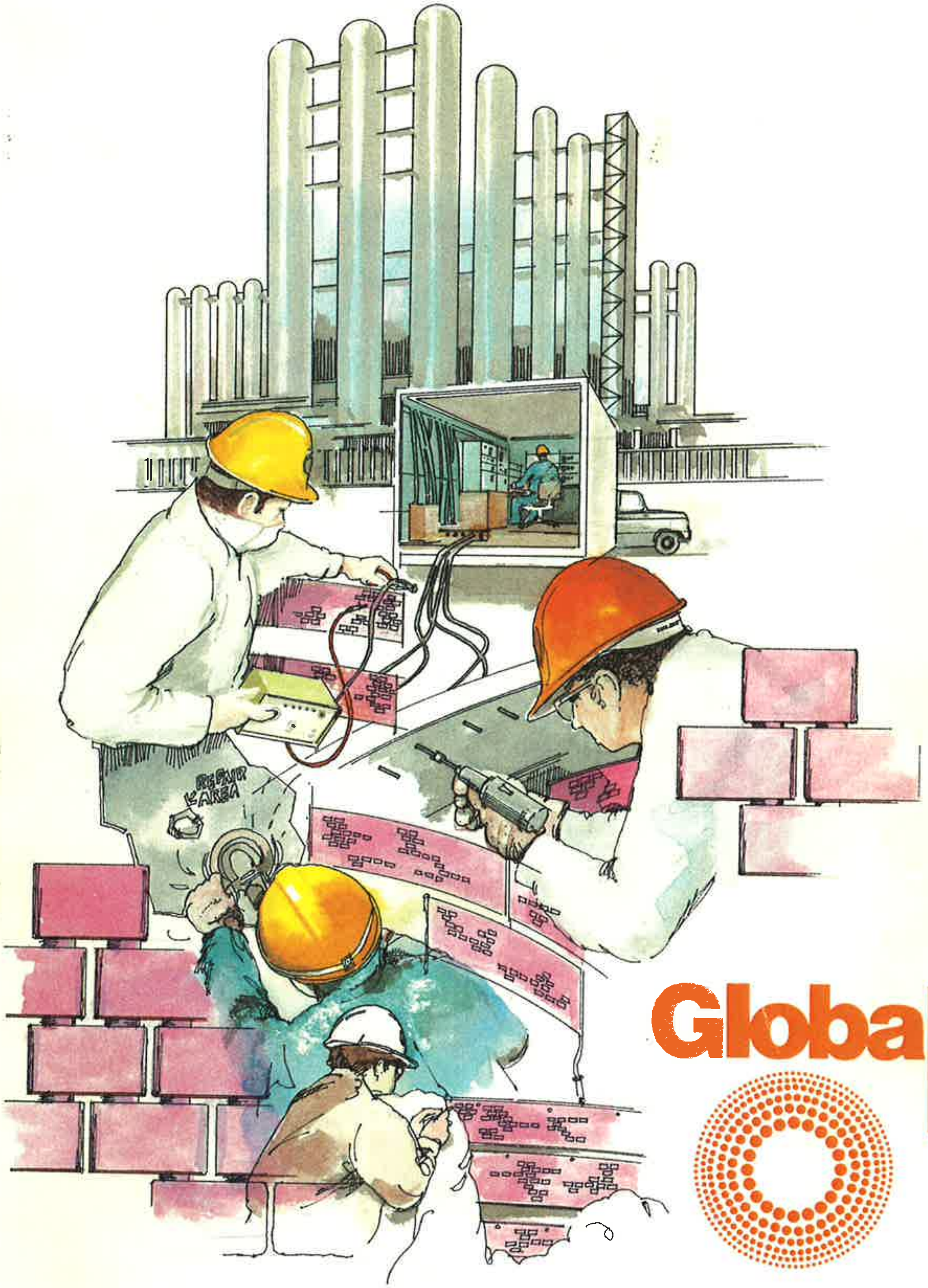


Operating Manual

Model No. P135-6
Heat Treatment Centre

Global Heat

Specialists in Metal Heat Treating Services

Global Heat

Table of Contents

Operating Manual For

GLOBAL HEAT

75 KVA HEAT TREATMENT CENTRE

Model P135-6

I N D E X

I) Six (6), energy regulators 0-100%.

J) Six (6), "Power On" indicating lights.

K) Six (6), panel mounted AUTO/OFF/MANUAL rocker switches.

L) Six (6), 0-150 ammeter.

M) Four (4), mini breakers for fans, instrumentation and auxiliary outlets.

GLOBAL HEAT

75 KVA (6 ZONE) HEAT TREATMENT CENTRE

MODEL P135-6

OPERATING PROCEDURES

OPERATION OF 75 KVA

HEAT TREATMENT CENTRE

INITIAL INSPECTION

Upon receipt, check for physical damage which may have occurred during transit.

Remove four eyebolts and lid to inspect for loose connection or signs of damage undetected by previous user.

Inspection found damaged components.

Notify supervisor, set aside for electrical inspection and repair.

Inspection found machine in good working order.

LOCATION OF EQUIPMENT

X

Inspect job and find suitable area to set up. Area should be dry and will remain that way throughout job.

If possible, job to be engineered so that secondary cables will not be in high traffic area, i.e. across roadways, foot paths, drain ditches, etc.

Heat treatment centre to be positioned so capacity of cables, i.e. 100′, will reach work piece.

X Unable to position heat treatment centre close to work piece.

Obtain cable extensions.

X Unable to run secondary cables in low traffic area or shelter from weather.

Have protection constructed Have barriers put up or planking installed to protect cables.

POWER SUPPLY

Remove back panel and inspect that primary tapping board is connected for correct voltage.

NOTE: Voltage supply and secondary discharge information located on information plate on top of transformer.

This unit requires 3 phase 3 wire supply with a good ground connection. The primary armored cable cores are coloured red, white, black and green. The green core is ground and must be connected on every occasion. The secondary connection must be hooked to proper tapping to accommodate heater voltage either 80 volt or 65 volt. When operator is completely satisfied both primary and secondary hook-ups are correct, replace back panel.

NOTE: Where primary cable enters cabinet, proper cable connector must be used.

Primary cable and plug are to be inspected. Cable should have no cuts or signs of damage. Plug must have all wire connected firmly and green wire must be connected to proper ground post.

1.0

Primary cable shows signs of damage.

Discard and replace

Plug incoming wires loose or not connected.

Tighten Connection

Plug and cable inspection show no signs of damage or loose connections.

With main wall mounted power supply breaker in the OFF position insert primary plug.

Male primary plug requires force to enter.

Disconnect and inspect for problem.

Male primary enters with minimal force.

With primary power disconnect in OFF position, wall mounted disconnect may now be placed in ON position, supply power to heat treatment centre.

HEAT TREATMENT CENTRE START UP

Connect the main supply leads for each channel to be used to the pair of 300 AMP female connectors in rear of unit.

NOTE: Channels #1 to #6 run from right to left when viewed from rear of unit.

Each main supply lead is accompanied with a type "K" thermocouple extension wire which is to be plugged into the proper panel mount thermocouple

4.2 When work piece has been set up with sufficient number elements and insulated properly, splitter connections can be made with heaters being connected in parallel, to a maximum of three heaters per circuit.

The main power switch to heat treatment centre may now be turned ON, observe fans and L.E.D. display on P250A programmer.

Panel mounted disconnect in ON position and receive no power.

All fans operational L.E.D. display on P250A showing "0".

Inspect wall mounted main breaker is in the ON position with functional fuses.

Inspect heat treatment centre breaker fuses have not tripped.

If any of these problems arise, switch all power OFF and have technician inspect unit.

OPERATION OF RECORDER

Turn on power button, recorder light will illuminate.

Recorder light not on.

Depress RECORD button on key operation assembly. This has a toggle switch action, push once for ON, push again for OFF.

Recorder light is illuminated.

Press data print button and observe all thermocouples being used are reading ambient temperature of work piece.

Thermocouples not being used will show, i.e. +3 ----

(open thermocouple).

Thermocouple used on work piece shows open or upscale reading.

Check thermocouple at work piece and associated cabling to heat treatment centre.

All thermocouples at work piece read ambient temperature.

Settings of

1. CHART SPEED
2. SCALING
3. DATE AND TIME
4. RECORDING FORMAT

All of these functions are preset and maintained in the recorder's memory.

Settings are not suitable.

Refer to owners manual for parameter settings.

Settings are satisfactory.

INSPECTION OF JOB SET-UP

With rocker switch to manual mode for channel #1 and thermocouple in panel mount at rear, check temperature controller for control.

- Open thermocouple, deviation meter will drift upward and maintain.
- Correct thermocouple attachment, deviation meter will move up and down according to movement of set point control.

With temperature controller, set point higher than work piece ambient, i.e. 200°F and energy regulator on 10.

At this point the channel indicator light (see FIG."A") will glow and the contactor will be heard to close. A check should be performed to test voltage output from channel #1 panel mount camlocks. Should read 80 volts or 65 volts, whichever it had been previously tagged for. Also the voltage output from the U-Ground duplex recepticals will indicate 115 volt - 125 volt approximately, confirming proper tapping.

U-Ground recepticals indicate lower or higher voltage output.

Panel mount camlocks voltage checks indicate lower or higher voltage output.

Disconnect all power supply and check tapping connections from transformer.

Turn the energy regulator knob to OFF, (see FIG."A") and the contactor should be heard to open and channel indicator light go out. Turn the energy regulator to 5 and the contactor and indicator light go on and off at regular intervals.

Repeat the above operation for the remaining five channels. At this point you should be confident all aspects of manual operation, temperature controller, energy regulator, panel mount camlocks and panel mount thermocouples are in proper working order.

Temperature controller indicates open thermocouple.

Check for incomplete circuit within machine from thermocouple to temperature controller.

Contactor heard to close and light on with no voltage output at rear panel mount camlock.

Check for incomplete circuit from contactor to panel mount camlocks. Check for incomplete circuit from transformer to contactor.

OPERATION OF P250A AUTO MODE

With main breaker switch in the ON position, press "RESET", L.E.D. should reset to 0, (see FIG."B").

No Power

L.E.D. Reads 0

Check the power supply breaker fuse. If fuse is in operation mode have technician check wiring.

Decide on the heat treatment specification programme and proceed as follows:

A) Operate the RESET switch, (see FIG."B") the "END OF PROGRAMME" will glow and the L.E.D. display will reset to zero.

B) Set the initial set point level in degrees F by means of the digital switch in the LEVEL section (see FIG."B").

C) Set the controlled rate of rise in degrees F per hour, on the digital switches marked RATE 1.

D) Set the soak time on the switch marked DWELL>

E) Set the controlled rate of fall in degrees F per hour on the digital switches marked RATE 2.

The programmer is now set for the work piece to be heat treated automatically.

Set the rocker switches for the channels being used to AUTO (See FIG."A") and position all energy regulators @ 10, then press the START button on the P250A. With the heat cycle preset in the programmer, all rates of rise, fall and dwell time should continue automatically.

Set energy regulators for channels being used to 10. With the programme started, the red channel indicator lights on the operative channels will glow as each channel calls for heat.

Simultaneously check that the correct amount of current is flowing through each selected channel via the ammeter gauges. Each heating element draws approximately 40 AMP, therefore, a circuit with three elements connected should indicate approximately 120 AMPS.

AMP gauges indicate insufficient draw for number of heaters used

Check that splitters have been connected in parallel properly. Check heaters for continuity, possible break in heater core wire.

Indicator light on with no amperage flowing.

- Secondary power supply not connected
- Incorrect splitter connection

If the work piece has been set up correctly and power input sufficient, the programme will proceed exactly in accordance with the settings.

If there is a fault in the set up, that is, if a heating element burns out, or the job has been set up with insufficient power, the programmer has an automatic HOLD feature to cater to such problems. This is operated by the programmer when any one or more channels lags the set point.

The indication to the operator is by means of the decimal point evident to the right of the L.E.D. number displayed and the fact that the programme set point is not advancing.

The instrument will hold until all channels are back in specification, at that time the heat cycle will recommence.

MANUAL OPERATION OF HEAT TREATMENT CENTRE

With all rocker switches in OFF position, energy regulators set at 0, and temperature controllers set at 0, main breaker may be switched ON.

