

USER'S OPERATING MANUAL FOR DIGITAL TEMPERATURE CONTROLLER

(Model : AI-7941e)



OVER ALL DIMENSIONS & PANEL CUT OUT (IN MM)

MODEL :- AI-7941E

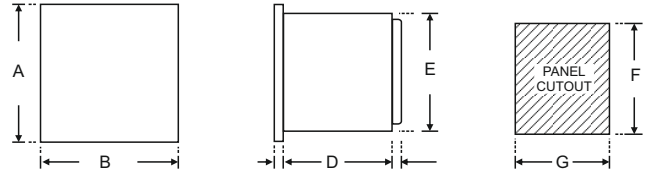


TABLE : 2

Dim Model	A	B	C	D	E	F	G	H
AI-7941E	96	96	10	45	89	92	92	9

SPECIFICATIONS: -

1. **DISPLAY TYPE** : 4-Digit 7 segment LED (RED) - 0.56"
STATUS LED : OP1 : Main Control Output

2. INPUT

- Sensor Input : TC : J,K & RTD : Pt-100
 Range : Refer below Table No. 1

Sensor Type	Range	Resolution	Accuracy
Fe-k(J) T/C	0 ~ 760°C	1 °C	± 1 °C
Cr-AL(K) T/C	0 ~ 999°C	1 °C	
Pt-100(RTD)	-99 ~ 450°C	1 °C	

- Sampling Time : 125 msec.
 CJC for TC : Built in automatic
 LWC for Pt-100 : Built in upto 18E max.
 Digital Filter : 1 to 10 Sec.

3. RELAY OUTPUT

- Contact type : N/O, CM, N/C
 Contact Rating : 5A @ 250VAC or 30 VDC
 Life expectancy : > 5,00,000 operations
 Isolation : Inherent

4. SSR DRIVE OUTPUT

- Drive Capacity : 12V @ 30mA.
 Isolation : Non-Isolated.

5. FUNCTION

- Output 1 : Main Control output
 Control Action : ON-OFF/PID (Select)
 Control Mode : Heat/Cool (Select)

6. ENVIRONMENTAL

- Operating Range : 0 ~50°C, 5~90% Rh
 Storage Humidity : 95% Rh (Non-condensing)

7. POWER SUPPLY

- Supply Voltage : 90~270VAC / 230VAC
 Consumption : 4W Maximum.

8. PHYSICAL

- Housing : ABS Plastic.

Model No.:	AI-7941e-U	AI-7941e - L
Weight (gms.)	200	300

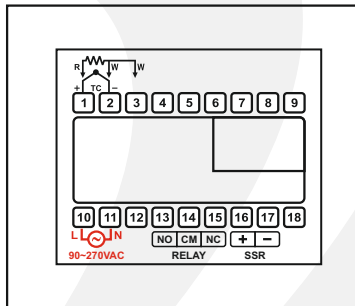
* U - Universal Supply (90 ~ 270 VAC)

* L - Linear Supply (230 VAC)

INSTALLATION GUIDELINES

1. Prepare the cut-out with proper dimension as shown in above figure.
2. Remove side clamp from controller.
3. Push the controller through panel cut-out and secure the controller in its place by tightening the side clamp.

Electrical Installation :-



Front Panel Layout :-

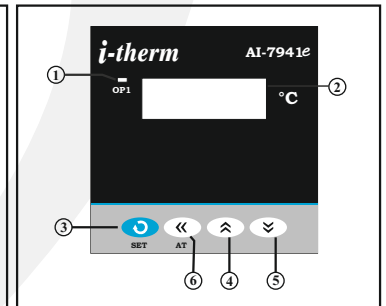


Table No. 3 :-

Sr.	NAME	FUNCTION
1	OP1 LED	Glows when OP1 is ON & flashes when delay time (dly) is in operation (if selected mode is ON-OFF)
2	DISPLAY	It will display: (1) Measured value of selected input or Error messages. (2) SP (Main set point) value in run mode. (3) Parameters Value/code in program mode.
3		SET Key :- (1) For SP programming. (2) To access Control mode with DN Key. (3) To access Configuration mode with UP key. (4) To scroll the parameter & store its value.
4		UP Key :- (1) To increase/alter parameter value in program mode. (2) To Enter in configuration mode(with SET key). (3) To Set SP Offset (with DOWN Key).
5		DOWN Key :- (1) To decrease/alter parameter value in program mode. (2) To Enter control mode
6		SHIFT Key :- (1) To Enter in Auto Tuning Mode (2) To change Numeric value along with Up & Dn Key.

