CAL 9900 AUTOTUNE PID TEMPERATURE CONTROLLER INSTALLATION AND OPERATING MANUAL

1 TO SELECT SENSOR AND ADJUST SET POINT

Step 1
POWER UP
Self check sequence

Step 2
ZERO FLASHES ON LEFT
Indicating no sensor selected

Note
Buttons only adjust flashing digits (shown green)

Step 3
PRESS TO SELECT SENSOR e.g. Type K = 2
Sensor options:
(For full table see 8)

Step 4
PRESS TO ENTER SENSOR INTO MEMORY
Display shows process temperature e.g. Ambient

Step 5
PRESS TO DISPLAY SET POINT

Step 6
PRESS AND HOLD TO INCREASE SET POINT

Output turns on and temperature rises

The controller is now operational with Factory PID settings:
Prop band 2.5%
Prop time 20 sec
Integral 5 min
DAC approach control 1.5

2 IMPORTANT - Please read before using Autotune AT

1 If required adjust: Range, H-Res O.1°
Negative temperature range, see 8
2 Proportional cycle-time 20 sec factory set, if unsuitable change now or use Autotune calculated value after tuning run see 6
3 For best results use normal set point and load conditions
4 Start Autotune AT with the load cool

TO AUTOTUNE

Step 7
START AUTOTUNE 'AT' NEAR AMBIENT

CAL Controls

The CAL 9900 microprocessor based temperature controller provides precise control with a minimum of setting up, the advanced Autotune algorithm tunes all five control parameters automatically. The simple setting up procedure below is normally sufficient; specialised applications may need the comprehensive 9900 features covered in this manual.

Step 8
PRESS P TO ACCESS PROGRAM MODE
Function O flashes on right

Step 9
PRESS TO CHANGE TO OPTION SELECTION
Option O flashes on left

Step 10
PRESS TO SELECT AUTOTUNE 'AT'
Option 1

Step 11
PRESS P TO START AUTOTUNE 'AT'

Autotuned parameters

- Autotune limits
- Entered automatically:
  - Proportional band/Gain 0.5 – 2G ± %/range
  - Integral time/Reset 0.2 – 45.5 min
  - Derivative time/Ratio 10 – 255 sec
  - DAC approach control 0.5 – 90 x gain

- Proportional cycle time 0.8 – 819 sec
- Calculated but for safety reasons needs manual acceptance see 6

Fig 1 Autotune AT

3.2 AUTOTUNE PT (Push-to-Tune)

Select Opt 2 of 2 step 10

Used to fine tune difficult applications at set point. Useful if the set point or thermal conditions are substantially changed. During PT tuning some overshoot will occur, if this is unacceptable, temporarily reduce set point. PT tunes the parameters listed above except DAC. Proportional cycle time is recalculated but needs manual acceptance

3 AUTOTUNE TYPES AND USES

Two types of Autotune are provided to ensure optimum control of a wide range of applications

AUTOTUNE AT – Normal method, tunes during warm up

AUTOTUNE PT – (Push-to-Tune) – For difficult applications, tunes at set point

3.1 AUTOTUNE AT

Start Autotune AT with the load cool. A short tuning cycle occurs at 75% set point during warm up. New PID values are automatically entered and the temperature rises to set point

3.3 OVERIDING AUTOTUNE VALUES

After AT/PT any Autotune parameter may be changed to an Option from the table. The original Autotune value is retained in memory.

Note: Subsequent Autotune AT or PT run replaces manual selections with new calculated values (except Cycle time)
4 CONTROLLER FUNCTIONS
DISPLAY AND SELECTION PROCEDURE

The facilities of the 9900 are selected from the Functions and Options Table see 8 using program mode
Functions (Fn) - The available controller facilities
Options (Op) - The available functions for each function e.g. Function O Option O (Fn 5/Op 0) = SPI Prop band of 2.5%
Note 1. Should difficulty occur in adjusting
Options check the Parameter lock see 14
Note 2. Normal control is maintained with
existing settings during programing

5 AUTOTUNE HINTS

5.1 Autotune error messages see 11 (EE5-7)
(latched, PRESS ▼ to reset)
AT/FT tunes most applications satisfactorily,
but if tuning fails and error messages
repeatedly occur, the application has
unusual characteristics requiring manual
tuning see 21

