9090 User's Manual

FDC-9090
Self-Tune Fuzzy / PID
Process / Temperature Controller

FUTUREDESIGN
CONTROLS

Warning Symbol ⚠

This ⚠ Symbol calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury or damage to or destruction of part or all of the product and system. Do NOT proceed beyond a warning symbol until the indicated conditions are fully understood and met.

Use the Manual

NOTE:

It is strongly recommended that a process should incorporate a LIMIT like L91 which will shut down the equipment at a preset process condition in order to preclude possible damage to products or system.

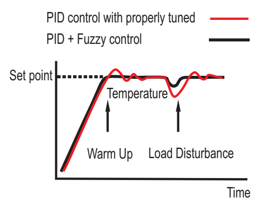
Model:FDC 9090
Instruction Manual

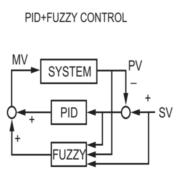
CONTENTS

1. INTRODUCTION

This manual contains information for the installation and operation of the Future Design Control's model FDC-9090 Fuzzy Logic micro-processor based controller.

The Fuzzy Logic is an essential feature of this versatile controller. Although PID control has been widely accepted by industries, it is difficult for PID control to work with some sophistic systems efficiently, for example, systems of second order, long time-lag, various set points, various loads, etc. Because of disadvantage of controlling principles and fixed values of PID control, it is inefficient to control the systems with many variables and the result is unacceptable control for some systems. The Fuzzy Logic control can overcome the disadvantage of PID control only. It controls the system in a efficient way by experiences it had before. The function of Fuzzy Logic is to adjust the PID values indirectly in order to making the manipulation output value MV adjusts automatically and quickly to adapt to various processes. It enables a process to reach its set point in the shortest time with minimum overshooting during tuning or external disturbance.





In addition, this instrument has functions of single stage ramp and dwell, auto-tunung and manual mode execution. Ease of use also an essential feature with it.

2. Model Order Matrix

FDC – □□□□□□□□
(1) (2) (3) (4) (5) (6) (7) (8)

(1) Power Input

4	90-264VAC
5	20-32VAC/VDC
9	Other

(2) Signal Input

5	Configurable (Universal)
9	Other

(3) Range Code

1	Configurable
9	Other

(4) Control Mode

3	PID / ON-OFF Control

(5) Output 1 Option

0	None
1	Relay rated 3A/240VAC resistive
2	SSR Drive rated 20mA/24V
3	4-20mA linear, max. load 500 ohms (Module OM93-1)
4	0-20mA linear, max. load 500 ohms (Module OM93-2)
5	0-10V linear, min. impedance 500K ohms (Module OM93-3)
9	Other

(6) Output 2 Option

0	None

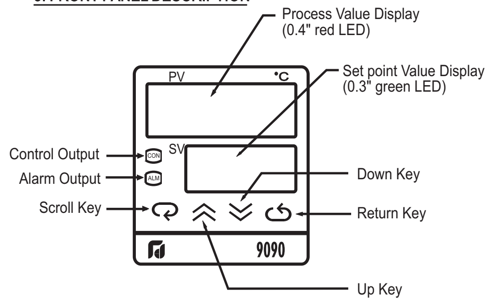
(7) Alarm Option

0	None
1	Relay rated 2A/240VAC resistive
9	Other

(8) Communication

0	None

3. FRONT PANEL DESCRIPTION



4. INPUT RANGE & ACCURACY

IN	Sensor	Input Type	Range(C/F)	Accuracy
0	J	Iron-Constantan	-50/999C -58/1830F	+/-2 C(4F)
1	K	Chromel-Alumel	-50/1370C -58/2498F	+/-2 C(4F)
2	T	Copper-Constantan	-270 to 400 C -454/752F	+/-2 C(4F)
3	E	Chromel-Constantan	-50/750C -58/1382F	+/-2 C(4F)
4	B	Pt30%RH/Pt6%RH	300/1800C 572/3272F	+/-2 C(4F)
5	R	Pt13%RH/Pt	0/1750C 32/3182F	+/-2 C(4F)
6	S	Pt10%RH/Pt	0/1750C 32/3182F	+/-2 C(4F)
7	N	Nicrosil-Nisil	-50/1300C -58/2372F	+/-2 C(4F)
8	RTD	PT100 ohms(DIN)	-200/400C -328/752F	+/-0.4 C(.8F)
9	RTD	PT100 ohms(JIS)	-200/400C -328/752F	+/-0.4 C(.8F)
10	Linear	-10mV to 60mV	-1999 to 9999	+/-0.05%

