

**Model 96VTR**  
**1/4 DIN Process Controller****1. INTRODUCTION**

The 96VTR is a microprocessor-based device which can compare a process input (thermocouple, RTD, or analog input) to a user-programmable setpoint and adjust the process (via relay or analog outputs), to bring the process to the desired setpoint. This Three-Mode PID controller offers:

- Simultaneous Process Value (PV) and Setpoint Value (SV) display
- Automatic alarm functions (11 in all)
- Autotuning automatically tailors the controller's response to a specific process
- Security lock-out
- Ramp-to-Setpoint and Soak functions
- Input selectability
- Optional RS-485 PC interface

## 2. SPECIFICATIONS

### 2.1 General Specifications

Display	Dual 7-segment 4-digit LED Displays: Red (PV), Green (SV)
LED Status Indicators	Control outputs (C1, C2), Alarm outputs (A1, A2), Autotune (AT), Manual mode (MA), and temperature units °C/°F
Display range (span)	-1999 to 9999 counts max (Programmable; limited by the range specified in Section 2.2 for each individual input type)
Indicating Accuracy	+0.2% Full Scale +1 digit
Sampling Time	4 readings per second
Memory	Nonvolatile. Meter memorizes user configuration on power-down
Meter Enclosure	ABS Plastic
Front Panel	Lexan (Drip and Dust Proof; IEC IP55, NEMA Equivalent)
Power Supply	85 to 260VAC 50/60 Hz (automatic switching)
Power Consumption	6 Watts
Insulation Resistance	>50M ohm
Noise Rejection	Common Mode: 110 dB typical; Normal Mode: 50 db typical
Oper. Temp/Humidity	14 to 122°F (-10 to 50°C); 90% RH max.
Storage Temperature	-4 to 140°F (-20 to 60°C)
Dimensions (Cutout)	3.58 x 3.58" ±0.02" (91.0 x 91.0mm ±0.5mm)

### 2.2 Input Specifications

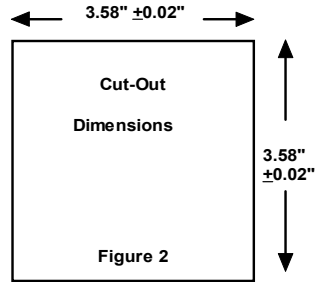
Thermocouple inputs (Programmable)	Types: J, K, T, E, B, R, S, N; Cold Junction Compensation; Thermocouple Break Protection: Upscale, Downscale Lead Wire Effect: 0.015%/ohm (Input impedance: 10 megohm)
RTD input	Pt 100 ohm (DIN, JIS); RTD Break Protection: Upscale, Downscale; Lead Wire Effect: 0.015%/ohm (automatically compensates if one lead wire is < 5Ω)
Current input	4-20mA DC (27Ω input resistance)
Voltage input	1-5V DC
<b>Thermocouple Ranges</b>	
Type K	-58 to 2498°F (-50 to 1370°C)
Type J	-58 to 1830°F (-50 to 1000°C)
Type B	32 to 3272°F (0 to 1800°C)
Type T	-454 to 752°F (-270 to 400°C)
Type E	-58 to 1382°F (-50 to 750°C)
Type R	32 to 3182°F (0 to 1750°C)
Type S	32 to 3182°F (0 to 1750°C)
Type N	-58 to 2372°F (-50 to 1300°C)
RTD PT100 input ranges	-392 to 932°F (-200 to 500°C); DIN or JIS
Linear input range	-1999 to 9999 display span (for 4-20mA, 1-5V, or special input)
Temperature Stability	5μV/°C typical
Repeatability	0.83°C (Thermocouple); 0.2°C (RTD); 1 digit (Linear)

### 2.3 Output Specifications

Control Output Relay 1 & 2	5A @ 110VAC; 3A @ 220VAC; SPDT (Resistive Load) Note: Relay 1 is called the Primary Output and Relay 2 the Secondary in this manual
Optional Pulsed Outputs	24V DC (DC drive for SSR) ON: 24V DC typical, 29V DC max.; OFF: 0.3V DC max
Optional Analog Control Output	4-20mA DC; Load limit: 600Ω impedance max.
Alarm/Timer Types	High/Low Deviation and Absolute Alarms w/deadband adjust and Soak/Event ON/OFF Timers
Alarm Output Relays 1 and 2	5A @ 110VAC; 3A @ 220VAC, SPST (Resistive Load)
<b>Output Control Modes</b>	
Proportional Band	0.0 to 100.0% of Full Scale (Autotune)
Integral Time	0 to 3000 secs. (Autotune)
Derivative Time	0 to 3000 secs. (Autotune)
Cycle Time	1 to 100 secs. (0 sec for 4-20mA output)
Anti-Reset Wind-Up	Inhibits integral action outside of the Proportional Band
Manual Reset	0 to 100% of Prop. Band
Hysteresis	0.0 to 25.5% of Full Scale

### 3. MOUNTING AND WIRING

- Prepare a 3.58 x 3.58" ±0.02" (91.0 x 91.0mm ± 0.5mm) panel cutout (refer to Fig.2). The panel on which the controller will be mounted may be up to 0.4" (10mm) thick.
- Slide the meter into panel through the cutout.
- Affix the mounting brackets to the top and bottom of the meter and tighten the bracket screws. Do not tighten the screws excessively.
- Connect the power cord to the meter but do not connect to power source.
- Connect sensor input and control/alarm outputs.
- Connect power to source.