5.2 Tuning with set point near ambient
Difficult both to control and Autotune. Use
PT. If tuning fails try with Fn 5/Op 1, otherwise
increase set point or tune manually

5.3 In High Resolution (O.1°)

Should error message EE6 occur during
tuning, select normal resolution (Fn 18/
Op 0) then Autotune and afterwards
re-select Hres. (Check range setting Fn 24)

5.4 AUTOTUNE VALUE DISPLAY

At the end of an Autotune run the AT value
is automatically entered and may be
displayed in Functions:
5 Prop band/Gain
6 Derivative time/Rate
7 DAC approach control
8 Integral time/Reset

Step 1
PRESS P TO ENTER
PROGRAM MODE

Step 2
PRESS AND HOLD
INDEX TO FUNCTION
e.g. Function 16
(Sensor select)
flushes

Step 3
PRESS X CHANGE TO
OPTION SELECTION
e.g. Option 2 (Type K)

Step 4
PRESS or
SELECT OPTION
REQUIRED
e.g. Option 1 (Type J)

Step 5
PRESS X CHANGE TO
FUNCTION/SELECTION
Set other functions as
required

Step 6
PRESS P TO EXIT
PROGRAM MODE WHEN
SELECTIONS COMPLETE
Process temperature displayed
Control commences with
new instructions now entered in
memory

4.2 MODE B - FUNCTION/OPTION DISPLAY
PROCEDURE

Used in Function 2 to set full scale alarms
and Function 24 - Range adjustment.
Mode 8 enables all digits to be used for
Options values

Step 1
PRESS X TO INDEX
TO FUNCTION
e.g. Function 24
(Range adjustment)
flushes
Note 2 bars = Mode 8

Step 2
PRESS X TO DISPLAY
OPTIONS VALUE
e.g. Range 400°
flushes

Step 3
PRESS AND HOLD
PRESS X TO INCREASE
PRESS X TO DECREASE
OPTIONS VALUE

5.4 AUTOTUNE VALUE DISPLAY

At the end of an Autotune run the AT value
is automatically entered and may be
displayed in Functions:
5 Prop band/Gain
6 Derivative time/Rate
7 DAC approach control
8 Integral time/Reset

Step 1
PRESS P TO ENTER
PROGRAM MODE

Step 2
PRESS X TO INDEX
TO FUNCTION
e.g. Function 5 Prop band
AT value = 35%

Note 3 LEDs show an AT value displayed

6 PROPORTIONAL CYCLE TIME

6.1 Autotune cycle time

Autotune calculates the optimum value but
for safety reasons does not automatically
implement it

6.2 If the cycle time needed is known

Applications known to require shorter times
than the 20 sec factory setting, including
SSR drive (1 sec), linear outputs (0.06 sec)
should select the appropriate Option in
Function 4 using the procedure see 4
This setting will not be changed, but may
be replaced with the calculated AT value
if preferred after the Autotune run

6.3 Normal procedure

Run Autotune AT see 2. When complete
alternating AT display stops) display the AT
value calculated cycle time and accept it
suitable, this will then replace the 20 sec
factory setting

Step 1
Index to Function 4
For procedure see 4
Option O 20 sec
factory setting

Step 2
PRESS X TO CHANGE
TO OPTION SELECTION

Step 3
PRESS X TO DISPLAY
CALCULATED AT VALUE
e.g. 9.8 sec
Note flashing bar
shows calculated AT value is displayed

6.4 AT Cycle time values in Function 4

Two AT cycle time values are stored, to
enable the current operation value to be
retained, until a new value from a sub-
sequent Autotune run is considered
Example of two AT cycle time values after
a subsequent Autotune run

Step 5
Index to Function 4
Operational AT value = 9.8 sec
As accepted previously
(Step 4) Note 3 LEDS ON

Step 6
PRESS X TO CHANGE TO
OPTION SELECTION

Step 7
PRESS X TO DISPLAY
Latest calculated AT value
e.g. 7.2 sec
Note flashing bar