5. SPECIFICATIONS

INPUT

Thermocouple (T/C):	J, K, T, E, B, R, S, N.
RTD:	PT100 ohm RTD (PTDN or JIS)
Linear:	-10 to 60 mV, configurable input attenuation
Range:	User configurable, refer to Table above
Accuracy:	Refer to Table above
Cold Junction Compensation:	0.1 C/ C ambient typical
Sensor Break Protection:	Protection mode configurable
External Resistance:	100 ohms max.
Normal Mode Rejection:	60 dB
Common Mode Rejection:	120dB
Sample Rate:	3 times / second

CONTROL

Proportion Band:	0 - 200 C (0-360F)
Reset (Integral):	0 - 3600 seconds
Rate (Derivative):	0 - 1000 seconds
Ramp Rate:	0 - 200.0 C / minute (0 - 360.0 F / minute)
Dwell:	0 - 3600 minutes
ON-OFF:	With adjustable hysteresis (0-20% of SPAN)
Cycle Time:	0-120 seconds
Control Action:	Direct (for cooling) and reverse (for heating)

POWER

Rating:	90-264VAC, 50/ 60Hz
Consumption:	Less than 5VA

ENVIRONMENTAL & PHYSICAL

Approvals:	UR File E196206, CSA 209463 CE., RoHS Compliant
EMC Emission:	EN50081-1
EMC Immunity:	EN50082-2
Operating Temperature:	-10 to 50 C
Humidity:	0 to 90 % RH (non-codensing)
Insulation:	20M ohms min. (500 VDC)
Breakdown:	AC 2000V, 50/60 Hz, 1 minute
Vibration:	10 - 55 Hz, amplitude 1 mm
Shock:	200 m/ s^2 (20g)
Net Weight:	170 grams
Housing Materials:	Poly-Carbonate Plastic

6. INSTALLATION

6.1 DIMENSIONS & PANEL CUTOUT

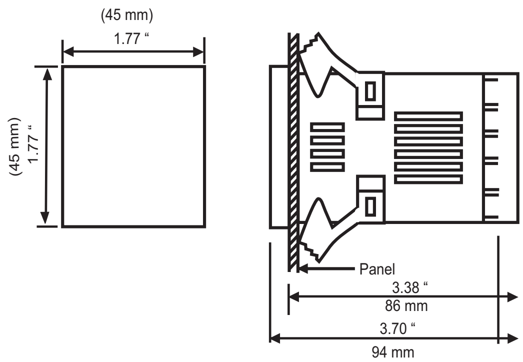
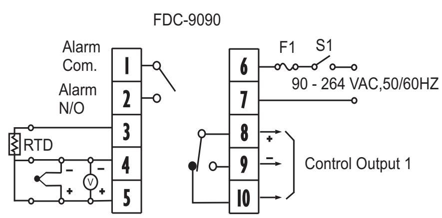


Figure 6.1 Mounting Dimensions

6.2 WIRING DIAGRAM



* F1: Fuse, S1: Power Switch

7. OPERATION

7.1 KEYPAD OPERATION

* With power on, it has to wait for 12 seconds to memorize the new values of parameters once it been changed.

TOUCHKEYS	FUNCTION	DESCRIPTION
	Scroll Key	Advance the index display to the desired position. Index advanced continuously and cyclically by pressing this keypad.
	Up Key	Increases the parameter
	Down Key	Decreases the parameter
	Return Key	Resets the controller to its normal status. Also stops auto-tuning, output percentage monitoring and manual mode operation.
Press for 6 seconds	Long Scroll	Allows more parameters to be inspected or changed.
Press for 6 seconds	Long Return	1. Executes auto-tuning function 2. Calibrates control when in calibration level
Press and	Output Percentage Monitor	Allows the set point display to indicate the control output value.
Press and for 6 seconds	Manual Mode Execution	Allows the controller to enter the manual mode.

