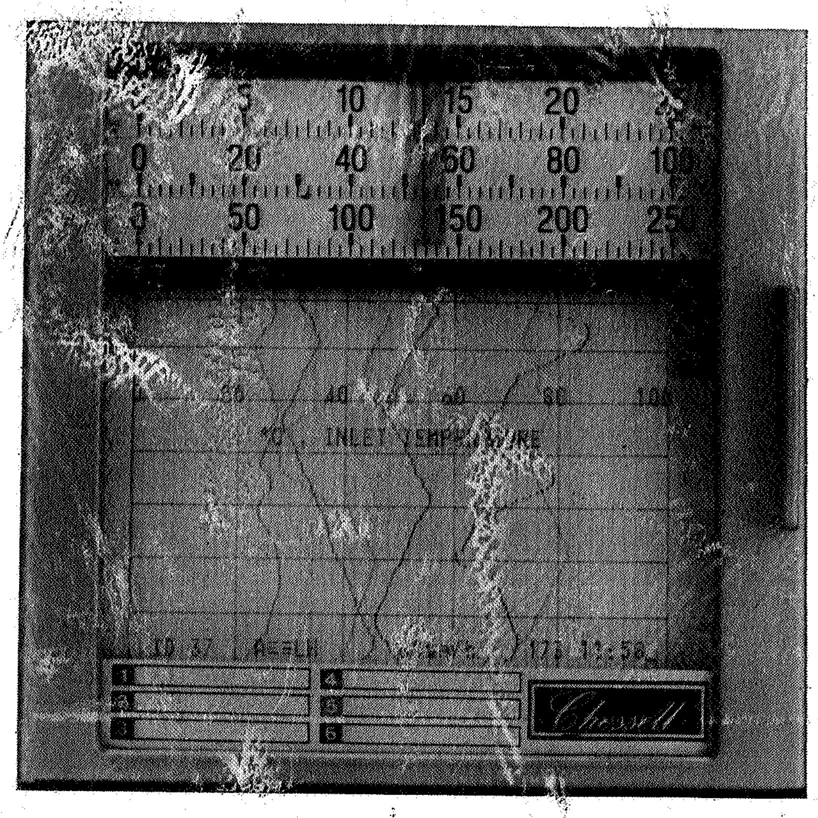
Chessell

306

Operation and Service Manual



6-channel annotating multipoint recorder

Operation and Service Manual
Addendum 306 versions B and C

Addendum 3 HA 232101 9/86

Change in Design of Fan-Fold Cassette

The current design of fan-fold (Z-fold) cassette differs substantially from the original design, described in this manual. The re-design has necessitated a minor change to the pen tray assembly. As a result, original design fan-fold cassettes can NOT be used with an un-modified* new pen tray.

When ordering spare parts for the recorder, the following new part numbers should be used:

BD238249	Chart guide moulding.
LA238265	Fan-fold cassette assembly.
LA238777	Pen tray assembly.

NOTE... This modification does not affect the operation of roll cassettes.

*Contact supplier for further information.

Operation and Service Manual Addendum 306 versions B and C

Addendum 2 HA 232101 4/86

Alternative Microprocessors

306B

With the 306B version it is possible to use two combinations of microprocessor (ICl), and PIA (IC6) on control board AH233257 U200.

One possible combination is a 6803 microprocessor with a 6821 PIA. For this combination, Link 2 on the control board should be fitted.

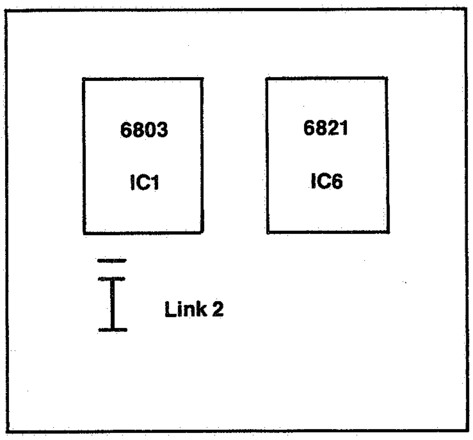
The other possible combination is to have a 63A03 microprocessor with a 68A21 PIA. In this case, Link 1 on the control board should be fitted.