Note 8 Alternate actions:
PRESS P to accept the latest calculated
AT value - 7.2 sec which replaces 9.8 sec
as the operational AT value
OR PRESS X to display current operational
AT value. Then PRESS P to retain 9.8 secs
OR PRESS X to select option from Table

7 ALARMS

7.1 SP2 Operating mode
The operating mode must be selected at
Function 19 before adjusting SP2 at Function 2

7.2 Alarm output operation
The alarm output is fail safe. SP2 relay is
designated and SP2 red LED on during the
alarm condition (Not with SP2 in Proportional
mode)

7.3 LBA - Loop break alarm see Fig. 3
LBA detects a control loop fault, and
displays an error message (EE3) The
alarm relay may be configured to act also
LBA operates if the controller fails to receive
the correct response to the output within a
set time. Technically
LBA occurs when SPI output is saturated
0% or 100% and the process temperature
fails to move more than 50% prop band
in the LBA time. SPI output state is unaffected by
LBA alarm condition

Fig 3 Typical faults detected by LBA

7.4 Selecting LBA - EE3 message only
1 Index to Function 12 - LBA time
Option O - LBA OUT, displayed
2 PRESS X to change option selection
3 PRESS X to select Option 14
The recommended initial setting
(2 x Integral time in use)
4 LBA alarm condition EE3 displayed
alternating with process temperature
display latches, to reset PRESS x together
To configure Alarm relay SP2 to LBA Select Option 6 in Function 19 (Relay latches in
alarm condition, to reset PRESS x)
Note Use LBA with SP2 ON/OFF mode only
(Fn 30/Op 0). Reset EE3/Relay before any
other program changes

444
250
44
4
98.4
0.4
0.4
5.0
### FUNCTIONS AND OPTIONS TABLE

**Please read these important notes first**

1. **Factory setting:** 6 Option O (except Functions 2 and 22)
2. **Initial configuration:**
   - Functions 10-24 must be selected first then exit by pressing the Exit button. Then AutoTune and other functions may be selected.
3. **Protected Functions:**
   - All functions except User Settings (Functions 1, 2, 3) may be locked in memory after setting to prevent tampering. See parameter lock.
4. **AT Values** (marked):
   - As calculated on the latest AT or PT run
5. **Locating Functions:**
   - Function 0 is the Program mode entry point
   - Pressing 'Option' increases
   - Move direct to Function 13 for access to higher functions
   - Hold pressed to auto index through table (Functions 13, 14, 25 are unused)

### OPERATING PARAMETERS

<table>
<thead>
<tr>
<th>Fn No.</th>
<th>Opt No.</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td><strong>Operating mode</strong></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>Normal Operation</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Start AutoTune AT</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Start AutoTune PT</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Park mode</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Manual heat %</td>
</tr>
</tbody>
</table>

### USER SETTINGS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manual Reset (OUT IN PID)</td>
</tr>
</tbody>
</table>

1. **SP2 Adjust**
   - 1st steps (max \(+127^\circ/50\%\) prop band)

### 16 Sensor Select and Range Table

<table>
<thead>
<tr>
<th>Range</th>
<th>Type</th>
<th>Factory set</th>
<th>Sensor range (SR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T/F</td>
<td>°C</td>
<td>°C/°F</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>400</td>
<td>800/1200</td>
<td>1400</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
<td>800/1200</td>
<td>1400</td>
</tr>
<tr>
<td>3</td>
<td>400</td>
<td>800/1200</td>
<td>1400</td>
</tr>
<tr>
<td>4</td>
<td>1600</td>
<td>1600</td>
<td>1600</td>
</tr>
<tr>
<td>5</td>
<td>1600</td>
<td>1600</td>
<td>1600</td>
</tr>
<tr>
<td>6</td>
<td>250</td>
<td>250/500</td>
<td>500</td>
</tr>
<tr>
<td>7</td>
<td>500</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>8</td>
<td>1600</td>
<td>1600</td>
<td>1600</td>
</tr>
</tbody>
</table>

1. **Range minimum:** 0°C/32°F
2. **Except TP100:**
   - Factory set 0°C/32°F
3. **Minimum available -200°C/°F**