7.2 AUTOMATIC TUNING

1. Ensure that controller is correctly configured and installed.
2. Ensure Proportional Band 'Pb' is not set at '0'.
3. Press Return Key for at least 6 seconds (maximum 16 seconds). This initializes the Auto-tune function. (To abort auto-tuning procedure press Return Key and release).
4. The Decimal point in lower right hand corner of PV display flashes to indicate Auto-tune is in progress. Auto-tune is complete when the flashing stops.
5. Depending on the particular process, automatic tuning may take up to two hours. Processes with long time lags will take the longest to tune. Remember, while the display point flashes the controller is auto-tuning.

NOTE: If an AT error(AtEr) occurs, the automatic tuning process is aborted due to the system operating in ON-OFF control(PB=0). The process will also be aborted if the set point is set to close to the process temperature or if there is insufficient capacity in the system to reach set point (e.g. inadequate heating power available). Upon completion of Auto-tune the new P.I.D. settings are automatically entered into the controller's non-volatile memory.

7.3 MANUAL P.I.D. ADJUSTMENT

Whilst the auto-tuning function selects control settings which should prove satisfactory for the majority of processes, you may find it necessary to make adjustments to these arbitrary settings from time to time. This may be the case if some changes are made to the process or if you wish to 'fine-tune' the control settings.

It is important that prior to making changes to the control settings that you record the current settings for future reference. Make slight changes to only one setting at a time and observe the results on the process. Because each of the settings interact with each other, it is easy to become confused with the results if you are not familiar with process control procedures.

TUNING GUIDE

Proportional Band

Symptom	Solution
Slow Response	Decrease PB Value
High Overshoot or Oscillations	Increase PB Value

Integral Time (Reset)

Symptom	Solution
Slow Response	Decrease Integral Time
Instability or Oscillations	Increase Integral Time

Derivative Time (Rate)

Symptom	Solution
Slow Response or Oscillations	Decrease Deriv. Time
High Overshoot	Increase Deriv. Time

7.4 RAMP & DWELL

The FDC-9090 controller can be configured to act as either a fixed set point controller or as a single ramp controller on power up. This function enables the user to set a pre-determined ramp rate to allow the process to gradually reach set point temperature, thus producing a 'Soft Start' function.

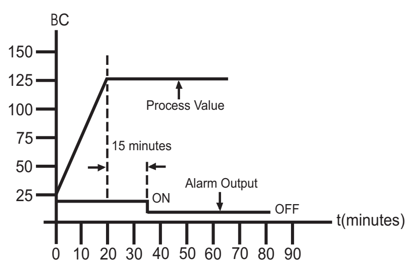
A dwell timer is incorporated within the FDC-9090 and the alarm relay can be configured to provide either a dwell function to be used in conjunction with the ramp function.

The ramp rate is determined by the 'rr' parameter which can be adjusted in the range 0 to 200.0 C/minute. The ramp rate function is disabled when the ' rr ' parameter is set to ' 0 '.

The soak function is enabled by configuring the alarm output to act as a dwell timer. The parameter ALM1 needs to be set to the value 12. The alarm contact will now operate as a timer contact, with the contact being closed at power up and opening after the elapsed time set at parameter ASP1.

If the controller power supply or output is wired through the alarm contact, the controller will operate as a guaranteed soak controller.

In the example below the Ramp Rate is set to 5 C/minute, ALM1 =12 and ASP1 =15 (minutes). Power is applied at zero time and the process climbs at 5 C/minute to the set point of 125 C. Upon reaching set point, the dwell timer is activated and after the soak time of 15 minutes, the alarm contact will open, switching off the output. The process temperature will eventually fall at an undetermined rate.



The dwell function may be used to operate an external device such as a siren to alert when a soak time has been reached.

