10Pro
Manual

Version 1.07

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For assistance please contact: Marathon Monitors Inc.
TEL: +1 513 772 1000 • FAX: +1 513 326 7090
Toll-Free North America +1-800-547-1055
erika.leeds@group-upc.com
www.group-upc.com

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INTRODUCTION

The MMI 10PRO Controller represents the state of the art in microprocessor-based process control technology.

The following features have been included to allow use of the instrument in a wide variety of applications:

- Fully site-configurable for single loop control with a variety of control modes
- a fully isolated analog input configurable for thermocouple, RTD, voltage, or current
- two (2) configurable control output triacs for combined use in single control loop mode
- a fully isolated analog output configurable for voltage or current output
- two (2) configurable alarm triacs, assignable as process alarms or deviation alarms
- an RS 422/485 communications port for data transfer to and from a host.

This manual provides all of the information required to install, set-up, operate, use the communication port and troubleshoot the MMI 10PRO.

NOTES

1 SET UP PROCEDURES

1.1 Installation Preparations

1.1.1 Location

The 10PRO instrument is designed for up to 1/8" panel mounting in a DIN standard opening of 3.62" square (adapter panels available by special order). Required rear clearance is 10.5" to allow for wiring.

As with all solid state equipment, the controller should be located away from excessive heat, humidity, and vibration (Refer to Section 1.4 for specifications). Since the unit uses red LED display devices, it should also be located such that direct sunlight will not interfere with the display's visibility. The instrument requires 120/240 VAC (jumper selectable on the power board inside the 10PRO) 50/60 Hz and should not be on the same circuit with other noise-producing equipment such as induction machines, large electrical motors, etc. Signal wiring must be run separate from control wiring.

1.1.2 Panel Mounting/Removal

Mounting

To mount the 10PRO in a control panel, a hole must be cut 3.62" square in the necessary location on the panel. The following procedure should be followed to mount the 10PRO in the panel.

1) INSERT unit into previously cut out 3.62" square hole in panel.

2) While supporting unit, insert one clamping bracket into the groove on the side of unit, and then install the 6-32 set screw.

3) Repeat step 2 for the opposite side of the unit.

4) With a HEX KEY wrench, alternately tighten the screw on either side of instrument to a torque of six in.-lbs. Insure rigidity of mounting.

To remove the instrument from the panel, reverse the above procedures.

1.1.3 Thermocouples and Other Signal Wires

The wiring used to connect the signal wires to the instrument should be run in conduit, separate from any AC lines in the area. This provides noise immunity and physical protection. Thermocouples should be wired with the appropriate alloy extension wire with no termination other than at the instrument. As with all cold-junction compensating instruments, **EXTREME CARE** should be used when an existing thermocouple is to be used for both the 10PRO and another instrument simultaneously.

1.1.4 Control Devices

The 10PRO provides simple ON/OFF as well as Proportional control through its 2 contact closure CONTROL OUTPUTS and its ANALOG OUTPUT. This allows control through simple ON/OFF devices or through Proportional control methods.

SIMPLE ON/OFF control: Set Control Mode for ON/OFF control. This provides contact closure at CONTROL

OUTPUT #1 to control absolute heat application/removal for such devices as heating elements etc.

Three types of Proportional control are:

1) Time-Proportioning: Refers to the modulation of the duty cycle. That is, the changing ratio of On Time versus Off Time in systems that use such devices as heating contactors, On/Off valves, and unidirectional motors.

2) Position-Proportioning: Refers to the adjustment of a variable positioning device such as a positioning motor using the two control contacts. (Note: Slidewire feedback is not supported in the 10PRO.)

3) Voltage or Current output: a constant, linear, and scalable analog output (voltage or current) is varied to control devices such as motor actuators.

Some typical applications for the methods are:

HIGH/LOW or HEAT/COOL heat application system: Set Control Modes for Time-Proportioning. This provides that CONTROL OUTPUT #1 (TBA-4) and CONTROL OUTPUT #2 (TBA-6) are in opposite conditions at either extreme of the control range and are both OFF at the midpoint of the control range.

ANALOG OUTPUT control: Set Control Modes for Time-Proportioning. This provides a 0 to 5 VDC or 4 to 20 mA output which is selectable at the ANALOG OUTPUT terminals (TBB-4 through TBB-6, See Section 1.2.4 for more details). The output control is based on 0 to 99% of the output device's control range. For example; 50% control would equal 2.5 VDC out where 5 VDC equals maximum heat output of the drive. This can be used with servo drives which require a voltage or current command signal for controlling heat output or servo positioning.

The above methods are just a few of the typical applications of the 10PRO. Many others can and do exist. Please call your MMI representative or application engineer for questions concerning your particular system.

1.1.5 Chart Recorders

If a chart recorder is to be used, it should have input specifications within the following ranges, for maximum accuracy:

0 to 5 VDC
4 to 20 mA

The ideal location of the recorder is adjacent to the instrument but it may be located remotely if the connecting wires are properly shielded. Long wiring runs from the chart recorder outputs should use the 4 to 20mA output of the instrument with a 250 ohm dropping resistive if a voltage signal is required This configuration will decrease the effects of shop noise. For best results the chart recorder input(s) should be isolated from ground.

1.1.6 Computer Interface

If advantage of the 10PRO's RS-485 digital communications capabilities is to be taken, refer to section 4.0 "Communications" for more details.

1.1.7 Alarms

Two user-programmable Triac alarm contacts are available in either process or deviation modes.

1.2 Electrical Connections

Connections to the unit are made via two terminal blocks, located on the REAR PANEL, labeled TBA and TBB. (Position 1 is located at the top and position 10(TBA) or 8(TBB) is located at the bottom of the terminal strip). AC power, control, and alarm connections are made on TBA. All communications and analog I/O signals are located on TBB. Refer to Figure 1.1 for a complete layout of the 10PRO REAR PANEL connections.

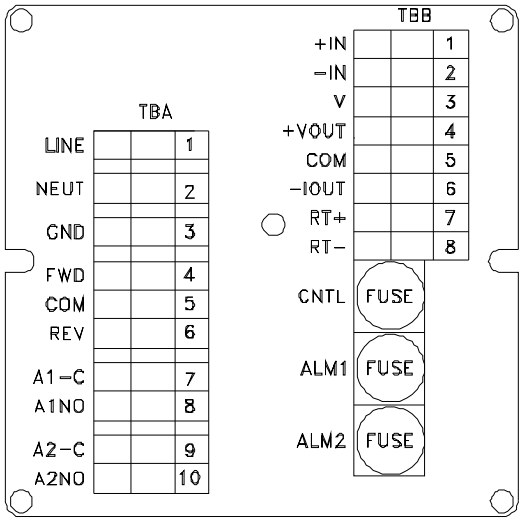


Figure 1.1 10Pro Rear Panel

1.2.1 AC Power

The 10PRO requires 120/240 VAC @ 1 AMP, connected as follows:

HIGH VAC	-	TBA-1
NEUTRAL	-	TBA-2
EARTH GROUND	-	TBA-3

1.2.2 Control Contacts

Eight control contacts are located on TBA and TBB as follows:

CNTRL #1	N.O.	-	TBA-4
	COM.	-	TBA-5
CNTRL #2	N.O.	-	TBA-6
ALARM #1	N.O.	-	TBA-8
	COM.	-	TBA-7
ALARM #2	N.O.	-	TBA-10
	COM.	-	TBA-9

1.2.3 Analog Input

The 10PRO allows for the input to be determined by a "daughter board" located on the main input board inside the unit.

INPUT +	-	TBB-1
INPUT -	-	TBB-2
SOURCE V	-	TBB-3 (Special Applications)

1.2.4 Analog Output

An isolated analog output is provided on TBB that can be selected as current or voltage output by wiring to the proper terminals.

For Voltage:

OUTPUT +	-	TBB-4
OUTPUT -	-	TBB-5

For Current:

OUTPUT +	-	TBB-5
OUTPUT -	-	TBB-6

Note: When switching from voltage to current, or current to voltage, the Analog output must be recalibrated. (See Section 3.0)

1.2.5 Communications

Half duplex RS 422/485 communications.

HOST PORT:

RT+	-	TBB-7
RT-	-	TBB-8

1.3 Thermocouple Burnout Jumper Selection

When using a thermocouple input, the thermocouple jumper selects either a full upscale or a full downscale reaction to take place when a thermocouple fails or becomes open. The jumper can be found on the thermocouple board, and has two possible settings (See Figure 1.2). For full scale upwards (upscale burnout), place the jumper from the + to the C; and for full scale downwards, place the jumper from the - to the C.

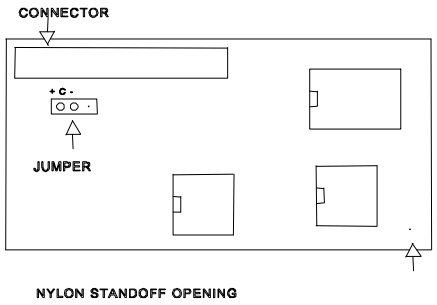


Figure 1.2 T/C Jumper Setting

Remove the 10PRO from the case following the removal procedure (Section 1.5).

ATTENTION

Electrostatic sensitive devices are exposed when the instrument is removed from the case. Observe ElectroStatic Discharge handling procedures.

1.4 Changing 110/220V Input Power Jumpers

The 10PRO is typically configured to accept 110 VAC for use in the Americas and 220 VAC for use in Europe and Asia. This section describes how to verify and change the power configuration of the 10PRO if it is required.

Remove the 10PRO from the case following the removal procedure (Section 1.5).

ATTENTION

Electrostatic sensitive devices are exposed when the instrument is removed from the case. Observe ElectroStatic Discharge handling procedures.

To verify the input power setting on the 10PRO, locate the power selection jumpers on the 10PRO power board. The power board can be identified by the ten position terminal block and two transformers mounted on the board. The power selection jumpers are at upper rear part of the board near fuse F4.

For 110 VAC operation the wire jumpers should be soldered to the four pads on the power board as shown in the following figure.

Jumper Configuration for 110 VAC Operation

For 220 VAC operation a wire jumper should be soldered to the forward two pads on the power board as shown in the following figure.

Jumper Configuration for 220 VAC Operation

It is necessary to desolder/solder these jumpers on the 10PRO power board to change the power input configuration. **Insure that proper ESD handling procedures are followed while working on the exposed circuit boards of the 10PRO.** It should not be necessary to remove the power board from the mounting brackets connecting it to the main board and display board.

When changing from 110 VAC to 220 VAC insure that both jumpers are removed before soldering the vertical jumper.

Inspect any modification to verify that no solder bridges exist between pads before installing the instrument and applying power.

Insert the instrument into the case and reconnect the wires that were attached to the rear panel if applicable.

1.5 Removing the 10PRO from the Case

This section describes how to remove the instrument from the case, if required.

WARNING

110 VAC or 220 VAC are present on the rear panel of the 10PRO. Insure that instrument power, external control and alarm voltages are secured to the instrument.

1) Insure that all power sources connected to the 10PRO are secured.

2) Disconnect and tag all connections at the rear panel of the 10PRO.

3) Remove the 6-32 Phillips screw near the center of the rear panel of the 10PRO.