Individually, #1 to #6, place each rocker switch in manual position and observe DEVIATION needle of temperature controllers.

- Open thermocouple needle will drift open.
- Correct thermocouple attachment deviation needle will move up and down according to temperature control setting.

Temperature controller indicates open thermocouple.

Short out female panel mount jack at rear of machine. If control is obtained problem is not in unit.

Replace extension plug and short at female end. If control is obtained, problem is not in extension lead.

Problem must be thermocouple, detach from work piece.

Set SET POINT controller higher than actual temperature. Set energy regulator at 10 (full on), red light for that channel should illuminate and contactor be heard to close.

Observing ammeter will indicate number of heaters operational. Each heater draws approximately 40 AMP, therefore, three heaters per channel will draw approximately 120 AMP.

Channel with three heaters only draws 40 AMP

Check for improper splitter hook up. Check for continuity of heaters, possible broken wire within.

Work piece has been set up properly with sufficient power and all heaters operational. Control is constantly maintained on each channel.

In a normal post weld heat treatment with a restricted rate of rise, the following steps should be taken.

A) Calculate the rate of rise in 50°F segments.

EXAMPLE: 400°F/hour rate of rise
400 divided by 50°F equals 8 segments
60 minutes divided by 8 (segments of 50°F)
Equals 7.5 minutes/50 segment

Therefore, every 7.5 minutes, turn the temperature controller up one 50°F segment for a rate of rise of 400°F/hour.

B) Turn temperature controller up as per rate of rise desired.

C) Set energy regulator at 5.

D) Observe deviation meter on temperature controller and note when the meter reaches 0 on the scale. If the meter reaches 0 before the next time interval for increase in temperature setting, turn energy regulator down. If the meter does not reach 0 on the scale before the next time interval for temperature increase, then turn the energy regulator up.

E) When the required hold temperature is achieved, leave temperature controller at set point until hold time is complete.

F) For rate of decline, use the same steps as rate of increase only turn the temperature controller down at the required time intervals.

* NOTE 1 * Some heat treatment set ups may be heavily insulated in relation to the size of the work piece. This should not be a problem as most codes require a maximum rate of decline not minimum.

* NOTE 2 * The Chino Model AH520-NNN has the capability to delete and re-enter channels, the instructions are as follows:

TO SKIP CHANNELS

Hold down shift button, push RANGE

R 01 : 2 0 1 0 2 0 0 0

R 01 - Channel Number
20 - Range Number (Always 20)
1 - CJ Always Switching
0 - 0-2000 Scale

Push SET, R 02 : 2010 2000, appears.

Push ENTER until channel you desire to delete shows up. Hold down shift and push CLEAR. You must push ENTER button until all twelve channels are entered. Go through all other channels and leave the ones you want and delete the ones you don't want, then hold down SHIFT and END, wait until underline quits flashing.

* NOTE 2 *

TO RE-ENTER CHANNEL

Hold down shift button, push RANGE

R 01 : 2 0 1 0   2 0 0 0

1st channel number will appear that you are using now.

Push SET

Push ENTER until R _ _ : Appears

Enter channel number you want to use,
Example: R 0 6 : _ _

Enter the following numbers in order, 2010 2000
Example: R 0 6 : 2 0 1 0   2 0 0 0 - Should appear on display

Push ENTER, R _ _ : Will Appear

Enter other channel numbers you might want to use. When you are done entering channels you want to use, hold down the shift key and push END. Wait until flashing has completed and display has gone back to original state.

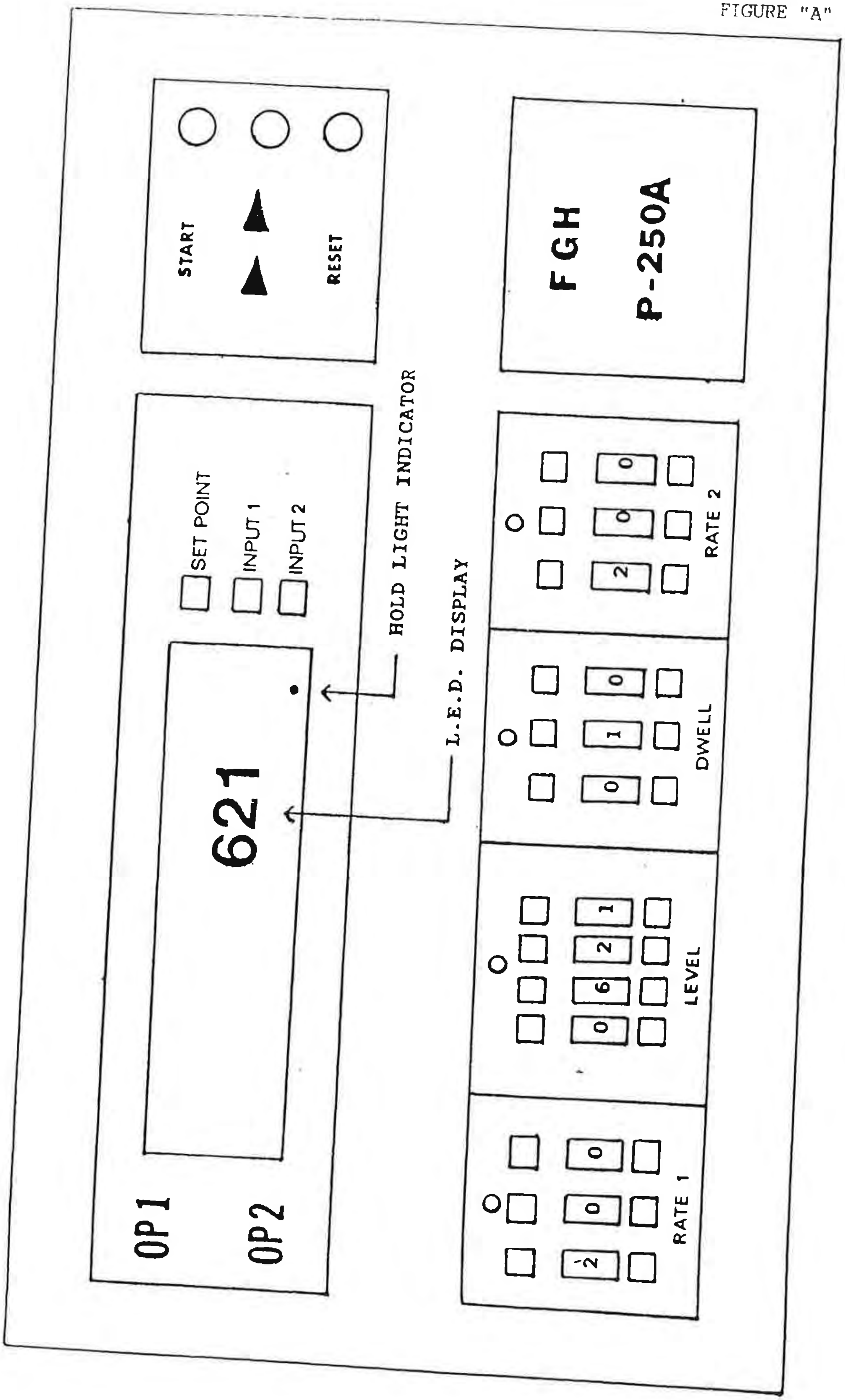
When you add channels you also add the unit F so that when the recorder digitally prints it will print F after the number.

Hold shift key and push unit
Example: You will see the first number of the channel being UCH.02. 1.2

C F - Check to see that it is in F, if not, push SET UCH.02. 1.2. Cursor will appear under Channel Number (underlined).

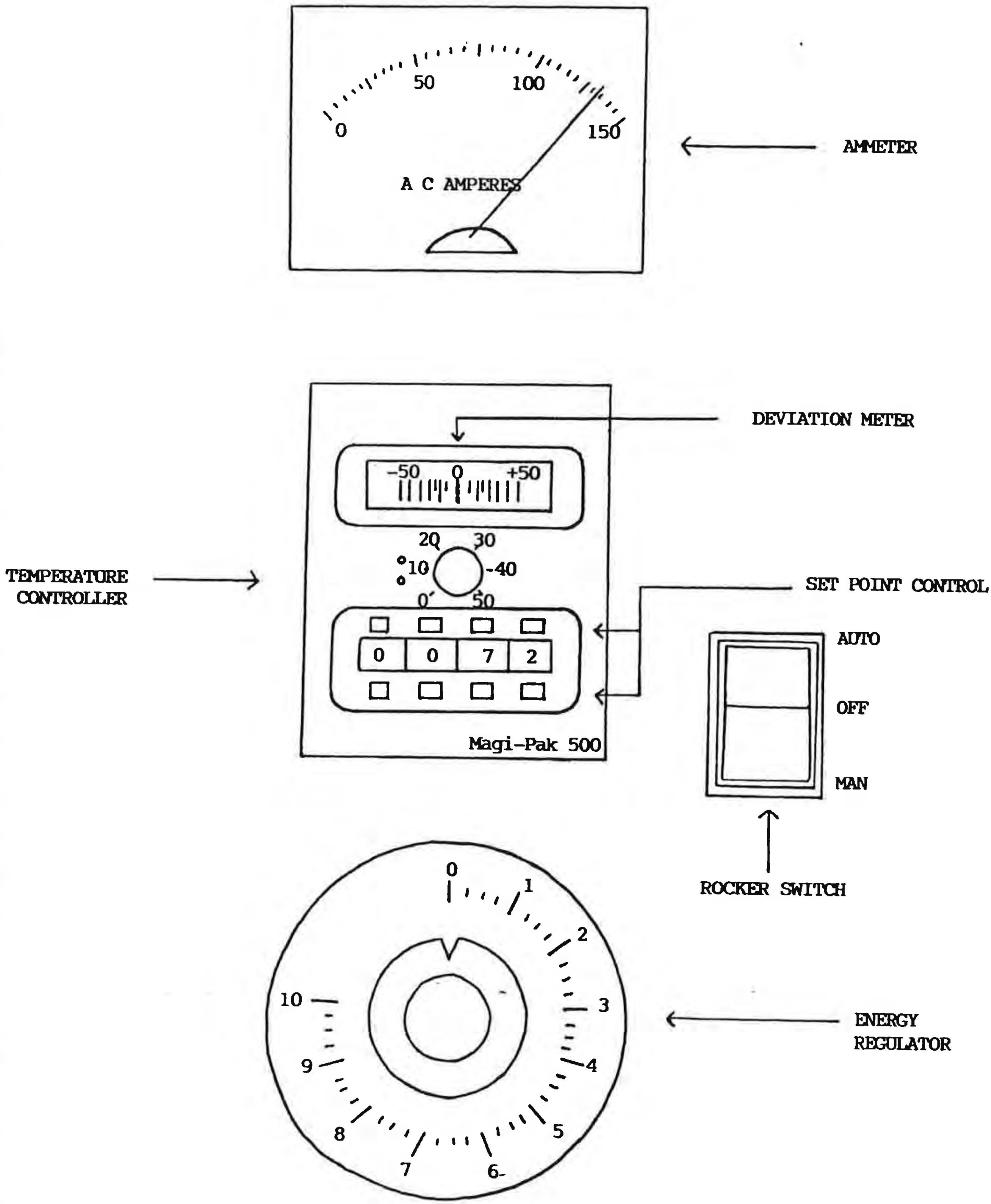
Move cursor via ___ until it is under the last two digits. If Degrees F light illuminates, than push enter. If Degrees C illuminates then hold down shift and push F key. When you have all channels complete, hold down shift and push END and wait until cursor stops flashing.

FIGURE "A"



START
RESET
FGH
P-250A
SET POINT
INPUT 1
INPUT 2
HOLD LIGHT INDICATOR
L.E.D. DISPLAY
621
OP1
OP2
RATE 2
DWELL
LEVEL
RATE 1

FIGURE A



0
50
100
150
A C AMPERES
AMMETER
DEVIATION METER
-50
0
+50
20
30
10
-40
0
50
TEMPERATURE CONTROLLER
SET POINT CONTROL
0
0
7
2
Magi-Pak 500
AUTO
OFF
MAN
ROCKER SWITCH
0
1
2
3
4
5
6
7
8
9
10
ENERGY REGULATOR

Global Heat

Operating Manual For

P250A

Auto Programmer

Contents

1 Unpacking & Inspection

Carefully unpack the instrument and perform a visual inspection. If there are any signs of damage, particularly if the packing is damaged, notify FGH Controls Ltd or your local distributor from whom the instrument was purchased immediately and retain the original package.

