Calibration Data and Certification Document,* adjust R54, BLUE POT until DVM display indicates the voltage listed at calibration point 1 for the channel under test.

7. Verify that flow rate and voltage values indicated on the Series 155, Model A or B LCD are the same as those listed on the *Calibration Data and Certification Document* for that calibration point.

   Note: *If the flow and/or voltage values indicated on the Series 155, Model A or B LCD do not agree with listed values on your documentation, recalibration should be performed.*

8. Repeat steps 6 and 7 for the remaining calibration points for channel A.

9. Repeat steps 6, 7, and 8 for the remaining channels of your instrument. Be sure to use the appropriate *Calibration Data and Certification Document* for each channel.

10. When testing is completed, press [C] until the Kurz Instruments, time and date message appears on the front panel LCD.

    Note: ***Output signals from this instrument may be used for automatic control of other devices, BEFORE performing the next step, verify that returning the instrument to service will not present a hazard to personnel or equipment!***

11. **Return switch SW2 to the OPERATE position.**

12. Verify that normal operation has been restored to the Series 155, Model A or B Mass Flow Computer and any processes that may be under its control.

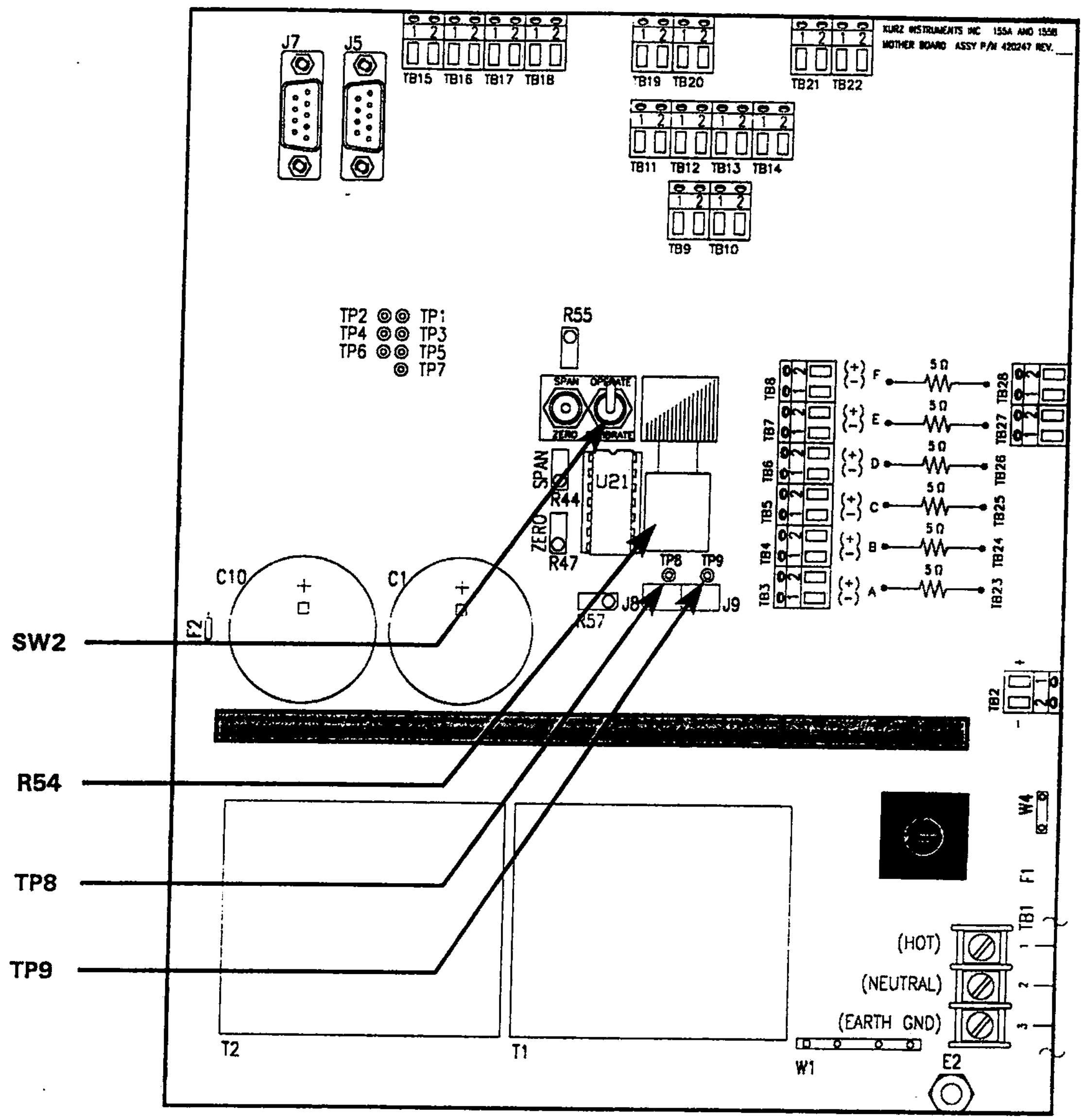
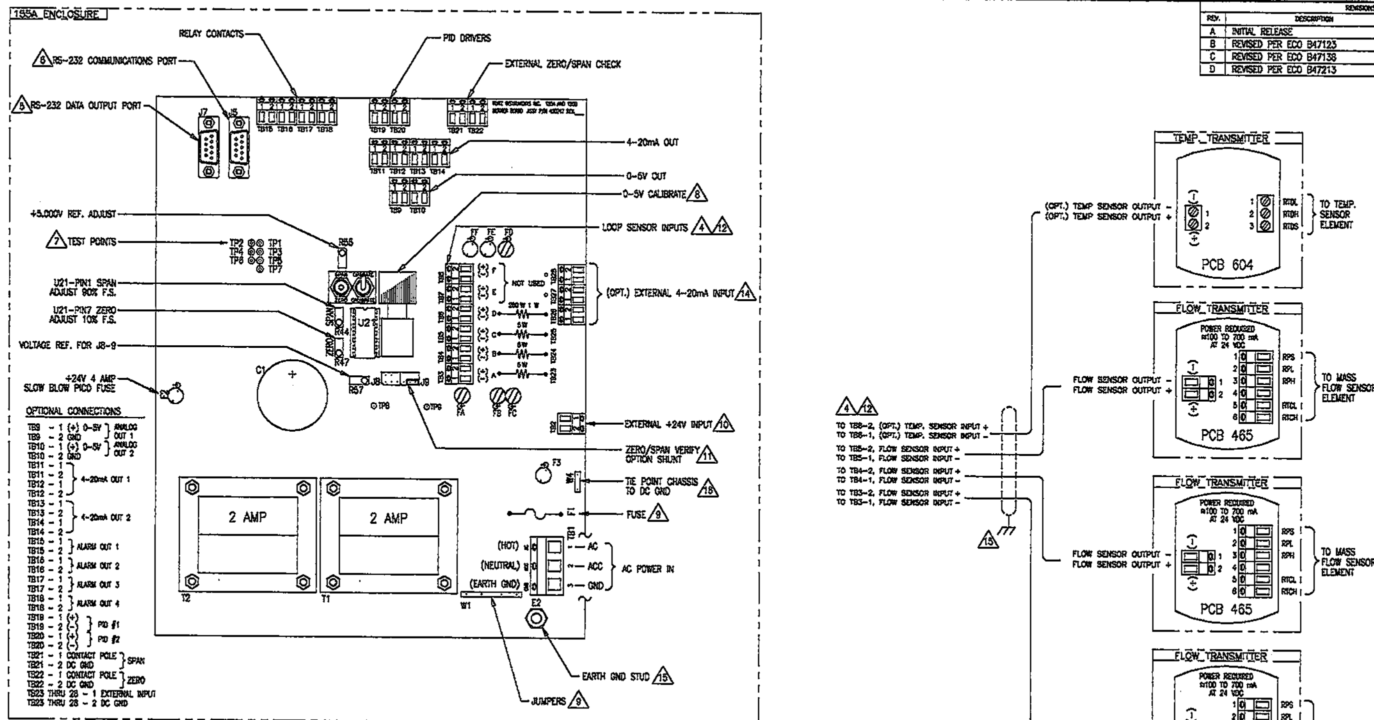


Figure 2. Mother Board, Models 155A and 155B, Input Calibration

REVISIONS					
REV.	DESCRIPTION	BY	CHKD	APPRD	DATE
A	INITIAL RELEASE	DFS	----	----	----
B	REVISED PER ECO B47123	DFS	TW	BBB	10/18/93
C	REVISED PER ECO B47138	DFS	BBB	CHM	3-30-94
D	REVISED PER ECO B47213	ADK	BQ	TW	10/27/94



NOTES:

1. THIS WIRING DIAGRAM IS USED IN CONJUNCTION WITH PARENT NUMBER 750206, 750207 & 750208.
2. REF. DESIGNATORS AND PIN NUMBERS ARE FOR REF. ONLY, AND MAY NOT APPEAR ON COMPONENTS
3. 15 TO 50 VDC.
4. TB3-1 THRU TB8-1 (INPUTS A THRU F) 0-5 VDC MAX. TB3-2 THRU TB8-2 (OUTPUTS A THRU F) 18 TO 24 VDC.
5. RS-232 COMMUNICATIONS PORT

J5

PIN		CUSTOMER CONNECT
N/C	1	9 PIN TO 9 PIN
TXD1	2	CABLE, STRAIGHT
RXD1	3	THROUGH
DTR	4	
GND	5	
DSR	6	
RTS	7	
CTS	8	
N/C	9	

6. RS-232 DATA OUTPUT PORT

J7

PIN		CUSTOMER CONNECT
N/C	1	9 PIN TO 9 PIN
TXD0	2	CABLE, STRAIGHT
RXD0	3	THROUGH
DTR	4	
GND	5	
DCD0	6	
RTS0	7	
CTS0	8	
N/C	9	

7. TEST POINTS.
TP1 5.0 REF
TP2 +5V
TP3 -9V
TP4 +10V
TP5 -5V
TP6 +12V
TP7 +15V

8. CALIBRATION TEST POINTS.
TP8 (+)
TP9 (GND)

9. W1
1 2 3 4
115VAC (STD.)
.75 AMP 3AG SLO-BLO
P/N 630058 (F1)
W1
1 2 3 4
230VAC (OPT.)
.375 AMP 3AG SLO-BLO
P/N 630056 (F1)

10. TB2 P1 +
P2 DC GND

11. JUMPER LOCATION WHEN NOT USED. SEE MANUAL.

12. FOR FLOW/TEMP. TRANSMITTER CONNECTION TO LOOP SENSOR INPUTS.

13. MAXIMUM LOOP SERIES RESISTOR VALUE=500W

14. EXTERNAL INPUT OPTION
TB26-1 EXTERNAL INPUT (+ EXTERNAL INPUT)
TB26-2 EXTERNAL INPUT (- EXTERNAL INPUT)

15. CONNECT INPUT/OUTPUT SHIELDS TO CONDUIT HUB FITTINGS AND TO EARTH GND (E2).

16. W4 JUMPER REQUIRED TO CONNECT DC GND TO EARTH GND (E2).

17. MINIMUM WIRE SIZE: 18 GA. (EXCEPT SENSOR INPUT WIRES. SELECT CABLE LENGTH AND WIRE GAGE SO THAT THE LOOP RESISTANCE DOES NOT EXCEED 4.0 OHMS. REFER TO MANUAL.)

NEXT ASSEMBLY	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	APPROVALS	DATE
750208	TOLERANCES ARE: FRACTIONS ± 1/32; ANGLES ± 0°-30'	DRAWN BY D.F.SINGLETON	8/16/93
750207	DECIMALS .X ± 0.1, .XX ± 0.01, .XXX ± 0.005, .XXXX ± 0.0010	CHECKED BY B.QUERFURTH	9/21/93
750206	DWG. RELEASE DATE	APPROVED T. WILSON	9/21/93

KURZ INSTRUMENTS, INC.

FIELD WIRING DIAGRAM, HOOK-UP, 155A, W/MODEL 90

DWG. SIZE D | DWG. NO. 340155-44 | REV. D

SCALE NONE | SHEET 1 OF 2

1554-B Loop power

See - users Guide 360157 RW A. pg# 9

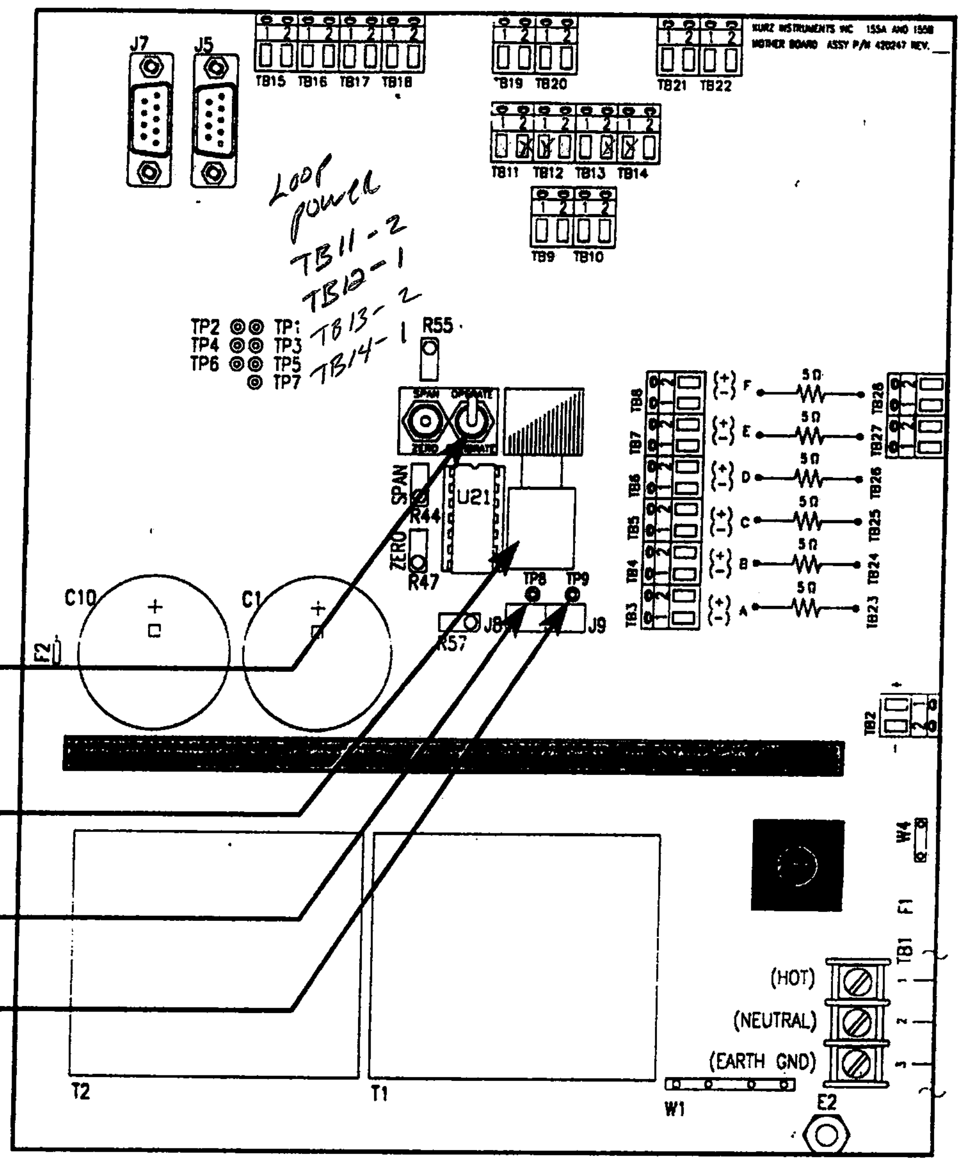


Figure 2. Mother Board, Models 155A and 155B, Input Calibration

Input Calibration

Please refer to the appropriate field wiring diagram in the Appendix for the following procedure. Each of the 155 models has a run or operate/calibrate switch or shunt defined on this drawing. (see the Installation section for a table of the drawings for each model)

Once in calibrate, another switch or shunt determines what voltage will be applied to the inputs. This voltage should be monitored with a precision multimeter with 4 ½ digit scale and 0.1% basic accuracy. Placing the volt meter ground at TPx and its positive lead on TPy you can read the exact voltage applied to the inputs.

Next, place the 155 in *Program Mode* and navigate to the Calibration menu

PRESS ENTER TO **CALIBRATE**

You press the **E** key and you should see the next menu for input calibration, if not press the **^v** key until you do:

PRESS ENTER FOR **INPUT CAL.**

Again you press the **E** key and you will now see this screen for the first input channel:

SET 'ZERO' VOLTS **CH A =0.0000 V**

You must have the input switch in the ZERO position and the multimeter reading 0.000 V. If they all agree you press **E** to move to the span setting. If the readings are not near zero, say 0.0056 then enter this number on the keypad followed by the **E** key.

SET 'SPAN' VOLTS **CH A =5.0000 V**

Which will read about 5 V when the input switch is in the SPAN position. Again you type in the actual voltage reading of the volt meter followed by the **E** key. You will now see the same menu screen for channel B:

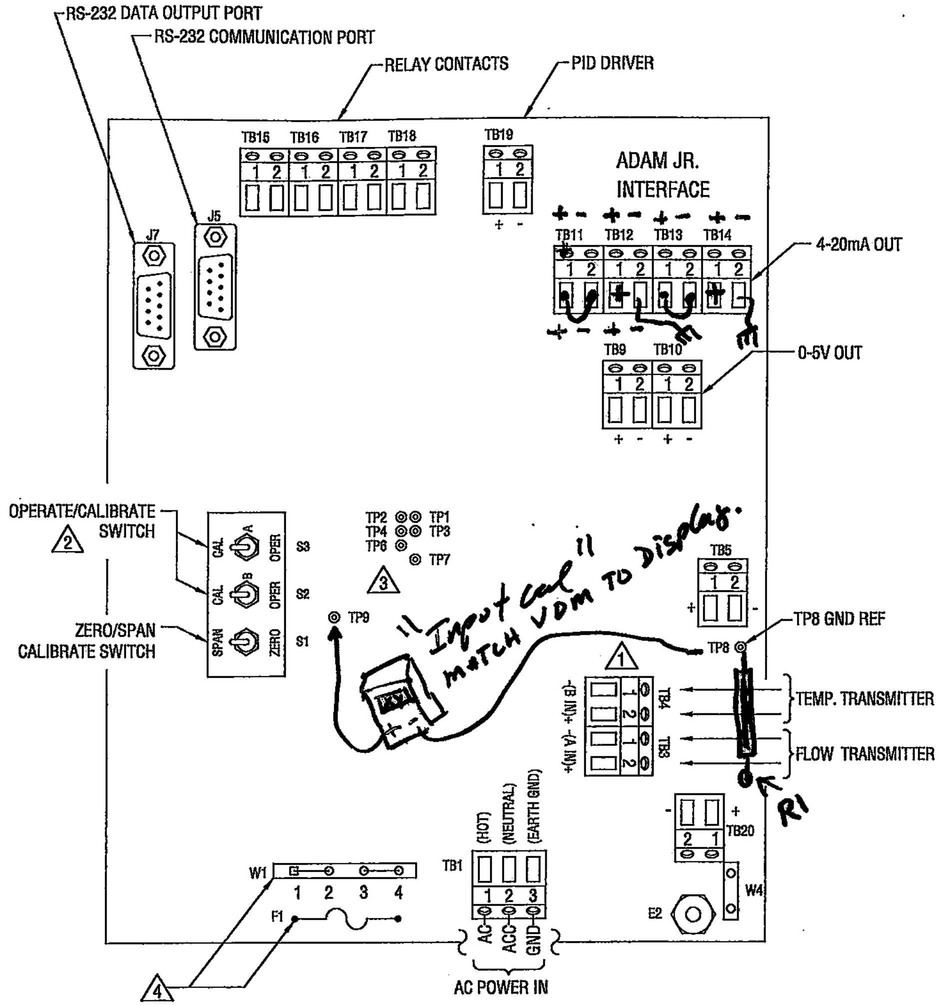
SET 'ZERO' VOLTS **CH B =0.0000 V**

Now you repeat the process you did for channel A. This is done for all active input channels.

When you are done, you press the **C** key a few times to exit *Program mode* and place the operate/calibrate switch/shut back into the operate position.

OPTIONAL CONNECTIONS

ADAM JR.



1. TB3-1 THRU TB4-1 (CHANNEL A THRU B) INPUTS 0-5 VDC MAX. TB3-2 THRU TB4-2 (CHANNEL A THRU B) OUTPUTS 18 TO 24 VDC.

2. SWITCH POSITION
   - CHANNEL CALIBRATE
   - OPERATE MODE

3. TP1 +2.500 REF
   TP2 +5V
   TP3 -9V
   TP4 +10V
   TP6 +12V
   TP7 +15V
   TP8 GND REF
   TP9 INPUT CAL

4. 1 2 3 4 — 115VAC (STD.) F1 IS ~~0.8~~ AMP 0.5 SB
   1 2 3 4 — 230VAC (OPT.) ~~F1 IS 0.15 AMP~~

5. CONNECT INPUT/OUTPUT SHIELDS TO CONDUIT HUB BUS BAR GROUND STUDS (NOT SHOWN).

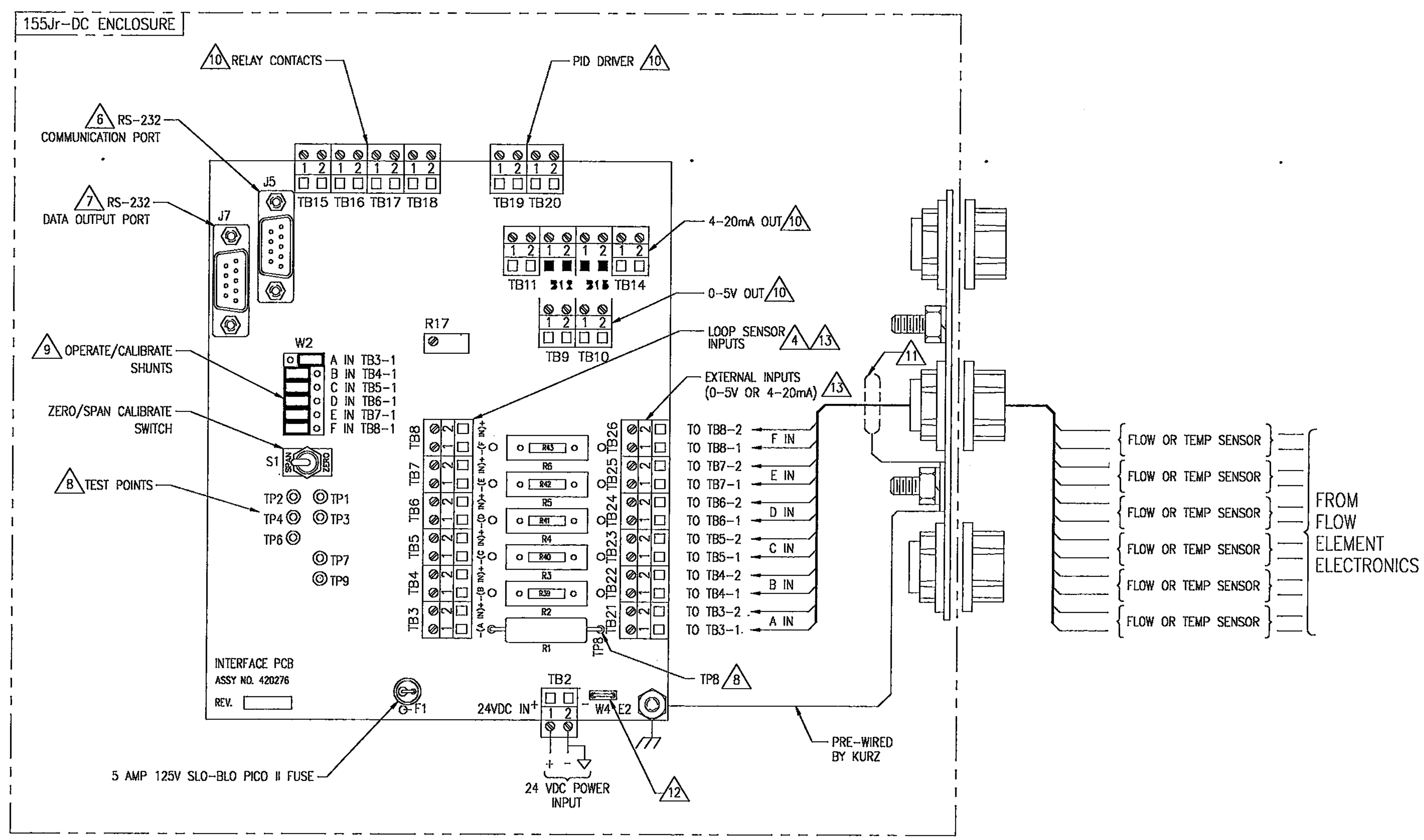
6. EXTERNAL INPUT OPTION
   TB20-1 INPUT A (+ EXT.)
   TB20-2 INPUT A (- EXT.)
   TB5-1 INPUT B (+ EXT.)
   TB5-2 INPUT B (- EXT.)

Rev. F

(SEE DWG 340155-29 IN MANUAL FOR MORE DETAIL)

LABEL P/N 170134F

REVISIONS					
REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	INITIAL RELEASE	DFS	TW	BBB	05-22-1995
B	REVISED PER ECO # B47303	FGM	BBB	BBB	01-10-1995
C	REVISED PER ECO # B47301	ADK	BBB	BBB	08-12-1996
D	REVISED PER ECO # B47723	JLM	BBB	BBB	10-19-2000
E	REVISED PER ECO # B47814	JLM	BBB	BBB	06-14-2001



NOTES: UNLESS OTHERWISE SPECIFIED

1. THIS WIRING DIAGRAM IS USED IN CONJUNCTION WITH PARENT NUMBERS 750101-DC, 750104-DC, 750105-DC, 750106-DC & 750107-DC.
2. REF. DESIGNATORS AND PIN NUMBERS ARE FOR REF. ONLY, AND MAY NOT APPEAR ON COMPONENTS
3. 15 TO 50 VDC.
4. FOR FLOW/TEMP. TRANSMITTER CONNECTION TO LOOP SENSOR INPUTS. CURRENT SENSE RESISTORS ARE REQUIRED FOR CHANNELS USED.
5. MAXIMUM LOOP SERIES RESISTOR VALUE=500 Ω.
6. RS-232 COMMUNICATIONS PORT:

J5

PIN		CUSTOMER CONNECT
N/C	1	9 PIN TO 9 PIN CABLE, STRAIGHT THROUGH
TXD1	2	
RXD1	3	
DTR	4	
GND	5	
DSR	6	
RTS	7	
CTS	8	
N/C	9	

(DTR 4 jumpered to DSR 6; RTS 7 jumpered to CTS 8)

7. RS-232 DATA OUTPUT PORT:

J7

PIN		CUSTOMER CONNECT
N/C	1	9 PIN TO 9 PIN CABLE, STRAIGHT THROUGH
TXD0	2	
RXD0	3	
DTR	4	
GND	5	
DCD0	6	
RTS0	7	
CTS0	8	
N/C	9	

(DTR 4 jumpered to DCD0 6; RTS0 7 jumpered to CTS0 8)

8. TEST POINTS:
TP1 +2.500 REF (ADJUST R17)
TP2 +5V
TP3 -9V
TP4 +10V
TP6 +12V
TP7 +15V
TP8 GND REF (LEAD ON R1)
TP9 INPUT CAL.