#### Wiring Notes:

**AC:** The AC supply terminals can handle 85 to 260VAC 50/60Hz.

**Control Output Relays:** Terminals 14,15 and 16,17 (NO); Terminals 16,18 (NC).

**Alarm Relays:** Terminals 11, 12 and 12, 13 are N.O. when controller is powered down AND when it's powered-up in non-alarm condition.

**2-Wire RTD Inputs:** Connect RTD across terminals 9 and 10. Short terminals 8 and 9.

**4-Wire RTD Inputs:** Connect in the same fashion as a 3-wire and leave the 4th RTD wire open.

**24VDC Pulse Output option:** Use the same terminals and polarity as 4-20mA outputs (shown in Figure 3).

**Warning:** An independent redundant alarm should be used if control/alarm relay failure could result in potential harm or damage.

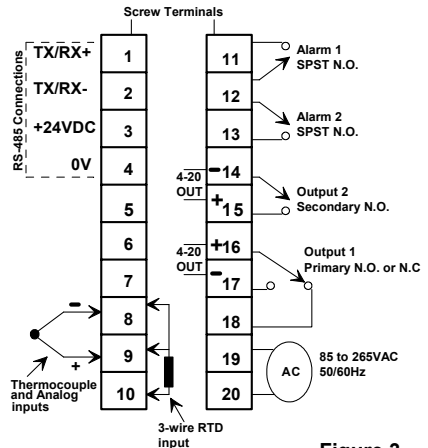


Figure 3

## 4. METER DESCRIPTION

1. Process Variable (PV) LED Display \*
2. Setpoint Variable (SV) LED Display \*
3. SCROLL key
4. UP and DOWN arrow keys
5. RETURN key
6. °C / °F Temperature unit indicators
7. Alarm, Control, Manual, Auto Tune status indicators

\* This display is also used for editing in the programming mode



## 5. FRONT PANEL DESCRIPTION

### 5.1 PV (Process Variable) Display LEDs

#### Normal Operation

The top LED (red digits) displays the actual process measurement (temperature, voltage, or current input signal). This is the "Process Variable" or PV.

#### Programming Mode

The red LEDs show the parameters for Programming Levels 1 through 4 (input type, control action, etc.), one at a time. These parameters can be edited to suit the user's requirements. Error messages are also displayed on these red LED Digits. Programming details and error messages are explained later in this manual.

### 5.2 SV (Setpoint Variable) LED Digits

#### Normal Operation

During normal operation, the bottom LED (green) displays the user-programmable Setpoint Variable (SV). This is the desired target to which the controller's output(s) will adjust the process. To change the setpoint, use the up/down arrow keys. The setting range equals the range the user selects in the LoLl (Low Limit) and HiLl (High Limit) parameters during programming.

#### Programming Mode

The green LED display shows the actual data that can be edited for the parameter shown on the red LED display. For example if the red LED is displaying Input Type, then the green LED lists the input types in numerical order (for J, K, Analog, etc. types). The user can then select the desired type. Refer to later sections for more on programming.

### 5.3 Status Indicators

#### 'ALM 1' Status Indicator (Alarm Relay 1 Status LED)

This red LED is lit when the Alarm 1 relay is active. Also, this LED flashes when Alarm 1 is configured as an Event or Soak Timer and is in the process of counting down. Refer to Appendix A and Section 11 for more on Alarm/Timer Functions.

#### 'ALM 2' Status Indicator (Alarm Relay 2 Status LED)

This LED is lit in red when the Alarm 2 relay is active. Refer to Appendix A for more on Alarm Functions.

#### 'C1' Control Output 1 (Primary) Status Indicator

Illuminates in green when control output 1 is active.

#### 'C2' Control Output 2 (Secondary) Status Indicator

Illuminates in green when control output 2 is active.

### 'MA' Manual Mode Status LED

Illuminates when the controller is in Manual Mode of operation, which permits the user to drive the control output manually. Refer to Section 10 for more details.

### 'AT' AUTO TUNE Status Indicator

When the controller is autotuning, this LED will blink. When the meter is finished tuning, the LED will extinguish. Auto Tuning may take from several minutes to several hours depending upon the process in question. Refer to Section 9.2 for more on Auto Tune.

'C' or 'F' Temperature Units Indicator for degrees C/F

#### LED Error Messages:

**Err 1:** A/D converter is inoperable. Unit must be repaired or replaced.

**uuuu:** Input under-range condition or input sensor not connected.

**nnnn:** Input over-range condition or input sensor not connected.

**OPEN :** Input sensor not connected or is inoperable.

## 5.4 Keypad Descriptions

### SCROLL Key

While programming the controller you can move from one programmable parameter to the next by pressing the Scroll key. The Scroll key is also used in combination with the RETURN key to move between programming levels. The red LED display will show each parameter title as you scroll through the list. Also, to activate an autotuning session, press and hold this key for 5 seconds.

### UP Arrow Key

Increases the Setpoint (SV) and increments parameter data when programming.

### DOWN Arrow Key

Decreases the Setpoint (SV) and decrements parameter data when programming.

