Temperature

Phoenix II P21 PID Controller

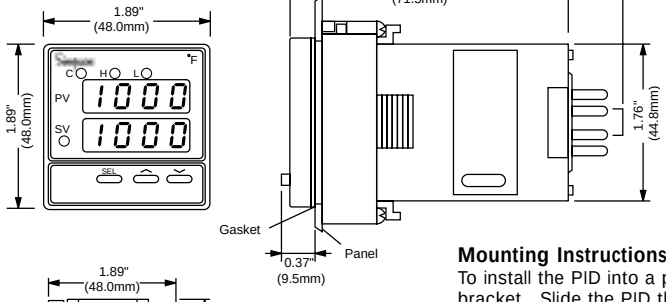
- **Fuzzy Logic With Auto-Tune to Optimize Control and Eliminate Overshoot**
- **Eight-Segment Ramp/Soak is Standard**
- **Optional Features Include:**
  2nd Control Output **High/Low Alarm**
  Heater Break Detection
- **Unwanted Parameters Can be Hidden from the Operator**
- **Screw Terminal Connectors for Easy Installation**
- **NEMA 4X-Rated Front Panel**
- **Size Variety: Choose from 1/16 DIN, 72mm, 1/8 DIN, and 1/4 DIN Sizes to Accommodate Your Space Requirements.**
- **Input Variety: Choose from 14 Thermocouple, RTD, and Process Inputs**

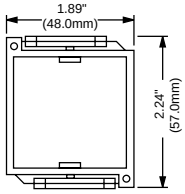
The P21 offers an array of sizes and options in a dependable temperature controller. By using fuzzy logic and PID auto-tuning, this controller virtually eliminates overshoot and ensures a process remains at set point. The four size options, 1/16 DIN, 72mm, 1/8 DIN and 1/4 DIN, assure there is a unit for your unique space requirements. Mounting brackets, screw-down termination and bezel gasket are standard for easy mounting installation and provide NEMA 4X-rated protection against dust and moisture.

The P21 is powered from 85-264 VAC or an optional 24V/DC and offers programmable 8-segment ramp/ soak function, an adjustable set point range, and a programmable decimal point as standard features. The P21 also has multiple-input capability, relay and SSR drive outputs, and many levels of security to prevent unauthorized use. These features combine to form a versatile PID controller capable of performing a variety of temperature control functions.

Installation and Panel Cutout

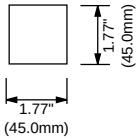
Models P21-1



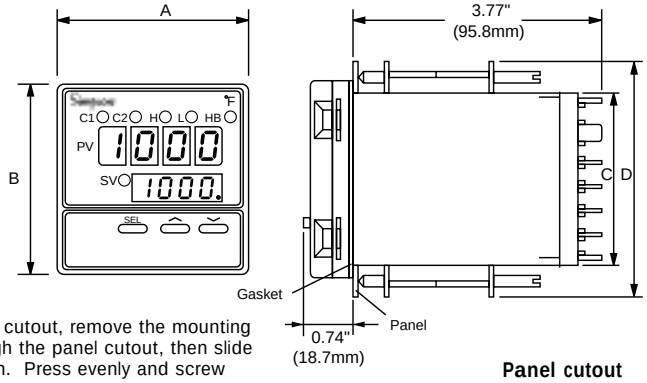


Mounting Bracket

Panel cutout



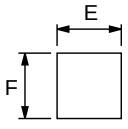
Models P21-2, P21-3, P21-4



Mounting Instructions

To install the PID into a panel cutout, remove the mounting bracket. Slide the PID through the panel cutout, then slide the mounting bracket back on. Press evenly and screw down to ensure a proper fit.

Panel cutout



Model	A	B	C	D	E	F
P21-2	2.07" 52.5mm	3.96" 100.5mm	3.56" 90.5mm	4.51" 114.5mm	1.77" 45.0mm	3.62" 92.0mm
P21-3	3.01" 76.5mm	3.01" 76.5mm	2.64" 67.0mm	3.58" 91.0mm	2.68" 68.0mm	2.68" 68.0mm
P21-4	3.96" 100.5mm	3.96" 100.5mm	3.56" 90.5mm	4.51" 114.5mm	3.62" 92.0mm	3.62" 92.0mm

