INDUSTRIAL HEATING CATALOG

ATHENA®

LEGENDARY QUALITY
PERFORMANCE & VALUE

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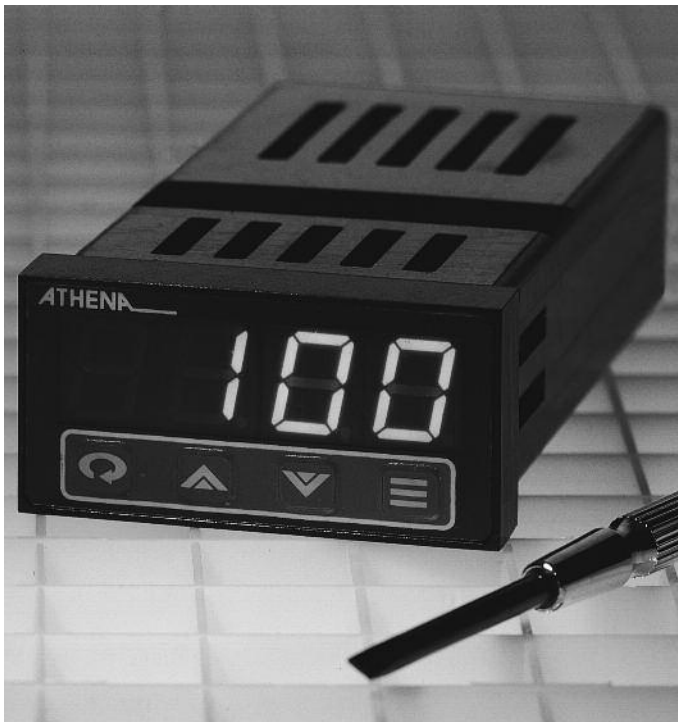
How to Order Information

To request a quote or more information on Athena products in this catalog, please go to **www.athenacontrols.com**, click on the **Sales Office Locator** link on the left side of the Home Page under the **Contact Us** tab and take the following steps:

1. Please click on your region of the world map to find the authorized Athena sales representative or distributor in your area
2. Please enter your zip code in the box and press the "Find Reps/Distributors" button to find your local representative or distributor
3. Please use the phone, fax or e-mail link found on your local representative or distributors page to request a quote or get more information on any of the products in this catalog

To contact us directly, please call **800-782-6776** (in the USA) or **610-828-2490** or e-mail us at **sales@athenacontrols.com**.

C-Series 32C Universal Temperature/Process Controller



The Athena 32C is a 1/32 DIN panel mounted, auto-tuning controller that can be used for precise control of a single loop with two independent outputs field-configurable as direct acting, reverse acting or alarm. An LED display provides visual indication of various controller functions.

- Field-Configurable Universal Inputs
- Bumpless Auto/Manual Transfer
- NEMA 4X (IP65) Dust and Splash-Proof Front Panel
- Decimal Display in 0.1° for Measured Temperatures Under 1000°F or °C
- On/Off through Full PID Operation (P, PI, PD, PID)
- Adjustable Hysteresis and Deadband
- Outputs Configurable as Alarms
- Field-Configurable Process and Deviation Alarms (Latching or Non-Latching)
- Dual Output/Dual Alarm Capabilities
- UL, cUL and CE Approvals
- Special and Custom Options Available

Range Information

Input	Range	Input	Range
"J"	-148°F to 1400°F (-100°C to 760°C)	100 ohm RTD	-328°F to 1562°F (-200°C to 850°C)
"K"	-220°F to 2462°F (-140°C to 1350°C)	100 ohm RTD (Decimal)	-199°F to 392°F (-128°C to 200°C)
"T"	-202°F to 752°F (-130°C to 400°C)		
Millivolt Linear (Scaleable)	0 to 50mV/10 to 50mV	Current Linear (Scaleable)	4 to 20mA, 0 to 20mA

Ordering Information

3 2 C – [ ] – [ ] – [ ] – [ ][ ]

Input Calibration
Code
T = Thermocouple
R = RTD
M = Millivolt Linear
C = Current Linear

Output 1 (Heating/Cooling)
(See Note)
Code
0 = None
B = Relay, N.O.
S = Pulsed 20Vdc or 17mA
T = Solid-State Relay

Output 2 (Heating/Cooling)
(See Note)
Code
0 = None
S = Pulsed 20Vdc or 17mA
T = Solid-State Relay

Special Options
00 = None
Consult Factory

Note: Both Outputs MUST be Field Configured to be either Direct Acting or Reverse Acting

Technical Specifications

Operating Limits

Ambient Temperature	32°F to 140°F (0°C to 60°C)
Relative Humidity Tolerance	90% R.H. maximum, non-condensing
Line Voltage Power	85 to 265 Vac, 50/60 Hz 120 to 375 Vdc, (auto polarity)
Power Consumption	Less than 6 VA (instrument)

Performance

Accuracy	± 0.2% of full scale, ±1 digit
Setpoint Resolution	1.0 count/0.1 count
Repeatability	±1.0 count
Temperature Stability	5 µV/°C (maximum)
TC Cold-End Tracking	0.05°C/°C ambient
Noise Rejection	100 dB common mode 70 dB series mode
Process Sampling	3.5 Hz (270 ms)

Control Characteristics

Setpoint Limits	Span of sensor
Alarms	Adjustable for high/low; selectable process or deviation
Proportional Band	1 to span of sensor
Integral	0 to 9600 sec
Derivative	0 to 2400 sec
Cycle Time	0.3 to 120 sec
Control Hysteresis	1 to span of sensor
Deadband	Range of sensor
Manual Control	Operator initiated
Auto-Tune	Operator initiated

Inputs

Thermocouple	J, K, T Maximum lead resistance, 100 ohms for rated accuracy
RTD	Platinum 2-wire, 100 ohms at 0°C, DIN curve standard (0.00385)
Linear	0-50mV/10-50mV 4-20mA/0 to 20mA
Decimal Position	Selectable: none, 1/10, 1/100

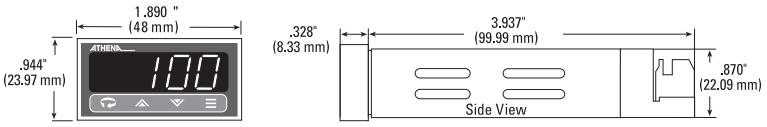
Outputs

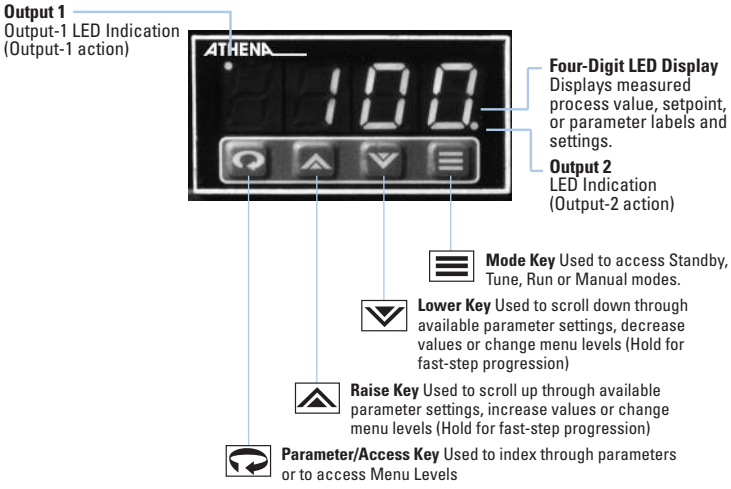
B	5 A/3 A (120/240Vac) normally open
S	20Vdc pulsed or 17mA
T	1 A , Solid-state relay

Mechanical Characteristics

Display	4-digit 0.39˝(10 mm) LED display
Front Panel Rating	NEMA 4X (IP65)
Connections	Screw Terminals
Numeric Range	-1999 to 9999
Front Panel Cutout	0.874˝x 1.771˝(22.19 mm x 45 mm)

Specifications subject to change without notice.





C-Series 16C Universal Temperature/Process Controller

The Athena 16C is a 1/16 DIN panel mounted, auto-tuning controller that can be used for precise control of a single loop with two independent outputs field-configurable as direct acting, reverse acting or alarm. RS-232 or RS-485 communications interfaces are available, and two digital LED displays provide visual indication of various controller functions.

- Field-Configurable Universal Inputs
- User-Selectable Ramp to Setpoint
- 8-Level Ramp/Soak Control
- Bumpless Auto/Manual Transfer
- NEMA 4X (IP65) Dust and Splash-Proof Front Panel
- Decimal Display in 0.1° for Measured Temperatures Under 1000° F or C
- On/Off Through Full PID Operation (P, PI, PD, PID)
- Adjustable Hysteresis and Deadband
- Outputs Configurable as Alarms
- Field-Configurable Process or Deviation Alarms; Latching or Non-Latching; Band and Inverse Band
- Dual Output/Dual Alarm Capabilities
- UL, cUL, and CE Approvals
- Options Include Multi-Function Contact/Digital Input, Transducer Excitation, and Auxiliary Output
- Special and Custom Options Available
- DIN Rail Option

Range Information

Input	Range	Input	Range
"B"	32°F to 3308°F (0°C to 1820°C)	"R"	-58°F to 3214°F (-50°C to 1768°C)
"C"	32°F to 4199°F (0°C to 2315°C)	"S"	-58°F to 3214°F (-50°C to 1768°C)
"E"	-238°F to 1832°F (-150°C to 1000°C)	"T"	-454°F to 752°F (-270°C to 400°C)
"J"	-328°F to 1400°F (-200°C to 760°C)	Platinel® II	-148°F to 2250°F (-100°C to 1232°C)
"K"	-454°F to 2462°F (-270°C to 1354°C)	100 ohm RTD	-328°F to 1562°F (-200°C to 850°C)
"N"	-450°F to 2372°F (-268°C to 1300°C)	100 ohm RTD (Decimal)	-328.0°F to 707.0°F (-200.0°C to 375.0°C)
"NNM"	32°F to 2570°F (0°C to 1410°C)	Current Linear (Scaleable)	4 to 20mA, 0 to 20mA
Millivolt Linear (Scaleable)	0 to 50mV/10 to 50mV 0 to 10mV/0 to 50mV 0 to 100mV	Volt Linear (Scaleable)	0 to 1V/0 to 5V 0 to 10V 0 to 5V

Ordering Information

16C – □ – □ – □ – □□ – □□

Input Calibration

Code		
T	=	Thermocouple
R	=	RTD
S	=	Decimal RTD
B	=	TC and RTD
M	=	Millivolt Linear
V	=	Volt Linear
C	=	Current Linear
A	=	All

Output 1

Code		
0	=	None
B	=	Relay, N.O.
E	=	0 to 20 mA
F	=	4 to 20 mA (500 ohm max)
G	=	4 to 20 mA (800 ohm max)
P	=	Pulsed 20 Vdc or 35 mA
S	=	Pulsed 20 Vdc or 17 mA
T	=	Solid-State Relay
V	=	0 to 5 Vdc
X	=	0 to 10 Vdc
Y	=	Relay, N.C.

Output 2

Code		
0	=	None
B	=	Relay, N.O.
E	=	0 to 20 mA
F	=	4 to 20 mA (500 ohm max)
G	=	4 to 20 mA (800 ohm max)
P	=	Pulsed 20 Vdc or 35 mA
S	=	Pulsed 20 Vdc or 17 mA
T	=	Solid-State Relay
V	=	0 to 5 Vdc
X	=	0 to 10 Vdc
Y	=	Relay, N.C.

Standard Options

Code		Options
00	=	None
Alarms		
10	=	Dual SSR, N.O.
20	=	Dual Open Collector
21	=	Dual 24 Vdc
22	=	Dual SSR, N.C.
23	=	Relay, N.O.
Communications		
30	=	RS-232 (Athena+ Protocol)
Communication, RS-485 Athena+ Protocol w/Contact/Digital Input		
31	=	RS-485, No Switch
36	=	Switch Closed
37	=	Switch Open
38	=	5 V Input

Code		Options
Digital Input w/Alarm		
40	=	Switch Closed
41	=	Switch Open
42	=	5 V Input
Communication RS-485 Modbus® Protocol w/Contact/Digital Input		
45	=	RS-485, No Switch
46	=	Switch Closed
47	=	Switch Open
48	=	5 V Input
Transducer Excitation		
50	=	10 Vdc
51	=	12 Vdc
52	=	15 Vdc
53	=	5 Vdc
Aux Output/PV Retransmit		
60	=	4 to 20 mA
61	=	1 to 5 V
62	=	0 to 20 mA
63	=	0 to 5 V

Special Options
00 = None
Consult Factory

Technical Specifications

Operating Limits

Ambient Temperature	32°F to 131°F (0°C to 55°C)
Relative Humidity Tolerance	90%, non-condensing
Power	100-250 Vac 125 to 300 Vdc 24 Vac/dc optional
Power Consumption	Less than 6 VA (instrument)

Performance

Accuracy	±0.20% of full scale (±0.10% typical), ±1 digit
Setpoint Resolution	1.0 count / 0.1 count
Repeatability	±1.0 count
Temperature Stability	5 µV/°C (maximum)
TC Cold-End Tracking	0.05°C/°C ambient
Noise Rejection	100 dB common mode 70 dB series mode
Process Sampling	10 Hz (100 ms)
Digital Filtering	Adjustable 0.1 to 10 sec

Control Characteristics

Setpoint Limits	Span of Sensor
Alarms	Adjustable for high/low; selectable for process or deviation
Proportional Band	2 to span of sensor
Integral	0 to 9600 sec
Derivative	0 to 2400 sec
Cycle Time	0.2 to 120 sec
Control Hysteresis	1 to span of sensor
Dead Band (Output 1 & 2)	Range of Sensor
Ramp to Setpoint	1 to 9999 min
Auto-Tune	Operator initiated from front panel
Manual Control	Operator initiated from front panel

Inputs

Thermocouple	B, C, E, J, K, N, NNM, R, S, T, Platinel II Maximum lead resistance 100 ohms for rated accuracy
RTD	Platinum 2- and 3-wire, 100 ohms at 0°C, (DIN curve standard 0.00385)
Linear	0-50 mV/10-50 mV, 0-20 mA/4-20 mA, 0-10 mV/0-50 mV, 0-100 mV, 0-1 V/0-5 V, 0-10 V, 1-5 V

Outputs

B	5 A/3 A (120/240 Vac), normally open
E	0-20 mA
F	4-20 mA, full output to load 500 ohm impedance, max.
G	4-20 mA, full output to load 800 ohm impedance, max.

Outputs

P	20 Vdc or 35 mA
S	20 Vdc or 17 mA
T	1 A, Solid-state relay
V	0 to 5 Vdc
X	0 to 10 Vdc
Y	5 A/3 A (120/240 Vac), normal closed relay

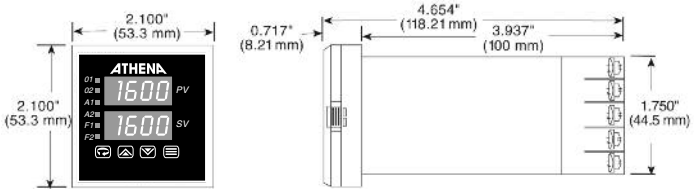
Alarm Type

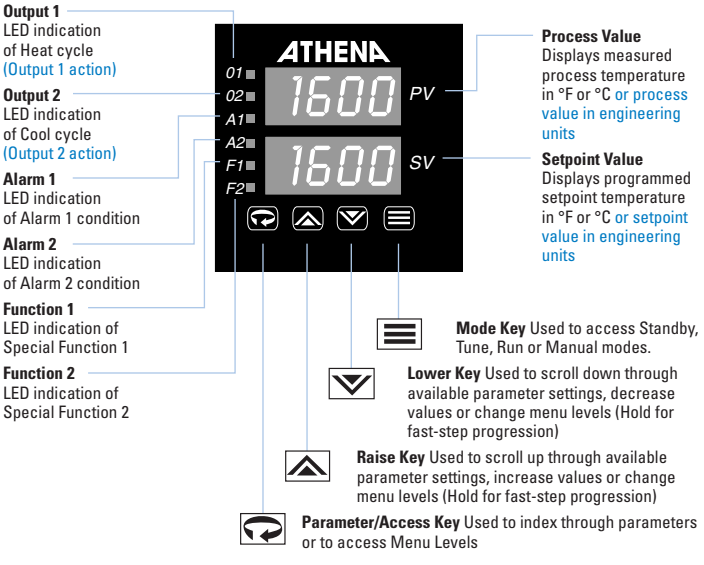
10	Dual SSR: Alarm 1: 24-240 Vac, 1 A Alarm 2: 24 Vac Only
20	Dual Open collector, 24 V, 20 milliamps
21	Dual 24 V, 20 mA
22	Dual SSR: Alarm 1: NC, 24-240 Vac, 1 A Alarm 2: 24 Vac Only
23	5 A/3 A (120/240 Vac), mechanical relay

Mechanical Characteristics

Display	Dual, 4-digit 0.36˝(9.2 mm) LED display Process Value: Orange Setpoint Value: Green
Numeric Range	-1999 to 9999
Front-Panel Rating	NEMA 4X (IP65)
Front-Panel Cutout	1.771˝x 1.771˝(45 mm x 45 mm)
Connections	Screw Terminals

Specifications subject to change without notice.





C-Series 18C and 19C Universal Temperature/Process Controllers

- Field-Configurable Universal Inputs
- User-Selectable Ramp to Setpoint
- 8-Level Ramp/Soak Control
- Bumpless Auto/Manual Transfer
- NEMA 4X (IP65) Dust and Splash-Proof Front Panel
- Decimal Display in 0.1° for Measured Temperatures Under 1000° F or C
- On/Off through Full PID Operation (P, PI, PD, PID)
- Adjustable Hysteresis and Deadband
- Outputs Configurable as Alarms
- Field-Configurable Process or Deviation Alarms; Latching or Non-Latching; Band and Inverse Band
- Dual Output/Dual Alarm Capabilities
- UL, cUL, and CE Approvals
- Options Include Remote Analog Setpoint, Multi-Function Contact/Digital Input, Transducer Excitation, and Auxiliary Output
- Special and Custom Options Available

The Athena 18C and 19C are available as 1/8 DIN (18C) vertical or 1/8 DIN (19C) horizontal models. Both panel mounted, auto-tuning controllers can be used for precise control of a single loop with two independent outputs field-configurable as direct acting, reverse acting, and 2 alarms. RS-232 or RS-485 communications interfaces are available for both models, and two digital LED displays provide visual indication of various controller functions.

