

7EF/7HF/7EC/7ES Temperature Controllers

ADVANTAGE EZ Series 7EF / 7HF / 7EC / 7ES 1/8 DIN Temperature Controllers

- **Dual 4 Digit LED Display**
- **Universal Input (6 T/C, RTD, mV, V, mA)**
- **Autotuning**
- **NEMA 4X**
- **100 to 240 Vac Switching Power Supply**
- **Algorithms for Heat or Heat/Cool Control**
- **2 Independent Setpoints Selectable from External Input Contact (7EF & 7HF)**
- **Up to 4 Outputs**
- **Up to 3 Independent Alarms Configurable with Automatic or Manual Reset**
- **Control Output Disable Function**
- **0 to 20 mA or 4 to 20 mA Output (7EC)**



The Advantage EZ 1/8 DIN Controllers are configurable autotuning controllers for applications where heater breakdown, RS-485 communications and 4 digit display are required.

Optional Features

- Opto-isolated RS-485 Serial Communication Interface with 3 Protocols
- Instrument Configurable by Keyboard or Through Serial Link
- Heater Breakdown Alarm and Load Current Display in Engineering Units (7EF/7HF)

Introduction

The Barber-Colman Series 7 establishes a new class of microprocessor based temperature controllers. The Series 7 offers a variety of standard features commonly found as options on our competitors controllers.

Light and compact, the Series 7 is able to perform in the most demanding applications with reliable control. NEMA 4X faceplates allow these units to be used in applications where washdowns and dust conditions exist.

Series 7 controllers are easy to configure and use. Even operators without skills in temperature process control or knowledge of PID control parameters can obtain perfect control. For best results in control stability, simply:

- wire the instrument
- configure the setpoint and alarm thresholds
- initiate the autotune function

7EF/7HF/7EC/7ES Temperature Controllers

7EF/7HF Specifications

Case:	ABS black. Self-extinguishing degree V-0 according to UL, VDE and CSA.
Front Protection:	Designed and tested for IP65 and NEMA 4X for indoor locations (when panel gasket is installed).
Installation:	Panel mounting by means of brackets.
Rear Terminal Block:	Up to 21 screw terminals, with safety rear cover.
Dimensions:	48 x 96 mm (1.890 x 3.780 in.) according to DIN 43700; 116 mm (4.567 in.) deep.
Weight:	400 grams maximum (1 pound).
Power Supply	
(Switch Mode):	100 to 240 Vac, 50/60 Hz (10% to -15% of the nominal value).
Power Consumption:	11 VA.
Insulation Resistance:	Greater than 100 M Ω according to IEC 348.
Isolation Voltage:	1500 Vrms according to IEC 348.
D/A Conversion:	Dual slope integration.
Noise Immunity:	a) Electrical fast transient/burst requirements: Severity Level 3 (according to IEC 801-4). b) Electric discharge requirements: Severity Level 8 (according to IEC 801-2).
Sampling Time:	250 ms for linear inputs. 500 ms for TC or RTD inputs.
Accuracy:	$\pm 0.2\%$ full scale value @ 25°C and nominal power supply voltage.
Common Mode	
Rejection Ratio:	120 dB @ 50/60 Hz.
Normal Mode	
Rejection Ratio:	60 dB @ 50/60 Hz.
Operating Temperature:	From 0 to 50°C.
Storage Temperature:	From -20 to 70°C.
Humidity:	From 20% to 85% RH non-condensing.
Protection:	a) Watch dog for automatic reset. b) DIP Switches for configuration and calibration parameters.

Inputs (All inputs are factory calibrated and selectable from the keyboard.)

Thermocouple	
Types:	J, K, L, R, S and N are keyboard configurable.
Engineering Units:	°C and °F keyboard configurable.
Sensor Break:	Downscale or upscale programmable. On RTD inputs, an OVERRANGE is indicated when input resistance is less than 15 Ω (short circuit sensor detection.)
Reference Junction:	Automatic compensation for an ambient temperature between 0 and 50 °C.
Reference Junction Drift:	0.1 °C/°C.
Input Impedance:	Greater than 1 M Ω .
Calibration:	According to IEC 584-1.