It is not recommended to mix the above pairings.

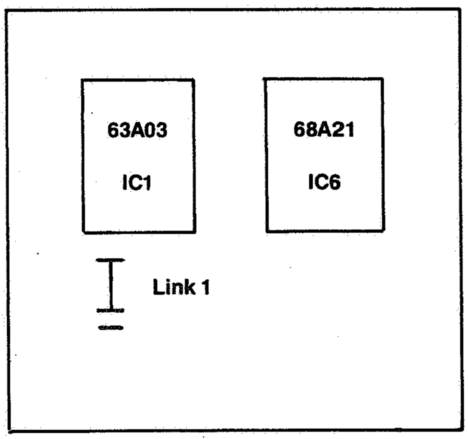
306C

Please note that the only combination which can be used on the C version is that of a 6303 microprocessor with a 6321 PIA. With this combination, Link 1 should be fitted.

306B

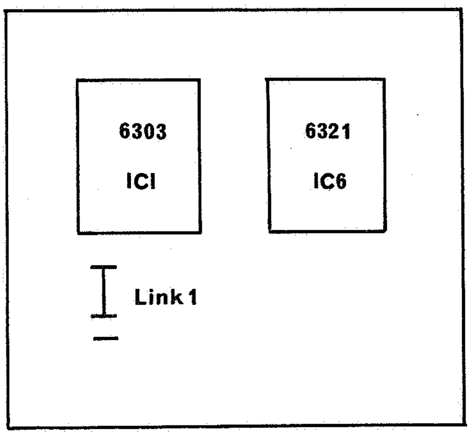


Combination A



Combination B

306C



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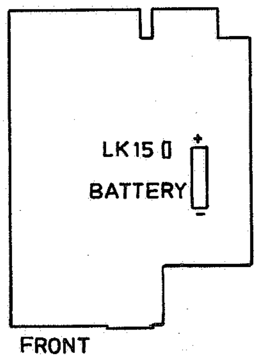
Addendum 1 HA232101 10/82

BATTERY



This instrument is fitted with a battery to save certain information during power failure. When supplied the battery is disconected.

Before putting the instrument into operation reconnect the battery as fol- lows:

Remove the cassette and using a screwdriver turn the unlocking screw in the centre of the control panel to release the instrument from the case.

Carefully pull the instrument out of the case.

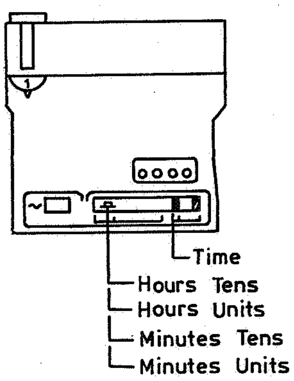
Turn the instrument onto its back on a clean flat surface to gain access to the control board.

Identify link LK15 from the diagram

Reconnect the battery by moving link LK15 into the position shown.

Note: When replacing the battery ensure correct polarity. Corrupt data in the battery supported memory causes a line to be drawn at the edge of the chart.

TIME SETTING



Apply power to the instrument and allow it to enter the 'RUN' mode.

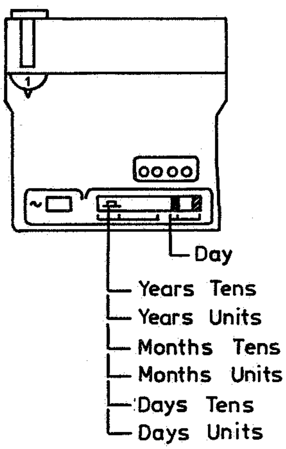
Remove the cassette and presss the 'ENTER' button until the 'TIME' LED is illuminated.