Range Information

Input	Range	Input	Range
"B"	32°F to 3308°F (0°C to 1820°C)	"R"	-58°F to 3214°F (-50°C to 1768°C)
"C"	32°F to 4199°F (0°C to 2315°C)	"S"	-58°F to 3214°F (-50°C to 1768°C)
"E"	-238°F to 1832°F (-150°C to 1000°C)	"T"	-454°F to 752°F (-270°C to 400°C)
"J"	-328°F to 1400°F (-200°C to 760°C)	Platinel® II	-148°F to 2250°F (-100°C to 1232°C)
"K"	-454°F to 2462°F (-270°C to 1354°C)	100 ohm RTD	-328°F to 1562°F (-200°C to 850°C)
"N"	-450°F to 2372°F (-268°C to 1300°C)	100 ohm RTD (Decimal)	-328.0°F to 707.0°F (-200.0°C to 375.0°C)
"NNM"	32°F to 2570°F (0°C to 1410°C)	Current Linear (Scaleable)	4 to 20mA, 0 to 20mA
Millivolt Linear (Scaleable)	0 to 50mV/10 to 50mV 0 to 10mV/0 to 50mV 0 to 100mV	Volt Linear (Scaleable)	0 to 1V/0 to 5V 0 to 10V 0 to 5V

Ordering Information

18C
19C

Input Calibration Code
T = Thermocouple
R = RTD
S = Decimal RTD
B = TC and RTD
M = Millivolt Linear
V = Volt Linear
C = Current Linear
A = All

Output 1 Code
0 = None
B = Relay, N.O.
C = Relay, N.O. w/o snubber
D = 0 to 7 mA
E = 0 to 20 mA
F = 4 to 20 mA (500 ohm max)
G = 4 to 20 mA (800 ohm max)
P = Pulsed 20 Vdc or 35 mA
S = Pulsed 20 Vdc or 17 mA
T = Solid-State Relay
V = 0 to 5 Vdc
X = 0 to 10 Vdc
Y = Relay, N.C.

Output 2 Code
0 = None
B = Relay, N.O.
C = Relay, N.O. w/o snubber
D = 0 to 7 mA
E = 0 to 20 mA
F = 4 to 20 mA (500 ohm max)
G = 4 to 20 mA (800 ohm max)
P = Pulsed 20 Vdc or 35 mA
S = Pulsed 20 Vdc or 17 mA
T = Solid-State Relay
V = 0 to 5 Vdc
X = 0 to 10 Vdc
Y = Relay, N.C.

Alarm 1 Code
0 = None
B = Relay, N.O.
S = 24 V
T = Solid-State Relay

Alarm 2 Code
0 = None
B = Relay, N.O.
S = 24 V
T = Solid-State Relay

Communications Code
0 = None
A = RS-232 Athena +
B = RS-485 Athena +
E = RS-485 Modbus

Option 1 Code

Aux Output/PV Retransmit	
PA	= 4 to 20 mA
PB	= 1 to 5 V
PC	= 0 to 20 mA
PD	= 0 to 5 V
Remote Analog Setpoint	
SA	= 0 to 5 Vdc w/ switch
SB	= 1 to 5 Vdc w/ switch
SC	= 0 to 20 mA w/ switch
SD	= 4 to 20 mA w/ switch
SE	= Switch only
SF	= 1 to 10 Vdc w/ switch

Option 2 Code

0	= None
Transducer Excitation	
1	= 10 Vdc
2	= 12 Vdc
3	= 15 Vdc
4	= 5 Vdc

Special Options
00 = None
Consult Factory

Technical Specifications

Operating Limits

Ambient Temperature	32°F to 131°F (0°C to 55°C)
Relative Humidity Tolerance	90%, non-condensing
Line Voltage	100 to 250 Vac 125 to 300 Vdc 24 Vac/dc optional
Power Consumption	Less than 6 VA (instrument)

Performance

Accuracy	±0.20% of full scale (±0.10% typical), ±1 digit
Setpoint Resolution	1 count / 0.1 count
Repeatability	±1 count
Temperature Stability	5 µV/°C (maximum)
TC Cold-End Tracking	0.05°C/°C ambient
Noise Rejection	100 dB common mode 70 dB series mode
Process Sampling	10 Hz (100 ms)
Digital Filtering	Adjustable 0.1 to 10

Control Characteristics

Setpoint Limits	Span of Sensor
Alarms	Adjustable for high/low; selectable process or deviation
Proportional Band	2 to span of sensor
Integral	0 to 9600 sec
Derivative	0 to 2400 sec
Cycle Time	0.2 to 120 sec
Control Hysteresis	1 to span of sensor
Dead Band (Output 1 & 2)	Range of sensor
Ramp to Setpoint	1 to 9999 min
Auto-Tune	Operator initiated from front panel
Manual Control	Operator initiated from front panel

Inputs

Thermocouple	B, C, E, J, K, N, NNM, R, S, T, Platinel II Maximum lead resistance, 100 ohms for rated accuracy
RTD	Platinum 2- and 3-wire, 100 ohms at 0°C, (DIN curve standard 0.00385)
Linear	0-50 mV/10-50 mV, 0-20 mA/4-20 mA, 0-10 mV/0-50 mV, 0-100 mV, 0-1 V/0-5 V, 0-10 V, 1-5 V

Outputs

B	5 A/3 A (120/240 Vac) normally open
C	5 A/3 A (120/240 Vac) normally open w/o snubber
D	0 - 7 mA
E	0-20 mA
F	4-20 mA, full output to load 500 ohm impedance max
G	4-20 mA, full output to load 800 ohm impedance max
P	20 Vdc or 35 mA
S	20 Vdc or 17 mA
T	1 A, Solid-state relay

Outputs

V	0 to 5 Vdc
X	0 to 10 Vdc
Y	1 A, normally closed relay

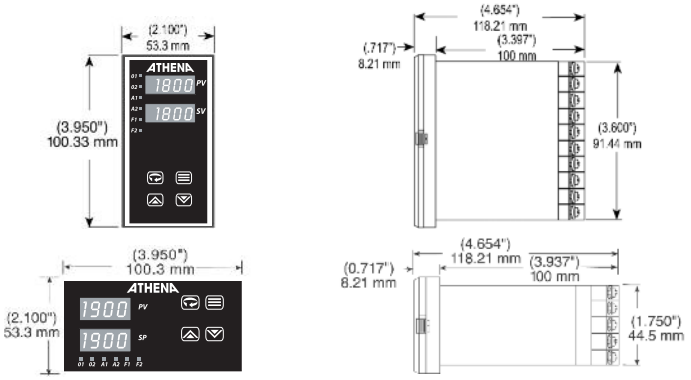
Alarm Outputs

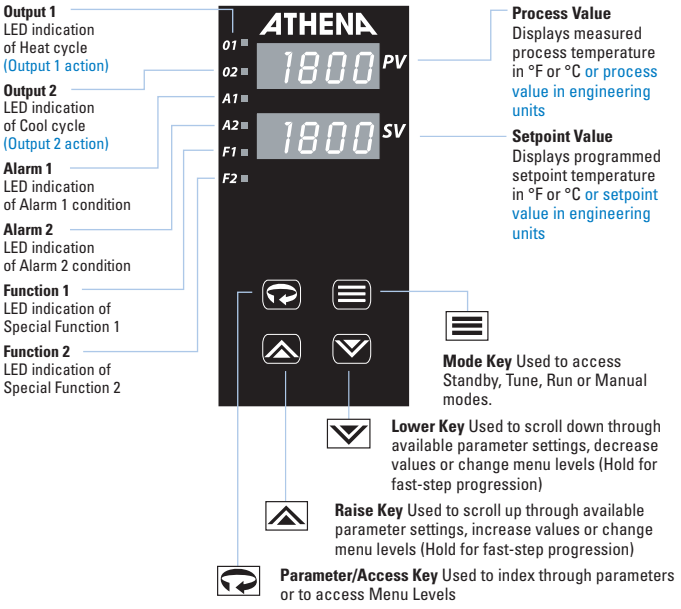
B	5 A/3 A (120/240 Vac), mechanical relay
S	24 V, 20 mA
T	SSR, NC, 24-240 Vac

Mechanical Characteristics

Display	Dual, 4-digit 0.36˝ (9.2 mm) LED display Process Value: Orange Setpoint Value: Green
Numeric Range	-1999 to 9999
Front Panel Rating	NEMA 4X (IP65)
Front Panel Cutout	3.622˝ x 1.771˝ (92 mm x 45 mm)
Connections	Screw terminals

Specifications subject to change without notice.





C-Series 25C Universal Temperature/Process Controller

The Athena 25C is a 1/4 DIN panel mounted, auto-tuning controller that can be used for precise control of a single loop with two independent outputs field-configurable as direct acting, reverse acting, and 2 alarms. RS-232 or RS-485 communications interfaces are available, and two digital LED displays provide visual indication of various controller functions.

- Field-Configurable Universal Inputs
- User-Selectable Ramp to Setpoint
- 8-Level Ramp/Soak Control
- Bumpless Auto/Manual Transfer
- NEMA 4X (IP65) Dust and Splash-Proof Front Panel
- Decimal Display in 0.1° for Measured Temperatures Under 1000° F or C
- On/Off through Full PID Operation (P, PI, PD, PID)
- Adjustable Hysteresis and Deadband
- Outputs Configurable as Alarms
- Field-Configurable Process or Deviation Alarms; Latching or Non-Latching; Band and Inverse Band
- Dual Output/Dual Alarm Capabilities
- UL, cUL, and CE Approvals
- Options Include Remote Analog Setpoint, Multi-Function Contact/Digital Input, Transducer Excitation, and Auxiliary Output
- Special and Custom Options Available

Range Information

Input	Range	Input	Range
"B"	32°F to 3308°F (0°C to 1820°C)	"R"	-58°F to 3214°F (-50°C to 1768°C)
"C"	32°F to 4199°F (0°C to 2315°C)	"S"	-58°F to 3214°F (-50°C to 1768°C)
"E"	-238°F to 1832°F (-150°C to 1000°C)	"T"	-454°F to 752°F (-270°C to 400°C)
"J"	-328°F to 1400°F (-200°C to 760°C)	Platinel® II	-148°F to 2250°F (-100°C to 1232°C)
"K"	-454°F to 2462°F (-270°C to 1354°C)	100 ohm RTD	-328°F to 1562°F (-200°C to 850°C)
"N"	-450°F to 2372°F (-268°C to 1300°C)	100 ohm RTD (Decimal)	-328.0°F to 707.0°F (-200.0°C to 375.0°C)
"NNM"	32°F to 2570°F (0°C to 1410°C)	Current Linear (Scaleable)	4 to 20mA, 0 to 20mA
Millivolt Linear (Scaleable)	0 to 50mV/10 to 50mV 0 to 10mV/0 to 50mV 0 to 100mV	Volt Linear (Scaleable)	0 to 1V/0 to 5V 0 to 10V 0 to 5V

Ordering Information

2 5 C — □ — □ — □ — □ — □ — □ — □ — □□ — □ — □□

Input Calibration Code
T = Thermocouple
R = RTD
S = Decimal RTD
B = TC and RTD
M = Millivolt Linear
V = Volt Linear
C = Current Linear
A = All

Output 1 Code
0 = None
B = Relay, N.O.
E = 0 to 20 mA
F = 4 to 20 mA (500 ohm max)
G = 4 to 20 mA (800 ohm max)
P = Pulsed 20 Vdc or 35 mA
S = Pulsed 20 Vdc or 17 mA
T = Solid-State Relay
V = 0 to 5 Vdc
X = 0 to 10 Vdc
Y = Relay, N.C.

Output 2 Code
0 = None
B = Relay, N.O.
E = 0 to 20 mA
F = 4 to 20 mA (500 ohm max)
G = 4 to 20 mA (800 ohm max)
P = Pulsed 20 Vdc or 35 mA
S = Pulsed 20 Vdc or 17 mA
T = Solid-State Relay
V = 0 to 5 Vdc
X = 0 to 10 Vdc
Y = Relay, N.C.

Alarm 1 Code
0 = None
B = Relay, N.O.
S = 24 V
T = Solid-State Relay

Alarm 2 Code
0 = None
B = Relay, N.O.
S = 24 V
T = Solid-State Relay

Communications Code
0 = None
A = RS-232 Athena +
B = RS-485 Athena +
E = RS-485 Modbus

Option 1 Code
Aux Output/PV Retransmit
PA = 4 to 20 mA
PB = 1 to 5 V
PC = 0 to 20 mA
PD = 0 to 5 V
Remote Analog Setpoint
SA = 0 to 5 Vdc w/ switch
SB = 1 to 5 Vdc w/ switch
SC = 0 to 20 mA w/ switch
SD = 4 to 20 mA w/ switch
SE = Switch only
SF = 0 to 10 Vdc w/ switch

Option 2 Code
0 = None
Transducer Excitation
1 = 10 Vdc
2 = 12 Vdc
3 = 15 Vdc
4 = 5 Vdc

Special Options
00 = None
Consult Factory

Technical Specifications

Operating Limits

Ambient Temperature	32°F to 131°F (0°C to 55°C)
Relative Humidity Tolerance	90%, non-condensing
Line Voltage	100 to 250 Vac 125 to 300 Vdc 24 Vac/dc optional
Power Consumption	Less than 6 VA (instrument)

Performance

Accuracy	±0.20% of full scale (±0.10% typical), ±1 digit
Setpoint Resolution	1 count / 0.1 count
Repeatability	±1 count
Temperature Stability	5 µV/°C (maximum)
TC Cold-End Tracking	0.05°C/°C ambient
Noise Rejection	100 dB common mode 70 dB series mode
Process Sampling	10 Hz (100 ms)
Digital Filtering	Adjustable 0.1 to 10

Control Characteristics

Setpoint Limits	Span of Sensor
Alarms	Adjustable for high/low; selectable process, or deviation
Proportional Band	2 to span of sensor
Integral	0 to 9600 sec
Derivative	0 to 2400 sec
Cycle Time	0.2 to 120 sec
Control Hysteresis	1 to span of sensor
Dead Band (Output 1 & 2)	Range of sensor
Ramp to Setpoint	1 to 9999 min
Auto-Tune	Operator initiated from front panel
Manual Control	Operator initiated from front panel

Inputs

Thermocouple	B, C, E, J, K, N, NNM, R, S, T, Platinel II Maximum lead resistance, 100 ohms for rated accuracy
RTD	Platinum 2- and 3-wire, 100 ohms at 0°C, (DIN curve standard 0.00385)
Linear	0-50 mV/10-50 mV, 0-20 mA/4-20 mA, 0-10 mV/0-50 mV, 0-100 mV, 0-1 V/0-5 V, 0-10 V, 1-5 V

Outputs

B	5 A/3 A (120/240 Vac) normally open
E	0-20 mA
F	4-20 mA, full output to load 500 ohm impedance max
G	4-20 mA, full output to load 800 ohm impedance max
P	20 Vdc or 35 mA
S	20 Vdc or 17 mA

Outputs

T	1 A , Solid-state relay
V	0 to 5 Vdc
X	0 to 10 Vdc
Y	1 A, normally closed relay

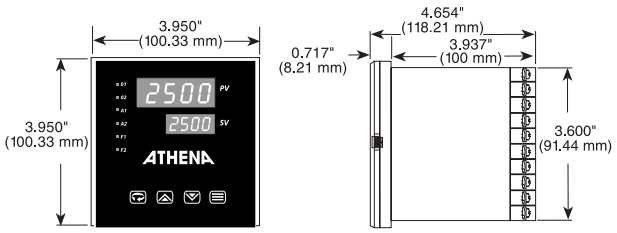
Alarm Outputs

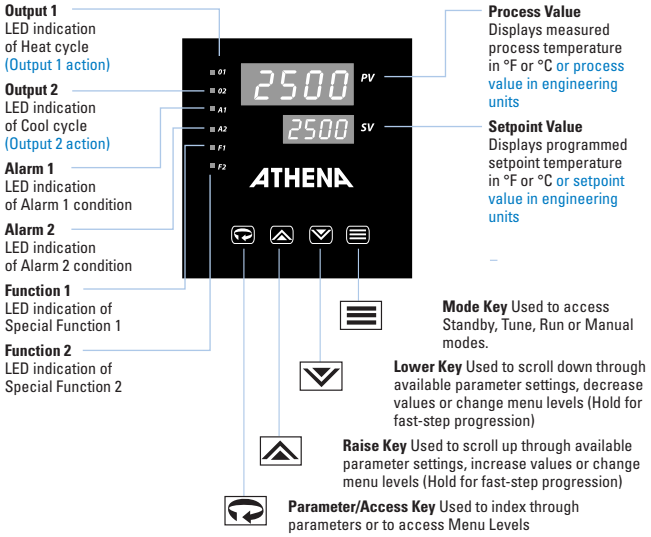
B	5 A/3 A (120/240 Vac), mechanical relay
S	24 V, 20 mA
T	SSR, NC, 24-240 Vac

Mechanical Characteristics

Display	Dual, 4-digit 0.36˝(9.2 mm) LED display Process Value: Orange Setpoint Value: Green
Numeric Range	-1999 to 9999
Front Panel Rating	NEMA 4X (IP65)
Front Panel Cutout	3.622˝ x 3.622˝(92 mm x 92 mm)
Connections	Screw terminals

Specifications subject to change without notice.





Power Controllers Series 19 and 39 SCR

The Athena 19 and 39 controllers are available as zero voltage switched controllers (19Z and 39Z) and phase-angle fired controllers (19P and 39P) that can be used for control of resistive heater loads. The controller provides capacity up to 80 Amps, and extends heater life while eliminating thermal shock.

- Optically Isolated
- Diagnostic Indicators
- Self-Synchronizing to Line Frequency
- Isolated Heat Sinks
- Compact Design
- Full Protection Against Line Voltage Spikes

c UL us
(Series 39 only)

Ordering Information

9 – – – – – –

Phase Code
1= Single
3= Three

Switching Mode Code
P = Phase angle firing
Z = Zero switched

Line Voltage (50/60 Hz) Code

02 =	24 Vac
12 =	120 Vac
20 =	208 Vac
24 =	240 Vac
38 =	380 Vac
44 =	440 Vac
48 =	480 Vac
57 =	575 Vac
60 =	600 Vac

Load Current (A) Code
040 = 40 A
060 = 60 A
080 = 80 A

Inputs Code

A =	4-20 mA
C =	10-50 mA
D =	Other mA or Voltage (Specify)
P =	Pulsed dc (0 to 20 Vdc) Z series only
S =	120 Vac

Soft Start/Voltage Limit P Series Only Code (Soft/Start Timing)

0 =	None
A =	9 sec
B =	15 sec
C =	30 sec
D =	60 sec
E =	120 sec
V =	Voltage limit

OPTIONS
Consult factory

00 =	None
0A =	Fuses

ACCESSORIES
Manual Station with Remote Potentiometer
(Requires Input "A" 4-20 mA)
See page 20.

