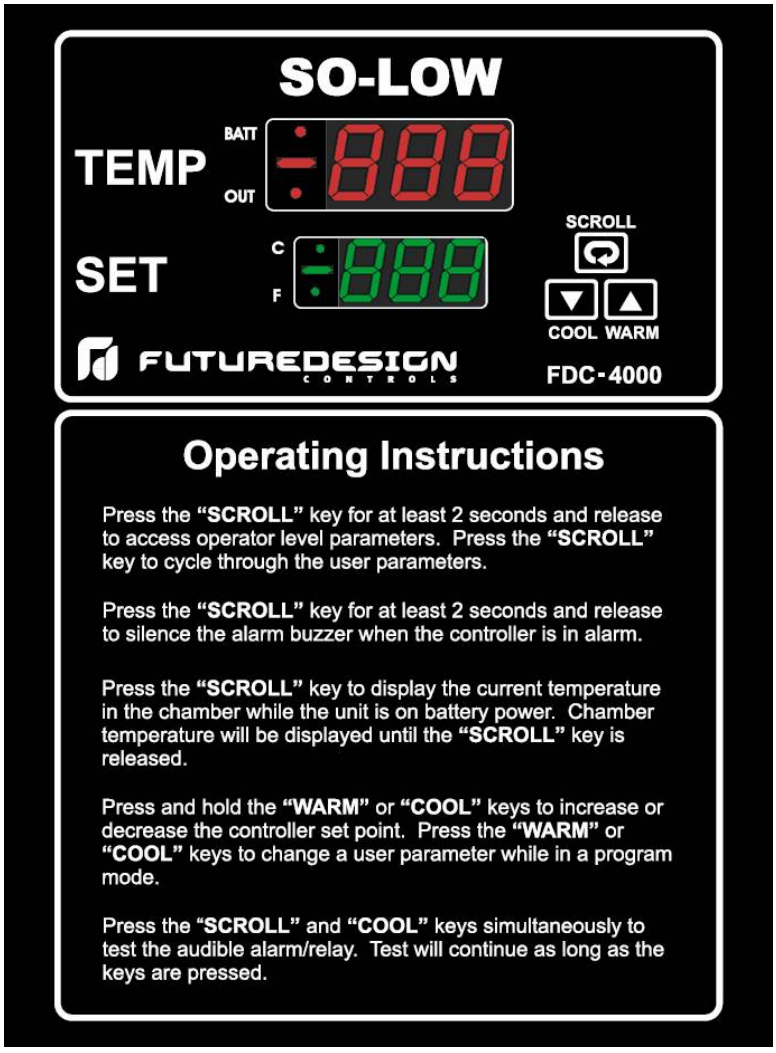
FDC-4000 Chamber Controller



Installation – Setup – Operation - Service

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FDC-4000 Chamber Controller

1-1 Features

* Simple operation
* Type “T” Thermocouple / RTD Input
* User selection of active probe (1 or 2)
* Degrees F or C operation
* Low voltage operation
* Deviation alarm operation with adjustable delay
* Power failure alarm operation
* Ring back alarm function
* Low battery indication
* Adjustable hysteresis for control/alarm outputs
* Process value offset adjustment
* “Ring Back” mode for audible alarm
* “Wake” mode for battery operation indication of PV
* Control/Alarm relay (DPDT) output contacts
* Audible alarm buzzer standard
* Optional RS485 Serial Communications

The FDC-4000 microprocessor-based controller incorporates dual, easy to read 4-digit LED displays. The LED displays indicate process value and set point, as well as other controller operations. This unit features keys to select the various operator views as well as control parameters. The FDC-4000 has been designed specifically for low temperature chamber operation, providing simple to use, “hassle” free operation for startup and operation of the chamber.

The FDC-4000 incorporates a 1 amp (DPDT) control relay output and a 1 amp (DPDT) alarm relay output as standard. Programmable deviation alarm set points allow the operator to monitor/indicate alarm conditions above and below chamber operational settings. “Ring Back” operation allows an operator to silence the internal alarm buzzer for a programmable length of time. If the “Ring Back time has elapsed and the alarm condition still exists, the alarm buzzer will re-energize to alert the operator to the pre-existing alarm condition.

Power failure mode will alert the operator when main power to the chamber is lost. During power failure, the alarm buzzer will sound and the alarm contact will be energized while on battery backup. While operating on battery backup power, pressing the “Scroll” key will display the current chamber temperature on the top LED display until the key is released.