### RETURN KEY

During normal operation, pressing the RETURN key permits the user to view the controller's output action as a percentage (0.0 to 100.0% power). The lower (green) display will indicate 'H' (heating outputs) followed by a percentage. After a few seconds, the controller will automatically display a 'C' (cooling output). Press the RETURN key from any mode to return to the normal SV display. The Return key pressed with the SCROLL key moves from one programming level to the next.

**Table I - Programming Level Parameters at a glance**

1st Prog. Level	2nd Prog. Level	3rd Prog. Level	4th Prog. Level
rAmp	Pb	rEmo	LoCA
oPoF	CPb	P-L	HiCA
A1SP or timE	ti	A1Fu	tunE
A2SP	td	A2Fu	
	db	A1HY	
		A2HY	
		Act	
		unit	
		dp	
		Ct	
		C Ct	
		HYST	
		EroP	
		Addr	
		PVoF	
		tYPe	
		LoLt	
		HiLt	

**Notes:** Symbols shown above are similar to the actual meter LED displays which show parameters in mixed case. Some parameters and even the 4<sup>th</sup> programming level can be locked out depending upon the setting in P-L (Parameter Lock in 3<sup>rd</sup> programming level).

## 6. FIRST PROGRAMMING LEVEL PARAMETERS

Press the SCROLL key to enter this level. Then use the SCROLL key to move through the parameter list. To return to normal operation at any time, press RETURN key once.

**Note:** The configuration of the controller dictates which parameters appear. For example, the 'ramp' parameter will not appear if 'Parameter Lock' (P-L) is set to '2'. Also, A1SP will not appear if 'A1Fu' (Alarm 1 Function) is set to 8,9,10, or 11.

**rAmp:** Programmable rate of rise limit for PV. Permits the user to restrict the rate at which the measured variable (PV) changes. Setting range: 0.0 to 100.0 units per minute. Default = 0. The controller will monitor the changing PV and override the controller output if necessary to limit the PV's rate of change.

**oPoF:** Output Offset. "Manual reset" function. The user can program a value (0.0 to 100.0%) which will then be added to the controller output percentage. For example, if the oPoF parameter is set to 10.0%, the controller's output percentage will always be 10% higher.

**A1SP:** Alarm 1 Setpoint value. First, set the desired Alarm type in the 'A1Fu' parameter (refer to Appendix A for Alarm functions). Then program the desired limit here. Allowable setting range is limited by parameter 'LoLt' and 'HiLt' (Low and High Limit) settings.

**timE:** Programmable duration for the Event or Soak Alarm 1 Timer. The range is 0 to 9999 minutes. Refer to Section 11 and Appendix A for details on Soak/Event Timers functions.

**A2SP:** Alarm 2 Setpoint value. First, set the desired Alarm type in the 'A2Fu' parameter (refer to Appendix A for Alarm functions). Then program the desired limit here. Allowable setting range is limited by parameter 'LoLt' and 'HiLt' (Low and High Limit) settings.

## 7. SECOND PROGRAMMING LEVEL PARAMETERS

Press and hold the **SCROLL** and **RETURN** keys simultaneously to enter this level from the previous programming level. To return to normal operation press the RETURN key.

**NOTE:** This is the Manual Tuning programming level. Rather than attempting a manual tuning (manually setting values for the parameters in this level), it is strongly recommended that **AUTO TUNING** be used to automatically set these parameters. If PID Tuning is unfamiliar to you, manual tuning can cause severe process disturbances. Try Auto Tuning first and then use Manual tuning afterward to fine tune the parameters if desired. For the instructions on how to initiate an Auto Tune session, refer to Sec. 9.2.

**Pb:** Primary Output Proportional band value. Setting range from 0.0 to 100.0% of controller's Span. Default = 10.0. Set Pb to 0.0% for ON/OFF control action. This value is automatically calculated by activating the AUTOTUNE function

**CPb:** Secondary Output Proportional band value. Setting range from 0.0 to 100.0% of controller's Span. Default = 10.0. Set CPb to 0.0% for ON/OFF control action.

**ti:** Integral (Reset) value. 0 to 3000 seconds setting range. Default = 240. This value is automatically calculated by activating the AUTOTUNE function.

**td:** Derivative (Rate) Time. 0 to 3000 seconds setting range. Default = 40. This value is automatically calculated by activating the AUTOTUNE function

**db:** Deadband. Setting range: -10.0% to +10.0% of Pb. Permits the user to set up a "neutral" zone within the proportional band (around the main control setpoint) where outputs 1 (Pri.) and 2 (Sec.) will not change state at the same time. Refer to Appendix C for in-depth details on db.

## 8. THIRD PROGRAMMING LEVEL PARAMETERS

Press and hold the SCROLL and RETURN keys simultaneously for 5 seconds to enter this level from the previous programming level. To return to normal operation at any time, press the RETURN key.

**rEmo:** Remote/Local toggle parameter. Set to "0" for local mode or "1" for optional RS-485 PC communications remote mode. In remote mode, the controller's keypad is inactive and only a connected PC can change the controller's parameters. In local mode the controller's keypad is active.

