INSTALLATION

Install the 9900 controller in panel **see 10.2**
Wire up connections **see 10.1**

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**)

J	1	R	4	E	7	RTD	9
K	2	S	5	L	8	PT100	
N	3	T	6	B	10		

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 ✳

PRESS ▲
TO INCREASE
SET POINT

Output turns on and temperature rises

The controller is now
operational with
factory PID settings:

Prop band 2.5%
Prop band 20 sec
Derivative 25 sec
Integral 5 min
DAC approach
control 1.5

2 IMPORTANT – Please read before using Autotune AT

1 If required adjust: Range. Hi-res 0.1°,
   Negative temperature ranging, **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
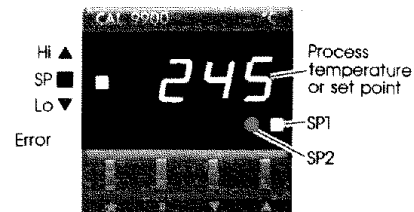4 Start Autotune AT with the load cool

TO AUTOTUNE

Step 7

START AUTOTUNE 'AT'
NEAR AMBIENT
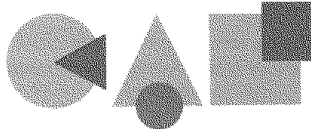
CAL Controls

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 applic-
ations may need the comprehensive
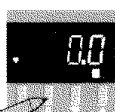9900 features covered in this manual.

Step 8

PRESS ℗ TO ACCESS
PROGRAM MODE
Function 0 flashes
on right

Step 9

PRESS ✳ TO CHANGE
TO OPTION SELECTION
Option 0 flashes
on left

Step 10

PRESS ▲ TO SELECT
AUTOTUNE 'AT'
Option 1

Step 11

PRESS ℗ TO START
AUTOTUNE 'AT'

AT and Process
temperature displayed
alternately during
Autotune

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

Hi ▲
SP ■
Lo ▼
Error
CAL 9900
245
Process
temperature
or set point
SP1
SP2

✳   View set point
✳ ▼   Decrease
✳ ▲   Increase

KEY CONTENTS GUIDE
9 Important caution - please read first
10 Installation   1 Setting up
2, 3, 5 Autotune   6 Prop cycle-time
Functions: 4 Selection   8 Table
7 Alarms   11 Error messages

Autotuned parameters	Autotune limits

Entered automatically:
Proportional band/Gain   0.5 – 20 % c/range
Integral time/Reset   0.2 – 43.5 min
Derivative time/Rate   1.0 – 255 sec
DAC approach control   0.5 – 9.0 x gain

Proportional cycle time   0.8 – 819 sec

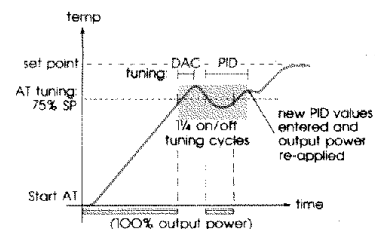Calculated but for safety reasons needs
manual acceptance **see 6**

Fig. 1 Autotune AT

**3.2 AUTOTUNE PT (Push-to-Tune)
Select Opt 2 at 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 re-
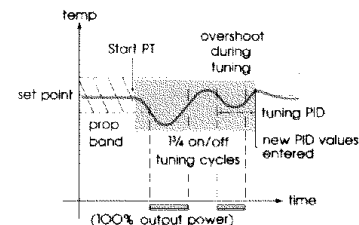calculated but needs manual acceptance

Fig. 2 Autotune PT

3.3 OVERIDING AUTOTUNE VALUES

After AT/PT any Autotuned parameter may
be changed to an Option from the table.
The original Autotuned 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 (Opt) – The available values for each Function e.g. Function 5 Option O
(Fn 5/Opt O) = SP1 Prop band of 2.5%
Note 1 Should difficulty occur in adjusting Options check the Parameter lock **see 14**
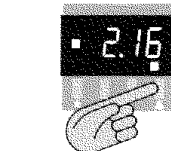Note 2 Normal control is maintained with existing settings during programming
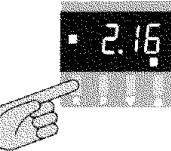
4.1 Step 1

PRESS P TO ENTER
PROGRAM MODE
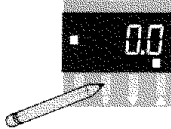
Step 2

PRESS AND HOLD ▲
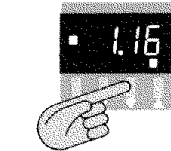INDEX TO FUNCTION
e.g. Function 16
(Sensor select)
flashes

