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# **Temperature Controllers**

Advanced PID Controller with Fuzzy Logic-Based Adaptive Tuning Provides Optimum Performance

- Available in 3 standard DIN sizes: Choose 1/4, 1/8 and 1/16 DIN
- Fuzzy adaptive tuning continually optimizes
  PID control based on current process conditions
- Field selectable sensor inputs, alarm functions and °F/°C scaling
- Digital inputs allow Run/Stop operation and external selection of multiple set points on 1/4 and 1/8 DIN units
- Plug-in outputs on 1/4 and 1/8 DIN units provide field interchangeability and easy servicing
- 1/4 and 1/8 DIN units offer serial communication options for interfacing with PLCs and other host devices



# Ordering Information \_\_\_\_

# ■ 1/4 and 1/8 DIN CONTROLLERS

Order control outputs separately below; for example, E5AJ-A2HB-F with E53-R output unit. All temperature controllers with communications capability have the designated board installed, except E5□J-A2HM-F. The E5□J-A2HM-F offers interchangeable communications boards that must be ordered separately. To order controllers marked for Celsius, drop the final "F" from the part number.

		Part Number				
Size	Standard	Serial communicatio	ns board installed	Communications ready		
		RS-232C	RS-422	RS-485	(no board installed)	
1/4 DIN	E5AJ-A2HB-F	E5AJ-A2H01-F	E5AJ-A2H02-F	E5AJ-A2H03-F	E5AJ-A2HM-F	
1/8 DIN	E5EJ-A2HB-F	E5EJ-A2H01-F	E5EJ-A2H02-F	E5EJ-A2H03-F	E5EJ-A2HM-F	

# ■ 1/16 DIN CONTROLLERS

	Part Number		
Description	Relay output	Voltage output	Current output
Two alarm points; one event input, heater burnout alarm (except current)	E5CJ-R2HB-F	E5CJ-Q2HB-F	E5CJ-C2B-F
Two alarm points; without event input	E5CJ-R2-F	E5CJ-Q2-F	E5CJ-C2-F
Without alarm and event input	E5CJ-R-F	E5CJ-Q-F	E5CJ-C-F

# ■ CONTROL OUTPUTS FOR 1/4 AND 1/8 DIN MODELS, CURRENT TRANSFORMERS

Description	Feature	Part number
Control outputs	SPDT relay, 5 A, 250 VAC*	E53-R
	SSR, 1 A, 75 to 250 VAC	E53-S
	Voltage, 12 VDC, NPN	E53-Q
	Voltage, 24 VDC, NPN	E53-Q3
	Voltage, 24 VDC, PNP	E53-Q4
	Linear current, 4 to 20 mA DC, 600 Ω	E53-C3
	Linear current, 0 to 20 mA, 600 $\Omega$	E53-C3D
	Linear voltage, 0 to 10 VDC, 1 KΩ	E53-V34

E5DJ

E5 J ==

### ■ CONTROL OUTPUTS FOR 1/4 AND 1/8 DIN MODELS, CURRENT TRANSFORMERS(continued)

	Linear voltage, 0 to 5 VDC, 1 K $\Omega$	E53-V35
Current transformers	5.8 mm (0.23 in) dia. hole	E54-CT1
for heater burnout function	12.0 mm (0.47 in) dia. hole	E54-CT3

\*Note: If control period is less than 5 seconds, use solid state relay or voltage relay.

### ■ COMMUNICATIONS BOARDS FOR E5AJ, E5EJ CONTROLLERS

Output	Write to temperature controller	Read from temperature controller	Part number
RS-232C	Set temperature, alarm value	Set temperature, alarm value, proportional	E53-J01
RS-422	proportional band, integral time,	band, reset time, rate time, output variable	E53-J02
RS-485	rate time, event input.	set limits, process value	E53-J03

### ACCESSORIES

Description	Part number	
NEMA 4 covers	VEMA 4 covers For E5CJ, 1/16 DIN size	
	For E5EJ, 1/8 DIN size	Y92A-49N
	For E5AJ, 1/4 DIN size	Y92A-96N

### REPLACEMENT PARTS

Description	Part number
Panel mounting adapter for E5CJ, supplied with each unit	Y92F-30

### TEMPERATURE RANGES

Input type		Thermocouple			Platinum RTD	
(switch selectable	e)	Туре К	Type J and L	Type T and U	Type N	100 Ω
Temperature	°C	-200 to 1,300	-100 to 850	-199.9 to 400.0	-200 to 1,300	-199.9 to 650.0
range	°F	-300 to 2,300	-100 to 1,500	-199.9 to 700.0	-300 to 2,300	-199.9 to 999.9
Unit of measure (main setting and alarm		1° C/F	1° C/F	0.1° C/F	1° C/F	0.1° C/F

### ■ GET THE ADVANTAGE OF ADAPTIVE TUNING USING THREE ALGORITHMS

Omron's "J" series controllers use fuzzy adaptive tuning to continuously monitor and optimize PID constants while the controller operates. Three tuning algorithms are used to recalculate the PID constants within 500 ms *after* the process value stabilizes at set point:

- Step-response method
- Disturbance tuning
- Hunting tuning.