**P-L:** Parameter Lock. This security feature locks out selected programming levels prohibiting tampering and inadvertent programming changes. Depending upon its setting, only certain parameters will display, refer to the list below. Allowable setting range: 0 to 15;

0 - All parameters displayed are adjustable (level 1 parameters: A1SP, A2SP)

1 - Same as '0' (level 1 parameters displayed: Ramp, A1SP, A2SP)

2 - Same as '0' (level 1 parameters displayed: oPoF, A1SP, A2SP)

3 - Same as '0' (level 1 parameters displayed: Ramp, oPoF, A1SP, A2SP)

4 - same as '0', w/level 4 locked	10 - same as '2', but levels 3, 4 locked
5 - same as '1', w/level 4 locked	11 - same as '3', but levels 3, 4 locked
6 - same as '2', w/level 4 locked	12 - same as '0', but levels 2, 3, 4 locked
7 - same as '3', w/level 4 locked	13 - same as '1', but levels 2, 3, 4 locked
8 - same as '0', w/levels 3, 4 locked	14 - same as '2', but levels 2, 3, 4 locked
9 - same as '1', w/levels 3, 4 locked	15 - same as '3', but levels 2, 3, 4 locked

**A1Fu:** Alarm 1 Function. Select an Alarm / Timer function from the function list in Appendix A.

**A2Fu:** Alarm 2 Function. Select an Alarm function from the alarm functions list in Appendix A.

**A1HY:** Hysteresis for Alarm 1. The Setting range is 0.0 to 25.5% of the controller's span settings. The controller's Span extends from the value programmed in 'LoLt' to the value programmed in the 'HiLt' parameter (Low and High Limits). Hysteresis is used to eliminate relay "chatter" by creating a deadband that extends from the alarm setpoint down or up (depending upon the alarm type) where no relay action can occur. The larger the hysteresis value the less the possibility of relay chatter.

**A2HY:** Same as A1HY except for Alarm 2.

**Act:** Primary Output (Output 1) control action. Set to "0" for cooling (direct) action or "1" for heating (reverse) action. Secondary Output (Output 2) is automatically configured as a cooling output.

**unit:** Unit of measure selection. Program as follows:

Set to '0' for degrees F

Set to '1' for degrees C

Set to '2' for analog inputs

**dP:** Decimal Point selection.

Set to '00' for no decimal point

Set to '01' for 0.1 resolution

Set to '02' for 0.01 resolution (cannot use this setting for temperature inputs)

Set to '03' for 0.001 resolution (cannot use this setting for temperature inputs)

**Ct:** Primary Control Output 1 Cycle Time. Range: 0 to 100 seconds. This is the rate at which the controller makes automatic output adjustments. The longer the time,

the less responsive the controller will be to process changes. Set Ct for the slowest rate possible without causing process oscillations; this will help to prolong the life of the relay. Not used with analog outputs or ON/OFF control. Set Ct to '1' second for the 24VDC Pulsed Voltage output option and '0' seconds for the 4-20mA analog output option. Parameter 'Ct' is not used when ON/OFF control is activated.

**C Ct:** Secondary Output 2 Cycle Time (same as Ct above except it is for the Secondary Control Output)

**Hyst:** Primary Control Output 1 Hysteresis (used with ON/OFF control). Users can create a deadband region from 0.0 to 25.5% of SPAN. Note: The SPAN is the range that extends from the user-programmable Low Limit (LoLt) value to the High limit (HiLt) value. Hysteresis is used to eliminate control relay chatter by creating a deadband that extends from the setpoint down or up (depending upon the relay's function) where no relay action can occur.

**EroP:** Error Protection. The desired state to which the Control and Alarm relay outputs default in the event of controller error. Select a setting from Table II below.

**Table II - Error Code Settings for Parameter 'EroP'**

Set	OUT 2	ALM 2	ALM 1	OUT 1	Set	OUT 2	ALM 2	ALM 1	OUT 1
0	OFF	OFF	OFF	OFF	8	ON	OFF	OFF	OFF
1	OFF	OFF	OFF	ON	9	ON	OFF	OFF	ON
2	OFF	OFF	ON	OFF	10	ON	OFF	ON	OFF
3	OFF	OFF	ON	ON	11	ON	OFF	ON	ON
4	OFF	ON	OFF	OFF	12	ON	ON	OFF	OFF
5	OFF	ON	OFF	ON	13	ON	ON	OFF	ON
6	OFF	ON	ON	OFF	14	ON	ON	ON	OFF
7	OFF	ON	ON	ON	15	ON	ON	ON	ON

**Addr:** Controller address used with the RS-485 communications option so that a PC can recognize a specific 96VTR controller from among a group of 96VTRs or other connected interface devices. Setting range is "0" to "31". Default = 0.

**PvoF:** PV Offset. Permits the user to offset the PV indication from the actual PV. For example, if the thermocouple used is producing readings 2° higher than the actual temperature across the range, the user can eliminate the 2° difference by programming a "-2" value at this parameter. Overall range of the setting is -180 to +180. The default value is '0'.

**tyPE:** Sensor input selection. Select from the list below:

Set to '00' for J type thermocouple	Set to '06' for S type thermocouple
Set to '01' for K type thermocouple	Set to '07' for N type thermocouple
Set to '02' for T type thermocouple	Set to '08' for RTD Pt100 ohm (DIN)
Set to '03' for E type thermocouple	Set to '09' for RTD Pt100 ohm (JIS)
Set to '04' for B type thermocouple	Set to '10' for Linear mode (analog)
Set to '05' for R type thermocouple	

**NOTE:** To change a controller configured for a Thermocouple input to an RTD or linear input, hardware modification is required. Please contact Extech for details.