2. Mechanical Installation

The P250A is intended for horizontal panel mounting and is designed to fit the DIN standard out out:-

Width 186 -0 +1.1
Height 92 -0 +0.8

The internal panel fixing clips are suitable for panel thicknesses up to 5mm (0.2 inches).

The approximate weight of the instrument is 2.6Kg.
Since the P250A incorporates integral temperature sensors at its rear terminals to achieve cold junction compensation for its thermocouple inputs, it is important that the instrument is mounted in a position such that it is not subject to rapid nor excessive changes in ambient temperature such as would occur due to draughts or radient heating from adjacent hot surfaces. Rapid changes in ambient temperatures may result in errors in control.
The front panel controls of the P250A instrument are not environmentally sealed and are proof against neither dust nor water contamination. In environments where dust or water spray is likely to be a hazard, it is strongly recommended that the instrument's front panel be protected.

3. Electrical Installation

3.1 General

The electrical connections of the P250A are shown in Table 1. The terminal blocks employed in the instrument are designed to suit cables from 0.5 to 1.5 square mm. When connecting cables to the instrument, [redacted] is neither desirable nor necessary to undo the terminal screws beyond approximately one and a half full turns since this opens the cable entry hole to its maximum. Any further unscrewing of these screws will only increase the possibility of the screws becoming free with the attendant danger of lost or cross threaded screws.
The insulation stripping length is 7mm and the total cable insertion depth is 18mm.
Attempt as far as possible to segregate and to keep segregated the low voltage sensor cables from the high voltage supply and relay cables.

3.2 Power Connections

The instrument is suitable for use on either 110V or 240V 50 to 60HZ supplies by means of an internally preset soldered wire link. Ensure that the P250A is set for the correct voltage since inadvertent connection of 240V to an instrument set for 110V will result in immediate permanent damage to the instrument.
The P250A must be earthed by means of the earthing stud on the rear panel whenever the supply is connected.
It is recommended that the P250A's supply is fused externally using a 0.25AF fuse.
The instrument consumes approximately 7VA.

3.3 Sensor Inputs

The P250A provides automatic cold junction compensation by sensing the temperature of its sensor input terminals.

It is therefore essential that the compensation (extension) cable be of the correct type and that it be wired right up to the sensor terminals at the rear of the instrument.
The upscale burnout feature of the P250A results in a flow of approximately 0.1 micro Amps through the thermocouple and its compensation cable, this will result in errors of measurement and control with very long runs of compensation cable. Errors of approximately -1 Deg C can be expected where the compensation cable resistance is 100 ohms for precious metal sensors or 400 ohms for base metal sensors. Each sensor input is galvanically isolated to a maximum voltage of 250V RMS.

3.4 Relay Outputs

The P250A provides four form A function relay contacts, one of which will close for each of the four program positions; Ready, Rate 1, Dwell and Rate 2.
These function relay contacts are rated at:-
250V RMS, 1A RMS Resistive Load.
nere are no arc supression components fitted to these contacts. If the load to be switched is significantly inductive then very high transient voltages may occur across the load as the contacts break the current in the load. Such high voltages and the resultant arc can lead to excessive erosion of the relay contacts or indeed flashover on the PCB, it is therefore recommended that inductive loads be arc supressed, see Fig 1 for general recommendations.

The P250 A provides a single form A time proportioning relay contact for each of its internal controllers. Note: Depending on the model supplied, output 2 may not be operative.
These relays are rated at:-
250V RMS, 2A RMS Resestive Load.
These contacts are internally arc supressed by means of a CR network and a voltage dependant resistor.
The status of these relays are shown by means of the front panel LED's.

5 **Other Input/Outputs**

Further inputs and outputs are provided as follows:-
3.5.1 A remote start and remote reset input on terminals 19 and 18 respectively. These are operated by means of an external voltage free contact closure to terminal 16 as indicated in Table 1.
3.5.2 A hold input on terminal 17. When connected to common on terminal 16 this input causes a hold condition on the programmer see Section 4.
3.5.3 A setpoint output on terminal 15. This output is a pseudo digital "PWM" setpoint, see section 7 for further details.

etting Up and Modes of Operation

4.1 The P250 A generates a setpoint temperature-time profile as illustrated in Fig 2. This is set as follows:-

1) Set the required rate of rise of temperature (in Deg C per Hr) on the three digit rate 1 switch.
2) Set the required temperature (in Deg C) at which rate 1 terminates on the four digit level switch.
3) Set the required dwell time (in hours and tenths of hours) on the three digit dwell switch.
4) Set the required rate of fall of temperature (in Deg C per Hr) on the three digit rate 2 switch.
5) A setting of zero on rate 1 or rate 2 switches will be interpreted as a step change (infinite rate).

The resultant setpoint generated by the above settings will be used by the P250A as a common setpoint for the two internal controllers. These controllers measure input 1 and input 2 and generate time-proportional outputs, output 1 and output 2. It is necessary to set the proportional bands of these controllers.
If at any time during the execution of a program input 1 (and input 2 if output 2 operative) deviates from the setpoint by more than an amount determined by the hold band, then a hold condition will occur. It is necessary to set the hold band of this controller(s).
When a hold condition is detected the P250A can respond in a number of different ways. It is necessary to set the hold mode and the hold type.
e proportional band, hold band, hold mode and type are set by means of n internally mounted DIL switch.

Access may be gained to the DIL switch by removing the four front panel fixing screws and then gently disengaging the panel from the bezel and digital switches. Note the front panel pushbuttons are still wired to the internals of the P250A and the front panel cannot be completely removed. Refer to Fig 3.

4.2 Proportional Band

This is determined by the first three switches of the DIL switch, both controllers within the P250A share a common proportional band setting. Refer to Fig 4, as can be seen, as the input increases towards and then exceeds the setpoint the amount of power delivered by the controller to the process decreases from 100% to 0%. The proportional band is defined as that change of input necessary to reduce the power from 100% to 0%, thus the power delivered is dependant upon the difference (error) between the setpoint and the input.
The proportional band of the P250A is positioned with respect ot the setpoint such that when the setpoint is zero then the amount of power (P) delivered to the process at zero error is 0% whereas when the setpoint is at its maximum, P at zero is 100%. The setpoint is however, always within the proportional band. This somewhat baffling feature of the P250A has been included so as to reduce the errors in the control action and to reduce any overshoots at the end of rates over a wide range of setpoint values.

The controllers within the P250A regulate the power delivered to the load by a technique known as "time-proportioning". The controller's output is a form A relay, to delivery 100% power the relay is energised continuously, to delivery 0% power the relay is de-energised continuously, to deliver a percentage P then the relay is energised for P% of the cycle time and de-energised for 100-P% of the cycle time where the cycle time is a constant 20 seconds (approximately).
To achieve the minimum error between the controller's input and its setpoint it is clearly important that the proportional band be set to as small a value as possible, the proportional band cannot be reduced below a certain critical value however since a point is reached where the load begins to fluctuate or "hunt" about setpoint and never settles down to a satble level. The critical value for the minimum proportional band and the magnitude of the load fluctuations depend in a complex manner upon the time delay introduced by the load itself between the controller's output relay and the controller's input.
To achieve best control of the load, therefore, a compromise can be reached between these two conflicting requirements of accuracy and stability as follows:-

4.2.1 Set the maximum proportional band (32 Deg C) by switching on switches 1,2 and 3.
4.2.2 Set the rates and level switches as required for the process but ensure that the dwell switch is set for a reasonably long period of time to ensure that adequate time is allowed for the load to stabilize and adjustments and observations to be made.
4.2.3 Start the programmer and process then fast rate the setpoint up to the level (see Section 5).
4.2.4 Monitor the process until a stable condition is reached. The error between setpoint and load temperatures should be constant and less than 16 Deg C.
4.2.5 Reduce the proportional band to 24 Deg C by operating switches 1,2 and 3 as per Fig 3. Introduce a disturbance into the process by reducing the setpoint by say 10 Deg C for a short time and then returning it to its original value.
4.2.6 Monitor the process until a stable condition is once again reached, the error should be now less than 12 Deg C.

4.2.7 Continue reducing the proportional band in a similar manner until the critical value of proportional band setting is discovered. As previously explained the load temperature will be seen to fluctuate, sometimes quite widely, about setpoint and will never settle down to a stable balue. The period of this fluctuation can sometimes be very long, dependent upon the nature of the load, so ensure that observation is maintained for long enough at each setting of proportional band so as to be sure if the load temperature really is fluctuating or not.

4.2.8 Take this critical value of proportional band setting and, as nearly as possible with the increments available, set the proportional band to twice this critical value. The load temperature will now stabilise and the error between it and the setpoint will be the minimum obtainable with the process controlled by proportional-only control.

4.2.9 If the process is such that a wide variety of loads have to be controlled from time to time, then either the above procedure will have to be replaced for each different load or a further compromise must be made between a proportional band setting large enough to give good stability with the load most difficult to control and a proportional band setting small enough to give an acceptable degree of error with the most stable load.

All of the above is illustrated diagramatically in Fig 5.

4.3 Hold Band

This is determined by switches 4 and 5 of the DIL switch. The P250A recognises a hold condition whenever the load temperature deviates from its current setpoint by an amount determined by the hold band. Both controllers, if fitted, within the P250A share a common hold band. As can be seen from Fig 4 the hold band is equally disposed about the setpoint and is settable in multiples of the proportional band. Therefore if the proportional band is set to, say, 16 Deg C and the hold band is set to X4 then the hold band will be equal to 64 Deg C.

4.4 Hold Mode

The hold mode selected determines the way in which the P250A responds to a hold condition.

4.4.1 If switches 6 and 7 are both off then the hold condition is totally ignored.

4.4.2 If switches 6 and 7 are both on then theP250A goes into a hold state for deviations both above and below the hold band.

4.4.3 If switch 6 is on and 7 is off then the P250A goes into a hold state only when the load temperature exceeds the setpoint by one half the hold band, deviations below setpoint are totally ignored.

4.4.4 If switch 7 is on and 6 is off then the P250A goes into a hold state only when the load temperature falls below the setpoint by one half of the hold band, deviations above setpoint are totally ignored.

4.4.5 The hold state is defined as either a rate hold, switch 8 off, or a dwell hold, switch 8 on.

4.5 Rate Hold

This state only has effect when the P250A is executing rate 1 or rate 2. When in rate hold the P250A maintains a constant setpoint irrespective of the rate switch settings for as long as the rate hold condition persists, see Fig 6.

4.6 Dwell Hold

This state only has effect when the P250A is executing its dwell time. If a hold state occurs during the dwell then the dwell timing is suspended during the period for which the hold state exists. As can be seen from Fig 6 the P250A will maintain its setpoint at the setting of the level switch for a period equal to the dwell switch setting plus those times during which a dwell hold existed.

4.7 Hold Indication

The presence of a hold state is indicated by means of the "decimal point" to the lower right hand corner of the digital display.

5. Running The Programme

Once the rate, level and dwell switches are set on the P250A's front panel and the proportional band, hold band and hold mode switches inside have been set the program may be run.

Switch on the supply. Immediately a number of apparently random things will occur, these are not symptomatic of a fault but are a natural consequence of the correct operation of the instrument. The following sequence should happen:- Immediately upon switch on nothing will appear to happen for approximately 1 second, then the digital display and LED;s on the front panel will flicker randomly and rapidly for approximately 2 seconds, during this period the output relays may energise at random. After this 3 second period the sequence of events is determined by the state that the P250A was in when it was last de-energised. If the P250A was running its program when last de-energised see section 5.5, if however, the P250A had finished its program and was in its ready state then after the 3 second period the random display flicker will cease and the display will show 0, the ready relay only will be energised and the display status LED's will indicate setpoint. All other LEDs and relays will de-energise.

