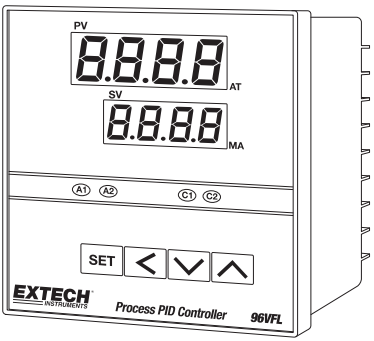
EXTECH®

USER MANUAL

Process PID Controllers

Model 96VFL 1/4 DIN Controller

Model 48VFL 1/16 DIN Controller



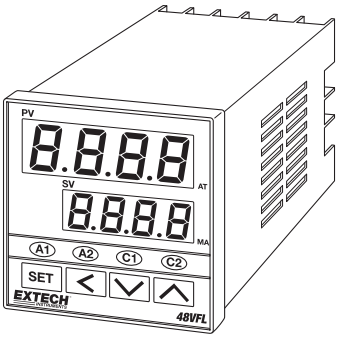


Table of Contents

1. Introduction

Thank you for selecting the Extech VFL Process Controller. The VFL series uses intelligent algorithms (including fuzzy logic) to offer highly precise process control. The wide array of features and functions are easily configured in the five program menu levels.

Controller Wiring

The controller must be wired before use. Inputs, outputs, and AC power are connected on the rear terminals as described in the Wiring section.

Process Inputs

The VFL series can be ordered in a variety of input configurations. For temperature versions, the controller accepts a thermocouple or RTD thermometer. For analog versions, the controller accepts a 4 to 20mA or 1 to 5V dc process signal.

PV (Process Variable) Display

Process inputs values are displayed on the PV (Process Variable) digits on the front panel.

Control Outputs

The VFL series offers three control output options: mechanical relay, pulsed DC Trigger (24VDC), and analog (linear 4-20mA). Relay and Trigger outputs are ON-OFF control types (pulsed). The 4-20 output, on the other hand, is a linear signal corresponding to the 0 to 100% output.

Alarm Outputs

The Alarm relays can be used to perform a variety of alarm and timer functions. Alarms can be used to shut down power in the event of an emergency, switch on an alert signal, control other variables in a process, and more. Alarm relays can also function as ON and OFF timers.

Setting Value (SV)

The Setting Value (SV), also known as the Setpoint, is the target point for your process. The SV is changed by first pressing the Shift (<) key to select a digit, using the arrow keys to change the digit's value, and then pressing SET to confirm. The SV is displayed on the lower LED digits in green.

Programming Menus

The controller has five Programming Menu Levels. Each menu includes a series of customizable control and tuning parameters.

Tuning the Controller

The controller's PID settings must be tuned for each application. Run the Auto Tune utility after the controller is wired and ready for use. Manual tuning adjustments can also be made. Tuning is key to a stable process.

Contact Extech

Visit the Extech website www.extech.com for customer support, up-to-date user documentation, and full warranty information. This device is covered by a 2-year limited warranty.

2. Safety

The installation, wiring, and maintenance of this process controller must be performed by qualified electrical technicians. Please read the entire user manual, including all safety information, before using this device. No user serviceable parts.

WARNINGS

- The electrical power required by this controller is hazardous. Use care when connecting the controller to power and other devices. Do not touch the rear of the controller when it is in operation.
- Before wiring, check the model number on the controller label. The model number is structured to show the input and output hardware options installed. Contact Extech if you are uncertain.
- To minimize the pick-up of electrical noise, the sensor input wiring should be routed away from high-current power cables or use shielded cables with the shield grounded at both ends.
- RFI and EMI can interfere with the controller's microprocessor. If the display characters are abnormal, an error message appears, or if the controller is performing unusually, take it out of service and have it repaired; check for the source of the interference before continuing.
- When using a relay output, it may be necessary to apply a filter circuit, suitable for suppressing emissions. The filter requirements will depend on the type of load.
- If the controller is operating abnormally or appears damaged, take it out of service and have it repaired before continuing to use.

3. Panel Cut-out, Dimensions, and Mounting

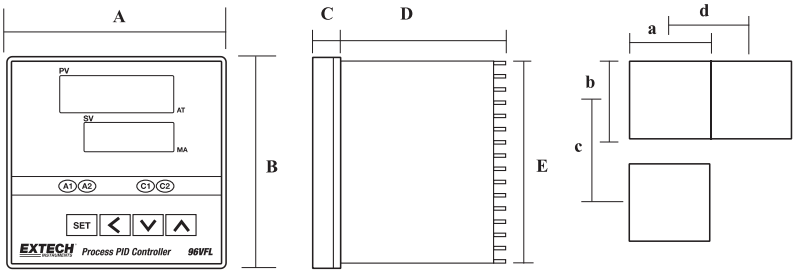


FIGURE 3.1: VFL CUT-OUT AND DIMENSIONS

	A	B	C	D	E	a	b	c	d
48VFL	48	48	6	100	45	45	45	60	48
96VFL	96	96	10	80	91	92	92	120	96

Units: mm (columns 'a' and 'b' are +/- 0.5mm)

3.1 48VFL Mounting

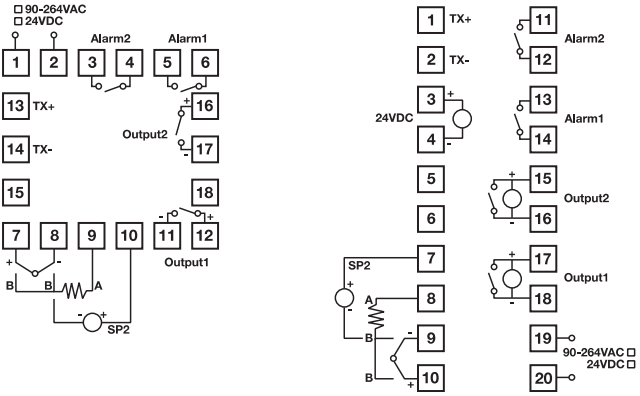
1. Remove the plastic mounting bracket and slide the controller into the panel, through the cutout.
2. Replace the mounting bracket and tighten the bracket screws. Do not over tighten.
3. Do not obstruct the ventilation openings on the side of the controller.

3.2 96VFL Mounting

1. The 96VFL uses two metal brackets (supplied) affixed to the top and bottom of the controller to secure it to the panel.
2. Slide the controller into the panel and connect the bracket clips to the insert holes on the top and bottom of the controller.
3. Tighten the bracket screws to secure the controller in the panel. Do not overtighten.

4. Wiring

FIGURE 4.1: SERIES VFL WIRING (48VFL ON LEFT, 96VFL ON RIGHT)



4.1 WARNING! Wiring Safety Considerations

Before you start wiring, please confirm the hardware options installed in your controller: Input (TC, RTD, or Analog); Outputs (relay, analog, or dc trigger), number of alarm and control outputs, etc.).

Your wiring plan must match your unique hardware options. For example, if you jump 120Vac power to output terminals when you have a 4-20ma output circuit installed, serious damage to the controller and personal injury can result.

The controller options label matches the model number ordered, contact Extech if there is any uncertainty. Improper wiring can cause personal injury and damage to the controller and connected equipment.

To avoid noise induction, keep input signal wires away from instrument power lines, load lines and power lines of other electrical equipment.

4.2 AC Power Wiring

96VFL: Terminals 19 and 20 can safely accept 90 to 260VAC 50/60Hz (24VDC is optional).

48VFL: Terminals 1 and 2 can safely accept 90 to 260VAC 50/60Hz (24VDC is optional).

4.3 Thermocouple Input Wiring

96VFL: Terminal 9 (-) and terminal 10 (+).

48VFL: Terminal 8 (-) and terminal 7 (+).