**LoLt:** Low limit (of Span or Range). Set the Low Limit lower than the lowest expected SV and PV display. Note that the low limit setting is limited by the range of the type of input used (refer to Section 2.2 for ranges).

**HiLt:** High limit (of Span or Range). Set High Limit higher than the highest expected SV and PV display. Note that the high limit setting is limited by the range of the type of input used (refer to Section 2.2 for ranges).

## 9. PARAMETERS IN THE FOURTH PROGRAMMING LEVEL

Press and hold the SCROLL and RETURN keys simultaneously for 5 seconds to enter this level from the previous programming level. To return to normal operation at any time, press the RETURN key.

**LoCA and HiCA:** Low and High Input Calibration values used for engineering units scaling. Refer to Section 9.1 below for details.

**tunE:** Auto-tuning 'automatic initialization mode' selection. Select the criteria by which the controller initiates an automatic Auto Tune session. Set this parameter as desired from the Table in Section 9.2. To activate Auto Tune manually, refer to Section 9.2.

### 9.1. CALIBRATION

**Important Note:** Special equipment is required to perform calibrations. Do not initiate the calibration process unless fully prepared to do so.

- a. "LoCA" (Low Calibration) is the first parameter to appear in this level.
- b. For temperature inputs, connect a Thermocouple (mV) or RTD (resistance) simulator to the controller's input terminals. For a process DC input, use a 4-20mA or 1-5VDC signal, depending on the input type of the controller.
- c. Apply the low input signal to the controller which corresponds to the range you are using, i.e., for 4-20 mA inputs, 4 mA would now be applied to the controller.
- d. Use the UP/DOWN arrow keys to set the value which will display when a 4mA signal is applied to the controller. For example, for a 4-20mA unit to display from -50 to +150, set 'LoCA' to -50.
- e. Press and hold the RETURN key for at least 5 seconds and the parameter on the display will change from "LoCA" to "HiCA" (High Calibration). The Low Calibration value is now written into the controller's non-volatile memory.
- f. Apply the high input signal to the controller which corresponds to the range you are using. For example, for a 4-20mA input controller, apply a 20mA signal.
- g. Use the UP/DOWN arrow keys to set the value which will display when a 20mA signal is applied to the controller. For example, for a 4-20mA unit to display from -50 to +150, set 'LoCA' to +150.
- h. Press and hold the RETURN key for at least 5 seconds. The display will change from "LoCA" to "SP". The High Calibration value is now written into the controller's non-volatile memory.
- i. Input a signal midway between the Low and High Calibration signals previously applied (12mA in the example for a 4-20mA input) and verify that the display shows a value midway between the high display and the low display. For the example above, for a -50 to +150 display range, a 12mA input will display +50. If not, try the calibration procedure again.
- j. Press the RETURN key when complete to return to normal operation.

### 9.2 AUTO TUNING

#### 9.2.1 Auto Tune Initialization Modes

The Controller has the capability to start an Auto Tune session automatically. If this is desired, select the conditions whereby an Auto Tune session will automatically begin from Table III below. The controller defaults to Setting = '0' (user initiates an Auto Tune session). To manually initiate an Auto Tune session follow the procedure in Section 9.2.2.

**Table III - Programmable Auto Tune Initialization Modes**

Setting	Auto Tune Initialization Modes
0	Autotune can only be initiated manually with the Setpoint (SV) not equal to the Process (PV)
1	Autotune can only be initiated manually with the Process (PV) equal to the Setpoint (SV)
2	Autotunes automatically when the controller is FIRST powered up if the PV < SV
3	Autotunes automatically when the controller is FIRST powered up if the PV = SV
4	EVERY time the controller is powered up the autotune process begins automatically if the PV < SV
5	EVERY time the controller is powered up the autotune process begins automatically if the PV = SV

### 9.2.2 Auto Tune Procedure

**Note:** For Auto Tune to be effective, the controller must be connected in line with the working application. The process must be running as close to expected operation as possible.

- In order to automatically set the Tuning parameters of Level 2 which are '**Pb**' Proportional Band, '**ti**' Integral time (also known as Reset), and '**td**' Derivative time (also known as Rate), first adjust the controller's setpoint (SV) to a value which closely approximates your application.
- Make sure that the value for Proportional Band (Pb) is NOT zero (zero initializes ON/OFF control).
- To initiate Auto Tune, press and hold the SCROLL key for at least 5 seconds until the 'AT' status LED lights.
- When Auto Tune is complete, the 'AT' status LED will extinguish. The new Tuning values will now be stored in nonvolatile memory. Adjustments can be made manually if desired in programming level 2.
- To abort an Auto Tune process, simply press and hold the RETURN key for 5 seconds until the 'AT' LED extinguishes. Be careful not to hold it longer than it takes for the 'AT' LED to extinguish otherwise you will access the MANUAL output control mode inadvertently.