Step 3

PRESS ✳ CHANGE TO
OPTION SELECTION
e.g. Option 2 (Type K)

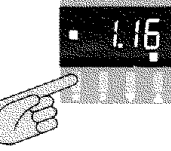Step 4

PRESS ▼ or ▲
SELECT OPTION
REQUIRED
e.g. Option 1 (Type J)

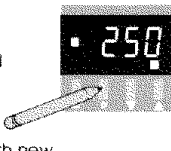Step 5

PRESS ✳ 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 B enables all digits to be used for
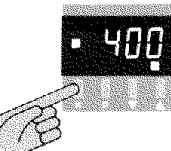Options values

Step 1

PRESS ▲ TO INDEX
TO FUNCTION
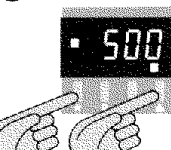e.g. Function 24
(Range adjustment)
flashes
Note 2 bars = Mode B
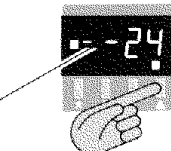
Step 2

PRESS ✳ TO DISPLAY
OPTION VALUE
e.g. Range 400°
flashes

Step 3

PRESS AND HOLD ✳
PRESS ▲ TO INCREASE
PRESS ▼ TO DECREASE
OPTION VALUE

5 AUTOTUNE HINTS

5.1 Autotune error messages see 11 (EE5-7)

(Latched: PRESS ▼ ▲ to reset)
AT/PT 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/Opt 1, other-
wise increase set point or tune manually

5.3 In High Resolution (0.1°)

Should error message EE6 occur during
tuning, select normal resolution (Fn 18/
Opt O) then Autotune and afterwards
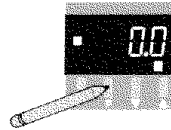re-select Hi-res, (check range setting Fn 24)

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

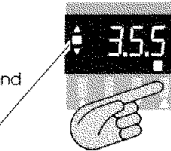Step 1

PRESS P TO ENTER
PROGRAM MODE

Step 2

PRESS ▲ TO INDEX
TO FUNCTION
e.g. Function 5 Prop band
AT value = 3.5%

Note 3 LED's show an AT value displayed

6 PROPORTIONAL CYCLE TIME

6.1 Autotuned 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 (0.05 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
calculated cycle time and accept if
suitable, this will then replace the 20 sec
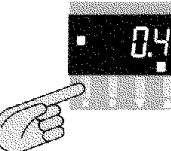factory setting

Step 1

Index to Function 4
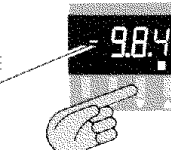For procedure **see 4**
Option O: 20 sec
factory setting
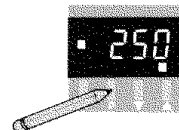
Step 2

PRESS ✳ TO CHANGE
TO OPTION SELECTION

Step 3

PRESS ▲ TO DISPLAY
CALCULATED AT VALUE
e.g. 9.8 sec
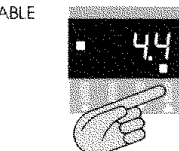Note Flashing bar
shows calculated AT
value is displayed

Step 4

IF AT VALUE SUITABLE

PRESS P TO ACCEPT
AT VALUE
NOW OPERATIONAL

OR IF AT VALUE UNSUITABLE

PRESS ▲ TO SELECT A
SUITABLE OPTION
FROM TABLE
e.g. Option 4: 30 sec

6.4 AT Cycle time values in Function 4

Two AT cycle time values are stored, to
enable the current operational 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 LED's ON
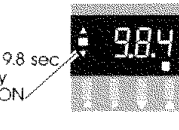
Step 6

PRESS ✳ TO CHANGE TO OPTION SELECTION

Step 7

PRESS ▲ TO DISPLAY
Latest calculated AT value
e.g. 7.2 sec
Note Flashing bar
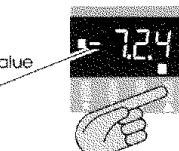
Step 8
Alternative actions:

PRESS P to accept the latest calculated
AT value – 7.2 sec which replaces 9.8 sec
as the operational AT value

OR PRESS ▼ to display current operational
AT value. Then PRESS P to retain 9.8 secs