#### Step-Response Method

This tuning method takes place on startup and after an upward set point change heating applications or a downward set point change in a cooling application. Step-response tuning changes mainly impact the proportional band.

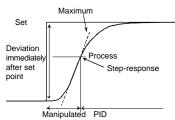
#### **Disturbance Tuning**

This tuning method takes place when the temperature exceeds the stable range between one and three times before settling back to set point. Changes in tuning are mainly made to the derivative (rate) time.

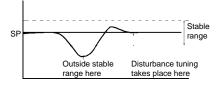
#### **Hunting Tuning**

This tuning method takes place when the temperature exeeds the stable range four or more times before settling back to set point. Changes in tuning are mainly made to the integral (reset) time.

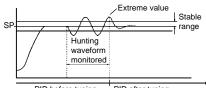
#### Step-Response Tuning



#### **Disturbance Tuning**



### **Hunting Tuning**



### PID before tuning PID after tuning

# Comparison of E5□J and E5□X Tuning Methods

Omron's "X" series controllers attempt to optimize the PID constants by using a limit cycle auto-tune. Although effective in most applications, this method has some drawbacks. For example, the auto-tuning must induce an upset into the process in order to make the process oscillate four times. In many processes these types of artificial upsets are not desirable. Adaptive tuning controllers do not induce an upset; instead, they use information from the actual process, eliminating unnecessary oscillations and enabling quicker start-up time.

Another drawback of the limit cycle autotune method is that PID constants will only be effective so long as the same basic conditions that were present when the auto-tune took place remain constant. Various factors such as a load change, heater performance degradation or set point changes can cause the auto-tuned values to be less than optimum. The new adaptive tuning method, however, is continually monitoring the process and will automatically adjust the PID constants whe nprocess parameters (i.e., heater degradation, load change, etc.) vary.

# Specifications\_\_\_\_\_

Part number			E5AJ	E5EJ	E5CJ			
Supply voltage	ne		100 to 240 VAC, 50/60 Hz					
Operating vo	,		85% to 110% of supply voltage range					
Power consumption			Approx. 10 VA at 100 VAC to 14 VA at 240 VAC 12 VA at 240 VAC					
Temperature	input type		Thermocouple types J, k	K, T, L, U, and N or platinur	n RTD (JPt 100/Pt100), selectable			
Event	Contact i	nput	ON: 1 kΩ max., OFF: 1					
input	No-conta	act input		ON: residual voltage: 3 V max., OFF: Leakage current 1 mA max.				
Control output	Туре				SPST-NO, 3 A, 250 VAC			
ouput	(see note 1) Voltage NPN, 40 mA at 12 VDC using E53-Q out NPN, 20 mA at 24 VDC using E53-Q3 ou PNP, 20 mA at 24 VDC using E53-Q4 ou All offer short-circuit protection			using E53-Q3 output unit using E53-Q4 output unit	NPN, 20 mA at 12 VDC			
		Current	4-20 mA, DC, 600 Ω ma using E53-C output unit		4-20 mA, 600 Ω max., resolution of 2,600			
	Hysteres	is		s of 0.1°C/°F during ON/OF				
	Update	Output	500 ms for pulse output					
	time	Display	500 ms					
	Service	Electrical	100,000 operations mini	mum for E53-R and alarm				
	life	Mechanical	•	ninimum for E53-R and alarr	n			
Alarm	Number		Two SPST-NO relay,s 3	A, 250 VAC	Two, SPST-NO relays, 1 A, 250 VAC			
output	Setting ra	ange	Thermocouple types J, K, L, N: -1999 to 9,999 °C/°F in units of 1 °C/°F Platinum RTD and thermocouple types T and U: -199.9 to 999.9 °C/°F in units of 0.1 °C/°F					
Heater	Туре		SPST-NO relay, 1 A, 250 VAC					
burnout output	Setting ra	ange	0.1 to 49.9 A in units of 0.1 A 0.0 setting disables the output 50.0 setting turns output ON continuously					
	Minimum ON time	detectable	• •	,	ntrol output is ON less than 200 ms			
Indication	General		$\pm 0.5\%$ of set point or $\pm 1^{\circ}$ , whichever is greater, $\pm 1$ digit max.					
accuracy	Exceptio	ns	Accuracy of types K, N and T thermocouples is ±2°C (3.6°F) from -100°C or below (-240°F or below), ±1 digit. Accuracy of type U thermocouple at any temperature is ±2°C (3.6°F), ±1 digit.					
Setting accur	racy		Set value coincides with the indicated value, since no relative error exists between both values					
Display Rang	ge		-9999 to 9999 (limited by output type)					
Control	Туре		PID with automatic fuzzy self-tuning, PID, or ON/OFF					
mode	Proportio	onal band (P)	0.1 to 999.9 °C/°F in unit	s of 0.1 °C/°F				
	Reset tin	ne (I)	0 to 3,999 seconds in 1-second units					
	Rate time	e (D)	0 to 3,999 seconds in 1-second units					
	Control p	period	Pulse output: 1 to 99 seconds in 1-second units					
	Sampling	g period	500 ms					
Memory prote	ection		Non-volatile memory					
Other functions	Input shi	ft	Offsets input value and display to accommodate a sensor input that deviates by a known value.					
			Thermocouple range: -999 to 9999 °C/°F Platinum RTD range: -99.9 to 999.9 °C/°F					
	Miscellar	neous	Upper and lower set value	ue limits, setting protection,	Normal and Reverse output			
Indicators	Present	value	15 mm (0.59 in) red LED digits	14 mm (0.55 in) red LED digits	12 mm (0.47 in) red LED digits			
	Set value	9	10.5 mm (0.41 in)	9.5 mm 0.37 in)	8 mm (0.32 in)			
	Set value		green LED digits	green LED digits	green LED digits			