**AUTO TUNE NOTE:** The Auto Tune process can last from several minutes up to several hours depending upon each individual process. However, if the Auto Tune process does take an inordinate amount of time in a fast responding process, it is recommended that the Auto Tune session be aborted by powering the controller down. Check all physical connections as well as the controller programming to ensure that the controller is properly configured in the system before trying another Auto Tune session.

## 10. AUTOMATIC AND MANUAL OUTPUT CONTROL

### AUTOMATIC CONTROL

Automatic Control is the normal mode of controller operation and does not require keystrokes or special menus to access. In automatic control mode the controller automatically adjusts the percentage of both the Heating (Primary) and the Cooling (Secondary) outputs so that the PV = SV.

### MANUAL CONTROL

Manual control allows the user to manually drive the Primary and Secondary output percentages from 0.0 through 100.0% (for testing purposes). To use this feature you first have to unlock it. Press and hold the DOWN and RETURN keys until the display flashes. Press and hold the RETURN key for 5 seconds to access the Manual Mode.

The controller's output percent will now appear on the SV display preceded by an 'H' for Heating or a 'C' for Cooling (depending upon how the action of the controller is configured under the parameter 'act'). The 'MA' Manual status LED will also illuminate and flash. To manually adjust the controller's output, use the UP and DOWN arrow keys. For controllers using two control outputs (primary and secondary), the SV display will automatically toggle between outputs 1 and 2. To return to normal operation, press and hold the RETURN key until the 'MA' LED extinguishes. To Lock this feature, press and hold the UP and RETURN keys until the display flashes. While locked, the Manual Mode is inaccessible.

## 11. RAMP-TO-SETPOINT AND EVENT/SOAK TIMER FUNCTIONS

The Exttech 96VTR controller operates as a fixed setpoint controller. However, the controller offers several advanced features which can enhance your application. These include Ramp-to-Setpoint and Event/Soak Alarm/Timers.

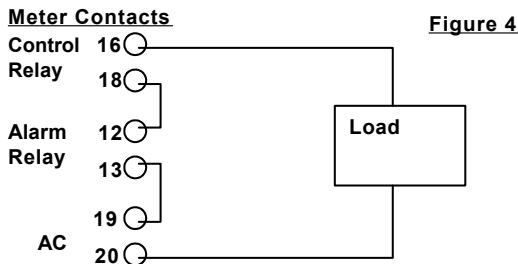
### 11.1 Ramp-to-Setpoint ('rAMP' Parameter)

To limit the rate at which the controller allows the process (PV) to move towards setpoint (SV), enter a limit value in degrees (or other units) per minute in the 'rAMP' parameter. The programmable limit ranges from 0.0 to 100.0 units per minute. The controller will automatically adjust the controller's outputs to maintain the desired limit programmed by the user. A setting of zero defeats the Ramp-to-Setpoint function.

### 11.2 Soak Timer Function (for use with Alarm 1 only)

The Alarm 1 Soak Timer allows the process to ramp to a setpoint and remain (Soak) at that setpoint for a user-programmable period of time. Set the "A1Fu" parameter to either '10' (Soak ON-TIMER) or '11' (Soak OFF-TIMER) depending upon the application (See

Appendix A, Table IV, for the difference between ON- and OFF-TIMERS). Set the Soak time in parameter 'timE' in the First Programming Level. The Output and Alarm Relays must be wired in series



Example of Wiring Alarm and Control Relays in Series

so that the Alarm relay can switch the control relay at the appropriate times (refer to Fig. 4). For example, when a setpoint of 500°F is reached, the Soak time (programmed by the user under parameter 'timE') begins to countdown. After the desired Soak time has elapsed, the Alarm relay switches thereby switching the Control relay.

### 11.3 Event Timer (Alarm 1 relay only)

Alarm relay 1 can be programmed to switch state at desired times in a process. This is accomplished by first setting the alarm function in parameter "A1Fu" to either an EVENT-ON or EVENT-OFF Timer (See Appendix A, Table IV, for the difference between ON- and OFF-TIMERS). Next, pick a count-down time. The relay timer will start counting down once the PV equals the SV. The duration of the count-down is set by the user at parameter "timE".

Application example: While maintaining a certain temperature for 4 hours, an event is to take place 2 hours into the process. The event, in this example, is the controller's alarm relay activating a pump. To do this, set the alarm function to an EVENT-ON

Timer (selection 8) in parameter "A1Fu". Set the time to 120 minutes (2 hours) in parameter "time". When the controller is powered the alarm relay will be OFF, when the PV = SV the relay remains OFF but the timer begins to countdown, and after 2 hours the relay will turn ON permitting the process event to take place.

## 12. RS-485 OPTION

The optional RS-485 PC interface permits up to 32 controllers to be connected to a PC for remote operation. Each controller must have a unique address between 0 and 31 which is programmed in parameter "addr". The "remo" parameter must be set to '1' to activate a controller's interface. The RS-485 wiring terminals are shown in Figure 3, Section 4. Detailed information is provided with the purchase of the RS-485 option.

## 13. CUSTOMER SERVICE

**Extech offers complete repair and calibration services** for all of the products we sell. For periodic calibration, NIST certification or repair of any Extech product, call customer service for details on services available. Extech recommends that calibration be performed on an annual basis to insure calibration integrity.