WARNING
Branch circuit overcurrent protection is to be provided in accordance with national and local codes.

To Order: Determine proper line voltage; load current; type of load; options required, if any; and input signal to power controller. Use these equations to determine load current.

For load currents above 200 A, consult Athena or your local Athena representative.

Single-Phase = watts (load) = amps
Load Current volts (line)

Three-Phase = watts (load) = amps
Load Current 1.73 x volts (line)

Technical Specifications

Supply Voltage	24 to 600 Vac
Frequency	50-60 Hz
Current Rating	40, 60 and 80 A
Control Signal Isolation	2500 Vac
Transient Voltage|Protection	MOV and RC suppression
Ambient Temperature	32°F to 122°F (0°C to 50°C) for listed current rating
Load	Resistive. 3-phase- 3 wire Delta or Ungrounded Wye 19Z/19P-1 phase, 1 line control 39Z-3 phase, 2 lines controlled 39P-3 phase, 3 lines controlled
Diagnostic Indicators	Shorted or open SCR reversed signal input (mA/V)

Zero Voltage Switched Controllers

The 19Z and 39Z SCR controllers are zero crossover fired, high-power solid state switching devices. Zero firing eliminates the RFI generation associated with mechanical relays. With zero voltage firing, the output appears as bursts of full sine waves of line voltage which provides excellent regulation to the load.

Phase Angle Fired Controllers

The 19P and 39P phase angle fired controllers turn each SCR on for a controlled portion of a half-cycle of the line voltage. The effective load voltage is determined by the portion of the line voltage delivered which is proportional to the input control signal. Additionally, the voltage is regulated as the line voltage changes.

DIMENSIONS			
MODEL #	Height	Width	Depth
19Z	10.25″	4.75″	4.0″
19P	10.25″	4.75″	4.0″
39Z	10.25″	9.62″	4.0″
39P	10.25″	14.37″	4.0″

Power Controllers Series 19P and 39P

The Athena 19P (single phase) and 39P (three phase) are phase-angle fired power controllers that can be used for control of resistive heater loads. The high amperage series provides capacity from 125 amps up to 250 amps and the controllers are designed to extend heater life while eliminating thermal shock.

- Optically Isolated
- Diagnostic Indicators
- Self-Synchronizing to Line Frequency
- Isolated Heat Sinks
- Compact Design
- Protection Against Line Voltage Spikes
- Fan Cooled

c US
(File No. E218665)

Ordering Information

	9	P	–			–				–		–			–		

Phase Code
1 = Single
3 = Three

Line Voltage (50/60 Hz) Code
02 = 24 Vac
04 = 48 Vac
12 = 120 Vac
20 = 208 Vac
24 = 240 Vac
38 = 380 Vac
48 = 480 Vac
60 = 600 Vac

Load Current (Amps) Code*
(To determine load current reference equations below)
125 = 125 A
200 = 200 A
250 = 250 A

Input Code
A = 4-20 mA
C = 10-50 mA

Soft Start Code
0 = None
A = 9 sec
B = 15 sec
C = 30 sec
D = 60 sec
E = 120 sec
V = Voltage limit

OPTIONS
Consult factory
00 = None

To Order: Determine proper line voltage, load current, and options required, if any.

***Single Phase Load Current (Amps) Equation**

$$\text{Total Amps} = \frac{\text{Total Watts (Load)}}{\text{Volts (Line Voltage)}}$$

***Three Phase Load Current (Amps) Equation**

$$\text{Total Amps} = \frac{\text{Total Watts (Load)}}{1.73 \times \text{Volts (Line Voltage)}}$$

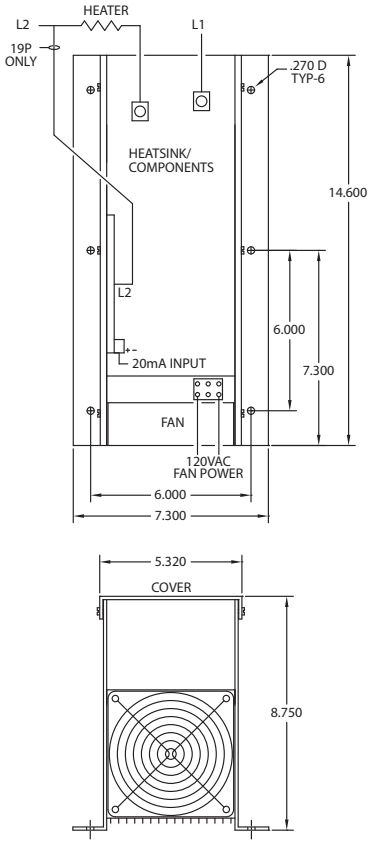
WARNING
Branch circuit overcurrent protection is to be provided in accordance with national and local codes.

Technical Specifications

Supply Voltage	24 to 600 Vac
Frequency	50-60 Hz
Current Rating	125 - 250 A
Input Control Signal Isolation	2500 Vac
Transient Voltage Protection	Inherent built in immunity
Ambient Temperature	32°F to 122°F (0°C to 50°C)
Load	Resistive. 39P Three Phase, 3 Leg Half Control for 3 Wire Delta or 3 Phase Ungrounded Wye 19P Single Phase, 1 Leg Control
Diagnostic Indicators	Shorted or open SCR, open or reverse input
Cooling Specification	Fan cooled, requires 120 Vac supply voltage

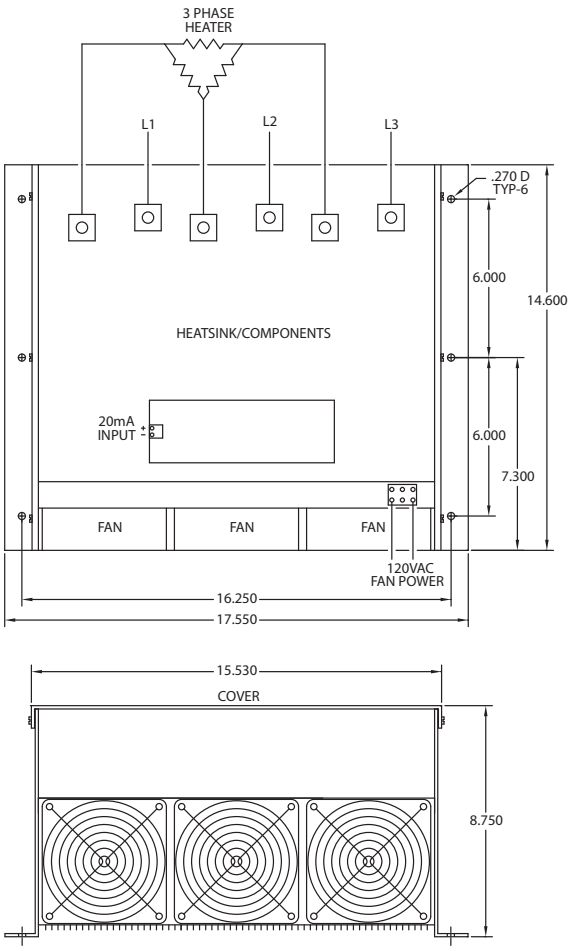
Phase Angle Fired Controllers

The 19P and 39P SCR Phase-Angle Fired Power Controllers turn on each SCR for a controlled portion of a half-cycle of the line voltage. The effective line voltage is determined by the portion of the line voltage delivered, which is proportional to the input control signal. Additionally, the voltage is regulated as the line voltage changes.



19P Single Phase Controller

Amperage Size 125 Amps	Weight 13.5 lbs.
Amperage Size 200 and 250 Amps	Weight 14.0 lbs.



39P Three Phase Controller

Amperage Size 125 Amps	Weight 35.5 lbs.
Amperage Size 200 and 250 Amps	Weight 37.5 lbs.

Accessories:

If a different input code is required other than listed, reference the Athena 90M manual station data sheet or consult Athena for your requirements.

Spare Fuses for Line Voltage Range from 24 thru 480 Vac:

	Part Number	Single Phase	Three Phase
125 Amps	210A044U01	1 Required	3 Required
200 Amps	210A046U01	1 Required	3 Required
250 Amps	210A045U01	1 Required	3 Required

Spare Fuses for Line Voltage Range from 575 thru 600 Vac:

	Part Number	Single Phase	Three Phase
125 Amps	210A047U01	1 Required	3 Required
200 Amps	210A006U01	1 Required	3 Required
250 Amps	210A048U01	1 Required	3 Required

Trigger Boards:

Single Phase Units	Part Number
125, 200, 250 Amps	785A432U01 - (Specify Exact Line Voltage, Single or Three Phase)

Example: 785A432U01, 240 Vac

Trigger Boards:

Three Phase Units	Part Number
125, 200, 250 Amps	785A095Uxx - (Specify Exact Line Voltage, Single or Three Phase)

Example: 785A095U01, 240 Vac

Power Controllers Series 19Z and 39Z

The Athena 19Z (single phase) and 39Z (three phase) are zero switched power controllers that can be used for control of resistive heater loads. The high amperage series provides capacity from 125 amps up to 250 amps. The controllers are designed to extend heater life while eliminating thermal shock.

- Optically Isolated
- Diagnostic Indicators
- Self-Synchronizing to Line Frequency
- Isolated Heat Sinks
- Compact Design
- Protection Against Line Voltage Spikes
- Fan Cooled

c UL us
(File No. E218665)

Ordering Information

	9	Z	–			–				–		–	0	–		

Phase Code
1 = Single
3 = Three

Line Voltage (50/60 Hz) Code
V1 = 24/48 Vac
V2 = 120/480 Vac
V3 = 575/600 Vac

Load Current (Amps) Code*
(To determine load current reference equations below)
125 = 125 A
200 = 200 A
250 = 250 A

Input Code
A = 4-20 mA
C = 10-50 mA
P = Pulsed dc (10 to 20 Vdc)
S = 120 Vac

OPTIONS
Consult factory
00 = None

To Order: Determine proper line voltage, load current, input signal and options required, if any.

***Single Phase Load Current (Amps) Equation**

$$\text{Total Amps} = \frac{\text{Total Watts (Load)}}{\text{Volts (Line Voltage)}}$$

***Three Phase Load Current (Amps) Equation**

$$\text{Total Amps} = \frac{\text{Total Watts (Load)}}{1.73 \times \text{Volts (Line Voltage)}}$$

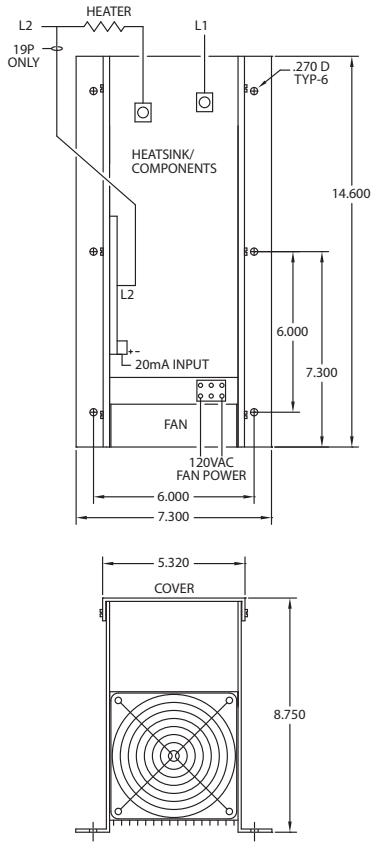
WARNING
Branch circuit overcurrent protection is to be provided in accordance with national and local codes.

Technical Specifications

Supply Voltage	24 to 600 Vac
Frequency	50-60 Hz
Current Rating	125 - 250 A
Input Control Signal Isolation	2500 Vac
Transient Voltage Protection	Inherent built in immunity
Ambient Temperature	32°F to 122°F (0°C to 50°C)
Load	Resistive. 39Z Three Phase, 2 Leg Control for 3 Wire Delta or 3 Phase Ungrounded Wye 19Z Single Phase, 1 Leg Control
Diagnostic Indicators	Open or reverse input
Cooling Specification	Fan cooled, requires 120 Vac supply voltage

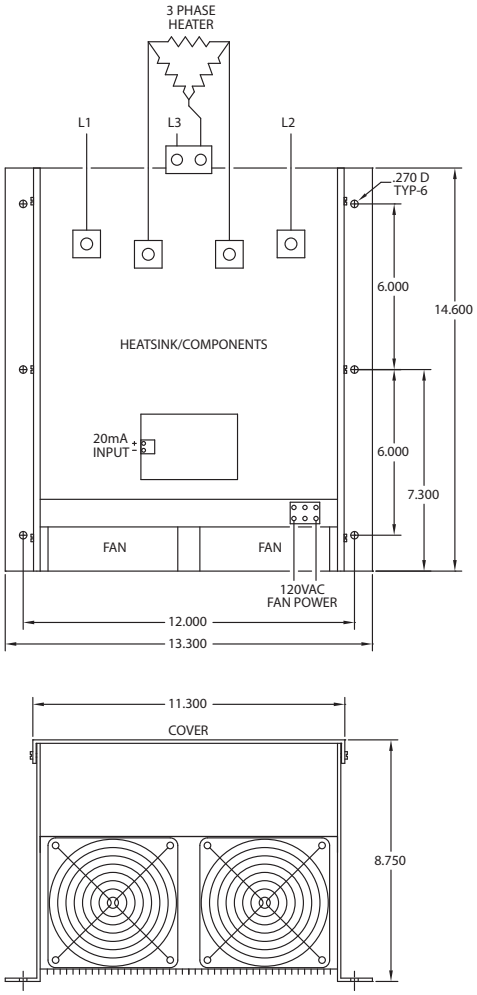
Zero Voltage Switched Controllers

The 19Z and 39Z SCR Power Controllers are zero crossover fired, high-power solid state switched devices. Zero crossover firing eliminates the RFI (radio frequency interference) generation associated with mechanical relays. With zero crossover firing, the output appears as bursts of full sine waves of line voltage which provides excellent regulation to the load.



19Z Single Phase Controller

Amperage Size 125 Amps	Weight 13.5 lbs.
Amperage Size 200 and 250 Amps	Weight 14.0 lbs.



39Z Three Phase Controller

Amperage Size 125 Amps	Weight 27 lbs.
Amperage Size 200 and 250 Amps	Weight 27.5 lbs.

Accessories:

If a different input code is required other than listed, reference the Athena 90M manual station data sheet or consult Athena for your requirements.

Spare Fuses for Line Voltage Range from 24 thru 480 Vac:

	Part Number	Single Phase	Three Phase
125 Amps	210A044U01	1 Required	2 Required
200 Amps	210A046U01	1 Required	2 Required
250 Amps	210A045U01	1 Required	2 Required

Spare Fuses for Line Voltage Range from 575 thru 600 Vac:

	Part Number	Single Phase	Three Phase
125 Amps	210A047U01	1 Required	2 Required
200 Amps	210A006U01	1 Required	2 Required
250 Amps	210A048U01	1 Required	2 Required

Trigger Boards:

Single and Three Phase Units for Line Voltage Range from 24 thru 600 Vac	Part Number
125, 200, 250 Amps	785A430U01 - (Specify Line Voltage Range, Single or Three Phase)

Example: 785A430U01, 240 Vac, Single or Three Phase

Solid-State Contactors Series ZC and PC

The Athena ZC and PC contactors are available as zero voltage switched (ZC) and phase angle-fired (PC) contactors that can be used for control of resistive heater loads. The controller provides full power rating at 102°F (49°C) ambient temperature, and extends heater life while eliminating thermal shock.

- All Solid-State Design – No Maintenance Required
- Soft-Start and Voltage Limit (Optional on PC)

Ordering Information

		C	–			–			–		–		–	

Switching Mode
Code

Z =	Zero Voltage Switched
P =	Phase Angle Fired

Line Voltage

Code		Model
12 =	120 V	PC
24 =	120-240	ZC or PC
48 =	277-480	ZC only

Maximum Load (Amps)
Code

10[1] =	3.6"	Heatsink	480 Vac
12[1,2]=	5.5"	Heatsink	480 Vac
15 =	3.6"	Heatsink	240 Vac
25 =	3.6"	Heatsink	240 Vac
35[2]=	5.5"	Heatsink	240 Vac

Mounting Configurations
Code

0 =	Free standing power pack
1 =	Case mounted power pack[3]
Note:	Specify (1) when unit ordered is to be mounted on an Athena 2000 or 4000 controller.

Model PC Only Special Options
Code

0 =	None
S =	Soft Start
V =	Voltage Limit

Example: Model ZC-2425-1-a controller with a zero voltage switching mode; a line voltage of 120-240 V; a maximum load (amps) of a 3.6" heatsink, 240 Vac; and a case-mounted power pack configuration.

CAUTION Possible fire hazard. Because these controls or associated equipment may not always fail safe, an approved temperature and/or pressure safety control should be used for safe operation.

NOTES:

[1] Only 480 Vac available. None higher. ZC only.

[2] Panel mounting only.

[3] Not available on 35A model

Technical Specifications

Inputs (minimum voltage)	3 V input signal, minimum, is needed. Standard Athena “S” or “F” output controllers can energize up to three units in series. Model ZC- 3-32 Vdc pulsed voltage, optically isolated from output (2500 V). Requires Athena output type “S”. Model PC- 4-20 mA proportional current, optically isolated from output (2500 V). Requires Athena output type “F”.
Ambient Temperature	120°F (49°C) maximum for rated amperes
Output Ampere Rating	Resistive loads only, 277-480 Vac is ZC Unit Only
Note	For greater ampere loads, consult factory.

Model	Supply Voltage	Nominal Rating Max. 3.6" Heat Sink	5.5" Heat Sink	Peak Surge	Voltage Drop	Max. Leakage
ZC	120-240	15 A	N/A	250 A	1.6 V	15 mA
	120-240	25 A	35 A	650 A	1.6 V	15 mA
	277-480	10 A	12 A	150 A	3.2 V	1 mA
PC	120/240	15 A	N/A	310	5.0 V	10 mA
	120/240	25 A	35 A	310	8.0/5.0 V	10 mA

Options Available for PC Units Only

Soft-Start Option	0 to maximum output within 30 seconds standard. Consult factory for slower or faster turn-on times.
Voltage Limit Option	Output limit is adjustable from 35% to 95% of line input voltage.

