

**Instruction Manual
for
SMART-3
1/4 Din Controller**

Front Panel Control and Display Functions

Display

- PV Process Temperature (actual temperature as measured by sensor)
SV Temperature Set Point (desired control temperature)

LED Indicators

- Out 1 (Y1) Control output #1 Main control (relay or analog)
Out 2 (Y2) Control output #2 (option) (Sub control - heat level, etc.)
AL1 Alarm #1 (Standard)
AL2 Alarm #2 (Option)
AT Auto-tune (Indicates Auto-tune in action)
PRO Program (8 or 16 segment) (Option)
MAN 0-100% manual output (1/4 DIN only)

Keypads

- SET Scan parameters (press to enter new parameter)
< - Shift key Press to enter new parameter value (flashing)
V - Down Key To change parameter digit (decrease)
^ - Up key To change parameter digit (increase)
A/M Auto/Manual control - Press to enter manual control 0-100% mode (1/4 DIN only)

Initial Startup

When power is initially applied to controller, display will indicate the following:
type of thermocouple
Degree C or F

Then it will indicate the temperature range before transfer to PV display of actual process temperature and SV display of preset temperature setpoint.

If no thermocouple is connected to instrument, PV display will indicate:
Open thermocouple InIE
or UUU1 for actual temperature above set point range
(thermocouple burnout)

Panel Cutout

1/16 DIN Controller
1.772" square
Depth behind panel - 3.2 inches

Panel Cutout

1/4 DIN Controller
3.5" square
Depth behind panel - 3.2 inches

Operation of Auto/Manual Function

- A. Press A/M key and upper display will read OUTL. The lower display will read the percentage of output (0-100%).
- B. Press the shift key < to change the percentage output manually. The digit will blink that will be changed by use of UP/DOWN keys. Unlike entering the temperature set point and other parameters, the 4-20 ma (0-100%) manual output changes as the value is entered. If the up/down keys are held down, the display and 0-100% output will scroll continuously from the least significant digit (the one that is blinking) to the desired value.
- C. The percent output can be observed on the 0-100% LED bargraph arrows under the digital display.

#Note:

If the A/M key is pressed again, the displays will revert to reading process temperature and set point temperature and change to automatic control. If the A/M key is not used, the display, after 1 minute, will revert to reading the process temperature and set point temperature but will stay in the manual mode with the 0-100% (4-20 ma) output staying the last value entered. It will stay in the manual fixed 4-20 ma output until the A/M key is depressed to enter automatic control of temperature. If it is desired not to go to automatic control but change the manual output, the set key must be used to scan to the Out 1 display (upper). The lower display will read the 0-100% output and can be changed by using the < shift key to enter 0.1%, 1.0% or 10.0% increments which can be scrolled from 0-100% with the UP and DOWN keypads.

Operator Instructions
for
1/4 DIN Temperature Controller

Upper Display - Process Temperature (PV)
Lower Display - Set Point Temperature (SV)

LED's Out 1 - 4-20 ma Output
AL1 - Alarm / Condition (red)
AT - Auto tune ON (yellow)

1. To enter SET POINT Temperature (lower Display)

- A. To enter set point temperature (Temperature at which process is to be controlled), Press the SHIFT KEY <, the first digit will begin blinking.
- B. Press the UP KEY ^ or the DOWN KEY to increase or decrease the value of the digit (*) then press the SHIFT KEY again to go to the next digit. After all digits are changed the display should read the desired set point temperature i.e. 500.0 for 50% i.e. 50% of span (900-3000 degrees C.)
- C. If the display for set point temperature is correct press SET KEY to enter the value.

** If the up/down keys are held down, the display will scroll continuously from the least significant digit (the one that is blinking) to the desired value.*

2. To Auto-Tune

- A. Press SET KEY until upper display reads (At) and lower display reads (no). Press the SHIFT KEY <, the first digit will begin blinking. Press UP or DOWN key to change lower display from NO to YES and press SET KEY to enter value and start Auto-tune of process.
- B. The controller should now automatically increase the process temperature (upper display) to the temperature as entered for the set point (lower display).

**In the auto-tune mode, the displays will return to reading PV & SV after one minute or press set key to scan back to these readings if you do not wish to wait one minute.*

Alarm Mode (If desired to use alarm)

To enter a temperature for the alarm operation

- A. Press the SET KEY until the upper display reads AL1. The lower display will read the alarm. (Units deviation from set point (high only)
- B. Press the SHIFT KEY to change the alarm temperature. The digit will blink that is to be changed; and use the UP/DOWN KEYS to change the value of the digit.

The alarm is preset for a deviation high limit operation code 11. If it is desired to change the type of alarm operation, the display must be changed to level #3 as follows:

- A. Press SET KEY and then SHIFT KEY < and hold both KEYS for 5 seconds until upper display reads INP1.
- B. Press SET KEY until upper display reads Ald1
- C. Change lower display to read 15 by pressing SHIFT KEY to blink and UP/DOWN KEYS to change value and SET to enter value.

There is a level #2 of Parameters which it is not usually necessary to change but they can be observed (or changed) as follows:

Press the SET KEY for 5 seconds until upper display reads P1 and the lower display will read the proportional band (0 to 200%). The PID parameters can now be observed by pressing the SET KEY to scan through the PID values. If it is desired to change any of the values manually the SHIFT KEY and UP/DOWN KEYS must be used as in the previous sections to change the values of each digit.

NOTE:

Level 3 is also used to select the type of input as well as the type of alarm action as previously outlined.

Level 3 is again accessed by pressing the SET KEY and then the SHIFT KEY and holding both for 5 seconds until upper display reads INP1.

- A. Enter J6 on lower display for 0-2192 deg. F range or J1 (0-392 deg. F), J2 (0-752 deg. F), J3 (0-1112 deg. F), J4 (0-1472 deg. F) or J5 for 0-1832 deg. F. Change J to K for type K chromel alumel thermocouple. See Input selection table in Instruction manual for other thermocouples.
- B. To change from deg. F to deg. C use SET KEY to scan until bottom display reads F or C. Change from F to C or vice versa by pressing the SHIFT KEY <, the first digit will begin blinking and then UP or DOWN KEY to enter value. The digit will blink that can be changed then use the UP/DOWN KEYS to change the value of the digit. You can move from one digit to the next by pressing the SHIFT KEY < until the digit that you want to change blinks.