2-1 Installation

To minimize the possibility of fire or electric shock hazards, do not expose this instrument to rain or excessive moisture.

Do not use this instrument in areas under hazardous conditions such as excessive shock, vibration, dirt, moisture, corrosive gases or oil. The ambient temperature of the areas should not exceed maximum ratings.

2-2 Unpacking

Upon receipt of shipment, remove the unit from the carton and inspect it for shipping damage. If there is any damage due to transit, report and file a claim with the carrier. Write down the model number and serial number for future reference when corresponding with our service center.

2-3 Mounting

Make a panel cutout to the dimensions shown in the following figure:

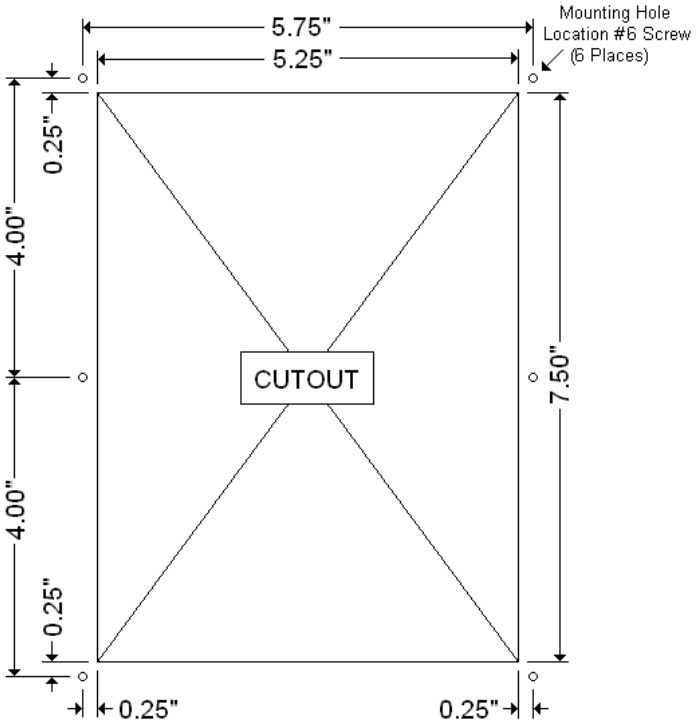


Figure 2.1 Mounting Dimensions

2-4 Power Wiring

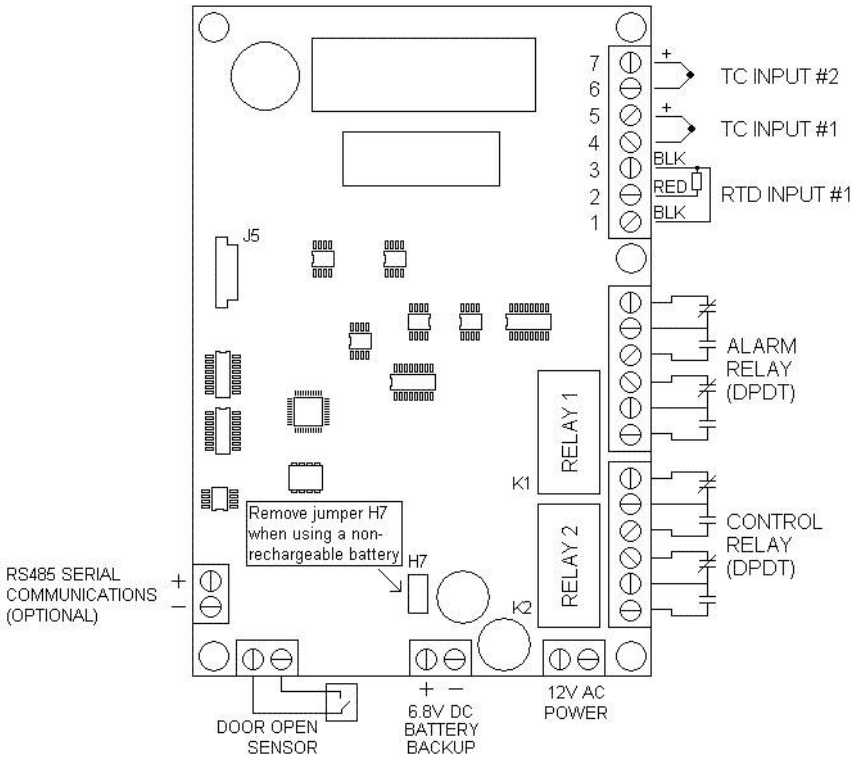


Figure 2.2 Controller Circuit Board

⚠ This equipment is designed for installation in an enclosure which provides adequate protection against electric shock. The enclosure must be connected to earth ground.