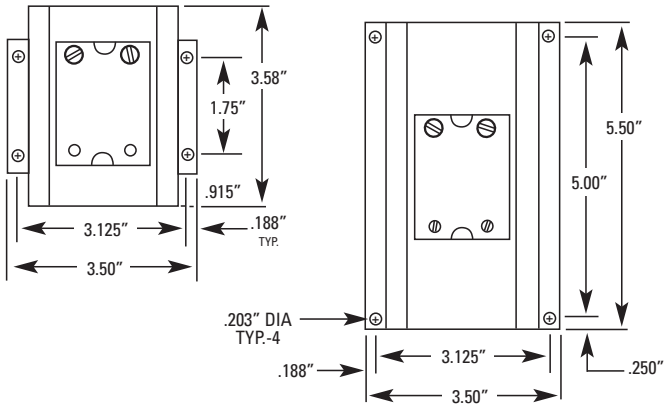
Zero Voltage Switching

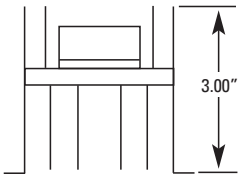
Series ZC contactors offer zero voltage switching for EMI/RFI free operation. A time proportional 3-32 Vdc input signal is required to energize these contactors (use with Athena “S” output controller).

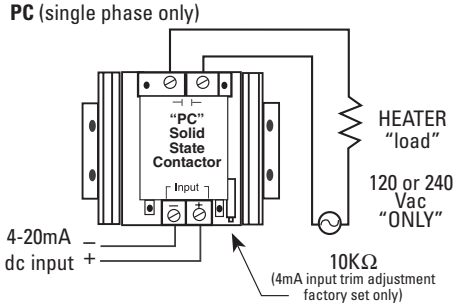
Phase Angle-Fired Switching

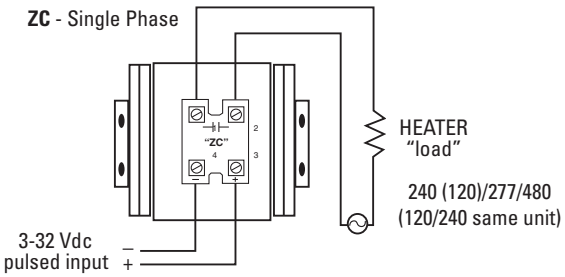
Phase angle-fired switching provides continuously variable voltage output by governing the point of turn-on (firing) of each half cycle of the full AC sine wave. Low mass heating elements such as heating lamps and hot wires are recommended applications. Use with Athena “F” output (4-20 mA) controller.

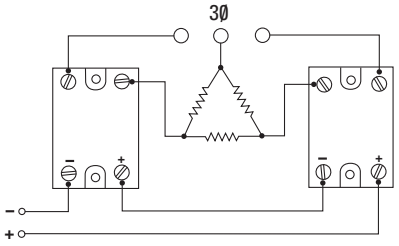
Phase angle firing allows for two options not available with ZC solid state contactors. Soft-Start provides slow turn on for high inrush loads, such as quartz lamps and Tungsten elements. Voltage limit restricts load current by capping the peak-to-peak output voltage.





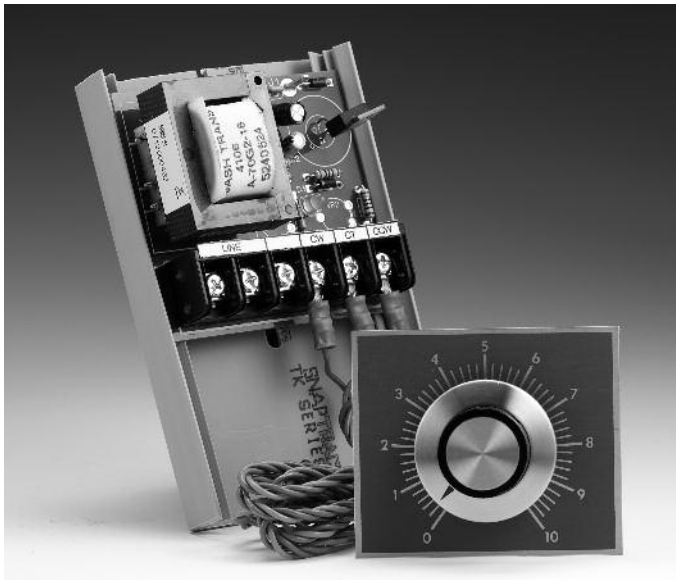






ZC - Three Phase

Manual Station Temperature Controller Series 90

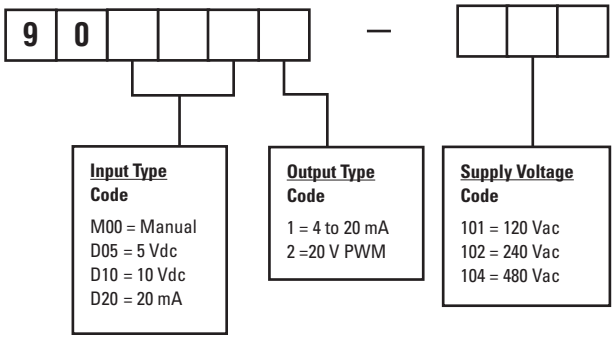


Remote Setpoint
Potentiometer (optional)

The Athena 90 is a non-indicating, manual station controller for low cost open loop control. The controller allows manual setting of output level on SCR power controllers, proportional valves, and other final control mechanisms.

- Fully Variable 4-20 mAdc or 20 V Pulse Width Modulation (PWM) Output
- Includes circuit board, mounting track, dial potentiometer with 48˝ leads, scale, knob, and female contacts.

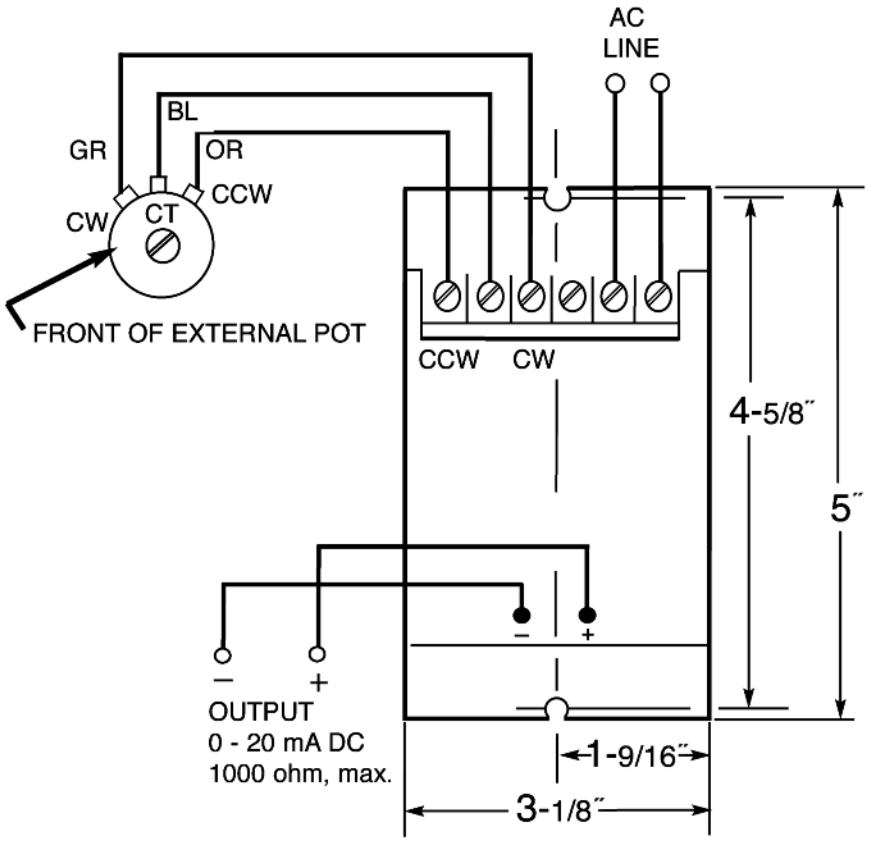
Ordering Information



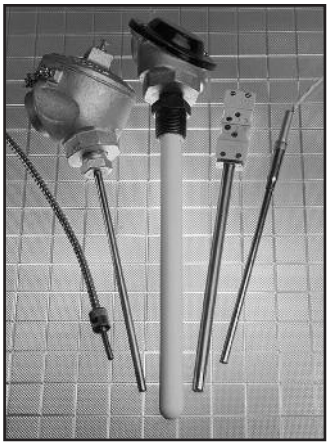
Technical Specifications

Power	120, 240, or 480 V +10% -15%, 50/60 Hz
Input	0-135 ohm minimum, 0-1000 ohm maximum potentiometer (500-ohm potentiometer supplied with 48˝ leads)
Ambient Temperature	32°F to 131°F (0°C to 55°C)
Dimensions	
Unit	5˝L x 3.25˝W x 2˝H (12.7 cm L x 8.26 cm W x 5.1 cm H)
Scale Plate	2.75˝W x 2.375˝H (6.98 cm W x 6.03 cm H)

Specifications subject to change without notice.



Temperature Sensors



When you have a technical problem or question about thermocouples, RTDs, or temperature measurement, give Athena a call. You'll speak with an experienced technician with a wide knowledge of the field. In addition to a complete line of Tudor brand temperature sensors, we build more "specials" and service a greater variety of industries than most any thermocouple manufacturer. In fact, chances are excellent we have already solved a problem similar to yours. We'll be happy to tell you about our experience and discuss possible solutions without obligation.

Many larger thermocouple manufacturers would rather not be bothered with "specials." They want large volume orders. So "specials" go to the bottom of the pile and delivery and communication with the customer are usually very poor.

Of course, we like large orders as much as the next company. But what sets us apart is our enthusiasm about solving problems for our customers, big and small. You can depend on Athena and Tudor brand temperature sensors to provide the temperature measurement and control solutions you need.

Athena's thermocouples and thermocouple wire meet accuracy standards as defined by the many technical societies and manufacturers. These accuracies are listed in the Engineering Data section of the Athena Reference Information publication, available on request and at our web site, www.athenacontrols.com. Special accuracy thermocouples and thermocouple wire are also defined and are detailed in this section.

Selected grade thermocouple wire can be supplied in instances where special or standard grade material does not provide the accuracy needed at specific temperatures. The availability of this grade depends on your specific requirements and stock levels.

Calibration of thermocouples or thermocouple wire is a laboratory test performed on a specific product or lot to determine its departure from a defined temperature–E.M.F. relationship. ASTM E 230 (ITS 90) describes the relationship for the various thermocouple types, portions of which can be found in Athena's Technical Reference Information booklet, available on request. Calibrations are conducted following the general guidelines of ASTM E 220. Test results are reported in certificate form indicating test temperatures, °F or °C corrections and standards traceable data.

Calibration is performed in accordance with MIL-C-45662, ANSI/NSCL Z540-1, and ISO 10012-1. Overall production satisfies the requirements of MIL-I-45208. Additionally, the product testing and certification requirements of AMS-2750-C and ASTM E 608 can be supplied.

Each product tested can be tagged with a test number, date and correction data. Pricing for calibration and testing is based on tests selected, quantity to be tested, and number of test temperatures. Test temperatures within the range of 0° C (32° F) to 1371° C (2500° F) are available at competitive pricing. Sub-zero checking and high temperature (above 1371° C) are available on special quotation only.

How to Order Information

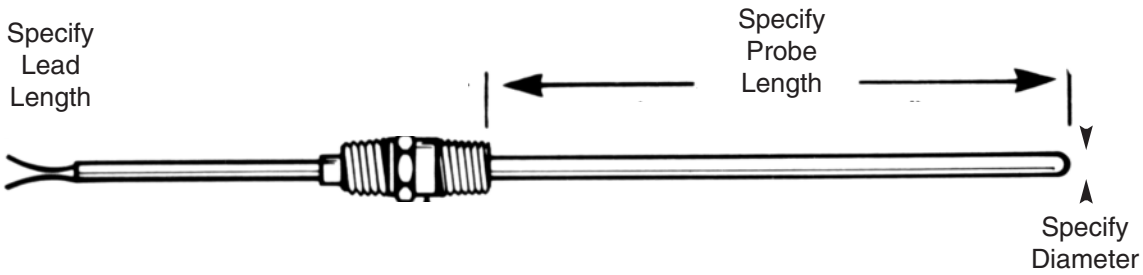
To request a quote or more information on Athena products in this catalog, please go to www.athenacontrols.com, click on the Sales Office Locator link on the left side of the Home Page under the Contact Us tab and take the following steps:

1. Please click on your region of the world map to find the authorized Athena sales representative or distributor in your area
2. Please enter your zip code in the box and press the "Find Reps/Distributors" button to find your local representative or distributor
3. Please use the phone, fax or e-mail link found on your local representative or distributors page to request a quote or get more information on any of the products in this catalog

For a Custom Probe quote, please complete the quote form found on Page 23, follow the above three (3) steps and fax the form to your local representative or distributor.

To contact us directly, please call 800-782-6776 (in the USA) or 610-828-2490 or e-mail us at sales@athenacontrols.com.

Custom Probe Quote Form



For a quick quotation on your special temperature probe requirements, draw the type of thermocouple or RTD profile desired below and fax a copy of this page to your local Athena Controls representative or distributor Please see previous page for “How to Order information”.

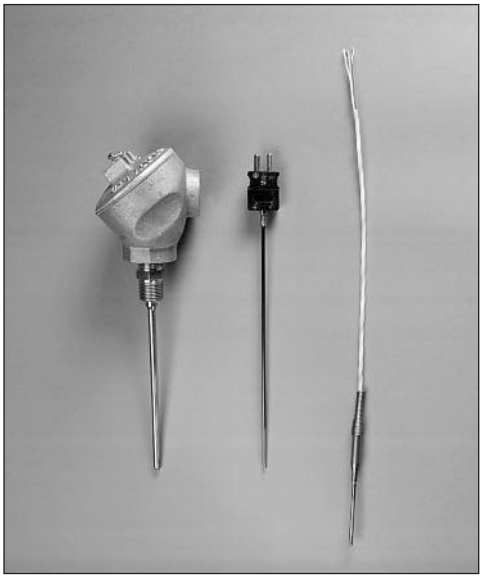
Name _____ Date _____
Title _____ RFQ # _____
Company _____
Address _____
City/State/Zip _____
Tel _____
Fax _____
E-mail _____

Specify:

❑ Probe Length _____
❑ Lead Length _____
❑ Probe Diameter _____
❑ Probe Material _____
❑ Termination _____
❑ Max. Temperature _____
❑ Test Requirements _____
❑ Atmosphere _____
❑ Thermocouple Type _____
❑ RTD _____

Additional Comments or Requirements:

Tu-Pak® Thermocouple Assemblies



Tu-Pak® is Athena's trademark for metal-sheathed, mineral-insulated (MI) thermocouple material. It is a departure from the traditional assembly of tubes, wires and insulators. It has a unit-construction with no replacement parts. Tu-Pak® has improved thermal response, greater flexibility and, size for size, it is longer lasting than traditional types.

Tu-Pak® Dimensions and Wire Sizes

Sheath Outside Diameter	Outside Diameter Tolerance, ±in.	Nominal Wall Thickness, in.	Approximate Wire B&S gauge	Nom. Conductor Diameters, in. 2-wire	4-wire
0.062	0.002	0.010	29	0.011	0.006
0.125	0.002	0.018	24	0.022	0.011
0.188	0.003	0.025	18	0.032	0.022
0.250	0.003	0.032	17	0.040	0.032
0.313	0.003	0.040	16	0.051	0.040
0.375	0.003	0.049	14	0.064	0.051

Tu-Pak® Suggested Upper Temperature Limits for Sheathed Thermocouples (per ASTM E608)

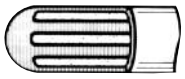
Nom. Dia. (in) / Nom. Wall (in)	0.062 / 0.010	0.125 / 0.018	0.188 / 0.025	0.250 / 0.032
Type K/N (°F/°C)	1690/920	1960/1070	2100/1150	2100/1150
Type J (°F/°C)	825/440	970/520	1150/620	1330/720
Type E (°F/°C)	950/510	1200/650	1350/730	1510/820
Type T (°F/°C)	500/260	600/315	700/370	700/370

TuPak® Sheath Material Limitations Recommended Limit

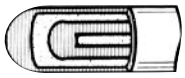
Materials	Melting Point, °F/°C	Maximum in Air, °F/°C	Recommended Operating Atmosphere	Continuous Maximum Temp., °F/°C
Stainless Steel:				
304	2560/1404	1920/1049	ORNV	1650/899
309	2560/1404	2000/1093	ORNV	2000/1093
310	2560/1404	2000/1093	ORNV	2100/1149
316	2500/1371	1650/899	ORNV	1700/927
321	2550/1399	1650/899	ORNV	1600/871
347	2600/1427	1680/916	ORNV	1600/871
430	2700/1482	1550/843	ORNV	1200/649
446	2700/1482	2000/1093	ORNV	2000/1093
Inconel	2550/1399	2000/1093	ONV†	2100/1149
Inconel X	2620/1438	1500/816	ONV†	2200/1204
Platinum	3217/1770	3000/1649	ON†	3000/1649
Pt-Rh 10%	3362/1850	3100/1704	ON	3100/1704

Symbols describing atmospheres are O = oxidizing; R = reducing; N = neutral; V = vacuum; † = Very sensitive to sulfur corrosion.

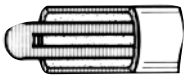
Measuring Junctions



Grounded Junction - The sheath and the thermocouple wires are welded together, forming a completely closed measuring junction. Recommended in the presence of liquids, moisture, gas, or high pressure. The thermocouple is protected from the environment. Response time approaches that of an exposed junction.