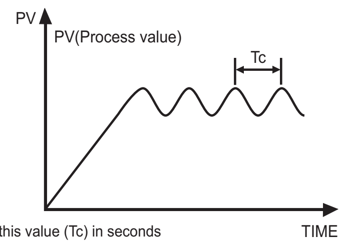
ALM1 need to be set to the value 13. The alarm contact will now operate as a timer contact, with the contact being open on the initial start up. The timer begins to count down once the set point temperature is reached. After the setting at ASP1 has elapsed, the alarm contact closes.

9. ERROR MESSAGES

Symptom	Cause (s)	Solution (s)
SbEr	Sensor break error	Replace RTD or sensor Use manual mode operation
LLEr	Process display beyond the low range set point	Re-adjust LLit value
HLEr	Process display beyond the high range set point	Re-adjust HLit value
AHEr	Analog hybrid module damage	Replace module. Check for outside source of damage such as transient voltage spikes
AtEr	Incorrect operation of auto tune procedure Prop. Band set to 0	Repeat procedure. Increase Prop. Band to a number larger than 0
oPEr	Manual mode is not allowable for an ON-OFF control system	Increase proportional band
CSEr	Check sum error, values in memory may have changed accidentally	Check and reconfigure the control parameters

7.5 MANUAL TUNING PROCEDURE

Step 1: Adjust the integral and derivative values to 0. This inhibits the rate and reset action
Step 2: Set an arbitrary value of proportional band and monitor the control results
Step 3: If the original setting introduces a large process oscillation, then gradually increase the proportional band until steady cycling occurs. Record this proportional band value(Pc).
Step 4: Measure the period of steady cycling

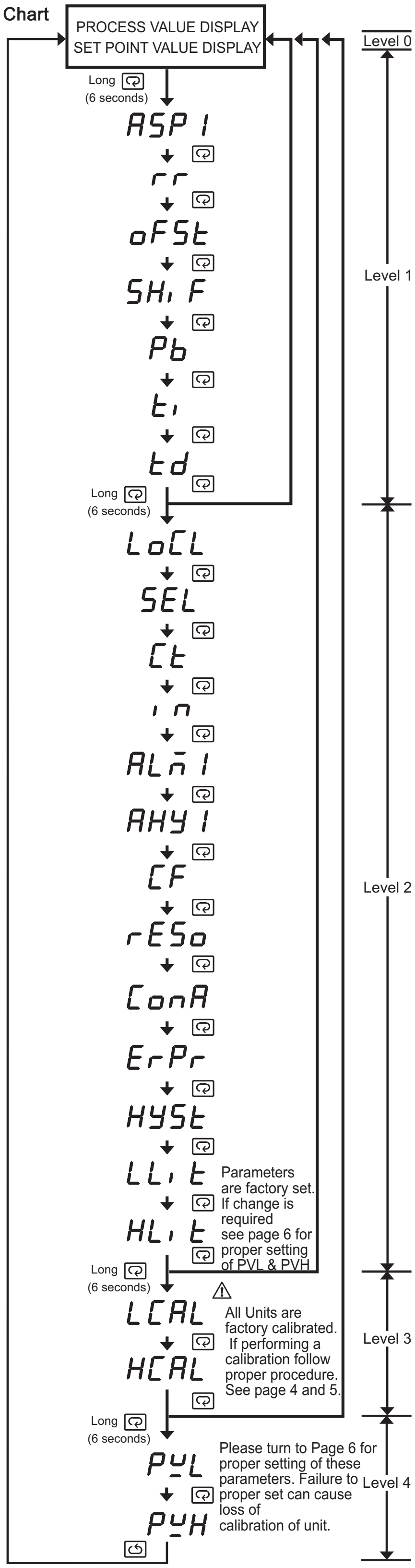


Record this value (Tc) in seconds

Step 5: The Control Settings are determined as follows:

Proportion Band(PB)=1.7 Pc
Integral Time (TI)=0.5 Tc
Derivative Time(TD)=0.125 Tc

7.6 Flow Chart



The "return" key can be pressed at any time. This will prompt the display to return to the Process value/Set point value.