Local requirements regarding electrical installation should be rigidly observed. Consideration should be given to prevent unauthorized persons access to the power terminals.

Battery Back-Up – Back-up power to the controller can be provided in the event of a main power failure. A 6Volt DC Lead Acid Rechargeable Battery is recommended for battery backup. The controller unit will automatically recharge and maintain the rechargeable battery. A non-rechargeable 6Volt DC battery may also be used; however, before connecting the non-rechargeable battery to the controller circuit board, remove jumper H7. This will prevent the controller from sending a charge current to the battery. Not removing this jumper (H7) may cause the non-rechargeable battery to leak or explode.

A low battery (Lo bAt) indication will be shown on the lower display when the battery voltage is below 5.5Volts. The audible alarm will give a brief “chirp” approximately every 30 seconds while the low battery condition exists. When the controller is operating only on battery power, both LED displays will go blank to conserve power. When the main power is restored, there will be a 7 second delay before energizing the control relay to allow the main power source to stabilize.

2-5 Sensor Installation Guidelines

Proper sensor installation can eliminate many problems in a control system. The sensor should be placed so that it can detect any temperature change with minimal thermal lag. Some experimentation with sensor location is often required to find the optimum position.

Proper sensor type is also an important factor to obtain precise measurements. The sensor must have the correct temperature range to meet the process requirements. In special processes, the sensor may need to meet different requirements such as leak-proof, anti-vibration, antiseptic, etc.

The FDC-4000 controller has been designed to use a type “T” Thermocouple or Platinum RTD (2 or 3-wire) temperature sensor. Figure 2.2 shows the proper connection of the sensors to the controller. The controller will auto-detect which type of sensor is connected to the unit (for Input #1). In order for the controller to do this, the sensor must be connected before power is applied to the controller. Input #1 is used to display PV (on the upper LED display). Input #2 can only be a type “T” Thermocouple sensor.

In the event of a sensor break, the display will show “Hi” and the control relay output will remain energized. The FDC-4000 controller can be set to monitor and control temperature using Input #1 or Input #2 in the Operator Mode (prompt INS) by selecting either 1 or 2 for the control probe. This allows Input #2 to be used as a back-up control sensor if there is a failure with the primary Input #1.

2-6 Control Relay

Connection to the control relay is made using the screw clamp terminal blocks provided on the controller circuit board (Figure 2.2). The control relay is a “double pole / double throw” (DPDT) configuration. The control relay will energize when the process value is at or above the set point value. The control relay will de-energize when the process value is at or below the set point value minus the control hysteresis (prompt OHY). The control relay will also de-energize when the controller is operating on battery power.

2-7 Alarm Relay

Connection to the alarm relay is made using the screw clamp terminal blocks provided on the controller circuit board (Figure 2.2). The alarm relay is a “double pole / double throw” (DPDT) configuration. The alarm relay will be energized when the process value is outside of the alarm deviation temperature for the set point or when the controller is operating on battery power.

The alarm delay (prompt ADL) can be used to delay the activation of the alarm relay for a period of 0-999 seconds. This delay affects the operation of the alarm relay for both temperature and “on battery power” alarms.

2-8 Control/Alarm Hysteresis Operation

The control type for relay output 1 is cooling (reverse) only. The control hysteresis (prompt OHY) is designed for safe sided operation. The control relay output will work in the following manner when the main control set point is adjusted for -80 Deg (C or F), with a control hysteresis setting of 2.0 deg. The control output relay will be energized until the temperature reaches -82 deg and then de-energize. When the temperature rises to -80 deg or above, the control output relay will energize to maintain cooling in chamber.

The alarm type for relay output 2 is a “deviation” alarm type only. The deviation set point (prompt ASP) follows the main controller set point and is divided evenly above and below the main controller set point (i.e. main control set point of -80 deg with 10 deg deviation setting equals alarm set points at -70 deg and -90 deg). The alarm is energized only when the temperature is outside of this alarm band.