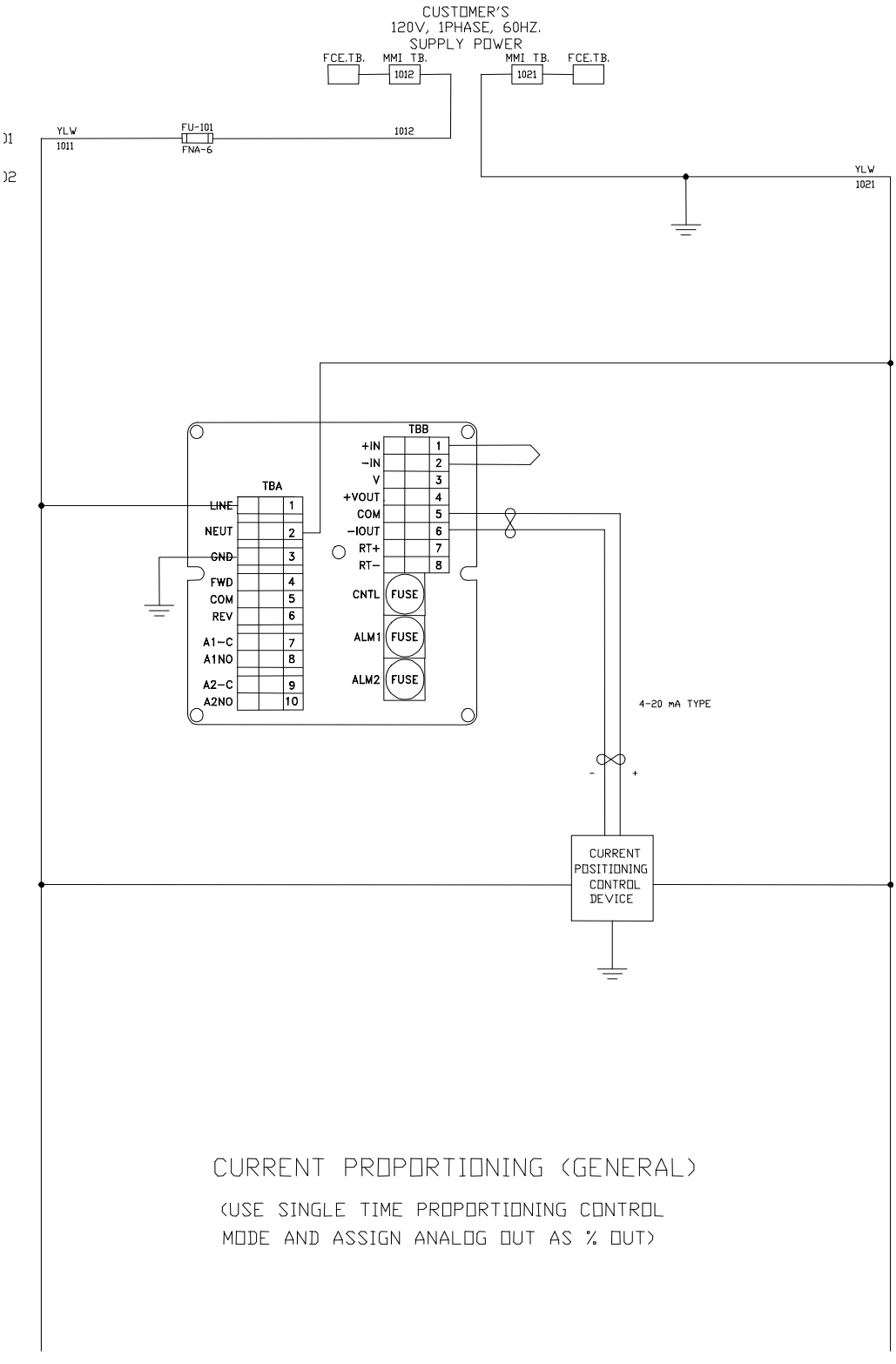
4) Push lightly on the terminal blocks at the rear panel until the outer edge of the terminal blocks meets the face of the rear panel.

ATTENTION

Electrostatic sensitive devices are exposed when the instrument is removed from the case.
Observe ElectroStatic Discharge handling procedures.

5) At the front of the panel continue to pull the instrument out of the case until the rear terminals clear the front bezel of the case.

6) If the instrument is to be shipped without the case, place it into an ESD shielding bag before adding any additional packing materials.



CURRENT PROPORTIONING (GENERAL)

(USE SINGLE TIME PROPORTIONING CONTROL MODE AND ASSIGN ANALOG OUT AS % OUT)

Figure 1.3

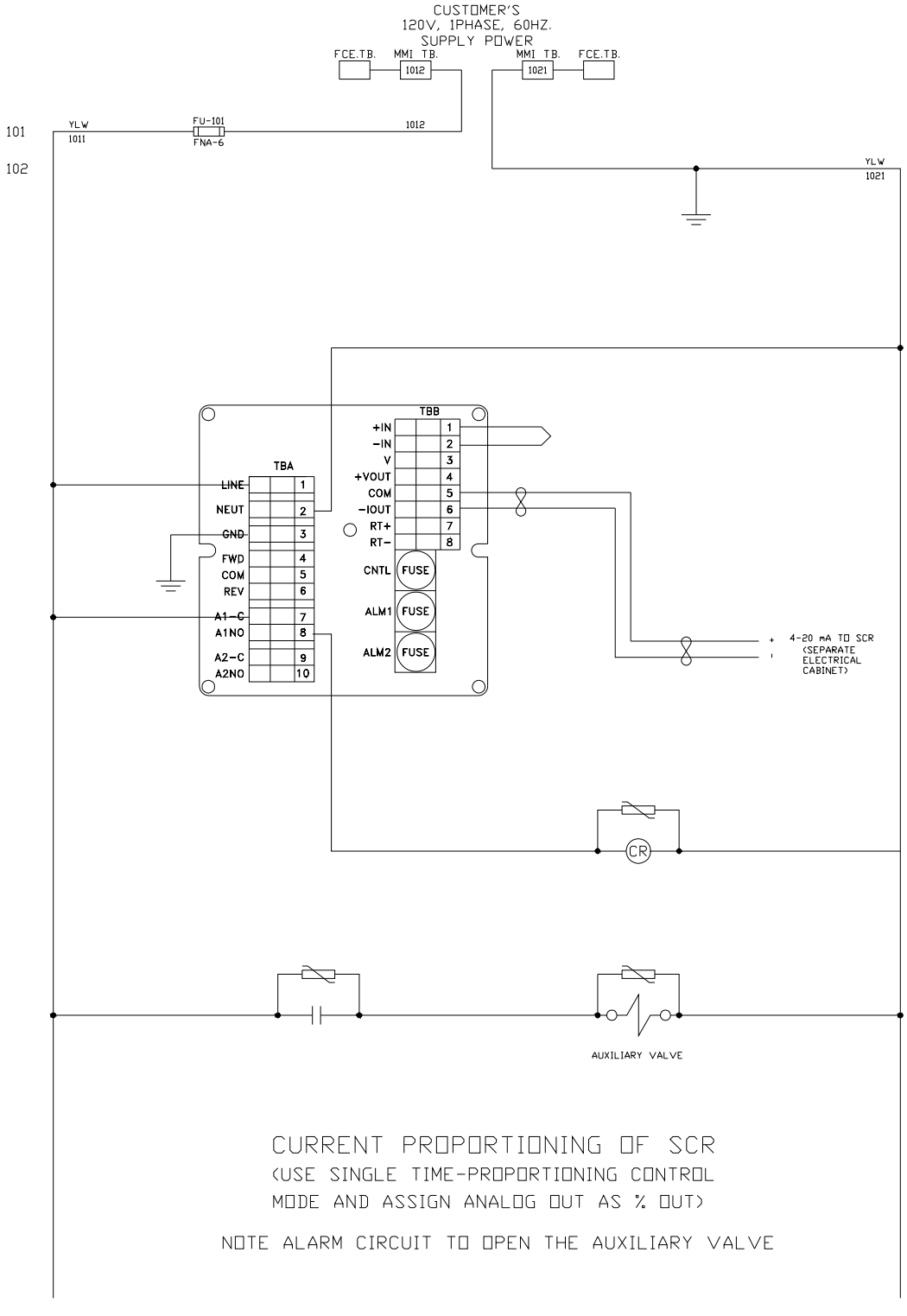

CUSTOMER'S
120V, 1PHASE, 60HZ.
SUPPLY POWER
FCE.TB.
MMI TB.
1012
MMI TB.
1021
FCE.TB.
101
102
YLW
1011
FU-101
FNA-6
1012
YLW
1021
TBA
LINE 1
NEUT 2
GND 3
FWD 4
COM 5
REV 6
A1-C 7
A1NO 8
A2-C 9
A2NO 10
TBB
+IN 1
-IN 2
V 3
+VOUT 4
COM 5
-IOUT 6
RT+ 7
RT- 8
CNTL FUSE
ALM1 FUSE
ALM2 FUSE
+
-
4-20 mA TO SCR
(SEPARATE
ELECTRICAL
CABINET)
CR
AUXILIARY VALVE
CURRENT PROPORTIONING OF SCR
(USE SINGLE TIME-PROPORTIONING CONTROL
MODE AND ASSIGN ANALOG OUT AS % OUT)
NOTE ALARM CIRCUIT TO OPEN THE AUXILIARY VALVE