Note: 1. If control period is less than 5 seconds, use solid state relay or voltage relay.

Note: 2. The E53-C3 Current Output Unit cannot be used if heater burnout alarm is used.

<u></u> = E5□J

# Specifications, continued \_\_\_\_\_

Materials		Plastic case				
Mounting		Fits 1/4 DIN panel cutouts, includes two panel mounting brackets	Fits 1/8 DIN panel cutouts, includes two panel mounting brackets	Fits 1/16 DIN panel cutouts, includes Y92F-30 panel mounting adapter		
Weight	Controller	Approx. 360 g (12.7 oz.)	Approx. 280 g (9.9 oz.)	Approx. 170 g (6.0 oz.)		
	Mounting hardware	Brackets 65 g (2.3 oz.)	Brackets 65 g (2.3 oz.)	Adapter 10 g (0.35 oz.)		
Connections		Plated steel screw terminal	s mounted on rear of unit			
Enclosure ratings	Front panel Rear case Terminals	IEC IP54, NEMA 4 with optional Y92A covers (see note) IEC IP20 IEC IP00				
Approvals	UL	Recognized, File number E68481				
	CSA	Certified, File number LR59623				
Ambient	Operating	-10° to 55° C (14° to 131°F)				
temperature	Storage	-25° to 65°C (-13° to 149°F)				
Humidity	•	35 to 85% RH				
Insulation res	sistance	20 M $\Omega$ minimum at 500 VDC, measured with an output unit installed				
Dielectric stre	ength	2,000 VAC, 50/60 Hz for 1 minutes between terminals of different polarities				
Vibration	Mechanical durability	10 to 55 Hz, 19.6 m/s <sup>2</sup> (2 G) in X, Y, and Z directions for 2 hours each				
	Malfunction durability	10 to 55 Hz, 9.8 m/s <sup>2</sup> (1 G) in X, Y, and Z directions for 10 minutes				
Shock	Mechanical durability	294 m/s <sup>2</sup> (30 G) in 6 direction	ons, 3 times each			
	Malfunction durability	196 m/s <sup>2</sup> (20 G) in 6 directions, 3 times each				

Note: Optional NEMA 4 panel covers are available for E5–J controllers: Y92A-96N for E5AJ, Y92A-49N for E5EJ, and Y92A-48N for E5CJ

### ■ CURRENT TRANSFORMERS FOR E5AJ, E5EJ, E5CJ□2HB-F

Part number	E54-CT1	E54-CT3		
Heater current	Maximum 50 A continuous service, single-phase			
Dielectric strength	1,000 VAC			
Vibration resistance	50 Hz (approx. 10 G)			
Weight	11.5 g (0.41 oz.)	50 g (1.8 oz.)		
Accessories included	—	2 contacts, 2 plugs		