Rotate the thumbwheel switch to show the 'TENS' of hours digit and momentarily press the ENTER button . All LEDs will flash once to acknowledge correct data entry.

The HOURS UNITS followed by the MINUTES TENS and then MINUTES UNITS are similarly ENTERED to complete the time setting sequence.

All LED's will then flash for 15 seconds or until the 'ENTER' button is again depressed to select the RUN mode.

DATE SETTING



The DATE entry sequence is independant of the printout format.

Apply power to the instrument and allow it to enter the RUN mode

Remove the cassette and press the 'ENTER' button until the 'DAY' led is illuminated.

Rotate the thumbwheel switch to show the TENS of years digit and momentarily press the 'ENTER' button. All LEDs will flash once to acknowledge correct data entry.

The YEARS UNITS, MONTHS TENS, MONTHS UNITS, DAYS TENS then DAYS UNITS follow to complete the date setting sequence.

All LED's will then flash for 15 seconds or until the 'ENTER' button is again depressed to select the RUN mode.

TIME OR DATE SETTING ERRORS

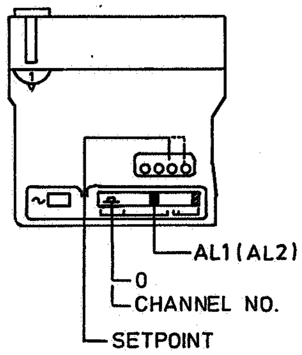
An attempt to enter an illegal time or date digit will result in all lights flashing for 5 seconds and the 306 returning to the time or date entry mode without accepting any of the entered digits.

ALARMS – TWELVE SETPOINTS

The twelve alarm setpoint option is selected by fitting Link 12 on the control board.

The twelve setpoint values are stored in battery backed memory installed on the control board.

ALARM SETTING – TWELVE SETPOINTS



Remove the chart cassette.

Press the 'ENTER' button until the AL1 (or AL2) LED is illuminated.

Turn the thumbwheel switch to '0' and press the 'ENTER' button momentarily to enter the setting routine. All LEDs will flash once to acknowledge entry.

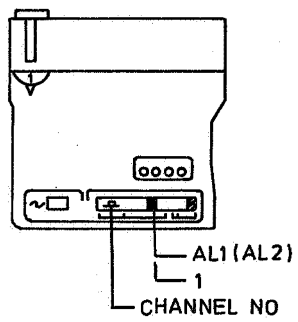
Select the required channel number on the thumbwheel switch and press the 'ENTER' button momentarily.
The pen will rotate to the channel selected and move to the position set on the AL1 (or AL2) potentiometer.

Use a small screwdriver to adjust the potentiometer AL1 (or AL2) until the required setpoint is obtained.

Press the 'ENTER' button to enter the new setpoint value into memory for that channel and return to the run mode.

Other setpoint values are entered by repeating the above procedure with the required alarm and setpoint selected.

ALARM REVIEW – TWELVE SETPOINTS



This facility allows individual setpoints to be checked without changing them.

Remove the chart cassette.

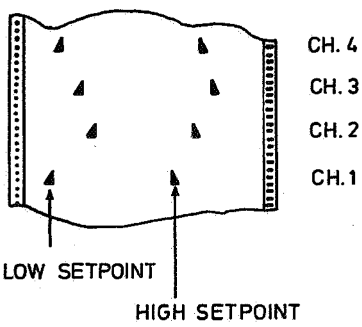
Press the 'ENTER' button until the AL1 (or AL2) LED is illuminated.

Turn the thumbwheel switch to '1' and press the 'ENTER' button momentarily to enter the review routine. All LEDs will flash once to acknowledge entry.

Select the required channel number on the thumbwheel switch and press the 'ENTER' button momentarily.