7EF/7HF/7EC/7ES Temperature Controllers

7EF/7HF Specifications (continued)

Standard Ranges

TC Type	Range
L	0 to 400.0 °C
L	0 to 900 °C
J	0 to 400.0 °C
J	0 to 1000 °C
K	0 to 400.0 °C
K	0 to 1200 °C
N	0 to 1400 °C
R	0 to 1760 °C
S	0 to 1760 °C
L	0 to 1650 °F
J	0 to 1830 °F
K	0 to 2190 °F
N	0 to 2550 °F
R	0 to 3200 °F
S	0 to 3200 °F

NOTE: For TC inputs, the minimum span is 300 °C or 600 °F, which makes it possible to increase the sensitivity of the control parameters.

RTD Input

RTD Type:	Pt 100 3 wire connection.
Calibration:	According to DIN 43760.
Line Resistance:	Maximum of 20 Ω/wire with no appreciable error.
Engineering Units:	°C and °F keyboard configurable.
Sensor Break Detection:	Open sensor (one or more open wires), and short circuit sensor detection.

Standard Ranges

°C	°F
-199.9 to 400.0 °C	-199.9 to 400.0 °F
-200 to 800 °C	-330 to 1470 °F

NOTE: For RTD inputs, the minimum span is 100 °C or 200 °F, which makes it possible to increase the sensitivity of the control parameters.

mAdc and Vdc Linear Inputs

mAdc Input (Standard):	0 to 20 mAdc and 4 to 20 mAdc keyboard configurable.
Input Impedance:	Less than 5 Ω.
Vdc Input:	0 to 5 Vdc and 1 to 5 Vdc, configurable. Input impedance greater than 200 KΩ. 0 to 10 Vdc and 2 to 10 Vdc configurable. Input impedance greater than 400 KΩ. 0 to 60 mVdc and 12 to 60 mV configurable. Input impedance greater than 1 MΩ.
Readout:	Keyboard configurable from -1999 to 4000.
Decimal Point:	Configurable to any position.

7EF/7HF/7EC/7ES Temperature Controllers

7EF/7HF Specifications (continued)

Standard Ranges

Input	Impedance
0-20 mA	Less than 5 Ω
4-20 mA	Less than 5 Ω
0-60 mV	Greater than 1M Ω
12-60 mV	Greater than 1M Ω
0-5 V	Greater than 200K Ω
1-5 V	Greater than 200K Ω
0-10 V	Greater than 400K Ω
2-10 V	Greater than 400K Ω

Current Transformer Input for OUT 1 Heater Breakdown Detection

(Optional, 7EF/7HF only)

This feature allows measurement of the load current by means of a current transformer and signals an alarm condition when the current is below a pre-programmed threshold value.

Input Range:	50 mAac.
Scaling:	Configurable from 10 Amps to 100 Amps (with a 1 Amp step).
Resolution:	- for full scale up to 20 Amps: 0.1 Amp. - for full scale from 21 Amps to 100 Amps: 1 Amp.
Active Period:	- for relay output: NO or NC configurable. - for SSR output: logic level 1 or 0 configurable.
Minimum On Time to Perform the measurement:	50 ms.

Logic Input

The 7EF/7HF is equipped with a logic input to select between the main and auxiliary setpoint (SP or SP2).

Setpoints

Two setpoints available:	- Main Setpoint (SP). - Auxiliary Setpoint (SP2).
Setpoint Transfer:	Transfer between SP and SP2 by logic input (contact closure). Transfer can be either by a step or by a ramp with two different configurable rates of change (ramp up and ramp down).
Setpoint Limits:	Setpoint low limit and setpoint high limit are configurable.

Control Action

Algorithm:	PID - Smart AT.
Type:	One (heating) or two (heating/cooling) control outputs.
Proportional Band:	Configurable - From 1.0% to 100.0% of the input span for a process with one control output. - From 1.5% to 100.0% of the input span for a process with two control outputs. Setting the PB equal to 0 changes the control action to ON/OFF.