Specifications

DISPLAY

Type: 4 digit, dual display, 7 Segment red and green LED

Height: .1/16 & 1/8 DIN-PV/SV .32" (8.12mm)
72mm - PV .41" (10.41mm) SV .32" (8.12mm)
1/4mm - PV .51" (12.96mm) SV .32" (8.12mm)

Decimal point: 3 position user-programmable

Overrange indication: Most significant digit = "1"

Polarity: Auto with "-" indication, "+" implied

POWER REQUIREMENTS

AC Volt: 85-264 VAC @40-440 Hz

DC Volt: 24V AC/DC

Power Consumption:
100 VAC: 10 VA or less
240 VAC: 15 VA or less

Dielectric Strength: 1500VAC for 1 min between power source terminal and input and output terminals. 500VAC for 1 min at other locations

Isolation Resistance: 50MΩ min. at 500 VDC

Rated Circuit to Ground Voltage: 750 VRMS

ACCURACY @ 25°C

0.5% FS ±1 digit
R T/C: 0-400°C ±1% FS ± 1 digit
B T/C: 0-500°C ±5% FS ± 1 digit

ENVIRONMENTAL

Operating Temperature: -10 to 50°C

Storage Temperature: -20 to 60°C

Relative Humidity: 0 to 90% non-condensing @ 40°C

Temperature Coefficient: (± 0.02% of input ± 0.2 digits) / °C

Warmup time: 30 minutes

NOISE REJECTION

NMRR: 50 dB, 50/60 Hz

CMRR: (w/1 KΩ unbalanced @ 60 Hz): 140 dB min

CONTROL FUNCTIONS

Fuzzy Control: Basic actions in PID control have been realized according to fuzzy control rules.

PID Control W / Auto-Tuning:
Proportional band (P) 0-999.9% FS (ON/OFF action when P=0)
Reset Time (I) 0-3200 sec (No integral action when I=0)
Rate time (D) 0-999.9 sec (No derivative action when D=0)

Sampling Cycle: 0.5 sec

Output Cycle: 1-150 sec

Hysteresis Width: 0-50% (ON/OFF control)

Ramping SV: 8-segment ramp/soak
(SV: 0-100% FS/Time: 0-99 hr. 59 min)
Power on start of ramping SV is possible

MECHANICAL

Weight:
P21-1: 150g
P21-2, -3: 300g
P21-4: 400g

Input Signal	Input Range (°C)	Input Range (°F)	Remarks
Thermocouple			
J	0-800	32-1472	Cold Juncation compensating function built-in
K	0-1200	32-2192	
R	0-1600	32-2912	
B	0-1800	32-3272	
S	0-1600	32-2912	
T	-199-200	328-392	
T	-150-400	-238-752	
E	-199-800	-328-1472	
N	0-1300	32-2372	
PL2	0-1300	32-2372	
RTD			
Pt100	-150-850	-238-1562	Allowable wiring resistance 10 ohms max (per wire)
DC Voltage/ Current			
1-5V	Scaling Range: -1999 to 9999 Engineering Units		For current input, use the 250Ω resistor to obtain 1-5V or 0-5V DC input
0-5V			
4-20mA			
0-20mA			

INPUT RATINGS

OUTPUT

Relay Contact Output: 220VAC/30VDC 2A (resistive load)

SSR Driver Output: On: 5VDC typ. (5.5V ±1V), 20mA max.
Off: 0.5V or less

Alarm Output / 2nd Control Output: 220VAC/30VDC 2A (resistive load)

Alarm: Configurable from the front panel keys as Absolute, Deviation, Zone, or Combination alarms with or without the hold feature.

Programming

The P21 controller programming menu consists of three blocks - SET POINT MENU, PROGRAMMING MENU, and CONFIGURATION MENU. At power up, the controller will be in the operational mode, and process variable (PV) and set point variable (SV) will be displayed. PV is the variable that is being controlled, and it is not programmable. When setting the parameters, turn off the power to the load (operating equipment) to ensure safety. Since it takes 30 minutes for the unit to stabilize in terms of temperature, all measurements should be carried out at least 30 minutes after the power is turned on. Option-related features are displayed only when the options are used.

Viewing and Setting Parameters

The data is automatically registered in 3 seconds after the setting. It can also be registered by pressing the SEL key.