### OPERATIONAL PARAMETERS

<table>
<thead>
<tr>
<th>Fn No.</th>
<th>Opt No.</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td><strong>SP1 Proportional cycle time</strong></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td><strong>SP1 Hysteresis band/Gain</strong></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td><strong>SP1 Derivative time/Rate</strong></td>
</tr>
</tbody>
</table>

### 12 LBA Loop break alarm - time

<table>
<thead>
<tr>
<th>Function</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>90</td>
</tr>
<tr>
<td>7</td>
<td>140</td>
</tr>
</tbody>
</table>

### 15 Reset Functions O - 24 to factory settings

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal</td>
</tr>
<tr>
<td>1</td>
<td>Reset (Function 22 not reset)</td>
</tr>
</tbody>
</table>

### Abbreviations:

- Fn: Function
- Opt: Option
- SR: Sensor range
- CR: Configured range

### Configuration range (CR) adjustment

<table>
<thead>
<tr>
<th>1° steps Mode B adjustment see 4.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(See Range Table in Function 16)</td>
</tr>
</tbody>
</table>
10 INSTALLATION

10.1 ELECTRICAL INSTALLATION

1. Check controller label is the correct supply voltage for your application.
2. Connections are shown on the socket label.
3. For connection to socket use, 250 Faston receptacles provided in accessory kit.
4. Recommended wire size for mains voltage and outputs 32/0.2 1.0 mm² (16 AWG 0.134") rated to 6 Amps at 300V at 70°C.
5. For use with 2 wire RTD an external link is required between connections 3 and 5.
6. IMPORTANT It is recommended that line interference suppressors are fitted across relay contacts to prolong relay life.

11 ERROR MESSAGES

APPLICATION FAULTS

E01 Sensor not Fault message.
E02 RTD/PT100 Failure.
FF3 LBA Loop break Fault.
AUTOTUNE AT/PT TUNING CYCLE FAULTS

Autotune run is aborted, Previous values are retained.

SOFTWARE FAULTS

E28 Calibration data error.
E99 System error.

PRESS together to reset latched message.

WARRANTY

CAL Controls warrant this product free from defects in workmanship and materials for three (3) years from date of purchase.

1. Should the unit malfunction, return it to the factory. Defective items will be repaired or replaced at CAL Controls discretion.
2. There are no user-serviceable parts in this unit. This warranty is void if the unit shows evidence of tampering with or subjected to excessive heat, moisture, corrosion or other misuse.
3. Components worn, or damaged due to misuse, are excluded.
4. To comply with this warranty the installation and use must be by suitably qualified personnel.
5. Neither CAL Controls Ltd or CAL Controls Inc shall be responsible for any damage or loss to other equipment howsoever caused, which may be experienced as a result of the installation or use of this product.
6. CAL Controls liability for any breach of this agreement shall not exceed the purchase price paid.

12 9900 SPECIFICATION

INPUTS

See Function 16 for Range Table

Thermocouple - 9 types

J Iron/Constantan K Chromel/Alumel L Fe50/Platinum N NiCrSi/NSI O Tin/Con P Platinum/Rh

Standards: IEC 58/84 DIN 43710

Linearity: 5 - 95% sensor range see 8

Resistance thermometers RTD/PT100 2 wire (optional 3 wire)

DIN 43760 100Ω ±0.1% 138.5Ω 100°C PI

Linearity +15% Impedance 100Ω min

Applicable to all inputs:

SR - sensor range, CR = configured range
Calibration accuracy: +2% SPI +1°C
Sampling frequency: Input 3Hz, CJC 5sec
Common mode rejection: Negligible effect to 140dB, 240V, 50-60Hz
Series mode rejection: 60dB, 50-60Hz
Temperature coefficient: 10ppm/°C SR
Reference accuracy: ±0.1°C
115/230V ±5%, after 30min settling time

OUTPUTS

OUTPUT MODULE - Dual standard

Main output: SPI
Relay standard: 5A/250Vac resistive
SSD optional: 5V/25mA non-isolated

Alarm/cool channel output: SP2
Relay standard: 3A/250Vac resistive
SSD optional: 5V/25mA non-isolated

9900 Controller output module - types

SPI output SP2
115V code 230V

RELAY

Relay Relay 9011C/F 9012C/F
Relay Ssd 9012C/F 9012C/F
Relay Ssd 9012C/F 9012C/F
Relay Ssd 9012C/F 9012C/F
Relay Ssd 9012C/F 9012C/F

9900 Controller output module - types

SPI output SP2
115V code 230V

CAL Controls policy of continuous development may cause detail changes to the enclosed information. E & OE
IMPORTANT: ADVANCED FUNCTIONS SECURITY

The advanced functions are intended for OEMs and process engineers. Access is therefore protected in the function tables.