Alarm hysteresis (prompt AHY) is designed for safe sided operation. The alarm relay output will work in the following manner when the main control set point is adjusted for - 80 Deg (C or F), with an alarm deviation set point of 10 deg and an alarm hysteresis setting of 2.0 deg. The alarm output relay will energize immediately when the temperature is above -70 deg or below -90 deg. When the temperature falls within the band plus hysteresis (-68 or -88) the alarm relay will de-energize.

2-9 Door Sensor

The FDC-4000 controller can be used to detect when the door to the chamber is open. A simple on/off switch is connected to the “door sensor” screw clamp terminal blocks provided on the controller circuit board (Figure 2.2). When the switch is opened, the audible alarm will give short, quick “chirps” to indicate that the door is open.

The door open indication delay time (prompt DOR) sets the time the door can remain open before the audible alarm sounds. The delay can be set between 0-120 minutes. Setting the delay to 0 disables door sensor operation when this feature is not required. A jumper wire can also be placed across the two terminals to disable the feature.

2-10 RS485 Serial Communications

The FDC-4000 controller provides an RS485 serial communications option (FDC-4000-XXX**1**). Connection to the optional communications interface is made using the screw clamp terminal blocks provided on the controller circuit board. Multiple FDC-4000 controllers can be connected to a single PC interface using an RS232/485 converter such as the FDC model SN10A.

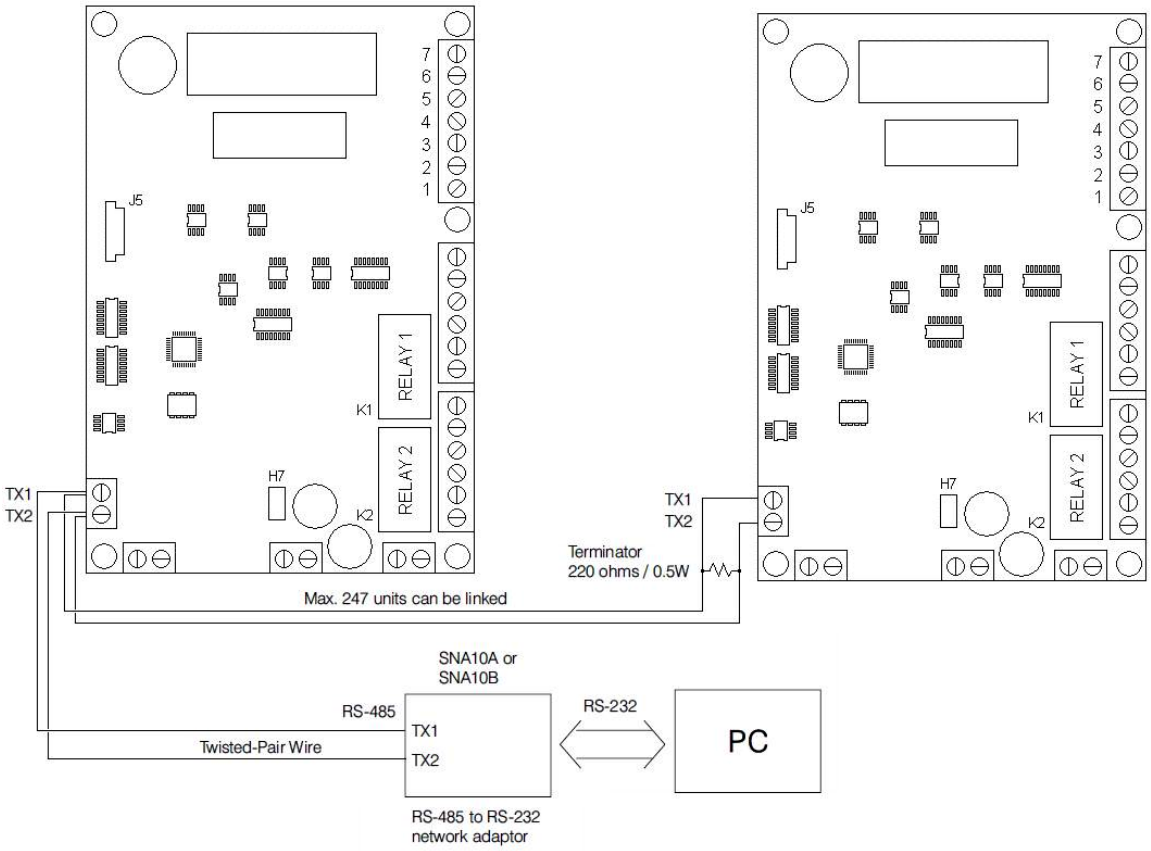


Figure 2.3 Communications Wiring

Each FDC-4000 on the communications link can be monitored at the PC as well as have their control set points changed using software compatible with the Modbus RTU communications protocol such as FDC's Envision software.