## 14. WARRANTY

EXTECH INSTRUMENTS CORPORATION warrants this instrument to be free of defects in parts and workmanship for one year from date of shipment (a limited warranty may apply on sensors and cables). If it should become necessary to return the instrument for service during or beyond the warranty period, contact the Customer Service Department at (781) 890-7440 for authorization. **A Return Authorization (RA) number must be issued before any product is returned to Extech.** The sender is responsible for shipping charges, freight, insurance and proper packaging to prevent damage in transit. This warranty does not apply to defects resulting from action of the user such as misuse, improper wiring, operation outside of specification, improper maintenance or repair, or unauthorized modification. Extech specifically disclaims any implied warranties or merchantability or fitness for a specific purpose and will not be liable for any direct, indirect, incidental or consequential damages. Extech's total liability is limited to repair or replacement of the product. The warranty set forth above is inclusive and no other warranty, whether written or oral, is expressed or implied.

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## APPENDICES

### Appendix A: Alarm Mode Selections for parameters 'A1Fu' and 'A2Fu'

**'00' Deviation High Alarm:** For the Deviation High Alarm, the value entered for the "A1SP" (Alarm 1 setpoint) or "A2SP" (Alarm 2 setpoint) parameters equals the amount the controller's HIGH alarm setpoint is offset from the main controller setpoint. For example, if SV = 400 and A1SP = +10 then the Limit Alarm relay will trip when the temperature reaches 410°. The Deviation alarm setpoint tracks the main setpoint meaning that it changes as the main setpoint changes always remaining a programmed number of units from the main setpoint.

**'01' Deviation Low Alarm:** With the Alarm setup as a Deviation Low Alarm, the value entered for the "A1SP" (Alarm 1 setpoint) or "A2SP" (Alarm 2 setpoint) parameters equals the amount to which the controller's LOW alarm setpoint is offset from the main controller setpoint. For example, if you entered SV = 400 and A1SP = -10 then the Alarm relay will trip when the temperature falls below 390°. The Deviation alarm setpoint tracks the main setpoint meaning that it changes as the main

setpoint changes always remaining a programmed number of units from the main setpoint.

**'02' Process High Alarm:** Relay trips when the process (PV) exceeds the value programmed at "A1SP" or "A2SP". Process alarms are fixed, absolute values and do not change as the main control setpoint changes.

**'03' Process Low Alarm:** Relay trips when the process (PV) falls below the value programmed at "A1SP" or "A2SP". Process alarms are fixed, absolute values and do not change as the main control setpoint changes.

**'04' Deviation High Alarm with Standby Sequence:** Same as the Deviation High Alarm but no relay action takes place until the process PV reaches the setpoint for a second time. Standby sequence is also known as "Startup Inhibit" and is useful for avoiding alarm trips during startup.

**'05' Deviation Low Alarm with Standby Sequence:** Same as the Deviation Low Alarm but no relay action takes place until the process PV reaches the setpoint for a second time. Standby sequence is also known as "Startup Inhibit" and is useful for avoiding alarm trips during startup.

**'06' Process High Alarm with Standby Sequence:** Same as the Process High Alarm but no relay action takes place until the process PV reaches the setpoint for a second time. Standby sequence is also known as "Startup Inhibit" and is useful for avoiding alarm trips during startup.

**'07' Process Low Alarm with Standby Sequence:** Same as the Process Low Alarm but no relay action takes place until the process PV reaches the setpoint for a second time. Standby sequence is also known as "Startup Inhibit" and is useful for avoiding alarm trips during startup.

*The following Alarm Timer Selections are available for Alarm 1 only*

**'08' EVENT ON-Timer:** Upon power-up the alarm is de-energized. When the PV = SV the alarm relay remains de-energized. When the timer counts down to zero, then the relay energizes. Set the timer at parameter 'time' in Programming Level 1. See Table IV below.

**'09' EVENT OFF-Timer:** Upon power-up the alarm relay energizes. When the PV = SV the alarm relay remains energized. When the timer counts down to zero, then the relay de-energizes. Set the timer at parameter 'time' in Programming Level 1. See Table IV below.

**'10' SOAK ON-Timer:** Upon power-up the alarm relay is de-energized. When the PV = SV the alarm relay energizes. When the timer counts down to zero the relay de-energizes. Set the timer at parameter 'time' in Programming Level 1. See Table IV below.

**'11' SOAK OFF-Timer:** Upon power-up the alarm relay energizes. When the PV = SV the alarm relay de-energizes. When the timer counts down to zero the relay energizes. Set the timer at parameter 'time' in Programming Level 1. See Table IV below.

**Table IV - EVENT and SOAK Timer Relay States**

A1Fu Setting	ALARM RELAY MODE	Controller at Power-up	When PV=SV Timer Starts	After Timer Counts Down
8	EVENT ON-TIMER	OFF	OFF	ON
9	EVENT OFF-TIMER	ON	ON	OFF
10	SOAK ON-TIMER	OFF	ON	OFF
11	SOAK OFF-TIMER	ON	OFF	ON

ON = Alarm Relay energized    OFF = Alarm Relay de-energized

## Appendix B: Application Programming Example

(Refer Fig.5). The aim is to maintain an oven temperature of 500°F. The controller monitors the oven temperature via the thermocouple. The controller compares the actual temperature (PV) to the desired temperature (500° setpoint SV) and throttles the heater as needed to maintain 500°F. If the oven temperature reaches too high, the controller's alarm output can trigger an audio or visual alert. The alarm contact can also be used to switch on/off an external device such as a master switch or cooling fan. In this example, the alarm will trigger an annunciator at 600°F. To program the controller to perform the task described above, refer to the steps below. The parameters not listed below are either inconsequential with regard to this example or they will not appear on the controller display due to the controller configuration. Use the programming level sequence shown below (i.e., Level 3 then Level 1. etc.)

