USER'S OPERATING MANUAL FOR PID DIGITAL TEMPERATURE CONTROLLER

(Models : AI 7441 / 7741 / 7941 / 7641 / 7841)

AI - 7441
(48 X 48)

AI - 7741
(72 X 72)

AI - 7941
(96 X 96)

AI - 7641
(96 X 48)

AI - 7841
(48 X 96)

SPECIFICATIONS : -

1. DISPLAY TYPE : 4- Digit 7 segment LED (Bright White)

Model no.	AI-7441	AI-7741	AI-7941	AI-7641	AI-7841
Display height	0.36"	0.56"	0.56"	0.36"	0.56"

STATUS LED : OP 1 : Main Control Output

2. INPUT

Sensor input : TC:J,K,R,S,N,T,B & RTD: Pt-100
Range : Refer below 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	
(R) T/C	0 ~ 1700°C	1 °C	
(S) T/C	0 ~ 1700°C	1 °C	
TC - N	-99 ~ 1300°C	1 °C	
TC - T	-99 ~ 400°C	1 °C	
TC - B	0 ~ 1800°C	1 °C	
Pt-100(RTD)	-100 ~ 450°C	1 °C	
Pt-100(RTD 0.1)	-99.9 ~ 450.0°C	0.1 °C	± 0.3 °C

Sampling Time : 125 msec.
Resolution : 1°C/0.1°C(Only for RTD)
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, 50/60Hz.
Consumption : 4W Maximum.

8. PHYSICAL

Housing : ABS Plastic

Model no.	AI-7441	AI-7741	AI-7941	AI-7641	AI-7841
Weight (gms.)	130	200	240	200	200

SAFETY INSTRUCTION : -

This controller is meant for temperature control applications. It is important to read the manual prior to installing or commissioning of controller. All safety related instruction appearing in this manual must be followed to ensure safety of the operating personnel as well as the instrument.

GENERAL : -

- The controller must be configured correctly for intended operation. Incorrect configuration could result in damage to the equipment or the process under control or it may lead personnel injury.
- The controller is generally part of control panel and in such a case the terminals should not remain accessible to the user after installation.

MECHANICAL : -

- The Controller in its installed state must not come in close proximity to any corrosive/combustible gases, caustic vapors, oils, steam or any other process by-products.
- The Controller in its installed state should not be exposed to carbon dust, salt air, direct sunlight or radiant heat.
- Ambient temperature and relative humidity surrounding the controller must not exceed the maximum specified limit for proper operation of the controller.
- The controller in its installed state must be protected against excessive electrostatic or electromagnetic interferences. Ventilation slits provided on the chassis of the instrument are meant for thermal dissipation hence should not be obstructed in the panel.

ELECTRICAL : -

- The controller must be wired as per wiring diagram & it must comply with local electrical regulation.
- Care must be taken not to connect AC supplies to low voltage sensor input.
- Circuit breaker or mains s/w with fuse (275V/1A) must be installed between power supply and supply terminals to protect the controller from any possible damage due to high voltage surges of extended duration.
- Circuit breaker and appropriate fuses must be used for driving high voltage loads to protect the controller from any possible damage due to short circuit on loads.
- To minimize pickup of electrical noise, the wiring for low voltage DC and sensor input must be routed away from high current power cables. Where it is impractical to do this, use shielded ground at both ends.
- The controller should not be wired to a 3-Phase supply with unearthed star connection. Under fault condition such supply could rise above 264 VAC which will damage the controller.
- The Electrical noise generated by switching inductive loads might create momentary Fluctuation in display, alarm latch up, data loss or permanent damage to the instrument. To reduce this use snubber circuit across the load.
- It is essential to install a over Temp. Protection device to avoid any failure of heating system. Apart from spoiling the product, this could damage the process being controlled.