OR PRESS ▲ 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 failsafe, SP2 relay is
de-energised 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 SP1 output is saturated
O% or 100% and the process temperature
fails to move a minimum 50% prop band in
the LBA time. SP1 output state is unaffected
by LBA alarm condition
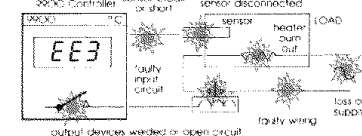
Fig. 3 Typical faults detected by LBA

7.4 Selecting LBA – EE3 message only
1. Index to Function 12 – LBA time
   Option O – LBA OUT, displayed

2. PRESS ✳ to change to option selection

3. PRESS ▼ 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 ▼ ▲ together
To configure Alarm relay SP2 to LBA Select
Option 6 in Function 19 (Relay latches in
alarm condition, to reset PRESS ▼ ▲)
Note Use LBA with SP2 ON/OFF mode only
(Fn 10/Opt O). Reset EE3/Relay before any
other program changes

1. Factory setting: is Option **O**
(except Functions 2 and 22)

2. Initial configuration:
Functions 16-24 must be selected first then entered into memory by exiting Program mode - **see 4** 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 14 Parameter lock

4. AT values (marked ⬓):
As calculated on the latest AT or PT run

5. Locating Functions:
Function O is the Program mode entry point

Pressing ⬆ increments

⬇ moves direct to Function 13
for access to higher Functions
Hold pressed to auto index through table
(Functions 13, 14, 25 are unused)

Fn No.	Opt No.	Parameter

OPERATING MODE ... Protected

O   Operating mode

O	Normal Operation
1	Start Autotune AT
2	Start Autotune PT
3	Park mode
4 – 100	Manual heat %

USER SETTINGS ...Unprotected

1   Manual Reset (OUT IN PID)

1° steps (max ±127°/50% prop band)

2   SP2 Adjust

1° steps   Factory setting 5°
SP2 mode must be selected in Function 19 **before** adjusting SP2

SP2 mode (Fn 19)	Option No.	Function 2 range
Deviation alarm	1 – 3	O – 127°
Full scale alarm	4 – 5	O – ✱
Cool strategy	7	±127°

(✱ Sensor range : Fn 16)

3   SP1 Lock

O	Unlocked
1	Locked

OPERATIONAL PARAMETERS ... Protected

4   SP1 Proportional cycle time

O	20 sec	10	3 sec
1	1 sec	11	7 sec
2	5 sec	12	14 sec
3	10 sec	13	45 sec
4	30 sec		
5	60 sec	14	⬓ Operational AT value
6	0.05 sec		
7	ON/OFF		Latest
8	0.3 sec	15	calculated AT value
9	2 sec		

5   SP1 Proportional band/Gain   SP1 Hysteresis in ON/OFF mode

O	2.5% CR	1.25%
1	0.5%	0.25%
2	1%	0.5%
3	2%	1%
4	3%	1.5%
5	5%	2.5%
6	10%	5%
7	20%	10%
8	1.5%	0.75%
9	4%	2%
10	6%	3%
11	7%	3.5%
12	8%	4%
13	14%	7%
14	100%	50%

15   ⬓ AT value

6   SP1 Derivative time/Rate

O	25 sec	9	3 sec
1	OUT	10	7 sec
2	5 sec	11	15 sec
3	10 sec	12	20 sec
4	50 sec	13	35 sec
5	100 sec	14	75 sec
6	200 sec		
7	1 sec	15	⬓ AT value
8	2 sec		

Fn No.	Opt No.	Parameter

OPERATIONAL PARAMETERS ... continued

7   SP1 DAC approach control

O	1.5 x prop band	5	3.0
1	0.5	6	4.0
2	1.0		
3	2.0	7	⬓ AT value
4	2.5		

8   SP1 Integral time

O	5 min	8	0.2 min
1	OUT	9	7 min
2	0.5 min	10	13 min
3	1 min	11	25 min
4	2 min	12	33 min
5	3 min	13	43 min
6	10 min		
7	18 min	14	⬓ AT value

9   Sensor error correction

1° steps (±127° max)

10   SP2 Proportional cycle time

O	ON/OFF	9	3 sec
1	1 sec	10	7 sec
2	5 sec	11	14 sec
3	10 sec	12	45 sec
4	20 sec		Non linear ranges
5	60 sec		for Cool strategy
6	0.05 sec	13	0.15–10 sec
7	30 sec	14	0.15–20 sec
8	2 sec	15	0.06–15 sec