Figure 1.4

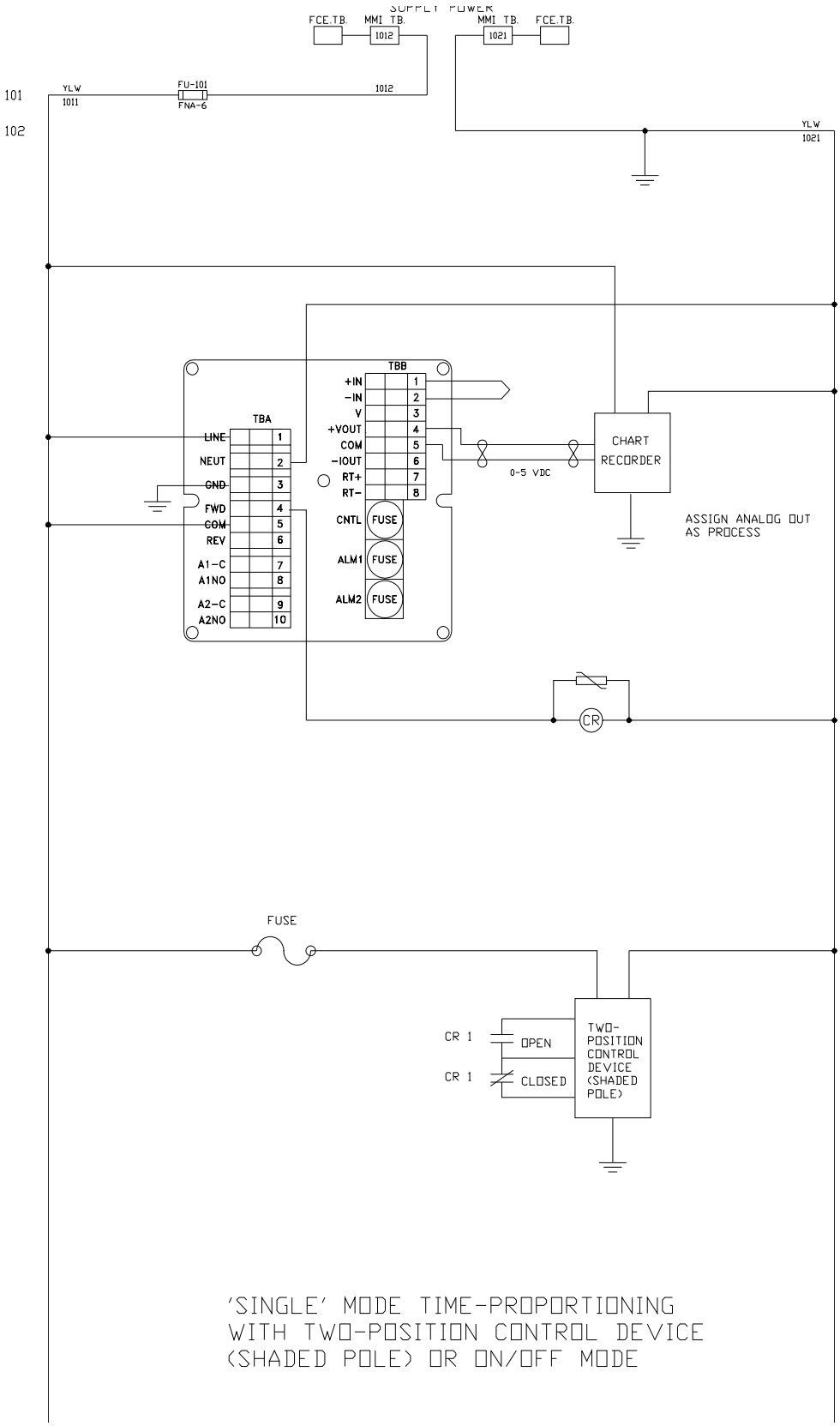
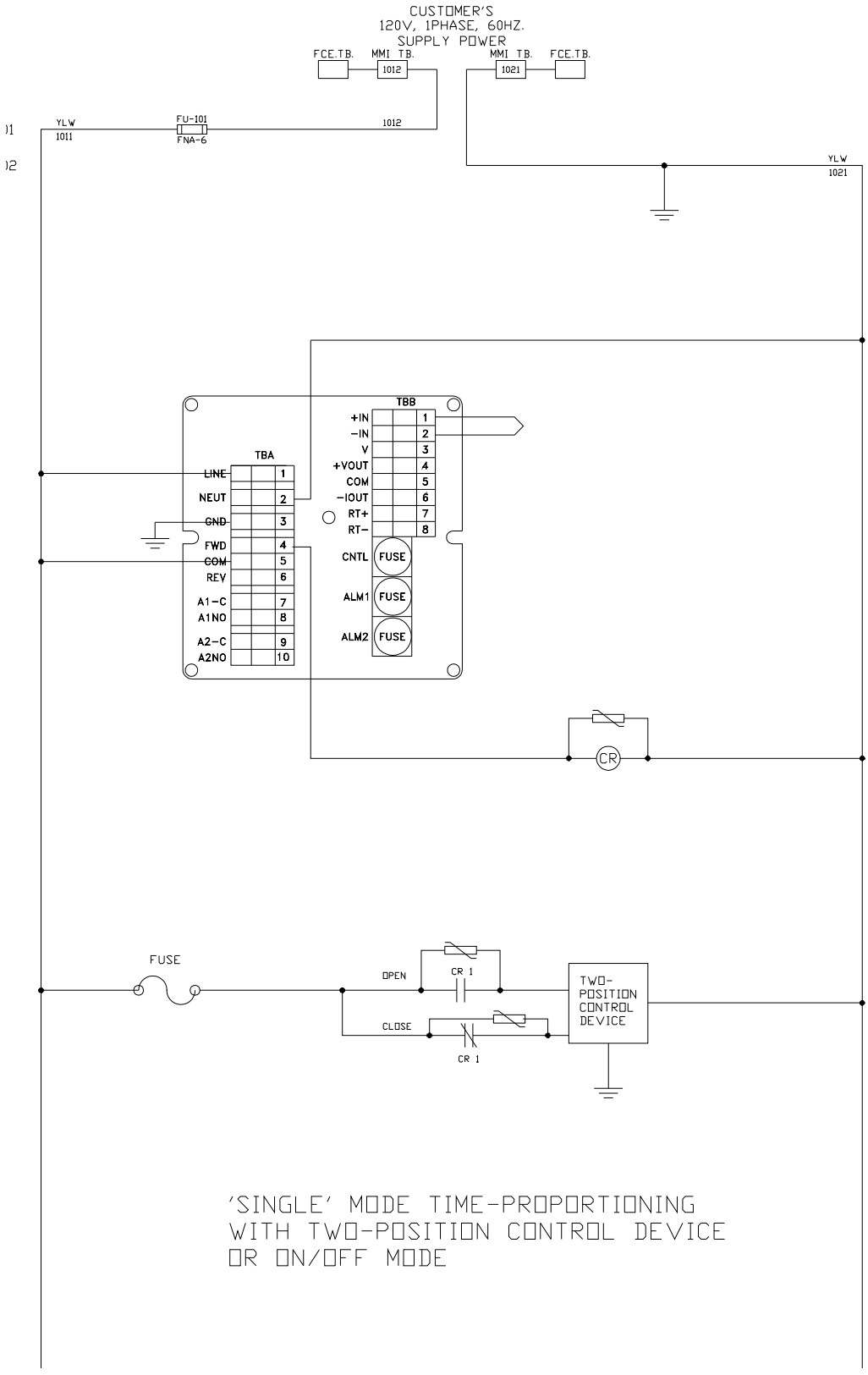

SUPPLY POWER
FCE.TB.
MMI TB.
1012
MMI TB.
1021
FCE.TB.
101
102
YLW
1011
FU-101
FNA-6
1012
YLW
1021
TBA
LINE 1
NEUT 2
GND 3
FWD 4
COM 5
REV 6
A1-C 7
A1NO 8
A2-C 9
A2NO 10
TBB
+IN 1
-IN 2
V 3
+VOUT 4
COM 5
-IOUT 6
RT+ 7
RT- 8
CNTL FUSE
ALM1 FUSE
ALM2 FUSE
0-5 VDC
CHART RECORDER
ASSIGN ANALOG OUT AS PROCESS
CR
FUSE
CR 1
OPEN
CR 1
CLOSED
TWO-POSITION CONTROL DEVICE (SHADED POLE)
'SINGLE' MODE TIME-PROPORTIONING WITH TWO-POSITION CONTROL DEVICE (SHADED POLE) OR ON/OFF MODE

Figure 1.5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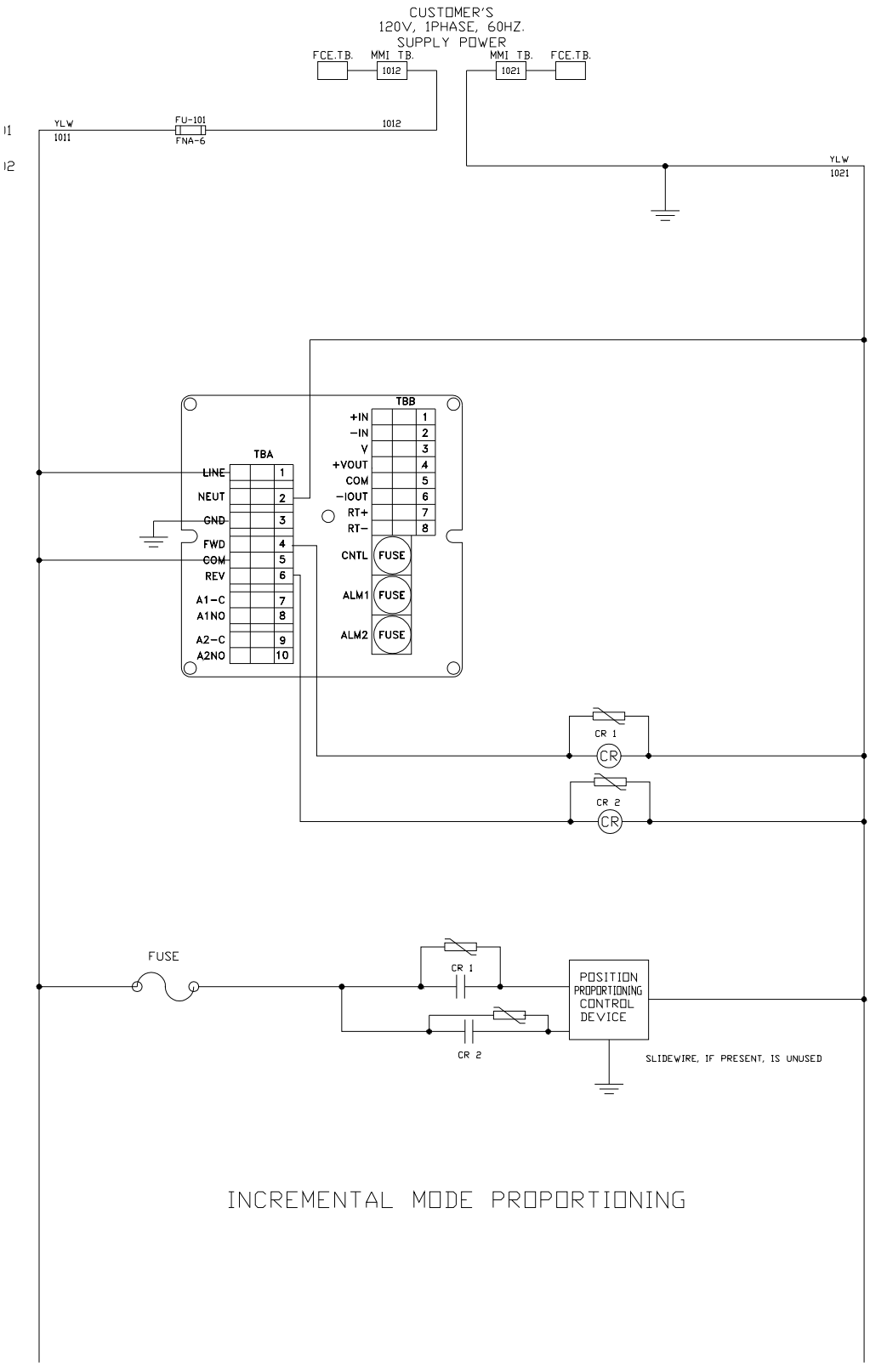
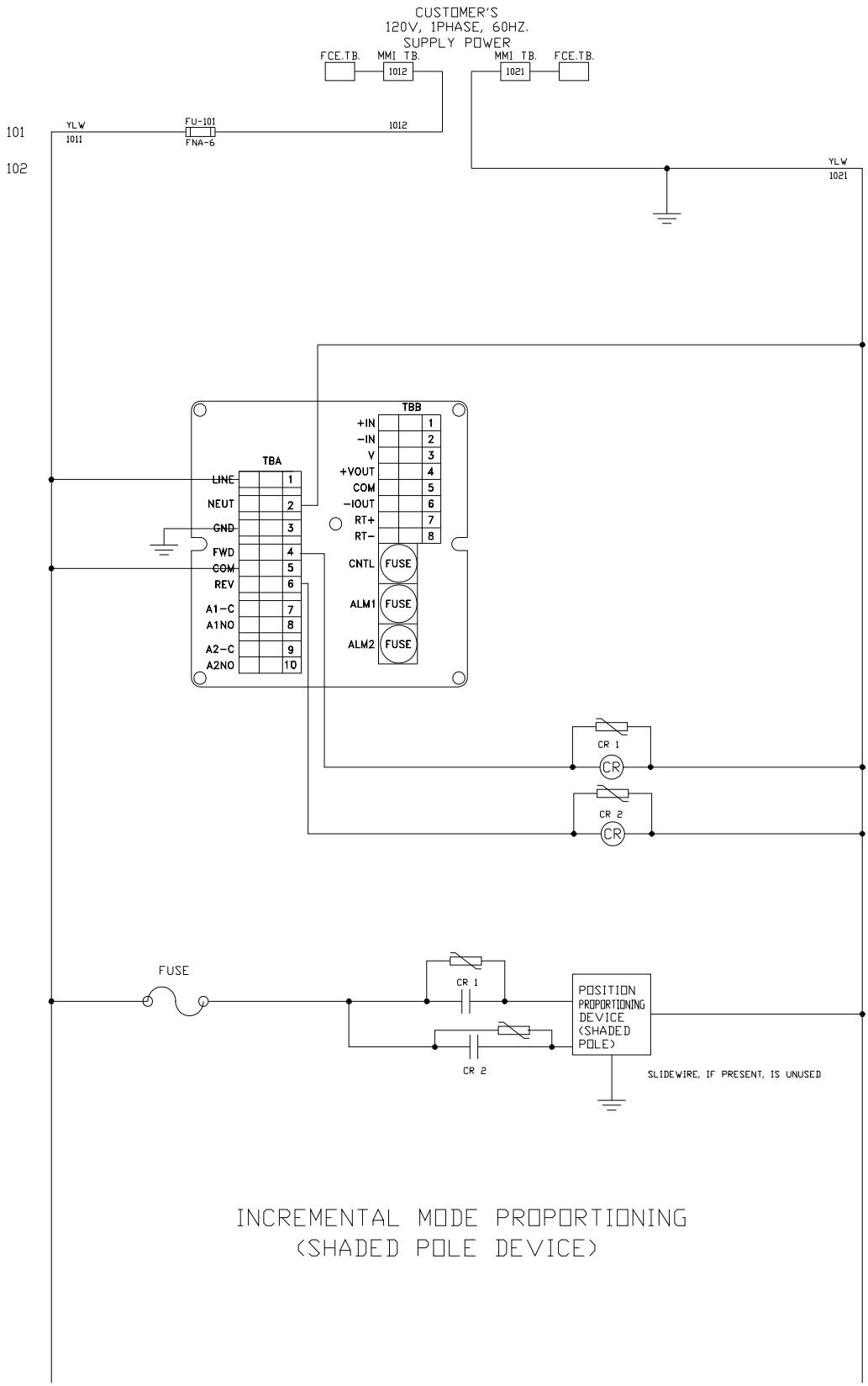
1012
MMI TB.
1021
FCE.TB.
YLW
1011
FU-101
FNA-6
1012
YLW
1021
TBB
+IN
-IN
V
+VOUT
COM
-IOUT
RT+
RT-
1
2
3
4
5
6
7
8
TBA
LINE
NEUT
GND
FWD
COM
REV
A1-C
A1NO
A2-C
A2NO
1
2
3
4
5
6
7
8
9
10
CNTL
ALM1
ALM2
FUSE
FUSE
FUSE
CR
FUSE
OPEN
CR 1
CLOSE
CR 1
TWO-
POSITION
CONTROL
DEVICE
'SINGLE' MODE TIME-PROPORTIONING
WITH TWO-POSITION CONTROL DEVICE
OR ON/OFF MODE