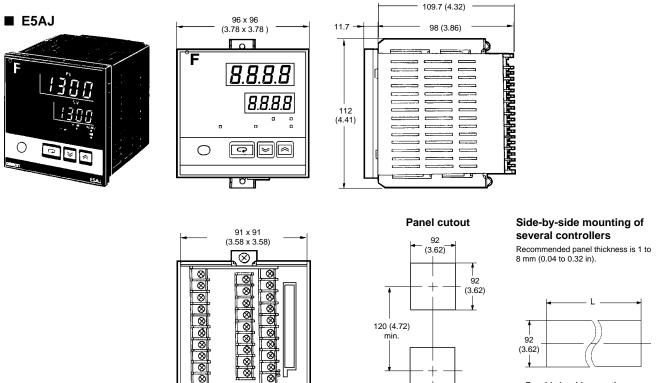
# ■ COMMUNICATIONS FOR E5AJ, E5EJ

Protocol	RS-232C	RS-422	RS-485		
Transmission method	4-wire half duplex	4-wire half duplex	2-wire half-duplex		
Maximum cable length	15 m (49.2 ft)	500 m (1,640 ft)	500 m (1,640 ft)		
Synchronization method	Start-stop synchronization (as	synchronous method)	·		
Baud rate	1,200/2,400/4,800/9,600/19,200 bps				
Transmission code	ASCII (7 bits)				
Write to temperature controller	Set point, alarm value, remote/local selection, proportional band, integral time, rate time (see note				
Read from temperature controller	Process value, output value, set point, alarm value, heater current value, initial status, proportional band, reset time, rate time, error codes, etc. (see note)				
System limits	Peer to peer only A maximum of 32 controllers can be connected to one host computer in serial communication				

Note: If E5AJ is in ON/OFF control mode or PID control mode with fuzzy self-tuning, an undefined error will result if the proportional band, integral time, or derivative time command is transmitted.

# Dimensions

Unit: mm (inch)

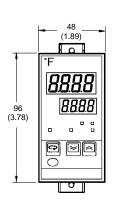


For side-by-side mounting:

L = 96 mm x number of units - 3.5 mm (3.78 in x number of units - 0.14 in)

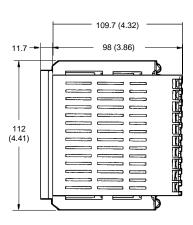
E5EJ



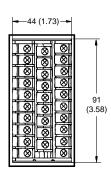


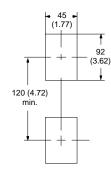
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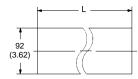


Panel cutout





Side-by-side mounting of several controllers

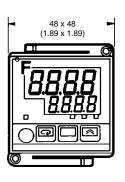


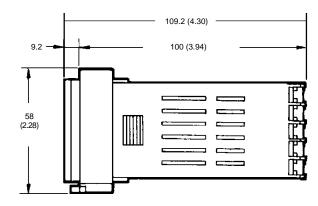
For side-by-side mounting: L = 48 mm x number of units - 2.5 mm= (1.89 in x number of units - 0.10 in)

Recommended panel thickness is 1 to 8 mm (0.04 to 0.32 in).

■ E5CJ



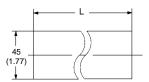




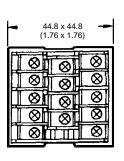
45 (1.77)

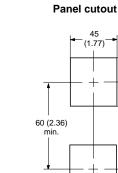
### Side-by-side mounting of several controllers

Recommended panel thickness is 1 to 4 mm (0.04 to 0.16 in). Mounting bracket Y92F-30 allows close side-by-side mounting.



For side-by-side mounting: L = 48 mm x number of units - 2.5 mm = (1.89 in x number of units - 0.10 in)