Power Applied:

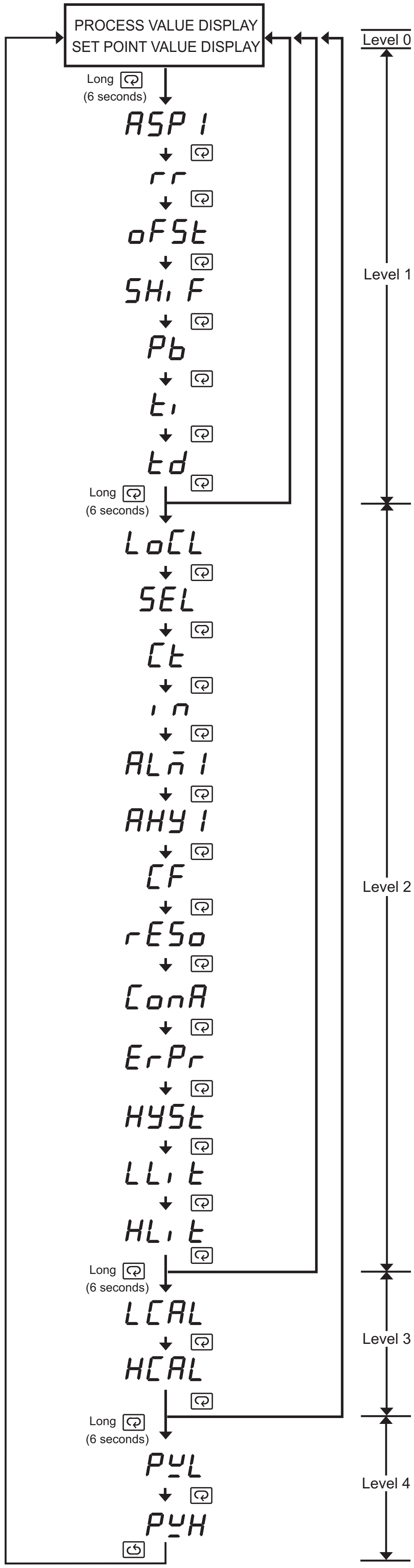
1. 9090 v3.6 Displayed for 4 seconds. (Software Version 3.6 or higher)
2. 8.8.8.8. 8.8.8.8. LED test. All LED segments must be lit for 4 seconds.
3. Process value and set point indicated.