How to set Set Point Value (SV)

Operation	Display
1. Power on.	Operational mode
2. Press UP or DOWN key	-SV value changes accordingly

SET POINT MENU

Operation	Display
1. Operational mode	-PV, SV
2. Press SEL key for 3 seconds	-'H' LED blinks; AH data (for units with alarm option)
3. Press UP or DOWN key	-AH data changes
4. Press SEL key to access the next parameter	-'L' LED blinks, ...
5. Press SEL key for 3 secs.	-Operational mode

PROGRAMMING MENU

Operation	Display
1. Operational mode	-PV, SV
2. Press SEL key for 7 seconds	-3 seconds later, "H" LED blinks 7 seconds later, "P"
3. Release and press SEL key again	-"P" data
4. Press UP or DOWN key	-"P" data changes accordingly
5. Press SEL key once	-"P"
6. Press DOWN key to scroll down the menu	-"i", "d", ..."Mod"
7. Press SEL key for 3 secs.	-Operational mode

CONFIGURATION PRESET MENU

Operation	Display
1. Operational mode	-PV, SV
2. Press SEL key for 9 seconds	-3 seconds later, "H" LED blinks 7 seconds later, "P" 9 seconds later, "P-n1"
3. Release and press SEL key again	-"P-n1" data
4. Press UP or DOWN key	-"P-n1" data changed
5. Press SEL KEY ONCE	-"P-N1"
6. Press DOWN key to scroll down the menu	-"P-df", ..."dsp7"
7. Press SEL key for 3 secs.	-Operational mode

Quick Reference

SET POINT MENU					
Parameter		Range	Description	Default Settings	DSP Settings
roFF-rHLd		roFF/rrUn/rHLd	Ramp/soak command	roFF	dSP1-1
H	AH	0 - 100% FS	High Alarm Set Point	10	dSP1-2
L	AL	0 - 100% FS	Low Alarm Set Point	10	dSP1-4
HB	P-An	0.0 - 50.0A	Heater break alarm set point	0.0	dSP1-8
AT	AT	0 - 2	Auto-tuning	0	dSP1-16
LoC	Loc	0 - 2	Lock-out	0	dSP1-32
PROGRAMMING MENU					
P	P	0.0 - 999.9% FS	Proportional band	5.0	dSP1-128
I	I	0 - 3200 sec	Integral time	240	dSP2-1
d	D	0.0 - 999.9 sec	Derivative time	60	dSP2-2
TC	TC	1 - 150 sec	Cycle Time (output #1)	†	dSP2-4
HYS	HYS	0 - 50% FS	Hysteresis	1	dSP2-8
TC2	TC2	1 - 150 sec	Cycle Time (output #2)	†	dSP2-16
CooL	CooL	0.0 - 100.0	Proportional band coefficient for cooling	1.0	dSP2-32
db	db	-50.0 - 50.0% FS	Deadband / Overlap	0.0	dSP2-64
bAL	bAL	0 - 100%	Balance	0.0/50.0	dSP2-128
Ar	Ar	0 - 100% FS	Anti-reset wind-up	100% FS	dSP3-1
P-n2	P-n2	0 - 16	Input type code	†	dSP3-2
P-SL	P-SL	-1999 - 9999	Lower range of input	0% FS	dSP3-4

† Based on the model

Parameter		Range	Description	Default settings	DSP settings
P-SU	P-SU	-1999 - 9999	Upper range of input	100% FS	dSP3-8
P-dP	P-dP	0 - 2	Decimal point position	0	dSP3-16
P-AH	P-AH	0 - 11	Alarm Type 1 code	5	dSP3-32
P-AL	P-AL	0 - 15	Alarm Type 2 code	9	dSP3-64
PVOF	PVOF	-10 - 10% FS	PV offset	0	dSP3-128
SVOF	SVOF	-50 - 50% FS	SV offset	0	dSP4-1
P-F	P-F	°C/°F	°C/°F selection	†	dSP4-2
STAT	STAT	--	Ramp/soak status	oFF	dSP4-4
SV-1	SV-1	0 - 100% FS	1st set point	0% FS	dSP4-8
TM1r	TM1r	0 - 99hr 59min	1st ramping time	0.00	dSP4-16
TM1S	TM1S	0 - 99hr 59min	1st soaking time	0.00	dSP4-32
SV-2	SV-2	0 - 100% FS	2nd set point	0% FS	dSP4-64
TM2r	TM2r	0 - 99hr 59min	2nd ramping time	0.00	dSP4-128
TM2S	TM2S	0 - 99hr 59min	2nd soaking time	0.00	dSP5-1
SV-3	SV-3	0 - 100% FS	3rd set point	0% FS	dSP5-2
TM3r	TM3r	0 - 99hr 59min	3rd ramping time	0.00	dSP5-4
TM3S	TM3S	0 - 99hr 59min	3rd soaking time	0.00	dSP5-8
SV-4	SV-4	0 - 100% FS	4th set point	0% FS	dSP5-16
TM4r	TM4r	0 - 99hr 59min	4th ramping time	0.00	dSP5-32
TM4S	TM4S	0 - 99hr 59min	4th soaking time	0.00	dSP5-64
MOD	MOD	0 - 15	Ramp/soak Mode code	0	dSP5-128