7EF/7HF/7EC/7ES Temperature Controllers

7EF/7HF Specifications (continued)

Hysteresis (for ON/OFF

control action):

Configurable from 0.1% to 10.0% of the input span.

Integral Time:

Configurable from 20 seconds to 20 minutes (or off).

Derivative Time:

Configurable from 1 second to 10 minutes (or off).

Integral Preload:

Configurable:

- for 1 control output, from 0 to 100% of the output range.

- for 2 control outputs, from -100% to 100% of the heating/cooling output range.

Out 1 (heating) Cycle Time: From 1 to 200 seconds.

AUTO/MANUAL Mode: Selectable by front pushbutton.

AUTO/MANUAL Transfer: Bumpless.

Two Control Outputs (Heating/Cooling)

Relative Cooling Gain: Keyboard configurable from 0.20 to 1.00.

Cooling Cycle Time: From 1 to 200 seconds.

Overlap/Deadband: Keyboard configurable from -20% (deadband) to 50% (overlap) of the PB.

NOTE: By setting the proper cooling medium (air, oil or water) during configuration, the instrument will automatically set the cooling (OUT 2) parameters.

Control Outputs

Type: Time Proportioning.

Direct/Reverse Action: Keyboard configurable.

Output Level Indication: Separately display of the Output 1 level (heating) and the Output 2 level (cooling).

Output Status Indication: Two LED indicators (OUT 1 and OUT 2) are lit when their respective output is ON.

Output Level Limits:

- For 1 control output: From 0 to 100% of the output span.
- For 2 control outputs: From -100 to 100% of the main (heating) output span.

This function can be made active at instrument startup for a configurable time, and it can be left active in order to avoid thermal shock or preheating.

Relay Outputs

Output Cycle Time: Configurable from 1 second to 99 seconds.

Output 1: SPDT contact. The selection of the NO or NC contact is made by jumper.

Contact Rating: 3 Amps at 250 Vac on a resistive load.

Output 2 (Cooling): SPST contact with rated current 2 Amps at 250 Vac on a resistive load.

Logic Voltage for SSR Driver

(Output 1 Only):

Logic Level 0: Less than 0.5 Vdc.

Logic Level 1: 14 Vdc \pm 20% @ 17 mA max.

24 Vdc \pm 20% @ 1 mA max.

Output Safety Value: When the instrument detects an out of range or a sensor break condition, it can force the output to a configurable safety value.

7EF/7HF/7EC/7ES Temperature Controllers

7EF/7HF Specifications (continued)

Output Disable Function

This function disables the control output allowing the instrument to operate as an indicator. When control is resumed, "turn off" is disabled and the instrument will operate as follows: the integral component of the output signal will be set to zero, the soft start function will be enabled, and the alarm masking function will be enabled.

Alarms

This instrument is equipped with two independent outputs configurable as:

- Heating + Alarm 1 + Alarm 2
- Heating + Cooling + Alarm 1

An optional 4 output is available as Alarm 3 or the heater breakdown alarm output.

Output Action:	Direct or reverse function configurable.
Alarm Functions:	Each alarm can be configured as process alarm, band alarm or deviation alarm.
Alarm Reset:	Automatic or manual reset programmable on each alarm.
Alarm Masking:	Each alarm can be configured as a masked or standard alarm. Alarm masking allows suppression of alarm indicators at startup and after a setpoint change.
Alarm Indications:	Two indicators show when the respective alarm is ON.
Alarm Outputs:	Two SPST relays. Contact rated at 2 Amps, 250 Vac on resistive load.

Process Alarm

Operating Mode:	High or low configurable.
Alarm Setpoint:	Configurable in engineering units within the entire range.
Hysteresis:	Configurable from 0.1% to 10.0% of the input span.

Band Alarm

Operating Mode:	Inside or outside band configurable.
Alarm Setpoint:	Configurable from 0 to 500 units.
Hysteresis:	Configurable from 0.1% to 10.0% of the input span.

Deviation Alarm

Operating Mode:	High or low configurable.
Alarm Setpoint:	Configurable from -500 to 500 units.
Hysteresis:	Configurable from 0.1% to 10.0% of the input span.