5.1 The program may be run either by pressing the front panel start button or by closing terminal 16 (COM) to 19 (Remote Start) whereupon the display will go blank for a nominal 7 seconds, the ready relay remains energised. During this 7 second period the P250A measures the temperature sensed by input 1. After this 7 second period the P250A automatically puts its setpoint at this temperature, the display is re-energised and will therefore indicate this temperature as the starting temperature of the program (see also section 5.7), the ready relay is de-energised, rate 1 relay is energised and the program status LED's will indicate rate 1. At this point the program has started and the controller output relays are enabled and begin to function in their time-proportioning mode. Thus it can be seen that Input 1 must be used rather than Input 2 if only one controller is employed.

5.2 At any time during the program the P250A may be reset back to its ready state with its setpoint resetting to 0 by either pressing the front panel reset button or by closing terminal 16 (COM) to 18 (Remote Reset). Note that the reset overrides all functions and if the remote reset is maintained then the P250A cannot be started until that reset is removed.

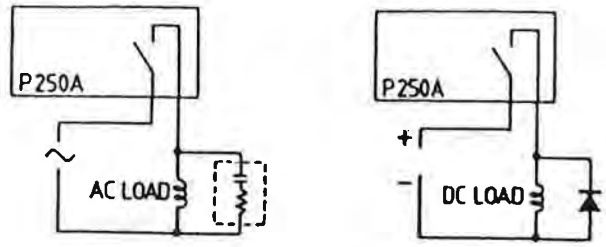
5.3 During either rate 1 or rate 2 the rate switch settings may be manually overriden from the front panel. Once the program has been started subsequent depressions of the start button have no effect, if however the start button is depressed and whilst depressed the F button is also pressed then the setpoint will move at the rate of approximately 100Deg C per second for as long as both F and start are held depressed. Upon release of the F button the normal program will resume.

HOLD ACKNOWLEDGE RELAY OPTION

The hold acknowledge - 'HACK' - relay option provides a single, form A, relay contact in place of the standard 'READY' contact (see section 3.4 of the manual).

This contact is connected between terminals 9 and 10.

Please read the notes about rating and arc suppression in section 3.4 of the manual before connecting to this contact.



Use proprietry contact suppressor network.
C = 0,1µF } typical
R = 100 }

Anode to load negative. Diode must have voltage rating greater than load voltage, current rating greater than load current.

FIG.1

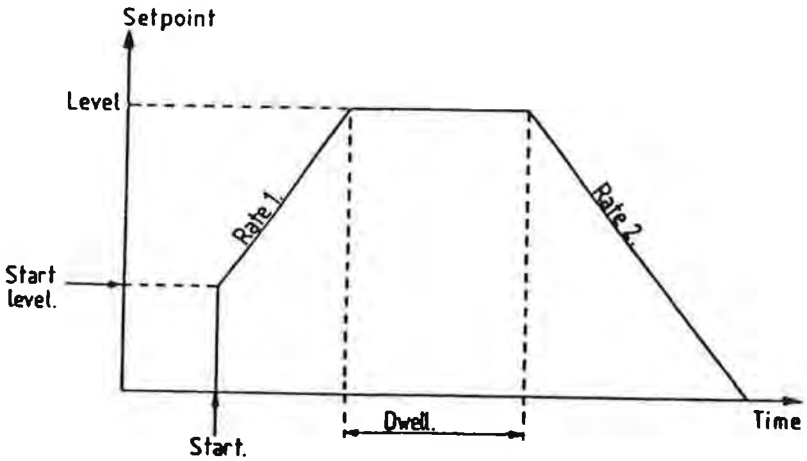
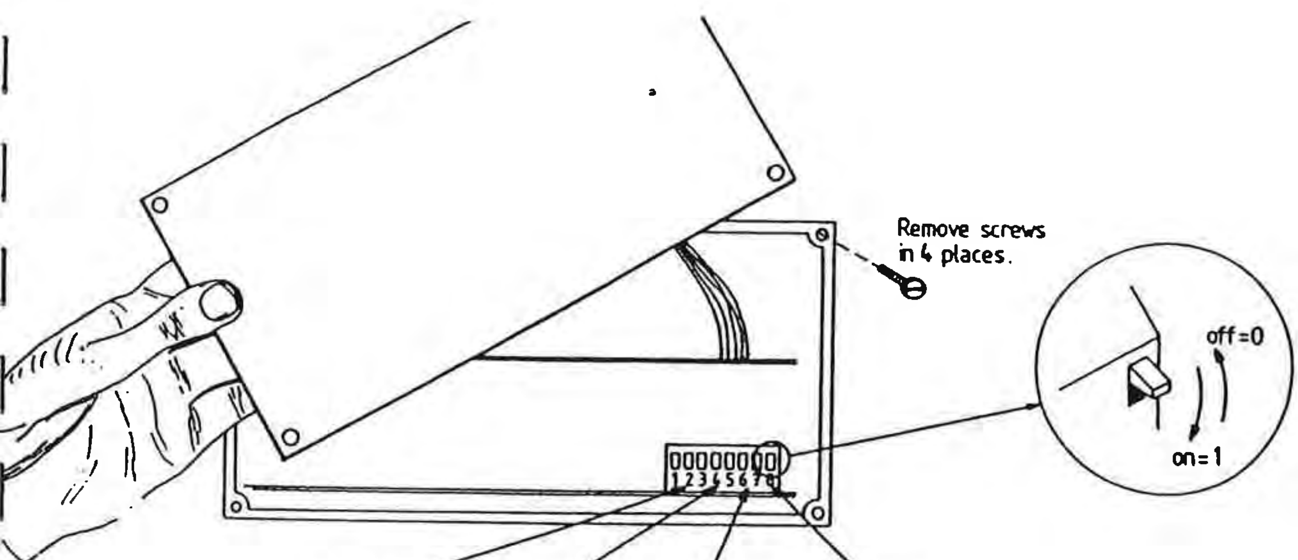


FIG.2



Xp	1	2	3
1	0	0	0
4	1	0	0
8	0	1	0
12	1	1	0
16	0	0	1
20	1	0	1
24	0	1	1
32	1	1	1

Xh	4	5
x2	1	0
x4	0	1
x6	1	1

H mode	6	7
None	0	0
Over	1	0
Under	0	1
Both	1	1

H mode	8
Rate	0
Dwell	1

FIG.3

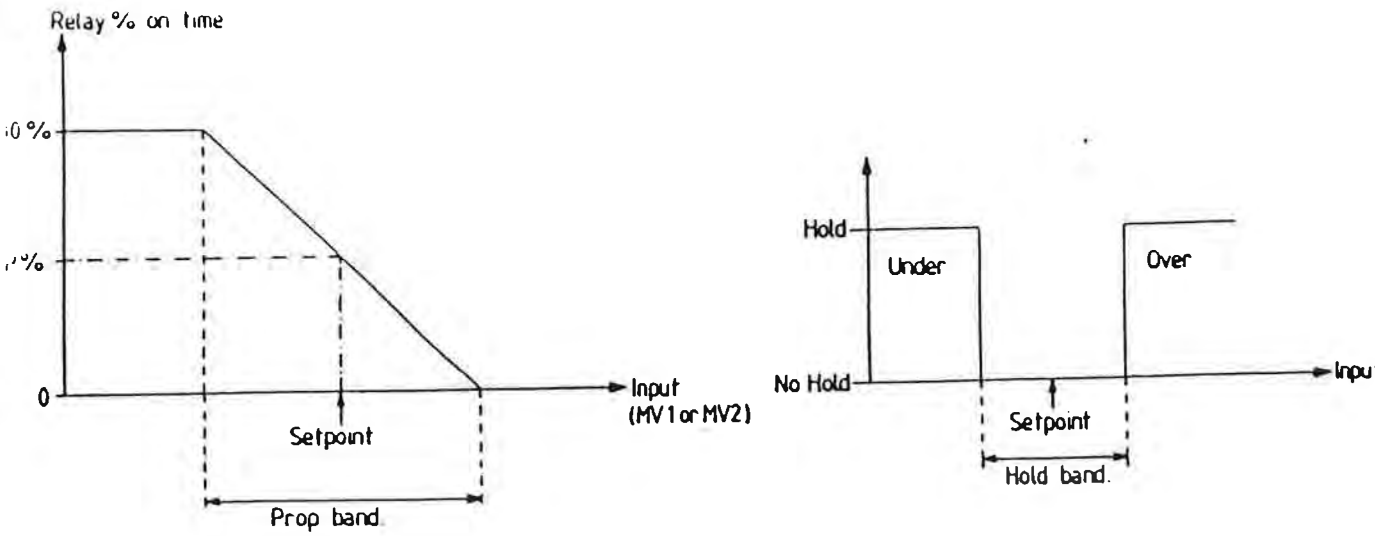


FIG. 4

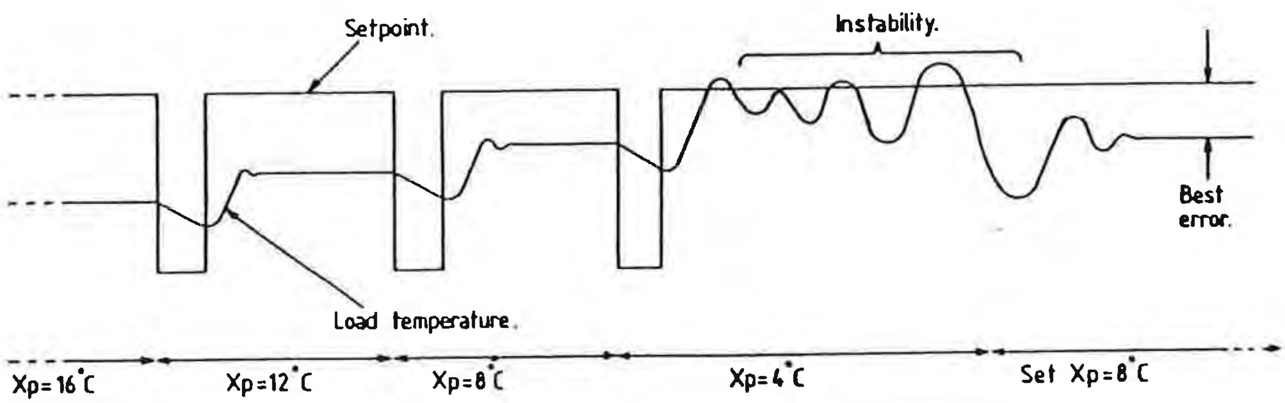


FIG. 5

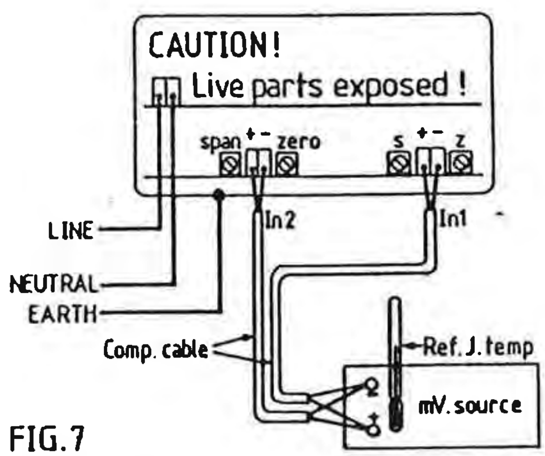
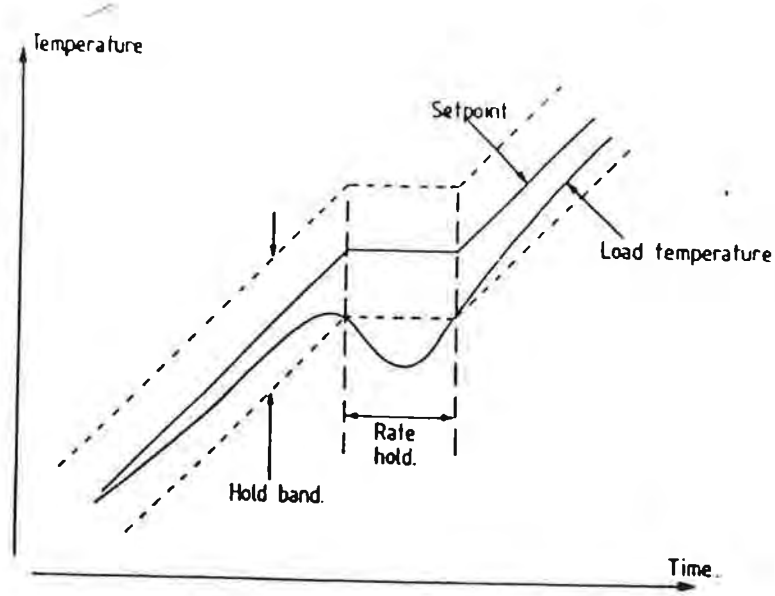
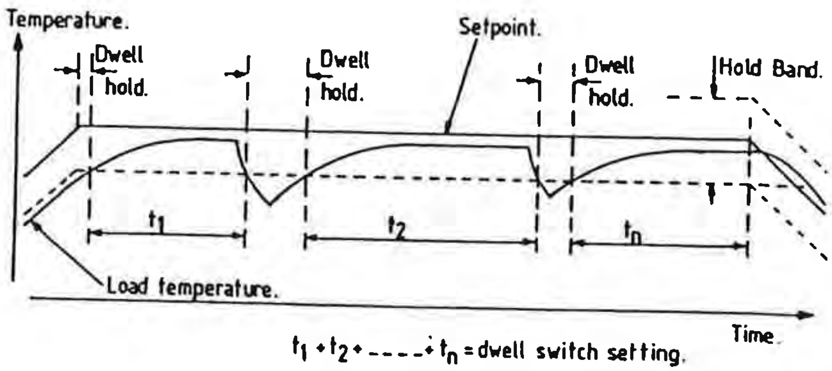