Figure 1.6



INCREMENTAL MODE PROPORTIONING

Figure 1.7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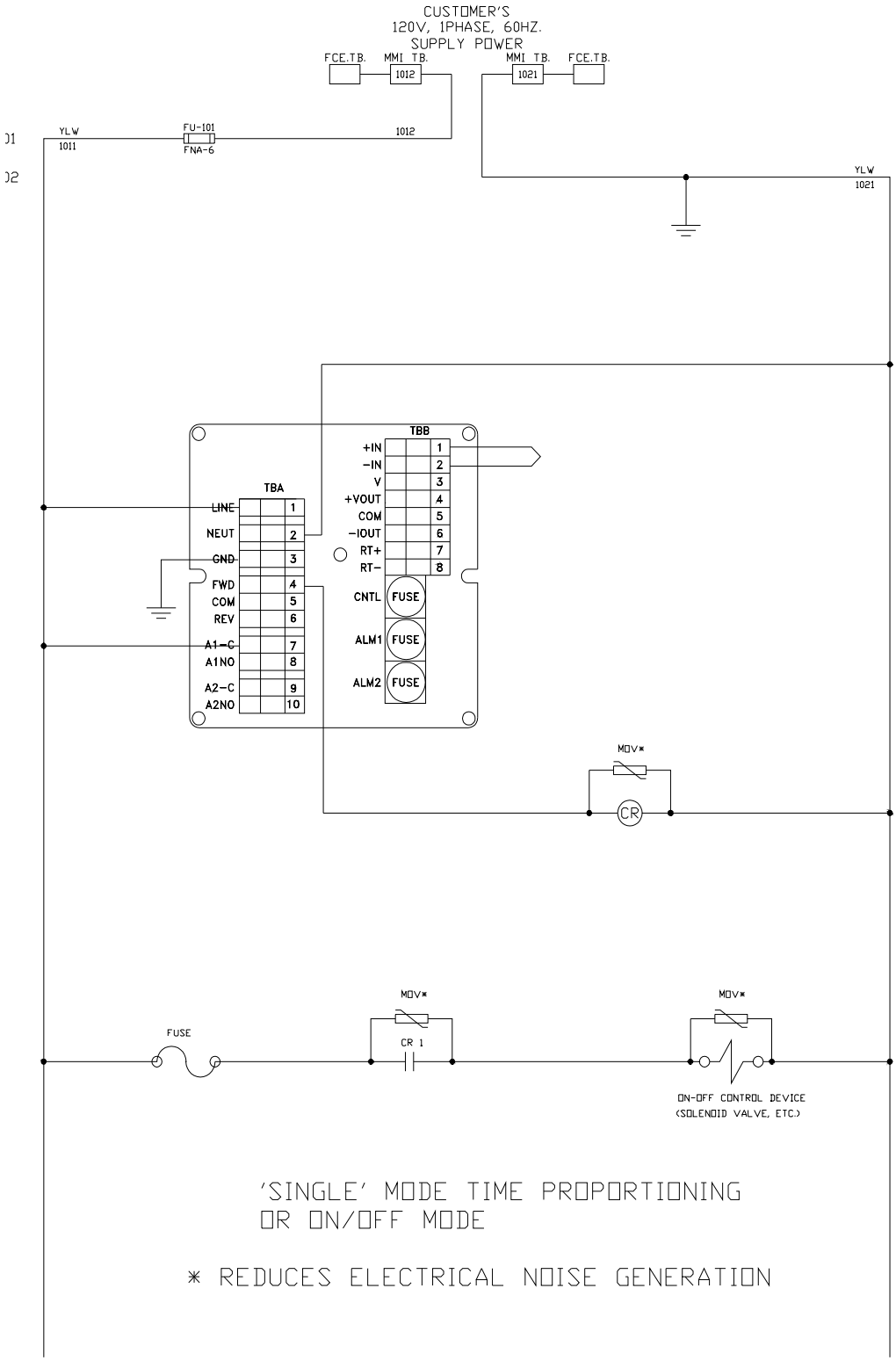
A1NO 8
A2-C 9
A2NO 10
TBB
+IN 1
-IN 2
V 3
+VOUT 4
COM 5
-IOUT 6
RT+ 7
RT- 8
CNTL FUSE
ALM1 FUSE
ALM2 FUSE
CR 1
CR
CR 2
CR
FUSE
CR 1
CR 2
POSITION PROPORTIONING DEVICE (SHADED POLE)
SLIDEWIRE, IF PRESENT, IS UNUSED
INCREMENTAL MODE PROPORTIONING
(SHADED POLE DEVICE)

Figure 1.8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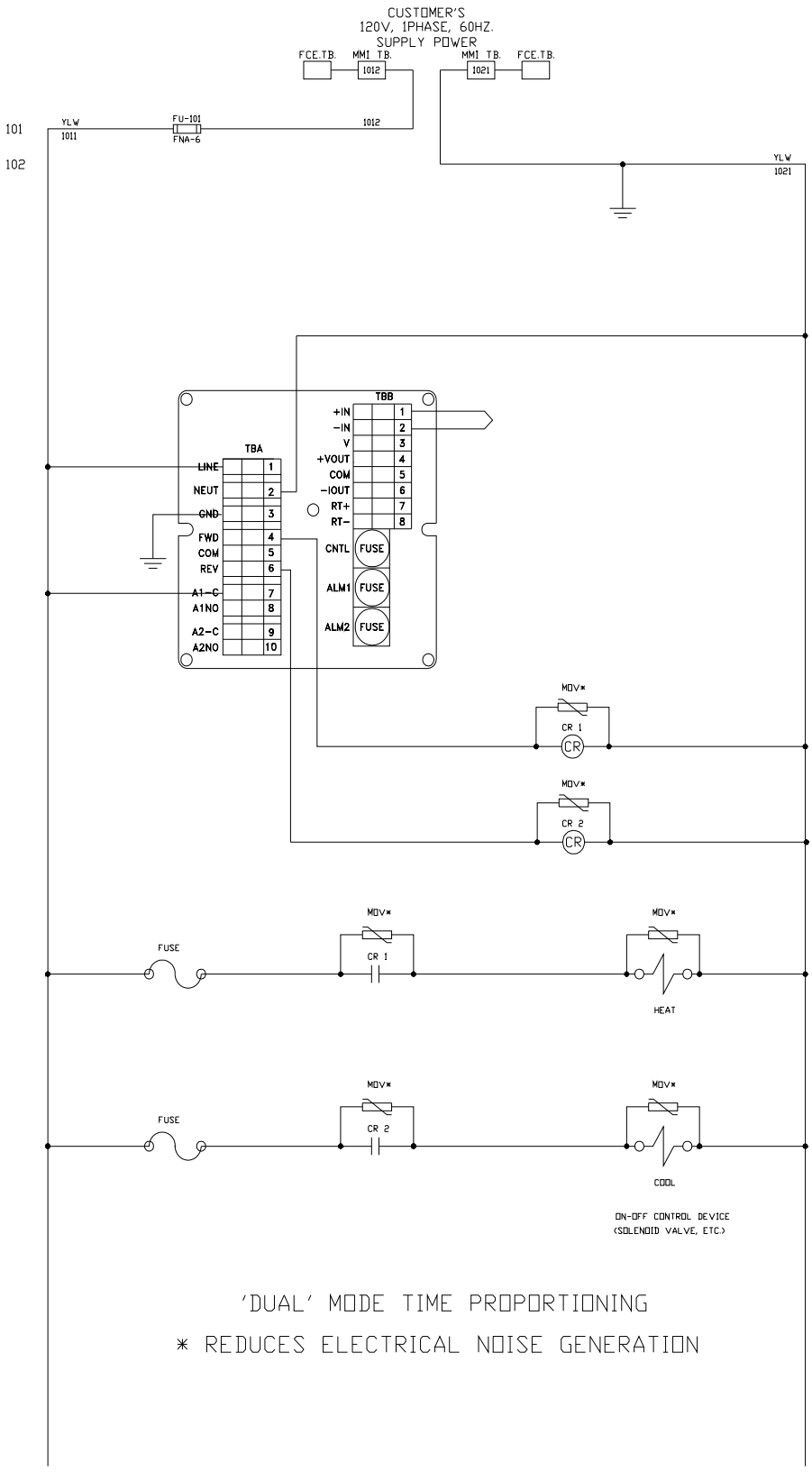
FU-101
FNA-6
1012
YLW
1021
TBA
LINE 1
NEUT 2
GND 3
FWD 4
COM 5
REV 6
A1-C 7
A1NO 8
A2-C 9
A2NO 10
TBB
+IN 1
-IN 2
V 3
+VOUT 4
COM 5
-IOUT 6
RT+ 7
RT- 8
CNTL FUSE
ALM1 FUSE
ALM2 FUSE
MOV*
CR
FUSE
MOV*
CR 1
MOV*
ON-OFF CONTROL DEVICE
(SOLENOID VALVE, ETC.)
'SINGLE' MODE TIME PROPORTIONING
OR ON/OFF MODE
* REDUCES ELECTRICAL NOISE GENERATION