**Calibration Procedure
for
4-20ma Input**

Preliminary Factory Set Instructions

1. Press SET button and hold for 5 seconds to enter level 2 (display will show P1/3)
(A) Scroll with SET button until upper display reads LCK (LOCK function) and lower display will read 0000.
(B) Change 0000 to 1111 by depressing Shift (<) key causing the digit to flash which can be changed by up ▲ and down ▼ buttons. Enter 1111 and press SET key to enter.
(C) Press the SET button and then the shift (<) button and hold both for 5 seconds until the upper display reads SET 1. Press SET button to SET 2. Display should read 0110, if not, change by use of Shift (<) button and up/down buttons to read 0110. The second digit from the right activates the AnL1 (zero adjustment) and AnH1 (span adjustment) - Return to Level #1 by depressing the SET and then the SHIFT (<) button and hold for 5 seconds. (This will reset the Lock Function LCK in level 2 to read 0000.

Calibration

1. Using SET & SHIFT buttons, go to level 3:

Example

0-100% range
0% = 4ma (Zero)
50% = 12ma
100% = 20ma (Span)

Span adjustment can be made using either the 12ma or 20ma input.

- (A) Connect 0 to 20ma source to input terminals on rear of controller #9 (+) and #10 (-). SET ma source to 12ma.
- (B) At level 3 scroll with SET button until display reads LSPL. Using the SHIFT and UP/DOWN buttons, set display to read 0000. Scroll to USPL and set display to read 100
- (C) Scroll to AnL1 (Zero) and AnH1 (Span). The normal settings are used to make the upper display read the desired numbers from (-) 1999 to (+) 9999. For our example the reading of the PV display for 4-20ma will be 0-100%. The SHIFT and UP/DOWN keys are used if it is desired to change the reading. If other ranges are desired than 0-100% the LSPL (Zero) and USPL (Span) must be changed before setting the exact calibration with the AnL1 and AnH1 parameters.

Note: When the LSPL and USPL parameters are being changed (digit flashing) the upper display will read the PV value corresponding to the 4-20ma signal. In the case of the example w/12ma input, the upper display will read 50% or value corresponding to 12ma input signal.

Secondary Functions

These are functions that are factory set and should not require changing but can be changed from the keypads if deemed necessary.

A. Calibration of thermocouple reading (PV display)

The temperature reading the PV (upper) display can be changed up (+) or down (-) by using the PV05 parameter on the Level 3 screen.

B. Calibration of 4-20 ma Output Models

The 1/4 DIN models which have a manual-automatic transfer mode have a zero (4 ma) and span (20 ma) adjustment available. These are accessed in the Level 3 parameter list as follows: CLO1 - Zero adj. (4ma) - Display - 0230-4ma-0%
CHO1 - Span adj. (20ma) - Display - 3600-20ma-100%

These adjustments can also be used to set the minimum output to greater than 4ma (0%) or the maximum output 20ma (100%) to less than 100% to prevent the controller from applying full power to the heater load.

Features

- Setpoint entry by continuous scroll or individual digit increments
- Keypad calibration adj for PV
- Min/Max 4-20 ma output keypad adj.
- True Fuzzy Logic Control
- PID Autotune
- Universal Thermocouple input
- Universal Power Supply 85-265 VAC
- Auto / Manual (1/4 DIN)
- Display of PV and SV
- Output status Indication
- Fault Indication
- Digital Filtering of input signal
- 14 BIT Resolution
- Input range limiting - Keypad Adj.
- Input/Output Isolation
- Sensor break protection
- Non-volatile memory
- 4-20ma, relay or SSR pulse output
- NEMA-4 Front Panel
- Screw termination
- 1/16 or 1/4 DIN styles
- Alarm Relay Output - Keypad configurable
- Keypad data lock function - Security Code

OPTIONS AVAILABLE

- A. Remote Set Point - 4-20 ma
- B. 2nd PID configurable output
- C. 2nd and 3rd alarm relay outputs
- D. Ramp/Soak - 2 patterns - 8 segments each
- E. Transmitter Output (PV) 4-20 ma
- F. D.C. Power Supply

OPERATION MANUAL

1. Front Panel Legend

a) Display

PV: process value

SV: setting value

b) LED's

OUT1: output 1

OUT 2: output 2

AT: auto-tuning

PRO: program execution (Ramp/soak option only)

AL1: alarm 1

AL2: alarm 2

MAN: manual

c) KEY

◁: shift key

Δ: up key

▽: down key

SET: mode & set key

A/M: auto/manual

2. Auto Tuning

- (a) In Level 1, set AT to YES to initiate auto-tuning, LED will flash.
- (b) When LED stops flashing, auto-tuning sequence has finished. If desired, check level 2 for the new PID parameters.
- (c) In level 2, ATVL = auto tuning off-set. Set value will be deducted from SV, to prevent temperature overshoot during auto-tuning (e.g. ATVL = auto tuning value, if SV = 200°C and ATVL=5 then auto tuning is at 195°C).
- (d) If auto tuning fails, check:
 - (1) ATVL is set too high (if unsure, set ATVL = 0)
 - (2) System time too long, in this case set PID parameter manually.

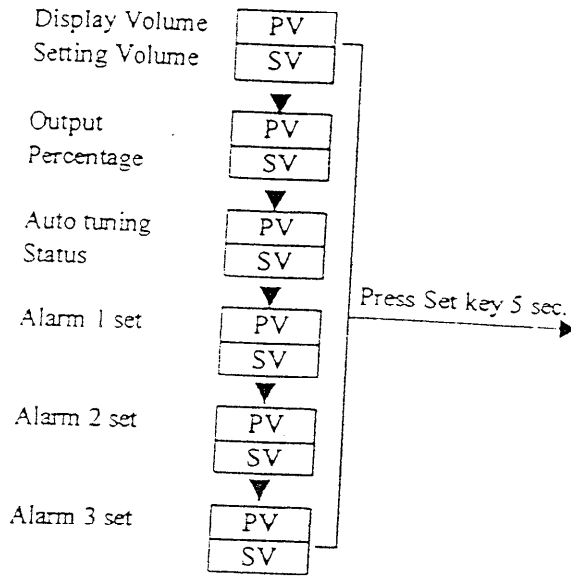
3. Error Information

1 0 1 E	Input open circuit
• A D C E	A/D converter failed
• C J C E	Cold junction compensation failed
1 0 2 E	Open circuit of sub control sensor
U U U 1	PV exceeds USPL
U U U 1	PV under LSPL
U U U 2	Input signal of sub-control exceeds the upper limit
U U U 2	Input signal of sub-control under the lower limit
• R A M E	RAM failed
1 0 E F	Interface failed
A U T E F	Auto-tuning failed