9. SHUNT POSITION
CHANNEL CALIBRATE
OPERATE MODE

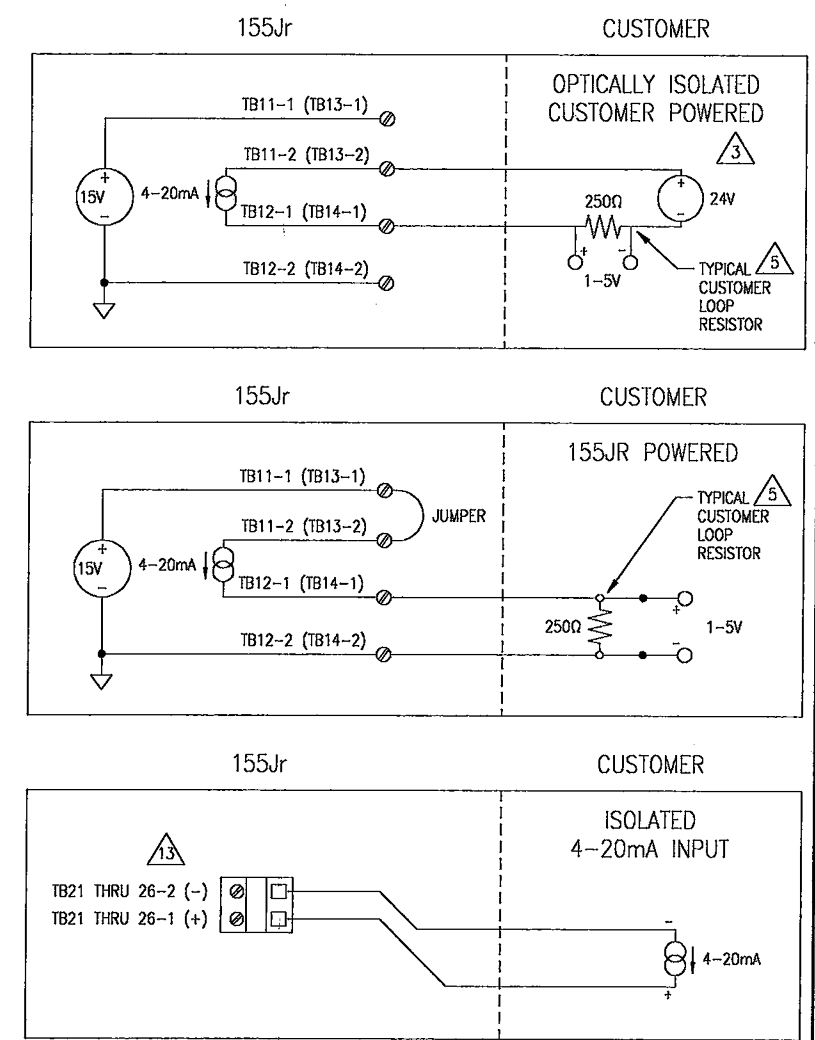
10. OPTIONAL CONNECTIONS:

TB9 - 1 (+) 0-5V, TB9 - 2 GND	ANALOG OUT 1
TB10 - 1 (+) 0-5V, TB10 - 2 GND	ANALOG OUT 2
TB11 - 1, TB11 - 2, TB12 - 1, TB12 - 2	4-20mA OUT 1
TB13 - 1, TB13 - 2, TB14 - 1, TB14 - 2	4-20mA OUT 2
TB15 - 1, TB15 - 2	ALARM OUT 1
TB16 - 1, TB16 - 2	ALARM OUT 2
TB17 - 1, TB17 - 2	ALARM OUT 3
TB18 - 1, TB18 - 2	ALARM OUT 4
TB19 - 1 (+), TB19 - 2 (-)	PID #1
TB20 - 1 (+), TB20 - 2 (-)	PID #2

11. CONNECT INPUT/OUTPUT SHIELDS TO GROUND BUS BAR.
12. W4 JUMPER REQUIRED TO CONNECT DC GND TO EARTH GND (E2).
13. INPUT CONNECTIONS

TB3-1, TB21-1 INPUT; TB21-2 GND; TB3-2 +24 VDC	INPUT CHANNEL (A)
TB4-1, TB22-1 INPUT; TB22-2 GND; TB4-2 +24 VDC	INPUT CHANNEL (B)
TB5-1, TB23-1 INPUT; TB23-2 GND; TB5-2 +24 VDC	INPUT CHANNEL (C)
TB6-1, TB24-1 INPUT; TB24-2 GND; TB6-2 +24 VDC	INPUT CHANNEL (D)
TB7-1, TB25-1 INPUT; TB25-2 GND; TB7-2 +24 VDC	INPUT CHANNEL (E)
TB8-1, TB26-1 INPUT; TB26-2 GND; TB8-2 +24 VDC	INPUT CHANNEL (F)

SAMPLE DIAGRAMS, 4-20mA CONNECTIONS



APPROVALS	DATE
DRAWN BY D.F.SINGLETON	05-11-1995
CHECKED BY T.WILSON	05-22-1995
APPROVED B.BUTTON	05-22-1995

KURZ INSTRUMENTS, INC.

WIRING DIAGRAM, HOOK-UP, 155 JR-DC

DWG. SIZE B | DWG. NO. 340155-50 | REV. E

SCALE NONE PRINT 1:2 | SHEET 1 OF 1

OUTPUT CALIBRATION

Refer to Figure 3 for component location.

1. Enter the Program Mode.

2. Press [P] until you see the message "PRESS ENTER TO CALIBRATE" on the front panel LCD, then press [E].

3. Press the up (YES) or down (NO) arrow until you see the message "PRESS ENTER FOR OUTPUT CAL" on the front panel LCD.

4. Press [E], you should see the message "SET 'ZERO' VOLTS CH 1 = 0.000 VDC".

5. Connect DVM as indicated in Table 1 for 0-5 VDC or 4-20mA outputs.

LOOP POWER

OUTPUT	0-5 VDC	4-20mA SELF -POWERED	4-20 mA CUSTOMER POWERED
CHANNEL 1	TB9 1(+), 2(Gnd)	TB12 1(+), 2(-)	TB11 2(+), TB12 1(-)
CHANNEL 2	TB10 1(+), 2(Gnd)	TB14 1(+), 2(-)	TB13 2(+), TB14 1(-)

6. Press the up (YES) or down (NO) arrow until the DVM indication is 0.000 VDC (for 0-5 VDC output) or 4.000 mA (for 4-20 mA output).

7. Press [E], you should see the message "SET 'SPAN' VOLTS CH 1 = 5.000 VDC".

8. Press the up (YES) or down (NO) arrow until the DVM indication is 5.000 VDC (for 0-5 VDC output) or 20.00 mA (for 4-20 mA output).

9. Press [E]. If your instrument is configured for another output channel the display will read "SET 'ZERO' VOLTS CH 2 = 0.000 VDC". If you wish to perform additional output calibration, repeat steps 4 through 8 for channel 2.

   If there are no more output channels configured, you will see the message "PRESS ENTER FOR INPUT CALIBRATION".

10. To set up linearizer data at this time press [C] until you see the message "SET LINEARIZERS". Then proceed to the section of this document titled "SET LINEARIZERS".

To exit the Program Mode press [C] until you see the KURZ INSTRUMENTS logo.

SET LINEARIZERS

Note: Performance of this procedure requires a current copy of the Calibration Data and Certification Document for your instrument.

1. Enter the Program Mode.
2. Press [P] until you see the message "PRESS ENTER TO SET LINEARIZERS" on the front panel LCD, then press [E].
3. Press [E] in response to the message "PRESS ENTER TO LINEARIZE CH A".
4. Press [P] to accept the current serial number if correct or, use the up (YES) or down (NO) arrow to scroll through the character set and press [E] for each desired character (letter, number, or symbol).
5. Press the up (YES) or down (NO) arrow until you see the desired engineering units as listed on the *Calibration Data and Certification Document* for channel A. Table 2 lists the available selections for instruments configured in English Units or in International Units.

English Units	International Units
SFPM	SMPS
SCFM	SCMM
DEGF	DEGC
SCFH	SCMH

6. Press [E] to enter the appropriate engineering units.
7. When the message "ENTER # OF CH A DATA POINTS..." appears, Press the up (YES) or down (NO) arrow until the correct number of points as listed on the *Calibration Data and Certification Document* is displayed.
8. Press [E] to enter the appropriate number of data points.
9. Using the number keys and decimal point as appropriate, enter the desired voltage for that data point and press [E]. You should see the message "NEW VALUE ACCEPTED", then the bottom line of the display prompts you to enter the flow value for that data point.
10. Using the number keys and decimal point as appropriate, enter the desired flow value for that data point and press [E]. You will then see a prompt to enter the voltage and flow information for the next data point. Continue to enter voltage and flow data for all of the data points listed on the *Calibration Data and Certification Document* for this channel.
11. **Repeat these steps for each channel as required.**

SET LINEARIZERS (VTM)

Velocity/Temperature Mapping (VTM) was developed by Kurz Instruments, Inc. to improve accuracy of its line of Thermal Mass Flow products in applications where large changes in velocity and temperature are encountered. VTM allows the customer to generate Data Sets at four different temperatures. Information from these Data Sets is used by ADAM® software to compensate for effects of temperature on flow calculations.

1. Enter the Program Mode.

2. Press [P] until you see the message "PRESS ENTER TO SET LINEARIZERS" on the front panel LCD, then press [E].

3. Press [E] in response to the message "PRESS ENTER TO LINEARIZE CH A".

4. Press [P] to accept the current serial number if correct or, use the up (YES) or down (NO) arrow to scroll through the character set and press [E] for each desired character (letter, number, or symbol).

5. Press the up (YES) or down (NO) arrow until you see the desired engineering units as listed on the *Calibration Data and Certification Document* for channel A. The following options are available:

   ☆ SFPM or SMPS
   ☆ SCFM or SCMM
   ☆ DEGF or DEGC

6. Press [E] to enter the appropriate engineering units.

7. Specify number of temperature Data Sets up to a maximum of four (TO, 1, 2, 3).

8. Press the up (YES) or down (NO) arrow until the desired temperature reference meter is indicated on the front panel display, then press [E].

9. Using the numeric keys, specify the desired temperature in DEGF or DEGC for the TO linearization curve, then press [E].

10. Specify the number of data points (up to 7) for channel A, then press [E].

11. Specify the voltage for data point 1, then press [E].

12. Specify the velocity for data point 1, then press [E].

13. Continue to specify the calibration points in each data set for Channel A, then repeat these steps for each channel the system. You can have up to three (A-C) channels in the Model A and six (A-F) in the Model B.

14. When you have completed setting the linearizers press [C] as required to return to the Executive Mode.

Models 155C-1, 155E-1, 155E-RM

USER'S GUIDE ADDENDUM

KURZ INSTRUMENTS, INC.
2411 Garden Road
Monterey, CA. 93940
408-646-5911
Fax 408-646-8901
www.kurz-instruments.com
sales@kurz-instruments.com

Table of Contents

Figure List

Document Title: Adam Series 155C-1,E-1 and E-RM Mass Flow Computer/Transmitter Addendum
Document Number: 360193, Revision A
Publication Date: 6-27-97

INTRODUCTION

This Addendum is the result of Kurz Instruments, Inc. commitment to provide the best possible product improvements for our customers. Use of the built in calibrator, input calibration, output calibration, setup of linearizers including Velocity/Temperature Mapping (VTM), and implementation of the zero and span drift check verification feature for Series 155C-1/E-1/E-RM Mass Flow Computers are presented in this document.

BUILT-IN FIELD CALIBRATOR

The Field Calibrator verifies system calibration by allowing the user or technician to insert the Current Sense Voltages listed in the ***Calibration Data and Certification Document*** through the use of an on board switch and variable resistor and the ADAM® software.

A calibrated digital voltmeter (DVM) with 4½ digits or better and ±0.05% accuracy is required for this procedure along with the appropriate ***Calibration Data and Certification Document*** for the instrument under test.

The ***Calibration Data and Certification Document*** lists the Current Sense Voltages in the column labeled "CSV VDC" (Current Sense Voltage Volts DC) for each calibration point. Corresponding velocity or mass flow values for each calibration point are listed in the column labeled "Velocity SFPM" or "Flow Rate SFPM". The first calibration point indicates a no-flow condition.

Before starting any procedure contained in this document, the following items should be noted or verified.

☆ Implementation of this procedure requires knowledge of user or technician level security codes. To obtain these codes, contact Kurz Instruments, Inc. Customer Service.

☆ All wiring is properly connected and input power is available and the instrument is energized.

☆ These procedures are performed with power applied to the instrument; appropriate steps must be taken to prevent contact with potentially dangerous electrical energy or serious damage to personnel and/or equipment may result.

☆ When switch SW103 is placed in the "Calibrate" position, the unit is no longer monitoring actual flow rates. Verify that removal of this equipment from service will not compromise personnel or equipment safety. Switch SW103 must be placed in the "Operate" position when returning the instrument to service. Access to these controls is gained by loosening the four thumbscrews and removing the upper cover plate.

☆ The current ADAM configuration has been saved on a PC disk using the Kurz Upload/Download program, compatable with the KAS software level. This will be needed to restore the configuration if the battery backed up data is lost.

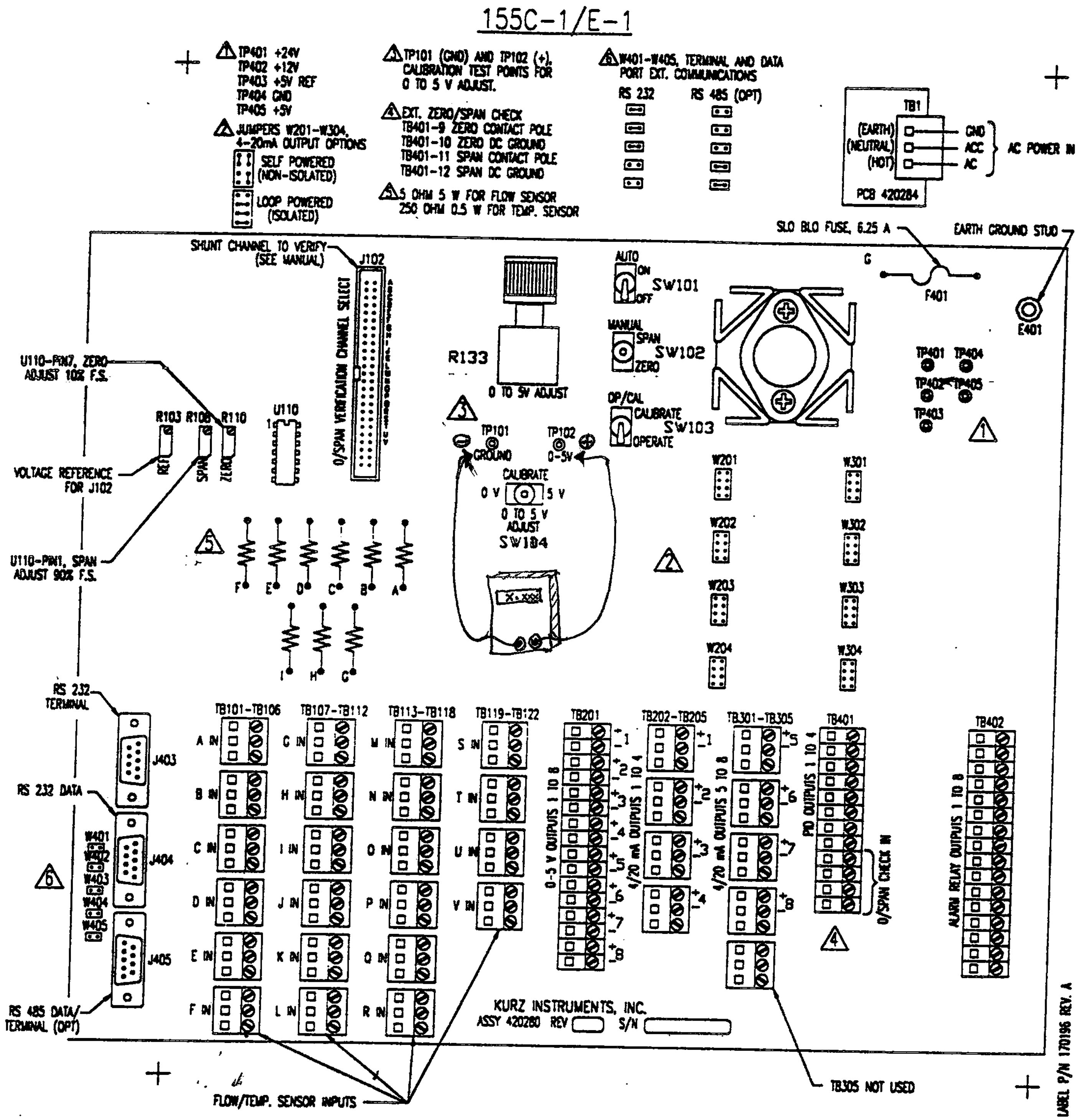


Figure 1. Mother Board, Models 155C-1/E-1/E-RM, Component Location.
The point of view show is for the 155C-1/E-1. The 155E-RM will be upside down from this figure when pulled out of its rack.

FIELD CALIBRATION CHECK

Refer to Figure 1 for component location.

1. Place switch SW103 in the **CALIBRATE** position and the three position switch SW104 in the center position.

2. Connect DVM to TP102(+) and TP101(-). The DVM monitors the adjustable input voltage to the Model 155.

3. Press **D** to see DISPLAY NEXT ^v METER #1.

4. Press **D** until the message "AVG'D CHS ABC... " appears on the front panel LCD. This tells you which channels are included in this Meter.

5. Press **D** to see the first input channel (usually channel A) flow and input voltage values.

6. Using the DC Voltage Current-Sense column of the ***Calibration Data and Certification Document***, adjust R133, until the DVM display indicates the voltage listed at calibration point 1 for the sensor channel under test.

7. Verify that flow rate and voltage values indicated on the Series 155 LCD display are the same (within 0.1% of reading) as those listed on the ***Calibration Data and Certification Document*** for that calibration point.

   Note: *If the flow and/or voltage values indicated on the Series 155, LCD do not agree with listed values on your documentation, recalibration should be performed.*

8. Repeat steps 6 and 7 for the remaining calibration points for channel A.

9. Repeat steps 6, 7, and 8 for the remaining channels of your instrument. Be sure to use the appropriate ***Calibration Data and Certification Document*** for each channel.

10. When testing is completed, press **C** until the Kurz Instruments, time and date message appears on the front panel LCD.

    Note: Output signals from this instrument may be used for automatic control of other devices, BEFORE performing the next step, verify that returning the instrument to service will not present a hazard to personnel or equipment!

11. Return switch SW103 to the **OPERATE** position.

12. Verify that normal operation has been restored to the Series 155 Mass Flow

Computer and any processes that may be under its control.

INPUT CALIBRATION

Refer to Figure 1 for component location.

1. Enter the Program Mode using technician level access code.

2. Press **P** until the message "PRESS ENTER TO CALIBRATE" appears on the front panel LCD, then press **E**.

3. Press the **up (YES)** or **down (NO)** arrow until the message "PRESS ENTER FOR INPUT CAL" appears on the front panel LCD, then press **E**.

4. Press **P** until you see the "SET ZERO VOLTS..." prompt for the channel you wish to calibrate. If you inadvertently pass the desired channel, pressing **C** once will return you to step 3.

5. When you see the message "SET ZERO VOLTS..." for the channel you wish to calibrate, place switch SW103 in the "CALIBRATE" position.

6. Connect DVM to TP102 (+) and TP101 (-)

7. Place the three position switch SW104 in the **0 V** position. (The center position allows the use of R133 to adjust the input voltage from 0 to 5 volts.)

8. Press the **up (YES)** or **down (NO)** arrow until the front panel LCD reading matches the DVM reading (~0.000 volts). The digits may also be entered using the number keys on the keypad. Then press **E**.

9. Place the three position switch SW104 in the **5 V** position. (The center position allows the use of R133 to adjust the input voltage from 0 to 5 volts.)

10. Press the **up (YES)** or **down (NO)** arrow until the front panel LCD reading matches the DVM reading(~5.000 volts). The digits may also be entered using the number keys on the keypad. Then press **E**.

11. This completes the input calibration process for one channel.

    11.1 If you wish to continue for the other channels return to step 4.

    11.2 If you wish to perform output calibration, press **C**, then proceed to the section titled "SET OUTPUT CALIBRATION" of this addendum.

OUTPUT CALIBRATION

Refer to Figure 1 for component location.

1. Enter the Program Mode.

2. Press **P** until you see the message "PRESS ENTER TO CALIBRATE" on the front panel LCD, then press **E**.

3. Press the **up (YES)** or **down (NO)** arrow until you see the message "PRESS ENTER FOR OUTPUT CAL" on the front panel LCD.

4. Press **E**, you should see the message "SET 'ZERO' VOLTS CH 1 = 0.000 VDC".

5. Connect DVM as indicated in the table for 0-5 VDC or 4-20 mA outputs. (See jumper settings Note 2 on Figure 1 for 4-20 mA output configuration.)

OUTPUT	0-5 VDC	4-20 mA SELF -POWERED	4-20 mA CUSTOMER POWERED
CHANNEL 1	TB201-1(+), 2(Gnd)	TB201-1(+), 2(-)	TB201-1(+), 2(-)
CHANNEL 2	TB201-3(+) ,4(Gnd) 1	TB202-1(+), 2(-)	TB202-1(+), 2(-)

Note: If you are using 4-20 mA outputs, ignore the corresponding 0-5 VDC outputs. They will not read exactly 0 and 5 volts. To measure the 4 - 20 mA current disconnect the load wires to attache the current meter on the output.

6. Press the **up (YES)** or **down (NO)** arrow until the DVM indication is 0.000 VDC (for 0-5 VDC output) or 4.000 mA (for 4-20 mA output).

7. Press **E**, you should see the message "SET 'SPAN' VOLTS CH 1 = 5.000 VDC".

8. Press the **up (YES)** or **down (NO)** arrow until the DVM indication is 5.000 VDC (for 0-5 VDC output) or 20.00 mA (for 4-20 mA output).

9. Press **E**. If your instrument is configured for additional output channels the display will read "SET 'ZERO' VOLTS CH 2 = 0.000 VDC". If you wish to perform additional output calibration, repeat steps 4 through 8 for the remaining channels.
   If there are no more output channels configured, you will see the message "PRESS ENTER FOR INPUT CALIBRATION".

10. To set up linearizer data at this time press **C** and then **P** until you see the message "SET LINEARIZERS". Then proceed to the section of this document titled "SET LINEARIZERS".

To exit the Program Mode press **C** until you see the KURZ INSTRUMENTS screen.

SET LINEARIZERS

Note: Performance of this procedure requires a current copy of the Calibration Data and Certification Document for your sensors. This is not part of a periodic calibration procedure but initial equipment setup or troubleshooting.

1. Enter the Program Mode.

2. Press **P** until you see the message "PRESS ENTER TO SET LINEARIZERS" on the front panel LCD, then press **E**.

3. Press **E** in response to the message "PRESS ENTER TO LINEARIZE CH A".

4. Press **P** to accept the current serial number if correct or, use the **up (YES)** or **down (NO)** arrow to scroll through the character set and press **E** for each desired character (letter, number, or symbol).

5. Press the **up (YES)** or **down (NO)** arrow until you see the desired engineering units as listed on the *Calibration Data and Certification Document* for the sensor connected to channel A. Table 2 lists the available selections for instruments configured in English Units or in International Units.

English Units	International Units
SFPM	SMPS
SCFM	SCMM
DEGF	DEGC

6. Press **E** to enter the appropriate engineering units.

7. When the message "ENTER # OF CH A DATA POINTS..." appears, Press the **up (YES)** or **down (NO)** arrow until the correct number of points as listed on the *Calibration Data and Certification Document* is displayed.

8. Press **E** to enter the appropriate number of data points.

9. Using the number keys and decimal point as appropriate, enter the desired voltage for that data point and press **E**. You should see the message "NEW VALUE ACCEPTED", then the bottom line of the display prompts you to enter the flow value for that data point.

10. Using the number keys and decimal point as appropriate, enter the desired flow value for that data point and press **E**. You will then see a prompt to enter the voltage and flow information for the next data point. Continue to enter voltage and flow data for all of the data points listed on the *Calibration Data and Certification Document* for this channel.

11. Repeat these steps for each channel as required.

SET LINEARIZERS (VTM)

Velocity/Temperature Mapping (VTM) was developed by Kurz Instruments, Inc. to improve accuracy of its line of Thermal Mass Flow products in applications where large changes in velocity and temperature are encountered. VTM allows the customer to generate Data Sets at four different temperatures. Information from these Data Sets is used by ADAM® software to compensate for effects of temperature on flow calculations.

1. Enter the Program Mode.

2. Press **P** until you see the message "PRESS ENTER TO SET LINEARIZERS" on the front panel LCD, then press **E**.

3. Press **E** in response to the message "PRESS ENTER TO LINEARIZE CH A".

4. Press **P** to accept the current serial number if correct or, use the **up (YES)** or **down (NO)** arrow to scroll through the character set and press **E** for each desired character (letter, number, or symbol).

5. Press the **up (YES)** or **down (NO)** arrow until you see the desired engineering units as listed on the *Calibration Data and Certification Document* for the sensor connected to channel A. The following options are available:

   ☆ SFPM or SMPS
   ☆ SCFM or SCMM
   ☆ DEGF or DEGC

6. Press **E** to enter the appropriate engineering units.

7. Specify number of temperature Data Sets up to a maximum of four (T1, 2, 3, 4).

8. Press the **up (YES)** or **down (NO)** arrow until the desired temperature reference meter is indicated on the front panel display, then press **E**.

9. Using the numeric keys, specify the desired temperature in DEGF or DEGC for the T1 linearization curve, then press **E**.

10. Specify the number of data points (up to 7) for channel A, then press **E**.

11. Specify the voltage for data point 1, then press **E**.

12. Specify the velocity for data point 1, then press **E**.

13. Continue to specify the calibration points in each data set for Channel A, then repeat these steps for each channel in the system.

14. When you have completed setting the linearizers press **C** as required to return to the Executive Mode.

USER NOTES/CALCULATIONS FOR THE ZERO AND SPAN DRIFT CHECK AND VERIFICATION

Two relays configured as low (zero) and high (span) alarms provide the zero and span drift check feature for the Models 155C-1/E-1/E-RM Mass Flowmeter Computer/Transmitters. A toggle switch (SW102) mounted on the motherboard allows the operator to adjust setpoints and perform the check. Typically, the Zero function is set to 10% of normal full-scale indication. The Span function is set to 90% of full scale indication. During the drift check process, voltage and flow readings are compared with original settings to confirm system accuracy.