Hbd Alarm

Operating Mode:	(for instruments with heater breakdown input option.) Low alarm.
Alarm Setpoint:	Configurable in engineering units within the readout span.

Digital Communications (Optional)

Type:	RS-485.
Protocol Type:	MODBUS, JBUS, or Barber-Colman proprietary polling/selecting.
Baud Rate:	Keyboard configurable from 600 to 19200 BAUD.
Byte Format:	7 or 8 bit configurable.
Parity:	Even, odd or none configurable.
Stop Bit:	One.
Address:	- From 1 to 31 for Barber-Colman protocol. - From 1 to 255 for all other protocols.
Output Voltage Levels:	According to EIA standards.

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7EC Specifications

Same as 7EF/7HF except:

Outputs

Output 1

Type:

Opto-isolated 0 to 20 mA or 4 to 20 mA configurable.

Function:

Programmable as:

- control output (heating or cooling).
- retransmission of the measured value.
- retransmission of the operating setpoint.

Scaling:

Configurable from -1999 to 9999.

Maximum Load:

500 Ω .

Resolution:

- 0.1% when used as control output.
- 0.05% when used as analog retransmission.

Digital Filter:

A digital filter is available for retrans out (with same time constant as the readout).

Output Level Indication

(as control output only):

From 0.0 to 100.0%.

Output Status Indication:

The OUT 1 indicator flashes with a duty cycle proportional to the output level.

Output 2

Type:

SPST relay contact (NO or NC selectable by jumper) with rated current of 3 Amps at 250 Vac on a resistive load.

Function:

Configurable as:

- Control output (heating or cooling).
- Alarm 1 output.

Output 3

Type:

Relay with SPST contact with rated current 2 Amps at 250 Vac on resistive load.

Function:

Configurable as:

- Control output (heating or cooling).
- Alarm 2 output.

Output 4

Type:

Relay with SPST contact with rated current 2 Amps at 250 Vac on resistive load.

Function:

Configurable as:

- Alarm 3 output.

Auxiliary Power Supply:

Non-isolated 24 Vdc ($\pm 10\%$) power supply rated at 25 mAdc, short circuit protected.

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7EC Specifications (continued)

Inputs

This instrument is equipped with a universal input capable of measuring TC Types, RTD, mA, mV and Volt signals. The only difference between the 7EC and the 7EF/7HF is the addition of TC Type T with the following ranges:

TC Type	Ranges	
T	0 to 400.0 °C	0 to 750 °F

Logic Inputs

The 7EC is equipped with 2 logic inputs used to select between as many as 4 setpoints (SP, SP2, SP3, SP4).

Setpoints

Four setpoints are available:

- Main Setpoint (SP).
- Auxiliary Setpoint (SP2).
- Auxiliary Setpoint (SP3).
- Auxiliary Setpoint (SP4).

Setpoint Transfer:

Transfer from setpoint to setpoint is by logic input (contact closure). Transfer can be by a step or a ramp, with two different configurable rates of change (ramp up and ramp down).

Setpoint Limits:

Setpoint low limit and setpoint high limit are configurable.

Control Action

Proportional Band:

Configurable from 1.0% to 200.0% of the input span. Setting a PB equal to 0 sets the control action to ON/OFF.

Integral Time:

Configurable from 1 second to 20 minutes (or off).

NOTE: The Heater Breakdown Alarm is not available in the 7EC.

Noise Immunity

The instrument conforms to EEC 89/336 directive regarding electromagnetic compatibility.

Emissions:

Generic emission standard EN 50081-2.
Basic emission standard EN 55011.

Immunity:

Generic immunity standard EN 50082-2, basic immunity standard:
a. Electrical discharge requirements: Severity Level 3 (according to IEC 801-2).
b. Electrical fast transient/burst requirements: Severity Level 3 (according to IEC 801-2).
c. Radiated electromagnetic field immunity between 27 MHz - 500 MHz, 10 V/m (according to IEC 801-3).