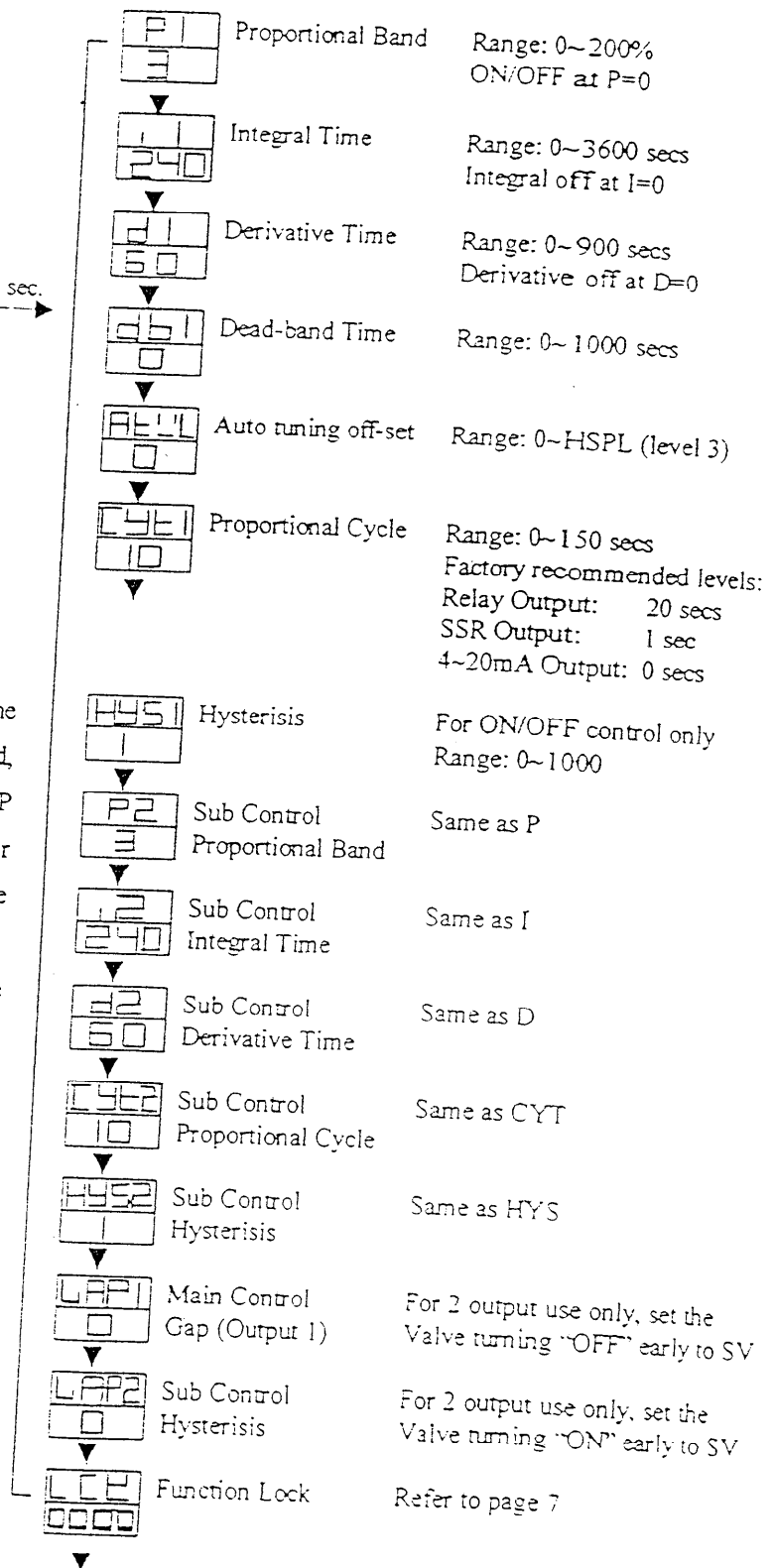
Note: If the "•" marked error occurs, the controller needs repairing. Please send it to your nearest sales office.

4. Operating Flow

LEVEL 1



LEVEL 2



- Press the SHIFT KEY ◀ to change the parameters. If the SHIFT KEY is pressed, the first digit begins blinking. Press the UP KEY ▲ or DOWN KEY ▼ to increase or decrease the value of the digit, then press the SHIFT KEY again to go to the next digit.
- SET KEY is also used to scroll through the menu. Each time the SET KEY is pressed, the display shows the next mode.
- Press the SET KEY for 5 secs, the display goes to level 2. To return to level 1, do the same.
- If any key has not been pressed for 1 min., the display returns to level 1.
- If you press the A/M KEY, the display always returns to level 1.
- If OUTL is set to "0", the controller has no output.

LOCK Function Level 2

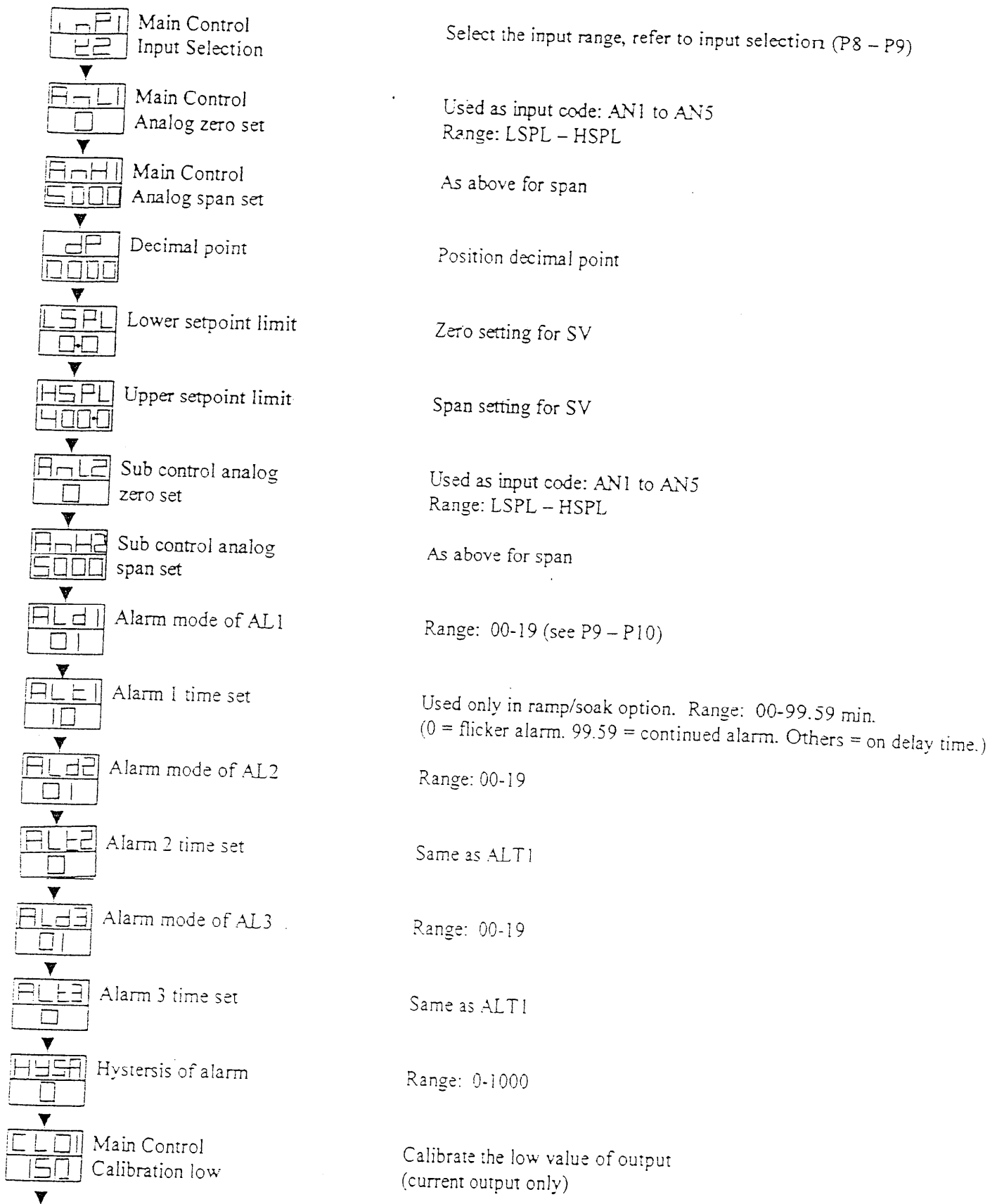
1. To reach Level 2, press SET Key and hold for 5 seconds until P1 is displayed.
2. Scroll with SET Key until upper display reads LCK.
3. Press shift key (<) until first digit on lower display blinks. Use shift key and up-down keys to set reading to:
 - (1) LCK= 0000 which permits access to levels 1, 2, 3.
 - (2) LCK= 0001 - operator can change temperature set point only (SV) lower display.
4. Press SET key for 5 seconds to return to level one or will automatically return after one minute.