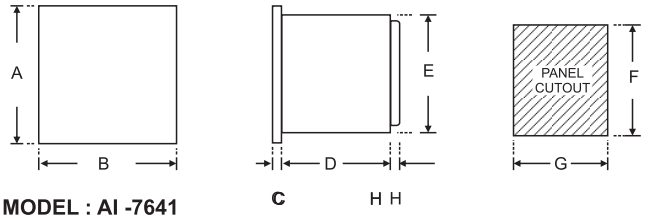
⚠ **CAUTION: To prevent the risk of electrical shock, switch off the power before making/removing any connection or removing the controller from its enclosure.**

MECHANICAL INSTALLATION

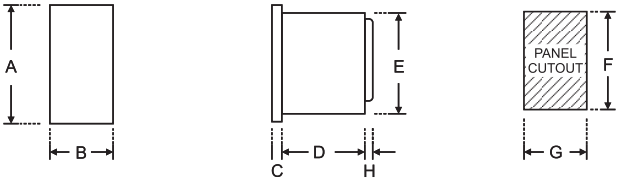
The label on the controller identifies the serial number, wiring connections and batch number.

OVER ALL DIMENSIONS & PANEL CUT OUT (IN MM)

MODEL:-AI-7441/7741/7941



MODEL : AI -7641



MODEL : AI -7841

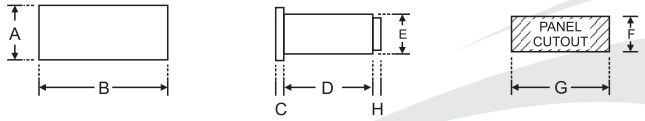


TABLE : 1

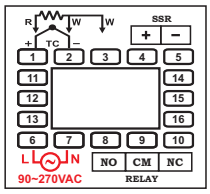
Dim / Model	A	B	C	D	E	F	G	H
AI-7441	48	48	8	75	43	44	44	9
AI-7741	72	72	10	65	66	68	68	9
AI-7941	96	96	10	45	89	92	92	9
AI-7641	96	48	10	45	89	92	44	9
AI-7841	48	96	10	45	43	44	92	9

INSTALLATION GUIDELINES

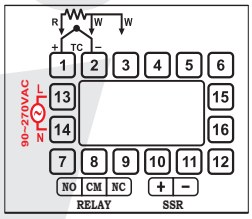
1. **Prepare the cut-out with proper dimension as shown in figure.**
2. **Remove clamp from controller**
3. **Push the controller through panel cut-out and secure the controller in its place by tightening the side clamp.**

ELECTRICAL INSTALLATION

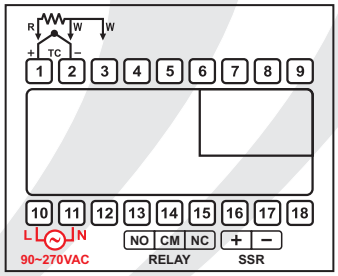
The electrical connection diagram is shown on the controller enclosure as below.