Implementation of this feature requires the following steps:

1. Adjustment of zero and span drift check flow values.
2. Setup of Verification Meter.
3. Alarm verification.

The flow value in SCFM (or SCMM) for a full scale, 5 VDC or 20 mA, output must be obtained so that the calculations required for set-up of the verification meter can be obtained.

The following percentages of full scale flow value need to be calculated:

10%	________
15%	________
85%	________
90%	________

The example below illustrates these steps for an instrument where the full scale flow output at 5 VDC = 3000 SCFM:

10%	300 SCFM
15%	450 SCFM
85%	2550 SCFM
90%	2700 SCFM

Adjustment of Drift Check Zero and Span Values

Refer to Figure 1 for component locations.

1. Remove the cover panel of the Model 155C-1/E-1/E-RM Mass Flowmeter Computer/Transmitter.

2. Adjust and record "zero" flowrate value.

   2.1 From the Executive Mode, press **D** to enter the Display Mode.
   2.2 Press **D** until you see the meter flowrate indication on the front panel LCD.
   2.3 Press **H** to hold the display.
   2.4 Hold internal zero/span switch (SW102) on the Series 155 motherboard in the ZERO position and adjust variable resistor R110 (ZERO) until the front panel display indicates 10% of full scale span for your system.
   2.5 Record flowrate indication and release switch SW102.
   2.6 Press **C** to clear the hold function.
   2.7 Press **D** until you see the Input Voltage display.
   2.8 Hold internal zero/span switch (SW102) on the Series 155 motherboard in the ZERO position and record input voltage.
   2.9 Verify that the 4-20 mA output reads 10% of flowrate range and record value.

3. Adjust and record "span" flowrate value.

   3.1 Press **D** until you see the flowrate displayed as in step 2.2.
   3.2 Press **H** to hold the display.
   3.3 Hold internal zero/span switch (SW102) on the Series 155 motherboard in the SPAN position and adjust variable resistor R108 (SPAN) until the front panel display indicates 90% of full scale value for your system.
   3.4 Record flowrate indication and release switch SW102.
   3.5 Press **C** to clear the hold function.
   3.6 Press **D** until you see the Input Voltage display.
   3.7 Hold internal zero/span switch (SW102) on the Series 155 motherboard in the SPAN position and record input voltage.
   3.8 Verify that the 4-20 mA output reads 90% of flowrate range and record value.

4. Verify external control function

   4.1 Short the terminals labeled EXT. ZERO DRIFT CHECK ENABLE on the front panel together (terminals 9 and 10 of TB401).
   4.2 Verify that the Series 155 flowrate indications and 4-20 mA values match the recorded data in steps 2.4 and 2.9.
   4.3 Remove short from terminals 9 and 10 of TB401.
   4.4 Short the terminals labeled EXT. SPAN DRIFT CHECK ENABLE on the

front panel together (terminals 11 and 12 of TB401).

4.5 Verify that the Series 155 flowrate indications and 4-20 mA values match recorded data in steps 3.3 and 3.8.

4.6 Remove short from terminals 11 and 12 of TB401.

Setup Verification Meter

Refer to Figure 1 for component locations.

1. Set Meter Definitions

   1.1 Enter the Program Mode

   1.2 Press the **up (YES)** or **down (NO)** arrow until the message "PRESS ENTER TO SET METER DATA" is displayed on the front panel LCD.

   1.3 Press **E**, then press the **up (YES)** or **down (NO)** button until the LCD indicates the first unused meter number, then press **E**.

   1.4 Using the 20 button keypad, enter the desired Meter ID, such as "ZERO/SPAN".

   1.5 Press **E** to accept the meter type as "INSERTION FLOW".

   1.6 Press the **up (YES)** or **down (NO)** arrow until the message "DISPLAY NEXT ^v FLOW IS SCFM" (or SCMM), appears on the front panel LCD.

   1.7 Press **E** to accept "FLOW IS SCFM" (or SCMM).

   1.8 The next messages will ask you which channels to include. Press the **down (NO)** arrow and **E** to bypass the channels already used by the system. Press the **up (YES)** arrow and **E** to enter the first unused input channel (A, B, C, etc.). Press the **down (NO)** arrow and **E** for the remaining unused channels.

   1.9 Using the 20 button keypad, enter the flow area of the duct in square feet.

   1.10 Since correction factors are not required for this feature, press **C** until you see the message "PRESS ENTER TO SET METER X" where "X" is the next meter #.

   1.11 Place a jumper on the appropriate contacts of J102 for channel selected in step 1.8.

2. Define Linearization Points

   2.1 Press the **up (YES)** or **down (NO)** arrow until the following message appears on the front panel LCD. "PRESS ENTER TO SET LINEARIZERS"

   2.2 Press the **up (YES)** or **down (NO)** arrow until the following message appears on the front panel LCD. "PRESS ENTER TO LINEARIZE CHANNEL X", where "X" is the channel selected for the zero/span drift check feature. Press **E** in response to the prompt.

2.3 Enter ID number of the zero/span meter as defined in step 1.4 of "SETUP VERIFICATION METER".

2.4 Press **up (YES)** or **down (NO)** arrow until message on front panel LCD indicates SCFM or SCMM units as selected in step 1.7 of "SETUP VERIFICATION METER", and press **E** to accept.

2.5 Press the buttons **2** and then **E**, in response to message"ENTER NUMBER OF CH (X) DATA POINTS XX".

2.6 For point 1, enter the voltage and flow units as noted in steps 2.5 and 2.8 of ADJUSTMENT OF ZERO AND SPAN VALUES" for 10% of full-scale span.

2.7 For point 2, enter the voltage and flow units as noted in steps 3.4 and 3.7 of "ADJUSTMENT OF ZERO AND SPAN VALUES" for 90% of full-scale span.

2.8 Press **C** to return to main programming menu.

3. Designate Alarm Points

3.1 Press the **up (YES)** or **down (NO)** arrow until the message "PRESS ENTER TO SET ALARMS" appears on the front panel LCD, then press **E**.

3.2 Press **E** to access alarm #1 data.

3.3 Press **E** to enter alarm data for meter #1.

3.4 Press the **up (YES)** or **down (NO)** arrow until the message "ALARM 1 IS ON" appears on the front panel LCD, then press **E**.

3.5 Press the **up (YES)** or **down (NO)** arrow to select either N.O. (normally open) or N.C. (normally closed) contacts, as required by your system, are displayed then press **E**.

3.6 Press the **up (YES)** or **down (NO)** arrow to select the type of alarm (usually flow rate or velocity for this feature), then press **E**.

3.7 Press **1** to select low alarm, then press **E**.

3.8 Enter a value equal to 15% of full-scale span.

3.9 Press **E** to access alarm #2 data.

3.10 Press **E** to enter alarm data for meter #2.

3.11 Press the **up (YES)** or **down (NO)** arrow until the message "ALARM 2 IS ON" appears on the front panel LCD, then press **E**.

3.12 Press the **up (YES)** or **down (NO)** arrow to select either N.O. (normally open) or N.C. (normally closed) contacts, as required by your system, are displayed then press **E**.

3.13 Press the **up (YES)** or **down (NO)** arrow to select the type of alarm (usually flow rate or velocity for this feature), then press **E**.

3.14 Press **2** to select high alarm, then press **E**.
3.15 Enter a value = to 85% of full-scale span.
3.16 Press **C** until the title screen of the Executive Menu appears.

Notes on the Zero and Span control switches:

The zero/span control functions at TB401 only work if SW101 the "auto zero span switch" is off.

The manual zero/span switch SW102 is independent of the position of SW101 the "auto zero span switch."

Alarm Verification

To verify the zero/span reference input:

Refer to Figure 1 for component locations.

1. Select the zero/span meter and press **D** until you see the average flow indicated on the front panel display.

2. Adjust R103 (REF) until the display reads approximately 50% of full-scale span.

3. To verify operation of the zero/span meter low alarm, hold the zero/span switch (SW102) in the ZERO position. You should hear the alarm click and see the low alarm message on the front panel display.

4. To verify operation of the zero/span meter high alarm, hold the zero/span switch (SW102) in the SPAN position. You should hear the alarm click and see the high alarm message on the front panel display.

5. Release switch SW102 to its center position. Verify that the alarms are reset and that the front panel display indicates the same value as step 2.

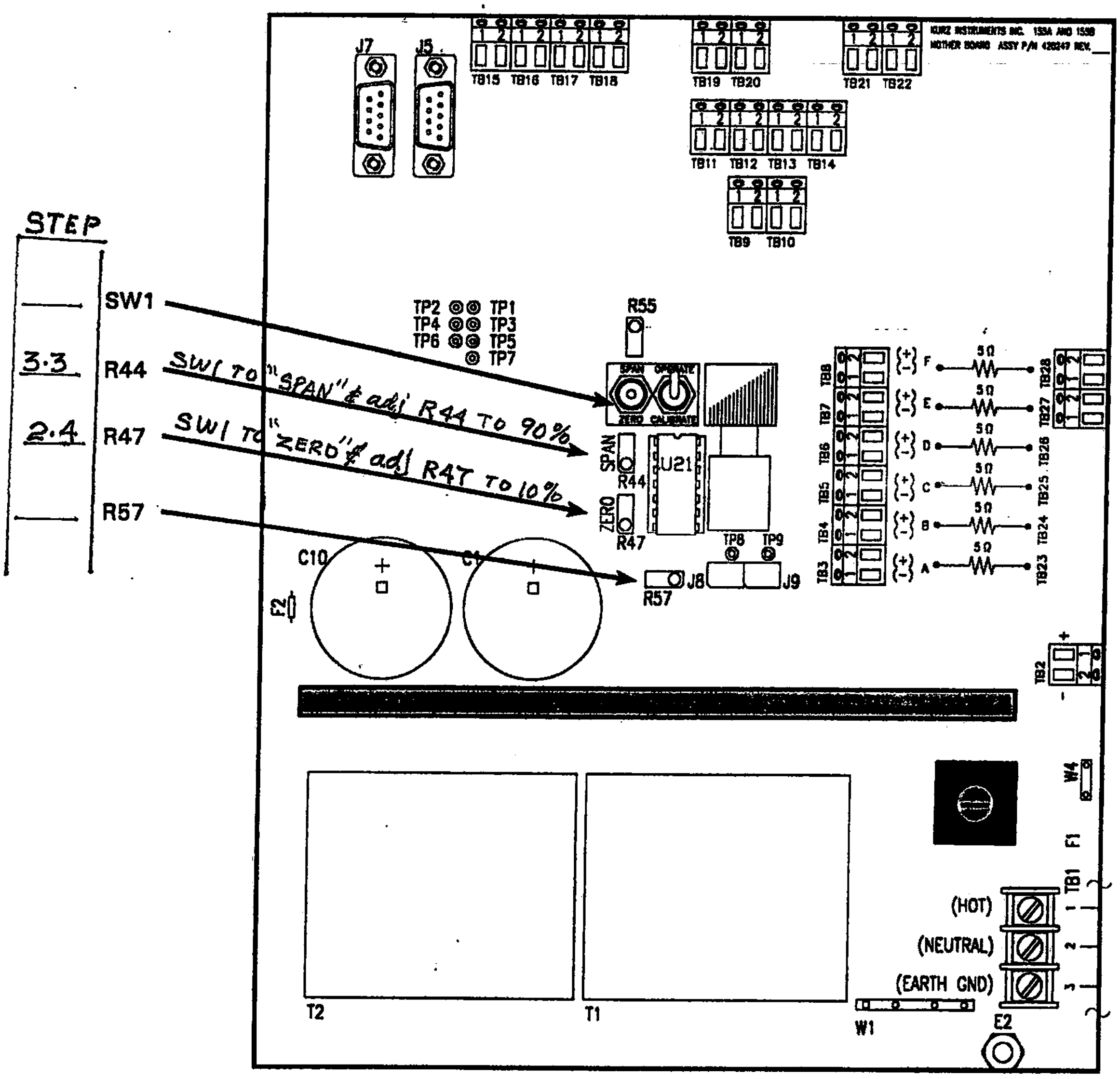


Figure 4. Model 155 A and B, Mother Board, Zero and Span Check Components

573 883 3029 Schuyler

Adjustment of Drift Check Zero and Span Values

Refer to Figure 4 for component locations.

1. Open the front panel of the Model 155A or B Mass Flowmeter Computer/Transmitter.

2. Adjust and record "zero" flowrate value.

   2.1 From the Executive Mode, press [D] to enter the Display Mode.
   2.2 Press [D] until you see the meter flowrate indication on the front panel LCD.
   2.3 Press [H] to hold the display.
   2.4 Hold internal zero/span switch (SW1) on the Model 155 A or B motherboard in the ZERO position and adjust variable resistor R47 until the front panel display indicates 10% of full scale span for your system.
   2.5 Record flowrate indication and release switch SW1.
   2.6 Press [C] to clear the hold function.
   2.7 Press [D] until you see the Input Voltage display.
   2.8 Hold internal zero/span switch (SW1) on the Series 155 motherboard in the ZERO position and record input voltage.
   2.9 Verify that the 4-20 mA output reads 10% of flowrate range and record value.

3. Adjust and record "span" flowrate value.

   3.1 Press [D] until you see the flowrate displayed as in step 2.2.
   3.2 Press [H] to hold the display.
   3.3 Hold internal zero/span switch (SW1) on the Series 155 motherboard in the SPAN position and adjust variable resistor R44 until the front panel display indicates 90% of full scale value for your system.
   3.4 Record flowrate indication and release switch SW1.
   3.5 Press [C] to clear the hold function.
   3.6 Press [D] until you see the Input Voltage display.
   3.7 Hold internal zero/span switch (SW1) on the Series 155 motherboard in the SPAN position and record input voltage.
   3.8 Verify that the 4-20 mA output reads 90% of flowrate range and record value.

4. Verify external control function

   4.1 Short terminals 1 and 2 of TB22 together.
   4.2 Verify that Model 155 A or B flowrate indications and 4-20 mA values match the recorded data in steps 2.4 and 2.9.
   4.3 Remove short from terminals 1 and 2 of TB22.
   4.4 Short terminals 1 and 2 of TB21 together.
   4.5 Verify that Model 155 A or B flowrate indications and 4-20 mA values match recorded data in steps 3.3 and 3.8.
   4.6 Remove short from terminals 1 and 2 of TB21.

Refer to Figure 4 for component locations.

1. Set Meter Definitions

1.1 Enter the Program Mode
1.2 Press the up (YES) or down (NO) arrow until the message "PRESS ENTER TO SET METER DATA" is displayed on the front panel LCD.
1.3 Press [E], then press the up (YES) or down (NO) button until the LCD indicates the first unused meter number, then press [E].
1.4 Using the 20 button keypad, enter the desired Meter ID, such as "ZERO/SPAN".
1.5 Press [E] to accept the meter type as "INSERTION FLOW".
1.6 Press the up (YES) or down (NO) arrow until the message "DISPLAY NEXT ^V FLOW IS SCFM" (or SCMM), appears on the front panel LCD.
1.7 Press [E] to accept "FLOW IS SCFM" (or SCMM).
1.8 The next messages will ask you which channels to include. Press the down (NO) arrow and [E] to bypass the channels already used by the system. Press the up (YES) arrow and [E] to enter the first unused input channel (A, B, C, D, E, or F). Press the down arrow (NO) and [E] for the remaining unused channels.
1.9 Using the 20 button keypad, enter the flow area of the duct in square feet.
1.10 Since correction factors are not required for this feature, press [C] until you see the message "PRESS ENTER TO SET METER X" where "X" is the next meter #.
1.11 Place a jumper on the appropriate contacts of J8 or J9 for channel selected in step 8.

2. Define Linearization Points

2.1 Press the up (YES) or down (NO) arrow until the following message appears on the front panel LCD. "PRESS ENTER TO SET LINEARIZERS"
2.2 Press the up (YES) or down (NO) arrow until the following message appears on the front panel LCD. "PRESS ENTER TO LINEARIZE CHANNEL X", where "X" is the channel selected for the zero/span drift check feature. Press [E] in response to the prompt.
2.3 Enter ID number of the zero/span meter as defined in step 1.4 of "SETUP VERIFICATION METER".
2.4 Press up (YES) or down (NO) arrow until message on front panel LCD indicates SCFM or SCMM units as selected in step 1.7 of "SETUP VERIFICATION METER", and press [E] to accept.
2.5 Press the buttons [2] [E] , in response to message"ENTER NUMBER OF CH

7/29 Evan C 513-489-1324

NOTES

ZERO AND SPAN DRIFT CHECK AND VERIFICATION

Two relays configured as low (zero) and high (span) alarms provide the zero and span drift check feature for the Models 155A and 155B Mass Flowmeter Computer/Transmitters. A toggle switch (SW1) mounted on the motherboard allows the operator adjust setpoints and perform the check. Typically, the Zero function is set to 10% of normal full-scale indication. The Span function is set to 90% of full scale indication. During the drift check process, voltage and flow readings are compared with original settings to confirm system accuracy.

Implementation of this feature requires the following steps:

1. Adjustment of zero and span drift check flow values.
2. Setup of Verification Meter.
3. Alarm verification.

The flow value in SCFM (or SCMM) for a full scale, 5 VDC or 20 mA, output must be obtained so that the calculations required for set-up of the verification meter can be obtained.

The following percentages of full scale flow value need to be calculated:

10%	____________
15%	____________
85%	____________
90%	____________

The example below illustrates these steps for an instrument where full scale flow at 5 VDC = 3000 SCFM:

10%	300 SCFM
15%	450 SCFM
85%	2550 SCFM
90%	2700 SCFM

ZERO AND SPAN DRIFT CHECK AND VERIFICATION

Two relays configured as low (zero) and high (span) alarms provide the zero and span drift check feature for the Models 155A and 155B Mass Flowmeter Computer/Transmitters. A toggle switch (SW1) mounted on the motherboard allows the operator adjust setpoints and perform the check. Typically, the Zero function is set to 10% of normal full-scale indication. The Span function is set to 90% of full scale indication. During the drift check process, voltage and flow readings are compared with original settings to confirm system accuracy.

Implementation of this feature requires the following steps:

1. Adjustment of zero and span drift check flow values.
2. Setup of Verification Meter.
3. Alarm verification.

The flow value in SCFM (or SCMM) for a full scale, 5 VDC or 20 mA, output must be obtained so that the calculations required for set-up of the verification meter can be obtained.

The following percentages of full scale flow value need to be calculated:

10%	____________
15%	____________
85%	____________
90%	____________

The example below illustrates these steps for an instrument where full scale flow at 5 VDC = 3000 SCFM:

10%	300 SCFM
15%	450 SCFM
85%	2550 SCFM
90%	2700 SCFM

7

18VDC

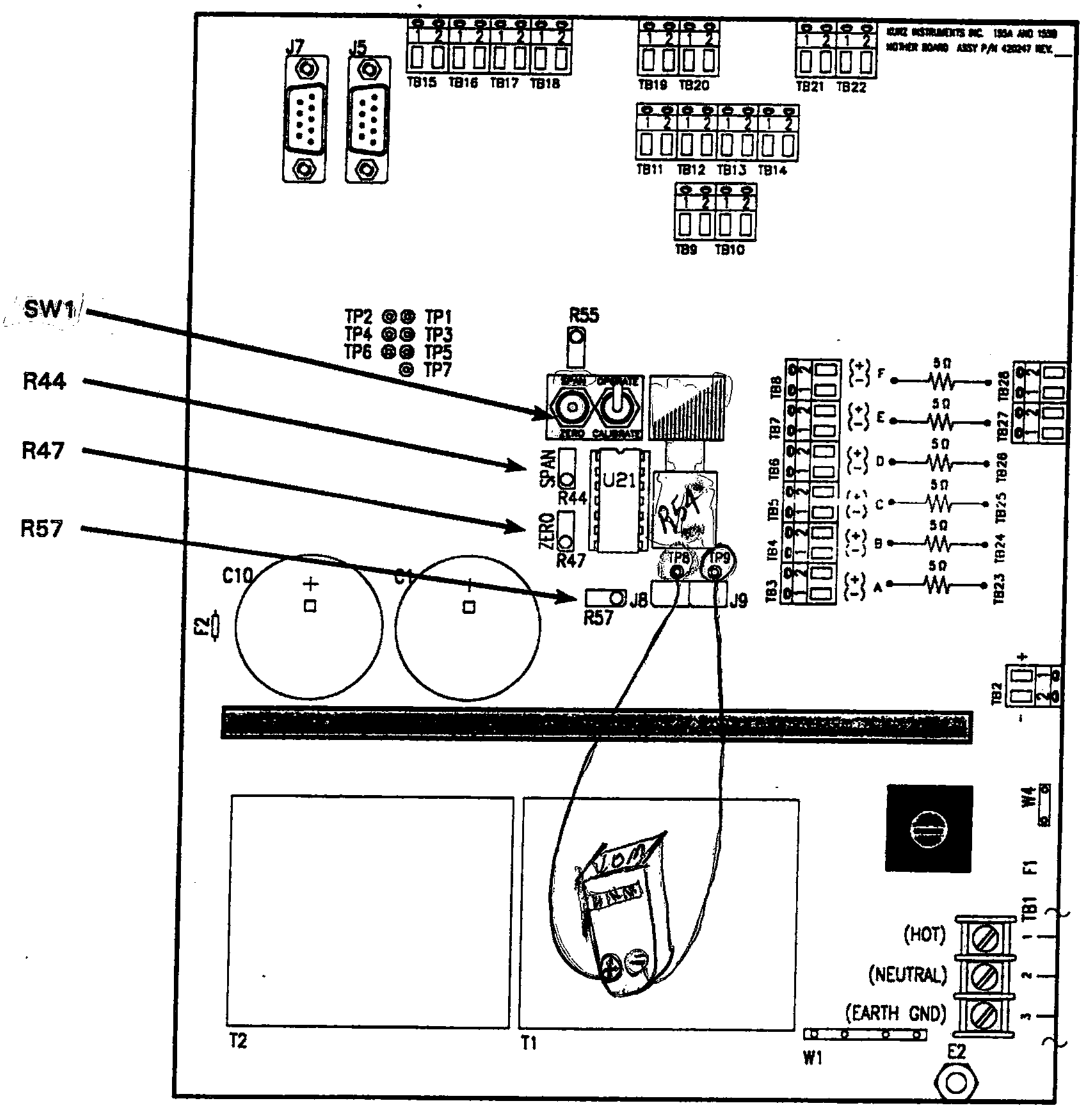


Figure 4. Model 155 A and B, Mother Board, Zero and Span Check Components

INPUT CALIBRATION

Refer to Figure 2 for component location.

1. Enter the Program Mode using technician level acess code. 654321

2. Press [P] until the message "PRESS ENTER TO CALIBRATE" appears on the front panel LCD, then press [E].

3. Press the up (YES) or down (NO) arrow until the message "PRESS ENTER FOR INPUT CAL" appears on the front panel LCD, then press [E].

4. Press [P] until you see the "SET ZERO VOLTS..." prompt for the channel you wish to calibrate. If you inadvertently pass the desired channel, pressing [C] once will return you to step 3.

5. When you see the message "SET ZERO VOLTS..." for the channel you wish to calibrate, place switch SW2 in the "CALIBRATE" position. (ZERO)

6. Connect DVM to TP8 (+) and TP9 (-)

7. Adjust R54 until the DVM indicates 0.000 VDC. (ZERO ADJ)

8. Press the up (YES) or down (NO) arrow until the front panel LCD indicates 0.000 volts. Then press [E].

9. Adjust R54 until the DVM indicates 3.000 VDC. (SPAN ADJ)

10. Press the up (YES) or down (NO) arrow until the front panel LCD indicates 3.000 volts. Then press [E].

11. This completes the input calibration process for one channel.

    11.1 If you wish to continue for the other channels (up to 3 for a Model A or 6 for a Model B) return to step 4.

    11.2 If you wish to perform output calibration, press [C], then proceed to the section titled "SET OUTPUT CALIBRATION" of this addendum.

Setup Verification Meter

Refer to Figure 4 for component locations.

1. Set Meter Definitions

   1.1 Enter the Program Mode
   1.2 Press the up (YES) or down (NO) arrow until the message "PRESS ENTER TO SET METER DATA" is displayed on the front panel LCD.
   1.3 Press [E], then press the up (YES) or down (NO) button until the LCD indicates the first unused meter number, then press [E].
   1.4 Using the 20 button keypad, enter the desired Meter ID, such as "ZERO/SPAN".
   1.5 Press [E] to accept the meter type as "INSERTION FLOW".
   1.6 Press the up (YES) or down (NO) arrow until the message "DISPLAY NEXT ^V FLOW IS SCFM" (or SCMM), appears on the front panel LCD.
   1.7 Press [E] to accept "FLOW IS SCFM" (or SCMM).
   1.8 The next messages will ask you which channels to include. Press the down (NO) arrow and [E] to bypass the channels already used by the system. Press the up (YES) arrow and [E] to enter the first unused input channel (A, B, C, D, E, or F). Press the down arrow (NO) and [E] for the remaining unused channels.
   1.9 Using the 20 button keypad, enter the flow area of the duct in square feet.
   1.10 Since correction factors are not required for this feature, press [C] until you see the message "PRESS ENTER TO SET METER X" where "X" is the next meter #.
   1.11 Place a jumper on the appropriate contacts of J8 or J9 for channel selected in step 8.

2. Define Linearization Points

   2.1 Press the up (YES) or down (NO) arrow until the following message appears on the front panel LCD. "PRESS ENTER TO SET LINEARIZERS"
   2.2 Press the up (YES) or down (NO) arrow until the following message appears on the front panel LCD. "PRESS ENTER TO LINEARIZE CHANNEL X", where "X" is the channel selected for the zero/span drift check feature. Press [E] in response to the prompt.
   2.3 Enter ID number of the zero/span meter as defined in step 1.4 of "SETUP VERIFICATION METER".
   2.4 Press up (YES) or down (NO) arrow until message on front panel LCD indicates SCFM or SCMM units as selected in step 1.7 of "SETUP VERIFICATION METER", and press [E] to accept.
   2.5 Press the buttons [2] [E] , in response to message"ENTER NUMBER OF CH

(X) DATA POINTS XX".

2.6 For point 1, enter the voltage and flow units as noted in steps 2.5 and 2.8 of ADJUSTMENT OF ZERO AND SPAN VALUES" for 10% of full-scale span.

2.7 For point 2, enter the voltage and flow units as noted in steps 3.4 and 3.7 of "ADJUSTMENT OF ZERO AND SPAN VALUES" for 90% of full-scale span.

2.8 Press [C] to return to main programming menu.

3. Designate Alarm Points

3.1 Press the up (YES) or down (NO) arrow until the message "PRESS ENTER TO SET ALARMS" appears on the front panel LCD, then press [E].

3.2 Press [E] to access alarm #1 data.

3.3 Press [E] to enter alarm data for meter #1.

3.4 Press the up (YES) or down (NO) arrow until the message "ALARM 1 IS ON" appears on the front panel LCD, then press [E].

3.5 Press the up (YES) or down (NO) arrow to select either N.O. (normally open) or N.C. (normally closed) contacts, as required by your system, are displayed then press [E].