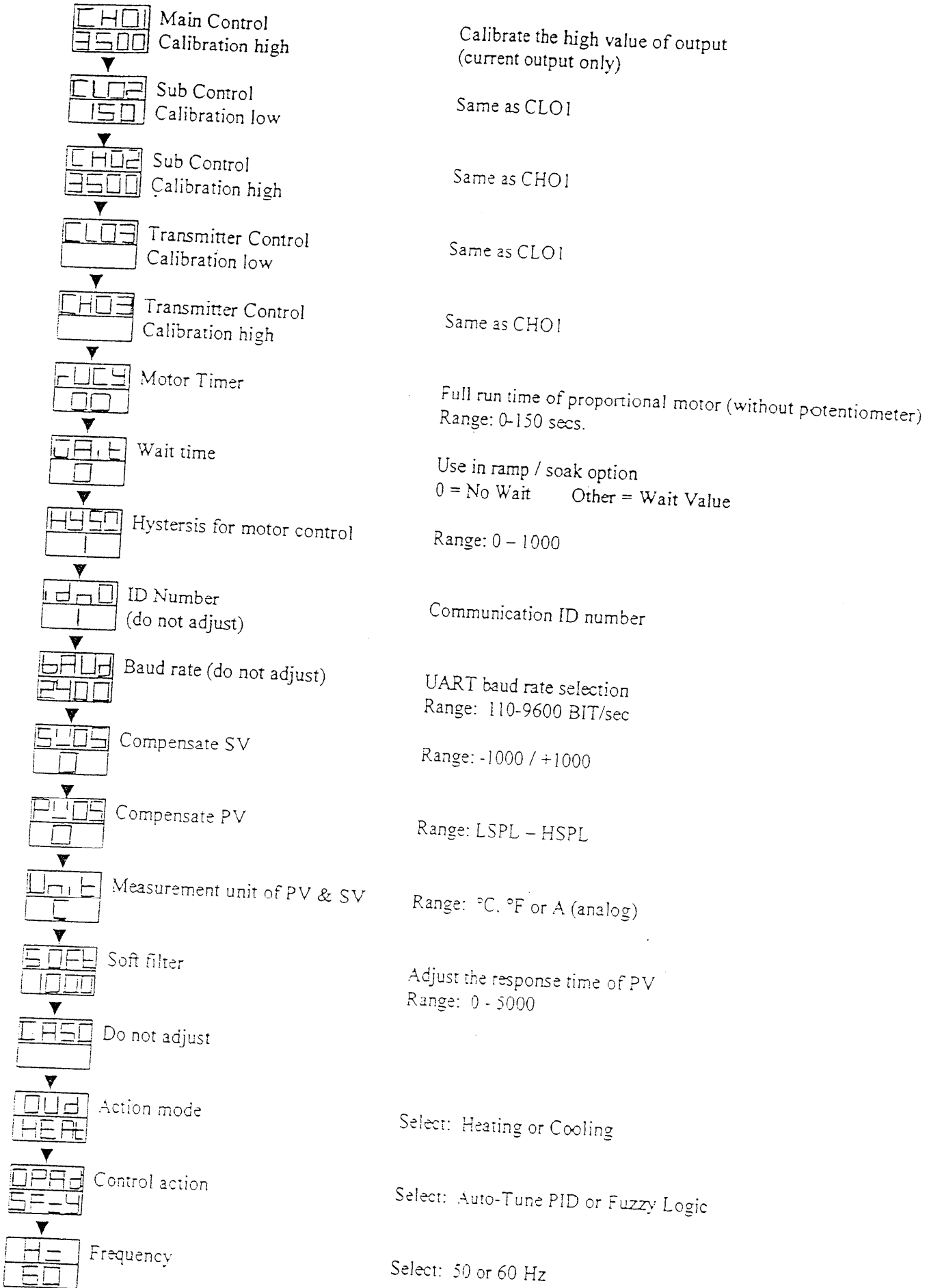
Note (A) When LCK= 0101 no parameter can be changed except LCK (all functions including set point are locked to operator access).

Note (B) To gain access to SET 0-9 factory settings in Level 4 the LOCK function is set at LCK=1111.

Note (C) With LCK set at 0110 only Level 1 parameters can be changed and Level 2 parameters can be read but not changed.

LEVEL 3 Adjust LCK = 0000, press SET KEY and then the SHIFT KEY and hold them both for 5 seconds to enter Level 3.