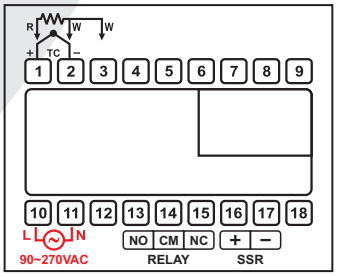
AI - 7441



AI - 7741

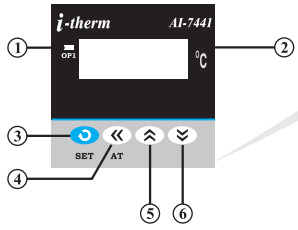


AI - 7941

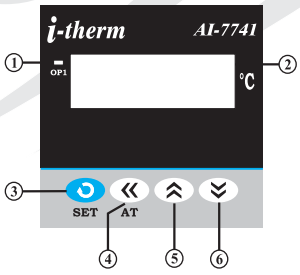


AI-7641 /AI-7841

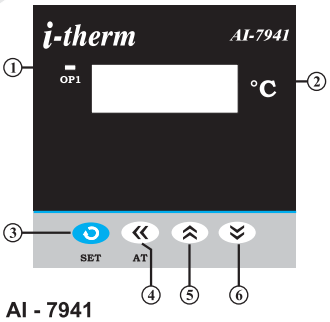
FRONT PANEL LAYOUT



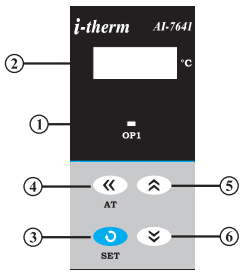
AI - 7441



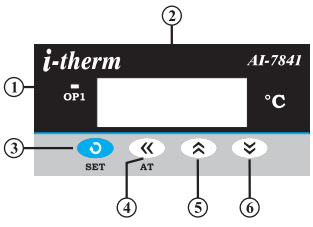
AI - 7741



AI - 7941



AI-7641



AI - 7841

FRONT PANEL LAYOUT DESCRIPTION :

Sr.	NAME	FUNCTION
1	OP1 LED	Glows when OP1 is ON & flashes when delay time (dly1) is in operation(if selected mode is ON-OFF)
2	UPPER DISPLAY	It will display (1)Measured value of selected input or Error massages. (2) SP value in run mode. Parameters Values/code in program mode
3	SET KEY	(1) For SP programming. (2) To access Control mode. (3) To access Configuration mode along with UP key. (4) To scroll the parameter & to store its value.
4	SHIFT KEY	(1) To increase/alter parameter value in program mode with Up / Dn Key. (2) Press for 3Sec in Programming this will help to go back to previous parameter.
5	UP KEY	(1) To increase/alter parameter value in program mode. (2) To Enter in configuration mode (with SET key) . (3) To acknowledge Alarm. (4) To enter in tune mode (with DOWN Key).
6	DOWN KEY	(1) To decrease / alter parameter value in program mode. (2) To enter in tune mode (with UP Key).

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 > 0	LSPL~HSPL	User can change SP value using UP/ DOWN keys. Holding the key, will change the value at a faster rate. 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 > 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
PRORTIONAL BAND	Pb > 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 > 240	0 to 3600 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 > 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	CYCt > 16.0	1.0 to 100 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 > 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 %.
TUNE OFFSET	t.OFS > 100	50 % to 100 %	This parameter will be promted 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 > 2	1 to 100 °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 hysterisis 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 > 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.
OUTPUT OFF	OP.OF > dSbL	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

CONFIGURATION LIST : (1) To enter in this mode, press and hold SET & UP key simultaneously for 3 sec.
(2) Press UP or DOWN key to scroll between 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)

<table>
<tr><th>PARA METER</th><th>DISPLAY</th><th>DESCRIPTION</th><th>DEFAULT</th></tr>
<tr><td>LOCK CODE</td><td>LOCP > 0</td><td>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.</td><td>0</td></tr>
<tr><td>INPUT TYPE</td><td>InPt
tC-J
tC-P
tC-r
tC-S
tC-n
tC-t
tC-b
rtd
rtd.1</td><td>This parameter value is set according to the type of sensor (Thermocouple or RTD input) connected to the controller's input terminals.
<table>
<tr><th>Sensor Type</th><th>Range</th><th>Resolution</th><th>Accuracy</th></tr>
<tr><td>Fe-k(J) T/C</td><td>0 ~ 760°C</td><td>1 °C</td><td rowspan="8">± 1 °C</td></tr>
<tr><td>Cr-AL(K) T/C</td><td>-99 ~ 1300°C</td><td>1 °C</td></tr>
<tr><td>(R) T/C</td><td>0 ~ 1700°C</td><td>1 °C</td></tr>
<tr><td>(S) T/C</td><td>0 ~ 1700°C</td><td>1 °C</td></tr>
<tr><td>TC - N</td><td>-99 ~ 1300°C</td><td>1 °C</td></tr>
<tr><td>TC - T</td><td>-99 ~ 400°C</td><td>1 °C</td></tr>
<tr><td>TC - B</td><td>0 ~ 1800°C</td><td>1 °C</td></tr>
<tr><td>Pt-100(RTD)</td><td>-100 ~ 450°C</td><td>1 °C</td></tr>
<tr><td>Pt-100(RTD 0.1)</td><td>-100.0 ~ 450.0°C</td><td>0.1 °C</td><td>± 0.3 °C</td></tr>
</table></td><td>TC - J</td></tr>
<tr><td>LOWER SP LIMIT</td><td>LSPL > 0</td><td>Sets the minimum limit for set point adjustment. It can be set from minimum specified range of selected sensor to HSPL value.</td><td>0 °C</td></tr>
<tr><td>HIGHER SP LIMIT</td><td>HSPL > 400</td><td>Sets the maximum limit for set point adjustment. It can be set from LSPL value to maximum specified range of selected sensor.</td><td>400 °C</td></tr>
<tr><td>PROCESS VALUE OFFSET</td><td>OFSt > 0</td><td>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 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.</td><td>0 °C</td></tr>
<tr><td>INPUT FILTER</td><td>FLtr > 1</td><td>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.</td><td>4</td></tr>
<tr><td>CONTROL MODE</td><td>Mode > PId
OnOF</td><td>User can select between PID or ON-OFF action algorithm to be adopted for output.</td><td>PID</td></tr>
<tr><td>CONTROL LOGIC</td><td>OP1L > HEAt
COOL</td><td>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.)