Table No. 4 :- Error Messages

Error Messages	Description
OPEN	Open Circuit of Control Sensor
LLLL	Process Value Under Sensor Range
HHHH	Process Value Above Sensor Range

PROGRAMMING :

USER LIST : To access the user list Press & Release SET key once.

(All following selected parameter's code shown in shaded will be displayed for 1 sec. followed by their values / options).

PARA METER	DISPLAY	RANGE	DESCRIPTION	DEFAULT
Control Set Point	SP > <input type="text" value="0"/>	LSPL ~ HSPL	User can change SP value using UP/DOWN/SHIFT keys. Press SET key to store the value & move on to the next parameter.	0°C

CONTROL LIST : To enter in this mode press SET & DOWN key simultaneously for 3 sec. User can set the control parameters.

(All following selected parameter's code shown in shaded will be displayed for 1 sec. followed by their values / options)

PARA METER	DISPLAY	RANGE	DESCRIPTION	DEFAULT
LOCK CODE	LOCK > <input type="text" value="0"/>	1 ~ 9999	Set this parameter to 15 (Default LOCK CODE) to access Control List. User has a choice to set different Lock Code via USER LOCK CODE in Config. List.	0
PRPORTIONAL BAND	Pband > <input type="text" value="5.0"/>	0.5 to 99.9°C	This parameter will be prompted only if selected control action is PID. It sets bandwidth over which the output power is adjusted depending upon the error (SV-PV). The value of this parameter is automatically set by Auto tune function.	5.0°C
INTEGRAL TIME	Int > <input type="text" value="240"/>	0 to 9999 Sec.	This parameter will be prompted only if selected control action is PID. It sets the time taken by PID algorithm to remove steady state error. Value of this parameter is automatically set by Auto Tune function. If set to '0', this function will be disabled.	240
DERIVATIVE TIME	dt > <input type="text" value="60"/>	0 to 300 Sec.	This parameter will be prompted only if selected control action is PID. It defines how strongly the Controller will react to the rate of change of PV. Value of this parameter is automatically set by Auto Tune function. If set to '0', this function will be disabled.	60
CYCLE TIME	CYCL > <input type="text" value="16.0"/>	0.5 to 100.0 Sec.	This parameter will be prompted only if selected control action is PID. User can set this value based on process being controlled & type of Output being selected. For Relay O/P, cycle time should be more than 12sec & for SSR O/P, cycle time should be less than 5 Sec.	16.0 Sec.
OUTPUT POWER LIMIT	OUTL > <input type="text" value="100.0"/>	0.0 % TO 100.0 %	This parameter will be prompted only if selected control action is PID. This parameter will decide the maximum output power in % applied to the load	100 %
OUTPUT OFF	OPOFF > <input type="text" value="d56L"/>	1 to 10	This parameter will be prompted only if selected control action is PID. With this parameter O/P will be Completely OFF after the Set Point + Offset Value. If Disable, O/P will act Depending upon the PID Value after Set Point achieved.	Disable
TUNE OFFSET	TOFS > <input type="text" value="100"/>	50 % to 100 %	This parameter will be prompted only if selected control action is PID. This parameter allows the user to carry out Auto Tuning function below the set point. (If tune offset is set to 50 %, tuning will be carried out at 50 % of the set point and If set to 100 %, tuning will be carried out at 100 % of the set point.)	100 %
CONTROL HYS.	HYS > <input type="text" value="2"/>	1 to 25 °C	This parameter will be prompted only if selected control action is ON-OFF. It sets the dead band between ON & OFF switching of the Output. Larger value of hysteresis minimize the number of ON-OFF operation of load. This increases life of actuators like contactors but also produces large errors (between PV & SV).	2°C
DELAY	dLY > <input type="text" value="0"/>	0 to 500 Sec.	This parameter will be prompted only if selected control action is ON-OFF. It sets the output restart time where O/P once turned OFF will turn ON only after restart time, regardless difference between PV & SP in Heat or Cool mode. If set to '0', O/P will be switched without delay. Also, Delay will be applicable at every power ON.	0 Sec.