5. Input Selection (INP1)

TYPE	CODE	RANGE
K	K1	0.0-200.0 C/0.0-392.0 F
	K2	0.0-400.0 C/0.0-752.0 F
	K3	0-600 C/0-1112 F
	K4	0-800 C/0-1472 F
	K5	0-1000 C/0-1832 F
	K6	0-1200 C/0-2192 F
J	J1	0.0-200.0 C/0.0-392.0 F
	J2	0.0-400.0 C/0.0-752.0 F
	J3	0-600 C/0-1112 F
	J4	0-800 C/0-1472 F
	J5	0-1000 C/0-1832 F
	J6	0-1200 C/0-2192 F
R	R1	0-1600 C/0-2912 F
	R2	0-1769 C/0-3216 F
S	S1	0-1600 C/0-2912 F
	S2	0-1769 C/0-3216 F
B	B1	0-1820 C/0-3308 F
E	E1	0-800 C/0-1472 F
	E2	0-1000 C/0-1832 F
N	N1	0-1200 C/0-2192 F
	N2	0-1300 C/0-2372 F
T	T1	-199.9-400.0 C/-199.9-752.0 F
	T2	-199.9-200.0 C/-199.9-392.0 F
	T3	0.0-350.0 C/0.0-662.0 F
W	W1	0-2000 C/0-3632 F
	W2	0-232 C/0-2372 F
PLII	PLI1	0-1300 C/0-2372 F
	PLI2	0-1390 C/0-2534 F
U	U1	-199.9-600.0 C/-199.9-999.9 F
	U2	-199.9-200.0 C/-199.9-392.0 F
	U3	0.0-400.0 C/0.0-752.0 F
L	L1	0-400 C/0-752 F
	L2	0-800 C/0-1472 F

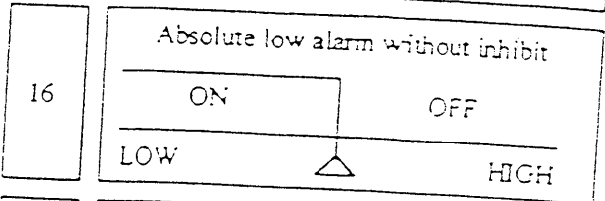
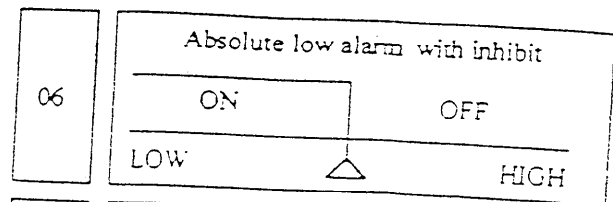
5.1 Alarm Selection

CODE	DESCRIPTION	INHIBIT
00/10	None	
01	Deviation high limit alarm	Yes
11	Deviation high limit alarm	No
02	Deviation low limit alarm	Yes
12	Deviation low limit alarm	No
03	Deviation high/low limit alarm	Yes
13	Deviation high/low limit alarm	No
04/14	Deviation high/low limit range alarm	No
05	Absolute value high limit alarm	Yes
15	Absolute value high limit alarm	No
06	Absolute value low limit alarm	No
16	Absolute value low limit alarm	Yes
07	Segment end alarm (use for program only)	-
17	Program end alarm (use for program only)	-
08	System error alarm - on	-
18	System error alarm - off	-
09	Heater break alarm - on (single phase)	-
19	On delay timer alarm	-

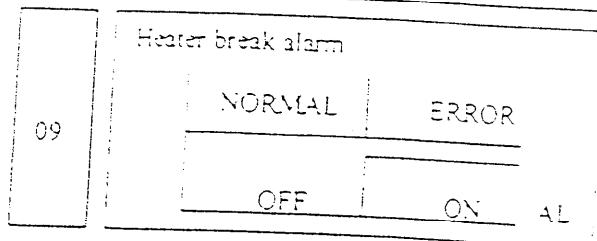
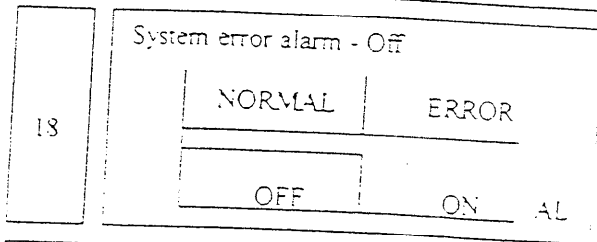
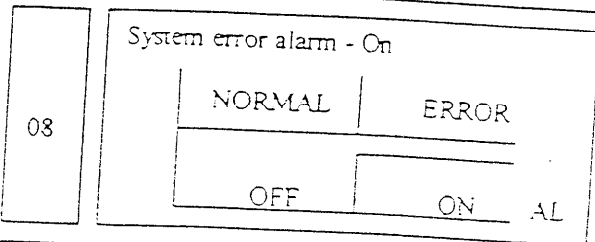
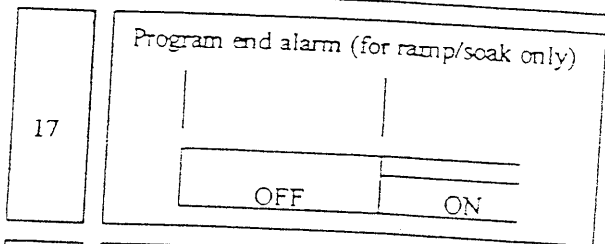
Note: The column "inhibit" indicates whether with the "inhibit" action, the alarm is not activated upon start - only once the temperature has gone past the SV for the first time.

5.2 Alarm action description

00 10	None
01	Deviation high alarm with inhibit
11	Deviation high alarm without inhibit
02	Deviation low alarm with inhibit
12	Deviation low alarm without inhibit
03	High / Low alarm with inhibit
13	High / Low alarm without inhibit
04 14	Band alarm
05	Absolute high alarm with inhibit
15	Absolute high alarm without inhibit



07 Segment end alarm
 (for program only)
 ALD1-3, set 07
 AL1-3 = Alarm segment No. set
 ALT1-3, if set 0 = flicker alarm
 ALT1-3, if set 99.59 = Continued alarm
 ALT1-3, if set others = On delay time