7EF/7HF/7EC/7ES Temperature Controllers

7ES Specifications

Same as 7EF/7HF except:

Control Outputs

Type: 3-wire servomotor drive (with slidewire feedback) or time proportioning.
Direct/Reverse Action: Keyboard configurable.
Output Level Indication: The instrument separately displays valve position, or the Output 1 level (heating) and the Output 2 level (cooling).
Output Status Indications: Two LED indicators (▲ and ▼) are lit when their respective output is ON.
Output Level Limits:
- For 1 control output: From 0 to 100% of the output span.
- For 2 control outputs: From -100 to 100% of the main (heating) output span.
This function can be made active at instrument startup for a configurable time, and it can be left active in order to avoid thermal shock or preheating.

Relay Outputs

Output Cycle Time: Configurable from 1 to 200 seconds.
Output 1: 2 relays interlocked (Open/Close), with SPST contacts (NO).
Contact Rating: 3 Amps at 250 Vac on a resistive load.
Function: Programmable as:
- Servomotor Output
- 1 Time Proportioning Output
Output 2: 1 relay, with SPST contacts (NO).
Contact Rating: 3 Amps at 250 Vac on a resistive load.
Function: Programmable as:
- Time Proportioning Output (only if Output 1 is also time proportioning)
- Alarm 1 Output
Output 3: 1 relay, with SPST contacts (NO).
Contact Rating: 3 Amps at 250 Vac on a resistive load.
Function: Programmable as:
- Alarm 2 Output and Alarm 3 Output (logically ORed)

Control Action

Proportional Band: Configurable from 1.0% to 200.0% of the input span. Setting the PB equal to 0 sets the control action to ON/OFF.
Integral Time: Configurable from 1 second to 20 minutes (or off).

NOTE: The Heater Breakdown Alarm is not available in the 7ES.

Inputs

This instrument is equipped with a universal input capable of measuring TC Types, RTD, mA, mV and Volt signals. The only difference between the 7ES and the 7EF/7HF is the addition of TC Types T and B with the following ranges:

TC Type	Ranges	
T	0 to 400.0 °C	0 to 750 °F
B	0 to 1820 °C	0 to 3310 °F

7EF/7HF/7EC/7ES Temperature Controllers

7ES Specifications (continued)

Logic Inputs

The 7ES is equipped with 3 logic inputs:

- Logic Input 1 is used to select between Setpoint 1 or 2.
- Logic Input 2 is used to select between Auto/Manual or Rev/Dir.
- Logic Input 3 is used to select between local or remote control.

Feedback Potentiometer

Range: From 100 to 10 K Ω

Operator Interface

(7EF Shown)









Upper Display

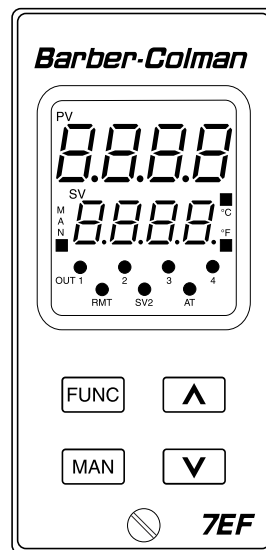
Shows the actual measured value or (during configuration) the value of the selected parameter.

Lower Display

Shows the operating setpoint; the output level; the heater current (in Amps); and the abbreviated name of the selected parameter.

Keyboard Description

-  Decreases the selected parameter.
-  Increases the selected parameter.
-  Displays in sequence all parameters and saves new settings or displays the output level and heater current.
-  Switches from auto to manual mode and vice versa.
-  +  Starts the default parameter loading procedure.
-  +  Enables/disables the output power OFF function.