FIG. 7



RATE HOLD



DWELL HOLD

FIG.6

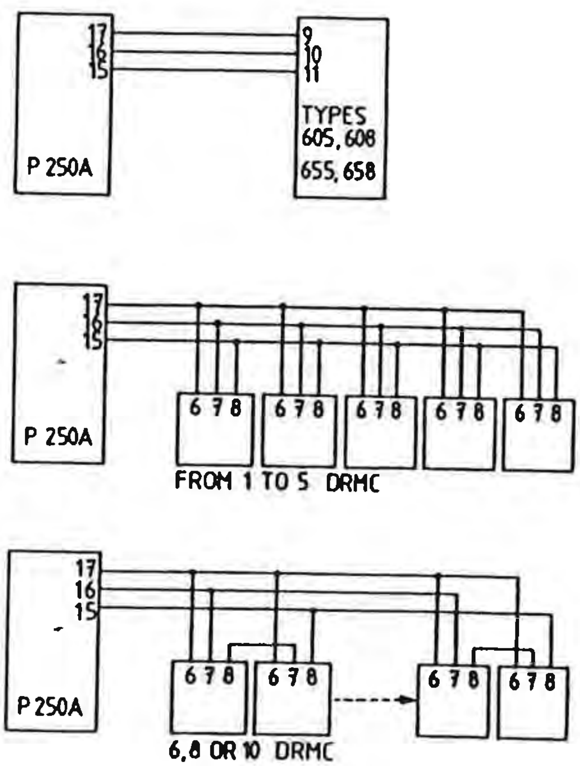


FIG.8

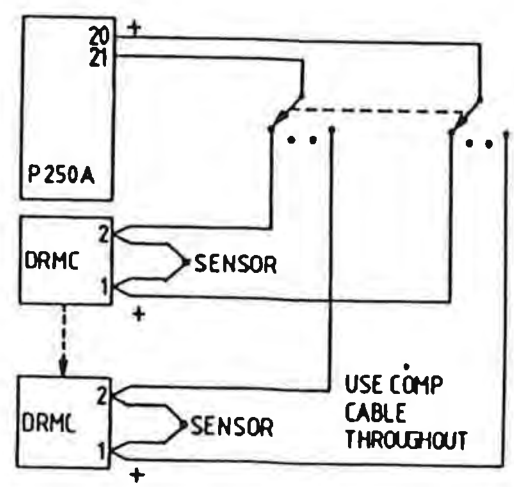


FIG.9

5.4 If at any time it is necessary to monitor the actual temperatures sensed at input 1 or input 2 this may be achieved by the use of the F button alone. Press the F button and hold it depressed, after a nominal 2 seconds the display status LED's will indicate input 2 and the display will show the actual temperature at input 2. This condition will persist for as long as the F button is held depressed. Release the F button and after a further 5 seconds the display status LED's will indicate input 1 and the display will show the actual temperature at input 2, this condition will persist for 5 seconds whereupon the display will return to showing setpoint, if however the F button is again depressed whilst input 1 is being shown then the display will continue to show input 1 for as long as the F button is held depressed. This facility in no way effects the running program.

5.5 If, during the execution of a program, the supply to the P250A is interrupted and then restored the P250A responds in a number of ways as follows:-

5.5.1 If the interruption occured during rate 1 then upon restoration of the supply the temperature at input 1 is measured and the setpoint is put equal to this temperature. The program will then continue in rate 1.

5.5.2 If the interruption occured during dwell then upon restoration of the supply the temperature at input 1 is measured and the setpoint is put equal to this temperature, if this is different from the level setting then the program reverts to rate 1 and the setpoint will change at rate 1 until the level is again attained, at which point the dwell time re-commences from zero.

If however, the temperature at input 1 is found to be still equal to the level setting then the program continues in dwell and executes the remainder of the unexpired dwell time.

5.5.3 If the interruption occured during rate 2 then, as above the program re-commences upon restoration with the setpoint equal to the temperature at input 1, the program will then continue in rate 2.

5.5.5 During the period that the supply is interrupted the program status is stored within the P250A in battery powered CMOS RAM. The battery takes a nominal 100 hours to charge fully. A fully charged battery will enable the RAM to store the program status for in excess of 1000 hours, it is unlikely that storage will be required for longer than a few tens of minutes, the battery attains sufficient charge for this after only two hours of powered operation.

5.6 If at any time during the program it is found necessary to modify the set program then this may be done as follows:-

5.6.1 Whilst rate 1 is being executed the setting of rate 1 may be changed, after which the setpoint will change at the newly set rate until the level is reached. Note: a setting of zero is equal to zero rate of change.

During rate 1 the level may be changed, if it is changed to a value equal to the setpoint then rate 1 will end and dwell will begin, if it is changed to a value less than the setpoint then rate 1 will reverse sign and reduce the setpoint at rate 1 until the newly set level is reached.

During rate 1 both dwell and rate 2 may be altered at will.

5.6.2 Whilst the dwell is being executed the level may be changed, at which point the dwell is terminated and the program state reverts back to rate 1. The setpoint will then change at rate 1 until the newly-set level is reached at which point the dwell time recommences from zero.

During the dwell both dwell and rate 2 may be altered.

5.6.3 During rate 2 the setting of rate 2 may be changed, after which rate 2 continues at the newly-set rate. Note: a setting of zero is equal to zero rate of change.

5.7 Each of the two built-in temperature controllers is fitted with upscale burnout as standard. In the event of an open circuit sensor the measured temperature will apparently increase slowly to a value greatly in excess of the span of the P250A. If this occurs during the execution of a program then the apparent steady increase at the P250A's input will reduce and eventually turn fully off the output, a hold condition will also be initiated if hold has been selected.

If a program is started with input 1 open circuit, and hence burned out, then rate 1 will commence from a setpoint of zero rather than the temperature of input 1.

Burnout takes a nominal sixty seconds between the sensor going open circuit and the measured temperature reaching the span of the P250A. 6.

Calibration Procedure

The following is written as a guide only to the general procedure to be employed when re-setting the instrument's calibration. The high quality components and circuitry used results in an instrument with good long term stability and so it is unlikely that adjustments will be required to the factory-set span and zero controls except after protracted periods of use. To ensure that the procedure is executed to an acceptable accuracy the equipment employed should be of a high standard and the reference junction must be maintained at a known contant temperature for the duration of the procedure.

CAUTION;- IT IS ESSENTIAL THAT THE METAL CASE OF THE P250A IS EARTHED WHENEVER THE SUPPLY IS CONNECTED - EVEN WHEN THE REAR PANEL IS REMOVED FOR CALIBRATION. LIVE PARTS ARE EXPOSED WHEN THE REAR PANEL IS REMOVED.

Remove the rear panel of the instrument to gain access to the internal preset span and zero potentiometers of the P250A's two built-in controllers.

Connect the P250A as shown in Fig 7, switch the supply on and wait five minutes for the instrument to "warm-up". Set the millivolt source to zero, use the P250A's F button to obtain a reading of Input 1, this should be the temperature of the reference junction plus or minus 1 Deg C. If an error is seen to exist then this may be corrected by slow and careful adjustment of Input 1 zero potentiometer. Repeat this part of the procedure for Input 2 and Input 2 zero potentiometer. Now set the millivolt source to the span of the P250A, this will depend upon the sensor type for which the P250A is calibrated and the reference junction temperature. Table 2 shows the span values for the various types of sensor for which the P250A is calibrated at a range of reference junction temperatures, values of span at reference junction temperatures other than those shown may be inter-polated by simple calculation. Use the P250A's F button to obtain a reading of Input 1, this should be 1600 Deg C plus or minus 4 Deg C for types S and R, 1000 Deg C plus or minus 3 Deg C for type J, 1200 Deg C plus or minus 3 Deg C for type K, 400 Deg C plus or minus 2 Deg C for type T and 1800 Deg C plus or minus 3 Deg C for type B. If an error is seen to exist then this may be corrected by slow and careful adjustment of Input 1 span potentiometer. Note that the controls are set back amongst other components and, although there is no danger of an electric shock from these components, it is advisable to use a completely insulated trimming tool to make any adjustments. Repeat this part of the procedure for input 2 and input 2 span potentiometer.

Re-check at zero to ensure that any adjustments made to the span controls have not changed the zero reading and the calibration procedure is complete. If span adjustments have significantly affected zero then the whole procedure should be repeated until both zero and span readings are correct.

7. Additional Controllers

The P250A has up to two built-in controllers, for those applications where further controllers are required the setpoint output and hold input is used.

The P250A's setpoint output is a pseudo-digital PWM signal available on terminal 15 (SPO-) and 16 (COM) and will generally only be suitable for controllers within the FGH range of products. See Fig 8.

7.1 The PWM signal from the P250A has a frequency of 42.67 Hz, it has a rectangular waveform whose mark-space ratio is proportional to the setpoint. The PWM signal has a maximum voltage of 10V and is constant current limited at 10mA.
It is available in two forms; linear, where the mark-space ratio is directly proportional to the setpoint temperature in Degrees C, or non-linear, where the mark-space ratio is directly proportional to the thermo-electric emf of a thermocouple (for which the P250A is calibrated) at the setpoint. The choice between linear and non-linear depends upon which controllers are to be used with the P250A.
Series 600 "Magii-Pak" instruments require a linear remote PWM setpoint signal. The P250A can only drive one Series 600 instrument.
Series DRMC instruments require a non-linear remote PWM setpoint signal. The P250A can drive up to five DRMC series instruments in parallel or up to ten DRMC in series/parallel.

7.2 The hold signals generated by S600 and DRMC series instruments may be connected to the P250A hold input terminal 17 (HOLD-) whereupon any hold condition generated by the remote controllers will be recognised by the P250A as if the hold conditions occured on input 1 or input 2.

7.3 If it is required to display the actual temperatures controlled by these additional controllers then input 2 may be used as a monitoring input by means of an additional 2-pole multi-way switch. See Fig 9. Note that input 2 should never be left open circuit if output 2 is operative or it will "burn-out" up-scale and may cause a hold condition, refer to sections 4.3 and 4.4 above.

8. **Spares & Service**

Service of Series P250A instruments is strictly "by return to FGH or their appointed Agents" except by prior arrangement with FGH.
Instruments returned for service should be securely packed, preferably in their original packing. Where possible, with fault or malfunction on Department. When ordering please quote:-

a) Instrument Type number
b) Instrument Serial Number
c) Component Type number or description.