† Based on the model

CONFIGURATION MENU					
Parameter		Range	Description	Default Settings	DSP Settings
P-n1	P-n1	0 -19	Control Action code	†	dSP6-2
P-dF	P-dF	0.0 - 900.0 sec	Input Filter Constant	5.0	dSP6-4
P-An	P-An	0 - 50% FS	Alarm Hysteresis	†	dSP6-8
rCJ	rCJ	-	N/A	ON	dSP-6-16
PLC1	PLC1	-	N/A	-3.0	dSP6-32
PHC1	PHC1	-	N/A	103.0	dSP6-64
PLC2	PLC2	-	N/A	-3.0	dSP6-128
PHC2	PHC2	-	N/A	103.0	dSP7-1
PCUT	PCUT	-	N/A	0	dSP7-2
FUZY	FUZY	OFF/ON	Fuzzy control	OFF	dSP7-4
GAIN	GAIN	-	N/A	1	dSP7-8
AdJ0	ADJ0	-	Zero calibration	0	dSP7-16
AdJS	ADJS	-	Span calibration	0	dSP7-32
oUT	OUT	-	N/A	-3.0	dSP7-64
dSP1 dSP7	dSP1 - 7	0-255	Parameter mask	†	-

† Based on the model

Wiring Diagram

Terminal connection

Warning

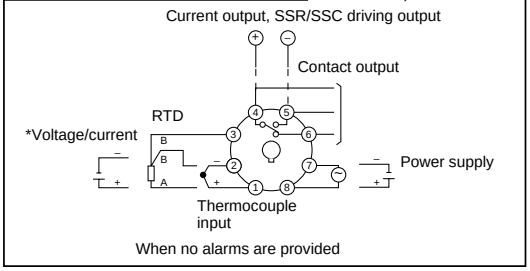
Be sure to use the rated power supply voltage and polarity.

*For current input, install the 250Ω precision resistor (accessory) before using the unit.

Wiring material

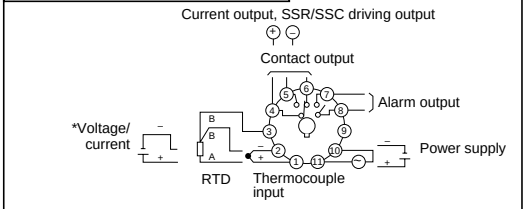
1. For terminals 1, 2, 3, use 18-36 gauge wire.
2. For terminals 4-9, use 14-24 gauge wire.

P21 socket type (standard) (viewing from the back of instrument)



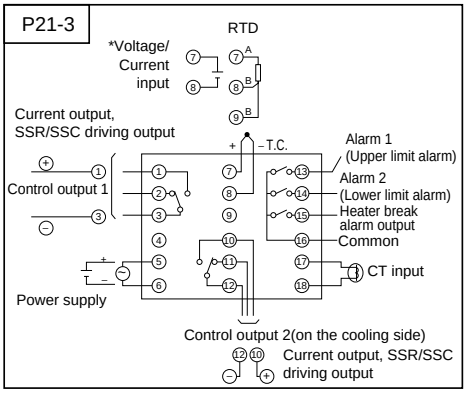
When no alarms are provided

P21 socket type (with alarm) (viewing from the back of instrument)