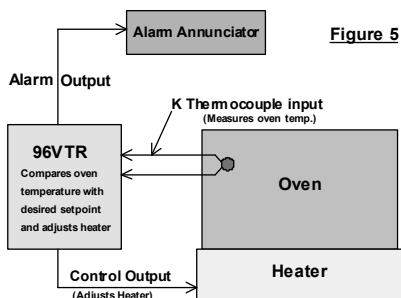


Figure 5

### Programming Level 3

**A1Fu** (Alarm Function): Set to '2' which is an absolute alarm meaning that the alarm is fixed. In this case the alarm will be fixed at 600°F. This 600°F value is programmed later in the procedure.

**A1HY** (Alarm Hysteresis): Set to '0'. Hysteresis is similar to 'deadband'. A region extending from the alarm setpoint up or down, depending upon the alarm type, where no relay action can occur to eliminate relay chatter.

**Act** (Action): This is control output action. Set to '1' for heating.

**unit:** Set to '1' for °F

**dp** (decimal point): Set to '0' for no decimal point

**Ct** (Cycle time): To start off with, set to approx. 6 seconds. This can be re-adjusted later after the process is observed. Cycle time is the rate at which the controller will make adjustments to the heater. Set for the longest time possible (to save relay life) without causing process oscillations.

**tYPe:** Set to '1' for a K Type Thermocouple

**LoLt and HiLt** (Low Limit / High Limit): Set these to 0° and 1000° respectively. This is simply a span setting.

### Programming Level 1

**A1SP** (Alarm Setpoint): Set to 600°F. Temperature at which the alarm relay will switch on the alert annunciator.

### Tuning the Controller (Level 2 parameters)

The best plan of attack with tuning is running the Auto Tune utility. Auto Tune will automatically program the controller to respond with little process oscillation around setpoint and minimal overshoot on oven heat-up. Run the Auto Tune utility per section 9.2 in this manual. Running Auto Tune supersedes programming Level 2 parameters.

### Calibration (Level 4 parameters)

Calibration is very rarely required. If calibration must be performed refer to Section 9.1 for details or contact Exttech.

## Appendix C: Proportional Band and Deadband Details

The two diagrams shown below illustrate how the Proportional Band (Pb), Cooling Proportional Band (CPb), and deadband (db) interact when controlling a process.

The region identified by the letter "A" reflects the action of the Proportional Band (PB). The proportional band is the region in which the controller's primary output is permitted to throttle between 0% and 100%. Outside this region the controller's primary output is either 0% (above the band) or 100% (below the band).

The region indicated by the letter "B" reflects the action of the Cooling Proportional Band (CPb) which is the region in which the controller's secondary (cooling) output is permitted to throttle between 0% and 100%. Outside this region the controller's secondary output is either 0% (above the band) or 100% (below the band).

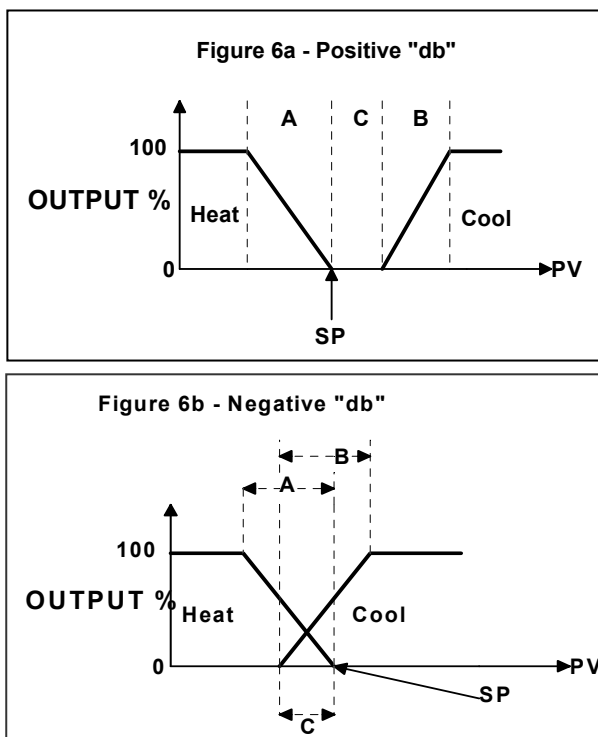


FIGURE 6

The region indicated by the letter "C" reflects the action of the deadband (db) which permits the user to decide whether or not the primary and the secondary outputs should ever be ON at the same time. By setting the "db" to a positive value (Fig. 6a) the two control outputs will never be ON at the same time (notice the deadband region in Fig. 6a). Fig. 6b illustrates a negative deadband value which permits the primary and secondary outputs' proportional bands to overlap causing the two outputs to potentially be ON at the same time.