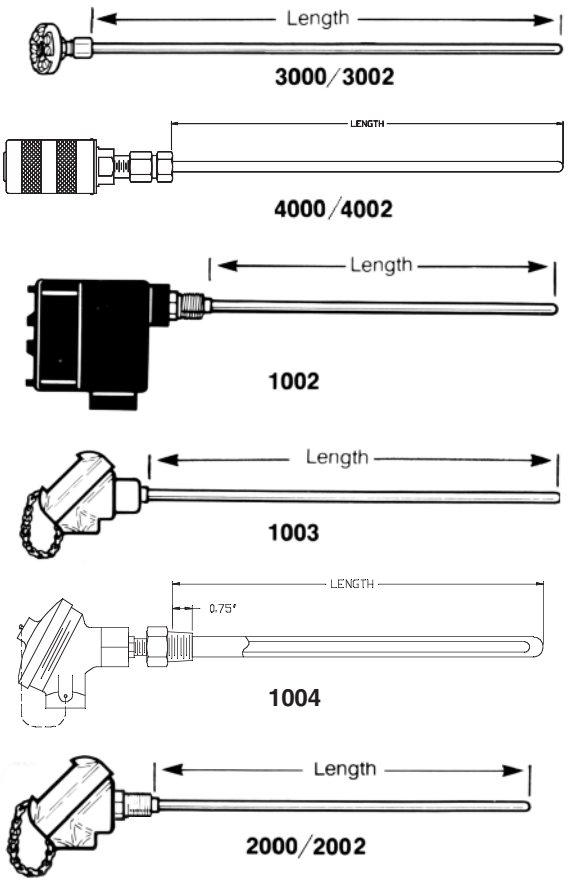
Ungrounded Junction - The thermocouple junction is insulated from the welded measuring junction closure. Recommended for applications where stray E.M.F.s could affect the instrument reading and for frequent/rapid temperature cycling. Response time is slower than a grounded junction.



Exposed Junction - The thermocouple junction is not protected by a welded closure. Insulation is sealed against liquid or gas penetration. Provides fastest response time. Not recommended for applications that are corrosive.

Tu-Pak® Industrial Head-Type Thermocouple Assemblies

Terminations and Length Specifications (Custom Head Type Terminations also available on request)	
Part No.	**Style**
1002	Hazardous Location Cast Aluminum Head
1003	Screw-Cover Thermoplastic Head
1004	Screw-Cover Cast Iron Head
2000	Screw-Cover Cast Aluminum Head
2002	Screw-Cover Aluminum Head with 1/2" NPT SS spring loaded oil and vapor seal
3000	300°F (149°C) max. Open Head
3002	1000°F (538°C) max. Open Head – Simplex only
4000	Screw Cover Mini-Head
4002	Bayonet Cover Mini Head



Ordering Information

Calibration is AVAILABLE Upon Request

x 0 0 x – □ – □ – □□□ – □ – □ – □□ – □□□

T/C Calibration

Code

J = Iron-Constantan
K = Chromel-Alumel
T = Copper-Constantan
E = Chromel-Constantan
N = Nicrosil-Nisil
S = Pt 10% Rh-Pt
R = Pt 13% Rh-Pt
B = Pt 30% Rh-Pt 6% RH

T/C Form

Code

S = Simplex
D = Duplex
T** = Triplex

**Available on 1002, 1003, 1004 and 2000 only.

Sheath Material

Code

A04 = 304SS
A10 = 310SS
A16 = 316SS
F46 = 446SS
INC = Inconel

Sheath Diameter

Code

1* = .062"
2 = .125"
3 = .187"
4 = .250"
5 = .312"
6 = .375"

*Can not be supplied in duplex or triplex ungrounded.

Measuring Junction

Code

G = Grounded
U = Ungrounded
E = Exposed

Length

Code

(Specify in inches)

Optional Comp. Fitting - NPT

Code

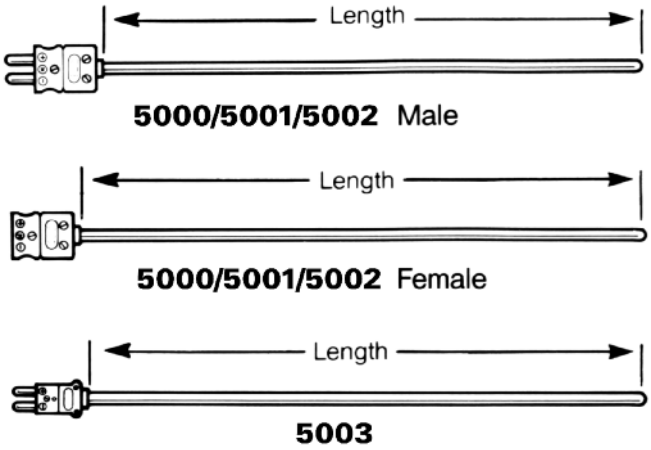
1 = Brass - 1/8
2 = Brass - 1/4
3 = SS - 1/8
4 = SS - 1/4
5 = SS Adj. - 1/8
6 = SS Adj. - 1/4
*7SL = 1/2 x 1/2 SS Sp. Ld.
*7S = 1/2 x 1/2 SS
0 = None

*Available on 1002, 1003, 1004, and 2000 only.

Tu-Pak® Quick Disconnect Thermocouple Assemblies

Standard Terminations & Length Specifications (Custom terminations also available on request)	
Part No.	**Style**
5000	350°F (177°C) Max Standard Connector
5001	500°F (260°C) Max Standard Connector
5002	1000°F (538°C) Max Standard Connector
5003	350°F (177°C) Max Miniature Connector*

Temperatures are exposure ratings for connectors only.



▲ Teflon® coating available upon request. ▲

Calibration is AVAILABLE Upon Request

Ordering Information

Limits of Error
Code
P = Premium
H = High (>2200° F)***
T = Standard

T/C Form
Code
S = Simplex
D = Duplex

Sheath Diameter
Code
1**** = .062″
2 = .125″
3 = .187″
4 = .250″
5 = .312″
6 = .375″

Length
Code
(Specify in inches)

Female Jack
Code
O = None
F** = Standard
FM* = Miniature
C = Ceramic

5 0 0 x – ☐ – ☐ – ☐☐☐ – ☐ – ☐ – ☐☐ – ☐ – ☐☐ – ☐

T/C Calibration
Code
J = Iron-Constantan
K = Chromel-Alumel
T = Copper-Constantan
E = Chromel-Constantan
N = Nicrosil-Nisil
S = Pt 10% Rh-Pt
R = Pt 13% Rh-Pt
B = Pt 30% Rh-Pt 6% RH

Sheath Material
Code*****
A04 = 304SS
A10 = 310SS
A16 = 316SS
F46 = 446SS
INC = Inconel

Measuring Junction
Code
G = Grounded
U = Ungrounded
E = Exposed

Male Plug
Code
O = None
H** = Std. Hollow
S** = Std. Solid
M* = Miniature
C = Ceramic

Optional Comp. Fitting
Code
0 = None
1 = Brass - 1/8
2 = Brass - 1/4
3 = SS - 1/8
4 = SS - 1/4
5 = SS Adj. - 1/8
6 = SS Adj. - 1/4

*Available in sizes 1/16″ to 3/16” only.
**Not available with 5003.
***Available in selected wires/materials only.
****Can not be supplied in duplex or triplex ungrounded.
***** Other materials available upon request.

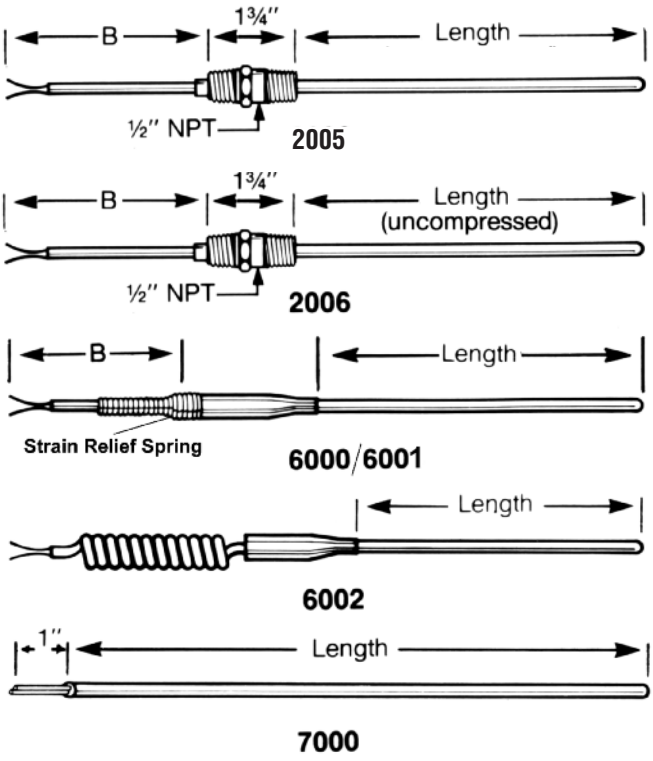
Tu-Pak® Lead Wire-Type Thermocouple Assemblies

Standard Terminations & Length Specifications

(Custom terminations also available on request)

Part No.	Style/Description
2005	1/2″ NPT x 1/2″ NPT SS Fitting
2006	1/2″ NPT x 1/2″ NPT Spring Loaded Stainless Steel Fitting
6000	Transition Ftg. with Strain Relief Spring
6001	Transition Ftg. w/o Strain Relief Spring
6002*	Transition to Polyurethane Coiled Cord. Simplex only. Omit Tables VIII and IX. Not available in S, R, or B calibration.
7000	Stripped 1″ Leads

Noble metal elements are not recommended for use in base metal sheaths.
*Available on 6002 only. Expands to approximately 5 per coiled foot.



Ordering Information

Calibration is AVAILABLE Upon Request

Limits of Error

Code
P = Premium
H = High (>2200° F)
T = Standard

T/C Form

Code
S = Simplex
D = Duplex
T = Triplex

Sheath Diameter

Code
1* = .062″
2 = .125″
3 = .187″
4 = .250″
5 = .312″
6 = .375″

Length

Code
(Specify in inches)

Lead Length

Code
B = If lead length is longer than 12″, enter length over 12″

Optional Comp. Fitting

Code
1 = Brass - 1/8
2 = Brass - 1/4
3 = SS - 1/8
4 = SS - 1/4
5 = SS Adj. - 1/8
6 = SS Adj. - 1/4
0 = None

	x	0	0	x	–		–			–		–			–			–		–		–		–		

T/C Calibration

Code
J = Iron-Constantan
K = Chromel-Alumel
T = Copper-Constantan
E = Chromel-Constantan
N = Nicrosil-Nisil
S = Pt 10% Rh-Pt
R = Pt 13% Rh-Pt
B = Pt 30% Rh-Pt 6% RH

*Can not be supplied in duplex or triplex ungrounded.

Sheath Material

Code
A04 = 304SS
A10 = 310SS
A16 = 316SS
F46 = 446SS
INC = Inconel

Measuring Junction

Code
G = Grounded
U = Ungrounded
E = Exposed

Lead Wire Insulation

Code
GG = Fiberglass
GS = Fiberglass/ SS Overbraid
PP = Polyvinyl
PS = Polyvinyl/SS Overbraid
TT = Teflon® - solid
TS = Teflon/SS Overbraid
CC1* = 1′ Coiled Cord
CC2* = 2′ Coiled Cord
CC3* = 3′ Coiled Cord
CC5* = 5′ Coiled Cord
SG = Stranded Glass
ST = Stranded Teflon
GSS = Stranded, with SS Overbraid
000 = 1″ Leads (7000 only)

Extension Cover

Code
0 = None
Flex SS = Flex Armor

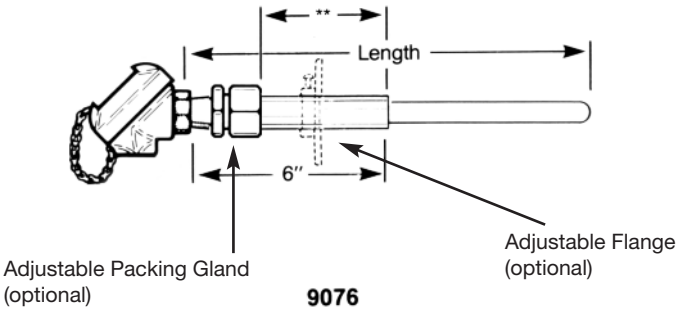
Connectors

Code
0 = None
P = Std. Plug (350° F max.)
J = Std. Jack (350°F max.)
MP = Miniature Plug (350° F max)
MJ = Miniature Jack (350°F max.)

Ceramic-Type Protection Tube Assemblies

Ceramic protection tube assemblies are offered in a wide variety of aluminum connection heads and mounting options. Specifications and part numbers are detailed in the tables below to permit excellent flexibility in selecting the exact design required. Assemblies are shipped pre-tested and ready to install.

Straight – Ceramic Protection Tube Assemblies	
Part No.	**Style**
9076	Screw Cover Cast Aluminum Head



9076

Ordering Information

Calibration is AVAILABLE Upon Request

9076 – □ – □□ – □ – □ – □□ – □□ – □□□□ – □□

T/C Calibration

Code
E = Chromel - Constantan
J = Iron - Constantan
K = Chromel - Alumel
T = Copper Constantan
N = Nicrosil - Nisil

Gauge Size

Code
8 = 8
14 = 14
20 = 20

T/C Form

Code
S = Simplex
D = Duplex

Protection Tube Material

Code
M = Mullite
A = 99.6% Alumina
L = Metal - Ceramic (7/8" O.D. Only)

Tube Length

(Specify in inches)

Tube O.D.

Code
6* = 3/8"
11 = 11/16"
14 = 7/8"
15 = 15/16"

Mounting Options
Choose One Only

Code
FL = Adjustable Carbon Steel Flange
AG = Adjustable Carbon Steel Packing Gland
PE = Pipe Extension
PE-FL = Pipe Extension and Adjustable Carbon Steel Flange
PE-AG** = Pipe Extension and Adjustable Carbon Steel Gland
0 = None

Special Options
** = Insertion Length

*Maximum wire size is 20 gauge.
**Minimum pipe extension length is 4 inches.

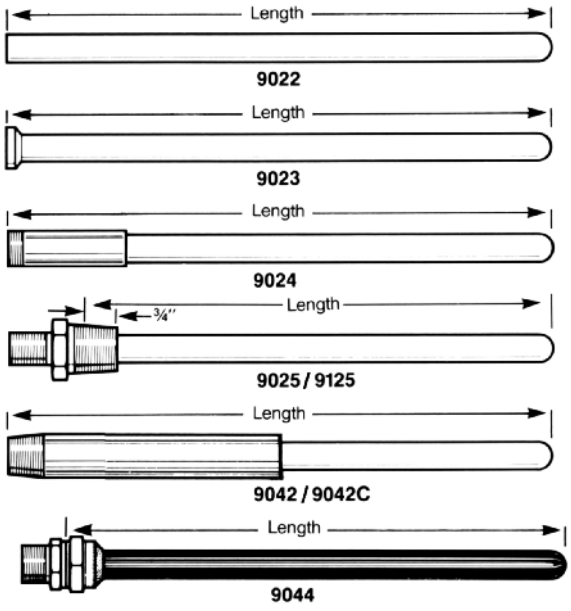
Ceramic and Non-Metallic Protection Tubes

Ceramic protection tubes are hemispherically closed on one end, and are offered in mullite, hi-purity alumina, and high temperature materials. These tubes are superior to metallic tubes at high temperatures and provide a virtually gas-tight enclosure to protect against harsh environments.

Ceramic and Non-Metallic Protection Tubes	
Part No.	**Style**
9022	Plain
9023	With collar
9024	With 2" brass ferrule (7/8" – 27, thread)
9025	With fitting – 3/4" NPT thread*
9125	With fitting – 1-1/4" NPT thread
9042	With 6" stainless steel pipe extension
9042C	With 6" carbon steel pipe extension
9044**	Metal-Ceramic – 7/8" O.D. – 3/4 NPT conduit connection

*Maximum tube size is 11/16" O.D.

Omit selection from **Tube Material and Tube Size.



Ordering Information

9	0	x	x	☐	–	☐	–	☐☐	–	☐☐

Tube Material

Code
M = Mullite
A = 99.6% Alumina

Tube Size

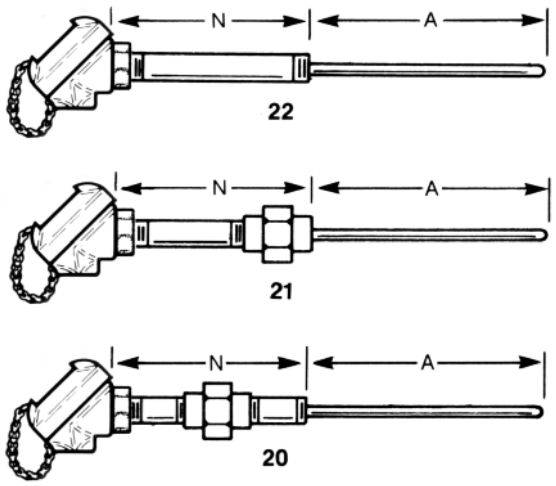
Code
3 = 3/16″ o.d.
4 = 1/4″ o.d.
5 = 3/16″ x 5/16″
6 = 1/4″ x 3/8″
11 = 7/16″ x 11/16″
14 = 5/8″ x 7/8″
16 = 3/4″ x 1″
20 = 1″ x 1-1/4″

Insertion Length

(Specify in inches)

Industrial Process/Pressure Vessel Thermocouples

Part No.	Style
22	Screw cover and aluminum head with nipple and element
21	Screw cover and aluminum head with nipple-union and element
20	Screw cover and aluminum head with nipple-union-nipple and element



Athena Control's Industrial Process/Pressure Vessel thermocouples are suitable for many applications. This style is most frequently applied in Power Generating Stations, Chemical Process Plants, Petrochemical Process Plants, and Petroleum Refining Plants.

The ordering specifications and style offerings provide a most flexible method to describe the exact design required.

The thermocouples consist of four basic components:

1. Connection Head - Screw cover cast aluminum head with terminal block.
2. Thermocouple Element - A spring-loaded MgO insulated metal sheathed element. Standard sheath material is 304SS - maximum compression is 1/2 inch.
3. Mounting Fittings - Carbon steel nipples
   - Female 150 lb steel unions
   - Nominal thread engagement is 1/2 inch
4. Drilled Thermowell - Standard and heavy duty type

Other materials and head assemblies are available upon request.

Ordering Information

Calibration is AVAILABLE Upon Request

2 x – □ – □ – □ – □ – □ – □□□ – □ – □□ – □

"N" Length
(Specify in inches, minimum 3 inches)

Nipple Size
Code
2 = 1/2" Pipe
3 = 3/4" Pipe

Calibration
Code
E = Chromel - Constantan
J = Iron - Constantan
K = Chromel - Alumel
T = Copper - Constantan
N = Nicrosil - Nisil

Form
Code
S = Simplex
D = Duplex
T = Triplex

Element
Code
3S = Spring - Loaded 3/16" Sheath
4S = Spring - Loaded 1/4" Sheath
6S = Spring - Loaded 3/8" Sheath
4IS = Spring - Loaded 1/4" Inconel

Measuring Junction
Code
G = Grounded
U = Ungrounded

"A" Length (uncompressed)
(Specify in inches)

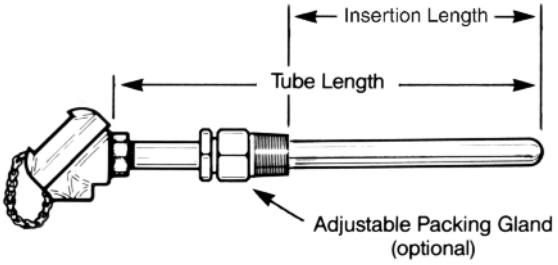
Well Number
Code
0 = None
W = See pg 104 thru 108 for thermowell ordering info.