19 On delay timer
 When PV = alarm SV, it keeps a set time before alarm action.
 Range: 00.00-99.59 (Hr Min)

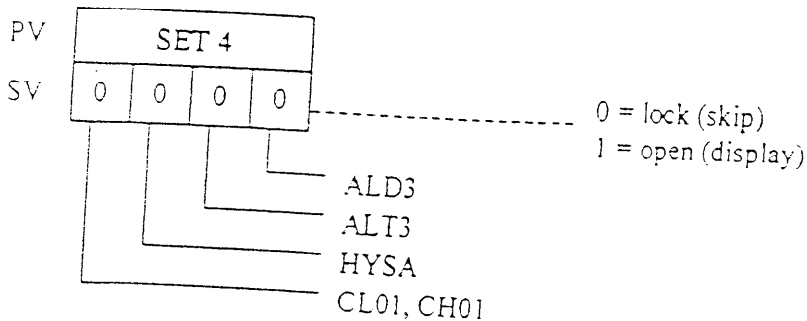
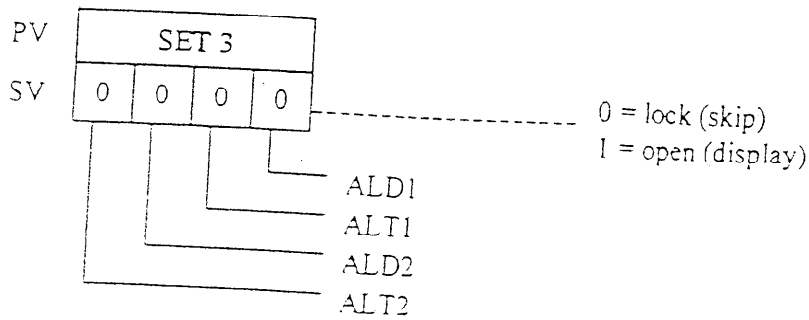
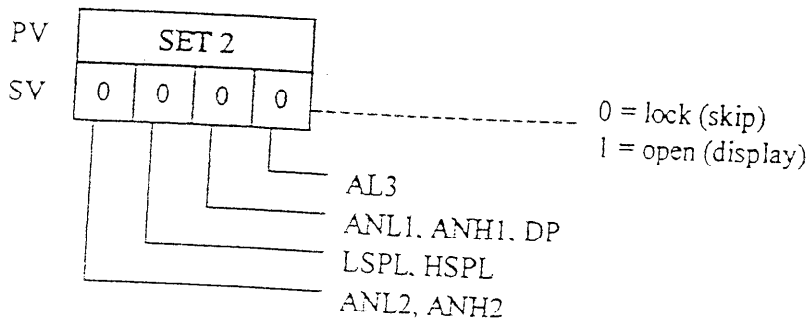
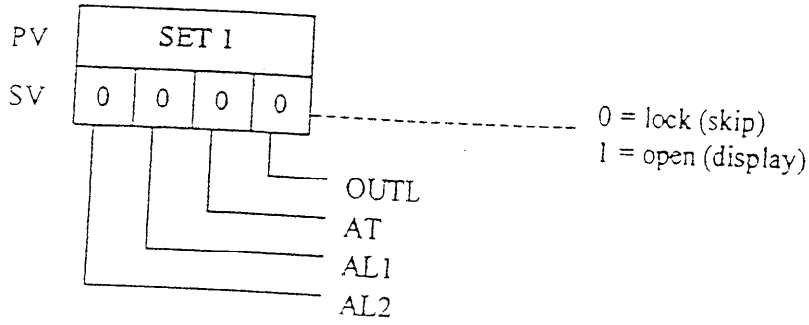
▲ : SV ▲ : Alarm set value (Inhibit: first time, no alarm)

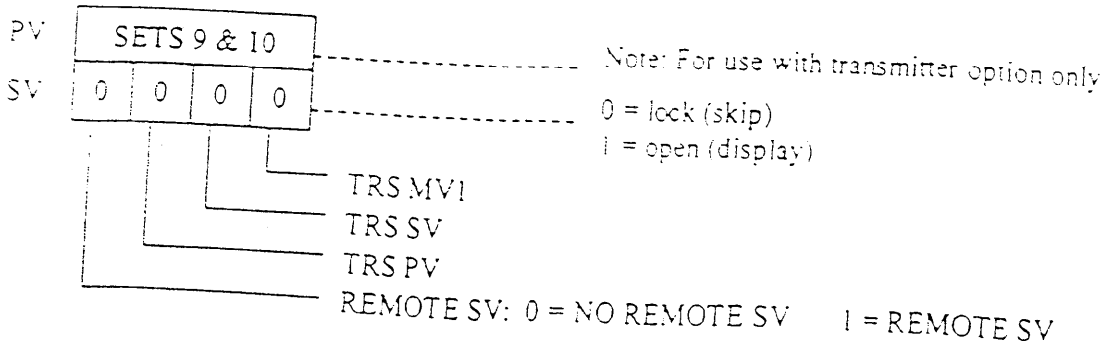
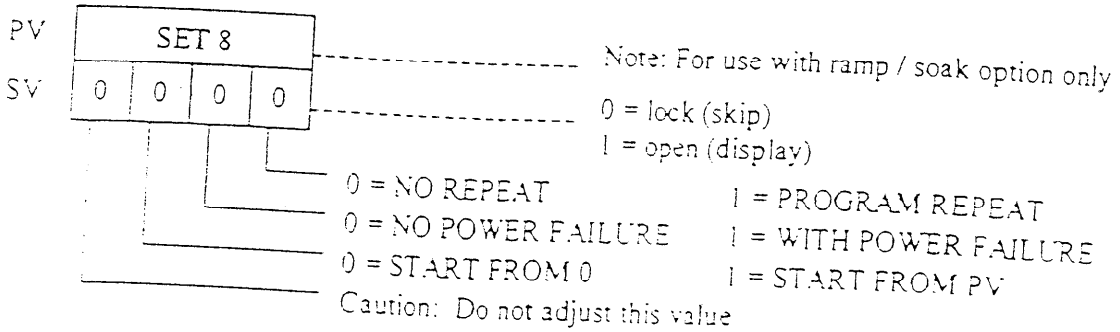
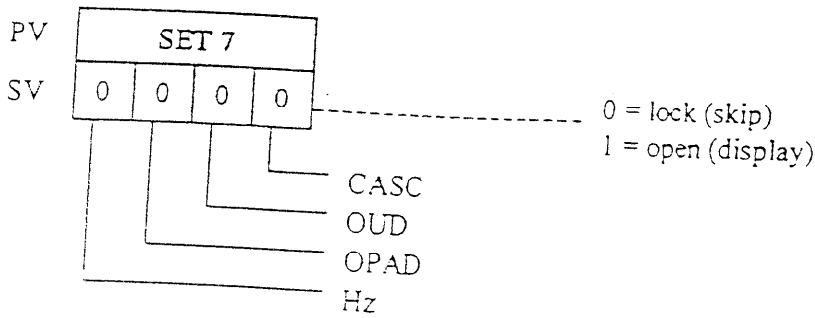
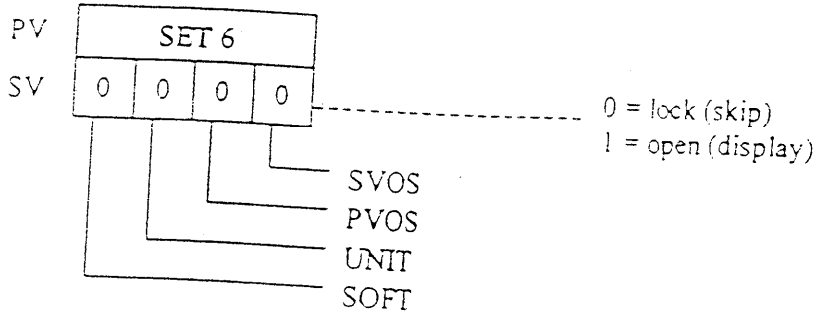
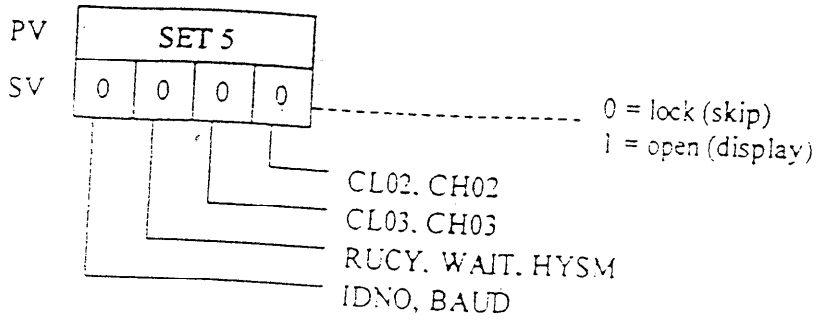
LEVEL 4 (Lock function)