11   SP2 Proportional band/Gain   SP2 Hysteresis in ON/OFF mode

O	2.5% CR	1.25%
1	0.5%	0.25%
2	1%	0.5%
3	2%	1%
4	3%	1.5%
5	5%	2.5%
6	10%	5%
7	20%	10%
8	1.5%	0.75%
9	4%	2%
10	6%	3%
11	7%	3.5%
12	8%	4%
13	14%	7%
14	100%	50%

12   LBA ... Loop break alarm – time

O	OUT	9	30 min
1	1 min	10	40 min
2	2 min	11	50 min
3	4 min	12	70 min
4	6 min	13	90 min
5	8 min		**Recommended**
6	10 min		**initial setting:**
7	15 min	14	**2 x Operational**
8	20 min		**Integral time**

15   Reset Functions O – 24 to factory settings

O	Normal
1	Reset (Function 22 not reset)

Abbreviations:

Fn	– Function
Opt	– Option
SR	– Sensor range
CR	– Configured range

Fn No.	Opt No.	Parameter

INITIAL CONFIGURATION ... Protected

16   Sensor Select and Range Table

Range Table

	Type	Factory set		Sensor range (SR)	
	T/C	°C	°F	°C	°F
1	J	400	800	800	1470
2	K	400	800	1200	1999
3	N	400	800	1200	1999
4	R	1600	1999	1600	1999
5	S	1600	1999	1600	1999
6	T	250	500	250	500
7	E	500	1000	600	1100
8	L	400	800	800	1470
10	B	1600	1999	1800	1999
	RTD				
9	PT100	200	400	400	750

Range minimum: O°C/32°F
Except T/PT100:
Factory set O°C/32°F
Minimum available –200°C/°F

	Linear process inputs		Display
11	O – 20mV		O – 100
12	4 – 20mV		O – 100
13	O – 20mV		O – 1000
14	4 – 20mV		O – 1000
15	O – 20mV		O – 2000

17   Negative temperature ranging

O	Disabled
1	Enabled (range min –200°)

18   Display resolution

O	Normal (1°)
1	Hi-res (0.1°) ±199.9°

1° settings become 0.1°
Ranged O – 200° on selection of Hi-res, (reset with Fn 24)

19   SP2 Operating mode
Select and enter Function 19 **before** adjusting SP2 in Function 2

O	OUT
1	Deviation alarm – High
2	Deviation alarm – Low
3	Deviation band alarm
4	Full scale alarm – High
5	Full scale alarm – Low
6	LBA – Loop break alarm
7	Cool strategy

20   SP1 Sensor break

O	Upscale
1	Downscale

21   SP2 Sensor break

O	Upscale
1	Downscale

22   °C/°F (Note Change top fascia)

O	°C	} Factory set
1	°F	{ not reset by Function 15

23   Software version number

24   Configured range (CR) adjustment

1° steps
Mode B adjustment **see 4.2**
(See Range Table in Function 16)

The advanced functions are intended for OEM's and process engineers. Access is therefore protected in the Function table

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

`0.0`

Step 2

PRESS ▼ TO GO DIRECTLY TO FUNCTION 13

`0.13`

Step 3

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

`0.38`

13.2 ADVANCED FUNCTIONS ... Protected

Fn No.	Opt No.	Parameter

26 SP1 Heat Power limit

O	100% max	8	60%
1	95% output	9	55%
2	90%	10	50%
3	85%	11	45%
4	80%	12	40%
5	75%	13	30%
6	70%	14	20%
7	65%	15	10%

Not in SP1 ON/OFF mode

27 SP2 Cool limit

O	100% max	4	40%
1	80% output	5	30%
2	60%	6	20%
3	50%	7	10%

Not in SP2 ON/OFF mode

Direct/Reverse mode selection

		Normal	OFF when logically ON
28	SP1 Output	O	1
29	SP1 LED	O	1
30	SP2 Output	O	1
31	SP2 LED	O	1

32 Error indicator resolution

O	**Normal** (2% range/segment)
1	High (1%)
2	Low (4%)

33 Temperature display sensitivity

O	**Normal**
1	High
2	Low

34 Derivative polling ratio

O	**0.5** x derivative time
1	0.2
2	0.7
3	1.0

35 Sensor span adjust

1% steps (+15°/-16° max)