Straight-Metal Protection Tube Assemblies

These metal protection tube assemblies are offered in a wide variety of aluminum connection heads and mounting options. Specifications and part numbers are detailed in the tables below, permitting the greatest flexibility in selecting the exact design required. Assemblies are shipped pre-tested and ready to install.

Straight-Metal Protection Tube Assemblies	
Part No.	**Style**
9035	Schedule 40 pipe with weatherproof Screw Cover Cast Aluminum Connection Head
9037	Schedule 80 pipe with weatherproof Screw Cover Cast Aluminum Connection Head

Straight Assemblies with Options



9035/9037

Ordering Information

Calibration is AVAILABLE Upon Request

9 0 3 x – [ ] – [ ][ ] – [ ] – [ ][ ][ ] – [ ][ ] – [ ][ ] – [ ][ ][ ][ ] – [ ][ ]

T/C Calibration

Code
E = Chromel - Constantan
J = Iron - Constantan
K = Chromel - Alumel
T = Copper - Constantan
N = Nicrosil - Nisil

Gauge Size

8 = 8
14 = 14
20 = 20

T/C Form

Code
S = Simplex
D = Duplex

Note: Duplex available in 14 & 20 gauge only

Protection Tube Material*

Code
CS = Carbon Steel
F46 = 446 Stainless Steel
INC = Inconel 600
A04 = 304 Stainless Steel
A10 = 310 Stainless Steel
A16 = 316 Stainless Steel
A35 = 35 NI - 19CR
NI = Nickel
WI = Black Iron

Tube Length

(Specify in inches)

Pipe Size O.D.

Code
9 = 1/4" (.540")
11 = 3/8" (.675")
13 = 1/2" (.840")
17 = 3/4" (1.05")
21 = 1" (1.32")

Mounting Options

Code		Length	
WBCS	-	Specify	= **Carbon Steel Welded Bushing
WBSS	-	Specify	= **Stainless Steel Welded Bushing
FL	-	—	= Adjustable Carbon Steel Flange
AG	-	—	= Adjustable Carbon Packing Gland (For 1/2" x 3/4" Pipe Only)
0	-	—	= None

Insertion Length
(if using mounting option)

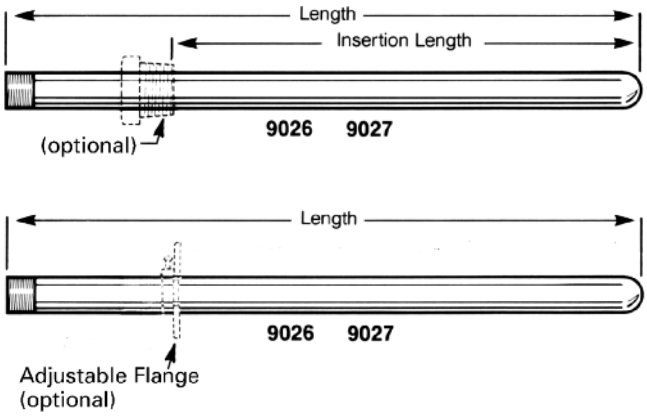
(Specify in inches)

*See page 31 for protection tube specifications.
**Mounting thread standard is next larger pipe size thread.

Metal Protection Tubes

Metal protection tubes offer environmental and mechanical protection for base metal thermocouples. Care should be exercised in selection of material and design in order to achieve optimum performance and economy. Athena personnel can assist you in making the best selection based on experience and the technical data presented in this catalog. The specification selection tables below offer a variety of standard mounting options.

Metal Protection Tubes



Metal Protection Tubes	
Part No.	**Style**
9026	Schedule 40 pipe
9027	Schedule 80 pipe

Pipe Specifications			
Nom Size	**Outside Diameter, in**	**Wall Thickness, inches Sch. 40**	**Sch. 80**
1/8*	0.405	.068	.095
1/4	0.540	.088	.119
3/8	0.675	.091	.126
1/2	0.840	.109	.147
3/4	1.050	.113	.154
1	1.315	.133	.179
1-1/4*	1.666	.140	.191
1-1/2*	1.900	.145	.200
2*	2.375	.154	.218

*Non-stock item. Available upon request.

Ordering Information

9 0 2 x – □□□ – □□ – □□ – □□ – □□□□ – □□

Tube Material

Code
CS = Carbon Steel
F46 = 446 Stainless Steel
INC = Inconel 600
A04 = 304 Stainless Steel
A10 = 310 Stainless Steel
A16 = 316 Stainless Steel
NI = Nickel
WI = Black Iron

Tube Size

Code
9 = 1/4" (.540")
11 = 3/8" (.675")
13 = 1/2" (.840")
17 = 3/4" (1.05")
21 = 1" (1.32")

Tube Length

(Specify in inches)

Mounting Options

Code	Length	
WBCS	Specify	= Carbon Steel bushing**
WBSS	Specify	= Stainless Steel bushing**
FL	—	= Adjustable Carbon Steel flange
AG	—	= Adjustable Carbon Steel packing gland (1/2" & 3/4" pipe only)
0		= None

Insertion Length
(if using mounting option)

(Specify in inches)

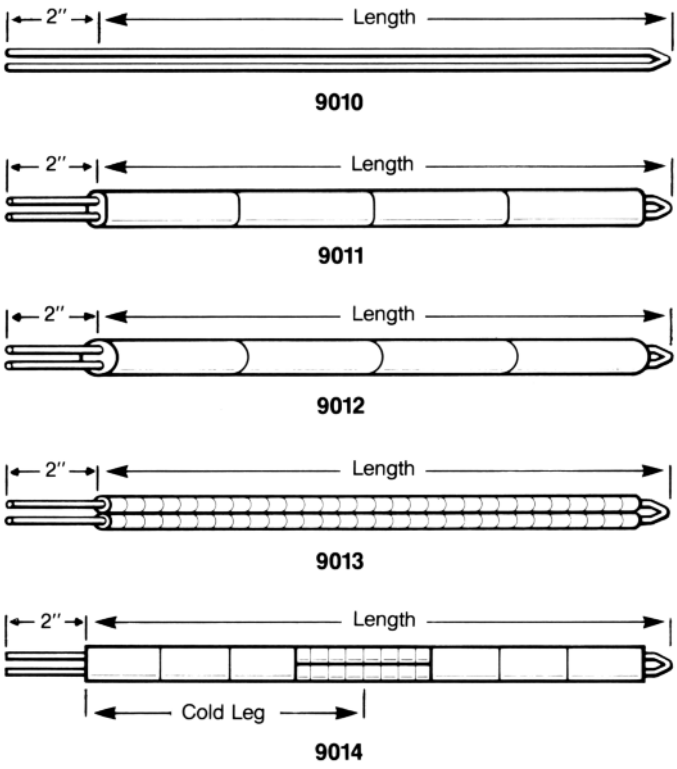
**Mounting thread standard is next larger pipe size thread.

Replacement Elements – Base Metal Type

A thermocouple element is the heart of all thermocouple assemblies. Prudent selection of gauge size, length and type of insulation is essential for optimum performance and economy. Athena's personnel can assist you in making the best selection based on the experience and the technical data present in this catalog.

Base Metal Replacement Elements	
Part No.	**Style**
9010	Bare wire without insulators
9011	3" oval insulators. Not available in duplex
9012	3" round insulators
9013	Ball & socket insulators
9014	Flexible section for angle type

Base Metal Elements



Ordering Information

Calibration is AVAILABLE Upon Request

9 0 1 x – □ – □□ – □ – □□ – □□

T/C Calibration

Code
E = Chromel - Constantan
J = Iron - Constantan
K = Chromel - Alumel
N = Nicrosil - Nisil
T = Copper - Constantan

Gauge Size

Code
8 = 8 ga
14 = 14 ga
20 = 20 ga
30 = 30 ga

T/C Form

Code
S = Simplex
D = Duplex

Length

(Specify in inches)

Cold Leg Length
(9014 only)

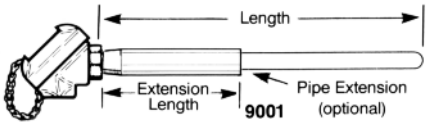
(Specify in inches)

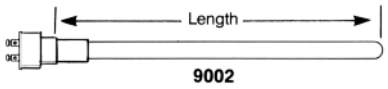
Noble Metal Thermocouple Assemblies

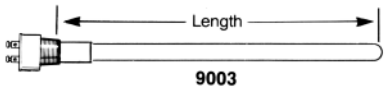
Noble metal thermocouple assemblies are for measurement of temperatures that range above that of base-metal couples, (to 3200°F/1760°C), or for more precise measurements at lower temperatures where the additional cost is justified. These assemblies come in a wide variety of ceramic primary protection tubes, and with ceramic or metal secondary protection tubes.

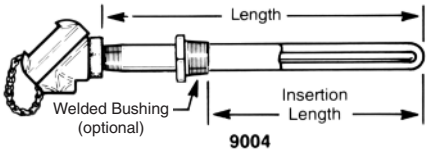
Thermocouple conductors are 24 gauge (0.020) unless otherwise specified. All assemblies are pretested and ready to install.

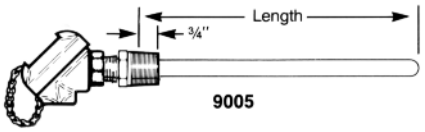
Noble Metal Assemblies	
Part No.	**Style**
9001	Noble Metal Assembly with Screw Cover Cast Aluminum Cover
9002	Noble Metal Assembly with Open Terminal Head
9003	Noble Metal Assembly with Open Terminal Head and 1" NPT Mounting Thread
9004	Noble Metal Assembly with Screw Cover Cast Aluminum Head and Ceramic Primary Tube, Inconel 1/2" I.P.S. Secondary Tube
9005	Noble Metal Assembly with Screw Cover Cast Aluminum Cover with Primary and Secondary Ceramic Tubes
9007	Noble Metal Assembly with Cast Iron Head

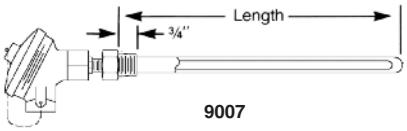












Ordering Information

Calibration is AVAILABLE Upon Request

9 0 0 x – [ ][ ] – [ ] – [ ][ ][ ] – [ ][ ] – [ ][ ][ ][ ] – [ ][ ]

Limits of Error

Code
T = Standard
P = Premium

T/C Calibration 24 gauge (.020)
Code
B = Plat. 30% Rh-Plat. 6% Rh
R = Plat. 13% Rh-Plat.
S = Plat. 10% Rh-Plat.

T/C Calibration 30 gauge (.010)
Code
B3 = Plat. 30% Rh-Plat. 6% Rh
R3 = Plat. 13% Rh-Plat.
S3 = Plat. 10% Rh-Plat.

T/C Form

Code
S = Simplex
D = Duplex**

Tube Material

Code
*A11 = 99.6% Alumina 7/16" x 11/16"
*M11 = Mullite 7/16" x 11/16"
***A6 = 99.6% Alumina 1/4" x 3/8
***M6 = Mullite 1/4" x 3/8"

Tube Length

(Specify in inches)

Mounting Options

Code	Length	
PE	- Specify	= Pipe Extension
PE-FL	- Specify	= Pipe Extension with Flange
VF**	- —	= Vented Fitting
0	- —	= N/A
WBCS	- Specify	= Carbon Steel Welded Bushing
WBSS	- Specify	= Stainless Steel Welded Bushing
TN	- —	= 3/4" NPT Process Connection

Pipe Extension Length
(where applicable)

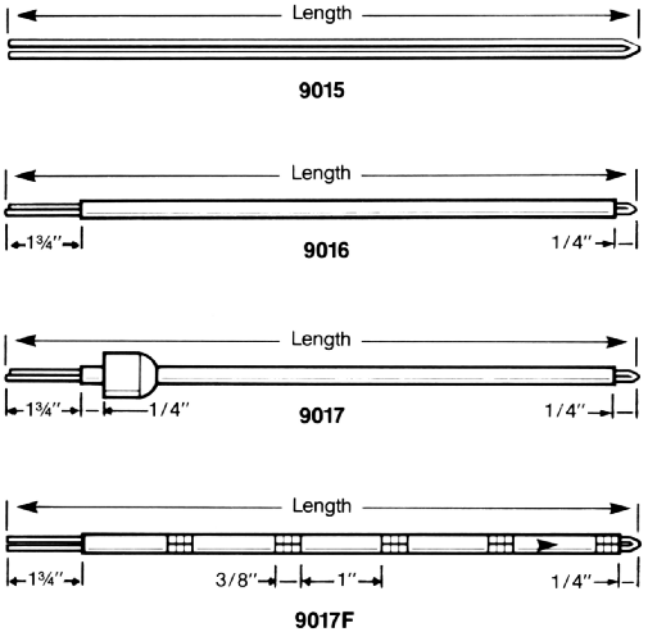
(Specify in inches)

*Not available when ordering **9004**
Not available when ordering **9002 and **9003**
***Not available when ordering **9005**

Thermocouple Replacement Elements

Noble Metal and Refractory Metal Replacement Elements	
Part No.	**Style**
9015	Bare wire without insulators
9016	Full length insulators
9017	Full length insulator & collar
9017F	Flexible noble metal

Noble and Refractory Metal Elements



Ordering Information

Calibration is AVAILABLE Upon Request

9	0	1	x		–			–			–			–			–		

Limits of Error

Code
T = Standard
P = Premium

T/C Calibration

Code
B = Platinum 30% Rhodium - Platinum 6% Rhodium
R = Platinum 13% Rhodium - Platinum
S = Platinum 10% Rhodium - Platinum
W5 = Tungsten 5% Rhenium - Tungsten 26% Rhenium
(available in 24 gauge only)

Gauge Size

Code
20 = 20 ga
22 = 22 ga
24 = 24 ga
30 = 30 ga

T/C Form

Code
S = Simplex
D = Duplex
T = Triplex[2]

Insulator and Diameter

Code
M3 = Mullite 3/16" diameter
A3 = 99.6% Alumina 3/16" diameter
M2 = Mullite 1/8" diameter
A2 = 99.6% Alumina 1/8" diameter

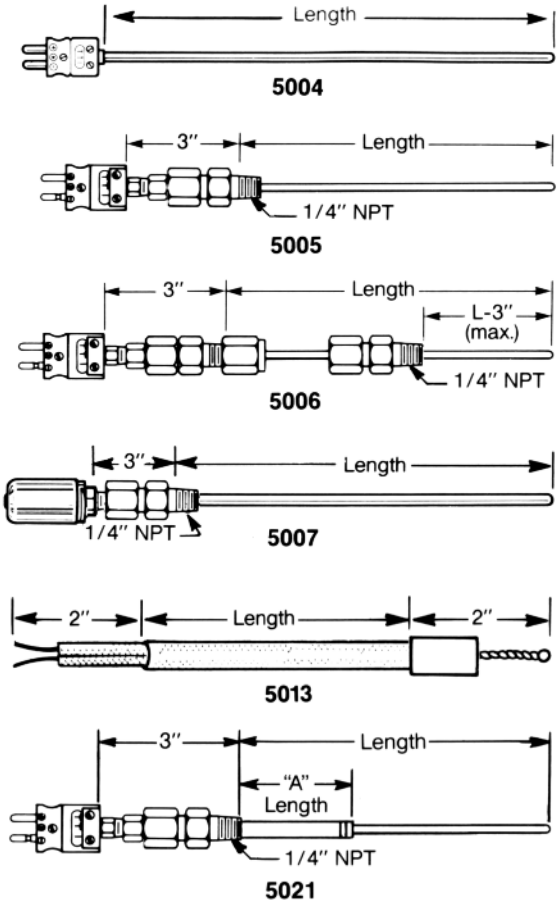
Length

(Specify in inches)

Vacuum Furnace Thermocouples

Athena's vacuum furnace thermocouples offer high reliability and time-proven performance. Made of the highest quality materials, some of these thermocouple assemblies feature vacuum tight seals and threaded process connections as standard features. Other quality accessory products and factory replacement parts are also listed to complete the temperature measurement system. Other sheath materials are available - consult factory.

Part No.	Style
5004	Quick connect plug with molybdenum sheath and potted end seal
5005	Quick connect plug with molybdenum sheath and vacuum gland end seal
5006	Same as 5005 with a vacuum type variable immersion fitting
5007	Miniature lightweight head with molybdenum sheath and vacuum gland end seal
5008	Same as 5007 with a vacuum type variable immersion fitting
5013	Work-survey chromel-alumel (Type "K") T/C. High temperature glass insulation, 20 gauge. Maximum measuring temperature 2000°F (1093°C)
5014	Same as 5013 except ceramic fiber insulation. Maximum measuring temperature 2300°F (1260°C)
5021	Quick connect plug with 1/4˝ OD high purity alumina tube, Inconel sleeve and vacuum gland end seal



Ordering Information

Calibration is AVAILABLE Upon Request

□5□0□x – □□ – □ – □□ – □□ – □ – □

Limits of Error
Code
T = Standard
P = Premium

T/C Calibration
Code
K = Chromel - Alumel
N = Nicrosil - Nisil
B = Platinum
R = Platinum 13% Rhodium - Platinum
S = Platinum 10% Rhodium - Platinum
W5 = Tungsten 5% Rhenium - Tungsten 26% Rhenium (not available for 5004)

T/C Form
Code
S = Simplex
D = Duplex

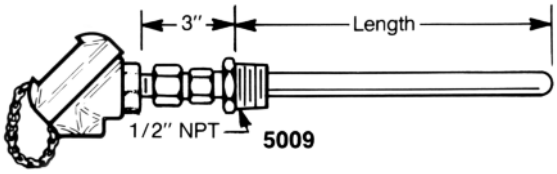
Length
Code
(Specify in Inches)

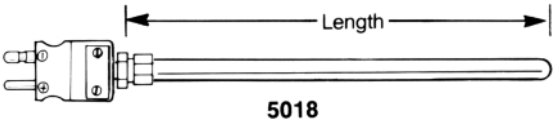
"A" Inconel Sleeve
(5021)
Code
(Specify in Inches)

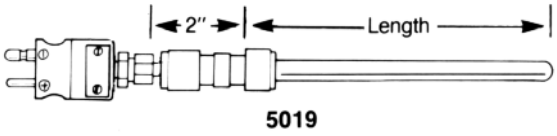
Mounting Options
(5004 and 5021 only)
Code
1 = 1/4" NPT Adjustable Mounting Fitting
0 = None

Tube O.D.
(5004 to 5008)
Code
2 = 1/8" outside tube diameter
3 = 3/16" outside tube diameter
4 = 1/4" outside tube diameter

Part No.	Style
5009	Recrystallized alumina tube assembly with Screw Cover Head and Vacuum Gland Seal End
5018	Recrystallized Alumina Tube Assembly with Quick Connect Plug and Potted Seal End
5019	Recrystallized Alumina Tube Assembly with Quick Connect Plug and Vacuum Gland Seal End







Ordering Information

Calibration is AVAILABLE Upon Request

5 0 x x – □□ – □ – □□ – □□ – □

T/C Calibration

Code
K = Chromel - Alumel
N = Nicrosil - Nisil
B = Platinum
R = Platinum 13% Rhodium - Platinum
S = Platinum 10% Rhodium - Platinum
W5 = Tungsten 5% Rhenium - Tungsten 26% Rhenium (Not available in 5018 assembly)

T/C Form

Code
S = Simplex
D = Duplex

Tube Length

Code
(Specify in Inches)

Tube O.D.