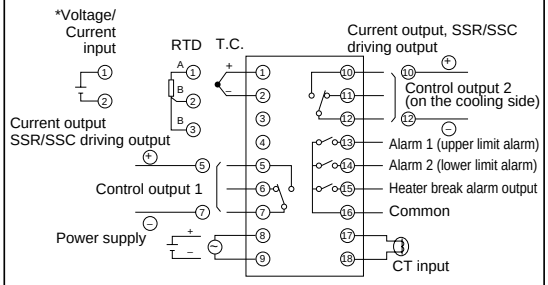


When alarms are provided

P21-3

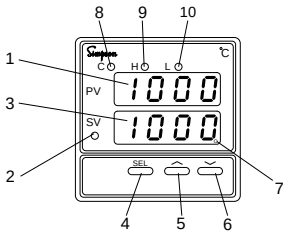


P21-2,4

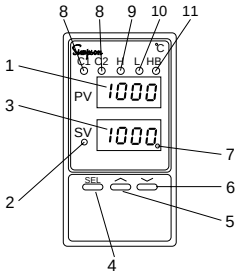


P21 Display

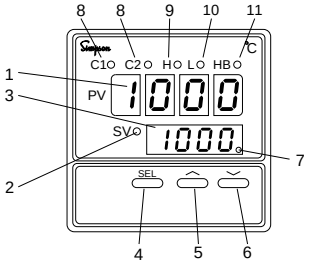
	NAME	FUNCTION
1	Process value (PV)	Displays the process value.
2	Set value (SV) indication lamp	Stays on while a set value is on the display.
3	Set value (SV)/ parameter display	Displays set value (SV), or parameter symbol or code when setting various parameters.
4	Select key	To be used when the first, second, or third block parameters are selected.
5	UP key	Pressing the key once will increase the value by one. By pressing it in succession, the value is continuously incremented.
6	DOWN key	Pressing the key once will decrease the value by one. By pressing it in succession, the value is continuously decremented.
7	Autotuning indication lamp	Blinks while the PID auto-tuning is being performed.
8	Control output indication lamp	Comes on when the control output is ON.
9	Upper limit alarm indication lamp	Comes on when the upper limit alarm is activated. Blinks while the alarm value is being set.
10	Lower limit alarm indication lamp (optional)	Comes on when the lower limit alarm is activated. Blinks while the alarm value is being set.
11	Heater Break Alarm indication lamp	Comes on when the heater break alarm is output.



Model : P21-1



Model : P21-2



Model : P21-3/-4

Auto Tuning

By Auto Tuning, the controller selects what it calculates to be the optimum PID and balance parameters for a particular process and stores them in memory for future use. The controller will not need to be re-auto tuned upon each power up, as long as the system requirements and characteristics remain the same. The auto-tune parameters selected are good only for the process for which it has been auto tuned. If the set point, input device, output device (load), or any portion of your system changes, auto tune must be initiated again.

These factors can upset the auto tuning function:

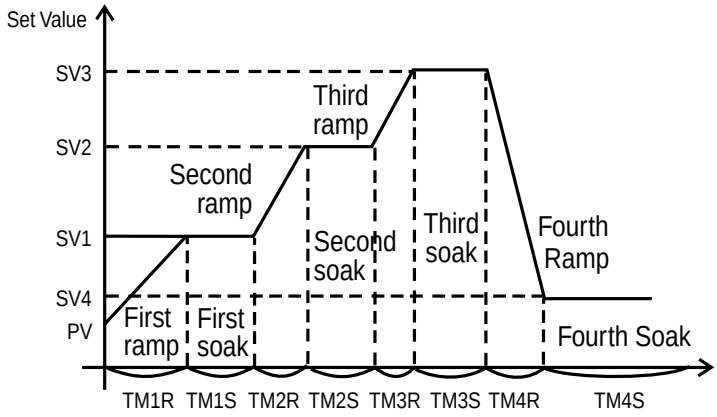
1. The system is affected by process disturbances external to the control loop. Adjacent heater zones, changing material levels, and exothermic reactions are examples of process disturbances which are external to the control loop.

2. The system is dynamic. The process variable changes quickly. Certain pressure and flow applications would be characterized as very dynamic. Because of how the auto tune function is performed, a dynamic system, when auto tuning, would create considerable overshoot that could jeopardize the process.

3. The system is insulated and cannot cool down in a timely manner. The system retains heat. With such heating systems, the auto tuning function would take a long time to complete and with questionable results.

Ramp / Soak

The Ramp / Soak program automatically changes the set point value with time in accordance with a preset pattern, as shown in the figure. This device allows a maximum of four ramp and four soak segments. Ramp is the region in which SV changes toward the target value. Soak is the region in which the target value is maintained.



Ramp: Region in which the set point changes toward the target value.
Soak: Region in which the set point stays unchanged at the target value.

Note 1: SV cannot be changed while the operation is running or suspended.
Note 2:: The use of fuzzy control is inhibited while Ramp/Soak operation is being performed.