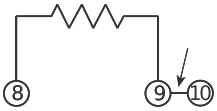
4.4 Analog Input (4-20mA) Wiring

96VFL: Terminal 9 (-) and terminal 10 (+).

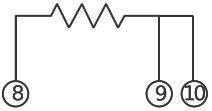
48VFL: Terminal 8 (-) and terminal 7 (+)

4.5 RTD Input Wiring

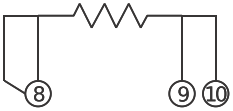
Wire a 2-, 3-, or 4-wire RTD as shown in the diagrams below.



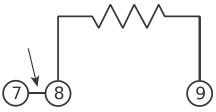
2-wire RTD wiring
96VFL



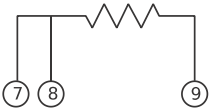
3-wire RTD wiring
96VFL



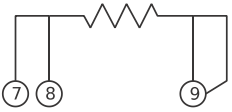
4-wire RTD wiring
96VFL



2-wire RTD wiring
48VFL



3-wire RTD wiring
48VFL



4-wire RTD wiring
48VFL

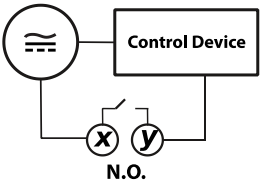
4.6 Control Relay Wiring

A basic VFL controller includes one control relay (OUT 1), the second control output (OUT 2) is optional.

Control relay outputs are single-pole, single-throw (normally open N.O.) mechanical switches. When the controller activates a control relay, the normally open switch closes. The relay itself does not provide power. AC or DC power must be wired in series with the relay and control device as shown below. Relays are rated 5 Amps @ 110V AC or 24VDC (Resistive Loads).

In the diagram below terminals 'x' and 'y' represent the VFL rear terminal designations, see the table below for the specific terminal numbers.

FIGURE 4.2: NORMALLY OPEN (N.O.) CONTROL OUTPUT WIRING



	OUTPUT 1	**OUTPUT 2**
48VFL *(x-y)*	Terminals 11 and 12	Terminals 16 and 17
96VFL *(x-y)*	Terminals 17 and 18	Terminals 15 and 16

4.7 Pulsed DC Trigger Output Wiring

The DC Trigger output delivers 24V DC (approx.) across the same terminals that are used for the relay outputs. See Control Relay terminals table above. The DC Trigger output is ON or OFF, not linear as the 4-20mA analog output.

4.8 Analog Output Wiring

Analog outputs are optional. Analog outputs are available across the same terminals that are used for the control relay outputs. See terminal designations below. Parameter 'Ct' (PID Menu 3) must be set to '0' when using an analog output.

96VFL Output 1: Terminal 18 (-) and terminal 17 (+).

96VFL Output 2: Terminal 16 (-) and terminal 15 (+).

48VFL Output 1: Terminal 11 (-) and terminal 12 (+).

48VFL Output 2: Terminal 17 (-) and terminal 16 (+).

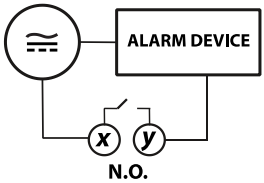
4.9 Alarm Relay Output Wiring

One relay is supplied in a standard VFL controller, the second alarm is optional. Alarm relays are normally open (N.O.) single-pole single-throw mechanical switches, but their logic state can be reversed (to normally closed N.C.) in the A1Fu or A2Fu programming menu. See all the alarm programming menus for more information on alarm functions, specialty modes, and event/soak timers.

Alarm relays do not supply power and should be wired in series with power. Alarm relays are rated for 3 Amps @ 110VAC or 24VDC (resistive loads) maximum.

In the diagram below terminals 'x' and 'y' represent the VFL rear terminal designations, see the table below the figure for the specific terminal numbers.

FIGURE 4.3 - ALARM RELAY OUTPUT WIRING



	ALARM 1	**ALARM 2**
48VFL *(x-y)*	Terminals 5 and 6	Terminals 3 and 4
96VFL *(x-y)*	Terminals 13 and 14	Terminals 11 and 12

4.10 Optional 24Vdc 'Loop Power' Supply (96VFL)

On the 96VFL, terminals 3 (+) and 4 (-) offer an optional 24Vdc power supply that can be used to provide 'loop power' to your process.

5. Product Description

The numbered call-out items below describe the basic operational functions for the displays, indicators, and keys. Advanced uses are explained in the Keypad Descriptions and Display Descriptions sections, and throughout this manual.

5.1 96VFL Front Panel

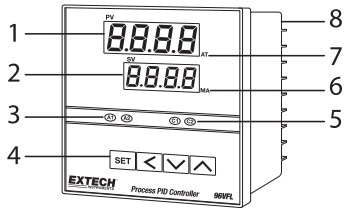


FIGURE 5.1: 96VFL FRONT PANEL

1. Process Variable (PV) display digits (red) show the process input.
2. Setting Variable (SV) display digits (green) show the programmed setpoint.
3. Alarm 1 (A1) and Alarm 2 (A2) relay status indicators.
4. Programming keys: Set, Scroll, Down arrow, Up arrow (left to right). See dedicated section below.
5. Control Output 1 (C1) and Control Output 2 (C2) status indicators.
6. MANUAL control mode status (rightmost decimal flashes on SV display).
7. AUTO TUNING mode status (rightmost decimal flashes on PV display).
8. Connection terminal blocks.

5.2 48VFL Front Panel

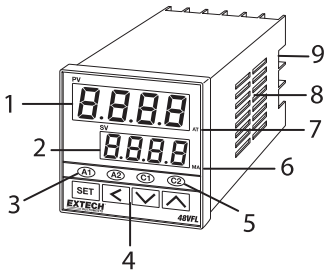


FIGURE 5.2: 48VFL FRONT PANEL

1. Process Variable (PV) display digits (red) show the process input.
2. Setting Variable (SV) display digits (green) show the programmed setpoint.
3. Alarm 1 (A1) and Alarm 2 (A2) relay status indicators.
4. Programming keypad: Set, Shift (<), Down arrow, Up arrow (left to right). See dedicated section below.
5. Control Output 1 (C1) and Control Output 2 (C2) status indicators.
6. MANUAL control mode status (rightmost decimal flashes on SV display).
7. AUTO TUNING mode status (rightmost decimal flashes on PV display).
8. Ventilation holes (do not obstruct airflow)
9. Rear screw terminal block.

5.3 Keypad Descriptions

SET Key

- Used to access and scroll through Menu 1 (User level) parameters. Used to scroll through menus 2, 3, 4, and 5 also, once they are accessed (see combination keystrokes paragraph below, and the Programming menu sections, for complete details).
- Long press (5 seconds) to reset an Alarm Timer.

SHIFT Key (<)

- Short press to access the SV setting mode, then press again to select a digit for editing. Change a digit's value with the arrow keys, and then press SET to confirm.
- Long press (5 seconds) to start the Auto Tuning utility.
- Long press (5 seconds) to abort an Auto Tune session.

Up/Down Arrow Keys

- The up/down arrows are used to adjust the Setting Value (SV) value: Use the SHIFT (<) button to first select a digit and then use the up/down arrows to change it. Press SET to confirm when done and to continue scrolling. This is basically the same procedure for changing settings in the menu system.
- Use the up/down arrows to change a setting in the programming menus. In most cases, the SHIFT key is used to select a digit for editing, and then the up/down arrows are used to change the digit value. SET is then used to confirm and continue scrolling.

Combination Keystrokes

- Press SET and the up-arrow key to return to the normal operation mode from a menu.
- Long press both the up and down arrow keys for 5 seconds to access 'LnLo' and 'LnHi' parameters in Menu Level 5. These are the Linear (analog) input's low and high scale values. See the programming menu sections for details.
- Press **SET** and **SHIFT (<)** for 5 seconds to enter the Programming Menu 2-3-4 loop.