7.7 PARAMETER DESCRIPTION

INDEX CODE	DESCRIPTION ADJUSTMENT RANGE	**DEFAULT SETTING
SV	Set point Value Control *Low Limit to High Limit Value	Undefined
ASP1	Alarm Set point Value * Low Limit to High Limit Value.(if ALM1 =0, 1, 4 or 5) * 0 to 3600 minutes (if ALM1 =12 or 13) * Low Limit minus set point to high Limit minus set point value (if ALM1 =2, 3, 6 to 11)	200 C (392F)
rr	Ramp Rate for the process value to limit an abrupt change of process (Soft Start) * 0 to 200.0 C (360.0 F) / minute (if in = 0 to 9) * 0 to 3600 unit / minute (if in =10)	0 C / min (32F / min).
oFSt	Offset Value for Manual Reset (if ti = 0) * 0 to 100%	0.0 %
SHiF	Offset shift for process value * -111 C to 111 C	0 C (32F)
Pb	Proportional Band * 0 to 200 C (set to 0 for on-off control)	10 C (50F)
ti	Integral (Reset) Time * 0 to 3600 seconds	120 sec.
td	Derivative (Rate) Time * 0 to 1000 seconds	30 sec.
LoCL	Local Mode 0: No control parameters can be changed 1: Control parameters can be changed	1
SEL	Parameter Selection (allows selection of additional parameters to be accessible at level 0 security) 0: None 1: ASP1 2: rr 3: oFSt 4: ASP1, rr 5: ASP1 oFSt 6: rr , oFSt 7: ASP1, rr , oFSt	0
Ct	Proportional Cycle Time * 0 to 120 seconds	Relay 20 Pulsed Voltage 1 Linear Volt/mA 0
in	Input Mode Selection 0: J type T/C 1: K type T/C 2: T type T/C 3: E type T/C 4: B type T/C 5: R type T/C 6: S type T/C 7: N type T/C 8: PT100 DIN 9: PT100 JIS 10: Linear Voltage or Current Note: T/C-Close solder gap G5, RTD-Open G5	T/C 0 RTD 8 Linear 10
ALM1	Alarm Mode Selection 0: Process High Alarm 1: Process Low Alarm 2: Deviation High Alarm 3: Deviation Low Alarm 4: Inhibit Process High Alarm 5: Inhibit Process Low Alarm 6: Inhibit Deviation High Alarm 7: Inhibit Deviation Low Alarm 8: Outband Alarm 9: inband Alarm 10: Inhibit Outband Alarm 11: Inhibit Inband Alarm 12: Alarm Relay OFF as Dwell Time Out 13: Alarm Relay ON as Dwell Time Out	0
AHY1	Hysteresis of Alarm 1 * 0 to 20% of SPAN	0.5%
CF	C / F Selection 0: F, 1: C	1
rESo	Resolution Selection 0: No Decimal Point 1: 1 Digit Decimal 2: 2 Digit Decimal 3: 3 Digit Decimal (2 & 3 may only be used for linear voltage or current in =10)	0
ConA	Control Action 0: Direct (Cooling) Action 1: Reverse (Heat) Action	1
ErPr	Error Protection 0: Control OFF, Alarm OFF 1: Control OFF, Alarm ON 2: Control ON , Alarm OFF 3: Control ON, Alarm ON	1
HYSt	Hysteresis for ON/OFF Control *0 to 20 % of SPAN	0.5%
LLit	Low Limit of Range	-50 C(-58F)
HLit	High Limit of Range	1000C (1832F)
LCAL	Low Calibration Figure	0 C (32F)
HCAL	High Calibration Figure	800 C (1472F)
PVL***	Low Calibration Figure Set to One Tenth the LCAL Value	0 C (32F)
PVH***	High Calibration Figure Set to One Tenth the HCAL Value	80 C (176F)

* Adjusting Range of the Parameter
** Factory settings. Process alarms are at fixed temperature points. Deviation alarms move with setpoints

NOTE *** Parameters are for Version 3.7 **ONLY**



Supplemental Instruction for the New Version V7.3 ONLY

NOTE: This procedure does NOT have to be performed unless the LLit and/or Hlit have been changed from the factory setting. This routine properly adjusts the calibration values IF the Llit and/or Hlit parameters have been changed from factory default. Setting the PVL and PVH correctly allows proper operation of unit. No additional calibration is required.

The unit with firmware version V3.7 has two additional parameters - "PVL" and "PVH" located in the level 4 as parameters flow chart on the left hand side indicates.

When you need to change the LLit value to a higher value or change the HLit value to a lower value, the following procedures MUST be performed to make the PVL value equivalent to one tenth of LCAL value and the PVH value equivalent to one tenth of HCAL value. Otherwise the measured process values will be out of specification.

1. Follow the Setup Parameter procedure and scroll down to the "LLit" parameter. Change parameter using the up and down arrow to new desired value you require.
2. Press and release the Scroll Key, "HLit" appears on the PV Display. Use Up and Down Keys to set the HLit value to the new desired value you require.
3. Turn the power OFF wait 5 seconds and re-power the unit.
4. Following the Setup parameter entry routine advance until the "LCAL" appears on the PV Display. Record the LCAL value.
5. Press and release the Scroll Key, then "HCAL" appears on the PV Display. Record the HCAL value.
6. Press the Scroll Key for at least 6 seconds and then release, "PVL" appears on the PV Display. Use UP and Down Keys to set the PVL value to **one tenth** of LCAL value.
7. Press and release the Scroll Key, "PVH" appears on the PV Display. Use UP and Down Keys to set the PVH value to **one tenth** of HCAL value.
8. Adjustment is complete. Exit by depressing the Return Key.
9. Unit should display the proper process value.