Each controller on the link must be set to its own unique communications address (prompt ID). Communications errors will result if more than one controller is set to the same address. All other communications parameters are fixed to make quick work of setting up the communications network using Envision software. If another software package is used to communicate with the FDC-4000, the following communications settings must be used:

Baud Rate: 9600
Data Bits: 8
Parity: Even
Stop Bits: 1

Table 2.1 Parameter Properties

Parameter Notation	Register Address	Parameter Description	Data Type *A	Range *B		Scale *C		Unit *D
				Low	High	Low	High	
SP	0	Set point	W	SPL	SPH	-19999	45536	PV
PV	65	Current Process Value	R	-19999	45536	-19999	45536	PV
SV	66	Current set point Value	R	-19999	45536	-19999	45536	PV
-	67	Not used	R	-	-	-	-	-
-	68	Not used	R	-	-	-	-	-
-	69	Not used	R	-	-	-	-	-
ALM	70	Current Alarm Status	R	0	1	0	65535	-

*A: R/W specifies readable / writable data, R specifies read only, W specifies write only.

*B The range of some parameters is dependant upon the input type. The range of Input #1 and Input #2 is shown in the following table.

Input Type	PT.DN	T_TC
Range Low	-230 ºC (-382 ºF)	-250 ºC (-418 ºF)
Range High	400 ºC (752 ºF)	300 ºC (572 ºF)

Note that an alarm status value of 0 = alarm off, 1 = alarm on.

*C The scale values specify the transformation relation between the value of the parameter and the value of the register. The parameter with a scale low value is stored in the register with a value of zero. The parameter with a scale high value is stored in the register with a value of 65535.

For example, if a value R is read form the addressed register, and LS = scale low value, HS = scale high value, then:

$$\text{the value of the parameter} = LS + R \times \frac{(HS - LS)}{65535}$$

Similarly, before writing the value of a parameter to the addressed register, the value W of the parameter must be transformed according to the following formula:

$$(W - LS) \times \frac{65535}{(HS - LS)}$$

Note that the value stored in the register is always a positive value.

*D The unit PV means that the unit of parameter is the same as the unit of PV (process value). The unit of PV is determined in the Operator Mode (prompt INU).

3-1 Keys and Displays

The FDC-4000 is programmed by using three keys on the front panel. The available key functions are listed in following table.

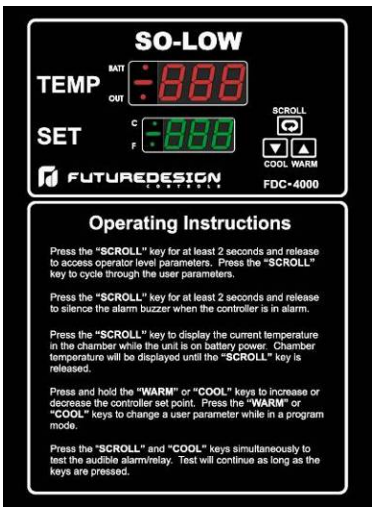
Table 3.1 Keypad Operation

TOUCH KEYS	FUNCTION	DESCRIPTION
▲	Warm Key	Press and hold to increase control set point. Press to change lower display program parameter.
▼	Cool Key	Press and hold to decrease control set point. Press to change lower display program parameter.
Pressing ↻ key while in normal control mode	Scroll Key	Press and hold for at least 2 seconds and release (while in normal control mode) to access operator level parameters. Press to cycle through all user parameters. Press and hold for 2 seconds to silence audible alarm under normal power or on battery power. While unit is in an alarm condition, the external alarm relay contacts will remain energized until the alarm condition no longer exists. Press and hold to display chamber temperature while the controller is on battery power. Chamber temperature will be displayed until key is released. Alarm contact will remain energized while operating on battery power.
Press both keys simultaneously for more than 2 seconds ▲ ↻	Current Power Reading	Displays current AC power (i.e. 110VAC). If power is < 90VAC or > 190VAC, unit will display 90. Mode is only active during normal control mode when top display is reading process value and lower display is reading set point. N/A on battery power.
Press both keys simultaneously for more than 2 seconds ▼ ↻	Alarm Test	Energize audible alarm and alarm relay output as long as keys are pressed when under normal power or battery power. Mode only active during normal control mode when top display is reading process value and lower display is reading set point.