Terminal	Function	Terminal	Function
1	SUPPLY LINE	13	OUTPUT 1 RELAY
2	SUPPLY NEUTRAL	14	OUTPUT 1 RELAY
3	2nd RATE RELAY	15	SETPOINT OUTPUT -
4	2nd RATE RELAY	16	COMMON +
5	DWELL RELAY	17	HOLD INPUT -
6	DWELL RELAY	18	REMOTE RESET
7	1st RATE RELAY	19	REMOTE START
8	1st RATE RELAY	20	+ INPUT 2
9	READY RELAY	21	– INPUT 2
10	READY RELAY	22	+ INPUT 1
11	OUTPUT 2 RELAY	23	– INPUT 1
12	OUTPUT 2 RELAY	STUD	EARTH

TABLE .1

TABLE 2

		SPAN in mV.			
Ref. J. Temp.		0°C	10°C	20°C	30°C
Type	S	16,77	16,72	16,66	16,60
	R	18,84	18,79	18,73	18,67
	J	57,94	57,44	56,92	56,41
	K	48,83	48,43	48,03	47,63
	T	20,87	20,48	20,08	19,67
	E	76,36	75,77	75,17	74,56
	B	13,58	13,58	13,58	13,58

The above figures will be found in greater detail in British Standards publication BS 4937 Parts 1 to 7

Operating Manual For

S502

Temperature Controller

/

Contents

1. Unpacking & Inspection

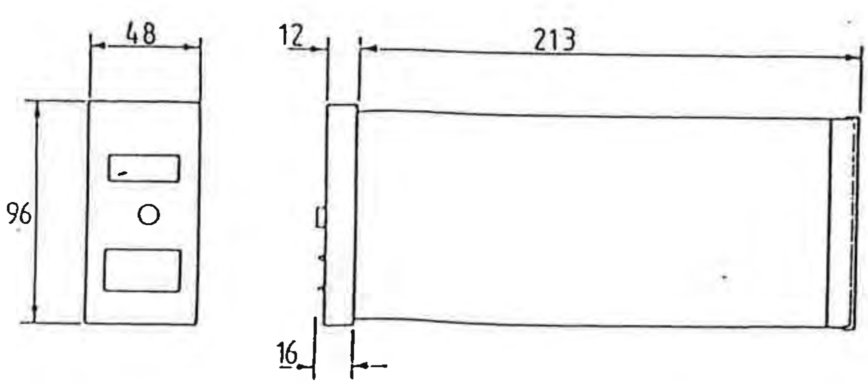
Carefully unpack the instrument and perform a visual inspection. If there any signs of damage, particularly if the packing is damaged, notify FGH Controls or your local distributor from whom the instrument was purchased immediately and retain the original package.
Note that Series 500 instruments are supplied with a pair of DIN panel fixing clips, be sure to remove these from the packing material.

2. Mechanical Installation

Series 500 instruments are intended for vertical panel mounting and are designed to fit the DIN standard cutout:-

Width 45 -0 +0.6mm
Height 92 -0 +0.8mm

The panel fixing clamps supplied are suitable for panel thickness up to 10mm(0.4 inches)
The approximate weight of the instrument is 0.55KG.



Since the Series 500 instrument incorporates an integral temperature sensor at its rear terminals to achieve its cold junction compensation, it is important that the instrument is mounted in a position such that it is not subject to rapid nor excessive changes in ambient temperature such as would occur due to draughts or radiant heating from adjacent hot surfaces. Rapid changes in ambient temperatures may result in errors in control.
The front panel controls of Series 500 instruments are not environmentally sealed and are proof against neither dust nor water contamination. In environments where these are likely to be a hazard, it is strongly recommended that the instruments front panel be protected.

3. Electrical Installation

3.1 General

The electrical connections are shown in Table 1 below.

TERMINAL	240VAC	110VAC SUPPLY
1	LINE	DO NOT USE
2	DO NOT USE	LINE
3	NEUTRAL	NEUTRAL
4	RELAY N/C	
5	RELAY COMMON	
6	RELAY N/O	
A	SENSOR +	
B	SENSOR −	
C	NOT USED	

TABLE 1 ELECTRICAL CONNECTIONS

The terminal blocks employed in the instrument are designed to suit cables from 0.5 to 1.5 square mm. When connecting cables to the instrument, it is neither desirable nor necessary to undo the terminal screws beyond approximately one and a half full turns since this opens the cable entry hole to its maximum. Any further unscrewing of these will only increase the possibility of the screws becoming free with the attendant danger of lost or cross threaded screws. The insulation stripping length is 7mm and the total cable insertion is 18mm.
Attempt as far as possible to segregate and to keep segregated the low voltage sensor cables from the high voltage supply and relay cables.

3.2 Power Connections

The instrument is suitable for use on either 100 to 130V AC or 200 to 260V AC 50 to 60HZ supplies by choice of the appropriate terminal number.
Ensure that the correct terminals are chosen since inadvertant connection of 240V to the 110V terminal will result in immediate permenant damage to the instrument.
It is recommended that the instrument's supply is fused externally using a 0.25A quick-blow fuse.
Power on indication is given by the lower of the two front panel LED's.

3

3.3 Thermocouple Input

The Series 500 instrument provides automatic cold junction compensation for all standard thermocouples, it is therefore essential that the compensation (extension) cable be of the correct type and that it be wired right up to the sensor terminals at the rear of the instrument.
The upscale or downscale burnout feature of the Series 500 results in a flow of current of approximately 0.2 Micro Amps through the thermocouple and its compensation cable. Where very long runs of compensation cable are used this current may lead to significant errors due to the resistance of the cable. To correct this error see section 6.

3.4 Relay Output

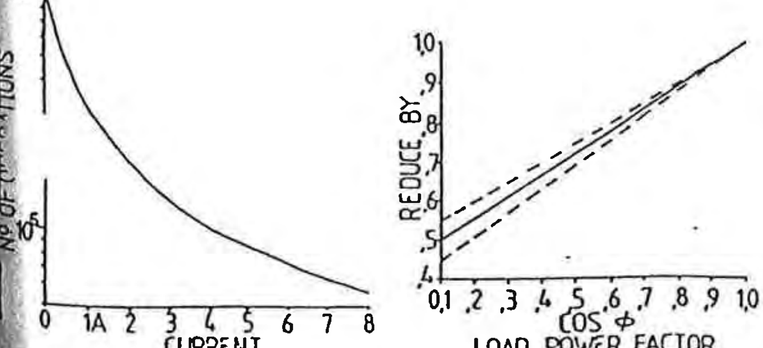
The series 500 is provided with a single set of voltage-free changeover contacts which provide the time-proportioning or on-off controlled output from the instrument.
When operating in a time-proprotioning mode (i.e. Xp greater than 0) the relay will switch on and off so as to proportion the ammount of power delivered to the load. The rate of switching is approximately 3 per minute. The expected life time of the relay contacts under this condition will depend upon the load rating.
In a similar way when operating in an on-off mode so as to control the temperature of a load, the relay will again switch o and off so as to hold the load temperature at the setpoint but the rate of switching will depend upon the thermal time-constant of the process. The expected lifetime of the relay contacts under this condition will depend upon the load rating and load time constant.
When the S500 is used as an alarm or trip instrument in its on-off (Xp = 0) mode, the contacts will operate infrequently but the contacts maximum ratings must be strictly observed.

The maximum ratings are:-

A) For AC circuits 50 to 60HZ
Maximum Continuous Current 8A RMS
Maximum Switching Voltage 250V RMS
Maximum Switching Power 2KVA

B) For DC circuits:-
Maximum Switching Power at 24V DC : 20W
Maximum Switching Power at 48V DC : 50W
Maximum Switching Power at 250V DC : 80W

All the above apply to resistive loads only. The expected life under load conditions are shown in FIG 2.

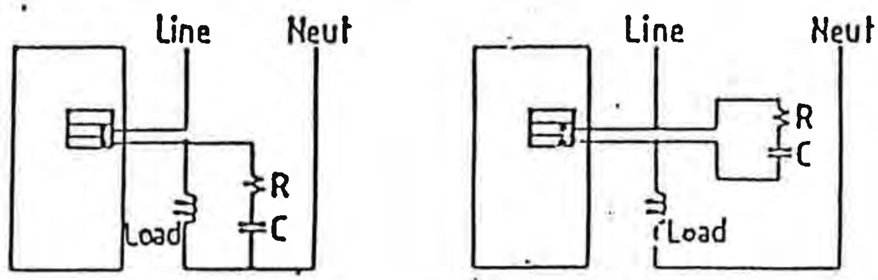


It should be noted that neither circuit protection nor arc-supression of these contacts is provided within the instrument. It is therefore recommended that where these maximum values could be exceeded due to faults in external circuitry then appropriate fuses should be installed.
If the load to be switched by these contacts is significantly inductive then very high transient voltages may occur across the load as the contacts break the current in the load. Such high voltages can lead to radio frequency interference being generated and will also cause excessive erosion of the relay contacts with a consequent reduction in relay life. It is therefore recommended that inductive loads be arc-supressed. See FIG 3 for general recommendations.
Note however that if arc-supression is fitted across the relay contacts then a small current will flow in the load via the supression network EVEN WHEN THE CONTACTS ARE OPEN.
The relay status is given by the upper of the two front panel LED's. LED on indicates relay on.

4. Calibration Procedure

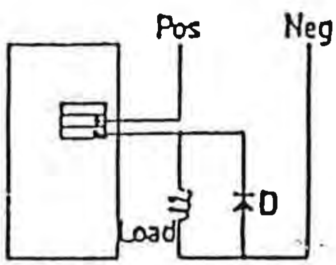
The following is written as a guide only to the general procedure to be employed when re-setting the instrument's calibration. The high quality components and circuitry used results in an instrument with good long term stability and so it is unlikely that adjustments will be required to the factory-set span and zero controls except after protracted periods of use.
To ensure that the procedure is executed to an acceptable accuracy the equipment employed should be of a high standard and the reference junction must be maintained at a known constant temperature for the duration of the procedure.
Refer to FIG 4 and connect the instrument up. Energise the instrument and allow about five minutes to "warm-up". Set the S500 Xp control fully anti-clockwise (on-off action). Set the S500 setpoint digital switches to the "zero" of the calibrated range. This is 200 Deg C for sensor types R or S and 0 Deg C for all other types. Now consult the appropriate part of BS4937 and set the millivolt source to the "zero" of the calibrated range. The setting of the source depends upon the reference junction temperature, if an ice point reference (0 Deg C) is used, then the figures can be read directly from BS4937, if an ambient temperature reference junction is used then the millivolt equivalent of Tamb must be subtracted from the millivolt equivalent of the required temperature setting.
Observe the state of the output relay and by slow and careful adjustment of the S500 zero control, set it such that the output relay just switches off. Repeat this zero adjustment a number of times to ensure that it is set as closely as possible, then verify this setting by making a small decrement to to the setting of the millivolt source, whereupon the relay should switch back on. This decrement should be of the order of the equivalent of 2 Deg C. Now consult BS4937 and set the millivolt source to the "span" of the calibrated range making due allowance for the reference junction temperature again. Set the setpoint digital switches to the "span" of the calibrated range of the S500, this is 1600 Deg C for types R or S, 1200 Deg C for type K, 999 Deg C for types J or E and 399 Deg C for type T. Observe the state of the output relay and adjust and verify the S500' span control in the same manner that the zero control was set.

Once the zero and span controls are set there are no other adjustments , intermediate setpoint values may be verified however using the above procedure to check the instruments calibration at points of particular interest to the user.



Use proprietry contact suppressor network obtainable from electronic component stockists. R typicaly 100. C, 0·1μF.

INDUCTIVE LOAD IN AC CIRCUIT



Diode, D, must be connected as shown ie, anode to load negative. Diode must have voltage rating greater than load DC voltage and current rating greater than load DC current.

INDUCTIVE LOAD IN DC CIRCUIT

FIG 3

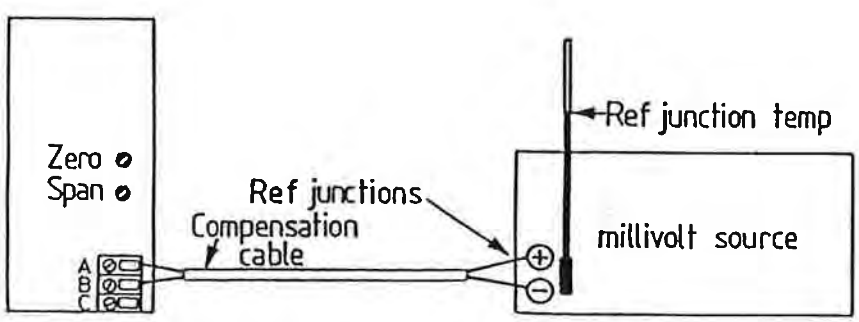


FIG 4 CALIBRATION

S502-P250A SYSTEM INSTRUCTION MANUAL
REFERENCE M18 ISSUE 2 April 4 1990

1. GENERAL

The S502 instrument is essentially an S500 instrument fitted with an additional printed circuit board that allows the S502 to control to either the local setpoint (front panel digital switches) or to a remote setpoint (derived from a P250A profile generator).