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

---

36 SP2 Latch alarms

O	**Normal**
1	Latch

Only for: SP2 ON/OFF mode, Fn 19/Opt 1-5

PRESS ▼▲ together to reset (in non alarm condition)

37 Spare

DIAGNOSTICS

Read only Functions 39-49 Mode B display **see 4.2**

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 (0.1°)

40 Read maximum temperature (°C/°F)

41 Read minimum temperature (°C/°F)

42 Read Duty Cycle Monitor (DCM) % heat (SP1 % ON time)

AUTOTUNE TUNING DATA Fig. 8

Overshoot/Undershoot (°C/°F)
Max 255°/Hi-res 25.5°

43	OS1	45	US
44	OS2		

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

46	QCT1	48	QCT3
47	QCT2	49	QCT4

50 Spare PRESS ▲ to Fn O

13.3 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 0.1°C/°F
Displayed temperatures are measured values, independant of set point. This high sensitivity monitor may be affected by interference. (Fit snubber to minimise disturbance)
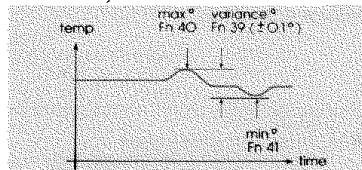
Fig. 7 Performance monitor (PM) Fns 38-41

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 autotune
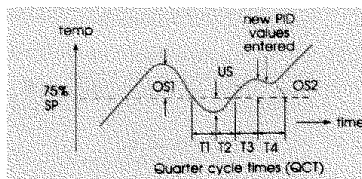
AUTOTUNE TUNING DATA (Fns 43-49)

Fig. 8

13.4 MONITOR OPERATION (PM/DCM)

Step		Select
1	To start monotor:	Fn 38/Opt 1
2	To return to normal operation	PRESS ℗
3	To view readings (PM/DCM)	Fns 39-42
4	To stop monitor: (Readings are retained)	Fn 38/Opt 0
5	**Reset**	
	Readings reset on next monitor start.	Fn 38/Opt 1
	Monitor and readings reset	On de-powering

14 PROGRAM SECURITY LOCK

To be made by qualified technicain. De-power controller before proceeding using a screw driver at side of bezel remove lower fascia containing push buttons. All functions except user settings - Functions 1-3 can be protected against tampering. To protect function settings change the plastic link from unlocked to locked position.

| • • | • | LOCKED (or remove link) |
| • | • • | UNLOCKED |

15 INTERNAL LINK CHANGES

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

To remove the 9900A board:
1. First removethe output module, carefully lever the retaining clips from the slots in the module cover with a small screwdriver.
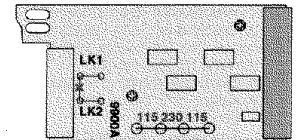
module cover   output module

2. Tap module cover on table top, as shown, to release the 9900A board. Carefully remove board, avoid damaging components on protruding tongue

9900A board
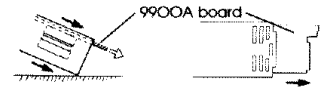
15.1 **To convert to 3 wire RTD/PT100** (inhibits thermocouple operation)
Carefully cut pad at **X** avoid damage to R3. Fit solder links LK1, LK2 using 22SWG wire.

15.2 **Supply Voltage Conversion** (Plug in links)
IMPORTANT - check your installation operating voltage before proceeding. Wrongful conversion 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

9900 FUNCTION/OPTION RECORD			
Customer Ref:			
9900	model	serial no.	
Function Number	Option Set		
	date:		

17 COOL STRATEGY FOR HEAT–COOL APPLICATIONS

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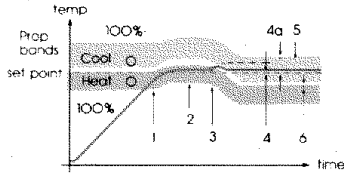

Fig. 9

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 (4a = offset without cool strategy integral action)
5. Stabilises e.g. 50% cool
6. Consistent dead band throughout

17.1 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 SP1/SP2 cycle times must be compatible with switching devices used (SP2 cool output is OFF at this stage)

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) **Fn 11**
   • Select **cool** cycle time option value nearest to Heat cycle time value (view Fn 4) **Fn 10**
   • Adjust SP2 dead band to 0° (Factory set 5°) **Fn 2**

3. **Run with normal background/ exothermic thermal conditions,** good results should be achieved and provide the basis for fine tuning