Note: When controller is displaying temperature in normal control mode, press and hold warm/cool to change the set point value. This set point mode does not apply to power off modes. Process value and set point will not display a decimal point.

Upper display used to display process value or menu prompt and error code. Blank when on battery power unless "Scroll" button is pressed. Lower display is used to show the set point value or parameter value and is blank while on battery power.

Status for battery, control output and temp units.



3 Buttons for ease of control setup and set point adjustment.

Operating instructions on front panel for customer ease of use.

Figure 3.1 Front Panel Description

Table 3.2 Display Form of Characters

A	A	E	E	I	I	N	n	S	S	X	
B	b	F	F	J	J	O	o	T	t	Y	Y
C	C	G	G	K	K	P	P	U	u	Z	
c	c	H	H	L	L	Q		V	V	?	?
D	d	h	h	M	M	R	r	W		=	-

◤: Confused Character

3-2 Menu Parameter Descriptions

Table 3.3 Parameter Descriptions

Contained In	Parameter Notation	Display Prompt	Parameter Description	Range	Default Value
User Menu Each time ⟲ key is pressed	INU	inu	Input Unit Selection	°C Degree C units °F Degree F units	°F
	INS	inS	Control Input Selection	Low: 1 High: 2	1
	SHF	SHF	PV Shift (offset) Value	Low: -20.0 High: 20.0	0.0
	ASP	ASP	Alarm Deviation Value	Low: 0 High: 100	18 °F (10 °C)
	AHY	AHY	Hysteresis Control for Alarm	Low: 0.1 High: 30.0	0.1
	ADL	AdL	Alarm Delay Time	Low: 0 Secs High: 999 Secs	0
	OHY	oHY	Control Output ON-OFF Hysteresis	Low: 0.1 High: 30.0	0.1
	RB	rb	Alarm RingBack Time	Low: 0 Mins High: 60 Mins	0
	DOR	dor	Door Sensor Delay Time	Low: 0 Mins High: 120 Mins	0
	ID	id	Communications Address	Low: 1 High: 256	1
	Notes Each time the scroll key is pressed, the upper display will cycle through the parameters in the order shown above. The upper display will show the prompt and the lower display will show the value for edit. Press the "Warm" or "Cool" key to change the value of the parameter. After the last user prompt is displayed, pressing the "Scroll" key will return the unit back to the normal control mode (PV = top display, SP = lower display). The unit will also revert back to the normal display mode if the user does not press a key for ~45 seconds. Above prompts will only be displayed if configured for viewing in the factory mode. If no prompts are configured for view, pressing the "Scroll" key will have no affect on the display.					
Factory Mode Press and hold ⟲ key in normal control mode for 10 seconds.	SHP	SHP	Ship Mode	oFF Ship Mode Not Active on Ship Mode Active	oFF
	SPL	SPL	Set point low limit	Low: -150 High: 200	-100
	SPH	SPH	Set point high limit	Low: -150 High: 200	-40
	A1	A1	Alarm status	oFF Alarm not active on Alarm active	on
	INU	inu	Temperature units shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	INS	inS	Control Input Selection shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	SHF	SHF	PV shift (offset) value shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	ASP	ASP	Alarm set point value shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	AHY	AHY	Alarm hysteresis value shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	ADL	AdL	Alarm delay time value shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	OHY	oHY	Control output hysteresis shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	RB	rb	RingBack value shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	DOR	dor	Door sensor delay time shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on
	SP	SP	Set point adjustment status	oFF Set point adjustment disabled on Set point adjustment enabled	on

	ID	id	Communications Address shown in User Menu	oFF Prompt not shown in user menu on Prompt shown in user menu	on

Parameter Definitions

SHP: Ship mode on/off. If “on”, sets delay timer for alarm (8 hours) after next power up.
SPL: Lower limit of user adjustable set-point range (no decimal point).
SPH: Upper limit of user adjustable set-point range (no decimal point).
A1: Alarm enable/disable.
INU: Temperature units selection for controller (degrees F or C).
INS: Control probe input selection (probe 1 or probe 2)
SHF: PV offset value that is added or subtracted from PV to adjust temperature reading (linear adjustment).
ASP: Alarm deviation set point in degrees.
AHY: Alarm output hysteresis set in degrees.
ADL: Alarm delay time set in seconds. Time delay begins when alarm deviation set point is exceeded.
OHY: Control output hysteresis set in degrees.
RB: RingBack time set in minutes. Time delay is activated after alarm silence button is pressed if alarm is active. RingBack will be active during normal and battery power conditions.
DOR Door open alarm delay time set in minutes. Time begins when door switch opens. Value of 0 disables door alarm.
SP: Enable/disable user from adjusting set point value.
ID: Controller address for optional RS485 serial communications.