5.4 Display Descriptions

Process Variable (PV) Display

- During normal operation, the top LED (red digits) displays the actual process measurement variable (PV).
- When you access one of the programming levels, these red LED digits display the currently selected parameter.
- These red LED digits also display error messages.
- The rightmost decimal flashes when the Auto Tune function is active.

Setpoint Variable (SV) Display

- During normal operation, the bottom LED (green) displays the Setting Variable (SV).
- SV cannot be adjusted higher or lower than the High and Low Limit parameters (see Menu 4, Options level).
- In program menus, the green LED digits show the setting for the selected parameter (shown on the red LED digits).
- The rightmost decimal point flashes on this display when Manual control mode is active.

Status Indicators

‘A1’ and ‘A2’ Relay Status LEDs

These LEDs light when the associated Alarm relay is active. They flash when the Alarm is configured as an ON or OFF Timer and the timer is running. Refer to the Alarm Timers section.

'C1' and ‘C2’ Control Relays Status LEDs

These LEDs switch on/off as the associated control output switches on/off.

‘MA’ Manual Control Status

The rightmost decimal flashes on the SV display when the controller is in Manual mode of operation. Refer to the Auto/Manual Control section.

‘AT’ Auto Tune Status

The rightmost decimal flashes on the PV display when the controller is Auto Tuning. Refer to the Auto Tuning section for more information.

PV Display Error Messages (see Troubleshooting section)

6. Process Control

6.1 Connect the Inputs

The input types (thermocouple, RTD, analog) are hardware dependent. The part number ordered, and the product label indicate the input type. If you are uncertain, please contact Extech. Wire the input as described in the Wiring section.

6.2 Connect the Outputs

The output types (relay, dc trigger, analog) are hardware dependent. The part number ordered, and the product label indicate the output type. If you are uncertain, please contact Extech. Wire the output as described in the Wiring section.

6.3 Program the Controller

The programming menus contain critical settings that optimize the control of your process. Success depends largely on configuring and tuning the controller correctly. Refer to the Programming Menu sections for details.

6.4 Primary Relay Output Control

The primary control output is a mechanical, single-pole, single-throw, relay contact, and, by definition, can only be in one of two states, ON or OFF (closed or open).

Control relays are wired in series with the control equipment (heater, pump, etc.) and require AC or DC power to operate.

The ON-OFF and PID Time Proportioning control methods, explained below, apply to Relay output control. The primary control output can be configured as a Heating (reverse acting) or Cooling (direct acting) control type (see the 'act' parameter in Menu 4, Options).

6.5 Secondary (optional) Relay Output Control

The secondary control output is a mechanical, single-pole, single-throw, relay switch, and, by definition, can only be in one of two states, ON or OFF.

Control relays are wired in series with the control equipment (cooler, pump, etc.) and require AC or DC power to operate.

The ON-OFF and PID Time Proportioning control methods, explained below, apply to Relay output control. The secondary control output is fixed at Cooling (Direct acting) control.

6.6 Pulsed DC Trigger Option

The optional DC Trigger supplies a 24V pulse (ON: 24V; OFF: 0V), it is not linear, as is the 4-20mA analog output. The screw connecting terminals are the same terminals that are used for the relay outputs. See the Wiring section for rear-terminal designations. The ON-OFF and PID Time Proportioning control methods, explained below, apply to relay as well as DC Trigger control.

Caution: With DC Trigger installed in your controller do not wire an external AC or DC voltage signal to the DC Trigger terminals.

6.7 Analog Output Option

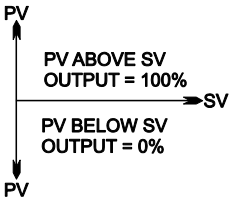
With the analog output option, the controller supplies 4-20mA to the process. Up to two 4-20 outputs can be installed (see the Wiring section for rear-terminal designations). The controller regulates the analog outputs to bring the process (PV) to setpoint (SV).

To use the analog output, ensure that 'Cycle Time' ('Ct' in Menu 3, PID) is set to '0'

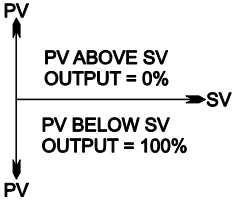
6.8 ON-OFF Control

ON-OFF is the simplest form of control, where the controller output is OFF at setpoint and ON away from setpoint. To use ON-OFF control, set the 'Pb' or 'CPB' parameter (Menu 3, PID) to '0'. Use the Hysteresis setting 'Hyst' to create a 'dead band' around the setpoint to minimize relay chatter. These are also found in Menu 3, PID.

FIGURE 6.1: ON-OFF COOLING AND HEATING CONTROL EXAMPLES



ON-OFF COOLING APPLICATION



ON-OFF HEATING APPLICATION

6.9 PID Control

ON-OFF control cannot be used for processes where setpoint overshoot or process oscillations are not acceptable and may cause damage to the materials in the process. For more precision, PID control is necessary. PID has three elements:

Proportional control ('Pb' parameter in Menu 3, PID)
Integral time ('ti' parameter in Menu 3, PID)
Derivative time ('td' parameter in Menu 3. PID)

PID control minimizes setpoint overshoot, oscillations, and disturbances in a process by throttling the controller output automatically. The controller must first be tuned so that it understands the speed and dynamics of the process. See the Auto Tune section.

Proportional-only control adjusts the controller output, proportional to the proximity of PV to SV. The closer to setpoint, the lower the output %. The further from setpoint, the higher the output %.

Proportional-only control, however, has a side effect (known as droop or offset) where the process is brought to equilibrium, but not exactly at setpoint. This is where Integral control is useful, as it checks for droop as often as you specify in the 'ti' parameter (Menu 3, PID).

Proportional-Integral (PI) control is fine for systems where there are no sudden process changes expected. In cases where sudden changes to process are possible (or even frequent), then Derivative control can be used.

Derivative control ('td' in Menu 3, PID) is known as anticipatory control, as it looks at the rate of change in a process and makes output adjustments to prevent process disturbances.

It calculates where the process will be at some point in the future, given the present rate of change, and uses that information to determine the output adjustment needed.

6.10 PID 'Time Proportioning' Control

PID control is easy to picture with a linear analog output, where a 4 to 20mA output, for example, responds linearly to the 0 to 100% control output variations. 0% power = 4ma, 50% power = 12ma, 100% = 20mA, and so on.

A relay, however, is very different from a linear analog output in that it has only two states, ON and OFF, where the 4 to 20 signal is continuous throughout its range. So, to apply PID control to a relay, Time Proportioning PID control is used.

Time Proportioning adjusts the ratio of relay ON-time to relay OFF-time, over an adjustable time duration, known as the Cycle Time ('ct' parameter in Menu 3, PID).

The controller 'throttles' the output relay, keeping the relay ON longer, when the PV is further from SV, and OFF longer, when the PV is close to the SV.

The ratio of relay ON-time to relay OFF-time is automatically adjusted at the start of each Cycle Time window, based on PV/SV proximity.

Time Proportioning control is active when the Proportional Band 'Pb' (or Cooling Proportional Band 'CPb') parameter is set to some value other than '0' in Menu 3, PID.

The examples below illustrate three stages in a process where the output % is changed, based on process conditions.

FIGURE 6.2: TIME PROPORTIONING CONTROL EXAMPLES

FIGURE 6.2a

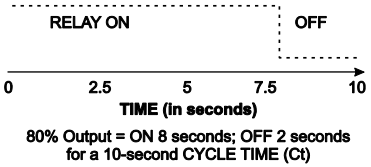


FIGURE 6.2b

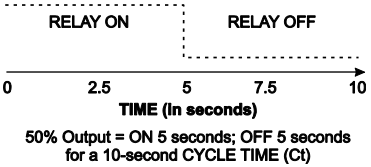


FIGURE 6.2c

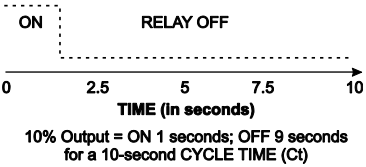


Figure 6.2a: The controller is calling for **80% power** since the PV is far from the SV.