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.)</td><td>HEAT</td></tr>
<tr><td>OUTPUT TYPE</td><td>OPtY > rLY
SSr</td><td>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.

Select SSR if LOAD is connected via SSR (DC voltage pulses). Whenever user selects SSR , Cycle time will automatically set to 1sec. User can modify cycle time via Control List.</td><td>RELAY</td></tr>
<tr><td>OVERSHOOT CONTROL POINT</td><td>OCP > dSbL</td><td>This parameter will be prompted only if selected control action is PID. Setting this parameter on higher side will slows down the rate of rise of PV to minimize overshoot (this may cause delay to reach SP). Disabling or Setting this parametr 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)</td><td>DISABLE</td></tr>
</table>

PARA METER	DISPLAY	DESCRIPTION	DEFAULT
AUTO TUNE	tunE > EnbL / dSbL	If Enabled, this parameter will be prompted if user press Up & Down keys Simultaneously for 3Sec. If Disabled, this parameter will not be prompted if user press Up & Down keys Simultaneously for 3Sec.	ENABLE
SET POINT 1	SP > EnbL / dSbL	If Enabled, User can View & edit the Set point 1 in USER list. If disabled, User can only View the Set Point 1 but Can not edit it in USER list.	ENABLE
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 minimum 3 sec.

PARA METER	DISPLAY	DESCRIPTION	DEFAULT
AUTO TUNING MODE	tUnE nO / 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 hysterisis set by User. (As shown in Fig : 3.1 & 3.2)

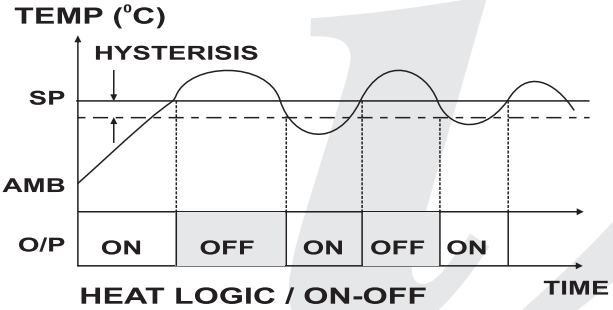


Fig: 3.1

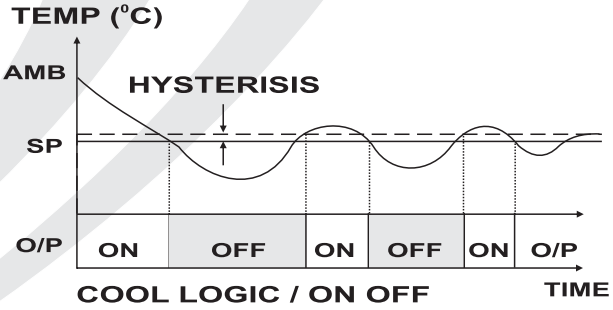


Fig: 3.2

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

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