Proper setting of the PVL and PVH parameters can be confirmed by entering the Setup parameter routine and scrolling through the complete parameter listing and verifying the PVL and PVH parameters are set to the required **one tenth** the value of LCAL and HCAL respectively.

7.0 Manual Calibration Procedures

All units are factory calibrated. If field calibration is required you must use NIST traceable calibration equipment to meet specifications. If proper equipment is not available please return to factory for proper service.

Equipment required is:

1.) A Millivolt source 0/100Mv +/- 0.005% accuracy

2.) K thermocouple simulator 0.01% accuracy

3.) RTD simulator 0/300 ohms 0.01%accuracy

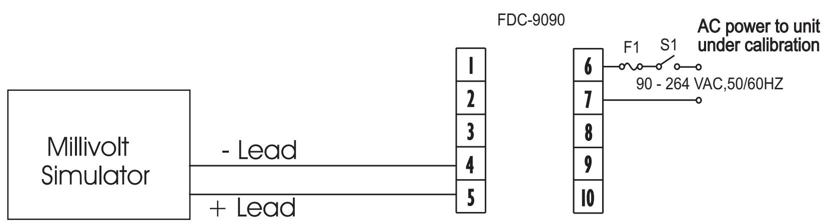
Main A to D Calibration:

This calibration procedure requires a Millivolt source.

This calibration **must** be done for **ALL** input types.

1.) Connect the Millivolt source as shown below:
Positive lead to terminal 5 and negative lead to terminal 4.
Set the Millivolt source for 0.00 MV.

Millivolt wiring Diagram



2.) Enter into the setup parameter menu and set the following parameters to the settings shown below;
IN = 1, LLiT= -50.0, HLit = 1370

3.) With HLit on the display press and hold scroll key for 6 seconds then release. The display should read LCAL set this value to 0.0 using up/down arrow keys to obtain 0.0

4.) Press and release scroll key the display reads HCAL set this value to 800.0 using arrow keys.

5.) Press and hold the scroll key for 6 seconds then release the display will read PVL, set this value to 0.0 using the arrow keys.

6.) Press and release scroll key display reads PVH set this value to 80.0 using the arrow keys.

7.) Press and hold the scroll key for 6 seconds then release. The display will read AdLo Input a 0.0 MV signal then press and hold the scroll key for 6 seconds, then release. The display will blink momentarily and a new value will be obtained.
If the display does not blink or the value is equal to -199.9 or 199.9 then calibration failed.

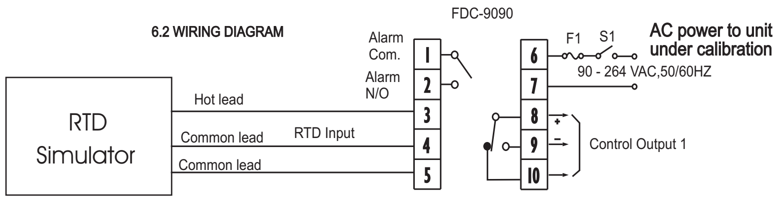
8.) Press and release scroll key. The display will read AdHi. Input a 60.0 MV signal then press and hold the scroll key for 6 seconds then release.
The display will blink momentarily a new value will be obtained.
If the display does not blink or the value is equal to -199.9 or 199.9 then calibration fails.
If calibrations fails check equipment connections and setting and repeat. If unsuccessful return to manufacturer.

If calibration is successful then proceed to next page for Cold Junction Calibration for thermocouples and RTD calibration if using RTD input.

7.0 Manual Calibration Procedures (continued)

RTD Input calibration - Perform this calibration if RTD input is to be used on the unit.
Solder Gap G5 **MUST** be **OPENED** prior to performing RTD calibration.*

1.) Connect a 3 wire RTD simulator to the RTD input as shown below: The "hot" lead connects to terminal 3. The 2 common leads go to terminals 4 & 5.



2.) Set the RTD simulator to simulate 100 ohms.