To avoid unauthorised use of these functions remove this section from the manual before supply to end user.

13.1 'HIDDEN' ACCESS TO ADVANCED FUNCTIONS

Step 1
PRESS " TO ENTER PROGRAM MODE

Step 2
PRESS " TO GO DIRECTLY TO FUNCTION 13

Step 3
PRESS & HOLD " FOR 5 sec TO ACCESS ADVANCED FUNCTIONS (Entry point Fn 38)

13.2 ADVANCED FUNCTIONS ... Protected

Fn Opt No. Parameter
No. No.
26 SPI Heat Power limit
O 100% max 8 60%
1 90% output 9 50%
2 85% output 10 45%
3 80% output 11 40%
4 75% output 12 35%
5 70% output 13 30%
6 65% output 14 25%
7 60% output 15 20%
8 55% output 16 15%
Not in SPI ON/OFF mode
27 SP2 Cool limit
O 100% max 4 40%
1 90% output 5 30%
2 85% output 6 25%
3 80% output 7 20%
4 75% output 8 15%
5 70% output 9 10%
6 55% output 10 5%
Not in SP2 ON/OFF mode
Direct/Reverse mode selection
OFF when logically ON
28 SPI Output
30 SP2 Output
31 SP2 Output
32 Error indicator resolution
O Normal (2% range/segment)
1 High (1%)
2 Low (2%)
33 Temperature display sensitivity
O Normal
1 High
2 Low
34 Derivative polling ratio
O 0.5 × derivative time
1 0.2
2 0.1
3 0.05
35 Sensor span adjust
1% steps (+15°/16° max)

Note: 'Hidden' Fn 15/Opt 5 resets ALL functions, except Fn 22

SP2 Latch alarms
O Normal
1 Latch
Only for: SP2 ON/OFF mode. Fn 39/30 Opt 1-5
PRESS " together to reset (in non alarm condition)
37 Spare

DIAGNOSTICS
Read only Functions 39-49 Mode B display see 42

PERFORMANCE MONITOR (PM)
38 Start monitor (Entry point from Fn 13)
O OFF
1 Start
Readings are reset on subsequent monitor start or de-powering
39 Read temperature variance (°C/°F)
40 Read maximum temperature (°C/°F)
41 Read minimum temperature (°C/°F)
42 Read Duty Cycle Monitor (DCM)
% heat (SPI ON time)
43 QCT1 45 US
44 QCT2
45 QCT3
46 QCT4

Quarter cycle times (sec)
Min 2 sec to max 1800 sec (30 min)

12.3 DIAGNOSTICS Functions 38 - 49

To assist with machine development, commissioning and trouble shooting

PERFORMANCE MONITOR (PM)

Monitors and displays minimum and maximum temperatures, and variance (deviation) to O.1°C/°F
Displayed temperatures are measured values, independent of set point. The high sensitivity monitor may be affected by interference. (Fit snubber to minimise disturbance)

Fig. 7 Performance monitor (PM) Fns 38-41

DUTY CYCLE MONITOR (DCM)

Monitors percentage power used in the previous proportioning cycle. Average several readings for a more accurate result
Power requirements outside the range 20% - 80% may be difficult to control and automate

AUTOTUNE TUNING DATA (Fns 43-49)

Fig. 8

13.4 MONITOR OPERATION (PM/DCM)

Select
1 or to start monitor
2 to return to normal operation
3 to view readings (PM/DCM) Fns 39-42
4 to step monitor
(Readings are retained)
5 Reset
Readings reset on next monitor start.
Monitor and readings reset on de-powering

14 PROGRAM SECURITY LOCK

To be made by qualified technician. Do not attempt to adjust before proceeding using a screwdriver.