3.6 Press the up (YES) or down (NO) arrow to select the type of alarm (usually flow rate or velocity for this feature), then press [E].

3.7 Press [1] to select low alarm, then press [E].

3.8 Enter a value = to 15% of full-scale span.

3.9 Press [E] to access alarm #2 data.

3.10 Press [E] to enter alarm data for meter #2.

3.11 Press the up (YES) or down (NO) arrow until the message "ALARM 2 IS ON" appears on the front panel LCD, then press [E].

3.12 Press the up (YES) or down (NO) arrow to select either N.O. (normally open) or N.C. (normally closed) contacts, as required by your system, are displayed then press [E].

3.13 Press the up (YES) or down (no) arrow to select the type of alarm (usually flow rate or velocity for this feature), then press [E].

3.14 Press [2] to select high alarm, then press [E].

3.15 Enter a value = to 85% of full-scale span.

3.16 Press [C] until the title screen of the Executive Menu appears.

Alarm Verification

To verify the zero/span reference input:

Refer to Figure 4 for component locations.

1. Select the zero/span meter and press [D] until you see the average flow indicated on the front panel display.

2. Adjust R57 until the display reads approximately 50% of full-scale span.

3. To verify operation of the zero/span meter low alarm, hold the zero/span (SW1) in the ZERO position. You should hear the alarm click and see the low alarm message on the front panel display.

4. To verify operation of the zero/span meter high alarm, hold the zero/span switch (SW1) in the SPAN position. You should hear the alarm click and see the high alarm message on the front panel display.

5. Release switch SW1 to its center position. Verify that the alarms are reset and that the front panel display indicates the same value as step 2.

than 25% full scale (zero) and a different signal which is greater than 75% full scale (span). During this check, the flow computer output is compared to a previously certified response to check its tracking. This feature is not supported on the two smallest flow computers, the155Jr or 155Jr-DC.

Note: The flow system must be field calibrated and reading the absolute value of interest before setting up the Zero-Span drift check.

The field wiring diagrams for the flow computers should be referenced to locate the variable resistors, switches, jumpers and terminals that will be referenced. The following table should be used to locate these components depending on which 155 unit you have.

Daily Zero-Span setup adjustments for the supported 155 Flow Computers

	155A/B/B-RM	155C-2/E-2/RM2
Zero adjustment	R47	R110
Span adjustment	R44	R108
Local Zero switch	NA	SW102, hold at Zero
Local Span switch	NA	SW102, hold at Span
External Zero Drift Check Enable	TB22-1 and 2	TB401-9 and 10
External Span Drift Check Enable	TB21-1 and 2	TB401-11 and 12
Verification Channel adjustment	R57	R103
Verification Channel Selection	J8 is Channels A, B and C; J9 is Channels D, E and F. One shut is used vertically in the position for the verify channel.	J102, pins 1 to 22 are Channels A to V. One shut is used horizontally for the verify channel.
Verification Alarm Contacts	User defined in *Program mode* to match the verification channel METER.	

Implementation of this feature requires the following steps:

1. Adjustment of zero and span drift check flow values.
2. Setup of Verification METER.
3. Alarm verification.

The flow value in SCFM (or SCMM) for a full scale, 5 VDC or 20 mA, output must be obtained so that the calculations required for set-up of the verification METER can be obtained.

The following percentages of full scale flow value need to be calculated:

10%	________
15%	________
85%	________
90%	________

The example below illustrates these steps for an instrument where the full scale flow output at 5 VDC = 3000 SCFM:

10%	300 SCFM
15%	450 SCFM
85%	2550 SCFM
90%	2700 SCFM

Adjustment of Drift Check Zero and Span Values

1. Remove the cover panel of the Model 155C-2/E-2/E-RM2 Mass Flow meter Computer/Transmitter.

2. Adjust and record "zero" flow rate value.

    2.1 From the Executive Mode, press **D** to enter the Display Mode.
    2.2 Press **D** until you see the METER flow rate indication on the front panel LCD.
    2.3 Press **H** to hold the display.
    2.4 Hold internal zero/span switch (or external contact) on the Series 155 motherboard in the ZERO position and adjust the Zero variable resistor until the front panel display indicates 10% of full scale span for your system.
    2.5 Record flow rate indication and release the switch (or external contact).
    2.6 Press **C** to clear the hold function.
    2.7 Press **D** until you see the Input Voltage display.
    2.8 Hold internal zero/span switch (or external contact) on the Series 155 motherboard in the ZERO position and record input voltage.
    2.9 Verify that the 4-20 mA output reads 10% of flow rate range and record value.

3. Adjust and record "span" flow rate value.

Ranging the 4-20 mA Output

To change the scale of the output range you must enter *Program mode* to specify the zero value for 4 mA, span for 20 mA and which analog output channel is assigned to the METER you want to transmit. The units available for the METER output depend on if the METER is flow rate, mass or temperature and the unit system, English or metric (the unit-system is a Factory program option only).

Enter Program mode by pressing **P** followed by the **tech. code** and **E**. Use the **P** key to find the menu category SET ANALOG OUTPUT then press **E**. The next screen:

PRESS ENTER FOR **ANALOG OUT 1**

can be changed to Output 1 - 8 but using the **^v** keys or the number on the keypad followed by **E** to select that output channel. The next screen:

ANALOG OUT 1 **ENTER METER # 1**

is used to select which METER, 1 to 16 that is assigned to output channel 1. You use the **^v** keys or type the number on the keypad to select the METER number followed by **E**. The next screen:

OUT #1 NEXT TYPE **^v FLOW RATE**

can be FLOW RATE or AVE VELOCITY for an insertion flow meter. If flow rate is selected, the specific flow units which show up depend on the METER type, volumetric (SCFM, SCFH, SCMM, SLPM) or mass rate (PPM, KGM) selected under the *SET METER DATA* menu category. The following screens select the zero and span values.

LO 0.00000000 SCFM

Where you can use the **^v** keys or type the value on the keypad followed by **E** to accept the value. The next screen shows:

LO 0.000000 SCFM **AT 0.0000 V**

You enter the voltage corresponding to the low output value and press **E** to accept. Leaving this at 0 V means 4 mA. The next screen is for the span which looks like:

HI XXXXX SCFM

You enter the value for span with the keypad or **^v** keys followed by **E** to accept. The next screen shows you the voltage of the span value, 5.00 V corresponds to 20 mA which you have previously calibrated.

HI XXXXX SCFM
AT 5.0000V

You can change the value with the keypad or **^v** keys followed by **E** to accept the changes. The next screen is for the next analog output which you can setup and repeat the above sequence or change the output number with the **^v** keys or keypad followed by **E** to accept the output channel number.

PRESS ENTER FOR
ANALOG OUT 2

Once you have set the output channel ranges you press **C** several times to exit *Program mode.*

Input Calibration

Please refer to the appropriate field wiring diagram in the Appendix for the following procedure. Each of the 155 models has a run or operate/calibrate switch or shunt defined on this drawing. (see the Installation section for a table of the drawings for each model)

Once in calibrate, another switch or shunt determines what voltage will be applied to the inputs. This voltage should be monitored with a precision multimeter with 4 ½ digit scale and 0.1% basic accuracy. Placing the volt meter ground at TPx and its positive lead on TPy you can read the exact voltage applied to the inputs.

Next, place the 155 in *Program Mode* and navigate to the Calibration menu

PRESS ENTER TO
CALIBRATE

You press the **E** key and you should see the next menu for input calibration, if not press the **^v** key until you do:

PRESS ENTER FOR
INPUT CAL.

Again you press the **E** key and you will now see this screen for the first input channel:

SET 'ZERO' VOLTS
CH A =0.0000 V

You must have the input switch in the ZERO position and the multimeter reading 0.000 V. If they all agree you press **E** to move to the span setting. If the readings are not near zero, say 0.0056 then enter this number on the keypad followed by the **E** key.

SET 'SPAN' VOLTS
CH A =5.0000 V

Which will read about 5 V when the input switch is in the SPAN position. Again you type in the actual voltage reading of the volt meter followed by the **E** key. You will now see the same menu screen for channel B:

SET 'ZERO' VOLTS
CH B =0.0000 V

Now you repeat the process you did for channel A. This is done for all active input channels.

When you are done, you press the **C** key a few times to exit *Program mode* and place the operate/calibrate switch/shut back into the operate position.

Channel Kickout

A channel kick-out (due to malfunction) is ~~based on a % change in this linearized~~ range, not the output range. Typically this is set to –1 % to 110 % of the ~~calibrated velocity~~ range for an insertion element or flow range of an in-line flow element. This function must be on for all channels or off for all channels. The only way to trim the kickout values between channels is by editing the linearizer data to cover more or less range.

This function is used to remove a defective sensor or disconnected sensor from a METER average calculation. On a four point K-BAR system, the readings would be 25% low if one of the sensors went out and it was not removed from the average. Alternately, the sensor can fail reading high velocity and this too would be removed by having an upper limit on the range (110% for example).

METER Correction Factors

There are two methods available in the 155 flow computer to apply field derived correction factors. The first is known as Variable Correction Factor (VCF) and the other is Configuration Correction Factor (CCF).

The VCF method allows up to seven correction factors at different average velocities. At each velocity of interest, you enter a number, which will multiply the data to achieve the correct flow rate. While the Series 155 is often configured for

```
ENTER # OF RM
DATA SETS 3
```

Here you enter the number of flow rate data sets you have collected data on. The RM refers the number of Reference Method data sets or flow rates you used. You might have used 100%, 75% and 50% of full scale in which case you would enter a **3** followed by the **E** key. Next you will see a screen to prompt you that data set 1 will be entered. You can use the **^v** keys to chose another data set if needed. You must start at the lowest flow rates first (50% for this example) and go up.

```
ENTER RM DATA
SET 1
```

Press the **P** or **E** key to move on to the next screen where you enter the average velocity computed from your traverse or other Reference Method that can compute the duct average velocity.

```
Vrm1
xxxx.xx SMPS
```

The Vrm1 is the reference method average velocity for data set 1. You enter the average velocity then press the **E** key. Next you see the screens for the individual channel velocities measured with the log at the same time you took the reference flow data.

```
Vds1 CH B
xxxx.xx SMPS
```

This is the observed velocity for the first included channel of that METER being calibrated. You repeat this process for all the included channels of the multipoint sensor element METERs.

After you enter the data for all channels, you will see the computed correction factor when all channels are active.

```
C.F. #1 = 0.980
AT  48.78 SMPS
```

You can now press the **P** or **E** keys to move to the next data set (if any) and repeat the channel data entry process listed above. Remember that you must enter the data from the lowest velocities up starting at data set 1.

Daily Zero-Span Drift Check

The Series 155 have been designed to comply with the EPA (Environmental Protection Agency) regulations on large energy users for a daily zero-span drift check of the CEMS (Continuous Emissions Monitoring Systems). This is simply a circuit which substitutes a sensor input signal to the flow computer which is less

USER'S GUIDE

TO

FLOW PERFECT™

Automatic Configuration Correction Factor

For Kurz Multi-Point Mass Flow Elements

Dr. Jerry Kurz

President

Kurz Instruments, Inc.

12-04-95

I. INTRODUCTION:

Flow Perfect™ is a user friendly software routine developed for the Series 155 Mass Flow Computers used with Multi-Point Thermal Mass Flow Elements. It's purpose is to increase relative accuracy, automatically correct for the deletion of one or more sensors and provide unexcelled reliability because of the overall system redundancy. Generally, Flow Perfect™ is used with the Series K-BAR 24 Multi-Point Mass Flow Elements to measure the mass flow rate of larger pipes, ducts or stacks. Because of the extreme reliability and accuracy requirements (and eventually sizable penalties), the currently most popular application is for stack flow monitoring required under the U.S. EPA, 40 CFR 75 regulations for the measurement of sulfur dioxide and other pollutants in large fossil fuel electric power plants. An equally important application is for combustion air flow measurement and control.

Although Kurz provides an accurate (NIST Traceable) wind tunnel velocity calibration of each independent mass velocity sensor, a non-uniform velocity profile, lack of an adequate number of sensing points, or effects of the gas thermal properties caused by the products of combustion (mainly water and carbon dioxide), requires that an insitu, field calibration be performed to certify the system under the rules of 40 CFR 75. Furthermore, a semi-annual or annual **R**elative **A**ccuracy **T**est **A**udit (RATA) must be passed. The system under test is compared against an approved **R**eference **M**ethod (RM). In most cases, this is the U.S. EPA Method II, which utilizes a Type S Pitot Tube used under very well defined procedures. Flow Perfect™ utilizes the Reference Method Test Data to automatically compute the flow **C**onfiguration **C**orrection **F**actor (CCF) over a wide range of flow rates (typically 20-100%), in the event of a change in configuration. Such a change may occur under the following conditions:

A) A sensor has failed due to damage, corrosion or a bad connection,

B) A K-BAR has been purposefully removed from the system for routine maintenance.

The most important advantage of Flow Perfect™ is that it allows system redundancy. Unlike single sensor flow monitors that fail completely when the single sensing system fails, the Kurz system with Flow Perfect™ keeps on operating at nearly the same accuracy, giving the user time to fix a problem or to do a scheduled maintenance without requiring a recertification simply because of the removal of one or more independent, redundant sensors. It is our opinion that Flow Perfect ™ eliminates any requirement to recertify a Kurz system simply because of a sensor failure.

II. MATHEMATICAL BASIS FOR FLOW PERFECT™.

The corrected flow rate is the product of the average measured velocity taken at the centroid of equal areas (same as the EPA Reference Method) times one or more appropriate experimental determined correction factors, times the flow area of the pipe duct or stack:

Equation (1):

$$Q \cdot (BCF)(CCF)(V_{AVG}) \times AREA$$

Where:
- Q = The corrected flow rate (SCFM)
- BCF is the bias correction factor
- CCF is the configuration correction factor
- V_{AVG} is the average velocity of the active mass velocity sensors in the meter array (SFPM)
- Area = the cross sectional area of the duct (FT^2)

BCF is usually applied after the reference method tests are completed. It is used to make small changes in the output or to correct for different standard conditions and is a constant.

When a Kurz multi-point mass flow system is installed, there is a wealth of information regarding the velocity profile because of the ability of the ADAM Mass Flow Computer to display the individual velocity readings of each sensor. Since most stack flow systems produce a fairly repeatable velocity profile under normal conditions, this information can be used to correct the measured average velocity in the event that one or more sensors are deactivated, whether for test, for inspection, or maintenance or due to an equipment failure. If one sensor continuously indicates a significantly higher reading than the average, if it were

deactivated, and the remaining sensors were used to compute the average, a significant error would be made if Flow Perfect™ were not used.

Since the ADAM Mass Flow Computer "knows" which sensors are inactive, it can correct the output based upon what the correction factor would have been if the inactive sensors had not been included in the average during the reference test. By using the Reference Method Test average velocity (V_{RM}) and the simultaneously measured readings on each velocity sensor (V_{ds}) for each stack flow data set the Flow Perfect™ software automatically calculates a correction factor for each data set whenever the sensor array configuration changes.

Therefore, whenever there is a configuration change, a new set of correction factors are generated as a function of the measured average velocity of the remaining sensors for each data set (four are allowed): This is a variable velocity correction factor such that different correction factors may be used at each data set. A lagrangian interpolation route is used to calculate the appropriate correction factors for intermediate velocities.

Therefore:

$$C.F.\#1 \bullet \frac{V_{RM1}}{(V_{ds1chA1} + V_{ds1chB} \cdots V_{ds1chV})/N} \bullet \frac{V_{RM1}}{V_{ds1AVG}} \qquad \textbf{(2)}$$

$$C.F.\#4 \bullet \frac{V_{RM2}}{(V_{ds2chA1} + V_{ds2chB} + \cdots V_{dschV})/N} \bullet \frac{V_{RM4}}{V_{ds4AVG}}$$

Where: V_{RM1} is the Reference Method Average Stack Velocity for Data Set 1, etc.

V_{ds1CHA} is the velocity of the sensor at input Channel "A" for Data Set 1, etc.

N = Number of active sensor channels

C.F. #1 = Correction Factor for Data Set #1, etc.

A simple example:

Assume that two reference data sets have been measured, and we have an array of four independent sensors and a 100 square foot duct. The collected data is:

Date Set #1:

V_{RM1} = 2000 SFPM, Q = 200,000 SCFM
V_{ds1chA} = 1500 SFPM
V_{ds1chB} = 2500 SFPM
V_{ds1chC} = 2500 SFPM
V_{ds1chD} = 1500 SFPM
V_{ds1AVG} = 2000 SFPM
C.F. #1 =1.00 @ V_{AVG} = 2000 SFPM with all four sensors working.

Data Set #2:

V_{RM2} = 4000 SFPM, Q = 400,000 SCFM
V_{ds2chA} = 3000 SFPM
V_{ds2chB} = 5000 SFPM
V_{ds3chC} = 5000 SFPM
V_{ds3chD} = 3000 SFPM
$V_{ds2AVG.}$ = 4000 SFPM
C.F. #2 = 1.00 @ V_{AVG} = 4000 SFPM with all four sensors working.

Next assume that the sensor at Channel B has been "kicked-out" by the Flow Perfect™ Software. ADAM will calculate new Correction Factors:

C.F. #1:

$V_{RM1} = 2000, N=3$

$$V_{ds1AVG} \bullet \frac{1500 \bullet 0 \bullet 2500 \bullet 1500}{3} \bullet 1833.33\ SFPM$$

$$C.F.\#1 \bullet \frac{2000}{1833.33} \bullet 1.090909\ @\ 1833.33 SFPM$$

C.F.#2:

VRM2 = 4000; N = 3

$$V_{ds2AVG} \bullet \frac{3000 \bullet 0 \bullet 5000 \bullet 3000}{3} \bullet 3666.66 SFPM$$

$$C.F.\#2 \bullet \frac{4000}{3666.66} \bullet 1.090909\ @\ 3666.66\ SFPM$$

Since the Correction Factor is the same as for Test Data Sets, the Correction Factor is constant and no interpolation is required for an indicated average velocity of 3666.66 SFPM, the corrected flow rate (with a BCF = 1.0) is

Q = (1.0) x 1.090909 x 366.66 x 100

= 400,000 SCFM which is the correct value.

Our simple example has assumed that the velocity profile doesn't change with flow rate. In actually use, the velocity profile may change, however, our velocity sensors change accordingly, and pick-up most of the non-uniform behavior, even though wemay use a small number of sensors. Obviously, a larger number of sensors will pick up more of these changes and give more accurate numbers. Flow Perfect™ works so well because it has knowledge of the output of each sensor; something a multi-point Pitot tube or Ultrasonic system cannot duplicate.

KURZ INSTRUMENTS

III. SETTING UP FLOW PERFECT™:

Please refer to the attached menu for Flow Perfect™. For other programming information refer to the ADAM Mass Flow Computer Manual. This program is used for Multi-Point Insertion Mass Flow Elements such as the K-BAR 16, K-BAR 24 or Multiple Single-Point Insertion Mass Flow Elements such as a Series 450.

DISPLAY NEXT ^V FLOW IS SCFM	Press the up (YES) or down (NO) arrow to select flow measurement in SCFM,SCFH or PPH. If the instrument is programmed for International units, the choices will be SCMM, SCMH or KGH.
SPECIFIC GRAVITY IS 1.000	This message will only be displayed if the user has selected PPH or KGH in the previous step. Use the numeric keys to specify the specific gravity of the gas to be measured, then press E. The default value is 1 (air).
INCLUDE CH X ^-YES V-NO	Press the up (YES) arrow to include the indicated channel in average flow calculations for this METER. Press the down (NO) arrow to exclude the indicated channel from average flow calculations for this METER.
ENTER FLOW AREA xxxxxx SQ. FT	Use the numeric keys to specify the area of the stack or duct where the probe is mounted. Engineering Units will be in square feet for instruments programmed in English Units or square meters when programmed for International Units.
CF TYPE ^=CCF V=VCF	CCF is the correct correction factor for using Flow Perfect™. Press the up (YES) arrow, then press E.
BCF = 1.000	BCF = Bias Correction Factor. It is a fixed correction

over

r the entire measurement range. It is usually used to adjust the output after the CCF data has been installed. The default value = 1.000, press E.

ENTER # OF RM DATA SETS x	Use the numeric keys to enter the number of Reference Method calibration measurement data sets taken up to a maximum of 4. Generally, these represent approximately 25, 50, 75, 100% of the maximum average velocity. Press E to continue.
Enter RM Data Set 1	This data must be entered in ascending order of velocity. Press E to continue.
V_{RM1} xxxxxx SFPM	V_{rm1} is the averge velocity measured by the Reference Method (RM) for the first data set. Press E to continue.
V_{ds1} CHA XXXXXXX SFPM	V_{ds1chA} is the simultaneously measured indicated velocity for each channel that constitute the Multi-Point Insertion Meter for Data Set 1. Similarly enter data for other channels and other data sets.
C.F. #1 = X.XXX AT xxxxx SFPM	This is the calculated value of the Correction Factor for Data Set #1. It is displayed for convenience. The C.F. is the ratio of the Reference Method Average Velocity (SFPM) divided by the average of the active channels indicated velocities $V_{ds1\ chA,\ B\ ....V}$. Press E to continue to enter the V_{RM} and V_{ds} for the remainder of the data sets. When completed, the LCD will prompt you to set meter data for the next METER, if

appropriate.

Below is an example of the sequential ADAM display while programming Flow Perfect™ for a Multi-Point System (Channels A, B, C and RM data sets). By using the ECHO terminal while in the program mode, this can be logged and printed by using a PC.

PRESS ENTER TO SET METER #1
ENTER METER ID: METER-000001
NEXT TYPE • • INSERTION FLOW
DISPLAY NEXT • • FLOW IS SCFM
INCLUDE CH A • =YES • =NO:YES
INCLUDE CH B • =YES • =NO:YES
INCLUDE CH C • =YES • =NO:YES
ENTER FLOW AREA 1 SQ FT
CF TYPE CCF • =CCF • =VCF
BCF = 1
ENTER # OF RM DATA SETS 3
ENTER RM DATA SET 1
V_{RM1} 750 SFPM
V_{DS1} CH A 500 SFPM
V_{DS1} CH B 500 SFPM
V_{DS1} CH C 500 SFPM
C.F. #1 =1.5 AT 500 SFPM
V_{RM2} 3250 SFPM
V_{DS2} CH A 2500 SFPM
V_{DS2} CH B 2500 SFPM
V_{DS2} CH C 2500 SFPM
C.F. #2 = 1.30 AT 2500 SFPM
V_{RM3} 5000 SFPM
V_{DS3} CH A 4000 SFPM
V_{DS3} CH B 4000 SFPM
V_{DS3} CH C 4000 SFPM
C.F. #3 = 1.250 AT 4000 SFPM
PRESS ENTER TO SET METER #2

IV. THE NEED FOR FLOW PERFECT™:

In the early stages of the development of the ADAM Mass Flow Computer and the K-BAR 24 Multi-Point Mass Flow Elements, we used VCF (Variable **V**elocity **C**orrection **F**actors). These were calculated based on Reference Method Tests. The Kick-Out Software routine was used to obtain the average velocity of the remaining sensors. However, unless there are enough sensors to "swamp-out" the effects of an "outlaw" sensor that is substantially higher or lower than the average, serious error can develop when the configuration changes due to a deactivated sensor. This is why Kurz developed Flow Perfect™.

Some users have suggested that we certify several configurations and obtain correction factors ahead of time. Since most large stack flow monitors have 12 sensors, one would need to compute 4096 separate configurations! This is why we used the intelligence and on-line computational power of ADAM. It only calculates a new set of correction factors when required, and does so automatically, to cover all 4096 possibilities!

One reason for developing Flow Perfect™, is to improve availability and accuracy, by having redundancy. Another is (unlike single sensor systems that are required by EPA to recertify whenever the sensor fails) we can continue to operate with nearly the same accuracy. We see no reason to force a recertification due to the removal for maintenance or replacement of sensors. Tennesse Valley Authority's test studies using Flow Perfect™ (removing 6 or 7 out of 8 sensors) had no noticeable effect at Widow's Creek, for example. We are certain that a user can remove up to at least 50% of the original sensors, and still maintain 7.5% relative accuracy.

We recommend that our customers fully document Flow Perfect™ by removing sensors and recording the results before and after. A random selection of sensors removable under operating conditions is very easy. If this data were taken carefully and documented to show how many sensors can be removed before affecting the results by a certain percentage, the Environmental

Protection Agency and other agencies should approve Flow Perfect™. By using the "Kick-Out Count" feature of Flow Perfect™, the number of allowable deactivated sensors may be set before an alarm relay is triggered. Our goal is to provide extremely high reliability and to simplify and reduce the cost of maintenance and truly unneccessary recertification testing.

We are asking the EPA to work with the Utilities and Kurz to verify the advantages and give approval to the use of Flow Perfect™ and our multi-point, independent sensor technology to improve the customer's availability, reliabilility, and reduce service and recertification expenses.

Introduction

The purpose of this procedure is to provide the User with the method to adjust the output of the Series 155 ADAM Mass Flow Computer to correct for possible calibration error. ADAM software allows the User to enter a Correction Factor (C.F.) for one or more reference test data sets. The ADAM software interpolates to provide a C.F. for intermediate flow rates. The basic idea is to record the Kurz output data at the same time that the reference flow measurements are made for each in-situ flow test and use this information to correct the Kurz data to agree with the reference method data.

Thus:

Corrected SCFM = (C.F.) x V_{KAVG} x A

C.F. = Correction Factor

V_{RMAVG} = Reference Method Average Velocity during test

V_{KAVG} = Kurz Average Velocity during test

A = Duct/Stack Area defined in Square Feet (FT^2)

SCF = Standard Cubic Feet

ET = Elapsed Time in minutes

Detailed Procedure

A) For each Reference Test:

1) At the start of the test, record the Kurz totalized flow (1), and elapsed time (1). This is most easily accomplished by using the Demand Print Feature (L) of the ADAM Mass Flow Computer. and a laptop computer with the Upload/Download/Record Program. This method averages the signals automatically and saves time.

2) At the end of the test, record the Kurz totalized flow (2), and elapsed time (2) as in Step 1.

3) Calculate the Reference Method Average Velocity measured with the Pitot Tube Velocity Measurement System using EPA Method 2 procedures, equivalent acceptable reference method, or Kurz Tracer Gas Dilution Method. Correct this data to Standard Conditions of 25°C and 760mm Hg.

4) Calculate the Kurz Average Velocity by using the data collected in Step 1 and 2:

   a) V_{KAVG} = SCF/[ET x A], or $V_{KAVG} = \frac{\text{Totalized Flow (2) - Totalized Flow (1)}}{\text{[Elapsed Time (2) - Elapsed Time (1)] x A}}$

b) Calculate the Correction Factor: C.F. = V_{RMAVG} / V_{KAVG}

5) Repeat this method for as many Reference Tests as conducted.