Heater Break Detection

The Heater Break option is used to detect heater break conditions and to energize an alarm relay when such conditions exist. In most cases, the options is used to detect the failure of one or more zones in a multi-zoned heater where all individual resistive heater zones are wired in parallel. Failed heater zones would create cold spots in a system which could hamper the process and even ruin the product. If cold spots in a system are a problem, the Heater Break option is an effective way of alerting the operator of a heater break condition, a cause of cold spots.

The P21 controller is able to detect a heater problem by analyzing the current used by the heater. The actual sensing is done by a current sensing transformer,, which is placed around the hot lead going to the heater and connected to the controller. The signal sent by the current transformer is timed with the output of the P21. When the output is energized, the signal sent from the current transformer is analyzed. When the output is de-energized, the signal sent from the current transformer is not analyzed. This eliminates the alarm condition turning on and off due to the output condition of the controller. If the signal sent when the output is energized indicates that the current level is below what the Heater Break alarm is set for, the alarm is energized. The alarm is non-latching.

Notes:

The Heater Break option cannot be used on the P21 controller with a 4-21mA DC output. The current transformer would pick up current changes due to fluctuation power output, between 0% and 100%, which would result in a heater break alarm condition even though no such condition existed.

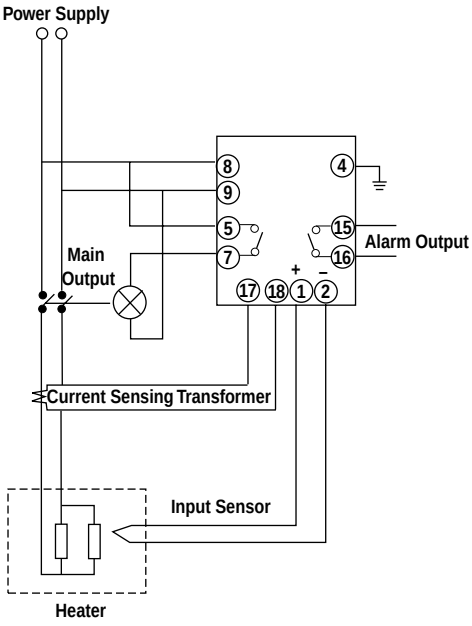
The Cycle Time must be set at 6 seconds or higher in order for the controller to correctly analyze the signal sent by the current sensing transformer.

Heater Break Detection (Cont'd)

Wiring and Setting:

1. Thread the hot lead going to the heater through the donut of the current sensing transformer. Connect the wires of the current transformer to the current transformer input terminals in the back of the controller.

2. Set Heater Break alarm set point parameter, "Hb." With the current transformer connected and the heater in operation (output energized), change the Heater Break Alarm setting from the maximum current setting for the particular current transformer being used to a lower value. Allow 3 seconds or more between setting changes. Continue lowering the setting until the relay is energized and the "Hb" status indicator is lit. This is the maximum current usage of the heater. Using the same procedure, find the maximum current usage of the heater minus one zone. Set the set point in between the two current readings. In this way, the operator knows if one or more zones fail because the current sensed will only be below the Heater Break Alarm setting if one or more zones fail.



Ordering Information

Your Phoenix II PID Controller can be configured by making an entry for each box.

Model P21

P21 — [ ] — [ ] — [ ] — [ ] — [ ] — [ ]

Unit Size		Power Supply		Input Signal		Control Output 1		Control Output 2		Alarm Options	
1/16 DIN	1	85-265 VAC	0	Thermocouple/RTD	1	Relay	1	None	0	None	0
1/8 DIN	2	24V AC/DC	1	Current/Voltage	2	SSR	2	Relay	1	HBD w/0-30A CT**	1
72mm	3					4-20mA	3	SSR*	2	HBD w/20-50A CT**	2
1/4 DIN	4							4-20mA*	3	High/Low Alarm & HBD w/0-30A CT**	3
										High/Low Alm & HBD w/20-50A CT**	4
										High/Low Alarm†	5

*Not available on 1/16 DIN unit, P21-1.
** Not available on 1/16 DIN unit, P21-1, or with 4-20mA Control Output 2.
† Not available on 1/16 DIN unit, P21-1, with Control Output 2.

Safety Symbols

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which if not correctly performed or adhered to, could result in personal injury.

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which if not correctly adhered to could result in damage to or destruction of part or all of the instrument.

Accessories

Accessories for the Phoenix II P21 PID Controller can be found on page D22.