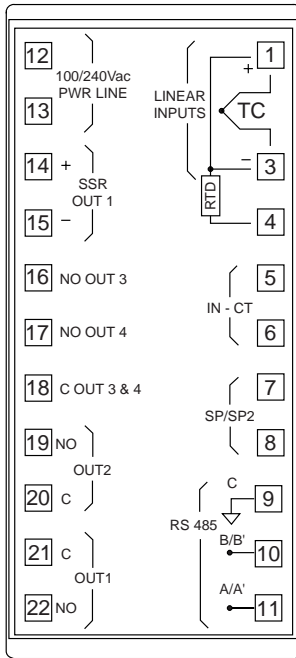
Indicators

- RMT** Lit when the instrument is under the control of digital communications.
- SV2** Flashes at a slow rate when SP2 is used. Flashes at a faster rate when a setpoint from digital communications is used.
- AT** Flashes during startup autotuning. Lit steadily during adaptive autotuning.
- MAN** Lit when in the manual mode.
- °C/°F** For TC or RTD input, one of these indicators is lit to show the selected units.
- OUT1** Lit when the Output 1 is ON.
- OUT2** Lit when Output 2 is ON or Alarm 1 is in the alarm state.
- OUT3** Lit when Alarm 2 is in the alarm state. Flashes at a slow rate when the heater current is lower than the programmed threshold (HBD). Flashes at a faster rate when the HBD alarm and Alarm 2 are both in the alarm state.
- OUT4** Lit when Alarm 3 is in the alarm state.

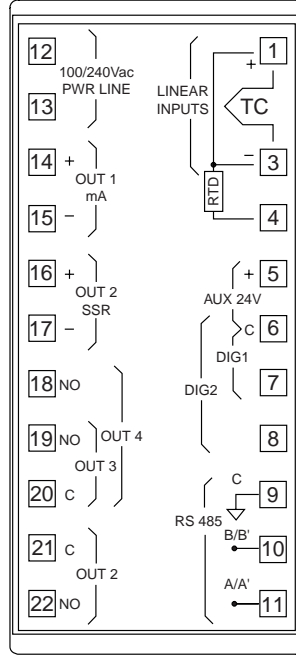
7EF/7HF/7EC/7ES Temperature Controllers

Wiring

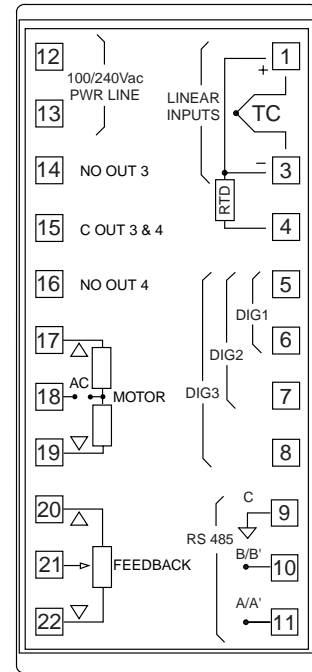
Rear Terminal Block



7EF/7HF



7EC

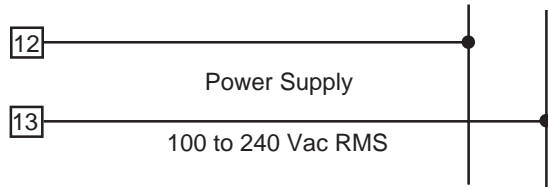


7ES

7EF/7HF/7EC/7ES Temperature Controllers

Wiring (continued)

Power Line Wiring (all models)



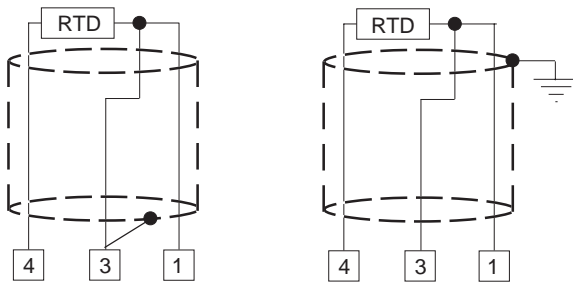
NOTE: Connect neutral to terminal 12.

To avoid electric shock, connect the power line at the end of the wiring procedure.

Input Wiring (all models)

NOTE: Do not run input wires together with power cables. For TC wiring use proper compensating cable, preferably shielded. If shielded cable is used, it should be grounded at one point only.