6) Tabulate C.F. data in order of **increasing average velocity** according to the following example data:

Test Number	1	2	3	4
C.F.	.950	.960	.980	1.020
V_{KAVG}	1000	2000	3000	4000

B) Enter C.F. Data into The Series 155 Mass Flow Computer by following Model 155 State Diagram:

1) Press P, Enter 6 digit Technical Access Code, Press Enter:

2) Press P until display indicates:

PRESS ENTER TO SET METER DATA

3) Press Enter.

4) The Display will then read:

PRESS ENTER TO SET METER #1

Use **Yes (Λ)** or **No (V)** keys to advance meter number to the appropriate "meter", and press enter.

5) Sequentially Press P until the display reads:

C F TYPE VCF Λ = CCF V VCF

Press No (V) to select "VCF", then press Enter. (Note: "CCF" is an automatic correction factor normally used with multi-point systems).

The display reads:

ENTER # C.F. DATA POINTS XX

Enter number of sets of Reference Test Data, press Enter. (Note: Up to seven sets maximum.)

6) The display then reads:

C.F.#1= 0.950

Put in calculated Correction Factor, then press Enter (E).

The display then reads:

C.F.#1 -0.950 AT XXXX SFPM

Put in the V_{KAVG} Value for C.F. #1, and press Enter (E).

The display reads:

C.F #1 = 0.950 AT 1000 SFPM

7) Repeat Step 6 until all C.F. Values and corresponding Velocity Values are programmed, in order of increasing Kurz Average Velocity.

For this example, you will display the following displays in sequence:

C.F. #1 = .950 AT 1000 SFPM

C.F. #2 = .960 AT 2000 SFPM

C.F. #3 = .980 AT 3000 SFPM

C.F. #4 = 1.020 AT 4000 SFPM

Kurz Instruments, Inc.

Series 452
Insertion Flow Element User Guide
360195 Rev. B

covers
Models 452, 452T, 452P & 452PT

March 1998

KURZ INSTRUMENTS INC
2411 GARDEN RD
MONTEREY CA 93940-5394
USA
Telephone: 408 (831 after July 98)-646-5911
FAX: 408 (831 after July 98)-646-8901
www.kurz-instruments.com

PUBLICATION NOTICES

COPYRIGHT

TRADEMARKS

PUBLICATION NOTICE

Every effort has been made to supply complete and accurate information to the customer. However, Kurz Instruments, Inc. assumes no responsibility for its use, nor any infringements of patents or other third parties which would result. In addition, Kurz Instruments, Inc. makes no representations or warranties of any kind concerning the contents of this publication. Under no circumstances will Kurz Instruments, Inc. be held liable for any loss or other damages pertaining to the use of this publication.

This publication is generic in nature. No guarantee is made that this publication conforms to the particular equipment produced for a particular application. As-built publications entail an additional charge. Factory and on-site training in the use and operation of Kurz Instruments, Inc. products may be made available at the buyer's expense, subject to agreement by Kurz Instruments, Inc.

The information contained in this publication is subject to change without notice. Kurz Instruments, Inc. reserves the right to make engineering changes and product improvements at any time and without prior notice. Consult your local Kurz Instruments, Inc. Representative or a factory applications engineer for information regarding current specifications.

Kurz Instruments, Inc. assumes no liability for damages or injuries (consequential or otherwise) caused by the improper use and/or improper installation of this product or where this product is used in any application other than what it was designed for and intended. Kurz Instruments, Inc. expressly denies any responsibility if this product has been modified without Kurz Instruments, Inc.'s written approval or if this product has been subjected to unusual physical or electrical stress, or if the original identification marks have been removed or altered.

Equipment sold by Kurz Instruments, Inc. is not intended for use in connection with any nuclear facility or activity unless specifically sold for such applications and specific conditions for such usage are detailed. If the equipment is used in a nuclear facility or activity without supporting quotation, Kurz Instruments, Inc. disclaims all liability for any damage, injury, or contamination, and the buyer shall indemnify and hold Kurz Instruments, Inc., its officers, agents, employees, successors, assigns, and customers, whether direct or indirect, harmless from and against any and all losses, damages, or expenses of whatever form and nature (including attorneys fees and other costs of defending any action) which they, or any of them, may sustain or incur, whether as a result of breach of contract, warranty, tort (including negligence), strict liability or other theories of law, by reason of such use.

KURZ INSTRUMENTS INC
2411 GARDEN RD
MONTEREY CA 93940-5394
USA
Telephone: 408 (831 after July 98)-646-5911
FAX:408 (831 after July 98)-646-8901
www.kurz-instruments.com

Document Title: Series 452 Insertion Flow Element Users Guide
Document Number: 360195, Revision B
Publication Date: March 1998

WARRANTY

LIMITED WARRANTY-PRODUCT

(Liability for Repair or Replacement Only)

The Company's products are warranted to be free from defects in material and workmanship for one year from date of shipment from the factory. The Company's obligation is limited to repairing, or at their option, replacing products and components which, on verification, prove to be defective, at the Factory in Monterey, CA. The Customer is responsible for the construction materials' selection and for the materials' suitability with the intended use of Kurz equipment. The Company shall not be liable for installation charges, for expenses of the Buyer for repairs or replacement, for damages for delay of or loss of use, or other indirect or consequential damages of any kind. The Company extends this warranty only upon proper use and/or installation of the product in the application for which intended and does not cover products which have been modified without the Company's approval or which have been subjected to unusual physical or electrical stress, or upon which the original identification marks have been removed or altered.

Whenever the design of the equipment to be furnished for the system in which it is to be incorporated originates with the Buyer, the Manufacturer's warranty is limited specifically to matters relating to the furnishing of equipment free of defects in material and workmanship and assumes no responsibility for implied warranties of fitness for purpose or use.

Transportation charges for material shipped to the Factory for warranty repair are to be paid by the Shipper. The Company will return items repaired or replaced under warranty prepaid. No items shall be returned for warranty repair without prior authorization from the Company.

TABLE OF CONTENTS

INTRODUCTION

The Kurz Instruments 452 series of insertion mass flow elements 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 flow element is half of a two part flow transmitter. The other half is the series 155 mass flow computer. The engineering output of the series 155 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 flow element must be calibrated in the fluid type to be measured or may be correlated from Air calibrations if available.

The 452x is a 2-wire current source device whose 100 to 600 mA output is exponentially (about the 1/4 power) proportional to the flow rate. The x can be blank, T, P or PT depending on the model, see brochure. The unit is 24 VDC powered from the 155 series. The 452T version also includes a 4-20 mA output to measure the ambient temperature from an RTD so it is a 4-wire device. The 452T is used for systems which have large temperature changes and use multiple calibration curves with temperature to interpolate the flow element output. The process of using multiple calibration curves at temperature to reduce the temperature coefficient is known as VTM (velocity temperature mapping). The 452P or 452PT have a purge port in the sensor window for automatic cleaning.

The typical flow element configuration has all the electronics in one enclosure, known as the TA configuration. If the sensor and a terminal wiring board are in a separate enclosure from the electronics, this is the TS configuration. All four cases, 452/452T and TA/TS are shown in the field wiring diagram. The TS configuration is used where the sensor enclosure ambient temperature is expected to exceed 60 °C, allowing the electronics to be mounted separately 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. The CE EMI compliance can be found in Appendix B along with descriptions of the Hazardous Area product approvals.

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:
  - Zero, Span, Area and specific gravity adjustments are made in the 155 mass flow computer. Correction factors as a function of velocity to account for velocity profiles or sensor blockage are also possible with the 155 mass flow computer.

- Sensor Pitch or Orientation to the Flow:
  - Is the flow arrow pointing in the same direction as the flow?

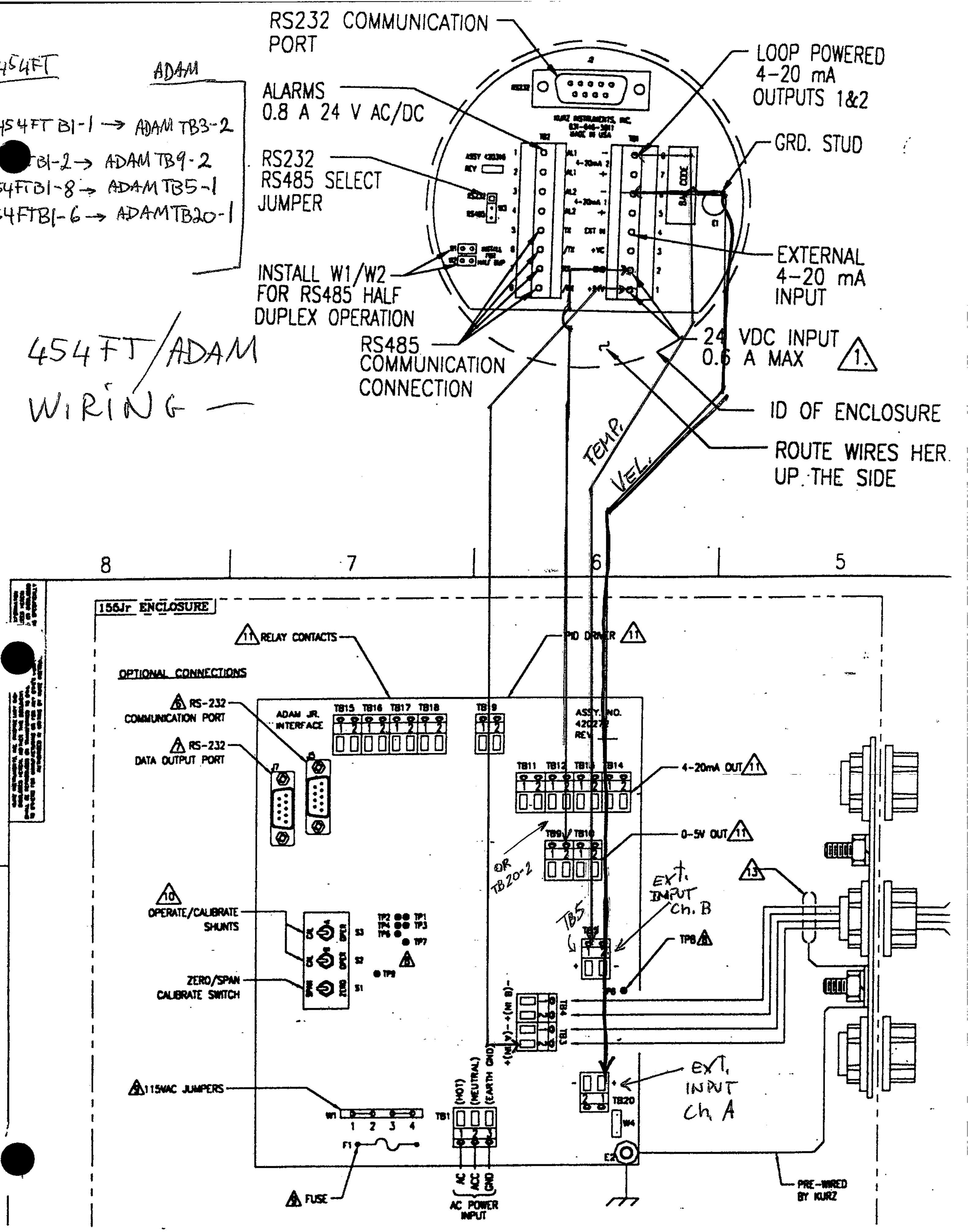
- Fluid to be Measured:
  - Was the unit calibrated in the fluid to be measured?
  - Is the fluid composition highly variable?
  - Does the fluid change phase?
  - Can material build up on the sensor?

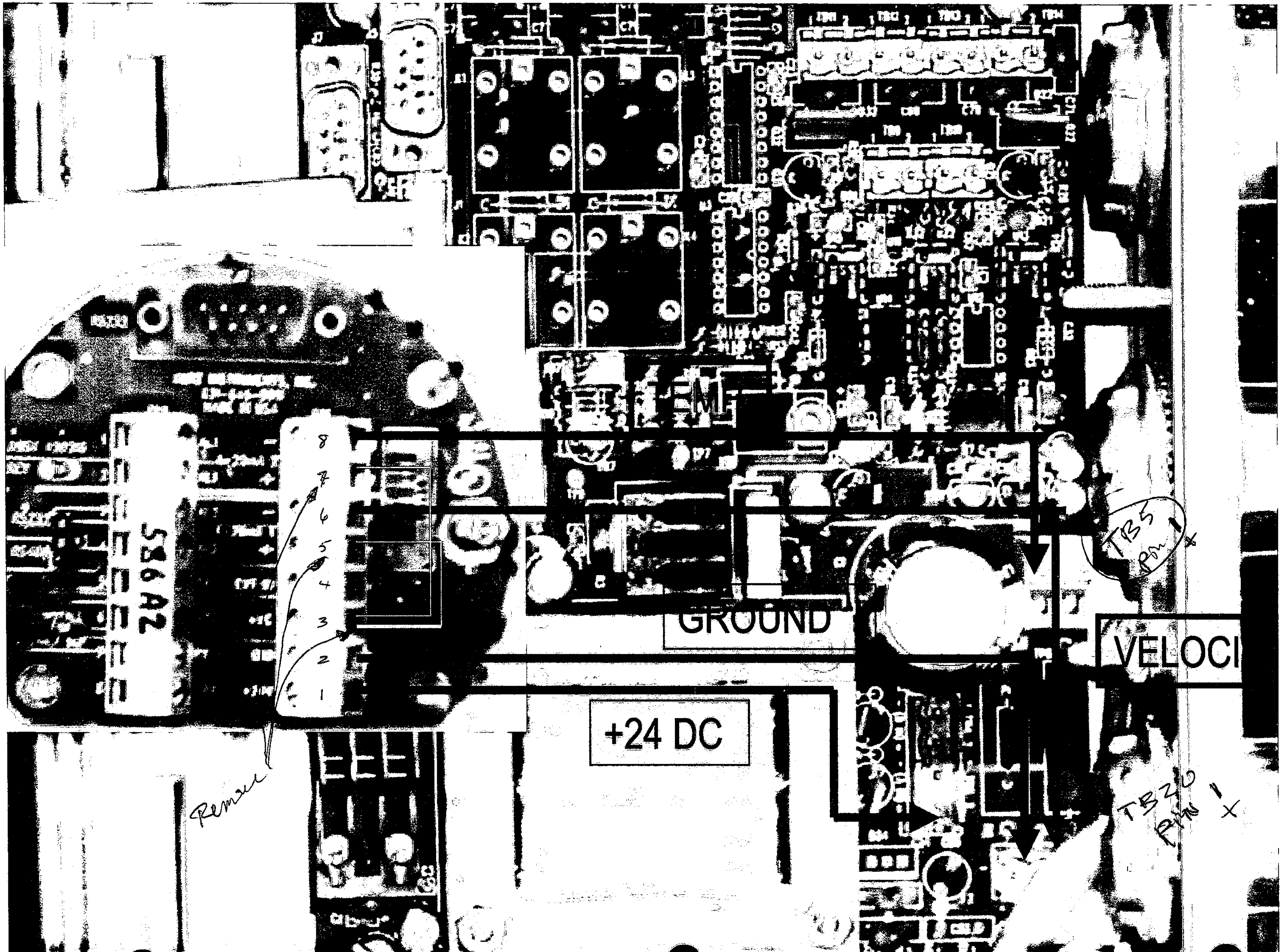
Answers to many of these question can be found in this manual or its appendices. Kurz customer service may also be contacted for assistance 408 (831 after July 98)-646-5911 or FAX 408 (831 after July 98)-646-1033. This user's manual covers installation, operation, calibration and maintenance information.

454FT → ADAM

454FT B1-1 → ADAM TB3-2
454FT B1-2 → ADAM TB9-2
454FT B1-8 → ADAM TB5-1
454FT B1-6 → ADAM TB20-1

454FT/ADAM WIRING —




536A2
1
2
3
4
5
6
7
8
GROUND
+24 DC
VELOCI
TB5 Pin 1 +
TB20 Pin 1 +
Remove

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 element is generally mounted with a compression fitting into a duct or on a flange (See Figure 1). See the product brochure (DCN 367027) for Kurz mounting accessories and a general outline drawing. Model specific outline drawings are available via request to the customer service department. 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 D.

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.

- For purge versions, the temperature of the purge gas and the due point of the process must be considered to prevent forming condensation on the sensor during the purge which will make the cleaning even more difficult. With water vapor, this means the purge gas needs to be heated above the ambient, 80 °C for example.

Field Wiring

There are up to three issues for the proper wiring installation of the Kurz 452x:

- Safety Grounding and Explosion Proof enclosure connections.
- Signal/power wiring and of the optional 4-20 mA temperature 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.

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.

24 VDC Powered Flow Element

The 24 VDC power is a nominal voltage since all circuits have a regulated supply and will work between 15 and 28 VDC. The exact voltage depends on the maximum temperature the unit is designed for. The series 155 will provide over 23 VDC to the bridge and its 5 Ω current sense resistor. You may also use an unregulated power supply with 50 to 60 Hz ripple as long as the instantaneous voltage is above the minimum and less than 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 342003.

The flow element 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.

Transmitter Separate (TS) Configurations

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 is keeping the 5 wires going to the proper terminals. When connecting the 5 wires to the 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.

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 0.01 Ω so the lead length correction will work properly. This procedure is needed to ensure that 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.

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. Alternately, a braided shield multiconductor cable between the two enclosures can be used. 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.

Peripherally bonded shield, cable glands and explosion proof versions:
Hawke America

600 Kenrick Suite C-10
Houston Texas 77060
United States of America
Tel: +1 281 445 7400
Fax: +1 281 445 7404
E-mail: hawke@hawkeusa.com
http://www.offshore-technology.com/contractors/cables/hawke/index.html

Optional Power-On Surge Check

Once the mechanical and electrical installation is complete and checked you may safely apply power. By monitoring the 100 to 600 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 100 to 600 mA signal (measure the current sense voltage, CSV, across a 5 Ω resistor). 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.

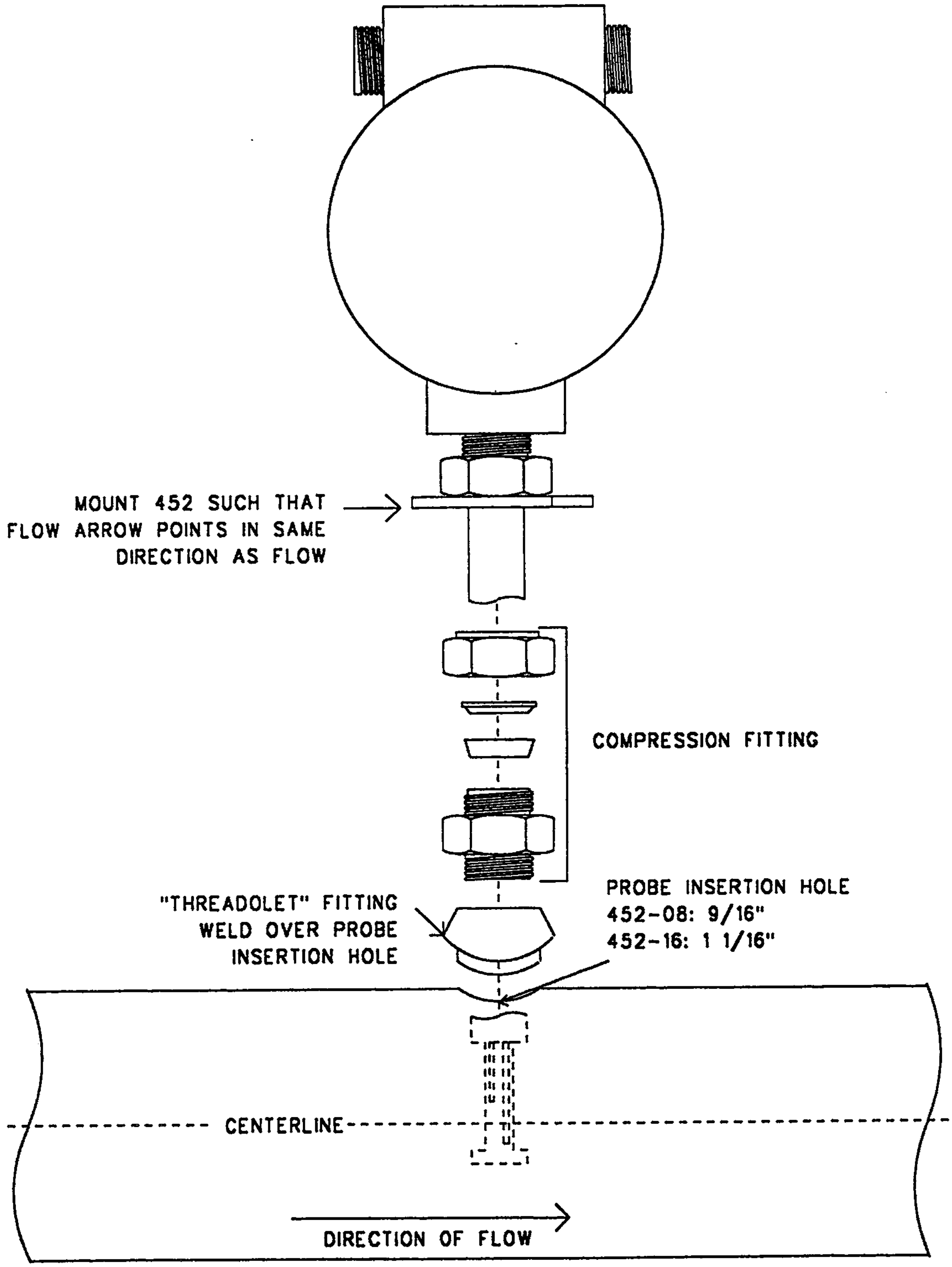
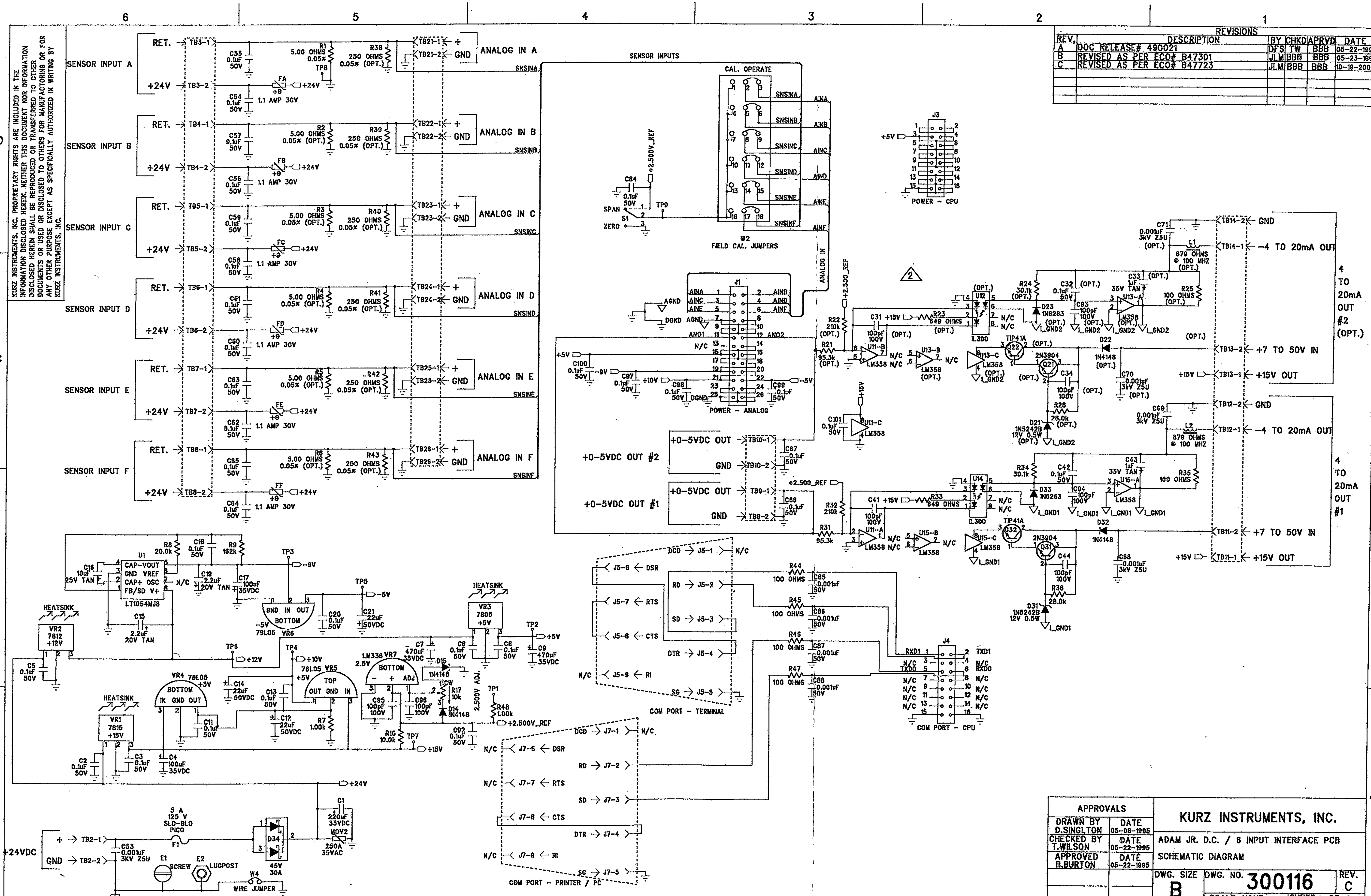
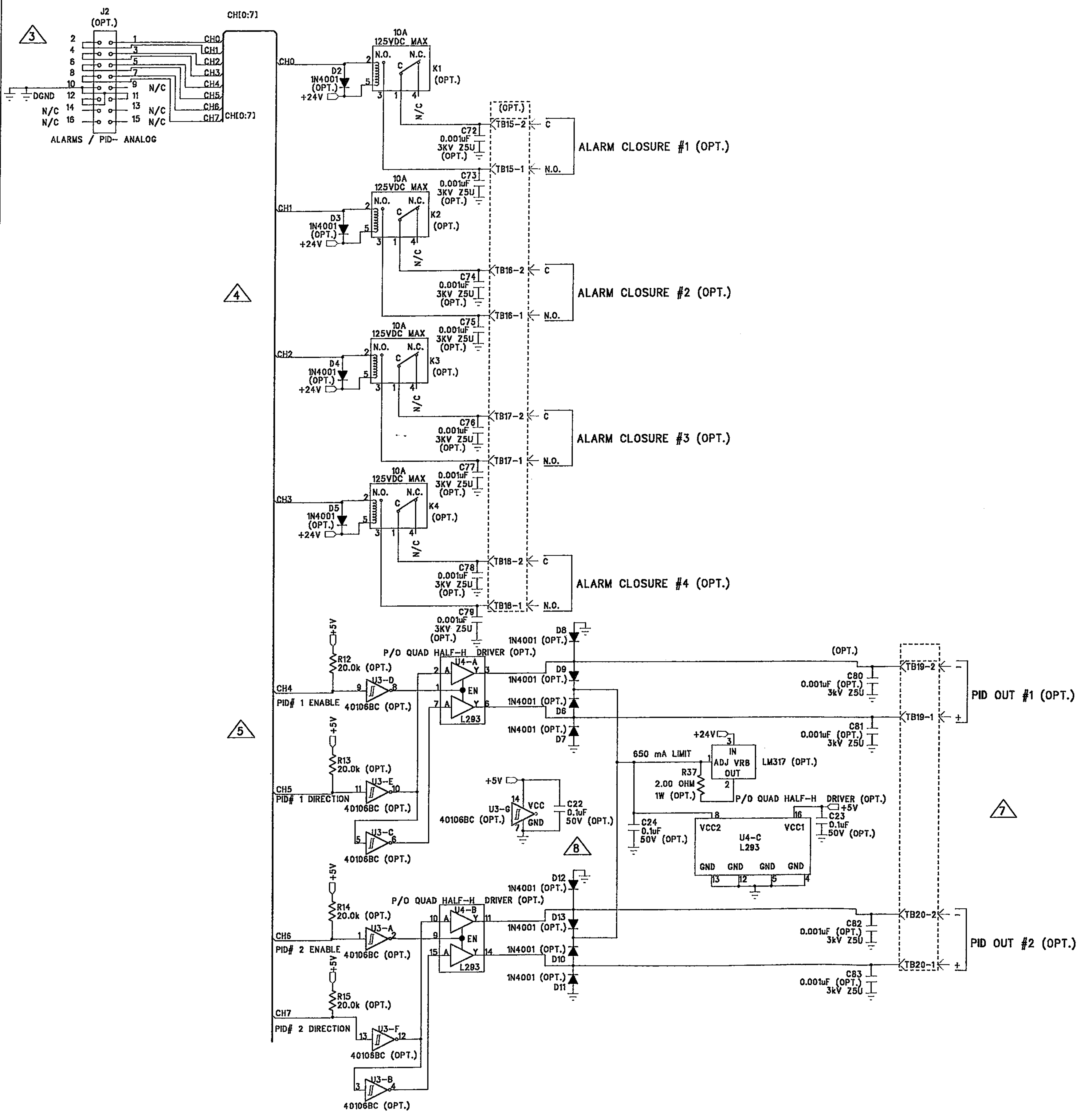


FIGURE 1. SERIES 452 INSTALLATION WITH COMPRESSION FITTING.