4. **Further adjustments:** e.g. Water cooling, Should oscillation occur try (in order):
   • Double **cool** prop band value **Fn 11** and reduce integral time value **Fn 8**
   • Halve **cool** cycle time **Fn 10**
   • Introduce **cool** overlap **Fn 2/(-)ve**

5. **Non-linear cooling**
   For water cooling above 100°C where flash to steam occurs. Select non-linear ranges in
   cool cycle time **Fn 10/Opt 13-15**

6. **Fine tuning**
   If **overshoot** (into cool) or **undershoot** (into heat) occurs, **slowly** make the following adjustments, observing the results:
   • Increase **cool** overlap **Fn 2/(-)ve**
   • Apply SP2 **cool** limit, progressively **Fn 27/Opt 1**
   If needed: SP1 heat limit **Fn 26/Opt 1**

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

---

18 NOTES ON OTHER FUNCTIONS

Function   Item
Fn 0 Park mode (Opt 3)
Temporarily turns outputs off

Display: ▲ and Process temperature ▼

Useful in commissioning and trouble shooting, e.g. Multizone applications
Manual heat % (Opt 4-100)
If sensor break occurs (EE1/2) SP1 output (heater power) may be manually controlled 4-100% (Not in ON/OFF mode)

Display: ▲ XXH (XX = % output) ▼

Fn 3 SP1 Set point lock
Stops unauthorised adjustment

Fn 5 Retransmission:
With 100% prop band, accuracy ±5% configuration range using linear input/output

---

19 RECALIBRATING TO A REMOTE STANDARD

To enable the 9900 calibration to match an external meter, data logger etc. (i.e. **'Remote'** reading)
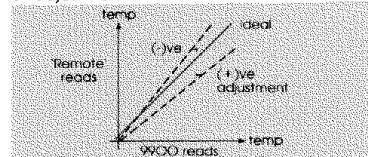
SENSOR ERROR CORRECTION: Fn 9
Provides correction at one single temperature
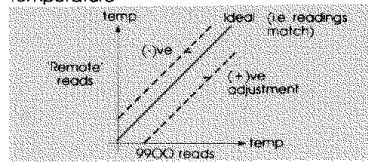
Example	Reads
9900	404°
'Remote'	400°

Error +4° Set (-4) correction at Fn 9
Note Error polarity applies to 9900 correction

Sensor span adjust: Fn 35
Provides correction where two temperatures require differing amounts of adjustment

1. Choose a temperature towards the bottom of the normal operating range and one at the top
2. Run at the lower temperature T1, note the error E1 between 9900 and 'Remote' reading
3. Repeat at upper temperature T2 and note error E2

Example	T1 reads	T2 reads
9900	60°	200°
'Remote'	58°	205°
Error E1 =	+2°	E2 = −5°

4. **Calculation of span adjustment for Fn 35**

Formula: $Fn\ 35 = \dfrac{E2 - E1}{T2 - T1} \times CR$ (as Fn 24)

Example: $Fn\ 35 = \dfrac{(-5°) - (+2°)}{200° - 60°} \times 250°$ (Fn 24 CR)

$= \dfrac{-3}{140} \times 250$

$Fn\ 35 = -5°$ Set (−5°) in Fn 35

5. A span error entered in Fn 35 immediately changes the reading, allow time to stabilise at T2, if an error exists correct with Fn 9. Then check at T1, if an error exists check readings and calculations; repeat if necessary

---

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 ranging
Enables type T/RTD–PT100 to be used below 0°C/32°F
Note Increased range, to -200°C/F, may effect PID values

Fn 18 Display resolution
Note Effect on set point and other values set in °C/°F e.g. 100.0° in hi-res = 1000° in normal

Fn 26 SP1 Heat power limit
Limits maximum heater power during warm up. Useful if heaters oversized

Fn 27 SP2 Cool power limit
Limits maximum cooling power outside prop band in heat-cool

---

20 PID TUNING NOTES

1. **Proportional cycle time: Fns 4/10**
   Determines the cycle rate of the output device

Output device	Recommended time
9900 Internal relays	10 sec minimum (5 sec with derated contacts & snubber)
SSR	1 sec
Linear output (mA/Vdc)	0.05 sec

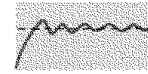   **Ideal**   **Too long** (oscillates)

2. **Proportional band/Gain: Fn 5/11**
   Smooths out oscillation occuring in ON/OFF control
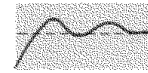

   Too narrow (oscillates)   **Too wide** (slow warm up and response)