Note: When in the User or Factory Menu, the upper LED will display the programming prompt and the lower LED will display the numeric parameter adjustment to match upper display prompt. Warm/Cool buttons will adjust the lower display value.

4-1 Error Codes and Troubleshooting

⚠ This procedure requires access to the circuitry of a live power unit. Dangerous accidental contact with line voltage is possible. Only qualified personnel should perform these procedures. Potentially lethal voltages are present.

Troubleshooting Procedures:

(1) If an error message is displayed, refer to Table 4.2 to see what caused the error and apply the corrective action.

(2) Check each point listed below. Experience has proven that many control problems are caused by defective external devices or improper wiring.

* Line wires are improperly connected
* No voltage between line terminals
* Incorrect voltage between line terminals
* Connections to terminals are open, missing or loose
* Thermocouple is open at tip
* Thermocouple lead is broken
* Shorted thermocouple leads
* Short across terminals
* Open or shorted cooling circuit
* Open coil in external contactor
* Burned out line fuses
* Burned out relay inside control
* Defective solid-state relays
* Defective line switches
* Burned out contactor
* Defective circuit breakers

Table 4.1 Common Failure Causes and Corrective Actions

Symptom	Probable Cause	Corrective Action
Keypad not functioning.	Bad connection between PCB and keypad.	Remove and re-insert flex cable of keypad into connector on PCB. Replace keypad.
LED's will not light.	No power to instrument. Power supply defective.	Check power line connections. Replace power supply board.
Some segments of display not lit or lit erroneously.	LED display or LED lamp defective. Related LED driver defective.	Replace LED display or LED lamp. Replace the related IC chip.
Display unstable.	Thermocouple or RTD sensor defective. Intermittent connection of sensor wiring. Analog portion or A/D converter defective.	Check output of sensor. Check sensor wiring connections. Replace related components on circuit board.
Considerable error in temperature indication.	Wrong sensor or thermocouple type. Incorrect offset value entered in control.	Check sensor or thermocouple type. Access USER MENU and configure "Shift" value.
Display goes in reverse direction (displayed temp increases as process temp decreases).	Reversed wiring of sensor.	Check wiring and correct.
Cool output stays on but indicator reads normal.	Output device shorted or power service shorted.	Check and replace.
Control abnormal or operation incorrect.	Incorrect set-up values. CPU or EEPROM (non-volatile memory) defective.	Read set-up procedures carefully. Check and replace.
Display blinks.	Electromagnetic interference (EMI) or Radio Frequency interference (RFI).	Suppress arcing contacts in system to eliminate high voltage spike sources. Separate sensor and controller wiring from "dirty" power lines. Check all "ground" connections.

Table 4.2 Error Codes and Corrective Actions

Error Code	Error Description	Corrective Action
Er1	Button on keypad collapsed or stuck.	Replace keypad.
Er2	Error reading/writing to non-volatile memory.	Replace EEPROM (requires returning unit to the factory for service).
Hi	Upscale sensor break.	Check sensor connections; verify output of sensor is valid.

5-1 Controller Specifications

Power Requirements
Main: 12VAC (420mA), 5VA Max.
Battery Back-up: 6 VDC
(Lead Acid Re-chargeable, 1.2Ah min.)
Battery Charge Current: < 400mA

Accuracy
+/- 1 Digit

Input #1
Type “T” Thermocouple or
Platinum 100 Ohm RTD (0.00385 Ohms/Ohm/ºC)

Input #2
Type “T” Thermocouple

Table 5.1 Input Ranges

Input Type	PT.DN	T_TC
Range Low	-230 ºC (-382 ºF)	-250 ºC (-418 ºF)
Range High	400 ºC (752 ºF)	300 ºC (572 ºF)

Sensor Break Detection
Sensor open for TC or RTD

Sensor Break Response Time
< 4 seconds for TC or RTD

Control Mode
Control Output: Cooling only (direct)
On/Off with adjustable set point and hysteresis.