KURZ INSTRUMENTS, INC. PROPRIETARY RIGHTS ARE INCLUDED IN THE INFORMATION DISCLOSED HEREIN. NEITHER THIS DOCUMENT NOR INFORMATION DISCLOSED HEREIN SHALL BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR USED OR DISCLOSED TO OTHERS FOR MANUFACTURING OR FOR ANY OTHER PURPOSE EXCEPT AS SPECIFICALLY AUTHORIZED IN WRITING BY KURZ INSTRUMENTS, INC.
REVISIONS
REV. DESCRIPTION BY CHKD APRVD DATE
A DOC RELEASE# 490021 DFS TW BBB 05-22-1995
B REVISED AS PER ECO# B47301 JLM BBB BBB 05-23-1996
C REVISED AS PER ECO# B47723 JLM BBB BBB 10-19-2000
SENSOR INPUT A
SENSOR INPUT B
SENSOR INPUT C
SENSOR INPUT D
SENSOR INPUT E
SENSOR INPUT F
ANALOG IN A
ANALOG IN B
ANALOG IN C
ANALOG IN D
ANALOG IN E
ANALOG IN F
SENSOR INPUTS
CAL. OPERATE
W2 FIELD CAL. JUMPERS
POWER - ANALOG
POWER - CPU
+0-5VDC OUT #2
+0-5VDC OUT #1
4 TO 20mA OUT #2 (OPT.)
4 TO 20mA OUT #1
-4 TO 20mA OUT
+7 TO 50V IN
+15V OUT
COM PORT - TERMINAL
COM PORT - CPU
COM PORT - PRINTER / PC
+24VDC
APPROVALS
DRAWN BY D.SINGLTON DATE 05-08-1995
CHECKED BY T.WILSON DATE 05-22-1995
APPROVED B.BURTON DATE 05-22-1995
KURZ INSTRUMENTS, INC.
ADAM JR. D.C. / 6 INPUT INTERFACE PCB
SCHEMATIC DIAGRAM
DWG. SIZE B
DWG. NO. 300116
REV. C
SCALE NONE
SHEET 1 OF 2



NOTES:

1 SEE DWG# 420276 FOR ASSEMBLY.

2 FOR 2ND 4 TO 20mA OUT ADD THE FOLLOWING PARTS :

REF. DESIG.	KURZ PART#
C31,C34, AND C93	510002
C32	510006
C33	510010
C70 AND C71	510059
R26	540215
R24	540221
R21	540313
R25	540316
R22	540381
R23	540486
D22	580001
D21	580017
Q21	580036
Q22	580085
D23	580089
L1	600005
U13	610006
U12	610041

3 FOR ALARM OPTION OR PID OPTION ADD J2 KURZ # 460324

4 FOR ALARM OPTION ADD THE FOLLOWING PARTS :

REF. DESIG.	KURZ PART#
23	460282
TB15	460443
K1,K2,K3, AND K4	490017
C72,C73,C74,C75,C76,C77,C78, AND C79	510059
D2,D3,D4, AND D5	580002

5 FOR PID OPTION ADD THE FOLLOWING PARTS :

REF. DESIG.	KURZ PART#
2	190066
4	190082
15 (X2)	460408 (X2)
TB19	460441
C22,C23, AND C24	510006
C80,C81,C82, AND C83	510059
R12,R13,R14, AND R15	540187
R37	540713
D6,D7,D8,D9,D10,D11,D12, AND D13	580002
VR8	580075
U3	610014
U4	610040
5	660141

6 SEE DWG # 340155–50 AND 340155–59 FOR WIRING DIAGRAM.

7 TB 19 AND TB 20 DESIGNATIONS FOR PULSED OUTPUTS ONLY:

TB	PIN	DESIGNATION
19	1	PULSED OUTPUT 1
19	2	PULSED OUTPUT 2
20	1	PULSED OUTPUT 3
20	2	PULSED OUTPUT 4

8 MODIFICATIONS FOR PULSED OUTPUTS ONLY.

REMOVE	ADD	
C 23,24	C 80–83 .001uF 3KV Z5U CAPACITOR KURZ # 510059	
D 6–13		
R 12–15,37	R 12–15 1.00k OHM .125 W RESISTOR KURZ # 540001	
U 3,4	TB 19 KURZ PART# 460441	
VR 8	WIRE JUMPER	
	FROM	TO
	U 3 PIN 1	U 3 PIN 2
	U 3 PIN 8	U 3 PIN 9
	U 3 PIN 10	U 3 PIN 11
	U 3 PIN 12	U 3 PIN 13
	U 4 PIN 1	U 4 PIN 6
	U 4 PIN 2	U 4 PIN 3
	U 4 PIN 9	U 4 PIN 14
	U 4 PIN 10	U 4 PIN 11

KURZ INSTRUMENTS, INC.

ADAM JR. D.C. / 6 INPUT INTERFACE PCB

SCHEMATIC DIAGRAM

DWG. SIZE B | DWG. NO. 300116 | REV. C

SCALE NONE | SHEET 2 OF 2

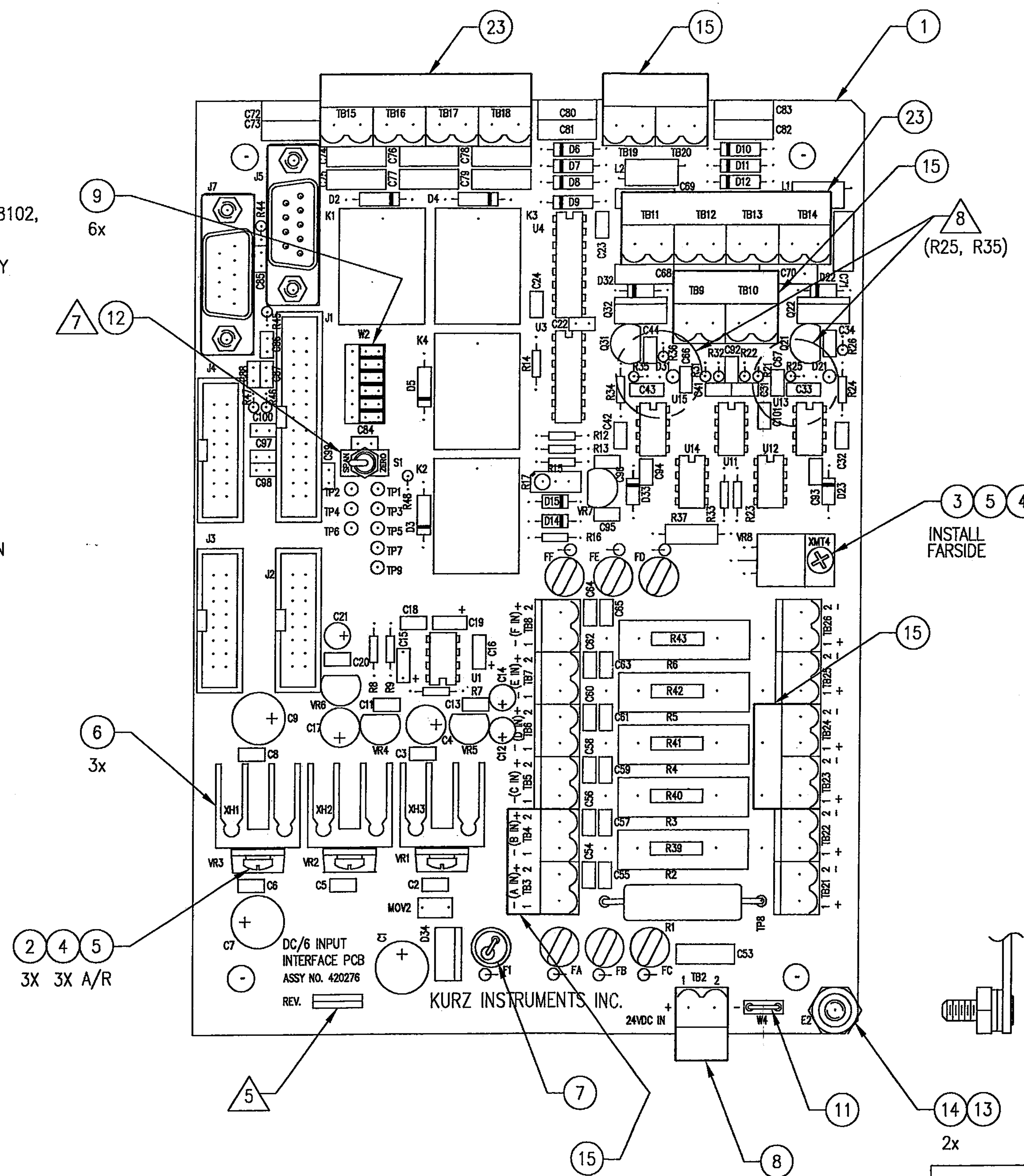
REVISIONS					
REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	INITIAL RELEASE	DFS	TW	BBB	5/22/95
B	REVISED PER ECO #B47301	ADK			

NOTES: UNLESS OTHERWISE SPECIFIED

1. MAKES KURZ P/N (SEE TABULATION)
2. MAT'L: (SEE MAPICS BOM, PER P/N)
3. FOR SCHEMATIC DIAGRAM SEE DWG #300116.
4. OPTIONAL & SELECTED ITEMS TO BE ASSEMBLED BY KURZ.
5. (△) MARK PCB ASSEMBLY REV. PER PROCEDURE 38102, WITH ITEM 10.
6. REF. DES. ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON COMPONENTS.
7. (△) ITEM 12 IS MADE FROM THE LEFT 1/3 OF KURZ P/N 140211 (CUT WITH SCIZZORS).

SPAN / ZERO — CUT HERE

8. (△) MOUNT R25 AND R35 IN OPPOSITE ORIENTATION FROM WHAT SILKSCREEN INDICATES.

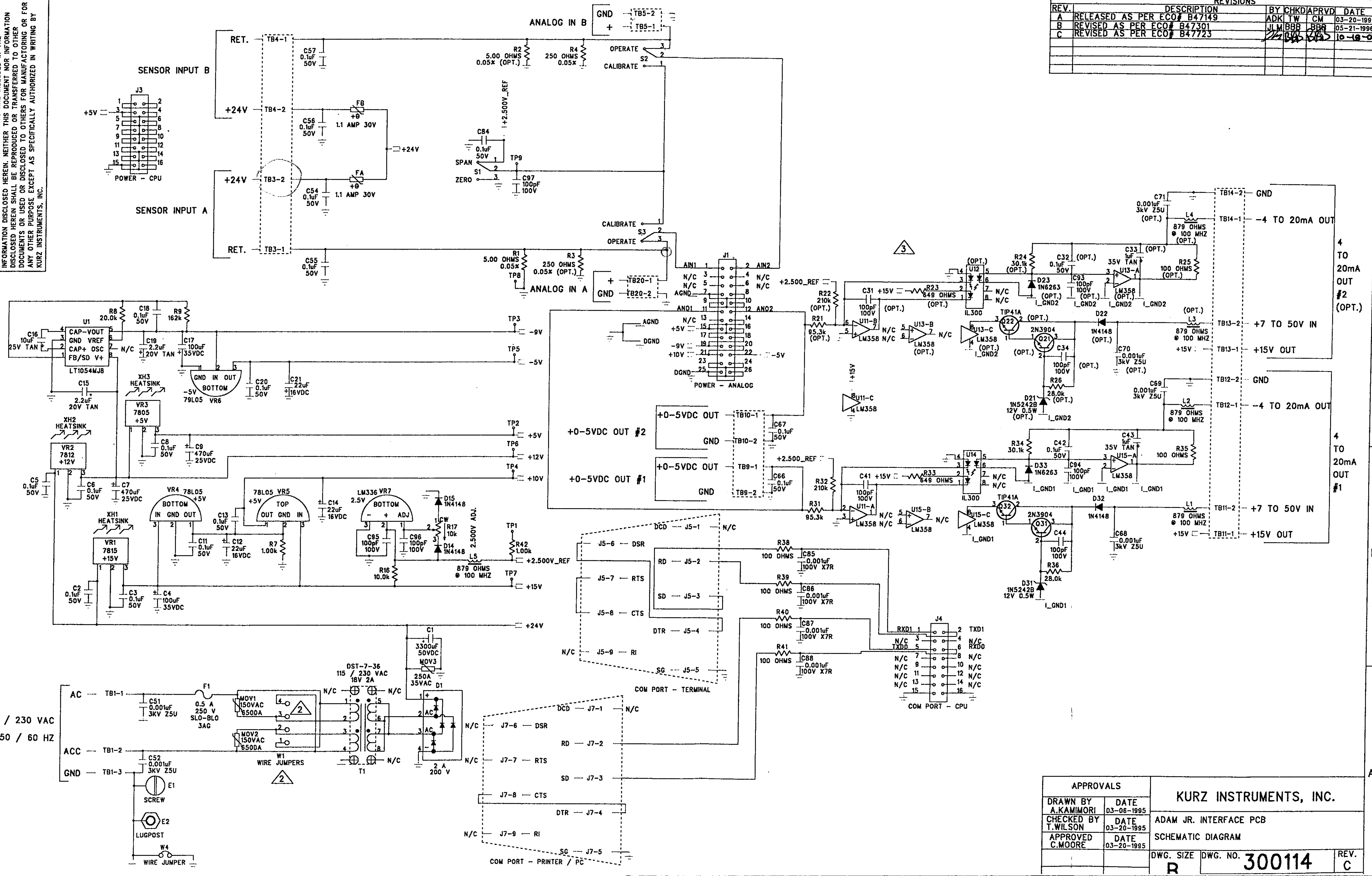


TABULATION	
KURZ P/N	DESCRIPTION
420276	MODEL 155JR (DC), MOTHER BOARD, PARTIALLY STUFFED
420276-01	MODEL 155JR (DC), MOTHER BOARD, FULLY STUFFED

	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	APPROVALS		KURZ INSTRUMENTS, INC.
	TOLERANCES ARE	DRAWN BY D.F.SINGLETON	DATE 5/10/95	
750106-DC	FRACTIONS ± 1/16	CHECKED BY T. WILSON	DATE 5/22/95	ASSY, 155Jr-DC MOTHERBOARD
750105-DC	ANGLES ± 1°-0'	APPROVED B. BURTON	DATE 5/22/95	
750104-DC	DECIMALS .X ± 0.1 .XX ± 0.01 .XXX ± 0.005			DWG. SIZE D / DWG. NO. 420276 / REV. B
750101-DC	ORIG. RELEASE DATE			SCALE 2" = 1" / SHEET 1 OF 1
NEXT ASSEMBLY				

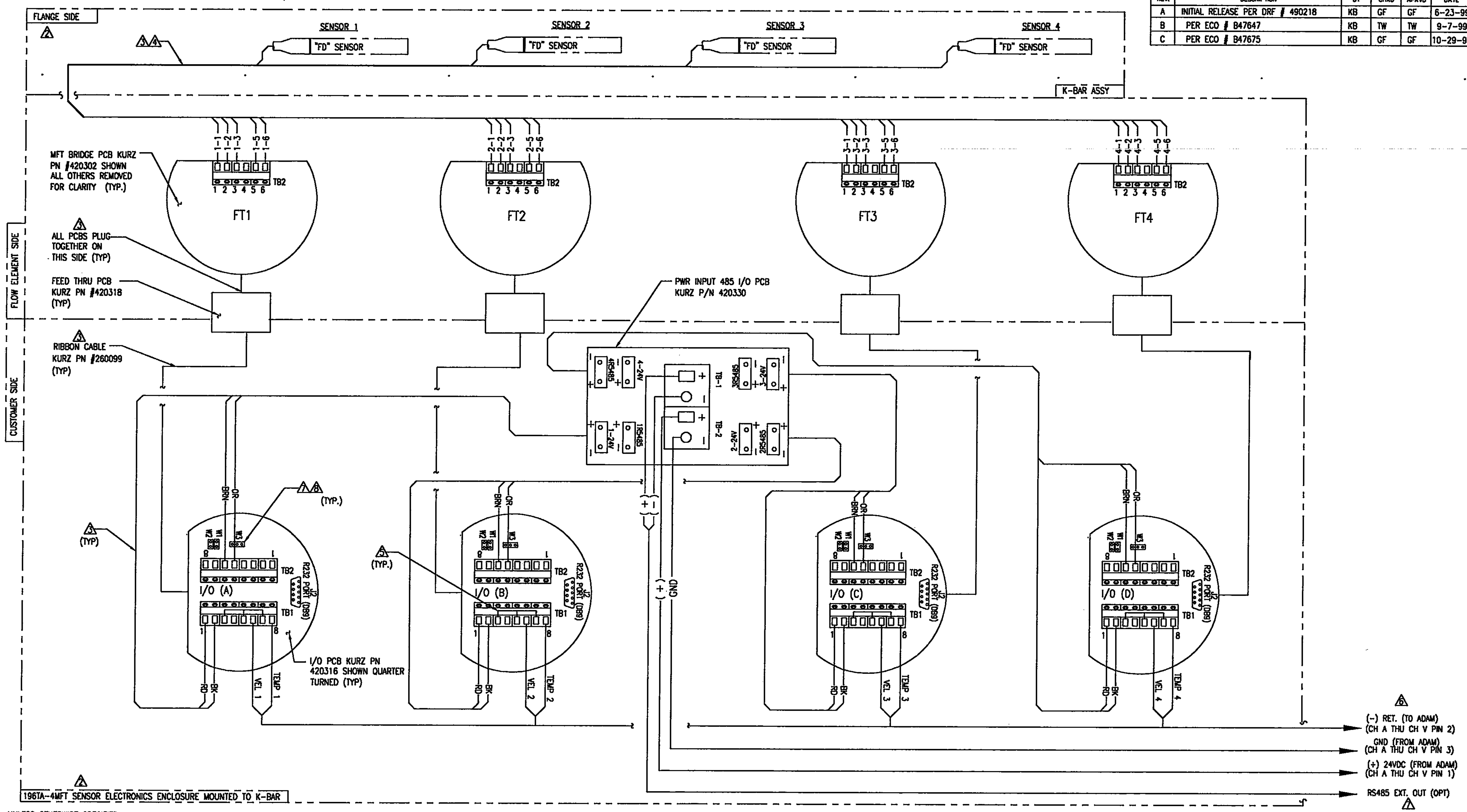
REVISIONS

REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	RELEASED AS PER ECO# B47149	ADK	TW	CM	03-20-1995
B	REVISED AS PER ECO# B47301	JLM	BBB	BBB	05-21-1996
C	REVISED AS PER ECO# B47723				10-18-00



APPROVALS		
DRAWN BY A.KAMIMORI	DATE 03-06-1995	KURZ INSTRUMENTS, INC.
CHECKED BY T.WILSON	DATE 03-20-1995	ADAM JR. INTERFACE PCB
APPROVED C.MOORE	DATE 03-20-1995	SCHEMATIC DIAGRAM
		DWG. SIZE B · DWG. NO. 300114 · REV. C

REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	INITIAL RELEASE PER DRF # 490218	KB	GF	GF	6-23-99
B	PER ECO # B47647	KB	TW	TW	9-7-99
C	PER ECO # B47675	KB	GF	GF	10-29-99



NOTES: UNLESS OTHERWISE SPECIFIED

1. REF. DES. AND TERMINAL NO. ARE FOR REFERENCE ONLY.

2. (DWG. SHOWN FULLY STUFFED) QUANTITY OF SENSORS MAY VARY. REFERENCE K-BAR ASSY AND K-BAR SET-UP SHEET. SENSOR SERIAL NUMBER ENDING IN "1" IS CLOSEST TO THE MOUNTING FLANGE.

3. PREWIRED BY KURZ

4. SENSOR LEAD COLOR CHART

NO.	WIRE COLOR	REF. DES.
1	RED	Rp(S)
2	RED	Rp(L)
3	YELLOW	Rp(H)
5	WHITE	Rtc(L)
6	WHITE	Rtc(H)

5. ON I/O PCB JUMPER TB1 PINS 3,5,&7 W/ KURZ PN #460490

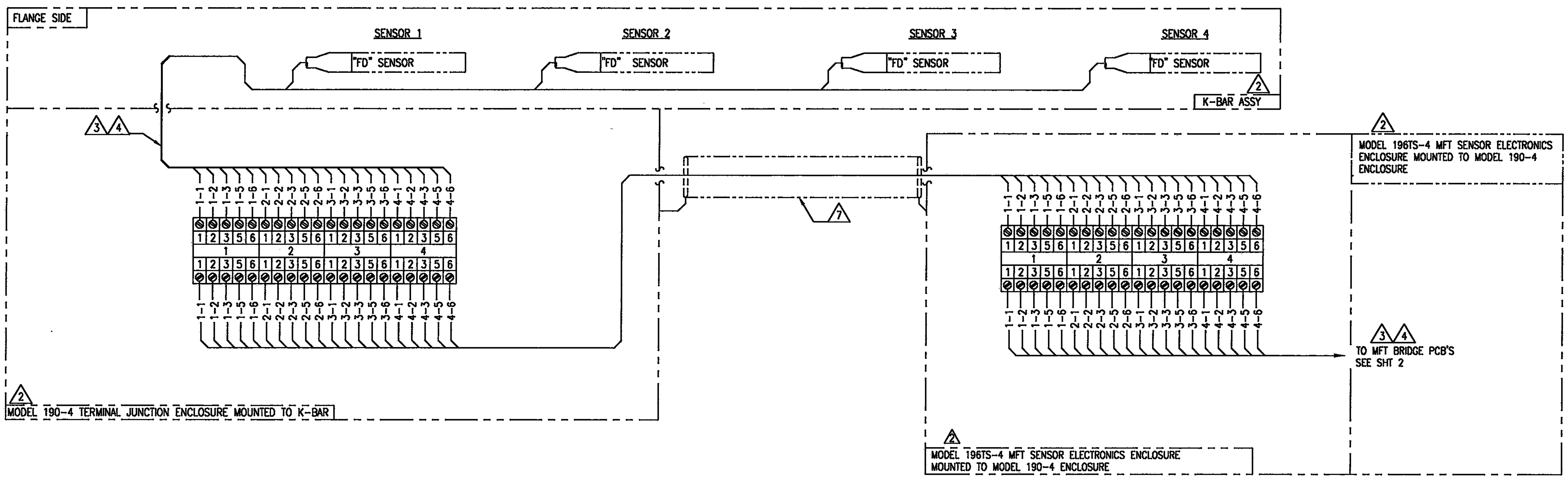
6. TO MASS FLOW COMPUTER (REFERENCE 155 SERIES ADAM CHANNEL/SENSOR SERIAL NUMBER SEQUENCE, PROGRAMMED IN ADAM)

7. FOR RS485 HALF DUPLEX COMMUNICATION: INSTALL JUMPER W1 & W2 INSTALL W3 TO RS485 POSITION (THIS MUST BE DONE ON EACH I/O PCB). YOU CAN NOT RUN UPLOAD/DOWNLOAD IN THIS CONFIGURATION

8. FOR UPLOAD/DOWNLOAD: MOVE JUMPER W3 TO RS232 (THIS MUST BE DONE ON EACH I/O PCB). WHEN DONE WITH UPLOAD/DOWNLOAD RETURN W3 BACK TO RS485 POSITION ON EACH PCB.

NEXT ASSEMBLY	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	APPROVALS		KURZ INSTRUMENTS, INC.
753752	TOLERANCES ARE: FRACTIONS ± 1/32; ANGLES ± 0°-30'	DRAWN BY KEN B	DATE 6-21-99	K-BAR 2000, 4PT ATTACHED INTERNAL /FEILD WIRING DIAGRAM
753722	DECIMALS: .X ± 0.1; .XX ± 0.01; .XXX ± 0.005; .XXXX ± 0.0010	CHECKED BY GF	DATE 6-23-99	DWG. SIZE D; DWG. NO. 342029; REV. C
753721	ORIG. RELEASE DATE	APPROVED GF	DATE 6-23-99	SCALE NONE; SHEET 1

REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	INITIAL RELEASE PER DRF #490218	KB	GF	GF	6-23-99
B	PER ECO B47647	KB	TW	TW	9-7-99
C	PER ECO B47675	KB	GF	GF	10-29-99



NOTES: UNLESS OTHERWISE SPECIFIED

1. REF. DES. AND TERMINAL NO. ARE FOR REFERENCE ONLY.

2. (DWG. SHOWN FULLY STUFFED) QUANTITY OF SENSORS MAY VARY. REFERENCE K-BAR ASSY AND K-BAR SET-UP SHEET. SENSOR SERIAL NUMBER ENDING IN "1" IS CLOSEST TO THE MOUNTING FLANGE.

3. PREWIRIED BY KURZ

4.