Figure 1.9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FNA-6
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YLW
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TBA
LINE 1
NEUT 2
GND 3
FWD 4
COM 5
REV 6
A1-C 7
A1NO 8
A2-C 9
A2NO 10
TBB
+IN 1
-IN 2
V 3
+VOUT 4
COM 5
-IOUT 6
RT+ 7
RT- 8
CNTL FUSE
ALM1 FUSE
ALM2 FUSE
MOV*
CR 1
CR
MOV*
CR 2
CR
MOV*
FUSE
CR 1
MOV*
HEAT
MOV*
FUSE
CR 2
MOV*
COOL
ON-OFF CONTROL DEVICE
(SOLENOID VALVE, ETC.)
'DUAL' MODE TIME PROPORTIONING
* REDUCES ELECTRICAL NOISE GENERATION

Figure 1.10

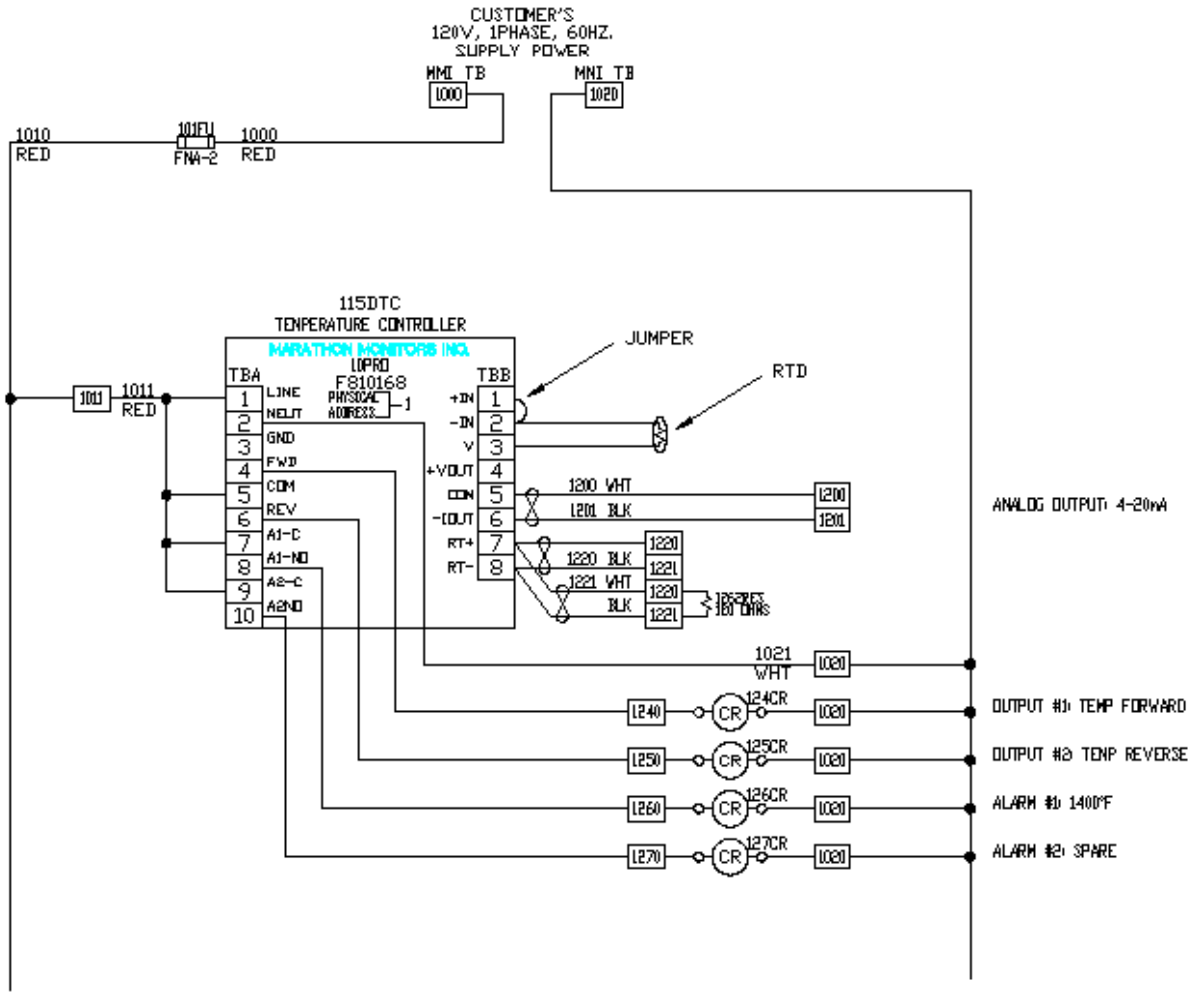


Figure 1.11 RTD Connection

1.6 Specifications

Alarm Outputs	One user selectable Triac output for process alarms. 1 A, 125/240 maximum (fused at 1 A)
Ambient Temperature	0 to 130°F
Analog Output	Two 4 to 20 mA for ZERO to full SPAN. Programmable to other ranges, but with a slight loss of accuracy.
Control Outputs	Two triac outputs selectable for Time-Proportioning or Position Proportioning. 1 A, 125/240 maximum (fused at 1 A)
Serial Interface:	
Host	RS-485, 1200/4800 BAUD, Half Duplex, Even Parity.
Dimensions	3.78"W X 3.78"H X 9.0"L
Humidity	0 to 85% non-condensing
Line Voltage	95 to 125 VAC, 50/60 Hz 190 to 250 VAC, 50/60 Hz
Panel Cutout	3.62"H X 3.62"W, (¼ DIN)
PID Constants	
Proportional Band	1 to 999% of Range
Reset	0 to 99.99 RPM
Rate	0 to 9.99 minutes
Cycle Time	0 to 200 seconds
Load Line	0 to 100%
Power Requirements	18 VA maximum
Setpoint	-300 TO 4000
Signal Input Range	-10 to +70 mV, mV board -50 to +2000 mV, High Level board
Signal Display Range	-300 to 4000 (±4) Depends on calibration and thermocouple type. (See Table II Sec. 3.1.3)

Thermocouple

Display Code	Rom #0:	Standard Set
L	L:	Linear
J	J:	Iron-Constantan
K	K:	Chromel-Alumel
S	S:	Platinum vs. Platinum 10% Rhodium

Rom #1:

L	L:	Linear
J	J:	Iron-Constantan
K	K:	Chromel-Alumel
r	R:	Platinum vs. Platinum 13% Rhodium

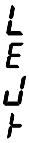
Rom #2:

L:	Linear
B:	Platinum 30% Rhodium vs. Platinum 6% Rhodium
C:	Tungsten 5% Rhenium vs.Tungsten 26% Rhenium
NNM:	Nickel vs. Nickel 18% Molybdenum

Rom #3:

L:	Linear
J:	Iron-Constantan
N:	Nickel 14.2% Chromium 1.4% Silicon vs. Nickel 4.4% Silicon 0.1% Magnesium
T:	Copper-Constantan

Rom #4:



L:	Linear
E:	Chromel-Constantan
J:	Iron-Constantan
K:	Chromel-Alumel

Rom #5:

L:	Linear
RTD:	100 Ω Platinum

Weight	Approximately 4 pounds

2 USING THE INSTRUMENT

2.1 Front Panel

The 10PRO front panel consists of two groups of four seven segment LED displays, eight LED indicators, and eight membrane keyboard keys. The upper seven segment LED display shows the process value in normal operation and is referred to as the Process window. When entering parameters, this display will show a message identifying the parameter being entered. The lower display in normal operation will show the process setpoint when in auto or remote and the control percent output when in manual and is referred to as the Set window. When entering parameters, this display will show the value of the parameter being entered. This display will temporarily show other data dependent on certain keys being held down as described in the keyboard section.

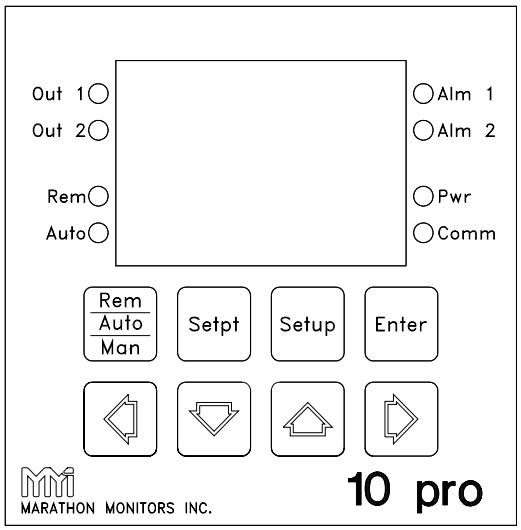


Figure 2.1 10PRO Front Panel

The eight LED indicators provide information on the operation of the 10PRO as follows:

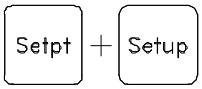
LED LIT	FUNCTION
Pwr	shows that the internal power supply is working properly
Comm	will flash whenever the 10PRO is transmitting over the RS-485 port
Auto	indicates that the 10PRO is in automatic control mode
Rem	indicates that the 10 Pro is in automatic control mode and will accept a setpoint from the Host communications port.

Note: If neither the Auto nor the Rem LED is lit, the 10Pro is in manual control mode

Out 1 and Out 2	indicate the state of the control output triacs. If either of the LEDs is illuminated, then the respective output triac is ON
Alm 1 and Alm 2	indicate the state of the two alarm triacs. If either of the LEDs is illuminated, then the respective output triac is on

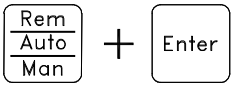
The functions of the eight membrane keys may change when the 10PRO is placed into different modes. This section will describe the keys if activated from the normal mode of operation. The sections on the various modes will describe how the keys are used in that mode.