15 INTERNAL LINK CHANGES

These operational modifications should be made by a qualified technician before installation.

To remove the 9000A board:
1. First remove the output module, carefully lever the retaining clips from the slots in the module cover with a small screwdriver.
2. Tap module cover on top, as shown, to release the 9000A board. Carefully remove the components from the board.

15.1 To convert to 3 wire RTD/PT100 (inhibits thermocouple operation)
Carefully cut pad at X avoid damage to F3. Fit solder links LK1, LK2 using 22SWG wire.

15.2 Supply Voltage Conversion (Plug in links)
IMPORTANT - check your installation operating voltage before proceeding. Wrong voltage could damage this unit.
For 115 Volt ±15% operation fit two links (spare link in accessories bag) in positions 115 and 115. For 230 Volt ±15% operation fit one link in position 230.

16

9900 FUNCTION/OPTION RECORD

Customer:
Ref:

Function
9900
Number:
date:
Option Set:

9900

spiral no.

9900

model


**COOL STRATEGY FOR HEAT−COOL APPLICATIONS**

Cool strategy: A change in load causes movement at the linked heat and cool prop bands.

Fig 9
1. Integral causes linked prop bands to move up.
2. Stabilises e.g. 30% heat.
3. Exothermic load change causes integral to move prop bands down (minimising disturbance).
4. Minimum offset achieved (d’o = offset without cool strategy integral action).
5. Stabilises e.g. 50% cool.
6. Consistent dead band throughout.

**SETTING UP ROUTINE FOR HEAT COOL**

(Single zone procedure)

Step 1. Run Autotune AT: (Set normal operating temp) Accept AT proportional cycle time Fn 4/Opt 15

Note: EPU/SP2 cycle times must be compatible with switching devices used.

2. When temperature stable at set point:
   - Select cool strategy Fn 19/Opt 7
   - Select cool prop band option value from table nearest to Heat prop band value (view Fn 5).
   - Select cool cycle time option value nearest to Heat cycle time value (view Fn 4).
   - Adjust SP2 dead band to 0°C (Factory set 5°C).

3. With normal background/exothermic thermal conditions, good results should be achieved.

4. Further adjustments:
   - Water cooling Shoul oscillate occur try (in order):
     - Double cool prop band value Fn 11
     - Reduce integral time value Fn 8
     - Have cool cycle time Fn 10
     - Introduce cool overlap Fn 2/15−9

5. Non-linear cooling
   - For water cooling above 100°C where flash to steam occurs. Select non-linear ranges in.

6. Fine tuning
   - If overshoot (cool) or undershoot (heat) occurs, slowly make the following adjustments, observing the results:
     - Increase cool overtake Fn 15/2−5
     - Apply SP2 cool limit, progressively Fn 27/15
     - If needed: SP1 heat limit Fn 26/15

7. Contact CAL for more application advice and data if required.

**RECALIBRATING TO A REMOTE STANDARD**

To enable the 9900 calibration to match an external meter, data logger etc. (i.e. ‘Remote’ reading)

**SENSOR ERROR CORRECTION:** Fn 9

Provides correction at one single temperature.

Example: Reads

<table>
<thead>
<tr>
<th>9900</th>
<th>40°C</th>
<th>Remote</th>
<th>40°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>+4°C</td>
<td>Set (-4°C) correction at Fn 9</td>
<td></td>
</tr>
</tbody>
</table>

Note Error polarity applies to 9900 correction.

Sensor span adjust: Fn 35

Provides correction where two temperatures require differing amounts of adjustment.

**PID TUNING NOTES**

1. Proportional cycle time: Fn 4/10

   Determines the cycle rate of the output device.