Do not run RTD wires together with power cables. If shielded cable is used, it should be grounded at one point only. Use copper wires of the appropriate size (see "Specifications").



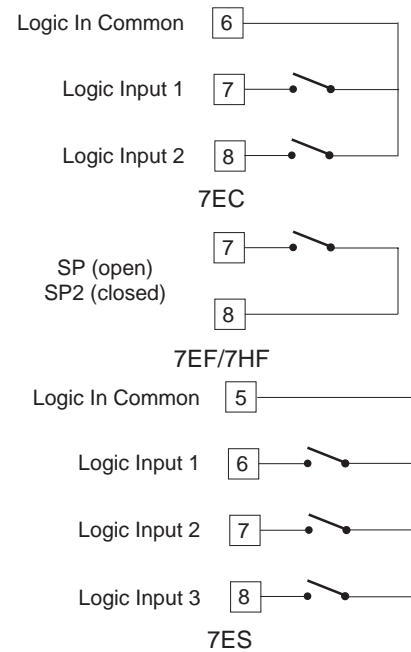
RTD Input Wiring

The resistance of the 3 wires must be the same.

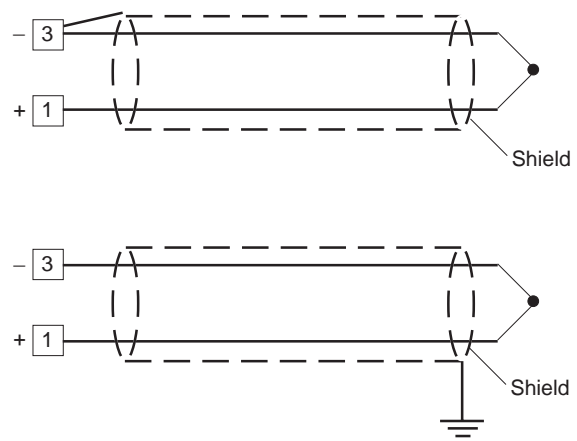
NOTE: Any external components (like zener diodes etc.) connected between sensor and input terminals may cause errors in measurement due to excessive or unbalanced line resistance, or possible leakage currents.

Logic Input Wiring (all models)

For logic inputs, use an external contact with a contact rating of at least 0.5 mA, 5 Vdc. The instrument requires at least 100 milliseconds to recognize a change in contact status.



Thermocouple Input Wiring

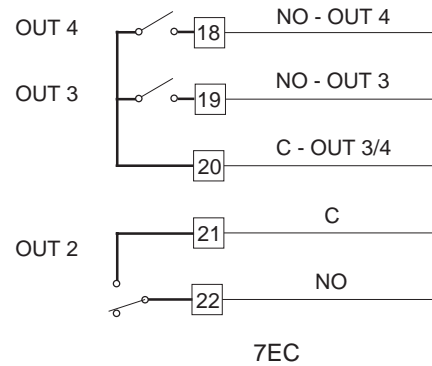
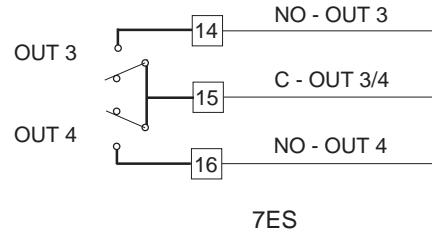
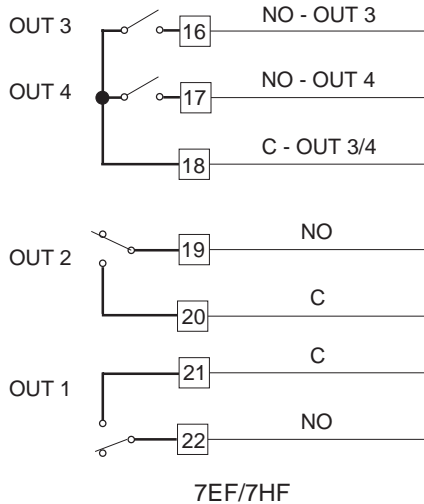


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Wiring (continued)

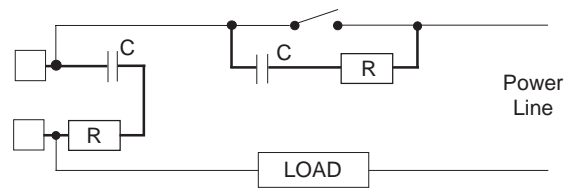
Relay Output Wiring (all models)

The relay outputs are protected by a varistor. Refer to the specifications for contact ratings of individual relays.