Alarm Output: Programmable deviation with adjustable hysteresis and delay.

Control and Alarm Output
DPDT Relay, 2A @ 30 VDC, 2A @ 125 VAC, 1A @ 230VAC (resistive)
(60 Watts total switching power)

Optional RS4845 Serial Communications
Protocol: Modbus RTU
Address: 1-256 (user adjustable)
Baud Rate: 9600
Data Bits: 8
Parity: Even
Stop Bits: 1

User Interface
Dual 4-Digit LED Displays:
Upper Display 0.55” (14mm)
Lower Display 0.40” (10mm)
Keypad (3 touch keys)

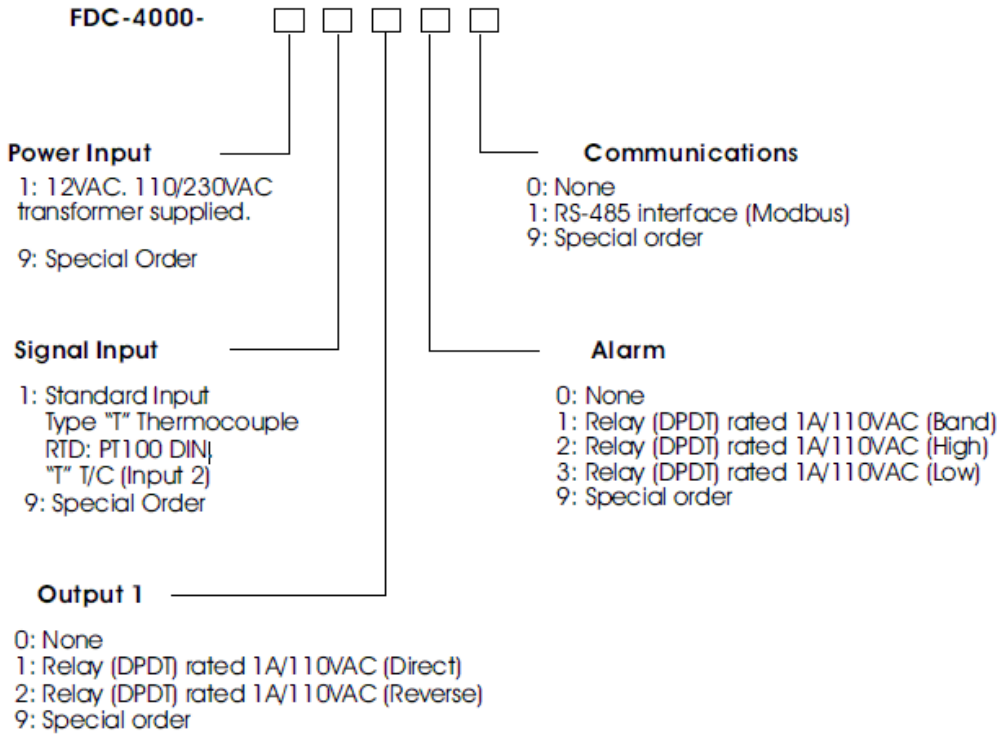
Overall Dimensions
6-1/4” x 8-1/2”
(158.75mm x 215.90mm)

Environmental
Operating Temp: 0 to +60ºC
Storage Temp: -40 to +60º
Humidity: 0 to 90% RH (non-condensing)

Approvals
UL / CUL / CE Pending

Battery Backup
70 hours using 6VDC, 1.2A
rechargeable battery
(recommended battery: Best Buy BP1.2-6)

6-1 Controller Part Number



7-1 Warranty

Future Design Controls warranties or representations of any sort regarding the fitness for use, or the application of its products by the Purchaser. The selection, application or use of Future Design products is the Purchaser's responsibility. No claims will be allowed for any damages or losses, whether direct, indirect, incidental, special or consequential. Specifications are subject to change without notice. In addition, Future Design reserves the right to make changes without notification to Purchaser to materials or processing that do not affect compliance with any applicable specification. Future Design products are warranted to be free from defects in material and workmanship for one year after delivery to the first purchaser for use. An extended period is available with extra cost upon request. Future Design's sole responsibility under this warranty, at Future Design's option, is limited to replacement or repair, free of charge, or refund of purchase price within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse or abuse.

RETURN MATERIAL AUTHORIZATION:
Please contact Future Design Controls for Return Material Authorization Number prior to returning to factory.

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