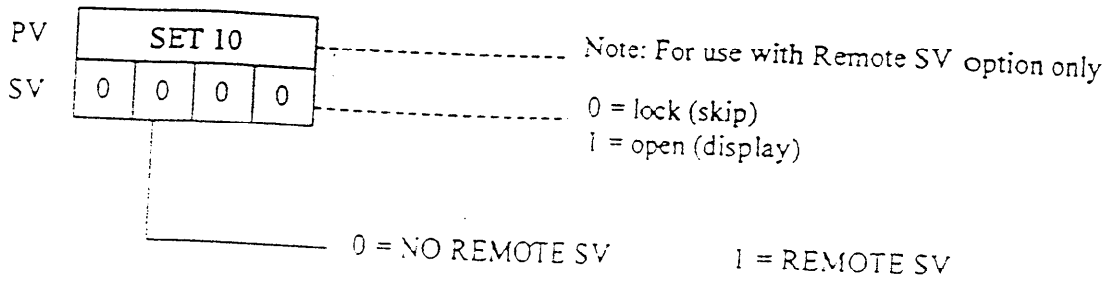
Step 1: Scroll to "LCK" in level 2 and set "1111" in LCK. Then press SET KEY and \triangleleft for 5 seconds to enter "SET" status.

Step 2: Press SET KEY to change SET 1 - 9

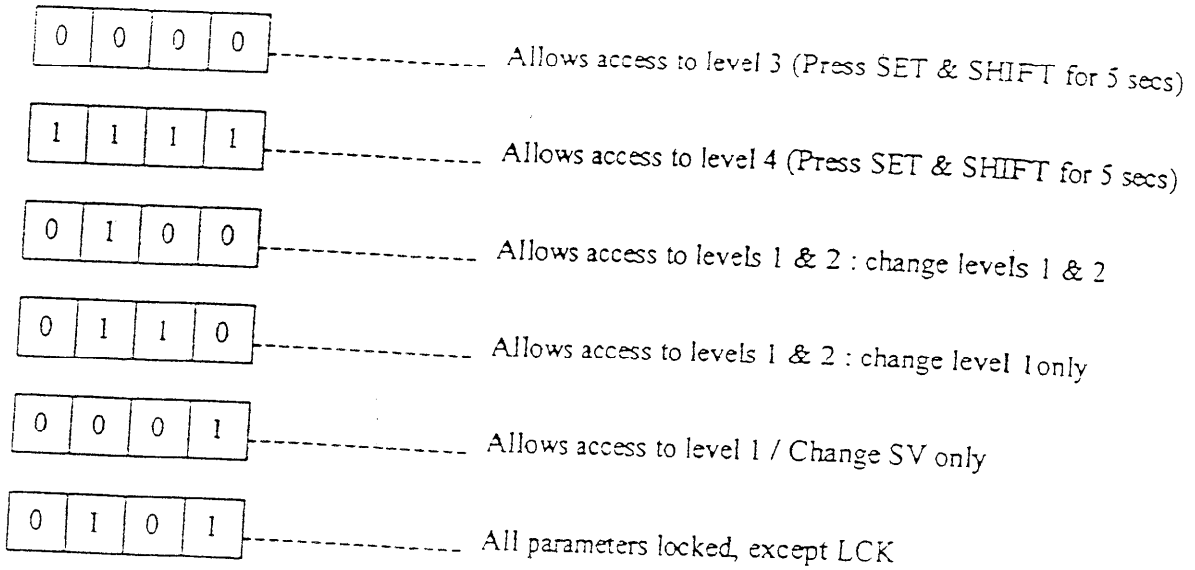
Function Set Modes







5. Function Lock Codes

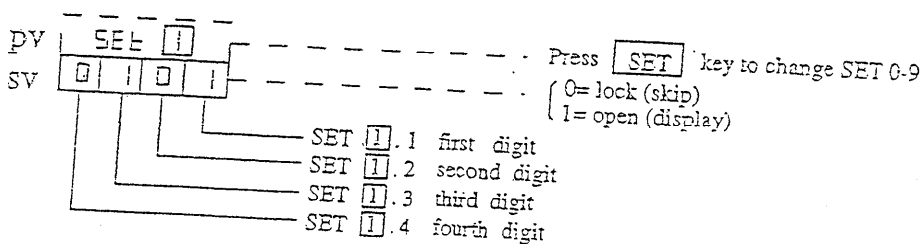


☆level 4 {Lock funtion)

Let display go to "LCK" in level 2, and set "1111" in LCK .
 Then prese SET key and ◁ for 5 secinds to enter "SET" status

◦ There are SET 0.1TO set 9.4 for use.