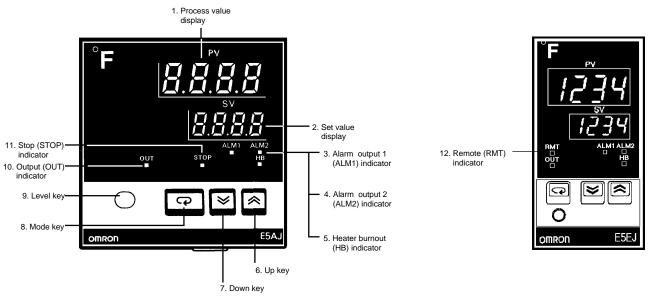




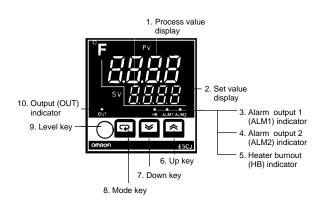
■ E5EJ with communications

# Nomenclature

# ■ E5AJ without communications



# ■ E5CJ without communications



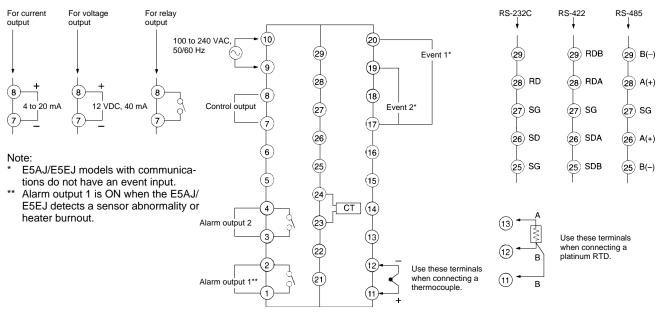
Key	Description	Key	Description
1	Process value indicator displays the present temperature, parameter being set and error messages.	7	Down key decrements the numeric value in the display. Pressed for 1 second or more, the display value deceases
2	Set value indicator displays the set values, messages and output value.		by 50 units in a second until the lower-limit value has been reached.
3	Indicator lights when alarm output 1 is turned ON.	8	Mode key changes the display mode within display levels.
4	Indicator lights when alarm output 2 is turned ON.	9	Level key changes the display level when depressed for at
5	Heater burnout indicator lights when a heater burnout is detected and stays lit until reset.	10	least 2 seconds. Output indicator lights when the control output is ON. It
6	Up key increments the numeric value in the display. Pressed for 1 second or more, the set value increases by 50 units in 1 second until the upper-limit value has been reached.		does not light when the output selector switch is set for a current output.
		11	Stop indicator lights when the temperature controller is not in operation.
		12.	Indicator lights when the controller is in remote (on-line) communication mode.

Note:

- 1. E5AJ and E5EJ models without communications have a Stop indicator.
- E5CJ-□2HB models have all indicators shown. E5CJ-□2 models have OUT, ALM1 and ALM2 indicators. E5CJ-□ models have OUT indicator only.

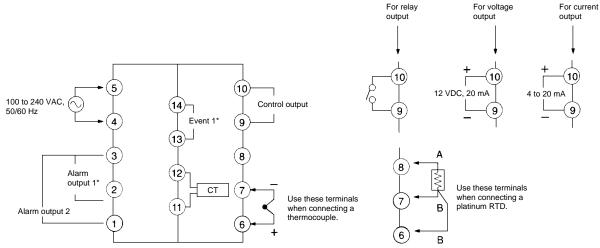
# Connections

### E5AJ, E5EJ CONTROLLERS



### ■ E5CJ-□2□B CONTROLLERS

Two Alarm Outputs, One Event Input, Heater Burnout Alarm

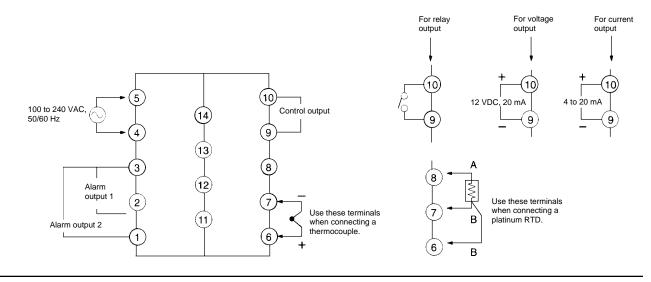


#### Note:

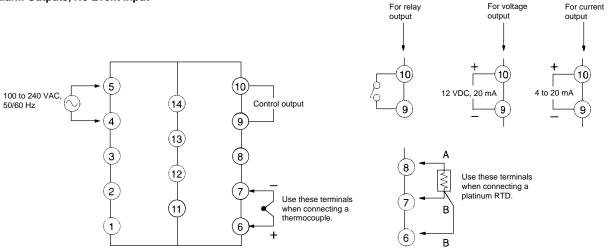
 Alarm output 1 is ON when the E5AJ/ E5EJ detects a sensor abnormality or heater burnout.

# ■ E5CJ-□2 CONTROLLERS

Two Alarm Outputs, No Event Input



### ■ E5CJ-□ CONTROLLERS No Alarm Outputs, No Event Input





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