KEY	DESCRIPTION
Rem / Auto / Man	This key selects the control mode of the 10PRO. Each press of this key cycles the control mode from Manual to Auto to Remote to Manual etc.
Setpt	Pressing this key places the 10PRO into parameter entry mode for the local setpoint, when the security is off.
Setup	Pressing this key places the 10PRO into parameter entry mode for all parameters except the setpoint. As a safety feature, the key must be held down for 5 seconds before activation occurs.
Enter	The Enter key by itself performs no function in the normal mode of operation. Therefore it is always used in multi-key operations, i.e. when two or more keys must be pressed simultaneously. **In multi-key operations, always first press and hold the Enter key then press the other keys.**
⇦	In auto or remote mode: pressing and holding the Left Arrow will cause the control percent output to be shown in the lower display. Releasing the key will allow the setpoint to be shown in the lower display. In manual mode: the Left Arrow key causes the percent output to decrease by 10 %.
⇩	The Down Arrow key is only used when in manual mode. Each press of the Down Arrow key will cause the percent output to decrease by 1%.
⇧	The Up Arrow is used to manually adjust the percent output in the manual mode. Each press of the Up Arrow key causes the percent output to increase by 1%.
⇨	The Right Arrow is only used when in manual mode. Each press of the Right Arrow key will cause the percent output to increase by 10 %.
⇧ + Enter	This two key combination will perform an LED test whereby every segment and decimal point of the seven segment display and every LED will be illuminated. Should one not light up then it is defective.
⇨ + Enter	This two key combination will cause the cold junction temperature to be displayed (in degrees Fahrenheit only) in the lower display as long as the keys are held down. When they are released the display will return to its normal function.
Setpt + Enter	This two key combination will place the 10PRO into the analog output mode. Refer to the calibration section for further details. (Section 3.2)



This two key combination places the 10PRO into parameter entry mode for the local setpoint, when security is on.

This three key combination will place the 10PRO into the analog input calibration mode. Refer to the calibration section for further details. (Section 3.1)



This two key combination will allow for cold junction compensation.

2.2 Parameter Entry Modes

There are two parameter entry modes; one activated by the Setpt key and one activated by the Setup key. In both modes, the upper display will show a message describing the parameter being entered. The lower display will show the present value of the parameter and flash the digit that can be adjusted. The keyboard functions are redefined as described below:

This key will save the value of the parameter being entered and then display the previous parameter (i.e. it will "back-up"). If the parameter being entered is out of range the display will flash and the display remains on that parameter until a valid entry is made.

In the Setup mode, then no action occurs. In Setpt mode, the setpoint is saved and the 10PRO returns to normal operation.

If in the Setpt mode, then the current parameter is saved and the Setup mode is entered unless the parameter is out of range. If in the Setup mode, the current parameter is saved and then the next parameter is displayed, unless the current parameter is out of range. If the current parameter was the last one in the sequence, then the 10PRO returns to normal operation. It is necessary to hold the Setup key for 5 seconds to enter Setup mode. Pressing the Enter key at any time while in Setup mode will exit the Setup menu.

The Enter key saves the current parameter and then returns the 10PRO to normal operation, unless the parameter is out of range, in which case the unit waits for a valid entry to be made.

The Left Arrow is used to select which digit to adjust by moving the flashing digit to the left.

The Right Arrow is used to select which digit to adjust by moving the flashing digit to the right.

The Down Arrow is used to adjust the flashing digit. Each press of the Down Arrow will decrease the digit by 1. If the digit is 0 then a press of the Down arrow will change it to a 9 unless the digit is the left most digit and the parameter is allowed to have a negative value, then it will change to a '-' and the next press of the Down Arrow will change it to a 9.

The Up arrow is used to adjust the flashing digit. Each press of the Up Arrow will increase the digit by 1. If the digit is 9 then a press of the Up Arrow will change it to a 0. If the digit is the left most digit and the parameter is allowed to have a negative value then the 9 will change to a '-' and then a '-' will change to a 0.

2.2.1 Setpt Parameter Mode

The Setpt parameter mode is entered by pressing the SETPT key. This menu contains only one option.

Local Setpoint — The value of the local setpoint (indicated by ????) can range from -300 to 4000.

Pressing SETPT or Enter after the entry of a new value exits to normal operation.

2.2.2 Setup Parameter Mode

The Setup parameter mode is entered and stepped through by pressing Setup key. It is necessary to press and hold the Setup key for at least 5 seconds to enter the Setup mode. Not all versions of the 10Pro will show the same list of parameters. All possible parameter settings are shown in the following list for reference.

OPTIONS	RANGE	
	Proportional Band	The controller proportional band (indicated by ????) can range from 1 to 999.
	Reset	The controller reset value (indicated by ??.??) can range from 0 to 99.99 repeats per minute.
	Rate	The controller rate value (indicated by ????) can range from 0 to 9.99 minutes.
	Cycle Time	The controller cycle time (indicated by ????) can range from 0 to 200 seconds.
	Load Line	The controller load line (indicated by ????) can range from 0 to 100 percent.
	High Percent	The high percent output limit (indicated by ????) can be set from 0 to 100 percent.
	Alarm 1 value	The alarm 1 setpoint (indicated by ????) can range from -300 to 4000.
	Alarm 2 value	The alarm 2 setpoint (indicated by ????) can range from -300 to 4000.
	Alarm 1 Type	The alarm 1 type is a number from 0 to 7 (indicated by ????) as is described below: 0 process alarm, direct 1 deviation band, direct 2 deviation, direct 3 percent output, direct 4 process alarm, reverse 5 deviation band, reverse 6 deviation, reverse 7 percent output, reverse
	Alarm 2 Type	The alarm 2 type is a number from 0 to 7 (indicated by ????) as described for the alarm 1 type.

Alarm 1 Turn On

Alarm 1 turn on delay in seconds (indicated by ????) from 0 to 200.

Alarm 1 Turn Off

Alarm 1 turn off delay in seconds (indicated by ????) from 0 to 200.

Alarm 2 Turn On

Alarm 2 turn on delay in seconds (indicated by ????) from 0 to 200.

Alarm 2 Turn Off

Alarm 2 turn off delay in seconds (indicated by ????) from 0 to 200.

NOTE: Earlier version of the 10Pro will have the SIO parameter setting, latter versions will have the HARD, BAUD, and HFOR parameter settings.

SIO setup

The SIO setup is a number from 0 to 31 (indicated by ????) which determines the instrument address and baud rate. The address (0 to 15) is added to the baud rate code, 0 for 4800 baud and 16 for 1200 baud, to determine the SIO setup number.

	Address															
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
BAUD 4800	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
RATE 1200	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

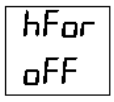
NOTE: The following parameters replace the SIO setting in new versions of the firmware.

Host Address

The host address setting sets the instrument's address.

Baud Rate

This setting allows for a selection of baud rates; 1200, 4800, 9600, 19.2k.



Host Format protocols.

This setting allows for a selection of communication protocols. The selections are;

Off	turns off communications
4btr	MMI Version 4 block protocol
10pr	10Pro parameter protocol
Both	Both are recognized.

Analog Input TC

The analog input thermocouple type (indicated by ?) is set by this parameter. There is a linear mode, L, and three other types in a given model chip. There are currently six different chips; see section 1.4 for details on the display codes.

Analog In Offset — This parameter provides an offset in the engineering units of the process being controlled by the instrument. The default for this parameter is 0000.

Control modes — The control mode is selected by a number from 0 to 7 (indicated by ????) described below:

0	On/Off control, direct
1	Time proportioning, single, direct
2	Time proportioning, dual, direct
3	Position proportioning, direct
4	On/Off control, reverse
5	Time proportioning, single, reverse
6	Time proportioning, dual, reverse
7	Position proportioning, reverse

Analog Output — The analog output source (indicated by ????) can either be a 0 for the process variable or a 1 for the control percent output.

Analog Output — The analog output zero starting value can be offset by a value from -300 to 3000. This is used to scale the process variable output range. This value is <u>not</u> used when control percent output is selected.

Analog Output — The analog output range is set by this Range parameter from 0 to 4000. This value is <u>not</u> used when control percent output is selected.

Degrees — The display of the temperature in degrees Fahrenheit (0) or degrees Centigrade (1) is selected by this parameter.

If the setpoint security feature is desired, then selecting (2) selects degrees Fahrenheit, and (3) selects degrees Centigrade. The security feature locks out the Setpt key and freezes the current setpoint setting. It is necessary to change this setting to make changes to the setpoint.

3 CALIBRATION

3.1 Analog Input Calibration

There is an analog input and a cold junction compensation sensor on the 10PRO. The input level for the input is determined by the daughter board that is mounted 'piggy back' on the main board. Presently there are three types of input daughter boards: thermocouple (T/C) input, high-level input (2VDC), and RTD (Pt100 Class A). The following is a brief description of each board and its specifications.

a)	T/C Input	
	Input range	-10 to +70 millivolts
	TC burnout	+full scale, -full scale, or none
	V output	none
b)	High-Level Input	
	Input range	-50 to +2000 millivolts, linear
	Input impedance	40 megohm
	Open input	pull to +full scale
	V output	2 volt dc at 5 milliamp max
c)	RTD Input	
	Class	Curve assumes Class A tol.
	Input range	-200 to +600 deg. C
	Open input	full scale +1000 deg. C
	V output	isolated –12VDC, 2mA

The standard factory configuration is for the input to be a T/C input.

3.1.1 Calibration Displays and Keyboard Operation

When in the calibration mode the displays and front panel keys take on special assignments. The process display shows the value of the input being calibrated with a flashing digit. This flashing digit indicates the relative sensitivity of the arrow keys, as described following the key descriptions. The set display indicates whether the zero value or the span value is being modified. The set display messages are as follows:

Message	Description
AI.nu	Zero Analog Input
AI.SP	Span Analog Input
AO.nu	Zero Analog Output
AO.SP	Span Analog Output

It is very important that the set display is indicating the proper mode before making an adjustment or the wrong value will be changed.

In the calibration mode, the following keys perform the described functions:

Key	Function
	Increases the adjustment sensitivity. When the adjustment is at the most sensitive position (far left position), a further press of the key loops the adjustment to the least sensitive position (far right position).
	Decreases the adjustment sensitivity. When the adjustment is at the least sensitive position (far right position), a further press of the key loops the adjustment to the most sensitive position (far left position).

Increases the indicated calibration factor by the value set with the adjustment sensitivity.

Decreases the indicated calibration factor by the value set with the adjustment sensitivity.

Resets the Zero or Span calibration factors to the theoretical value.

Alternates between Zero and Span and saves the calibration factors.

Saves the calibration factors and exits from calibration mode.

3.1.2 Adjustment Sensitivity

The adjustment sensitivity works in the following manner. If the right most digit in the process display is flashing then each press of the up or down arrow key will change the indicated factor by one calibration unit. This is the least sensitive position. If the left most digit is flashing then each press of the up or down arrow key will change the indicated factor by a thousand calibration units. Likewise the middle digits will indicate sensitivities of a hundred and ten calibration units respectively. The input value will usually change by an amount less then the calibration factor; however, by observation of the change, the sensitivity can be selected in order to allow the calibration factors to be adjusted more quickly.

3.1.3 Preparing for Calibration

Before placing the 10PRO into calibration mode, check to be sure that the proper thermocouple type has been selected.

The 10PRO is placed into calibration mode by simultaneously pressing the Enter, the Setup, and the Rem/Auto/Man keys. To insure the integrity of the calibration values, power should not be removed until after exiting the calibration mode.

Follow the calibration procedure in accordance to the type of input board installed in the 10PRO. Once the input has been calibrated, be sure to press the Enter key in order to be assured that the latest calibration factors are stored.