Code
2 = 1/8″ outside tube diameter
3F= 3/16″ outside tube diameter
4 = 1/4″ outside tube diameter
5 = 5/16″ outside tube diameter
6 = 3/8″ outside tube diameter

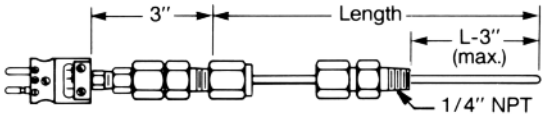
Mounting Options

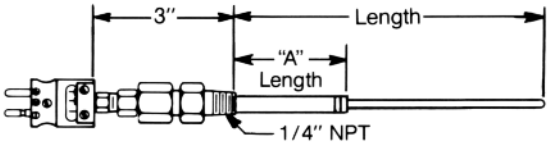
Code
0 = None
1 = Adjustable 1/2″ NPT Mounting Adapter
2 = Adjustable 1/4″ NPT SS Compression Fitting

Custom Vacuum Furnace Thermocouples

Athena's custom vacuum furnace thermocouples offer high reliability and long service life. Manufactured from the highest quality materials, some of these custom vacuum furnace thermocouples can be ordered with vacuum tight seals and threaded process connections to meet specific application requirements.

To order a custom vacuum furnace thermocouple starting with an SK designation, fill out the below blocks under Ordering Information. If the part number following the SK designation does not fit in the blocks, please write your part number on the line below and fax a copy of this page to your local Athena Controls representative or distributor.





Custom Vacuum Furnace Thermocouple
Part # _____

Ordering Information

Calibration is AVAILABLE Upon Request

S K – ☐☐☐☐☐☐ – ☐☐ – ☐ – ☐☐ – ☐☐ – ☐ – ☐

T/C Calibration

Code
K = Chromel - Alumel
N = Nicrosil - Nisil
B = Platinum
R = Platinum 13% Rhodium - Platinum
W5 = Tungsten 5% Rhenium - Tungsten 26% Rhenium

T/C Form

Code
S = Simplex
D = Duplex

Length

Code
(Specify in Inches)

"A" Inconel Sleeve

Code
(Specify in Inches)

Mounting Options

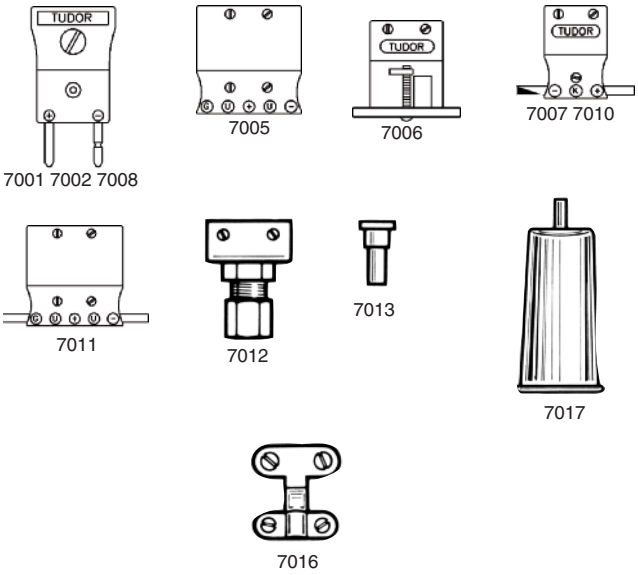
Code
1 = 1/4" NPT Adjustable Mounting Fitting
0 = None

Tube O.D.

Code
2 = 1/8" outside tube diameter
3 = 3/16" outside tube diameter
4 = 1/4" outside tube diameter

Convenience Connectors, Standard Size

Part No.	Style
7001	Male convenience connector with protected terminal connections, solid pins.
7002	Male convenience connector with protected terminal connections, hollow pins.
7003	Female convenience connector with protected terminal connections.
7004	Male convenience connector with protected terminals and ground wire pin.
7005	Female convenience connector with protected terminals and ground wire socket.
7006	Female circular convenience connector with protected terminals for panel mounting in 1 1/8″ diameter knockout.
7007	Female convenience connector with protected terminals for panel mounting in 1″x 9/16″ knockout.
7008	Male convenience connector with external access terminals and solid pins.
7009	Female convenience connector with external access terminals.
7010	Female convenience connector with external access terminals for panel mounting in 1″x 9/16" knockout.
7011	Female convenience connector with protected terminals and ground socket panel mounting in 1-1/2″x 9/16″knockout.



Standard Size Accessories	
Part No.	**Style**
7012	Compression type tube adapter.
7013	Crimping type tube adapter.
7016	Insulated-wire clamp.
7017	Weatherproof rubber boot (pair).

Ordering Information

7 0 x x – □ – □□ – □ – □

T/C Calibration

Code		Body Color
E	= Chromel - Constantan	Purple
J	= Iron - Constantan	Black
K	= Chromel - Alumel	Yellow
T	= Copper - Constantan	Blue
N	= Nicrosil - Nisil	Orange
S	= Plat. 10% Rh. - Plat.	Green
R	= Plat. 13% Rh. - Plat.	Green
B	= Plat. 30% Rh. - Plat. 6%	White
W	= Tungsten - Tungsten Re.	White
U	= Uncompensated	White

Maximum Temperature

Code	
3	= 350°F (177°C)
5	= 550°F (288°C)
10	= 1000°F (538°C)

Tube Size

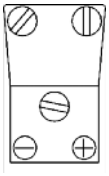
Code	
0	= .040″ tube diameter
1	= .063″ tube diameter
2	= .125″ tube diameter
3	= .188″ tube diameter
4	= .250″ tube diameter
5	= .312″ tube diameter

T/C Circuits

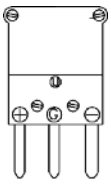
Code	
S	= Simplex (1 Pair)
D	= Duplex (2 Pair)

Convenience Connectors, Miniature Size

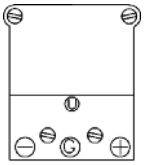
Miniature Size Connectors	
Part No.	**Style**
7020	Male convenience connector.
7021	Female convenience connector.
7022	Male convenience connector with ground pin.
7023	Female convenience connector with ground socket.
7024	Female circular convenience connector panel mounting in 7/8" diameter knockout.
7025	Female circular convenience connector panel mounting in 1-1/16" diameter knockout, with ground socket.
7026	Female convenience connector panel mounting in 5/8" x 3/8" knockout.
7027	Female convenience connector panel mounting in 1" x 3/8" knockout with ground socket.
Miniature Size Accessories	
Part No.	**Style**
7028	Adapter type insert.
7030	Insulated-wire clamp.
7031	Neoprene grommet.



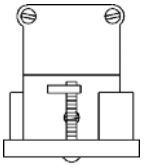
7021



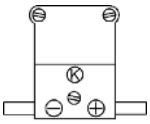
7022



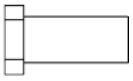
7023



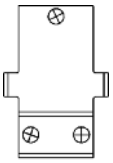
7024



7026



7028



7030

Ordering Information

7	0	x	x

–

T/C Calibration

Code
E = Chromel - Constantan
J = Iron - Constantan
K = Chromel - Alumel
T = Copper - Constantan
N = Nicrosil - Nisil
P = Plat. 10% Rh. - Plat
P = Plat. 13% Rh. - Plat
B = Plat. 30% Rh. - Plat
W = Tungsten - Tungsten Re.
U = Uncompensated

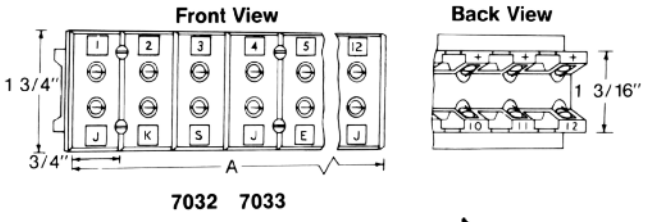
–

Tube Size
(for 7028 and 7029 only)

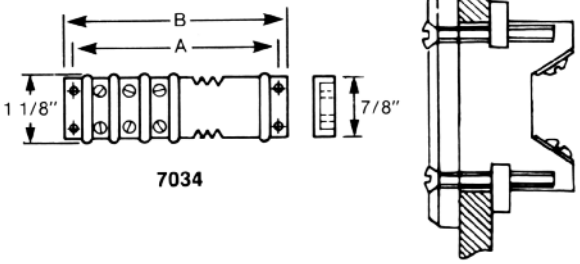
Code
0 = .040" tube diameter
1 = .063" tube diameter
2 = .125" tube diameter
3 = .187" tube diameter

Convenience Connectors, Strip Panels and Terminal Blocks

Strip panels can be wired and installed completely from the front. A self-contained fastening device is permanently attached which simplifies mounting and holds tight. Alloys of inserts match ANSI thermocouple grade calibrations to maintain sensing accuracy. Alloy and circuit numbers are marked on face of strip panel with corresponding circuit numbers and polarity identification on the back. Collet type spring loaded inserts have low mass, eliminate temperature gradients and spurious E.M.F. Negative inserts are larger than positives to avoid polarity mix-ups. Large head brass terminal screws facilitate tight connections without deforming or stressing the finest wire. Molded of high impact and shock resistant compound.

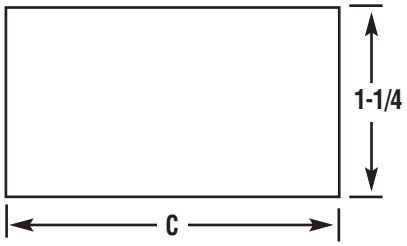


7032 7033



7034

Strip Panel Mounting Cutout Dimensions



Strip Panel & Terminal Block Connectors	
Part No.	**Style**
7032	Polarized strip panel, maximum temperature 300°F (149°C), two to twelve circuits.
7033	Polarized strip panel, maximum temperature 1000°F (538°C), two to twelve circuits.
7034	Barrier type terminal strip, two to ten circuits.

Ordering Information

7	0	3	x	–	☐☐	–	☐☐	–	☐☐	–	To complete order number see example below

T/C Calibration* **Code**

E = Chromel - Constantan
J = Iron - Constantan
K = Chromel - Alumel
T = Copper - Constantan
N = Nicrosil - Nisil
P = Plat. 10% Rh. - Plat
P = Plat. 13% Rh. - Plat
B = Plat. 30% Rh. - Plat
W = Tungsten - Tungsten Re.
U = Uncompensated

*See ordering example below

Dimensions	Number of Circuits										
	2	3	4	5	6	7	8	9	10	11	12
"A"	1 1/2"	2 1/4"	3"	3 3/4"	4 1/2"	5 1/4"	6"	6 3/4"	7 1/2"	8 1/4"	9"
"B"	1 5/16"	2 1/16"	2 13/16"	3 9/16"	4 5/16"	5 1/16"	5 13/16"	6 9/16"	7 5/16"	8 1/16"	8 13/16"

To order 7032 or 7033:
1. Give part number.
2. Specify number of circuits.
3. Name calibration code (specify each circuit if mixed). Table 1
4. Indicate vertical mounting position if other than horizontal as illustrated.
5. Specify number sequence if other than series beginning with 1.

Example: **7032 - 12 - 6K - 6J - HOR - 1 to 12**

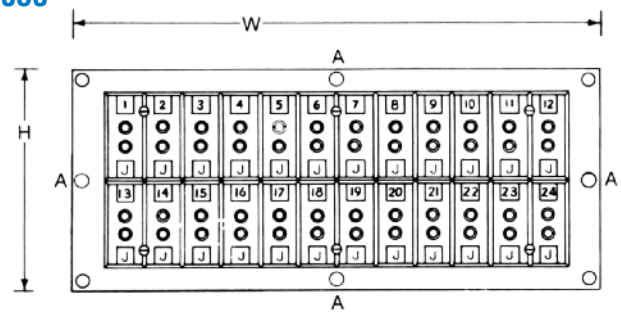
To order 7034:
1. Give part number.
2. Specify number of circuits.
3. Name calibration code (specify each circuit if mixed). Table 1

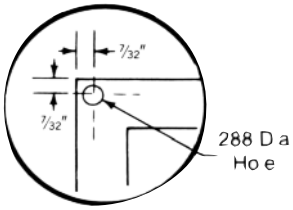
Example: **7034 - 10 - E**

Convenience Connectors, Strip Panels with Mounting Frame

An assembly of strip panel modules can be combined to accommodate any number of connections. A one-piece mounting frame made of 3/32" thick rigid steel, with dull black finish, holds strip panel modules (shown on previous page).

Part No.
7035





Strip Panel Frame Detail for Mounting Holes in Panel.

Mounting holes "A" are used only when "H" and "W" dimensions each exceed 13 1/2".

Dimensions for Panel Assembly

H_0 and W_0 are Mounting Cutout Dimensions

Number of Row		Circuits Per Row																								
		W = 2¾" W_0 = 1½"	W = 3½" W_0 = 2¼"	W = 4¼" W_0 = 3"	W = 5" W_0 = 3¼"	W = 5¾" W_0 = 4½"	W = 6½" W_0 = 5¼"	W = 7¼" W_0 = 6"	W = 8" W_0 = 6¾"	W = 8¾" W_0 = 7½"	W = 9½" W_0 = 8¼"	W = 10¼" W_0 = 9"	W = 11" W_0 = 9¾"	W = 11¾" W_0 = 10½"	W = 12½" W_0 = 11¼"	W = 13¼" W_0 = 12"	W = 14" W_0 = 12¾"	W = 14¾" W_0 = 13½"	W = 15½" W_0 = 14¼"	W = 16¼" W_0 = 15"	W = 17" W_0 = 15¾"	W = 17¾" W_0 = 16½"	W = 18½" W_0 = 17¼"	W = 19¼" W_0 = 18"
	H = 2⅝" H_0 = 1½"	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	H = 4⅜" H_0 = 3¼"	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
	H = 6⅛" H_0 = 5"	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72
	H = 7⅞" H_0 = 6¾"	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96
	H = 9⅝" H_0 = 8½"	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	H = 11⅜" H_0 = 10¼"	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144
	H = 13⅛" H_0 = 12"	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147	154	161	168
	H = 14⅞" H_0 = 13¾"	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192
	H = 16⅝" H_0 = 15½"	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180	189	198	207	216
	H = 18⅜" H_0 = 17¼"	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240

Ordering Information

1. Give catalog number.
2. Specify number of rows and circuits per row.
3. Name calibration s, use strip panel table on page 41 (specify each circuit if mixed).
4. Indicate vertical mounting position if other than horizontal as illustrated.
5. Specify numbering sequence if other than series beginning with 1.

Example: **7035 - 4 rows - 12C per row - Hor - 1 to 48**

Insulated Thermocouple and Extension Wire

Athena's thermocouple wire and thermocouple extension wire are known for premium performance and reliability. Careful selection of materials, plus the latest type of special machinery and quality control, assure superior wire uniformity.

Quality Control

Quality control of all Athena's brand thermocouple wire and thermocouple extension wire provides testing in accordance with NBS Circular 590 and are traceable to NIST.

Shipping

All Athena's duplex insulated thermocouple and extension wires are normally packaged in 1000-foot reels. This length is ±10% on each reel. However, each reel and the container in which it is shipped is marked with the exact length. On any order for either standard or special wire, we reserve the right to ship ±10% of the total amount ordered.

Calibrating, Checking and Tagging

Thermocouple wire and extension wire are available calibrated, when so specified, at an extra charge. Wires of this classification are within the Standard Limits of Error but, most important, their specific departure temperatures specified is known and can be taken into account. Each thermocouple, coil, reel, or spool of wire is checked and tagged to show the departure from the curve. Refer to the Engineering Data section of the Reference Information publication (available on request) for limits of error applicable to your particular thermocouple wire or extension wire.

Color Coding

Standard ANSI color coding is used on all insulated thermocouple wire and extension wire when type of insulation permits. In color coding, a tracer may be used to distinguish the calibration.

ANSI Type		Magnetic		ANSI Color Code		
T/C	Single	Yes	No	Single	Overall Extension Wire	Overall T/C Wire
T	TP TN		X X	Blue Red	Blue	Brown
J	JP JN	X	 X	White Red	Black	Brown
E	EP		X X	Purple Red	Purple	Brown
K	KP KN	 X	X	Yellow Red	Yellow	Brown
R, S	RP, SP RN, SN		X X	Black Red	Green	—
B	BP BN		X X	Grey Red	Grey	—
N	NP NN	 X	X	Orange Red	Orange	Brown

ANSI Letter Designations

Thermocouple and extension wires are specified by ANSI letter designations for calibration. Positive and negative legs are identified by the appropriate letter suffixes P and N, respectively.