SENSOR LEAD COLOR CHART		
NO.	WIRE COLOR	REF. DES.
1	RED	Rp(S)
2	RED	Rp(L)
3	YELLOW	Rp(H)
5	WHITE	Rtc(L)
6	WHITE	Rtc(H)

5. ON I/O PCB JUMPER TB1 PINS 3,5,&7 W/KURZ PN #460490

6. TO MASS FLOW COMPUTER (REFERENCE 155 SERIES ADAM CHANNEL/SENSOR SERIAL NUMBER SEQUENCE, PROGRAMMED IN ADAM)

7. WIRE IN RIGID CONDUIT ATTACHED DIRECTLY TO EACH ENCLOSURE IS RECOMMENDED, HOWEVER, BRAIDED SHIELDED CABLE WITH PERPHERIAL BONDED SHIELD AND CABLE GLANDS AT EACH ENCLOSURE IS ACCEPTABLE. 5-WIRE CABLE FOR FLOW ELEMENT OR 8-WIRE CABLE FOR FLOW ELEMENT WITH TEMPERATURE 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

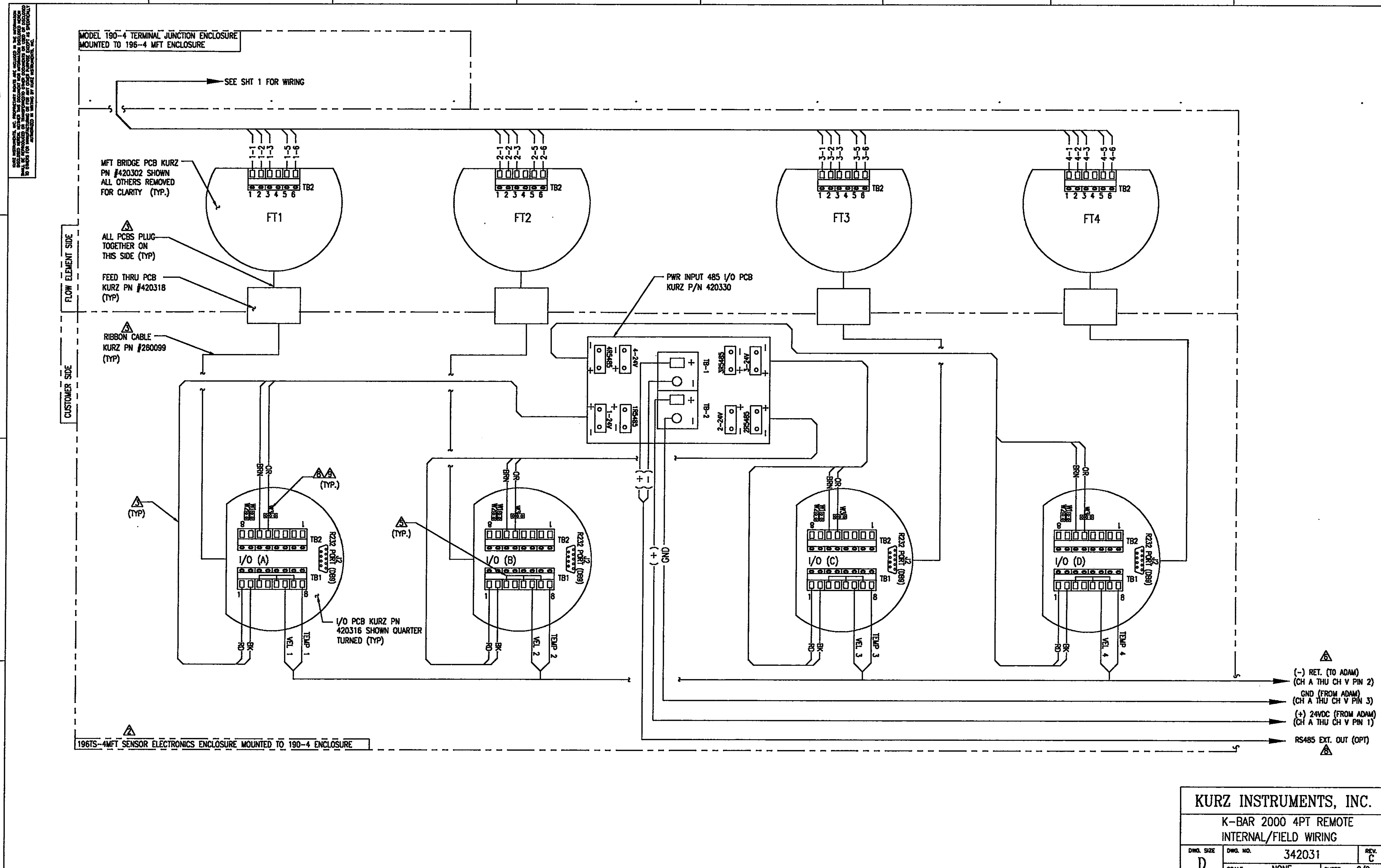
AWG	MAX. LENGTH (FT)
18	157
16	249
14	396
12	630

$|WIRE(Rph) - WIRE(Rpl)| \leq 0.01\ \Omega,\ \Delta R\ 0.01\Omega$ MAX.

8. FOR RS485 HALF DUPLEX COMMUNICATION: INSTALL JUMPER W1 & W2 INSTALL W3 TO RS485 POSITION (THIS MUST BE DONE ON EACH I/O PCB). YOU CAN NOT RUN UPLOAD/DOWNLOAD IN THIS CONFIGURATION

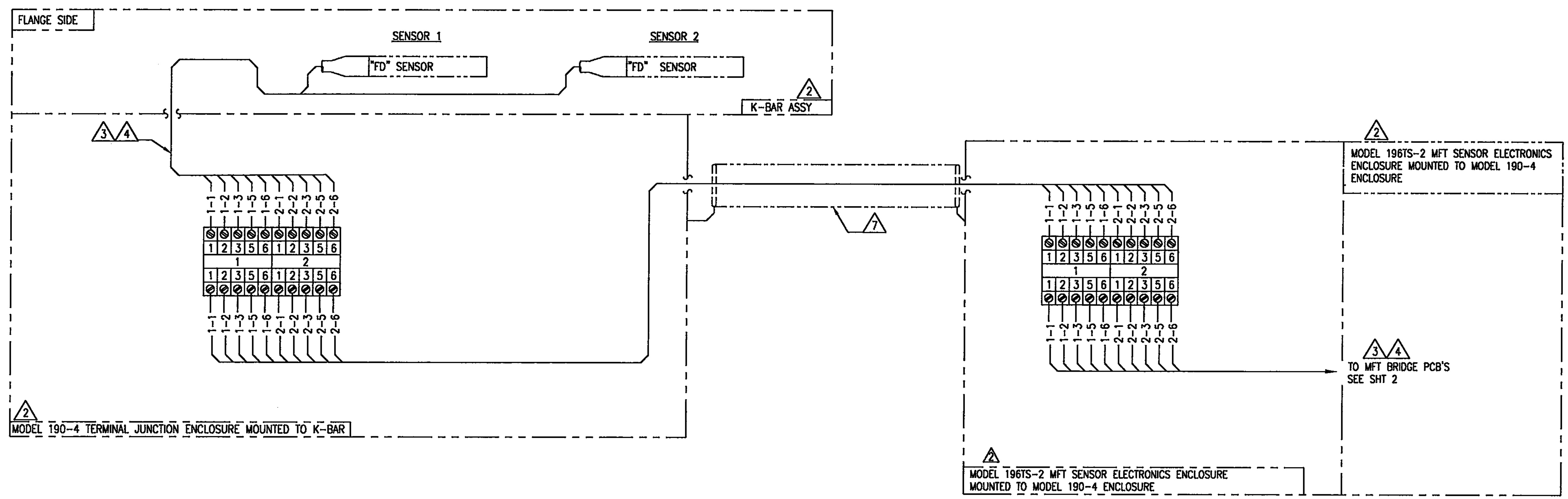
9. FOR UPLOAD/DOWNLOAD: MOVE JUMPER W3 TO RS232 (THIS MUST BE DONE ON EACH I/O PCB). WHEN DONE WITH UPLOAD/DOWNLOAD RETURN W3 BACK TO RS485 POSITION ON EACH PCB.

NEXT ASSEMBLY	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	APPROVALS		
753721	TOLERANCES ARE: FRACTIONS ± 1/32; ANGLES ± 0°-30'; DECIMALS .X ± 0.1, .XX ± 0.01, .XXX ± 0.005, .XXXX ± 0.0010	DRAWN BY KEN B	DATE 6-21-99	KURZ INSTRUMENTS, INC.
753722		CHECKED BY G.FOSTER	DATE 6-23-99	K-BAR-2000 4PT. REMOTE INTERNAL /FEILD WIRING DIAGRAM
753723	ORIG. RELEASE DATE	APPROVED G.FOSTER	DATE 6-23-99	DWG. SIZE D; DWG. NO. 342031; REV. C; SCALE NONE; SHEET 1 OF 2



MODEL 190-4 TERMINAL JUNCTION ENCLOSURE MOUNTED TO 196-4 MFT ENCLOSURE
SEE SHT 1 FOR WIRING
MFT BRIDGE PCB KURZ PN #420302 SHOWN ALL OTHERS REMOVED FOR CLARITY (TYP.)
ALL PCBS PLUG TOGETHER ON THIS SIDE (TYP)
FEED THRU PCB KURZ PN #420318 (TYP)
RIBBON CABLE KURZ PN #260099 (TYP)
FLOW ELEMENT SIDE
CUSTOMER SIDE
FT1
FT2
FT3
FT4
TB2
PWR INPUT 485 I/O PCB KURZ P/N 420330
TB-1
TB-2
I/O (A)
I/O (B)
I/O (C)
I/O (D)
TB1
R232 PORT (DB9)
BRN
OR
RD
BK
VEL 1
TEMP 1
VEL 2
TEMP 2
VEL 3
TEMP 3
VEL 4
TEMP 4
GND
I/O PCB KURZ PN 420316 SHOWN QUARTER TURNED (TYP)
(TYP.)
(-) RET. (TO ADAM) (CH A THU CH V PIN 2)
GND (FROM ADAM) (CH A THU CH V PIN 3)
(+) 24VDC (FROM ADAM) (CH A THU CH V PIN 1)
RS485 EXT. OUT (OPT)
196TS-4MFT SENSOR ELECTRONICS ENCLOSURE MOUNTED TO 190-4 ENCLOSURE
KURZ INSTRUMENTS, INC.
K-BAR 2000 4PT REMOTE INTERNAL/FIELD WIRING
DWG. SIZE D
DWG. NO. 342031
REV. C
SCALE NONE
SHEET 2/2

REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	INITIAL RELEASE PER ECO# B47675	KB	GF	GF	10-29-99



NOTES: UNLESS OTHERWISE SPECIFIED

1. REF. DES. AND TERMINAL NO. ARE FOR REFERENCE ONLY,

2. (DWG. SHOWN FULLY STUFFED)
QUANTITY OF SENSORS MAY VARY.
REFERENCE K-BAR ASSY AND K-BAR SET-UP SHEET.
SENSOR SERIAL NUMBER ENDING IN "1" IS
CLOSEST TO THE MOUNTING FLANGE.

3. PREWIRIED BY KURZ

4. SENSOR LEAD COLOR CHART

NO.	WIRE COLOR	REF. DES.
1	RED	Rp(S)
2	RED	Rp(L)
3	YELLOW	Rp(H)
5	WHITE	Rtc(L)
6	WHITE	Rtc(H)

5. ON I/O PCB JUMPER TB1 PINS 3,5,&7 W/KURZ PN #460490

6. TO MASS FLOW COMPUTER (REFERENCE 155 SERIES ADAM CHANNEL/SENSOR SERIAL NUMBER SEQUENCE, PROGRAMMED IN ADAM)

7. WIRE IN RIGID CONDUIT ATTACHED DIRECTLY TO EACH ENCLOSURE IS RECOMMENDED, HOWEVER, BRAIDED SHIELDED CABLE WITH PERPHERIAL BONDED SHIELD AND CABLE GLANDS AT EACH ENCLOSURE IS ACCEPTABLE. 5-WIRE CABLE FOR FLOW ELEMENT 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

$|WIRE(Rph) - WIRE(Rpl)| \leq 0.01\ \Omega$, ΔR 0.01Ω MAX.

8. FOR RS485 HALF DUPLEX COMMUNICATION: INSTALL JUMPER W1 & W2 INSTALL W3 TO RS485 POSITION (THIS MUST BE DONE ON EACH 1/0 PCB). YOU CAN NOT RUN UPLOAD/DOWNLOAD IN THIS CONFIGURATION

9. FOR UPLOAD/DOWNLOAD: MOVE JUMPER W3 TO RS232 (THIS MUST BE DONE ON EACH I/O PCB). WHEN DONE WITH UPLOAD/DOWNLOAD RETURN W3 BACK TO RS485 POSITION ON EACH PCB.

NEXT ASSEMBLY
753721
753722
753723

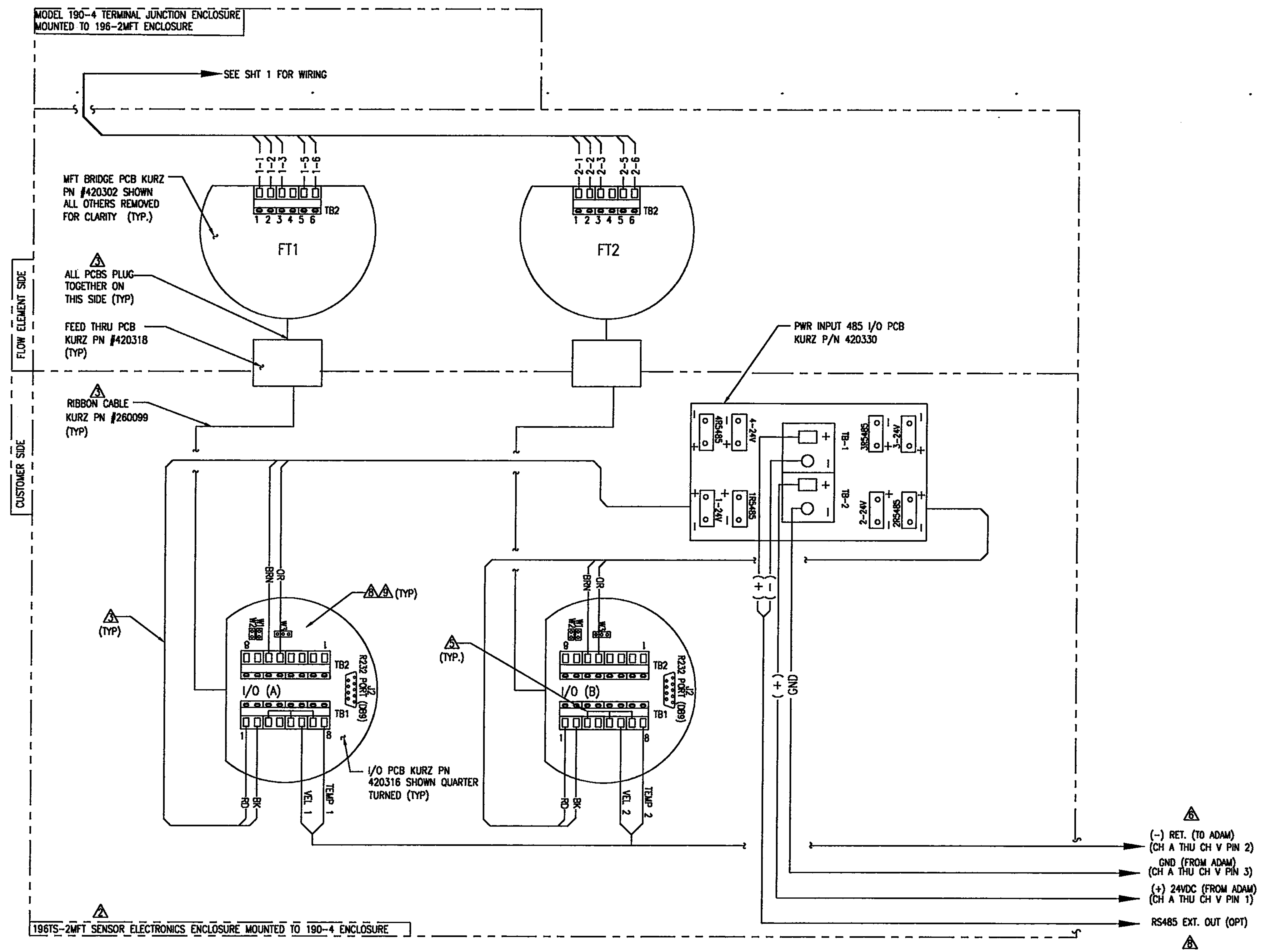
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE: FRACTIONS ± 1/32; ANGLES ± 0°-30'; DECIMALS .X ± 0.1, .XX ± 0.01, .XXX ± 0.005, .XXXX ± 0.0010
ORIG. RELEASE DATE

APPROVALS	DATE
DRAWN BY KEN B	10-26-99
CHECKED BY	
APPROVED	

KURZ INSTRUMENTS, INC.

K-BAR-2000 2PT. REMOTE INTERNAL /FEILD WIRING DIAGRAM

DWG. SIZE D | DWG. NO. 342032 | REV. A | SCALE NONE | SHEET 1 OF 2



KURZ INSTRUMENTS, INC.

K-BAR 2000 2PT REMOTE INTERNAL/FIELD WIRING

DWG. SIZE	DWG. NO.	REV.
D	342032	A
	SCALE NONE	SHEET 2/2

NOTES: UNLESS OTHERWISE SPECIFIED

1. REF. DES. AND TERMINAL NO. ARE FOR REFERENCE ONLY.

△2 (DWG. SHOWN FULLY STUFFED) QUANTITY OF SENSORS MAY VARY. REFERENCE K-BAR ASSY AND K-BAR SET-UP SHEET. SENSOR SERIAL NUMBER ENDING IN "1" IS CLOSEST TO THE MOUNTING FLANGE.

△3 PREWIRED BY KURZ

△4

SENSOR LEAD COLOR CHART

NO.	WIRE COLOR	REF. DES.
1	RED	Rp(S)
2	RED	Rp(L)
3	YELLOW	Rp(H)
5	WHITE	Rtc(L)
6	WHITE	Rtc(H)

△5 ON I/O PCB JUMPER TB1 PINS 3,5,&7 W/ KURZ PN #460490

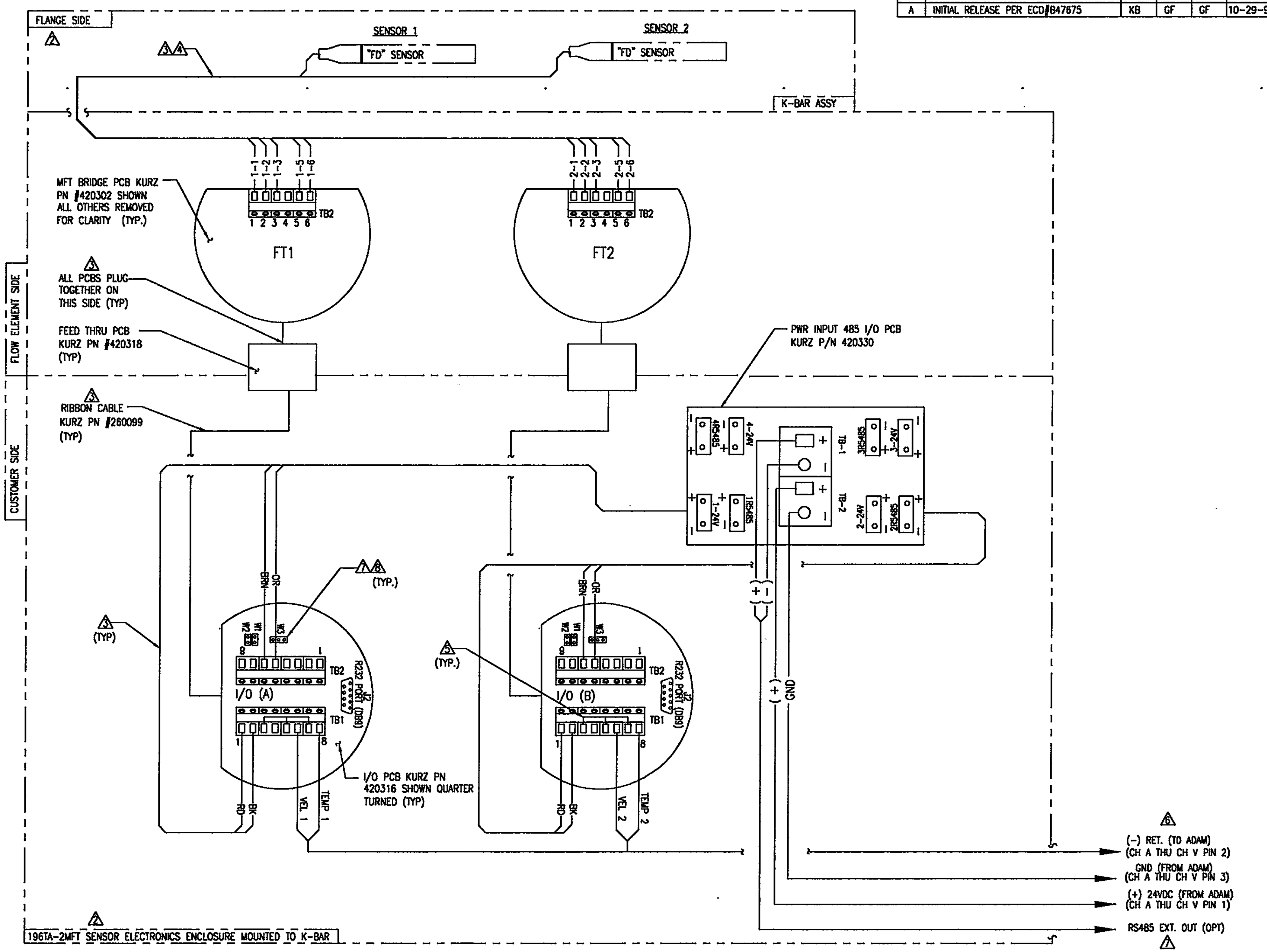
△6 TO MASS FLOW COMPUTER (REFERENCE 155 SERIES ADAM CHANNEL/SENSOR SERIAL NUMBER SEQUENCE, PROGRAMMED IN ADAM)

△7 FOR RS485 HALF DUPLEX COMMUNICATION: INSTALL JUMPER W1 & W2 INSTALL W3 TO RS485 POSITION (THIS MUST BE DONE ON EACH I/O PCB). YOU CAN NOT RUN UPLOAD/DOWNLOAD IN THIS CONFIGURATION

△8 FOR UPLOAD/DOWNLOAD: MOVE JUMPER W3 TO RS232 (THIS MUST BE DONE ON EACH I/O PCB). WHEN DONE WITH UPLOAD/DOWNLOAD RETURN W3 BACK TO RS485 POSITION ON EACH PCB.

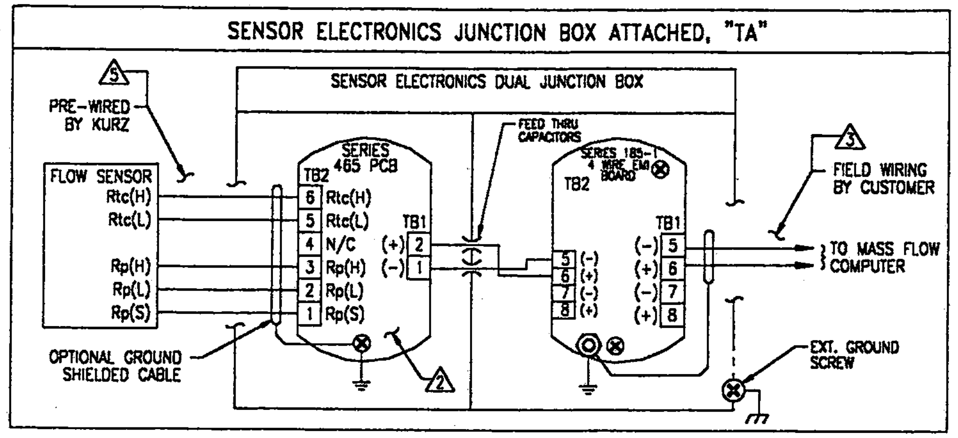
REVISIONS

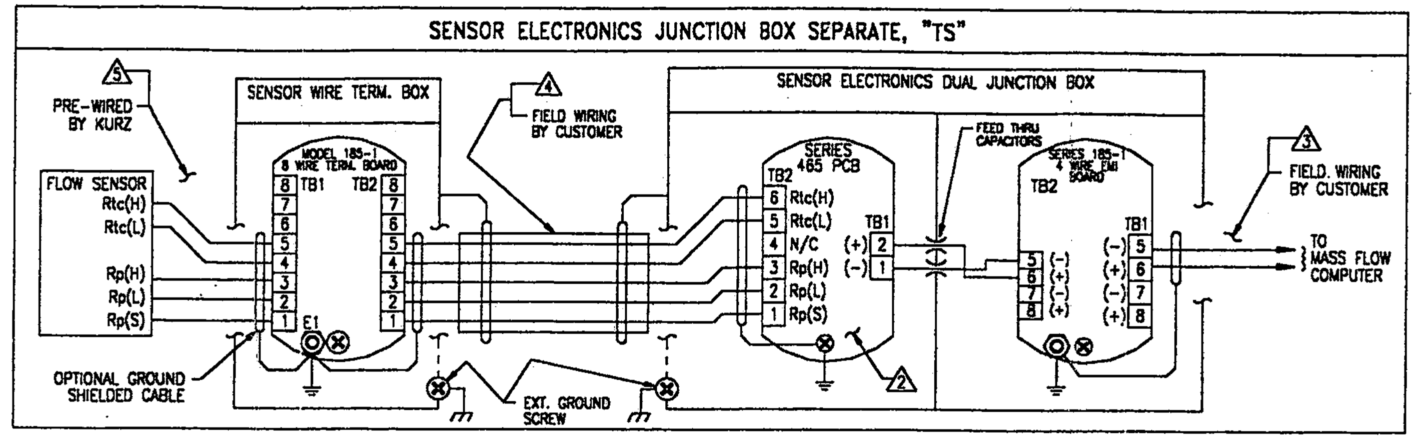
REV.	DESCRIPTION	BY	CHKD	APPVD	DATE
A	INITIAL RELEASE PER ECO#B47675	KB	GF	GF	10-29-99