3.1.4 Calibration of the Thermocouple Input Board

This calibration procedure assumes that a thermocouple type has been selected. If not then follow the procedure for the high level input board using a 0 to 50 millivolt signal.

Calibration procedure:

1. Connect the input to be calibrated to a junction compensated calibrator (i.e. Biddle Instrument Co. Versa-Cal Calibrator) using the proper extension wire for the thermocouple type selected.

2. Activate the calibration mode by pressing the Enter, Setup, and Rem/Auto/Man keys simultaneously.

3. Using the Enter key select the zero mode (i.e. AI.nu).

4. Set the calibrator output to the recommended zero value in Table I for the thermocouple type selected.

5. Using the arrow keys, adjust the process value to equal the calibrator output.

6. Press the Enter key to select the span mode (i.e AI.SP).

7. Set the calibrator output to the recommended span value in Table I for the thermocouple type selected.

8. Using the arrow keys, adjust the process value to equal the calibrator output.

9. Repeat steps 3 through 8 until no additional change is needed.

10. Press the Rem/Auto/Man key to exit the calibration mode.

TABLE I
Recommended Calibration Values

Thermocouple type	Zero F(C)	Span F(C)
B	200 (90)	3000 (1800)
C	32 (0)	3000 (1800)
E	32 (0)	1300 (900)
J	32 (0)	1300 (900)
K	32 (0)	2300 (1200)
N	32 (0)	2300 (1200)
NNM	32 (0)	2000 (1100)
R	300 (150)	3000 (1800)
S	300 (150)	3000 (1800)
T	32 (0)	700 (350)

The usable ranges of the thermocouple types is shown in Table II. If it is desirable to have a high accuracy over a specific operating range then the input should be calibrated over that range. Follow the calibration procedure for normal calibration except use the low end of the desired range as the zero value and the high end as the span value. There will be more interaction between zero and span with this method. The desired operating range must fit within the limits of table II.

Table II
Usable Thermocouple Range

T/C type	Minimum Value	Maximum Value
B	110	3330
C	-105	4000
E	-340	1845
J	-335	1400
K	-340	2505
N	-325	2395
NNM	-10	2395
R	-450 *	3340
S	-300 *	3260
T	-380	755

* Due to the extreme non-linearity at low level signals, the use of type R and S below 300 F is not recommended.

3.1.5 Calibration of the High Level Input Board

This calibration procedure assumes that linear characterization has been selected.

Calibration procedure:

1. Connect the input to be calibrated to a precision variable, stable DC voltage source using copper wire.

2. Activate the calibration mode by pressing the Enter, Setup, and Rem/Auto/Man keys simultaneously.

3. Using the Enter key select the zero mode (i.e. AI.nu).

4. Set the DC source output to zero volts.

5. Using the arrow keys, adjust the process value to equal zero.

6. Press the Enter key to select the span mode (i.e AI.SP).

7. Set the DC source output to 2000 millivolts.

8. Using the arrow keys, adjust the process value to equal 2000.

9. Repeat steps 3 through 8 until no additional change is needed.

10. Press the Rem/Auto/Man key to exit the calibration mode.

3.1.6 Calibration of the RTD Input Board

This calibration procedure assumes that 'r' (RTD) characterization for AItc (analog input tc) has been selected using ROM #5 only. This procedure also assumes that parameter dEG = 1 for centigrade.

If an RTD calibrator is not available, the RTD can be simulated with a series of precision resistors. Three 100 ohm 1% resistors are recommended for calibration. These resistors can be connected in series. Refer to Figure 1.11 for an example of how the RTD is connected to the instrument.

Use the following values if the three 100 ohm resistors are to be used.

Input Resistance	Temp (deg C)
100 ohm	000
200 ohm	268
300 ohm	561

Calibration procedure:

1. Connect the 100 ohm resistor or set the RTD simulator for 0 deg C.

2. Activate the calibration mode by pressing the Enter, Setup, and Rem/Auto/Man keys simultaneously.

3. Using the Enter key select the zero mode (i.e. AI.nu).

4. Using the arrow keys, adjust the process value to equal zero.

5. Press the Enter key to select the span mode (i.e AI.SP).

6. Connect the series resistors for 300 ohms at the input or set the RTD simulator to 561 deg. C.

7. Using the arrow keys, adjust the process value to equal 561.

8. Repeat steps 3 through 8 until no additional change is needed.

9. Press the Rem/Auto/Man key to exit the calibration mode.

10. Connect the series resistors for 200 ohms at the input or set the RTD simulator to 268 deg. C.

11. Verify that the instrument display shows 268 deg C +/- 1 deg.

3.2 Analog Output Calibration

The Analog Output signal can be configured as 0 to 5V or 4 to 20mA. The output mode for the Analog Output is determined by how the output is wired (See Section 1.25). Any time the mode of operation is switched between current and voltage the output must be recalibrated. The output does not have to be recalibrated when switching between signal types, however.

For example, if the output is calibrated for 0 to 5 volts, and it is desired to change from Process Variable to Proportional Output, no recalibration is necessary (5 volts will be equal to 100%).

Review section 3.1.1 for operation of the keys during calibration mode. With the Analog output calibration, the Process display (the top set of LEDs) will be all dashes (----). (i.e.)

The Analog Output may be calibrated for other current and voltage ranges (i.e. 0-20 mA, 1-5 V, etc.) with a slight decrease in signal accuracy.

3.2.1 Calibrating the Output

Calibration procedure:

1. Connect the measuring device (i.e. recorder, voltmeter, or ampmeter) to the proper output terminals. (See Section 1.2.5)

2. Activate the calibration mode by pressing the Enter and Setpt keys simultaneously.

3. Using the Enter key, select the zero mode (i.e. AO.nu).

4. Using the arrow keys, adjust the output until the measuring device indicates the zero value (i.e. 0 volts for voltage, and 4mA for current).

5. Press the Enter key to select span mode (i.e. AO.SP).

6. Using the arrow keys, adjust the output until the measuring device indicates the span value (i.e. 5 volts for voltage or 20mA for current).

7. Repeat steps 3 thru 6 until no additional change is needed.
8. Press Rem/Auto/Man to exit calibration mode.

4 Host Communications

4.1 Hardware Description

The HOST communications is RS-485, Half Duplex, even parity and baud rates of 1200 or 4800. Terminal connections are made on the rear panel at TBB-7 and TBB-8. Twisted pair wire with or without a shield must be used for all communications wiring. Conventional RS-232 cable is required along with a half-duplex RS-232/422 converter (P/N F890051).

A typical Host Computer connection will have the following pins jumpered together as follows:

9-Pin = 1,4,6,8 25-Pin = 5,6,8,20

The transmit and receive connections are shown in the following table.

Function	9 Pin	25 Pin
Tx	3	2
Rx	2	3
Common	5	7

Consult the Computer's Documentation for your particular connections.

The 10PRO never initiates communications, and is always in the receive mode unless responding to a question.

4.2 Protocol Format

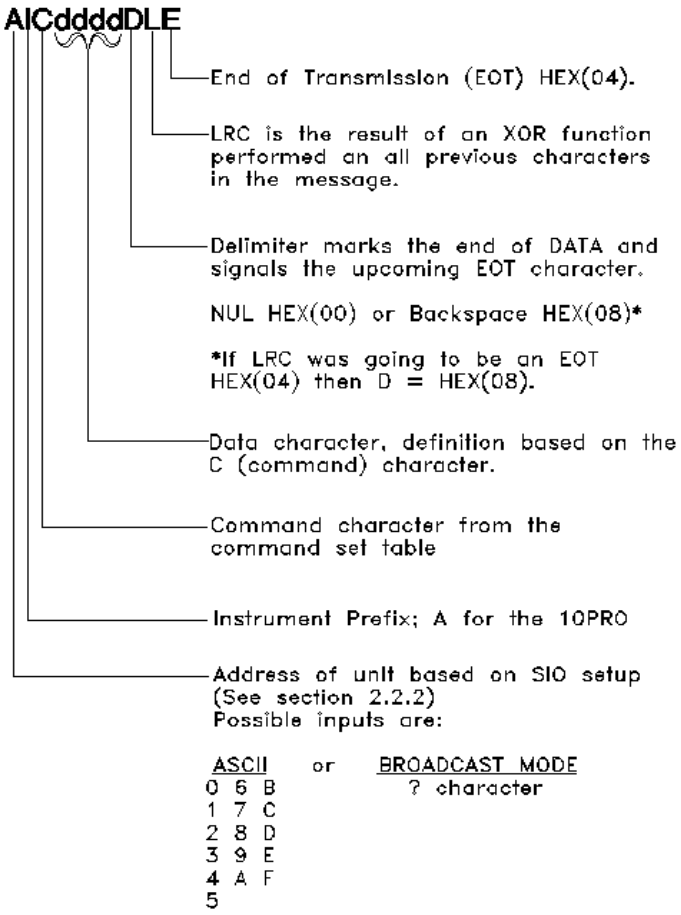
4.2.1 Response

If an error free and valid message was received by the 10PRO it will respond with the first character being an (ACK) HEX(06) and then echo the message received inserting any requested data. If an error was detected or an invalid request made, the first character would be a (NAK) HEX(15).

4.2.2 Message

The message protocol format is displayed, with explanations, on the next page.

Message Protocol Format



4.3 Command Set

The 10PRO command set is as follows:

COMMAND LETTER	DESCRIPTION
p	Read Auto/Manual mode
o	Read Remote/Local
i	Read Setpoint
h	Read Setpoint
I (as in Instrument)	Update Setpoint Temporarily
J	Update Setpoint Permanently
l (as in limits)	Read Temperature

m	Read % Output
P	Update Auto/Manual mode

5 PID CONTROL

5.1 PID Theory and Basic Principles

PID (Proportional, Integral, Derivative) is a control method that holds a process to a setpoint value while minimizing overshoot and undershoot during process upsets. These control functions are Proportional, Integral (time), and Derivative (rate); thus creating Proportional-Integral-Derivative Control, or PID control.

5.1.1 Proportional

Proportion control creates a signal that is proportional to the actual condition, or signal, that is present. The magnitude of this signal is based upon the error that is present between the actual condition and the desired condition, such as a setpoint.

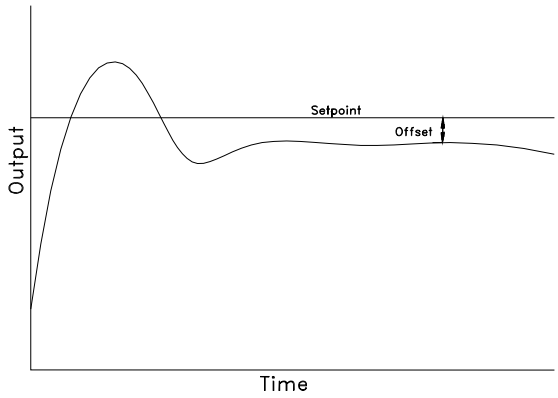


Figure 5.1 Proportional only

Proportional control alone however will not completely eliminate the error. This is due to the proportional correction working with large errors but not small ones. Therefore a small error will always be present and will appear as an offset from the desired condition when graphed.

5.1.2 Integral

Integral control creates a signal that when added to the proportional control, eliminates the offset or remaining error. This integral signal is produced by summing remaining error over time.

Thus, a combined proportional and integral control will eliminate the process error and the offset.

The integral control method is designed to eliminate the offset, or constant remaining smaller error, but it does not eliminate overshoot. Overshoot is a condition that occurs when an error is overcompensated for. When graphed, this overshoot will occur above the line of desired value.