When controlling to the remote setpoint the S502 is able to provide a hold signal to the P250A whenever the measured value (controlled temperature) deviates from the remote setpoint by more than the holdband.

2. CONNECTIONS

The system mains supply, output relays, function relays and thermocouple connections are all made according to the connection instructions in the S500 and P250A instruction manuals. If the P250A has a supply output to power the S502 'local/remote' switches then this is brought out to pins 16 (+ve) and 18 (-ve), and there are no remote start or reset inputs.

The connections between the S502 and P250A are made to the additional 6 way connector at the rear of the S502; this is a two part connector and may be unplugged if required.

A typical S502-P250A system connection diagram is shown at FIG 1. Up to ten S502s may be controlled by a single P250A, as can be seen, all the S502s are wired in parallel.

All the inputs and outputs to the S502 are optically isolated and full galvanic isolation is maintained between each of the thermocouples in the system shown.

Attempt, as far as is possible, to keep the high-voltage relay wiring segregated from the remote setpoint and hold wiring to minimise the chance of electrical interference affecting the setpoint and hold.

3. HOLD

The P250A instruction manual explains the concept of holdband and details how to set the holdtype and holdband of the two controllers that are built into the P250A. When operating with S502s the holdtype and holdband of each S502 are set within the S502's themselves.

To change the holdtype and holdband the S502 has to be opened. Ensure that the unit is completely de-energised, withdraw the unit from the panel and remove the lid retaining screw from the side of the S502.

Remove the lid by sliding it open and rearwards and the remote setpoint and hold board PC1537 is revealed. When all the changes are done replace the lid and replace the retaining screw. Do not overtighten the screw or the plastic thread may be damaged.

4. HOLDTYPE

The holdtype is factory set to either above hold, below hold or both above and below holds. Refer to FIG 2 and either remove diodes by cutting or install diodes by soldering to achieve the required pattern of diodes. Note that the S502 cannot distinguish between ramp holds and dwell holds.

5. HOLDBAND

The holdband is factory set at maximum by means of the single turn potentiometer mounted on PC1537. The control is linear and may be user-set anywhere between the minimum of 22 degrees and the maximum of 50 degrees (C or F) either side of set point.

Note that it is unwise to set the holdband to less than the proportional band or the S502 may signal a hold to the P250A even though it is correctly controlling within it's proportional band.

6. LOCAL-REMOTE SELECTION

The local-remote selector switch requires an additional power supply, this can be any convenient DC or AC supply in the voltage range 10 to 20 volts, or from the P250A if ordered with this option. The input resistance is 2200 ohms, the current consumption is, therefore, approximately 5 milliamp per S502.

Note that when controlling to the local setpoint no hold signal can be generated by the S502.

7. SERVO START

Note the connection between zone1 thermocouple (master zone) and terminals 22,23 of the P250A. This allows the P250A to sense the temperature of zone1 for servo-start and must be made using the appropriate compensation (extension) cable. For a full explanation of servo-start see P250A instruction manual.

8. TEMPERATURE DISPLAY

If a digital display of the actual zone temperatures is required then an optional switch may be used to route the zone thermocouples to terminals 20,21 (channel 2) of the P250A. Each temperature may then be viewed by selecting channel 2 and switching the selector switch to each thermocouple in turn. Note that all the thermocouple wiring to this switch must be in the appropriate compensation (extension) cable. The switch should be two-pole, break before make and suitable for switching low level signals.

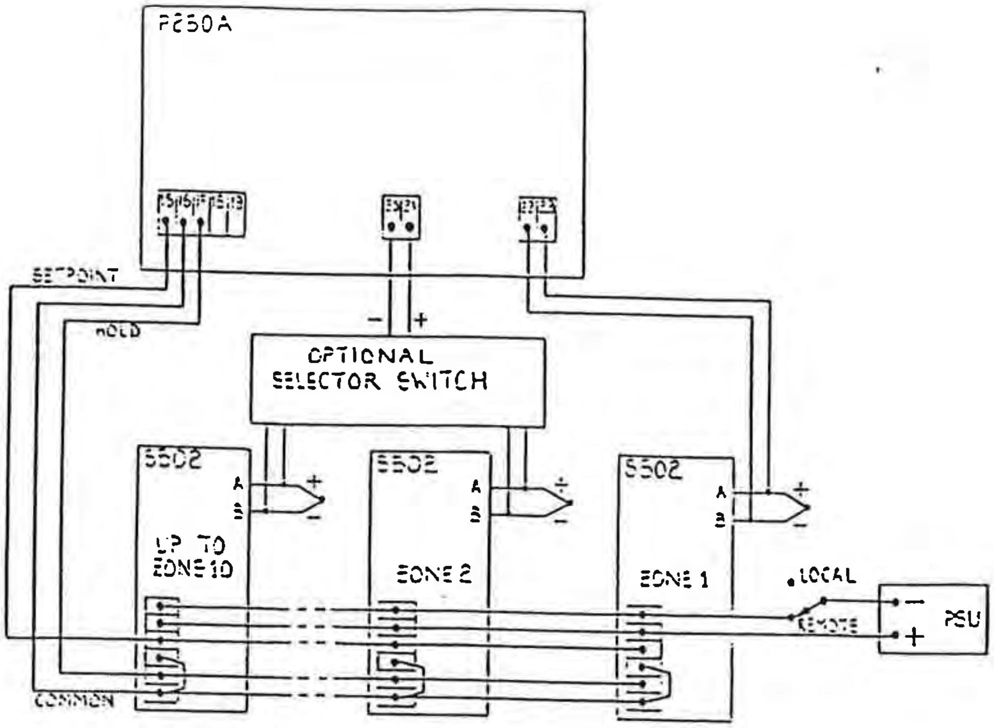
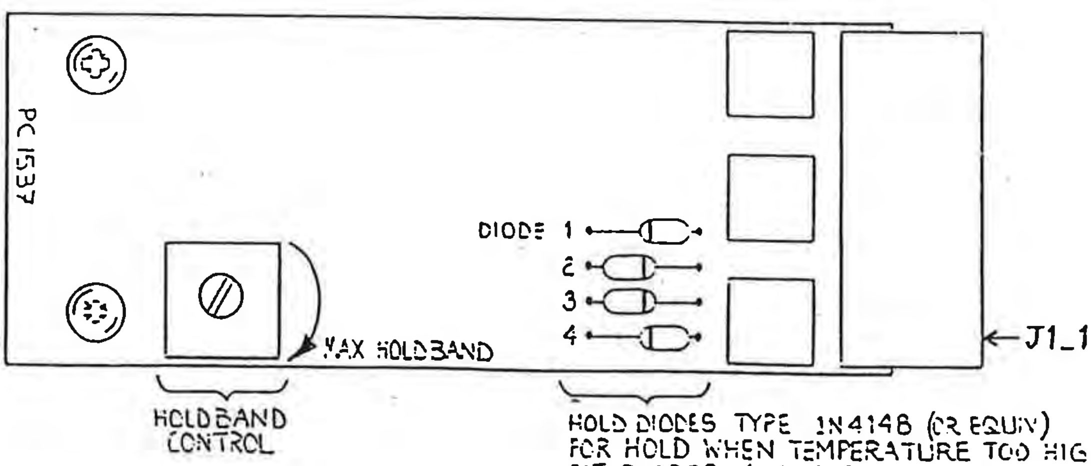


FIG 1



HOLD DIODES TYPE 1N4148 (OR EQUIV)
FOR HOLD WHEN TEMPERATURE TOO HIGH
FIT DIODES 1 AND 3

FOR HOLD WHEN TEMPERATURE TOO LOW
FIT DIODES 2 AND 4

FOR HOLD WHEN EITHER TOO HIGH OR LOW
FIT ALL FOUR DIODES

FIG 2

Table 2 has been prepared from BS4937 and shows the millivolt source settings for a range of reference junction temperature which may be interpolated by simple calculation.

5. Brief Circuit Description

The S500 incorporates a DAC (Digital to Analogue Converter) so as to convert the setpoint on the digital switch to an analogue voltage. The DAC comprises an oscillator IC (555), two counter IC's (4518) and a quad two input NAND gate IC (4093). These function together as follows:-
The 555 produces a continuous train of pulses at approximately 30KHZ (test point n), these are fed to the 4518's which are connected as a counter which can count from zero to 1999. When 1999 is reached, the next pulse sends the 4518's back to zero whereupon they begin counting again. The outputs from the 4518's are taken via diodes to the setpoint digital switch, these diodes form an AND gate which gives an output (test point r) when the number reached by the 4518's agrees with the setting of the digital switch. Test point r therefore is at logic 0 whilst the 4518's are counting between zero and the setpoint, it goes to logic 1 when the 4518's are at the setpoint and when the 4518's are counting between setpoint and 1999 test point r may be at either logic 0 or logic 1.
Test point r is taken via a 4093 gate to a bistable formed from the remaining three 4093 gate. The bistable is a conventional R.S. bistable except that one half of it utilises two gates operating in parallel. This bistable is reset by test point r pulse, it is set by a capacitor coupled pulse derived from the MSD of the 4518's (test point p). Test point p is actually an output from a 4028 decoder which is connected to the 4518's and by means of blob pads (2K-1K) permit the S500 to be used with a restricted setpoint range of zero to 1000 for types J and E thermocouples.
The bistable output (4093 Pin No.10) is therefore logic 0 whilst the 4518's are counting between zero and the setpoint and logic 1 whilst the 4518's are between the setpoint and 1999.
The 4093 is powered by its own 5.1V supply (reference voltage V REF). The 4093 output is taken via a resistor-capacitor network to AOT 1 resistor such that the voltage developed across AOT 1 (test point g) bears a linear relationship to the setting of the setpoint switch since the rectangular waveform voltage signal at the bistable output will have been smoothed out to an assentially steady DC voltage level. Thus when the setpoint is zero the voltage at test point g is zero, when the setpoint is 1999 the voltage at test point g is at its maximum, when the setpoint is 1000 then the voltage at test point g is exactly half of its maximum.
It is this voltage at test point g which is compared with the thermocouple voltage, thermocouple outputs are non-linear therefore test point g voltage should be rendered non-linear so as to conform to the non-linearities of the thermocouple type for which the S500 is calibrated. This is performed as follows:-
The 4028's decoder's outputs effectively break up the 4518's counting into ten equal divisions each corresponding to 200 pulses at test point n (100 pulses for types J, E and T).
During eachof these divisions a seperate resistor (AOT 4 to AOT 13) may be connected to the 555's CR network so as to modify the frequency at which it oscillates. In this way the 4518's are caused to count at up to ten different rates as they count from

zero to 1999. Since the linearity of the voltage at test point g is dependant upon the constancy of the frequency at test point n, then by varing test point n's frequency test point g voltage is rendered non-linear. The non-linearity is dictated by resistors AOT 4 to AOT 13.