Figure 6.2b: The PV is closer to SV, so the controller calls for **50% power**.

Figure 6.2c: The PV is very close to SV, so the output is at **10% power**.

The controller must be tuned, and the Cycle Time set accurately, before Time Proportioning can be effective. See the Auto Tune section for tuning details. Cycle Time 'Ct' (Menu 3, PID) should be set to the longest time possible without causing process oscillations.

6.11 Proportional Control Considerations

Proportional control adjusts the VFL output % in proportion to the PV/SV proximity. The Proportional Band setting ('Pb') and Cooling Proportional Band ('CPb') settings have a dramatic effect on the controller's reaction to process changes. See Menu 3, PID.

When the 'Pb' setting is very narrow, the gain is high, the controller reacts quickly, and the process is affected immediately. When the 'Pb' setting is very wide, the gain is low, the controller takes time to react, and the process changes are slower. The tuning process is essentially setting the 'Pb' size to match the dynamics of your process.

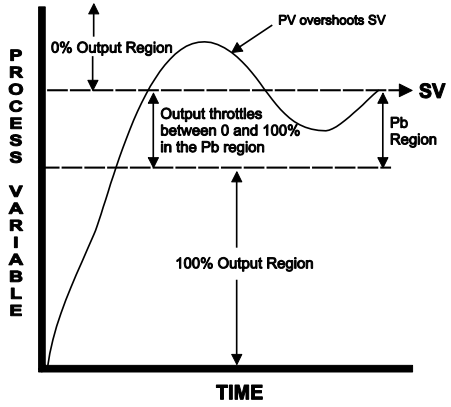
The Proportional Band is set as a % of 'span'. Span is the distance between the Low and High Limit settings (Menu 4, Options). Therefore, if you increase the span, you increase the width of the Proportional Band and if you decrease the span, you decrease the width of the Proportional Band.

Whenever possible, use the Auto Tune to automatically set 'Pb' (and/or 'CPb'). Proportional Band examples are illustrated below.

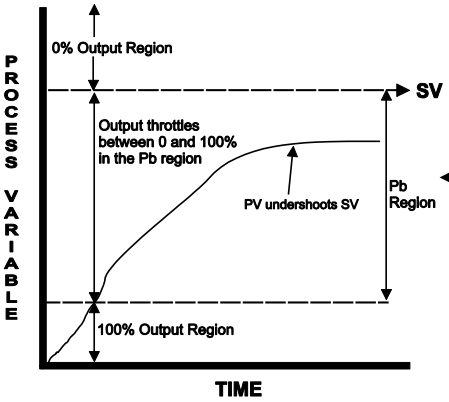
FIGURE 6.3: PROPORTIONAL BAND EXAMPLES

Pb setting too narrow

When Proportional Band is set too narrow, the PV rises too quickly and typically overshoots the SV, as shown.



Proportional Band (Pb) set too narrow



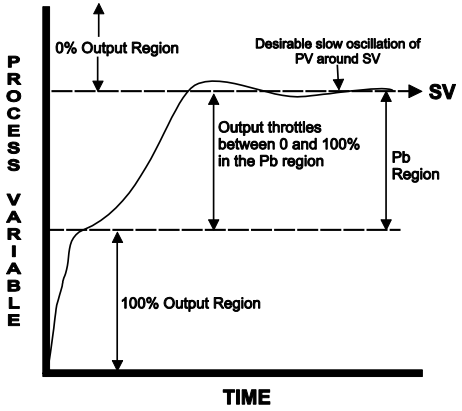
Pb setting too wide

When Proportional Band is set too wide, the PV rises too slowly and may never reach the SV.

Proportional Band (Pb) set too wide

Pb set correctly

When Proportional Band is set correctly, the PV rises to the SV in the desired time with little overshoot. A slight oscillation of the PV (within specification) is typical once the SV is reached.



Proportional Band (Pb) set correctly

6.12 Dead Band Considerations

The dead band (db) parameter (Menu 3, PID) is used to determine the interactive behavior of the controller outputs when the controller is equipped with two control outputs.

The ‘db’ parameter allows you to control whether the primary output and the secondary cooling output can be ON at the same time. Set ‘db’ to a positive value to restrict the outputs from being ON at the same time. Set ‘db’ to a negative value to allow the outputs to be ON at the same time. Fig. 6.4 shows a positive ‘db’ value example; Fig. 6.5 shows a negative ‘db’ value example.

In the examples, the x-axis represents the Process Variable (PV) and the y-axis represents the Control Output percent. The SV setting is shown on the PV line.

In both figures, the region identified by the letter "A" represents the action of the Proportional Band ('Pb’). ‘Pb’ is the region where the primary output throttles between 0% and 100%. Outside the ‘Pb’, the output is either OFF (0%), above the band, or ON (100%), below the band.

In both figures, the region indicated by the letter "B" represents the action of the Cooling Proportional Band (‘CPb’) which is the region where the controller's secondary (cooling) output throttles between 0% and 100%. Outside the ‘CPb’, the output is either OFF (0%), above the band, or ON (100%), below the band.

In both figures, the region indicated by the letter "C" shows the dead band. In Fig. 6.4, with a positive ‘db’ setting, the primary and secondary outputs cannot be ON at the same time. In Fig. 6.5, with a negative ‘db’ setting, the two outputs are ON at the same time, as represented by the overlapping lines.

FIGURE 6.4: DEAD BAND (db) SET TO A POSITIVE NUMBER

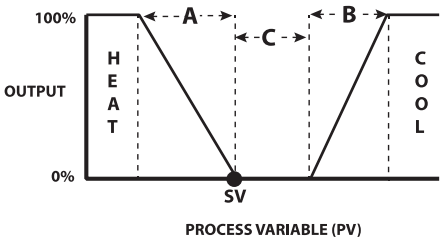
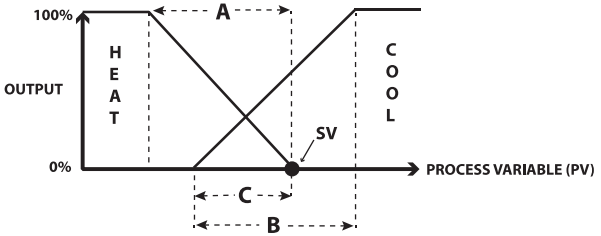


FIGURE 6.5: DEAD BAND (db) SET TO A NEGATIVE NUMBER



7. Programming Menu Basics

The VFL series controllers have 5 programming levels.

1. MENU 1 (User): Set control/alarm setpoints, auto tune, and manual control.
2. MENU 2 (Soft-start): Set soft-start and ramp-to-setpoint limits.
3. MENU 3 PID Tuning level: Set tuning parameters, parameter lock, hysteresis, and more.
4. MENU 4 (Option): Set input type, display resolution, low and high limits, and more.
5. MENU 5 (Linear): Set the low/high display scaling for the analog input option.

Navigating the Menus

- To access Menu 1 (User level) press SET, and then continue to use SET to scroll through Menu 1 until you exit the menu and return to the normal operating screen.
- Press the SET and SHIFT (<) keys together for 5 seconds to access the Menu 2-3-4 *LEVEL* selector. Use the arrow keys to select Soft (Menu 2), PID (Menu 3), or Option (Menu 4).
-  : The 'Level' Menu 2-3-4 selector display code.
- While in Menu 2, 3, or 4 use the SET key to scroll. Use the Shift key (key) to select a digit for editing, and then use the arrows to change the selected digit. Use SET to continue through the menu.
- To switch between menu levels 2, 3, and 4, use the SET key to scroll to the 'Level' screen, and then use the up/down arrow keys to select a menu level. You can then use the SET key to scroll through the selected menu, as explained above.
- Press SET and the up-arrow key to exit the Menu 2-3-4 loop.
- To access Menu 5, press the up and down arrow keys together for 5 seconds. Scroll to 'LnLo' or 'LnLo' and use the SHIFT (<) key to select a digit for editing and then use the arrow keys to change a digit. Use the SET key to continue to the normal operating screen when done.