<table>
<thead>
<tr>
<th>Output device</th>
<th>Recommended time</th>
</tr>
</thead>
<tbody>
<tr>
<td>9900 internal relays</td>
<td>10 sec minimum (5 sec with derated contacts &amp; snubber)</td>
</tr>
<tr>
<td>Linear output (mA/Vdc)</td>
<td>1 sec O.05 sec</td>
</tr>
</tbody>
</table>

2. Proportional band/Gain: Fn 5/11

   Smooths out oscillation occurring in ON/OFF control.

   | Too short (overshoots and oscillates) | Too wide |
   | Too long (slow warm up and response) |

3. Integral time/Reset: Fn 8

   Automatically corrects offset errors caused by proportional control.

   | Too long (oscillates) |
   | Too short (slow warm up and response) |

4. Derivative time/Rate: Fn 6

   Suppresses overshoot and speeds response to disturbances.

   | Too long (oscillates and over corrects) |
   | Too short (slow steped warm up) |

5. DAC approach control: Fn 7

   Tunes warm up characteristics independent of normal operating conditions.

   | Too small (overshoot) |
   | Too large (slow stepped warm up) |

**PID MANUAL TUNING GUIDE**

For unusual applications producing error messages (EES/G) on Autotune AT/FT

1. Initial settings:

   Fn 5/10

   | Of Reset functions: Fn 5/10 |
   | 4/10 (ON/OFF Mode) |

   Normal operating set point

   (Then allow process to stabilise)

2. Take several readings of:

   | Amplitude A |
   | Time period T |

   (Diagnose Fs 38/39 may help)

3. Set PID values:

   | Set opt value |
   | Fn 4 Prop cycle T sec | Nearest time (Ensure compatible with output device) |
   | Fn 5 Prop | A x 15 x 100% |
   | Fn 6 Derivative | T sec |
   | Fn 7 DAC | Approach control |

| Fn 8 Integral | T min |
| Fn 9 SP2 | Cool power limit |

**NOTES ON OTHER FUNCTIONS**

Function Item

<table>
<thead>
<tr>
<th>Function</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fn 0</td>
<td>Park mode (Opt 3)</td>
</tr>
<tr>
<td>Fn 1</td>
<td>Display</td>
</tr>
<tr>
<td>Fn 2</td>
<td>Usefull in commissioning and troubleshooting, e.g. Multitone applications</td>
</tr>
<tr>
<td>Fn 3</td>
<td>Manual heat</td>
</tr>
<tr>
<td>Fn 4</td>
<td>If heater break occurs (EEN/2) SPI output (heater power) may be manually controlled 4-100%</td>
</tr>
<tr>
<td>Fn 5</td>
<td>Not in ON/OFF mode</td>
</tr>
<tr>
<td>Fn 6</td>
<td>Display</td>
</tr>
<tr>
<td>Fn 7</td>
<td>SP1</td>
</tr>
<tr>
<td>Fn 8</td>
<td>Stops unauthorised adjustment</td>
</tr>
<tr>
<td>Fn 9</td>
<td>Retransmission:</td>
</tr>
<tr>
<td>Fn 10</td>
<td>With 100% prop band, accuracy ±5% configuration range using linear input/output</td>
</tr>
</tbody>
</table>

**PID NOTES**

Fn 16 Linear process inputs

Optional 9900-PIM Process interface module (Data from CAL) This remote module provides greater versatility when using the 9900 with linear inputs.

Fn 17 Negative temperature range

Enables type T/RTD-P1000 to be used below 0°C/32°F

Note: Increased range to -200°C +200°C may affect PID values.

Fn 18 Display resolution

Note Effect on set point and other values set in °C/°F e.g. 100.0°C in hres = 1000 in normal

Fn 20l SP1 heat power limit

Limits maximum heat power below prop band in warm up. Useful if heaters oversized.

Fn 27 SP2 Cool power limit

Limits maximum cooling power outside prop band in heat-cool

Fn 38/39 may help
ADDITIONAL INSTALLATION INFORMATION FOR SINGLE OUTPUT

STANDARD INPUT
CAL9910xx Single 5A Relay
CAL9920xx Single 5VDC SSR

3-WIRE PT100 INPUT
CAL9810xx Single 5A Relay
CAL9820xx Single 5VDC SSR

The single output models listed above have only one output fitted which has different connections to the two output versions described in this manual.
Please read carefully the following information to ensure correct use of the controller.

SINGLE OUTPUT MODEL WIRING

TYPICAL WIRING DIAGRAM FOR SINGLE OUTPUT