CONFIGURATION LIST : (1) To enter in this mode, press and hold SET & UP key simultaneously for 3 sec.

(2) Press UP/DOWN/SHIFT key to change parameter options.

(3) Press SET key to store the current parameter & move on to the next parameter.

(All following selected parameter's code shown in shaded will be displayed for 1 sec. followed by their values / options)

PARA METER	DISPLAY	DESCRIPTION	DEFAULT														
LOCK CODE	LOCK > <input type="text" value="0"/>	Set this parameter to 15 (Default LOCK CODE) to access Config. List. User has a choice to set different Lock Code between 1 to 9999 via USER LOCK CODE in Config. List.	0														
INPUT TYPE	INPT <input type="text" value="tc-J"/> <input type="text" value="tc-P"/> <input type="text" value="rtd"/>	This parameter value is set according to the type of sensor (Thermocouple or RTD input) connected to the controller's input terminals. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Sensor Type</th> <th>Range</th> <th>Resolution</th> <th>Accuracy</th> </tr> </thead> <tbody> <tr> <td>Fe-k(J) T/C</td> <td>0 ~ 760°C</td> <td>1 °C</td> <td rowspan="4" style="text-align: center; vertical-align: middle;">± 1 °C</td> </tr> <tr> <td>Cr-AL(K) T/C</td> <td>-99 ~ 1300°C</td> <td>1 °C</td> </tr> <tr> <td>Pt-100(RTD)</td> <td>-100 ~ 450°C</td> <td>1 °C</td> </tr> </tbody> </table>	Sensor Type	Range	Resolution	Accuracy	Fe-k(J) T/C	0 ~ 760°C	1 °C	± 1 °C	Cr-AL(K) T/C	-99 ~ 1300°C	1 °C	Pt-100(RTD)	-100 ~ 450°C	1 °C	J Type
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PARAMETER	DISPLAY	DESCRIPTION	DEFAULT
LOWER SP LIMIT	LSPL > 0	Sets the minimum limit for set point adjustment. It can be set from minimum specified range of selected sensor to HSPL value.	0 °C
HIGHER SP LIMIT	HSPL > 400	Sets the maximum limit for set point adjustment. It can be set from LSPL value to maximum specified range of selected sensor.	400 °C
PROCESS VALUE OFFSET	OFSt > 0	Function of this parameter is to add/subtract a constant value to the measured PV to obtain Final PV for control applications. This parameter value needs to be altered for one of the following reason : - (i) To compensate for known thermal gradient. (ii) To match the display values with another recorder or indicator measuring the same PV.	0 °C
INPUT FILTER	FLtr > 1	Controller is equipped with an adaptive digital filter which is used to filter out any extraneous pulses on the PV. Filtered PV Value is used for all PV dependent functions. If PV signal is fluctuating due to noise, increase the filter time constant value.	1 °C
CONTROL MODE	mode > PID ↓ ↑ OnOFF	User can select between PID or ON-OFF action algorithm to be adopted for output.	PID
CONTROL LOGIC	LOGC > HEAT ↓ ↑ COOL	This parameter will be prompted only if selected control mode is ON-OFF. User can select HEAT logic in which OP1 will remain ON till PV < SP. (PV increases when output is ON.)	HEAT
		This parameter will be prompted only if selected control mode is ON-OFF. User can select cooling logic in which OP1 will remain ON till PV > SP. (PV decreases when output is ON.)	
OUTPUT TYPE	OPLY > rLY ↓ ↑ SSr	User has to set this parameter very carefully in accordance with the output used. (Separate terminal for RELAY & SSR : - Refer electrical installation) Select Relay if LOAD is connected via contactor. Whenever user selects Relay, Cycle time will automatically set to 16 sec. User can modify cycle time via Control List.	RELAY
		Select SSR if LOAD is connected via SSR (DC voltage pulses). Whenever user selects SSR, Cycle time will automatically set to 1sec. Cycle time can be modified in Control List.	
OVERSHOOT CONTROL POINT	OCP > d5bL	This parameter will be prompted if selected control action is PID. Setting this parameter on higher side will slow down the rate of rise of PV to minimize overshoot this may cause delay to reach SP. Disabling or Setting this parameter on lower side will increase the rate of rise of PV which may cause overshoot. Disable this option if delay is not required to reach SP. (This may cause overshoot w.r.t. SP)	50%
AUTO TUNE	tUNE > EnbL ↓ ↑ d5bL	If Enabled, this parameter will be prompted if user press Up & Down keys Simultaneously for 3Sec.	Enable
		If Disabled, this parameter will not be prompted if user press Up & Down keys Simultaneously for 3Sec.	
SET POINT 1	SP > EnbL ↓ ↑ d5bL	If Enabled, User can View & edit the Set point 1 in USER list.	Enable
		If disabled, User can only View the Set Point 1 but Can not edit it in USER list.	
USER LOCK CODE	ULOC > 15	Default USER LOCK CODE is 15 to access Control & Configuration List. User has a choice to set its own USER LOCK CODE between 1 to 9999, this is to prevent unauthorized access of Control & Configuration List.	15