Programming Menu Level Overview

Menu 1 (User)	Menu 2 (Soft)	Menu 3 (PID)	Menu 4 (Option)	Menu 5 (Linear)
USER LEVEL	SOFT START LEVEL	PID LEVEL	OPTION LEVEL	LINEAR INPUT
	LEVL			
A1SP	SoFt	Pid	oPt1	LnLo
A2SP	rAnP	Pb	tYPE	LnHi
At	SSP	t1	Unit	
HAnd	oUt	td	dP	
oUtL		Ct	ACt	
		CPb	LoLt	
		Ct1	H1Lt	
		Ctd	F1Lt	
		CCt	PtnE	
		HYS1	A1FU	
		HYS2	A1nd	
		A1HY	A2FU	
		A2HY	A2nd	
		db	Addr	
		SPoF	bAUd	
		PYoF		
		LoCK		

Menu Notes:

1. When the secondary output (cooling) is not installed, **CPb**, **Cti**, **Ctd**, **HYS2**, and **db** parameters do not appear in the menu.
2. When **Pb** is not set to 0.0, **HYS1** does not appear in the menu.
3. When **CPb** is not set to 0.0, **HYS2** does not appear in the menu.
4. When **Pb** is set to 0.0, **ti** and **td** do not appear in the menu.
5. When **CPb** is set to 0.0, **Cti** and **Ctd** do not appear in the menu.

8. Programming Menu 1 (User level)

- Press the SET key to access Menu 1 (User level).
- Continue to use the SET key to scroll through the menu. At the end of the menu you will return to the normal operating screen. This applies to Menu level 1 only.
- In the menu, Use the SHIFT (<) key to select a digit for editing and then use the up/down arrows to change a digit's value.
- Use SET key to confirm and continue to the normal operating screen when done editing.
- Long press the SET and SHIFT (<) keys for five (5) seconds to enter the Menu 2, 3, 4 'Level' selector screen and then use the up/down arrows to select a menu level.

Display	Definition	Description	Range	Default
A 1SP	Alarm 1 Setpoint	Set the Alarm type using the 'A1Fu' parameter first, and then return here to set the Setpoint; See Section 11.3 for function list table. When an alarm is configured as an ON/OFF Timer, set the time here.	Note 1*	Note 1*
A2SP	Alarm 2 Setpoint	Same as Alarm 1 (using 'A2Fu').	Note 1*	Note 1*
At	Auto Tune	Set to 'no' to disable. Set to 'YES 1' for normal Auto Tune or 'YES 2' for gentler Auto Tune action.	NO YES1 / YES2	NO
HAnd	Manual Control	Set to 'YES' to control the output levels manually with the arrow keys.	NO / YES	OFF
oUtL	Output Level	Control output level (%) is shown while in the Manual control mode (see 'Hand').	0 ~ 100%	0%

***Note 1**: Controller input type dependent.

9. Programming Menu 2 (Soft Start level)

- From any display, long press the SET and SHIFT (<) keys for five (5) seconds to enter the Menu 2-3-4 'Level' selection screen. Use the up/down arrows to select Menu 2 (or Menu 3 or 4).
- Use the SET key to scroll through the menu.
- Use the SHIFT (<) key to select a digit for editing and then use the up/down arrows to change the setting. Press SET when done to confirm and to continue scrolling.
- To change between menu levels, scroll to the 'Level' screen and use the up/down arrows to select a menu (this applies to Menus 2, 3, and 4 only).
- Press the SET key and the up-arrow key together to exit the Menu 2-3-4 menu loop.

Display	Definition	Description	Range	Default
SoFt	Soft-start menu	Top level name of Menu 2.	n/a	n/a
rAnP	Ramp to Setpoint	Limits the rate at which the measured variable (PV) can change. Set as 'units per minute'.	0 ~ 9999 (0.0 ~ 999.9)	0.0 - OFF
S.SP	Soft start setpoint	Restricts the output to the output % limit set in the next parameter ('out') until this setpoint is reached.	Same as input range.	0 (OFF)
oUt	Soft start output level	Controller output is limited to this % until the 'S.SP' (above) setpoint is reached.	0.0 ~ 100.0 %	100.0

9.1 Soft-Start Utility Overview

Restricts the control output from going higher than the percentage set in the 'OUT' parameter (Menu 2, above), until the setpoint, set in the 'S.SP' parameter, is reached.

For example, with an 'S.SP' setting of 100 units and an 'OUT' setting of 50%, the controller will not exceed 50% power until the PV reaches 100.

A setting of '0.0' disables the feature.

9.2 Ramp-to-Setpoint (Ramp) Overview

To limit the rate at which the PV can ramp to setpoint, use the arrow keys to adjust the 'Ramp' parameter (Menu 2). The setting range is 0.0 to 100.0 units per minute.

For a setting of 20.0, for example, the controller will not allow the process to change more than 20 units per minute.

A setting of '0.0' disables the feature.

10. Programming Menu 3 (PID level)

- From any display, long press the SET and SHIFT (<) keys for five (5) seconds to enter the Menu 2-3-4 'Level' selection screen. Use the up/down arrows to select Menu 3 (or Menu 2 or 4).
- Use the SET key to scroll through the menu.
- Use the SHIFT (<) key to select a digit for editing and then use the up/down arrows to change the setting. Press SET when done to continue scrolling.
- To change between menu levels, scroll to the 'Level' screen and use the up/down arrows to select a menu.
- Press the SET key and the up-arrow key together to exit the Menu 2-3-4 menu loop.

Display	Definition	Description	Range	Default
PId	PID Menu	Tuning and Lock parameter menu		
Pb	Proportional Band	Output 1 Pb setting. Automatically set by Auto Tune. The lower the setting, the higher the output gain. The larger the setting the lower the output gain.	0.0 ~ 300.0% (of span*)	10.0
ti	Integral time (reset)	Automatically set by Auto Tune. The lower the setting the more responsive the controller is to PV/SV offset.	0 ~ 3600 secs.	240
td	Derivative (rate)	Automatically set by Auto Tune. The lower the setting, the more responsive the controller is to accelerating process changes.	0 ~ 900 secs.	60
Ct	Cycle time	Interval between automatic output changes. Set to the longest time possible without causing process oscillations. Set to '0' for the 4-20mA analog output option.	0 ~ 100 secs.	15
CPb	Cooling Proportional band	Same as 'Pb' for OUT 2.	0.0 ~ 300.0% (of span*)	10.0
Cti	Cooling Integral time	Same as 'ti' for OUT 2.	0 ~ 3600 secs.	240
Ctd	Cooling Derivative	Same as 'td' for OUT 2.	0 ~ 900 secs.	60
CCt	Cooling Cycle time	Same as 'Ct' for OUT 2.	0 ~ 100 secs.	15