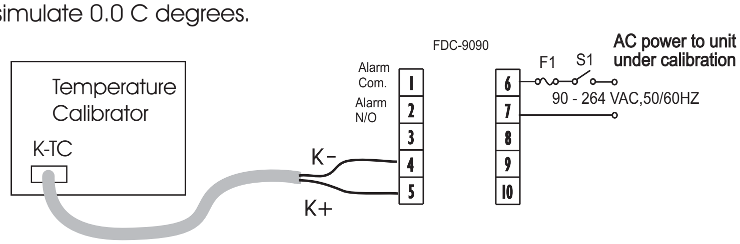
3.) If you exited the calibration mode, Re-enter as described in the parameter setup routine and scroll down until display reads rtdL. With rtdL on the display and 100 ohm input from simulator, press and hold the scroll key for 6 seconds then release.
The display will blink momentarily and a new value will be obtained.
If the display does not blink then calibration fails.

4.) Press and release the scroll key the display reads rtdH. Now set the RTD simulator to 300 ohms,with rtdH on the display press and hold the scroll key for 6 seconds then release the scroll key.
The display will blink momentarily and a new value will be obtained.
If the display does not blink or the value equals -199.9 or 199.9 then calibration fails.
If successful RTD calibration is complete. Disconnect the RTD and program as needed.

Cold Junction Calibration - Perform this calibration if Thermocouple input is to be used on the unit. NOTE: Solder **Gap G5** MUST be **ClOSED** to perform this calibration. *

1.) Connect a K thermocouple simulator wired as shown below:
Terminal 5 is the Positive lead (Yellow) and terminal 4 is negative lead (Red).

2.) Set the K simulator to simulate 0.0 C degrees.



2.) If you exited the calibration mode enter as performed in the main calibration routine and scroll down to the parameter CJLo. With 0.0C simulated on input use the Up and Down arrow key to obtain a reading of 40.0. Once value at unit is set to 40.0 press and hold the scroll key for 6 seconds then release key.
The display should blink momentarily and a new value is obtained.
If display does not blink and a value equals -5.00 or 40.00 the calibration fails.

If unit can not be field calibrated return to factory for evaluation/repair.

NOTE: All units are shipped typically in thermocouple mode. If RTD input is required you must OPEN the solder gap G5 on processor board. You do NOT need to recalibrate as ALL calibration procedures were performed at factory.

* Solder Gap G5 is found on the small "tail like" PC board inside of unit. To remove unit from housing push up on the release tab on the bottom from of display bezel and pull bezel forward. Observer PC board where solder gap G5 is located.

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Warranty and Return Statement

WARRANTY

Future Design Controls products described in this manual are warranted to be free from functional defects in materials and workmanship at the time the products leave Future Design Controls Facilities and to conform at that time to the specifications set forth in the relevant Future Design Controls manual, sheet or sheets for a period of 3 years after delivery to the first purchaser for use.

There are no expressed or implied Warranties extending beyond the Warranties herein and above set forth.

Limitations:

Future Design Controls provides no warranty or representations of any sort regarding the fitness of use or application of its products by the purchaser. Users are responsible for the selection, suitability of the products for their application or use of Future Design Controls products.

Future Design Controls shall not be liable for any damages or losses, whether direct, indirect, incidental, special, consequential or any damages, costs or expenses excepting only the cost or expense of repair or replacement of Future Design Controls products as described below.

Future Design Controls sole responsibility under the warranty, at Future Design Controls option, is limited to replacement or repair, free of charge or refund of purchase price within the warranty period specified. The warranty does not apply to damage resulting from transportation, alteration, misuse or abuse.

Future Design Controls reserves the right to make changes without notification to purchaser to materials or processing that does not effect the compliance with any applicable specifications.

Return Material Authorization:

Contact Future Design Controls for Return Material Authorization Number prior to returning any product to our facility.

Future Design Controls
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User's Manual

FDC-9090 Process / Temperature Controller

FUTUREDESIGN CONTROLS

FUTUREDESIGN CONTROLS

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Um9090 Rev 3.0

Version3.0 Dated 6/2013