ZERO mV					
REF J	TEMP	0	20	25	30°C
TYPE	S	1,44	1,33	1,30	1,27
	R	1,47	1,36	1,33	1,30
	J	0	-1,02	-1,28	-1,54
	K	0	-0,80	-1,00	-1,20
	T	0	-0,79	-0,99	-1,20
	E	0	-1,19	-1,50	-1,80

SPAN mV					
TYPE	S	16,77	16,66	16,63	16,60
	R	18,84	18,73	18,70	18,67
	J	57,94	56,92	56,66	56,41
	K	48,83	48,03	47,83	47,63
	T	20,87	20,08	19,88	19,67
	E	76,36	75,17	74,86	74,56

TABLE 2

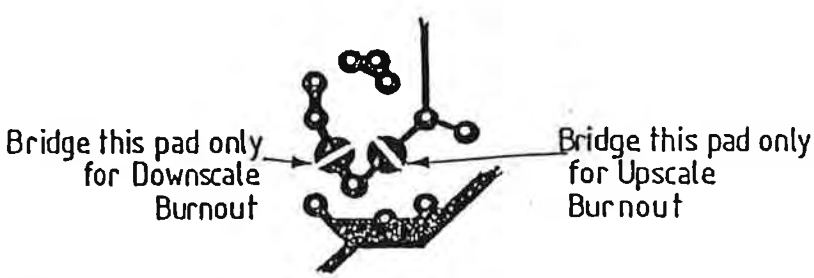


FIG 5 UP OR DOWN SCALE BURNOUT

To compare test point g voltage with the thermocouple requires that test point g be compensated for cold conjunction effects (CJC), this is performed by a transistor BC558 mounted physically close to the thermocouple input terminals. The base-emitter voltage of the BC558 changes at a known rate with temperature and may be set by the zero control. Once set therfore the BC558 introduces a voltage to test point g by means of AOT 2 such that the change in base-emitter voltage compensates for the thermocouple cold junction effect. The comparision is performed by connecting the thermocouple in series opposition with test point g, the resultant difference appearing at test point h. Test point h voltage is amplified by the 725 operational amplifier, it's output (test point m) is fed to the deviation meter and to the S500's output stage.
The output stage is best considered under two operating conditions.

(a) Xp = 0

The 351 operational amplifier functions with it's inverting input (Pin No.2) connected via a 3M3 resistor to zero volts, there is no negative feedback. Test point m voltage is fed to the non-inverting input ot the 351 and positive feedback via a 330K causes the 351 (Pin No.6) to switch cleanly between approximately -6V and +6V as test point m voltage excurses around zero volts by approximately 0.1V. The s500's output relay is therefore caused to switch for small deviations about zero error.

(b) Xp greater than 0

The inverting input of the 351 is now connected by the 3M3 resistor and the 22 microF capacitors so as to form a negative feedback loop. The 351 now has both a negative and a positive feedback loop, the negative having a time constant formed by the 3M3 and 22 microF's. This causes the 351 output to oscillate, switching cleanly between -6V and +6V. The mark-space ratio of oscillation depends upon the magnitude of the voltage at test point m such that when m is negative the 351 output spends most of its time at -6V, when m is positive most of its time is spent at +6V and when m is zero volts an equal time is spent at +6V and -6V. The S500's output relay therefore switches in a time-proportioning mode, output = 50% (nominal) at zero error.
The S500 derives its power from the mains transformer which is over-temoerature protected by means of a non-resettable thermal cut-out (OT) mounted between the transformer and the printed circuit board. The secondary of the transformer prvides via a bridge recifier both a +16V and a -16V (approximately) unregulated DC supply. The +16V powers the relay and the front panel LED's, it is then regulated at approximately +7.6V by a 8.2V zener and a BC548 transistor (test point j). The -16V is regulated at -8.2V by a 8.2V zener (test point l).
The common of the power supply is test point k to which all the above mentioned test point voltages are refered.
Upscale or downscale burn-out is achieved by passing a small (0.2mA approx) current either into or out of the 725 input circuitry. This small current is derived from a 10M resistor from either a small positive or negative voltage selected by the D or U blob pads (Fig 5).

6. Spares and Service

Service of Sreies 500 instruments is strictly by "return to FGH or their appointed Agents" except by prior arrangement with FGH. Instruments returned for service should be scurely packed, preferably in their original packing. Where possible, with the fault or malfunction indicated on the Advice Note. Spare components may be ordered from FGH Service Department. When ordering please quote :-

a) Instrument Type number
b) Instrument Serial number
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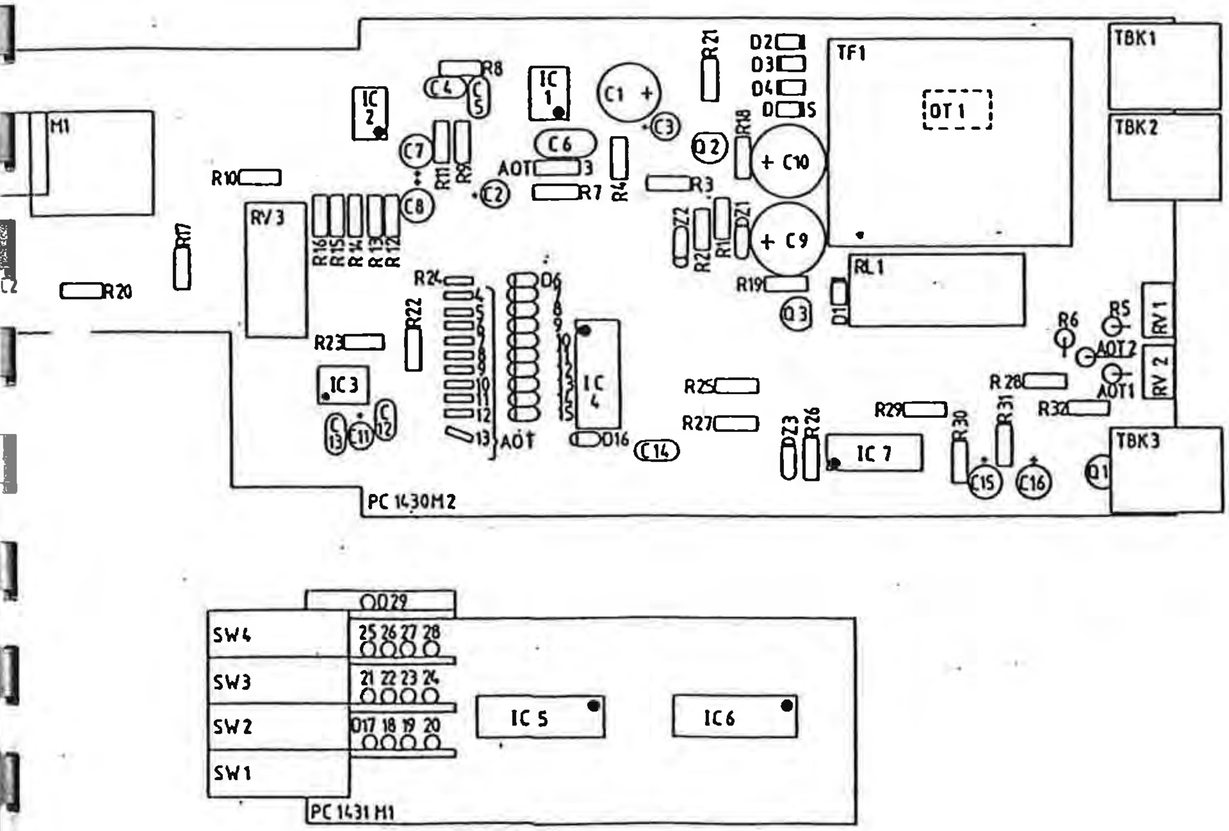

FIG 8 PCB ASSY

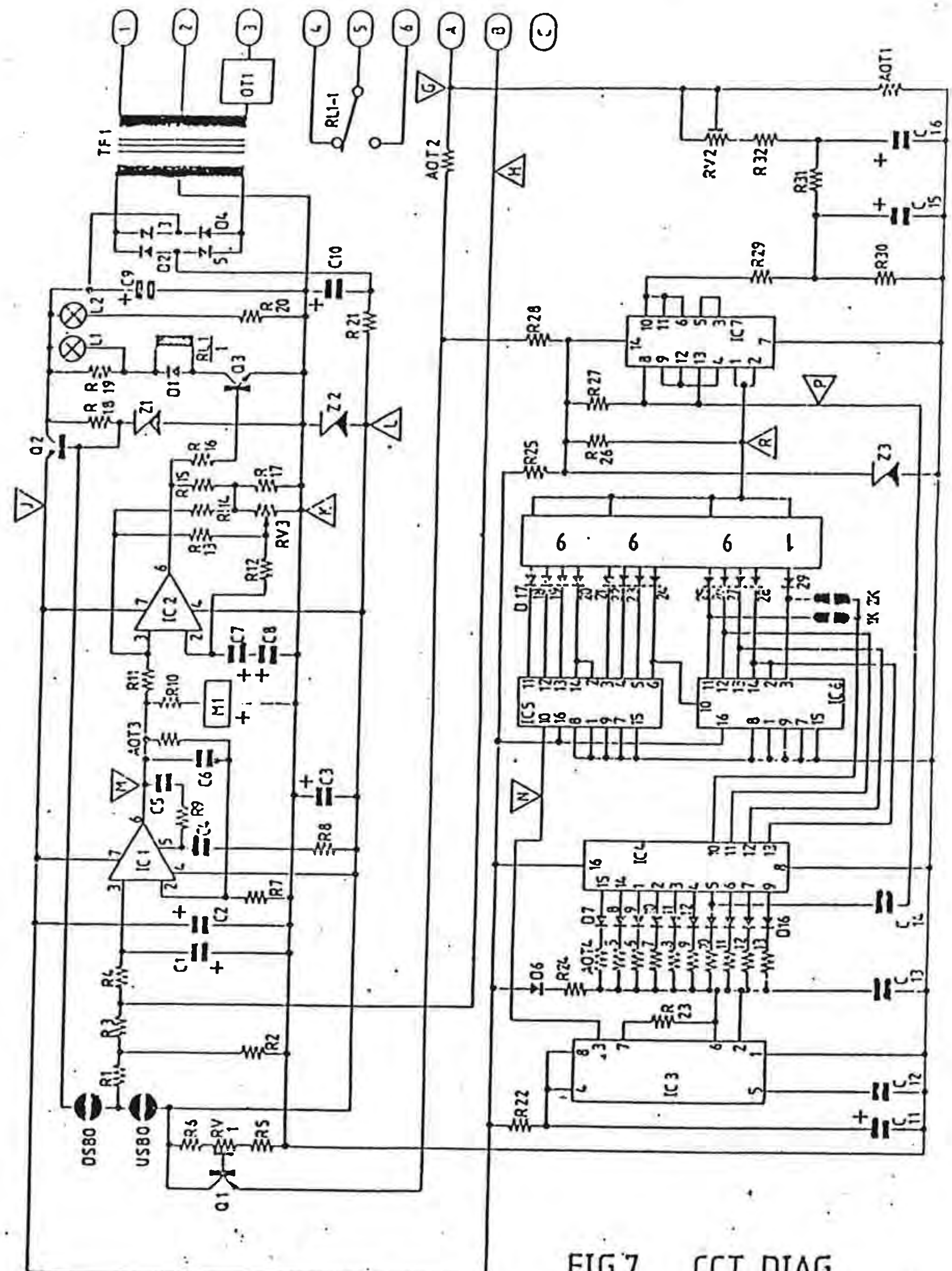

FIG 7   CCT DIAG

Global Heat

Wiring Schematics For

Heat Treatment Control Centre

Model No. P135-6

Global Heat

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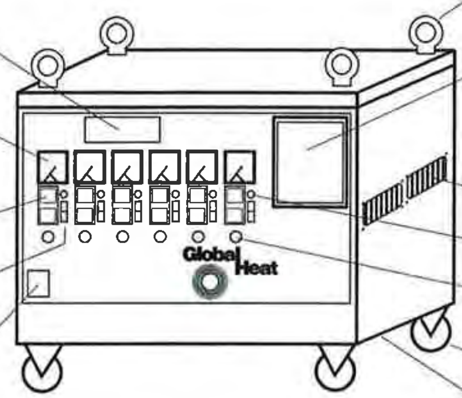
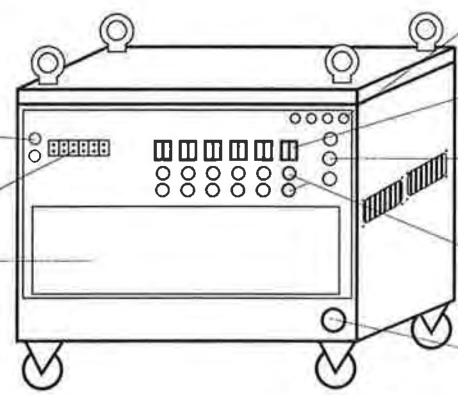
P135-6 SPECIFICATIONS

FRONT VIEW



REAR VIEW



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