AUTO TUNING MODE : To enter in this mode, Press & hold SHIFT key for 3 sec.

PARAMETER	DISPLAY	DESCRIPTION	DEFAULT
AUTO TUNING MODE	tUNE 0 ↓ ↑ YES	This function will be executed only if selected control action is PID. Auto-tuning function can be initiated by setting this parameter to 'YES'. The decimal of LSB flashes till Auto Tuning function is in progress. During Auto-tuning, Controller learns the process characteristics by itself & calculates required P, I & D values. User can cancel or abort this feature by setting this parameter to 'NO'.	NO

USER GUIDE :

ON-OFF ACTION : In this mode, Output (Relay/SSR) remains ON till actual temperature reaches to the set point value. On reaching SP, Output turns OFF & remains OFF till actual temperature drops down (in Heat logic) or raises (in Cool logic) equal to hysteresis set by User. (As shown in Fig : 3.1 & 3.2)

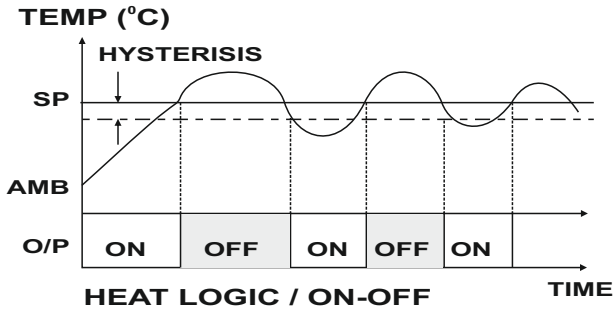


Fig: 3.1

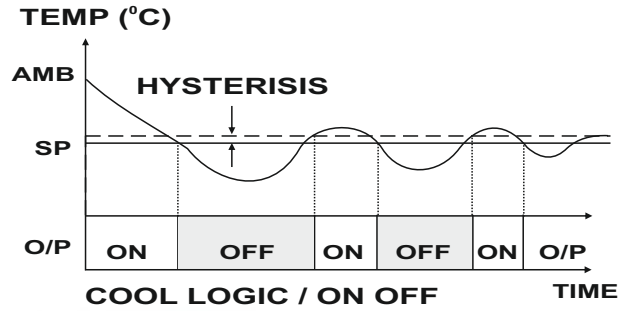


Fig: 3.2

AUTO TUNING MODE : In this mode, Controller learns the process characteristics by itself and calculates the required P,I & D values. It can be performed at any time after power ON but, it is best to start it when the process is at Ambient temperature in order to minimize overshoot & undershoot. Auto tuning is applied in case of :

- (1) Initial set up for a new process.
- (2) Substantial change in SP from previous auto tuning value.
- (3) Control accuracy is not satisfactory.

If the control performance by using auto-tuning is still unsatisfactory, User can apply the further adjustments of P,I & D values as shown below

Adjust	Symptom	Solution
Proportional Band	Slow Response	Decrease PB
	Over Shoot or Oscillations	Increase PB
Integral Time	Slow Response	Decrease Int
	Instability or Oscillation	Increase Int
Derivative Time	Slow Response or Oscillation	Decrease Dt
	High Over Shoot	Increase Dt

ABBREVIATION :	C.A. : Control Action	NC : Normally Close terminal of Relay	SP : Set Point Value(set temp.)
	CJC : Cold junction compensation	NO : Normally Open terminal of Relay	SSR : Solid State Relay
	CM : Common terminal of relay	OP1 : Output 1	T/C : Thermocouple
	LWC : Lead wire (Length) compensation	PV : Process Value (actual temp.)	



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