Inductive Loads

High voltage transients may occur when switching inductive loads. These transients may introduce disturbances which can affect the performance of the instrument. The internal varistor assures protection up to 0.5 Amp of inductive component of the load. The same problem may occur when a switch is used in series with the internal contacts. In this case, it is recommended to install an additional RC network across the external contact as shown.



External Switch in Series with the Internal Contact

The value of capacitor (C) and resistor (R) are shown in the following table.

Load Current	C (uF)	R (W)	Resistor Power (W)	Resistor and Capacitor Voltage
Less than 150 mA	0.1	22	2	260
Less than 0.5 Amp	0.33	47	2	260
Less than 1 Amp	0.47	47	2	260

Relay output wiring must be as far away as possible from input or communication cables.

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Wiring (continued)

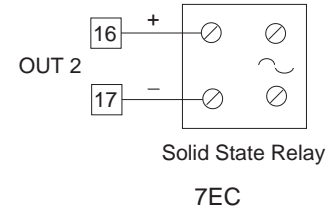
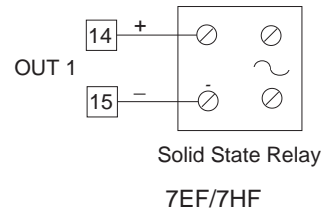
Voltage Output for SSR Drive (7EF/7HF and 7EC)

Logic voltage for SSR drive.

Logic status 1: 24V \pm 20% @ 1 mA
14 V \pm 20% @ 20 mA

Logic status 0: Less than 0.5 V

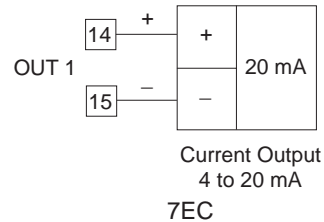
NOTE: This output is not isolated. Isolation between instrument output and power supply must be assured by the external solid state relay.



Current Output (7EC only)

This output is configurable as a control output or as a retransmission output of either the measured value or the control setpoint.

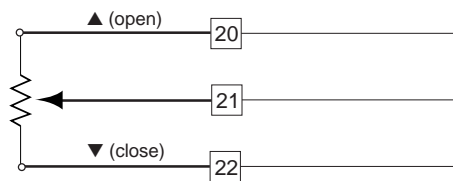
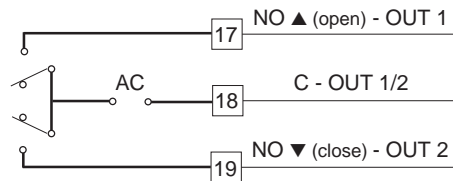
NOTE: This is an isolated output with a maximum load of 500 Ω



Servomotor Control (7ES only)

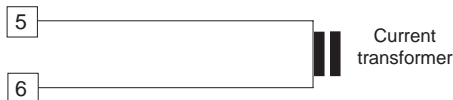
The servomotor output can be used as a closed loop output with feedback potentiometer or as an open loop output with or without valve position indication. The relay outputs are interlocked and can be configured as either reverse or direct acting. Contacts for these relays are rated at 3 Amps/250 Vac.

NOTE: OUT 1 can alternately be used as a time proportioning output.

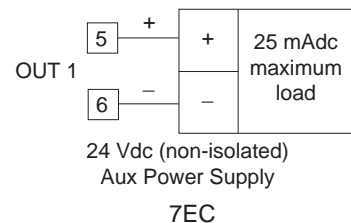


7ES

Current Transformer Wiring (7EF/7HF)



Aux 24Vdc Supply Wiring (7EC)



See "Controller Mounting Dimensions" at the end of this section.