The pen will rotate to the channel selected and move to the position retained in memory for that channel setpoint.
All LED's will then flash for 15 seconds or until the 'ENTER' button is again depressed to select the RUN mode.

ALARM SETPONT PRINTOUT – TWELVE SETPOINTS



Twelve setpoints are shown by individual pairs of triangular alarm flags printed along the length of the chart in channel colours. Clear indication of setpoint sense, High or Low, is provided by the printed triangular flags.

A channel with ALARM SKIP selected will not print flags on the chart.

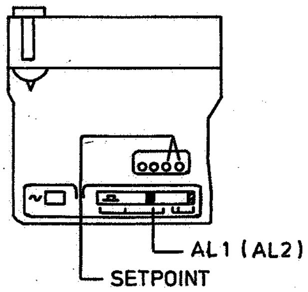
Corrupt data in the battery supported memory causes a line in the appropriate colour to be drawn at the edge of the chart.

ALARMS - TWO SETPOINTS

The two alarm setpoint option is selected by fitting Link 11 on the control board.

The two setpoint values are taken from the positions of the Alarm 1, (AL1), and Alarm 2, (AL2), potentiometers found behind the chart cassette.

ALARM SETTING - TWO SETPOINTS



Remove the chart cassette.

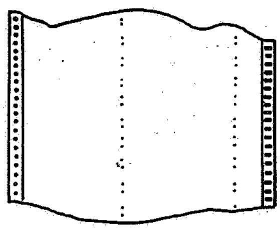
Press the 'ENTER' button until the AL1 (or AL2) LED is illuminated.

The pen will now move to the position set by the AL1 (or AL2) potentiometer.

Use a small screwdriver to adjust the AL1 (or AL2) potentiometer until the pen moves to the required alarm setpoint.

Press the 'ENTER' button to return to the run mode.

ALARM SETPONT PRINTOUT - TWO SETPOINTS



Two setpoints per instrument cause two lines to be dotted along the length of the chart showing the setpoints.

HIGH/LOW ALARM SELECTION

Alarm setpoints can be switch selected as either high or low alarms.

One switch on the control board configures all Alarm 1 (AL1) setpoints while a second switch configures all Alarm 2 (AL2) setpoints.

ALARM SKIP

Each channel may have the alarm function skipped for that channel by switch selection on the control board.

ALARM RELAYS - TWO

Two relays mounted on the power supply board. One assigned to Alarm 1 setpoint and one to Alarm 2 setpoint.

ALARM RELAYS - TWELVE

Twelve Relays contained in a DIN rail mounted
enclosure providing independant changeover contacts for each setpoint.

A DIN rail is fitted to the instrument rear terminal cover for mounting the relay unit although the module can be mounted up to 2metres away by using a module extension cable.

Relay Contact Ratings (MAX) Voltage 250V ac
Current 2A
Power 30 watts or 60VA

Connections
Screw clamp terminals to accomodate wire sizes 0.5mm to 1.5mm.