3. **Integral time/Reset: Fn 8**
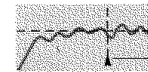   Automatically corrects offset errors caused by proportional control

   Too short (overshoots and oscillates)   **Too long** (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 warm up and response under corrects)

5. **DAC approach control: Fn 7**
   Tunes warm up characteristics independant of normal operating conditions. Controls when derivative action starts on warm up, (smaller setting = closer to set point) Useful when sensor very remote from heater

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

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21 PID MANUAL TUNING GUIDE

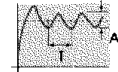For unusual applications producing error messages (EE5/6) on Autotune AT/PT

1. **Initial settings:**
   Fn 5/Opt 0
   (or Reset funtions: Fn 15/Opt 1)
   Fn 4/Opt 7 (ON/OFF Mode)
   Normal operating set point
   (Then allow process to stabilise)

2. **Take several readings of:**

   Amplitude **A**

   Time period **T**

   (Diagnostics Fns 38/39 may help)

3. **Set PID values:**

		Set opt value
Fn 4 Prop cycle time (Ensure compatible with output device)	$\dfrac{T}{20}$ sec	Nearest
Fn 5 Prop band/Gain	$\dfrac{A \times 1.5 \times 100\%}{\text{config range}}$	Next larger
Fn 6 Derivative time/Rate	$\dfrac{T}{10}$ sec	Next shorter
Fn 8 Integral time/Reset	$\dfrac{T}{60}$ min	Next longer
Fn 7 DAC Approach control	1.5 factory set	**see 20.5**

Designed for use: UL 873 - only in products where the acceptability is determined by Underwriters laboratories Inc.
EN61010-1-Within Installation Categories II and III environment and polution degree 2.
To avoid possible hazards accessible conductive parts of final installation should be protectively earthed in accordance with EN61010 for Class 1 equipment.
Output wiring should be within a grounded cabinet. Sensor sheaths should be bonded to ground or not be accessible.
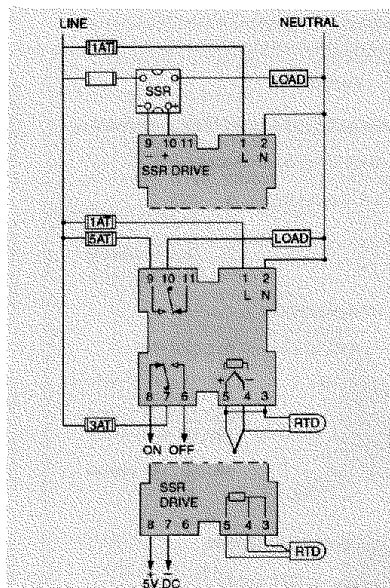Live parts should not be accessible without use of a tool.

10 INSTALLATION

10.1 ELECTRICAL INSTALLATION
CAUTION RISK OF ELECTRICAL SHOCK.
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 1.0mm² (18 AWG 0.04"²) rated to 6 Amps/ 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 interference suppressors are fitted across relay contacts to prolong relay life.

11 ERROR MESSAGES

APPLICATION FAULTS

EE1 Sensor burnout	Check sensor	Self clearing
EE2 RTD/PT100 short	Check sensor	Self clearing
EE3 LBA Loop break	Check control loop	Latches: Reset

AUTOTUNE AT/PT TUNING CYCLE FAULTS

Autotune run is aborted:
Previous values are retained

EE5 Outside time limit	Latches: Reset
EE6 O/shoot exceeds limit	Latches: Reset
EE7 Unable to run Autotune,	Latches: Reset
SP1 in ON/OFF mode	

SOFTWARE FAULTS

EE8 Calibration data error	Replace unit if it persists
EE9 System error	Replace unit

PRESS ▼▲ together to reset latched message

Designed by BDC Technical Services, Baldock, UK

It is the responsibility of the installation engineer to ensure that this equipment's compliance to EN61010 is not impaired when fitted to the final installation and to use this equipment as specified in this manual, failure to do so may impair the protection provided. Follow wiring diagrams and regulations.

Fuses: 250VAC rated, time lag type to IEC 127.