HYS 1	Hysteresis OUT 1	Region where relay switching is disabled. Region extends equally above and below SV.	0 ~ 2000 (0.0 ~ 200.0)	1
HYS2	Hysteresis OUT 2	Same as 'HYS1' for OUT 2.	0 ~ 2000 (0.0 ~ 200.0)	1
A 1HY	Hysteresis Alarm 1	Region where relay switching is disabled. Region extends equally above and below A1SP (Menu 1).	0 ~ 2000	1
A2HY	Hysteresis Alarm 2	Same as 'A1HY' for Alarm 2.	0 ~ 2000	1
db	Dead band	Set to a negative value to allow OUT 1 and OUT 2 to be ON at the same time. Set to positive value to restrict this action.	-1000 ~ 1000 (-100.0 ~ 100.0)	0
SPoF	Setpoint offset	'Manual reset'. Select a value to offset the SV display.	-1000 ~ 1000 (-100.0 ~ 100.0)	0
PVoF	Process Variable offset	Select a value to offset the PV display.	-1000 ~ 2000 (-100.0 ~ 200.0)	0
LoCK	Parameter Lock	0000 – All parameters locked 0001 – Only SP is adjustable 0010 – Only USER menu adjustable 0011 – Only USER and PID menus adjustable 0100 – USER, PID, OPTION, menu adjustable 0101 – USER, SOFT, PID, OPTION menus adjustable 0101 ~ 0111 – All parameters in all levels unlocked **For Output 2: 1000 ~ 1111: 1000=0000, 1001=0001, 1010=0010, 1011=0011, 1100=0100**		

11. Programming Menu 4 (Option level)

- From any display, long press the SET and SHIFT (<) keys for five (5) seconds to enter the Menu 2-3-4 'Level' selection screen. Use the up/down arrows to select Menu 4 (or Menu 2 or 3).
- Use the SET key to scroll through the menu.
- Use the SHIFT (<) key to select a digit for editing and then use the up/down arrows to change the setting. Press SET when done to continue scrolling.
- To change between menu levels, scroll to the 'Level' screen and use the up/down arrows to select a menu.
- Press the SET key and the up-arrow key together to exit the Menu 2-3-4 menu loop.

Display	Definition	Description	Range	Default
oPt1	Options menu	Customize the controller options.		
tYPE	Input type	Select thermocouple, RTD, or Line input (analog). See Input Type settings section below this table.		
Unit	Unit of measure	Set the temperature or engineering units (analog inputs).	°C, °F, or EnG	°C
dP	Decimal setup	0000, 000.0 00.00 (linear inputs only) 0.000 (linear inputs only)	See description	0000
ACt	Control action	Output 1 control action. Set to '0' for cooling (direct) action or '1' for heating (reverse) action. Secondary output is automatically configured for cooling.	REV: Reverse (heat) DIR: Direct (cool)	REV
LoLt	Low limit	Low limit of the input range. See the Specifications for input ranges. Also, see dedicated paragraph on Low/High Limits below.	Full range	0
HiLt	High limit	High limit of the input range.	Full range	1000
FiLt	Filter	Software filter. Used to control the display update rate. Increase the setting to slow the display rate.	00 ~ 99.9	10.0
PtmE	Alarm Timer	Set the Alarm ON/OFF Timer format.	MM:SS/HH:MM	MM:SS
A1FU	Alarm 1 function	Alarm and Timer Functions. Select a function from the Alarm/Timer function list (Section 11.3).	See Alarm function section	Differential high alarm

A 1md	Alarm 1 mode	Select a specialty mode from the Alarm mode list (Section 11.3).	See Alarm mode section	None
A2FU	Alarm 2 function	Same as 'A1FU' for Alarm 2.	See Alarm function section	Differential low alarm
A2md	Alarm 2 mode	Select a specialty mode from the Alarm mode list (Section 11.3).	See Alarm mode section	None
Addr	RS-485 controller address	Set a controller address for optional RS-485 communications. The setting must be '0' when the option is not installed.	00 ~ 31	0
bAUd	Baud rate	Communication speed for RS-485 interface. See Section 11.6 for more.	2.4k, 4.8k, 9.6k, 19.2k	9.6k

11.1 Input Type Selection

Set the 'TYPE' parameter in Menu 4, above. See the available settings in the table below. The selection must match the controller's hardware configuration. Contact Extech if unsure. See the Specifications section for the range and resolution data for each type.

Input Type Selections for the 'TYPE' parameter

Setting	Input type	Notes
00	J type thermocouple	The controller hardware is configured at the factory per the part number used when ordering (check the meter label if unsure). Converting from one input type to another may require a hardware modification.
01	K type thermocouple	
02	T type thermocouple	
03	E type thermocouple	
04	B type thermocouple	
05	R type thermocouple	
06	S type thermocouple	
07	N type thermocouple	
08	RTD Pt100 ohm (DIN)	
09	RTD Pt100 ohm (JIS)	
10	Linear mode (voltage or current input)	

11.2 Low and High Limit Considerations

The Low and High Limit settings (Menu 4, Options) default to the low and high range values of the controller's input type (see the Specifications for the input types and their ranges).

The High/Low Limit 'span' directly affects the size of the Proportional Band, as the Proportional band value ('Pb') is set as a percentage of span (Menu 3, PID). The wider the span, the wider the Proportional Band.

The span also sets the low and high boundaries for basic operation. For example, the setpoint cannot be adjusted higher than the high limit or lower than the low limit settings.

11.3 Alarm Functions and Specialty Modes

ALARM FUNCTION LIST

Once a function is programmed in the 'A1Fu' and 'A2Fu' parameters (Menu 4, Options), set the setpoint in Menu 1 ('A1SP' or 'A2SP' menu items).

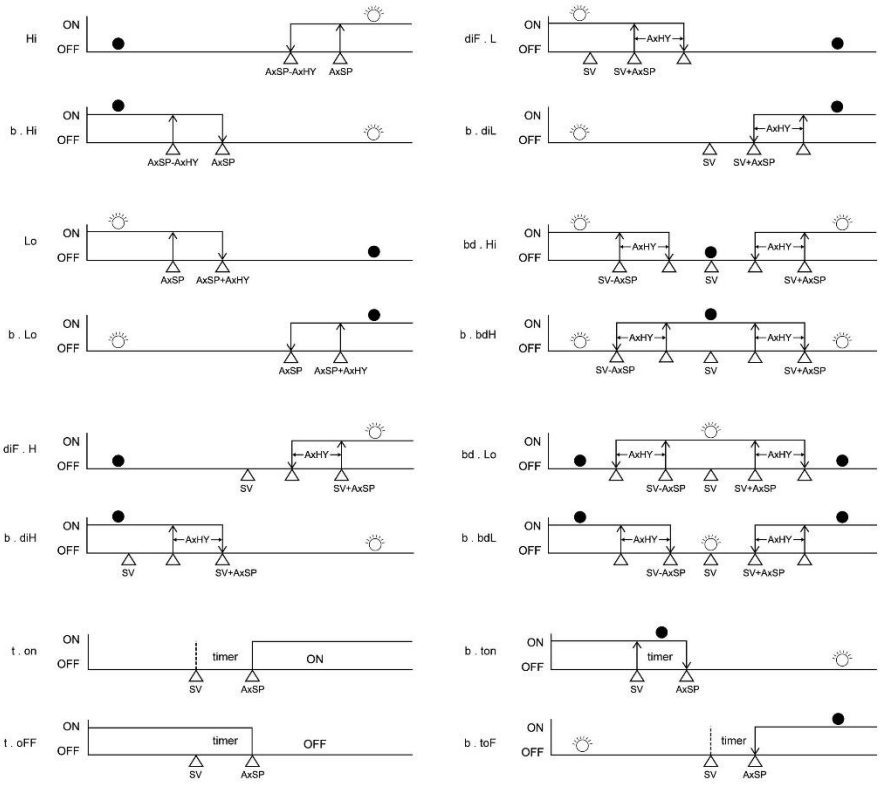
'A1FU' / 'A2FU' setting	Alarm Type	Operation
	No Alarms	No Alarms
	Process High alarm	Relay trips when the process (PV) exceeds the 'AxSP' value (Menu 1).
	Process Low alarm	Relay trips when the process (PV) falls below the 'AxSP' value (Menu 1).
	Deviation High alarm	The Alarm setpoint equals the Setpoint (SV) plus the 'AxSP' (Menu 1) setting. For example, if SV = 400 and A1SP = +10 then the Alarm relay will trip when the temperature rises above 410 º (400 + 10 = 410).
	Deviation Low alarm	The Alarm setpoint equals the Setpoint (SV) plus the 'AxSP' setting. For example, if SV = 400 and A1SP = -10 then the Alarm relay will trip when the temperature falls below 390º (400 – 10 = 390).
	Band High alarm	Alarm trips when PV is higher than the setpoint band.
	Band Low alarm	Alarm trips when PV is lower than the setpoint band.
	ON-Timer	See dedicated ON/OFF Alarm Timer section.
	OFF-Timer	See dedicated ON/OFF Alarm Timer section.