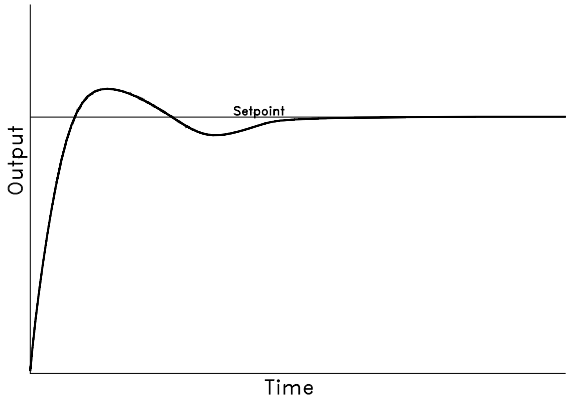


Figure 5.2 Proportional and Integral

5.1.3 Derivative

Derivative Control creates a signal that is used to eliminate or minimize overshoot. The signal is created from the rate that the error changes over time. The derivative control measures the rate that the error is changing and tries to predict when the actual will intersect or reach the desired. The control will then produce a signal to stop, or hold, the actual condition when it reaches the desired condition.

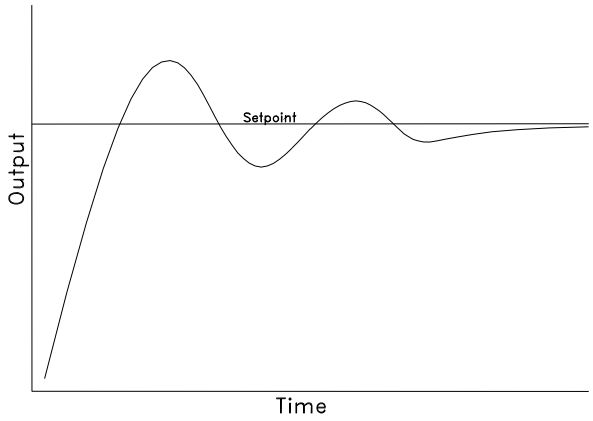


Figure 5.3 Proportional , Integral, and Derivative

Thus, the combination of the proportional, integral, and derivative signals produce a signal that reaches and maintains the desired condition with very little to no error, offset, and overshoot.

5.1.4 Creation of a PID - Example

A common example for the use of PID control is that of a hot water converter that converts steam, received through a valve, into hot water. For this example, the direction of the controlled device is reverse-acting. If the direction were direct-acting, then sections of the equations about to be derived

would need to be changed.

The Proportional Equation

As mentioned above, the proportional section of PID control creates a signal in proportion to the amount of error present. Therefore, the first step is to define the setpoint (SP). After the setpoint is defined, the error produced may be measured. ERROR = HWT - SP, where HWT is the hot water temperature, and SP is the setpoint temperature.

With the amount of error known, the process of creating the output signal can be begun. As was stated earlier, the signal is in proportion to the error, this Proportioned Signal, or PS, is often denoted as follows:

PS = ERROR x (units of control signal/unit of error)

(as a convention, x denotes multiplication and / represents division)

The (units of control signal/unit of error) term is used to insure that the output signal produced is in the correct units.

The Integral Equation

As discussed earlier, the integral section of PID control creates a signal designed to eliminate offset by summing the error over time. Therefore, the equation for the summation follows as:

INTEGRAL = INTEGRAL + (ERROR x TIME)

In this equation, INTEGRAL stands for the sum of the error over time, therefore the previous value is always added to the new error and time value. (TIME is the elapsed time)

After the integral value has accumulated for some time, this value is multiplied by a term similar to that used in the proportion section to insure that proper units are used. This term is (units of control/units of error, time).

When this new value is added to the PS formula, a new Proportioned Integrated Signal is produced as follows:

PIS = ERROR x (units of control/units of error) + INTEGRAL x (units control/units of error, time)

The Derivative Equation

As previously mentioned, the derivative section of PID control is designed to eliminate overshoot by 'predicting' when setpoint will be achieved. This 'predicting' is achieved by measuring the differences in error and dividing that value by the amount of time it took to achieve that difference. Thus an equation occurs as follows:

DERIVATIVE = (ERROR - PE)/TIME

Where PE is the value of the previous error, and TIME is the amount of elapsed time between the previous error value, and the present error. This derivative term is then multiplied by a constant term to insure the proper units of the signal. This term is ((units of control x units of time)/units of error).

When this term is then added to the PID formula, a new Proportioned integrated and Derivative Signal is produced as follows:

PIDS = ERROR x (units of control/units of error) + INTEGRAL x (units of control/units of error, time) + DERIVATIVE x ((units of control x units of time)/units of error)

5.1.5 Implementation of PID control on the 10PRO

The 10PRO uses the Proportional Band as a representation of the Proportion section of PID, the Reset as a representation of the Integral section of PID, and the Rate as a representation of the Derivative section of PID. Thus by following a simple procedure, PID tuning can easily be implemented on the 10PRO instrument. A suggested procedure is diagramed on the following page.

All of the PID parameters may be altered by following the procedures outlined in section 2.2. The following procedure assumes the initial PID values for a typical batch furnace. You may be able to start with a proportional band setting of 10 or less for a smaller box or temper furnace.

If, after following the procedure, the process continues to oscillate, it may be necessary to change the HIPO parameter. Make sure that the control output is linear through the full range of HIPO. In situations where the system is difficult to tune, it is most likely the output is not linear or there is too much lag time between the control command and measurable changes in the process. Test the system in manual mode to verify the output is linear. A much higher proportional band may be necessary for extreme lag in the process response. In most cases, the derivative part of the control equation is not necessary. Generally, furnace control can be maintained using only the proportional band and the reset parameters.

Make sure you record <u>all</u> operating parameters and keep them in a secure place for later reference.

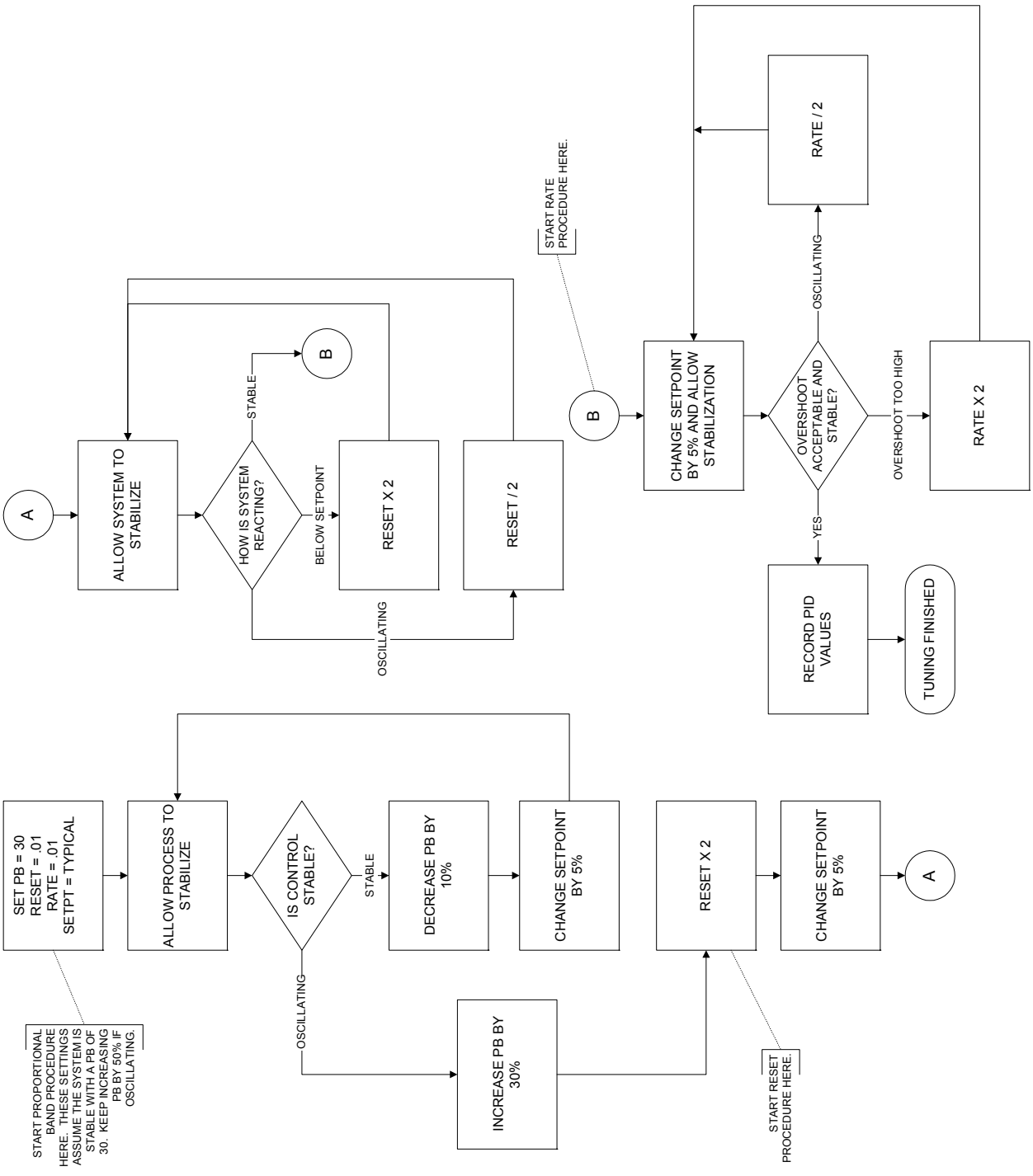


Figure 5.4 PID Tuning Procedure

Application Notes #1

PROGRAMMING THE ANALOG OUTPUTS

The PRO Series instruments allow the output range of the analog outputs to be specified, by the user, providing that neither of the control loops' percent outputs have been selected. This is achieved by entering the proper analog output offset and range value.

The analog output offset is the value the selected variable achieves when the analog output is at its zero value (i.e. zero volts or 4ma). The analog output range is the difference between the value of the selected variable when the analog output is at full scale and the value of the variable when the analog output is at its zero value. This is demonstrated with a few examples. In each of the examples it is presumed that the analog output has previously been calibrated for 0 to 5 volts.

Example #1
Desire 0 to 1000 Degrees F to give 0 to 5 volt analog output. In this case the analog output offset value is 0 and the range value is 1000.

Example #2
Desire 1000 to 1250 mv to give 0 to 5 volt analog output. In this case the analog output offset value is 1000 and the range value is 250.

Example #3
A recorder has a 1 to 5 volt input range which is to represent 0 to 2000 Degrees F. In this case it is necessary to interpolate at what value the analog output 0 would occur. Since 0 to 2000 is represented by a 4 volt range, the slope is 500 degrees per volt. Therefore, the analog output zero would occur at -500 degrees which is what is used for the analog output offset. The analog output range is the full scale value, 2000, minus the offset value, -500, which is 2500.

As shown by the examples, the programmable analog output can be programmed to not only provide the desired range, but to also compensate for differences in ranges of a recorder and the instrument.

For assistance please contact: Marathon Monitors Inc.
TEL: +1 513 772 1000 • FAX: +1 513 326 7090
Toll-Free North America +1-800-547-1055
erika.leeds@group-upc.com
www.group-upc.com