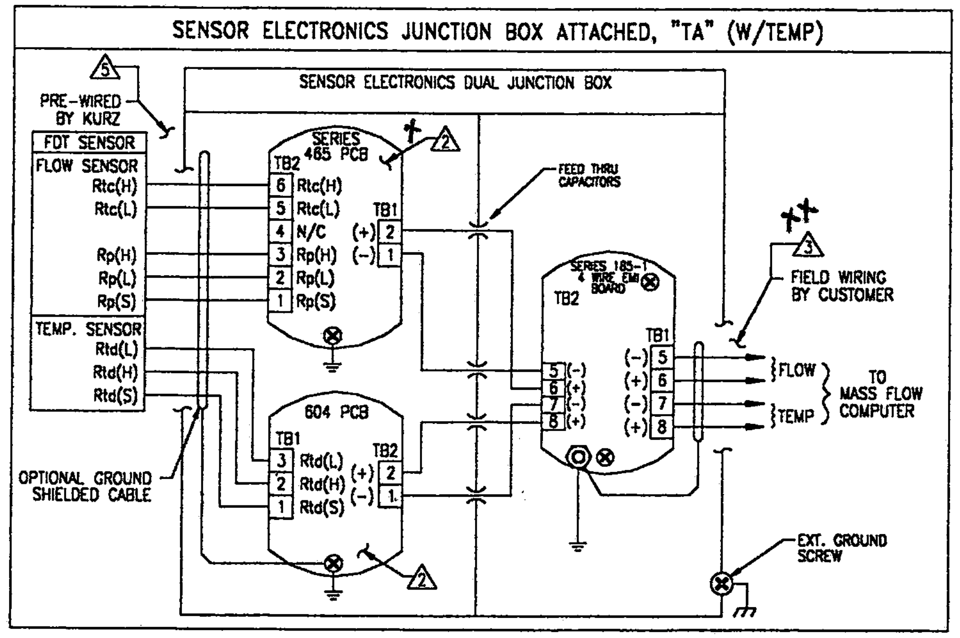


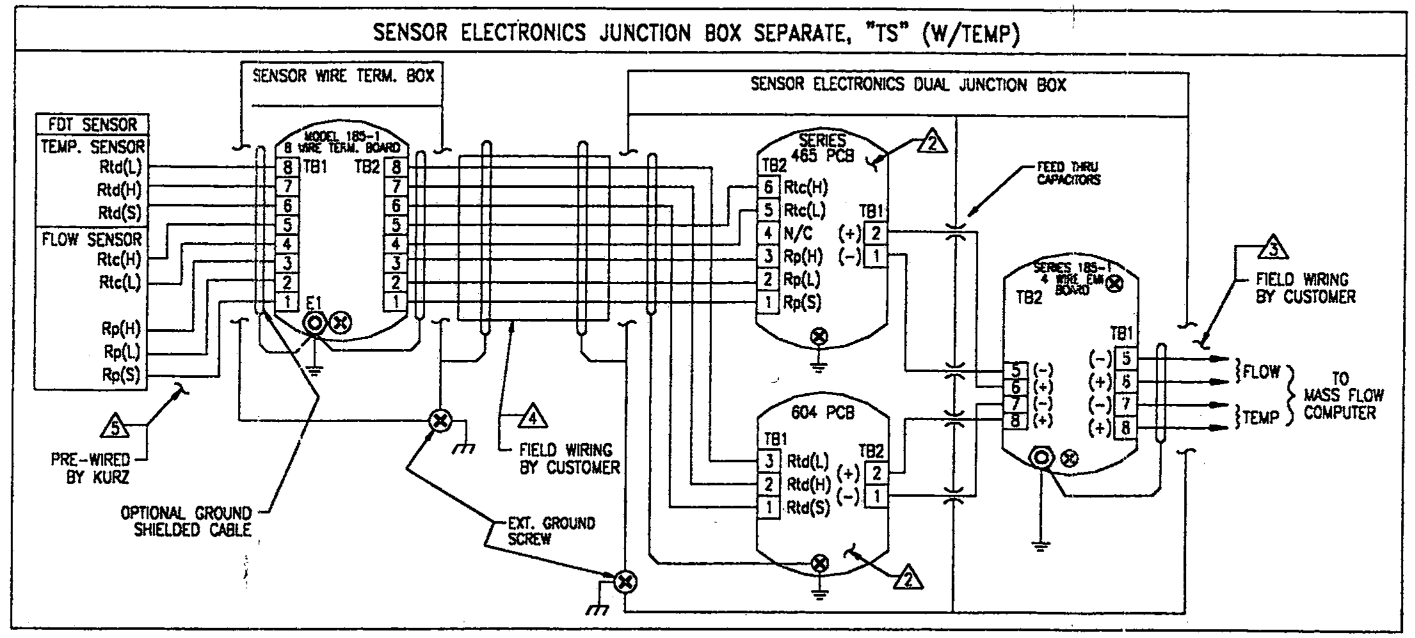
	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	APPROVALS		KURZ INSTRUMENTS, INC.	
	TOLERANCES ARE	DRAWN BY KEN B	DATE 10-26-99	K-BAR 2000,2PT ATTACHED INTERNAL /FEILD WIRING DIAGRAM	
	FRACTIONS ± 1/32	CHECKED BY	DATE		
	ANGLES ± 0°-30'	APPROVED	DATE		
753752	DECIMALS .X ± 0.1 .XX ± 0.01 .XXX ± 0.005 .XXXX ± 0.0010			DWG. SIZE D	DWG. NO. 342033 REV. A
753722					
753721	ORIG. RELEASE DATE				SCALE NONE SHEET 1
NEXT ASSEMBLY					

REVISIONS					
REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	INITIAL RELEASE	FM	BBB	TW	9/11/95
B	REVISED PER ECO #B47314	ADK	GF	GF	4/5/96
C	REVISED PER ECO #B47398	ADK	[illegible]	[illegible]	[illegible]









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. TWISTED PAIR WITH SHIELD (OR TWISTED CABLE WITH SHIELD) AND METAL CONDUIT BY CUSTOMER.

2? MAXIMUM PER WIRE (Cu)

AWG	MAX. LENGTH (FT)
18	314
16	498
14	792
12	1260

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) BRIADED 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 OR 8-WIRE CABLE FOR FLOW ELEMENT WITH TEMPERATURE MUST HAVE MATCHED RESISTANCE ON EACH WIRE SO THE SENSOR BRIDGE CIRCUIT CAN COMPENSATE FOR THE SENSOR LEAD RESISTANCE.

CONSTRAINTS:

MAXIMUM WIRE LENGTH FOR 1? PER WIRE

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

IE: |WIRE(Rph) − WIRE(Rpl)| ≤ 0.01?, ?R 0.01? 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
Rtd LOW SIDE, Rtd(L)	BLUE	N/A
Rtd HIGH SIDE, Rtd(H)	BLACK	N/A
Rtd SENSE LEAD. Rtd(S)	BLUE	N/A

SERIES 502, 522, 532	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	APPROVALS	KURZ INSTRUMENTS, INC.
SERIES 452	TOLERANCES ARE: FRACTIONS ± 1/32; ANGLES ± 0°-30'; DECIMALS .X ± 0.1, .XX ± 0.01, .XXX ± 0.005, .XXXX ± 0.0010	DRAWN BY A. KAMIMORI, DATE 6/13/95; CHECKED BY B. BURTON, DATE 9/12/95; APPROVED T. WILSON, DATE 9/12/95	WIRING DIAGRAM, FIELD, SINGLE-POINT MASS FLOW ELEMENT, CE SERIES
NEXT ASSEMBLY	ORIG. RELEASE DATE		DWG. SIZE D; DWG. NO. 342003; REV. C; SCALE NONE; SHEET 1 OF 1

PLOT 1/1.25

342015
410/510

INSERTION FLOW ELEMENT 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 2 and 3 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 3. The series 155 mass flow computer converts this signal to a linearly proportional one. The data from Figure 2 is entered under the input channel the flow element is connected to. Remember, once this data is loaded into a channel, it is now matched to that sensor.

Field Calibration

If Field Calibration data are available on the process, this can be entered into the series 155 as a correction factor at flow xx, for up to 7 flow rates. Alternately, "Flow Perfect" can be used were the observed flow rate on the element and the reference rate are entered for up to four rates and the series 155 will calculate the correction factor. Flow Perfect has the advantage for multipoint arrays of re-computing the proper correction factor even if a sensor becomes defective. It re-computes the CF based on the reading of the remaining good signals. Many of the issues for obtaining accurate flow or mass rate readings from an insertion unit are covered in Appendix A and B.

Velocity Traverse
Another method of field calibration using the factory calibrated standard velocity signal can be used to help establish the volumetric or mass flow calibration. You can use the point velocity measurement to traverse the duct with equal area measurements and average the readings. The ratio between the indicated reading where the sensor sits and the average you computed is the CF you use.

Tracer Dilution
Kurz Instruments offers insitu flow calibrations which account for all the profile issues etc. Here the tracer injection flow rate is measured at a know injection concentration, the diluted concentration is then measured with an analyzer and the unknown flow is then calculated. This method is described under Kurz Doc Number 364011. 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
Web Site: www.kurz-instruments.com

---> Sensor Calibration Data <---

Serial no/Filename : FD9999A/FD9999A.WTC
Date : 11/1/97
Customer Code/Name : 999999/XYZ_CO.
Purchase Order No :
Model No : 452-08-MT
PART No : 752731-03-23-16-01-88-01-01-0000-21
MAPICS Item NO :
Flow Units : SFPM
Reference Fluid : AIR
Standard Conditions : 77 °F and 29.92 inHg.

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

Note: CSV is a voltage measured from signal source

Kurz Model 400D Wind Tunnel Calibration System

FLOW ELEMENT CALIBRATION REFERENCE
Model no: 450-08-AT-12, Serial no: DLI7383F
NIST Calibration Due Date: 02-03-1998

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

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. D

Sheet *1* of *1*

Figure 2 Typical input calibration sheet

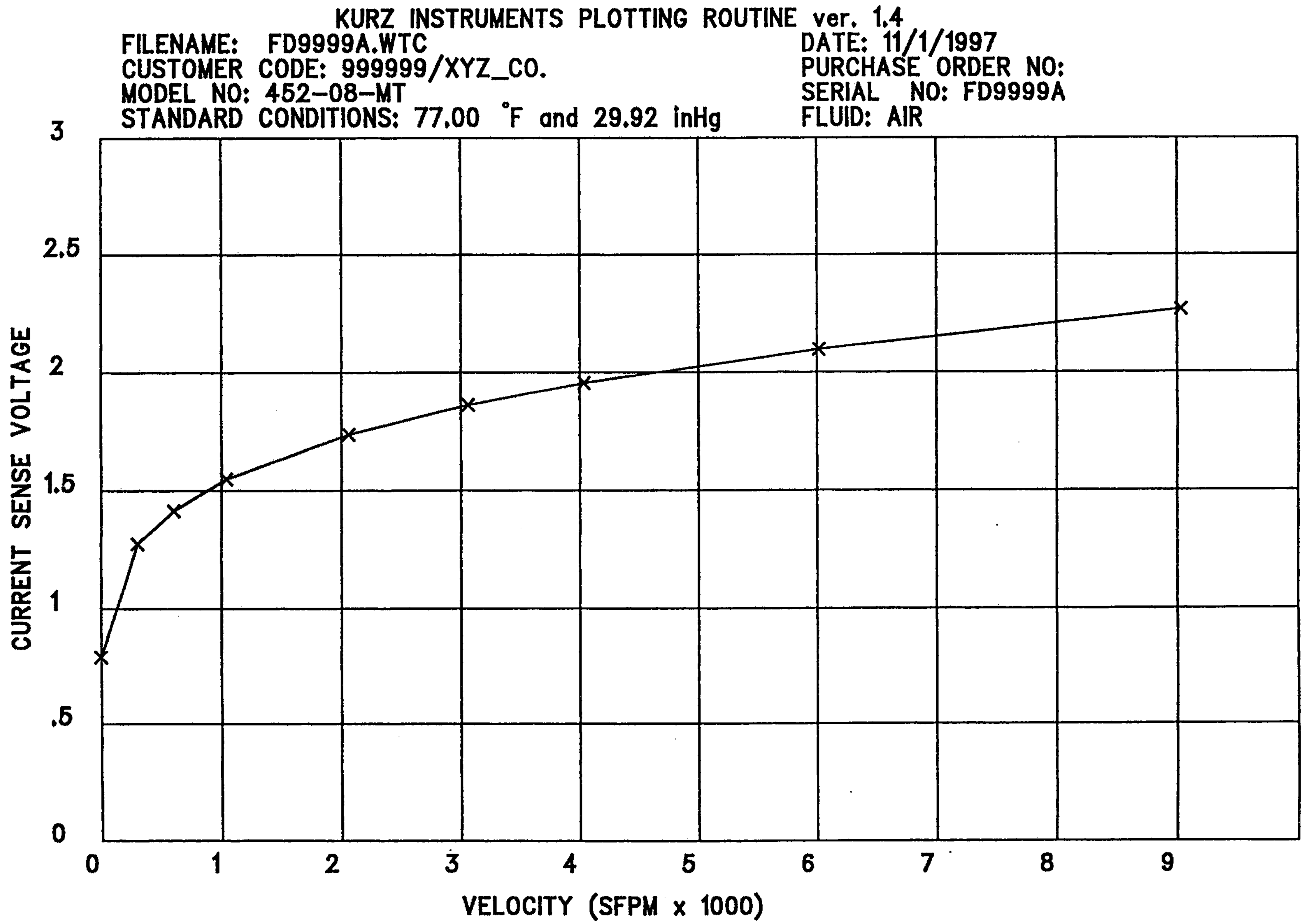


FIGURE 3 TYPICAL CALIBRATION CURVE

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 (ie: is the sensor clean? does it have a typical 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 which 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.

The purge versions are blasted on a periodic rate which is determined by experiment to give consistent calibration results. One must remember that the sensor takes about 30 seconds (could be more if the purge temp is different from the process) to recover from a purge

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 502 line will provide an accurate "out of the box" calibration. You must follow the guidelines to avoid flow disruptions from being too close to the element.

For either in-line or insertion flow elements, 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.

TABLE 2	
TROUBLESHOOTING CHART	
Symptom	Possible Reasons
No CSV signal	- Loss of power - Reversed polarity leads - Bridge Board Defective. See Note 1.
Output Signal “motor boating”	- Sensor has too much leakage current, corrosion or water damage - Defective Bridge Board
CSV does not change with flow	- Defective Sensor or Bridge - Is sensor cover removed?
Unit does not read zero at zero flow	- The gas type or pressure may be different than when calibrated. - Defective series 155, 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 series 155.
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. - Is the flow element connected to the proper channel of the series 155. Check the series 155 setup sheet.

Calibration is too high.	- Have sensor blockage & flow profile effects been accounted for? This is a significant factor in ducts measuring less than 1ft². - Is the sensor oriented 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) Is the flow element connected to the proper channel of the series 155. Check the series 155 setup sheet.
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.
CSV output is "noisy".	- Poor electrical contact. Make sure all electrical connections are clean and tight. - Look for foreign objects on the sensor or blocking the sensor in the duct.
No 4-20 mA temperature signal (452T)	- Check for proper polarity on wiring - Defective 604 board

Temperature Calibration off (452T)	- Check that the three RTD wires are connected properly - Check that the calibration data in the series 155 matches the 604 board calibration - The linearization table for the temperature channel can be changed in the series 155 or use the CF features. You can also change the Zero/Span for the meter output used for temp in the series 155.

Note 1.
The bridge board fuse, F1 on assembly 420242, may blow due to shorts between the power semiconductors and the chassis, conducting water on the electronics or just a week fuse. This is a 3/4 A fast blow fuse which is surface mounted. It is removed by heating with a soldering iron one end and lifting it up from that end at the same time. Then the other side is unsoldered. This fuse is Pico part number R459.750 or Kurz stock number 630051.

Major Subassemblies used in the 452 series flow elements.

Description	Part Number
465R8 bridge board for HHT sensors	420242-02
465R8 bridge board for FD sensors (MT versions)	420242-05
185-1-02, Lightning suppression board, 4 wire	420251-02
185-1-04, Lightning suppression board, 2 wire	420251-04
185-1-03, Remote Junction box terminal board	420251-03
604, 4-20 mA temperature transmitter	420046

RETURN SHIPMENT

RMA # (Return Material Authorization #)

If you believe your unit is not working properly, contact the Kurz Customer Service Department at phone # 408 (831 after July 98)-646-5911. Please have the following information ready to give to the Kurz Customer Service Representative:

Defective unit's model #, item # 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 to

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:

$$Re = \rho v d/\mu$$

where

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

t 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 = 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 = (Standard Volumetric Flow) x ρ_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 = (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 ideal 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. By contrast He has nearly no viscosity change with pressure. These errors are largest at low flow were the free convection term becomes significant. At 7 atmosphere pressure (about 100 psi) and 750 SFPM, this error is about 4% reading. It would be larger at lower velocities and higher pressures.

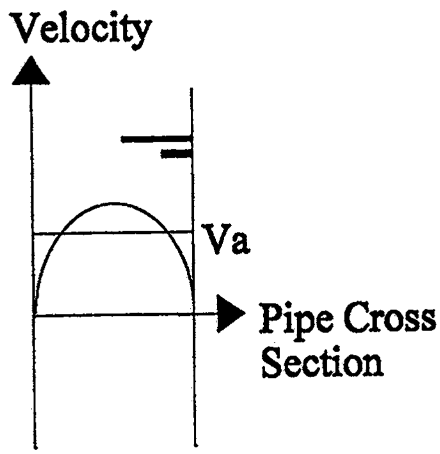
- **Temperature changes** will affect the gas thermal conductivity and viscosity so the calibration will drift. This is typically 2.5% /100 °C. The minimum drift occurs near 3000 SFPM where the dynamic temperature compensation is performed.

- **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.

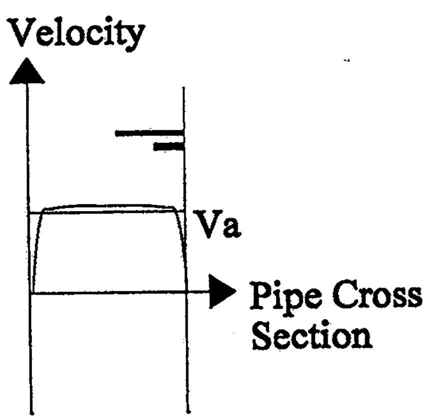
The best solution for all these error sources is to do an in-situ calibration so their contribution is included thus eliminating this error.

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).



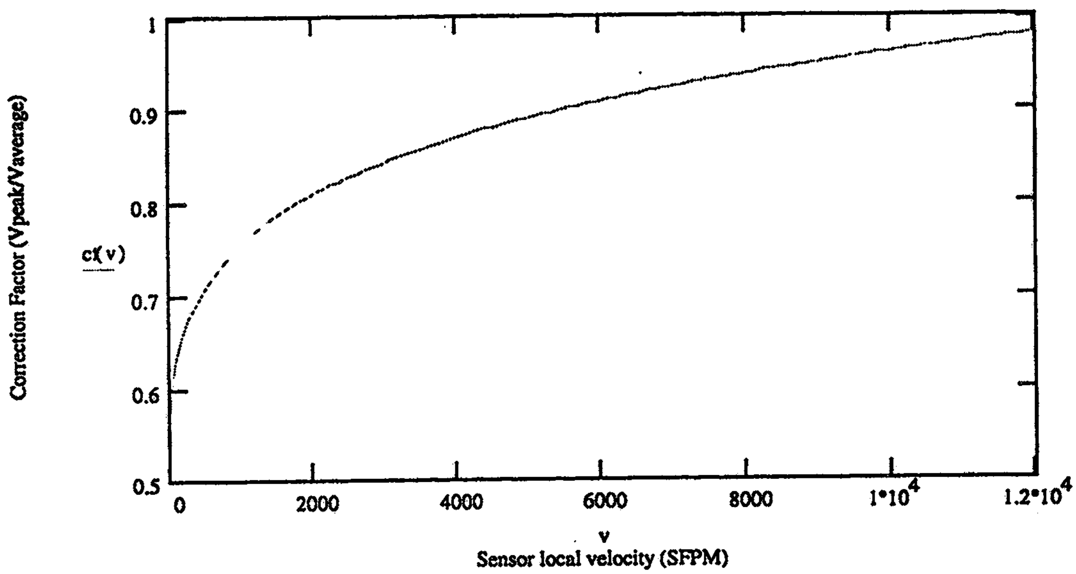
High Velocity (Reynolds Number) Turbulent Profile

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 (K-BAR) are also 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). 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, 1996 version

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: Jerome L. Kurz
Date: 10/24/96

Name: JEROME L. KURZ
Position: PRESIDENT/OWNER

Document Number 430007, Revision B.

Hazardous Area Product Approvals

Explosion Proof: Series 452 and 452T
CSA File LR 87908-5
300 PSI Maximum Process Pressure.
Explosion Proof For Class I, Zone 1, Group IIB +H_2, T3 or Class I, Division 1, Groups B, C &D, Temperature Rating T3. -40 to 60 °C Ambient Temperature, Rated Input 24 VDC, 660 mA. Indoor & Outdoor Enclosure: Type 4

FMRC File J.I. 0Z7A0.AE
300 PSI Maximum Process Pressure.
Explosion Proof For Class I, Division 1, Groups B, C & D. Dust Ignition Proof For Class II, Division 1, Groups E, F & G Sutable for Class III Hazardious Locations. Temperature Rating T1. -40 to 60 °C Ambient Temperature. Rated Input 24 VDC, 660 mA. Indoor & Outdoor Enclosure: NEMA 4

CENELEC, KEMA No. Ex-96.D.1608
300 PSI Maximum Process Pressure.
Flameproof: EExd IIC T3. -40 to 60 °C Ambient Temperature. Rated Input 24 VDC, 660 mA. Indoor & Outdoor Enclosure: IP66. Do Not Open While Flammable Gases are Present.

Nonincendive: Series 452, 452T, 452P and 452PT
CSA File LR 87908-5
300 PSI Maximum Process Pressure.
Nonincendive For Class I, Division 2, Groups A, B, C and D. Class II, Division 2, Groups F and G. Class III, Division 2. Class I, Zone 2, Group IIC. Temperature Rating T5. -40 to 60 °C Ambient Temperature. Input Rating 24 VDC, 660 mA. Indoor & Outdoor Enclosure: Type 4.

FMRC File J.I. 0Z7A0.AE
300 PSI Maximum Process Pressure.
Nonincendivie For Class I, Division 2, Groups A, B, C and D. Suitable For Class II, Division 2 Hazardous Locations. Temperature Rating T5. -40 to 60 °C Ambient Temperature, Nonhazardious Processes Only. Rated Input 24 VDC, 660 mA. Indoor and Outdoor Enclosure: NEMA 4.

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

DR. JERRY KURZ
PRESIDENT
KURZ INSTRUMENTS, INC.
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

1.036

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

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

For DC

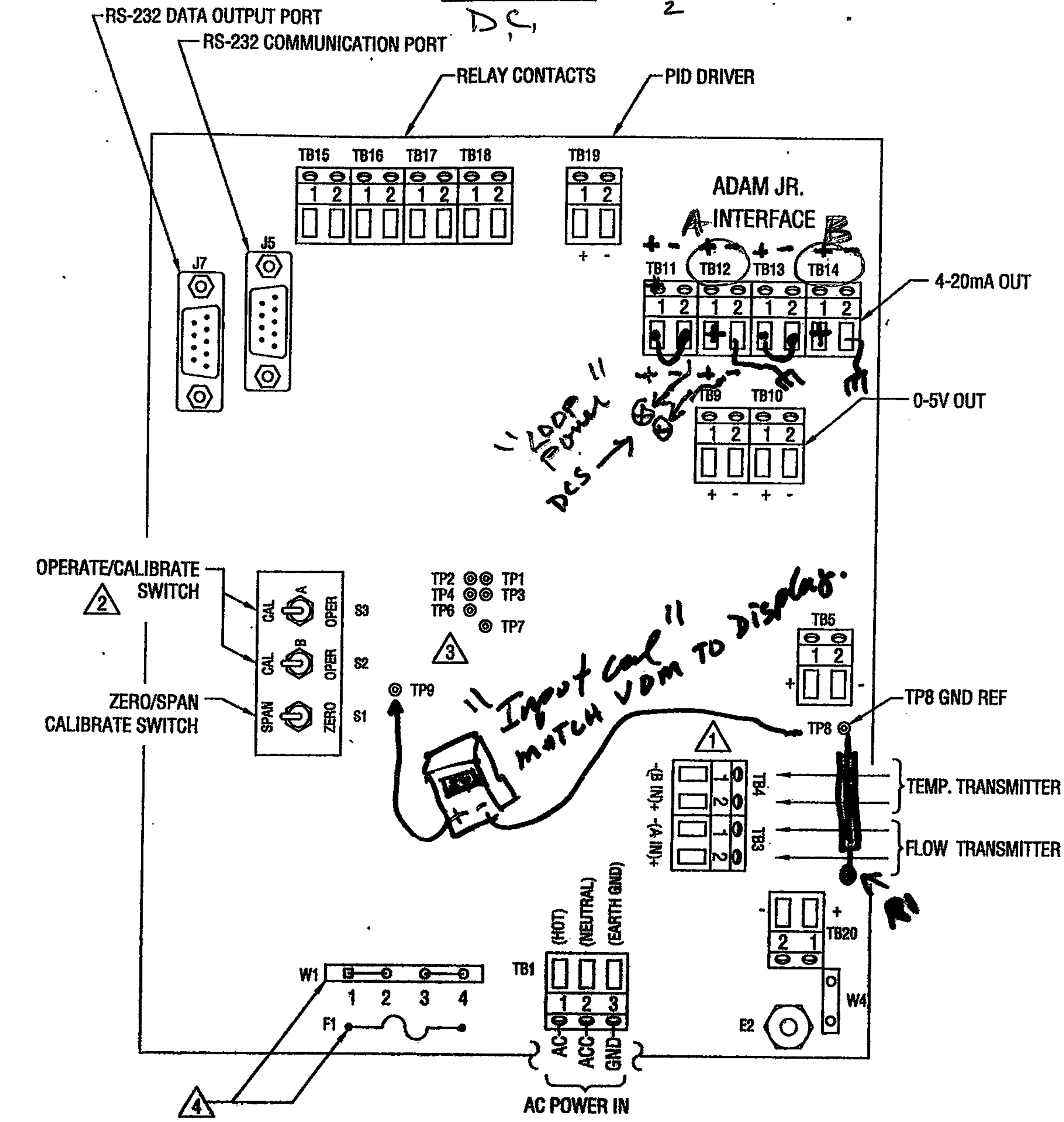
TB12 → Amloc #1, meter #1, CH A
Label = A #1

TB14 → Amloop #2 B #2 meter #2, CH B
meter = 2

OPTIONAL CONNECTIONS

ADAM JR.

D.C.



1. TB3-1 THRU TB4-1 (CHANNEL A THRU B) INPUTS 0-5 VDC MAX. TB3-2 THRU TB4-2 (CHANNEL A THRU B) OUTPUTS 18 TO 24 VDC.

2. SWITCH POSITION
   - CHANNEL CALIBRATE
   - OPERATE MODE

3. TP1 +2.500 REF
   TP2 +5V
   TP3 -9V
   TP4 +10V
   TP6 +12V
   TP7 +15V
   TP8 GND REF
   TP9 INPUT CAL

4. 1 2 3 4
   115VAC (STD.)
   F1 IS ~~0.8~~ AMP 0.5 SB
   1 2 3 4
   230VAC (OPT.)
   ~~F1 IS 0.15 AMP~~

5. CONNECT INPUT/OUTPUT SHIELDS TO CONDUIT HUB BUS BAR GROUND STUDS (NOT SHOWN).

6. EXTERNAL INPUT OPTION
   TB20-1 INPUT A (+ EXT.)
   TB20-2 INPUT A (- EXT.)
   TB5-1 INPUT B (+ EXT.)
   TB5-2 INPUT B (- EXT.)

Rev. F

(SEE DWG 340155-29 IN MANUAL FOR MORE DETAIL)

LABEL P/N 170134F