12 9900 SPECIFICATION

INPUTS
See 8 Function 16 for Range Table
Thermocouple – 9 types

J	Iron/Constantan	T	Copper/Con
K	Chromel/Alumel	R	Pt - 13% Rh/Pt
L	Fe/Konst	S	Pt - 10% Rh/Pt
N	NiCroSil/NiSil	B	Pt - 30% Rh/
E	Chromel/Con		Pt - 6% Rh

Standards: IPTS 68/DIN 43710
Linearity: 5 - 95% sensor range **see 8**
J/K/L/N/E ±1°C, T ±2°C, B ±6°C>500°C
R/S 0-300°C ±5°C, 300-1600°C ±2°C
CJC Rejection: 20:1 (0.05°/°C) typical
External resistance: 100 Ω maximum

Resistance thermometers
RTD/PT100 2 wire (optional 3 wire)
DIN 43760 100 Ω 0°C/138.5 Ω 100°C Pt

Linear process inputs: 0-20mV/4-20mV
Linearity: ±1.5% Impedence 100k Ω min

Applicable to all inputs
SR=sensor range, CR=configured range
Calibration accuracy: ±0.25% SR ±1°C
Sampling frequency: Input 3Hz, CJC 5sec
Common mode rejection: Negligible effect up to 140dB, 240V, 50-60Hz
Series mode rejection: 60dB, 50-60Hz
Temperature coefficient: 150ppm/°C SR
Reference conditions: 22°C ±2°C,
115/230V ±5%, after 30m settling time

OUTPUTS

OUTPUT MODULE – Dual standard
Main output: SP1
Relay standard:	5A/250Vac resistive SPDT/Form C
SSd-optional:	5V/25mA non-isolated

Alarm/Cool channel output: SP2
Relay-standard:	3A/250Vac resistive SPDT/Form C
SSd-optional:	5V/25mA non-isolated

9900 Controller output module · types

SP1 output	SP2	115V code	230V
Relay	Relay	991.11C/F	991.12C/F
Relay	SSd	991.21C/F	991.22C/F
SSd	Relay	992.11C/F	992.12C/F
SSd	SSd	992.21C/F	992.22C/F
Relay	–	991.01C/F	991.02C/F
SSd	–	992.01C/F	992.02C/F

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1. CONFIGURATION
All functions are front key selectable, it is the responsibility of the installing engineer to ensure that the configuration is safe. Remove the function lock link to protect critical functions from tampering.
2. ULTIMATE SAFETY ALARMS
Normal safety advice: Do not use SP2 as the sole alarm where personal injury or damage may be caused by equipment failure.

10.2 MECHANICAL
1. Prepare a 1/16 DIN panel cut out: 45 x 45mm +0.6 -0 1.77" x 1.77" +0.02 -0
2. Remove the socket, pressing in the lock buttons
3. Slide the controller into the cut out
4. Fit the mounting clip see fig. pressing it firmly against the panel, jacking screws optional
5. Plug on the socket
6. After installation remove and discard the protective front window label
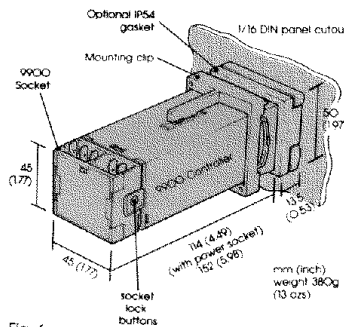7. Cleaning - if required wipe with damp cloth (water only)

Fig. 6

CONTROL CHARACTERISTICS
SPI PID Parameters	Field selectable
Prop band/Gain	0.5-100% CR
Prop cycle-time	0.05-81s or ON/OFF
Integral time/Reset	0.2-43m or OUT
Derivative time/Rate	1.0-255s or OUT
DAC approach control	0.5-9.0 x PB
(ON/OFF Hysteresis	0.25-50ΩCR)

GENERAL
Supply Voltage:	115V or 230V ±15% 50-60Hz 6VA (Link selectable)
Digital LED Display:	3½ digit 10mm high. High brightness green.
Error indicator:	3 step LED.
Output LEDs:	SP1 Green SP2 Amber.
Keypad:	4 Elastomeric Buttons.

ENVIRONMENTAL
Humidity:	Max. 80%
Altitude:	Up to 2000M
Installation:	Categories II and III
Pollution:	Degree II
Safety:	UL873, CSA 22.2/142-87. EN61010
Protection:	IP54 (with gasket)
EMC Emission:	EN50081-1 FCC Rules 15 Sub-part J Class A
EMC Immunity:	EN50082-1, RF Field ±2% FS
Ambient:	0.50°C (32-130°F)
Mouldings:	Flame Retardent Polycarbonate

401 1296