ANSI Letter	Description	Popular Generic & Trade Names*
T	TP	Copper
	TN	Constantan, Cupron™, Advanced
J	JP	Iron
	JN	Constantan, Cupron, Advanced
E	EP	Chromel™, Tophel™, T_1
	EN	Constantan, Cupron, Advanced
K	KP	Chromel, Tophel, T_1 Thermokanthal KP
	KN	Alumel™, Nial™, T_2 Thermokanthal KN
R	RP	Platinum 13% Rhodium
	RN	Pure Platinum
S	SP	Platinum 10% Rhodium
	SN	Pure Platinum
B	BP	Platinum 30% Rhodium
	BN	Platinum 6% Rhodium
N	NP	Nicrosil
	NN	Nisil

Solid and Stranded Conductors

Thermocouple wire and extension wire are usually solid conductors. When greater flexibility is required, stranded construction is available. The accompanying table gives the stranding combinations used.

Stranding Combinations

Conductor Gauge	ANSI Type	No. of Strands	Stranding Gauge
14	All	7	22
16	All	7	24
18	All	7	26
20	All	7	28
22	All	7	30
24	All	7	32

Not all combinations are standard and may require a minimum purchase quantity.

Insulation Type

Code	Single Conductor: Insulation Wall Thickness	Single Conductor: Impregnation	Duplex Conductors: Insulation Wall Thickness	Duplex Conductors: Impregnation	Temperature Rating: Continuous	Temperature Rating: Single Reading	ANSI Physical Properties: Color Coded	ANSI Physical Properties: Abrasion Resistance	ANSI Physical Properties: Moisture Resistance	Notes
301	Amorphous Silica Fiber .015"	None	Amorphous Silica Fiber .020"	None	871°C 1600°F	1093°C 2000°F	No	Fair	Fair	
302	Double Glass Braid .012" Wall	Silicone Modified Resin	Glass Braid .006"	Silicone Modified Resin	482°C 900°F	538°C 1000°F	Yes	Good	Good	Impregnation retained to 204°C (400°F)
304	Glass Braid .006"	Silicone Modified Resin	Glass Braid .006"	Silicone Modified Resin	482°C 900°F	538°C 1000°F	Yes	Fair	Good	Impregnation retained to 204°C (400°F)
305	Double Glass Wrap .005"	High Temp. Varnish	Glass Braid .006"	Silicone Modified Resin	482°C 900°F	538°C 1000°F	Yes	Fair	Good	Impregnation retained to 204°C (400°F)
321	Hi-Temp Glass Braid .012"	Hi-Temp Varnish	Hi-Temp Glass Braid .012"	Hi-Temp Varnish	704°C 1300°F	871°C 1600°F	Yes	Good	Good	Impregnation retained to 204°C (400°F)
350	Polycrystaline Braid .012" Wall	None Modified Resin	Polycrystaline .006"	None Modified Resin	1430°C 2600°F	1430°C 2600°F	No	Good	Fair	
502	Polyvinyl .013" to #20 .014" to #16 .016" to #14	—	Polyvinyl .016"	—	-29 to +105°C -20 to +221°F	105°C 221°F	Yes	Good	Excellent	
504	Nylon .010"	—	Nylon .008" - .010"	—	150°C 300°F	150°C 300°F	Yes	Excellent	Fair	Over-all jacket is clear
505	Polyvinyl .012" - .014"	—	Ripcord	—	-29 to +105°C -20 to +221°F	105°C 221°F	Yes	Good	Excellent	
506	Teflon® TFE Tape fused .005"	—	Teflon TFE Tape fused .0075"	—	204°C 400°F	316°C 600°F	Yes	Very Good	Excellent	Aluminum/Kapton Foil Shield with #20 Nickel plated copper Drain Wire
507	Teflon FEP Extr. .008"	—	Teflon FEP Extr. .010"	—	204°C 400°F	316°C 600°F	Yes	Very Good	Excellent	
508	Teflon TFE Tape fused .005"	—	Teflon TFE Tape fused .0075"	—	260°C 500°F	316°C 600°F	Yes	Good	Excellent	
509	Teflon FEP Extr. .009"	—	Teflon FEP Extr. .010", twisted	—	204°C 400°F	316°C 600°F	Yes	Very Good	Excellent	Aluminum/Mylar shield w/ #20 drain wire
510	Polyvinyl .015"	—	Polyvinyl .020" Twisted	—	-29 to +80°C -20 to +176°F	80°C 176°F	Yes	Good	Excellent	Aluminum/Mylar shield w/ #20 drain wire
511	Fused Kapton Tape .004"	—	None Twisted	—	316°C 600°F	427°C 800°F	Both legs have tracer	Excellent	Excellent	FEP binder melts at approximately 260°C (500°F)
513	Fused Kapton Tape .006"	—	Fused Kapton .004"	—	316°C 600°F	427°C 800°F	Yes	Excellent	Excellent	FEP binder melts at approximately 260°C (500°F)
516	Extruded PFA .008"	—	Extruded PFA .010"	—	260°C 500°F	316°C 600°F	Yes	Good	Excellent	

□□ – □□□ – □□ – □ – □□□ – □□

T/C Type Code
B
E
J
K
N
NM
R
S
T
W5

Ext. Wire Code
BX = Platinum 30% Rhodium - Platinum 6% Rhodium
EX = Chromel - Constantan
JX = Iron - Constantan
KX = Chromel - Alumel
NX = Nicrosil - Nisil
M = Nickel - Nickel Moly
RSX = Platinum 13% Rhodium - Platinum
RSX = Platinum 10% Rhodium - Platinum
TX = Copper - Constantan
W5X = Tungsten 5% Rhenium - Tungsten 26% Rhenium

B & S Gauge Size
Code
14 = 14
16 = 16
18 = 18
20 = 20
22 = 22
24 = 24
26 = 26
28 = 28
30 = 30

Grade & Conductor
Code
1 = Solid T/C grade
2 = Solid premium limits T/C grade
3 = Stranded T/C grade
4 = Stranded premium limits T/C grade
5 = Solid extension grade
6 = Solid premium limits extension grade
7 = Stranded extension grade
8 = Stranded premium limits extension grade

Insulation Type
Code
See above chart

Overbraid Selection
Code
SS = Stainless steel wire braid
CU = Tinned copper wire braid
0 = None

Selection Guide for Protection Tubes

Application	Protection Tube Material
Heal Treating	
Annealing	
Up to 1300°F (704°C)	Wrought iron
Over 1300°F (704°C)	28% chrome iron or Inconel®
Carburizing hardening	
Up to 1500°F (816°C)	Wrought iron or 28% chrome iron
1500 to 2000°F (1093°C)	28% chrome iron or Inconel
Over 2000°F (1093°C)	Ceramic
Nitriding salt baths	
Cyanide	28% chrome iron
Neutral	Nickel
High speed	Ceramic
Iron and steel	
Basic oxygen furnace	Quartz
Blast furnaces	
Downcomer	Inconel, 28% chrome iron
Stove Dome	Silicon carbide
Hot blast main	Inconel
Stove trunk	Inconel
Stove outlet flue	Wrought iron
Open hearth	
Flues and stack	Inconel, 28% chrome iron
Checkers	Inconel, Cermet
Waste heat boiler	28% chrome iron, Inconel
Billet heating slab heating and butt welding	
Up to 2000°F (1093°C)	28% chrome iron, Inconel
Over 2000°F (1093°C)	Ceramic, silicon carbide
Bright annealing batch	
Top work temperature	Not required (use bare Type J thermocouple)
Bottom work temperature	28% Chrome iron
Continuous furnace section	Inconel, ceramic
Forging	Silicon carbide, ceramic
Soaking pits	
Up to 2000°F (1093°C)	Inconel
Over 2000°F (1093°C)	Ceramic, silicon carbide
Nonferrous metals	
Aluminum	
Melting	Cast iron (white-washed)
Heat treating	Wrought iron
Brass or bronze	Not required (use dip-type thermocouple)
Lead	28% chrome iron, wrought iron
Magnesium	Wrought iron, cast iron
Tin	Extra heavy carbon steel
Zinc	Extra heavy carbon steel
Pickling tanks	Chemical lead
Cement:	
Exit flues	Inconel, 28% chrome iron
Kilns-heating zone	Inconel
Ceramic:	
Kilns	Ceramic and silicon carbide
Dryers	Wrought iron, silicon carbide
Vitreous enameling	Inconel, 28% chrome iron

Application	Protection Tube Material
Glass	
For hearths and feeders	Platinum thimble
Lehrs	Wrought iron
Tanks	
Roof and wall	Ceramic
Flues and checkers	28% chrome iron, Inconel
Paper	
Digesters	Type 316 stainless steel, 28% chrome iron
Petroleum	
Dewaxing	Type 304 stainless steel or carbon steel
Towers	Type 304 stainless steel or carbon steel
Transfer lines	Type 304 stainless steel or carbon steel
Fractionating column	Type 304 stainless steel or carbon steel
Bridgewall	Type 304 stainless steel or carbon steel
Power	
Coal-air mixtures	Type 304 stainless steel
Flue gases	Wrought iron or 28% chrome iron
Preheaters	Wrought iron or 28% chrome iron
Steel lines	Type 347 or 316 stainless steel
Water lines	Carbon steel
Boiler tubes	Type 309 or 310 stainless steel
Gas producers	
Producer gas	28% chrome iron
Water gas carburetor	Inconel, 28% chrome iron
Super heater	Inconel, 28% chrome iron
Tar stills	Carbon steel
Incinerators	
Up to 2000°F (1093°C)	28% chrome iron, Inconel
Over 2000°F (1093°C)	Ceramic (primary) Silicon carbide (secondary)
Food	
Baking ovens	Wrought iron
Charretort, sugar	Wrought iron
Vegetables and fruit	Type 304 stainless steel
Sanitary	Type 316 stainless steel
Chemical	
Acetic acid	
10 to 50%, 70°F	Type 304 stainless steel
50%, 212°	Type 316 stainless steel
99%, 70 to 212°F	Type 430 stainless steel
Alcohol, ethyl, methyl	
70 to 212°F	Type 304 stainless steel
Ammonia	
All concentration, 70°F	Type 304 stainless steel

Selection Guide for Protection Tubes

Application	Protection Tube Material
Chemical	
Ammonium chloride	
All concentration, 212°F (100°C)	Type 304 stainless steel
Ammonium nitrate	
All concentration, 70 to 212°F (22 to 100°C)	Type 304 stainless steel
Ammonium sulphate	
10% to saturated, 212°F (100°C)	Type 316 stainless steel
Barium chloride	
All concentration, 70°F (22°C)	Monel®
Barium hydroxide	
All concentration, 70°F (22°C)	Carbon steel
Barium sulfate	Nichrome
Brines	Monel
Bromine	Tantalum
Butadiene	Type 304 stainless steel
Butane	Type 304 stainless steel
Butylacetate	Monel
Butyl alcohol	Copper
Calcium chlorate	
Dilute, 70 to 150°F (22 to 66°C)	Type 304 stainless steel
Calcium hydroxide	
10 to 20%, 212°F (100°C)	Type 304 stainless steel
50%, 212°F (100°C)	Type 316 stainless steel
Carbolic acid	
All 212°F (100°C)	Type 316 stainless steel
Carbon dioxide	
wet or dry	2017-T4 aluminum, Monel
Chlorine gas	
Dry, 70°F (22°C)	Type 316 stainless steel
Moist, 20 to 212°F (-7 to 100°C)	Hastelloy® C
Chromic acid	
10 to 50%, 212°F (100°C)	Type 315 stainless steel
Citric acid	
15%, 70°F (22°C)	Type 304 stainless steel
15%, 212°F (100°C)	Type 315 stainless steel
Concentrated, 212°F (100°C)	Type 316 stainless steel
Copper nitrate	Type 304 stainless steel
Copper sulphate	Type 304 stainless steel
Cresols	Type 304 stainless steel
Cyanogen gas	Type 304 stainless steel
DOWTHERM™	Carbon steel
Ether	Type 304 stainless steel
Ethyl acetate	Monel
Ethyl chloride	
70°F (22°C)	Type 304 stainless steel
Ethyl sulphate	
70°F (22°C)	Monel
Ferric chloride	
5%, 70°F (22°C) to boiling	Tantalum

Application	Protection Tube Material
Chemical	
Ferric sulphate	
5%, 70°F (22°C)	Type 304 stainless steel
Ferrous sulphate	
Dilute 70°F (22°C)	Type 304 stainless steel
Formaldehyde	Type 304 stainless steel
Formic acid	
5%, 70 to 150°F (22 to 66°C)	Type 304 stainless steel
Freon	Monel
Gallic acid	
5%, 70 to 150°F (22 to 66°C)	Monel
Gasoline	
70°F (22°C)	Type 304 stainless steel
Glucose	
70°F (22°C)	Type 304 stainless steel
Glycerine	
70°F (22°C)	Type 304 stainless steel
Glycerol	Type 304 stainless steel
Hydrobromic acid	
98%, 212°F (100°C)	Hastelloy B
Hydrochloric acid	
1%, 5%, 70°F (22°C)	Hastelloy C
1%, 5%, 212°F (100°C)	Hastelloy B
25%, 70 to 212°F (22 to 100°)	Hastelloy B
Hydrofluoric acid	Hastelloy C
Hydrogen peroxide	
70 to 212°F (22 to 100°)	Type 316 stainless steel
Hydrogen sulphide	
Wet and dry	Type 316 stainless steel
Iodine	
70°F (22°C)	Tantalum
Lactic acid	
5%, 70°F (22°C)	Type 304 stainless steel
5%, 150°F (66°C)	Type 304 stainless steel
10%, 212°F (100°C)	Tantalum
Magnesium chloride	
5%, 70°F (22°C)	Monel
5%, 212°F (100°C)	Nickel
Magnesium sulphate	
Hot and cold	Monel
Muriatic acid	
70°F (22°C)	Tantalum
Naphtha	
70°F (22°C)	Type 304 stainless steel
Natural gas	
70°F (22°C)	Type 304 stainless steel
Nickel chloride	
70°F (22°C)	Type 304 stainless steel
Nickel sulphate	
Hot and cold	Type 304 stainless steel
Nitric acid	
5%, 70°F (22°C)	Type 304 stainless steel
20%, 70°F (22°C)	Type 304 stainless steel
50%, 70°F (22°C)	Type 304 stainless steel
50%, 212°F (100°C)	Type 304 stainless steel
65%, 212°F (100°C)	Type 316 stainless steel

Selection Guide for Protection Tubes

Application	Protection Tube Material
Chemical	
Nitric acid	
Concentrated, 70°F (22°C)	Type 304 stainless steel
Concentrated, 212°F (100°C)	Tantalum
Nitrobenzene	
70°F (22°C)	Type 304 stainless steel
Oleic acid	
70°F (22°C)	Type 316 stainless steel
Oleum	
70°F (22°C)	Type 316 stainless steel
Oxalic acid	
5%, hot and cold	Type 304 stainless steel
10%, 212°F (100°C)	Monel
Oxygen	
70°F (100°C)	Steel
Liquid	Stainless steel
Elevated temperatures	Stainless steel
Palmitic acid	Type 316 stainless steel
Pentane	Type 304 stainless steel
Phenol	Type 304 stainless steel
Phosphoric acid	
1%, 5%, 70°F (22°C)	Type 304 stainless steel
10%, 70°F (22°C)	Type 316 stainless steel
10%, 212°F (100°C)	Hastelloy® C
30%, 70°F, 212°F (22°C,100°C)	Hastelloy B
85%, 70°F, 212°F (22°C, 100°C)	Hastelloy B
Picric acid	
70°F (22°C)	Type 304 stainless steel
Potassium bromide	
70°F (22°C)	Type 316 stainless steel
Potassium carbonate	
70°F (22°C)	Type 304 stainless steel
Potassium chlorate	
70°F (22°C)	Type 304 stainless steel
Potassium hydroxide	
5%, 70°F (22°C)	Type 304 stainless steel
25%, 212°F (100°C)	Type 304 stainless steel
60%, 212°F (100°C)	Type 316 stainless steel
Potassium nitrate	
5%, 70°F (22°C)	Type 304 stainless steel
5%, 212°F (100°C)	Type 304 stainless steel
Potassium permanganate	
5%, 70°F (22°C)	Type 304 stainless steel
Potassium sulphate	
5%, 70°F (22°C)	Type 304 stainless steel
Potassium sulphide	
70°F (22°C)	Type 304 stainless steel
Propane	Type 304 stainless steel
Pyrogalic acid	Type 304 stainless steel
Quinine bisulphate	
Dry	Type 316 stainless steel
Quinine sulphate	
Dry	Type 304 stainless steel
Sea water	Monel

Application	Protection Tube Material
Chemical	
Salicylic acid	Nickel
Sodium bicarbonate	
All concentration, 70°F (22°C)	Type 304 stainless steel
Saturated, 70 to 212°F (22 to 100°C)	Type 304 stainless steel
Sodium carbonate	
5%, 70 to 150°F (22 to 66°C)	Type 304 stainless steel
Sodium chloride	
5%, 70 to 150°F (22 to 66°C)	Type 316 stainless steel
Saturated, 70 to 212°F (22 to 100°C)	Type 316 stainless steel
Sodium fluoride	
5%, 70°F (22°C)	Monel
Sodium hydroxide	Type 304 stainless steel
Sodium hypochlorite	
5% still	Type 316 stainless steel
Sodium nitrate	
fused	Type 316 stainless steel
Sodium peroxide	Type 304 stainless steel
Sodium sulphate	
70°F (22°C)	Type 304 stainless steel
Sodium sulphide	
70°F (22°C)	Type 316 stainless steel
Sodium sulphite	
150°F (66°C)	Type 304 stainless steel
Sulphur dioxide	
Moist gas, 70°F (22°C)	Type 316 stainless steel
Gas, 575°F (302°C)	Type 304 stainless steel
Sulphur	
Dry-molten	Type 304 stainless steel
Wet	Type 316 stainless steel
Sulphuric acid	
5%, 70 to 212°F (22 to 100°C)	Hastelloy B
10%, 70 to 212°F (22 to 100°C)	Hastelloy B
50%, 70 to 212°F (22 to 100°C)	Hastelloy B
90%, 70°F (22°C)	Hastelloy B
90%, 212°F (100°C)	Hastelloy D
Tannic acid	
70°F (22°C)	Type 304 stainless steel
Tartaric acid	
70°F (22°C)	Type 304 stainless steel
150°F (66°C)	Type 316 stainless steel
Toluene	2017-T4 aluminum
Turpentine	Type 304 stainless steel
Whiskey and wine	Type 304 stainless steel
Xylene	Copper
Zinc chloride	Monel
Zinc sulphate	
5%, 70°F (22°C)	Type 304 stainless steel
Saturated, 70°F (22°C)	Type 304 stainless steel
25%, 212°F (100°C)	Type 304 stainless steel

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