NOTE: The complete parameter table above is listed twice in the AxFu programming menus, with the second set reversing the alarm relay logic (normally closed, which is Form B, instead of normally open, which is Form A) . The second set has a 'b' (for Form B) at the beginning of the menu item name ('b.Hi', for example). See the alarm logic relay illustrations below.

ALARM FUNCTION GRAPHIC DESCRIPTIONS

Each alarm option, listed in the AxFu parameter lists above, is illustrated below.

- ON and OFF: The output status of the alarm relay. The hollow circle represents an 'ON' relay state. The black filled circle represents an 'OFF' relay state.
- SV: Setting Variable
- AxHY: Hysteresis of the Alarm.
- AxSP: Alarm Setpoint.



ALARM STANDBY AND LATCH SPECIALTY MODES

'A1md' / 'A2md' setting	Operation
nonE	Normal alarm mode. When an ON or OFF Timer function is selected, with the PV<SV, the timer function is disabled.
StdY	Standby mode (start-up inhibit). For any alarm function, this will prevent an alarm trip when there is an alarm condition upon power up. The alarm will not trigger the first time the PV reaches the alarm setpoint. This helps avoid alarm trips during startup.
LAtH	Latch mode. When selected, the alarm output and indicator remain ON even after the alarm condition has been cleared (unless the power to the meter is removed). Select 'none' to release the latch.
StLA	Standby and Latch modes both active.

11.4 ON-OFF Alarm Timers (Event and Soak Timers)

The alarm relays can be used as ON (Event) or OFF (Soak) Timers as explained below.

For ON (Event) Timers, the alarm relays are normally open (OFF). When the PV reaches the SV, the timer starts counting (relay is still OFF). When the timer counts down, the relay switches ON (this is the 'Event').

For OFF (Soak) Timers, the alarm relays are normally open (OFF), but they close (switch ON) when the PV reaches the SV. At that point, the timer starts counting (the 'Soak' begins). When the timer counts down, the relay switches OFF (the 'Soak' ends). See the table below:

Relay Action for ON and OFF Timers

	Controller at power-up	Timer Starts (PV=SV)	Timer Stops
ON TIMER	Relay OPEN (OFF)	Relay stays OFF	Relay CLOSES (ON)
OFF TIMER	Relay OPEN (OFF)	Relay CLOSES (ON)	Relay OPENS (OFF)

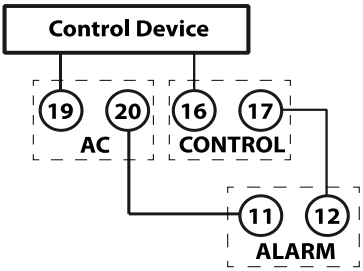
Set the 'A1Fu' or 'A2Fu' Alarm function to ON Timer ('t.on') or OFF Timer ('t.off') in Menu 4, Options.

Set the time format (MM:SS or HH:MM) using the 'P.tme' parameter in Menu 4. Lastly, set the time in the A1SP (for Alarm 1) or A2SP (Alarm 2) parameter in Menu 1, User level.

11.5 Using an Alarm Relay for Emergency Shutdown

A controller alarm relay can be wired in series with a control output to shut down a process to avoid catastrophic conditions. The alarm relay can be programmed to remain closed in normal operation and to open if a specific alarm setpoint is reached.

FIGURE 11.1 - ALARM OUTPUT WIRED TO CONTROL OUTPUT



11.6 RS-485 PC Interface Option

The optional RS-485 PC communications utility allows up to 32 controllers to be addressed individually by a Windows PC. When communicating, the controller's keypad is inactive and only the connected PC can control the VFL. Contact Extech for additional information.

12. Programming Menu 5 (Linear Input level)

Long press the up and down arrow keys for 5 seconds to access Menu 5. Use the SET button to scroll. Use the SHIFT (<) key to select a digit for editing and then use the up/down arrows to change the digit. Use the SET button to continue scrolling to the normal operating screen when done.

Display	Definition	Description	Range	Default
LnLo	Linear input low display	Low end of the display range for an analog (linear) input.	-1999 ~ 9999 (-199.9 ~ 999.9)	0.0
LnHi	Linear input high display	High end of the display range for an analog (linear) input.	-1999 ~ 9999 (-199.9 ~ 999.9)	100.0

13. Automatic Tuning

The Auto Tune feature automatically sets the tuning parameters for Menu 3 parameters '**Pb**' Proportional Band, '**ti**' Integral time (reset), and '**td**' Derivative time (rate). This also applies to the secondary (optional cooling) output parameters (**CPb**, **Cti**, and **Ctd**).

The controller must be wired to the process before proceeding.

1. Adjust the setpoint (SV) to the desired level. To set the SV, use the SHIFT (<) key to select a digit and then use the up/down arrows to adjust it. Press SET when done.
2. Ensure that Proportional Band ('Pb' or 'CPb') in Menu 3 is not set to zero (zero is reserved for ON/OFF control; Auto Tune does not apply in ON/OFF control mode).
3. Set the 'at' parameter, in Menu 3, to **YES 1,** for normal tuning, or **YES 2,** to a place a buffer at the setpoint (10% of full scale). 'YES 2' is a less aggressive form of tuning, used for sensitive processes.
4. The rightmost decimal on the PV display begins flashing when Auto Tune begins.
5. Auto Tune will run two cycle oscillations. After that, the controller will use the learned PID settings. The PID values are stored in nonvolatile memory.
6. An Auto Tune session may require only several minutes for quick processes but may require up to two hours for slower processes. An error will appear after 2 hours. This could mean that the control system is not in a closed loop with the controller, re-check the wiring and system configuration. Contact Extech if issues persist.
7. When Auto Tune is complete, the decimal will stop flashing.
8. To abort an Auto Tune session, set the 'at' parameter in Menu 3 to **no**.

14. Automatic and Manual Control Modes

Automatic Control

Automatic Control is the normal mode of operation. In Auto mode the controller automatically adjusts the control output to bring process to setpoint as described.

Manual Control

Manual control allows you to manually adjust the control outputs from 0.0 to 100.0%.

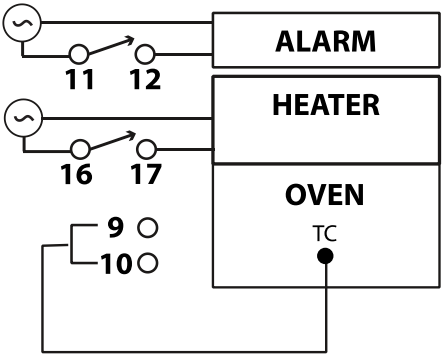
1. Set the 'HAND' parameter, in Menu 1, to **YES** to access Manual control. The SET key takes you through Menu 1.
2. The rightmost decimal in the SV display will flash while the controller is in the Manual mode.
3. Go to the 'OUTL' parameter in Menu 1 to view the output percent.
4. Use the up/down arrow keys to change the output percentage (0 ~ 100%).
5. The controller will alternately display the PV and the control output level.
6. To return to normal operation, set the 'HAND' parameter to **NO**.