① EXAMPLE:



② FUNCTION OF SET

- | | |
|----------------------------|------------------------------|
| SET 1.1 for OUTL | SET 4.3 for HYSA |
| SET 1.2 for AT | SET 4.4 for CL01, CH01 |
| SET 1.3 for AL1 | SET 5.1 for CL02, CH02 |
| SET 1.4 for AL2 | SET 5.2 for CL03, CH03 |
| SET 2.1 for AL3 | SET 5.3 for Rucy, WAIT, HYSM |
| SET 2.2 for ANL1, ANH1, DP | SET 5.4 for IDNO, BAUD |
| SET 2.3 for LSPL, USPL | SET 6.1 for SVOS |
| SET 2.4 for ANL2, ANH2 | SET 6.2 for PVOS |
| SET 3.1 for ALD1 | SET 6.3 for UNIT |
| SET 3.2 for ALT1 | SET 6.4 for SOFT |
| SET 3.3 for ALD2 | SET 7.1 for CASC |
| SET 3.4 for ALT2 | SET 7.2 for OUD |
| SET 4.1 for ALD3 | SET 7.3 for OPAD |
| SET 4.2 for ALT3 | SET 7.4 for Hz |

Error information

1 n 1 E	Open circuit of main control sensor.
* A d C F	A/D convertor failed.
* C J E E	Cold junction compensation failed.
1 n 2 E	Open circuit of sub control sensor.
U U U 1	PV exceeds USPL.
n n n 1	PV under LSPL.
U U U 2	Input signal of sub control exceeds the upper limit.
n n n 2	Input signal of sub control under the lower limit.
* r A O F	RAM failed.
1 n E F	Interface failed.
A U E F	Auto tuning failed.

NOTE: If the "*" marked error occurs, the Temperature Controller needs repair..

Operator Procedures for Ramp/Soak Program

Factory Preset Settings:

SET 2.1 = 1 (Level 3 - LCK = 1111)
 SET 4.1 = 1 (Level 3 - LCK = 1111) If ramp is not used set ALd3=0 (Level 3)
 ALd 3 = 9 (Level 3 - LCK = 0000)
 ALd1/ALd2 = 19 (Level 3 - LCK = 0000)

RAMP Segment

A. Scroll with SET Keypad until upper display (PV) reads rAtE. Enter the desired ramp time on lower display (SV).

Range = 0000 to 9999 (0-99.99 deg/min)

B. Enter desired set point (operating temperature) The program will ramp to this temperature at the rate as set in step A.

Note: (A) The ramp will start at the temperature of the process (PV) as displayed on the upper display at the time the ramp is started.

Note: (B) The ramp is started by initial application of control power to the temperature controller or by depressing the shift key (<) and then the SET key.

SOAK Segment

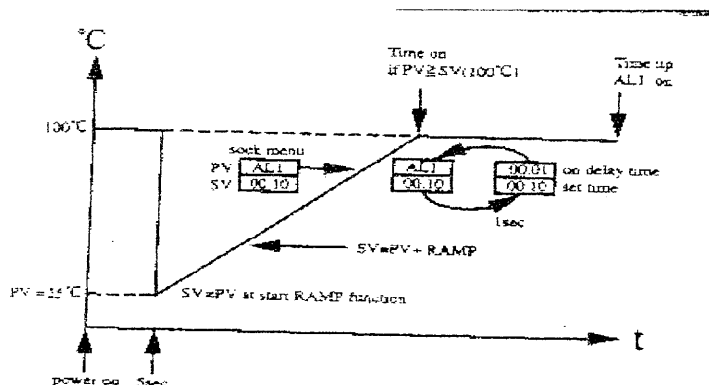
If it is desired to remain at the operating temperature for a prescribed length of time (SOAK), the time of the SOAK period is entered at level 1 by scrolling to the AL1 parameter and entering the desired time on the lower display.

Range = 00.00-99.59 hrs

Note: The SOAK period is started when the process temperature (PV) reaches the desired set point (operating temperature). i.e. PV = SV as originally set as operating set point (SV).

At the end of the SOAK period, relay contact AL1 on rear of controller will be activated and can be used to shutdown process or signal the operator.

Example:



Fuzzy Logic Temperature Controllers
SMART - 2, 3
Complete Initial Instructions
for
Ramp/Soak Program

1 Segment - Ramp

1 Segment - Soak

To Enter SET Function Level 3

- A. Press SET keypad for 5 seconds to enter level 2 parameter list.
- B. Scroll parameter list with SET keypad until upper (PV) display reads LCK (function lock).
- C. Using the shift key (<) and the up/down keypads, change the lower display which normally reads 0000 to read 1111. The shift key is depressed until the digit flashes that is to be changed and the up keypad to change from 0 to 1.
- D. Press the SET keypad and then the shift (<) keypad and hold both for 5 seconds to enter Level 4, set parameter list.
- E. Scroll Level 4 parameter list for SET levels 0-9. Go to the SE2 and set the right hand digit to 1 (1111) by use of shift key and up/down keypads (refer to step C).
- F. Repeat step E for SET 4 and set right hand digit to 1.
Note: These may be previously set for SET 2.1 and SET 4.1
Return to Level 1 by depressing the SET keypad and then the shift (<) keypad for 5 seconds to return to Level 1. Press SET keypad and hold for 5 seconds to go to Level 2 parameter list. Scroll with SET keypad to LCK parameter and check to see if it has returned to 0000, which is normal operation. If not use shift and up/down keypads to change from 1111 to 0000.
- G. Return to Level 1 and scroll with SET keypad until upper display reads rAtE. You can now enter the desired time in degrees per minute on lower display (SV). 0000 to 9999 (0 to 99.99 deg/min).
- H. Return to Level 3 and set ALd3 parameter to nine (ALd3=9).
- I. Enter desired set point temperature on lower display (operating temperature). This is the temperature which the controller will ramp to in the preset time (step H) Example: 0100 (100 degrees F). The ramp will start at the temperature of the process at the time the ramp is started. Start ramp by applying control power initially or by depressing the shift key (<) and then the SET key, i.e. If the process temperature on the upper display is reading 75 degrees, the ramp will start at 75 degrees on the lower display and increase the set point temperature from 75 degrees to the desired operating temperature set point (Example: 100 degrees).

**Factory Settings
ON/OFF Control
(Relay or SSR Output)**

Level 2 **Set P1** (Proportional Band) to **Zero "0"**

Set HYS1 to value from 0-1000

0 = 0 degrees Hysteresis band (will switch on and off at temperature set point (SV) with no dead band (hysteresis).

I (Integral time) and d1 (derivative time) are set to "0" for ON/OFF control.

**Time Proportioning Control
(Relay or SSR Output)**

Either use Auto-tune for controller to set PID parameters or enter values manually in Level 2.

P1 = Proportional Band 0-200%

I = Integral Time 0-3600 seconds

d1 = Derivative Time 0-900 seconds

db1 = Dead band time Normally set to "0" used for process with Dead Time for compensation.

Note: When output of controller is a SSR output, **CYti** is set at 1, Relay Output set to 10, Range 0-150 seconds (Prop. Cycle Rate).