15. Appendix A: Troubleshooting

Errors	Probable Cause	Action
oPEn	Sensor break or sensor not connected.	Connect or replace sensor.
AdEr	A/D converter failure.	Service required. Check for EMI or RFI interference.
AtEr	Auto Tune time-out error.	Manually tune control.
Keypad not functioning	Keypad locked. Keypad defective.	Check the 'LOCK' parameter. Service unit.
Process value unstable	Improper PID tuning.	Tune the controller.
No heat or output	Fuse blown. Incorrect wiring. Heater defective.	Check wiring and fuse. Check heater.
LEDs and display not lighting up	No power to controller. Controller failure.	Check power connection. Service meter.
Process Value changed abnormally	Electromagnetic (EMI) or Radio Frequency (RFI) interference.	Protect the controller with arc suppressing external circuitry. This will eliminate high voltage spikes. Separate the sensor and power wiring. Ground heaters
Entered data lost	EEPROM error.	EMI or RFI interference. Service required.

16. Appendix B: Heating Process Example

FIGURE 16.1 - CONTROLLING AN OVEN WITH A 96VFL



Controlling Oven Temperature

- The thermocouple **TC** input (terminals 9 and 10), control output relay (16 and 17), and alarm relay (11 and 12) are wired to the process as shown above. Note that the AC power pictured represents an external power source. The controller power wiring terminals (19 and 20) are not pictured.
- Configure the controller per the Programming Menu instructions below.
- The user adjusts the setpoint (SV) to the desired oven temperature (500°F, for example). To set the SV, use the SHIFT (<) key to select a digit and then use the up/down arrows to adjust it. Press SET when done.
- The thermocouple senses oven temperature and displays it on the front panel (PV).
- The controller output switches the heater ON/OFF, as needed, to maintain the setpoint.
- If the oven temperature reaches the alarm setpoint, the alarm relay triggers an alert.
- Note that you could wire the alarm relay in series with the control relay as an emergency shut-down configuration if desired.

Programming the Controller

- **A1Fu** (Alarm Function) Menu 4**:** Set to '2' (High Process Alarm). The Alarm relay will trip when the temperature reaches 600°F, triggering the over-temperature alert.
- **A1SP** (Alarm 1 setpoint) Menu 1: Set the alarm setpoint to 600°F.
- **Act** (Action) Menu 4: Control output action. Set to '1' for heating.
- **Units** Menu 4: Set to '1' for °F.
- **dp** (decimal point) Menu 4: Set to '0' for no decimal point.
- **Ct** (Cycle time) Menu 3: Set to longest time possible without causing process oscillations.
- **Type** (Input type) Menu 4: Set a thermocouple input type.
- **AT** (Auto Tune) Menu 1: Set to 'YES:1' to start an Auto Tune session.

17. Specifications

17.1 General Specifications

Display	Dual 7-segment 4-digit LEDs
Display range	-1999 to 9999
Indicating accuracy	± (0.2% full scale + 1 digit)
Display update rate	4 readings per second
Output status indication	Front panel Alarm (ALM) and Control (OUT) LEDs
Out-of-range indication	PV display flashes
'No input' indication	PV displays 'OPEN'
Auto Tune indication	Right-most decimal on the PV display flashes
Programming data	Stored in non-volatile memory
Materials and IP rating	Housing: ABS plastic
	Front panel: Lexan (NEMA/IEC IP55 equivalent)
Power	90 to 264VAC 50/60Hz
Power consumption	< 5 VA
Insulation Resistance	> 50 M ohms
Noise rejection	Common Mode: 120 dB; Normal Mode: 60 dB (typical)
Operating conditions	14 to 122°F (-10 to 50°C); 90% Relative Humidity max.
Storage temperature	-4 to 140°F (-20 to 60°C)
Panel cut-out dimensions	48VFL: 1.77 x 1.77" ±0.02" (45.0 x 45.0mm ±0.5mm)
	96VFL: 3.62 x 3.62" ±0.02" (92.0 x 92.0mm ±0.5mm)

17.2 Thermocouple Input Specifications

Thermocouple types	J, K, T, E, B, R, S, C, and N (user selectable)
Break-protect	Upscale and downscale
Lead wire effect	0.015% / ohm
Input impedance	> 10M ohms
Repeatability	0.83°C
Temperature stability	5uV/°C typical
Type K range	-58 to 2498°F (-50 to 1370°C)
Type J range	-58 to 1830°F (-50 to 1000°C)
Type B range	32 to 3272°F (0 to 1800°C)

Type T range	-454 to 752°F (-270 to 400°C)
Type E range	-58 to 1382°F (-50 to 750°C)
Type R range	32 to 3182°F (0 to 1750°C)
Type S range	32 to 3182°F (0 to 1750°C)
Type N range	-58 to 2372°F (-50 to 1300°C)
Type C range	-58 to 3272°F (-50 to 1800°C)

17.3 RTD Input Specifications

RTD types	Platinum (PT100) 100 ohms (DIN and JIS)
RTD ranges	(DIN) -328 ~ 1652°F (-200 ~ 850°C)
	(JIS) -328 ~ 1202°F (-200 ~ 650°C)
Break protection	Up- and down-scale
Lead wire effect	0.015° / Ohm
Repeatability	0.2°C

17.4 Analog (Linear) Input Specifications

Current Input	4 to 20mA DC (2.7 ohms input impedance)
Voltage Input	1 to 5V DC (> 10M ohms input impedance)
Display range	-1999 to 9999 digits
Repeatability	+/- 1 digit

17.5 Relay and DC Trigger Control Output Specifications

Relay output	SPST, mechanical, dry contact relay
	Rated for 5 Amps @ 110V AC or 24VDC (Resistive Loads)
DC trigger (pulse) output	24V DC (DC drive for external SSR)
	ON: 24V DC typical, 29V DC max; OFF: 0.3V DC max
Control actions	Indirect (heating) and Direct acting (cooling)
Control types	ON/OFF control with Hysteresis
	Time proportioning control (for relay/pulsed DC)
	Standard proportional output (analog output)
Automatic tuning	Determines proportional band % and integral/derivative times

Manual Tuning	Proportional Band (Pb): 0.0 to 300.0% of range
	Integral time or 'Reset' (Ti): 0 to 3600 seconds (includes anti-reset wind-up)
	Derivative time or 'Rate' (Td): 0 to 900 seconds
	Cycle Time: 1 to 100 seconds (set to '0' for 4-20mA output)
	Hysteresis: 0 ~ 2000 (0.0 ~ 200.0)
	Dead band: -1000 ~ 1000 (-100.0 ~ 100.0)

17.6 Alarm Output Specifications

Alarm relay output	SPST, dry contact relay
	Rated for 3 Amps @ 110VAC or 24VDC (Resistive Loads)
Alarm modes	Deviation and Absolute Alarms with hysteresis adjustment
	Alarm relay can also be used as a Soak or Event Timer

17.7 Analog Output Specifications

Analog output	4-20mA DC
Load limit	600 ohms max.
Programming	Set Cycle Time parameter in the PID Menu (Ct) to '0' to enable the analog output.

18. Two-year Warranty

FLIR Systems, Inc. warrants this Extech brand instrument *to be free of defects in parts and workmanship for* ***two years*** *from date of shipment (a six-month limited warranty applies to sensors and cables). To view the full warranty text please visit: http://www.extech.com/support/warranties.*

19. Calibration and Repair Services

FLIR Systems, Inc. offers calibration and repair services for the Extech brand products we sell. We offer NIST traceable calibration for most of our products. Contact us for information on calibration and repair availability, refer to the contact information below. Annual calibrations should be performed to verify meter performance and accuracy. Product specifications are subject to change without notice. Please visit our website for the most up-to-date product information: www.extech.com.

20. Customer Support

Customer Support Telephone List: https://support.flir.com/contact

Calibration, Repair, and Returns: repair@extech.com

Technical Support: https://support.flir.com

Before contacting technical support, please have the following information ready:

- Current menu settings
- Wiring diagram of the process, including the controller
- User Manual
- Controller error messages (if any)

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