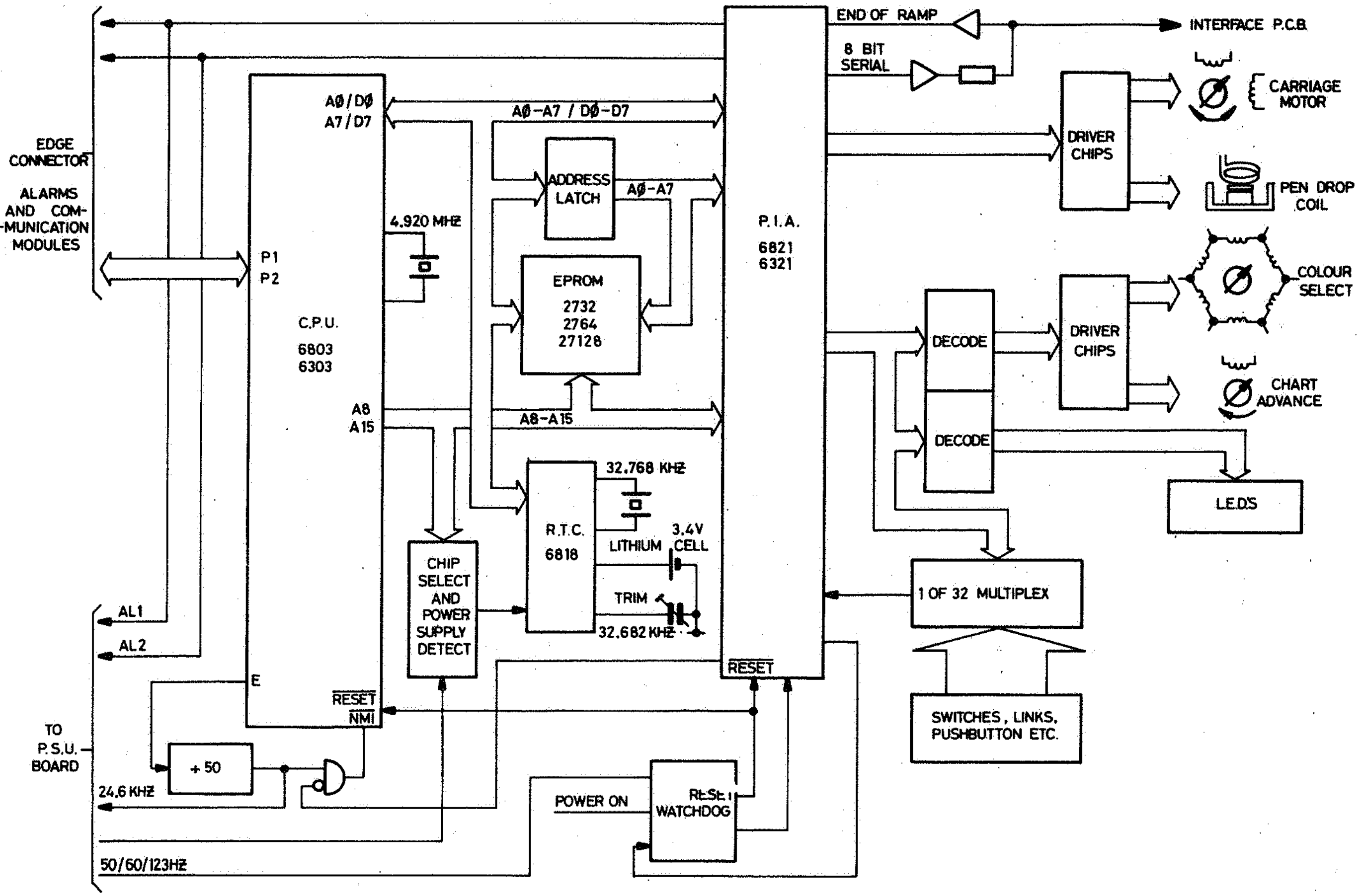
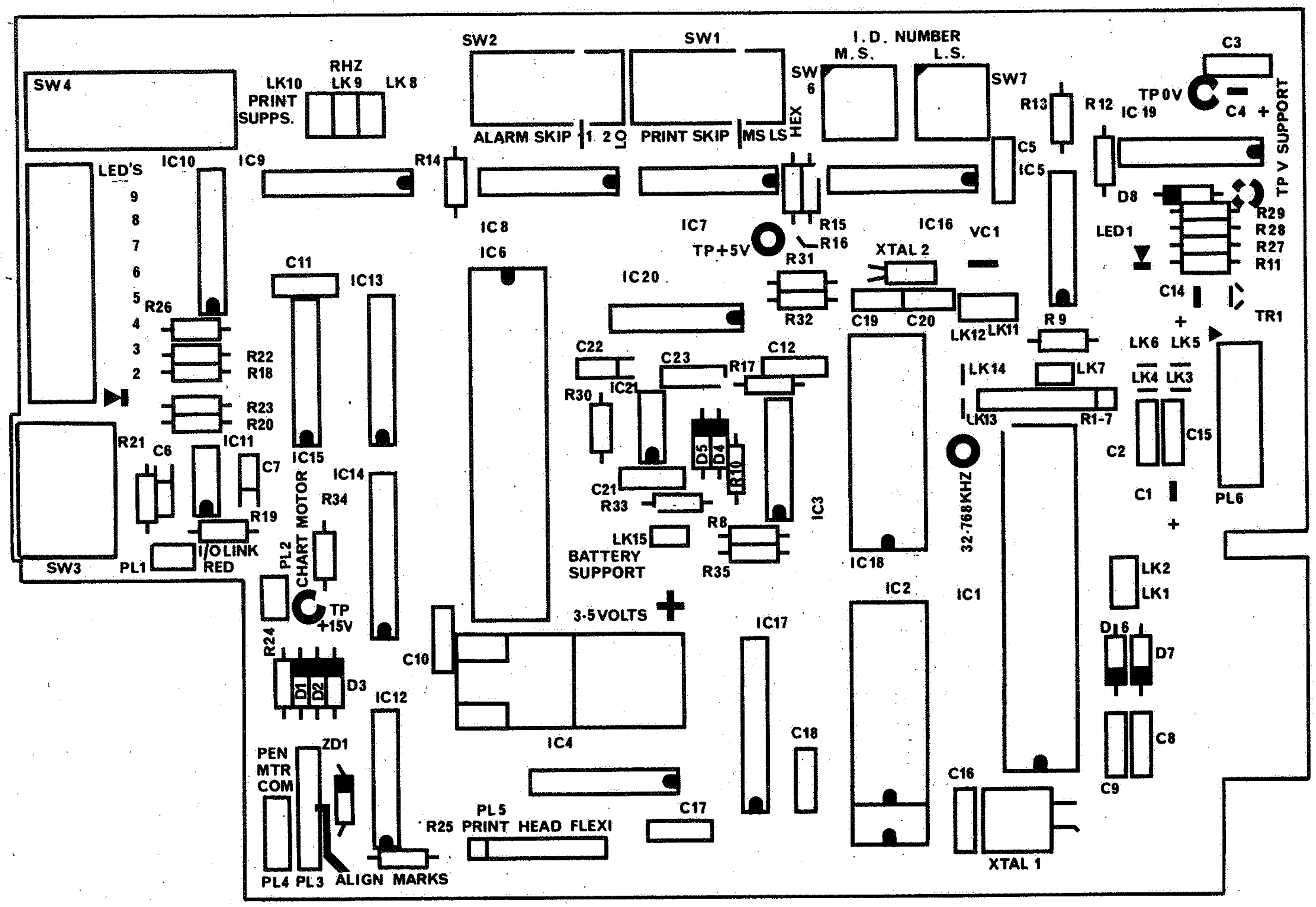


Figure 306 DETAILED BLOCK DIAGRAM

Figure CONTROL BOARD PCB COMPONENT LAYOUT
(Drawing No. AH233257, Issue 1)



LINKS

LK 1	Fitted with 6303 processor
LK 2	Fitted with 6803 processor
LK 3	Spare, not used
LK 4	Links AL1 output to AL1 relay driver
LK 5	Spare, not used
LK 6	Links AL2 output to AL2 relay driver
LK7	Watchdog enable, normally fitted
LK 8	Demonstration PROM enabled
LK 9	Right hand zero for all channels
LK 10	Suppresses overprinting when fitted
Lk 11	Two alarm setpoints or no setpoints
LK 12	Twelve alarm setpoints
LK 13	Fitted for 27128 EPROM
LK 14	Fitted for 2732 EPROM
LK 15	Battery connection link

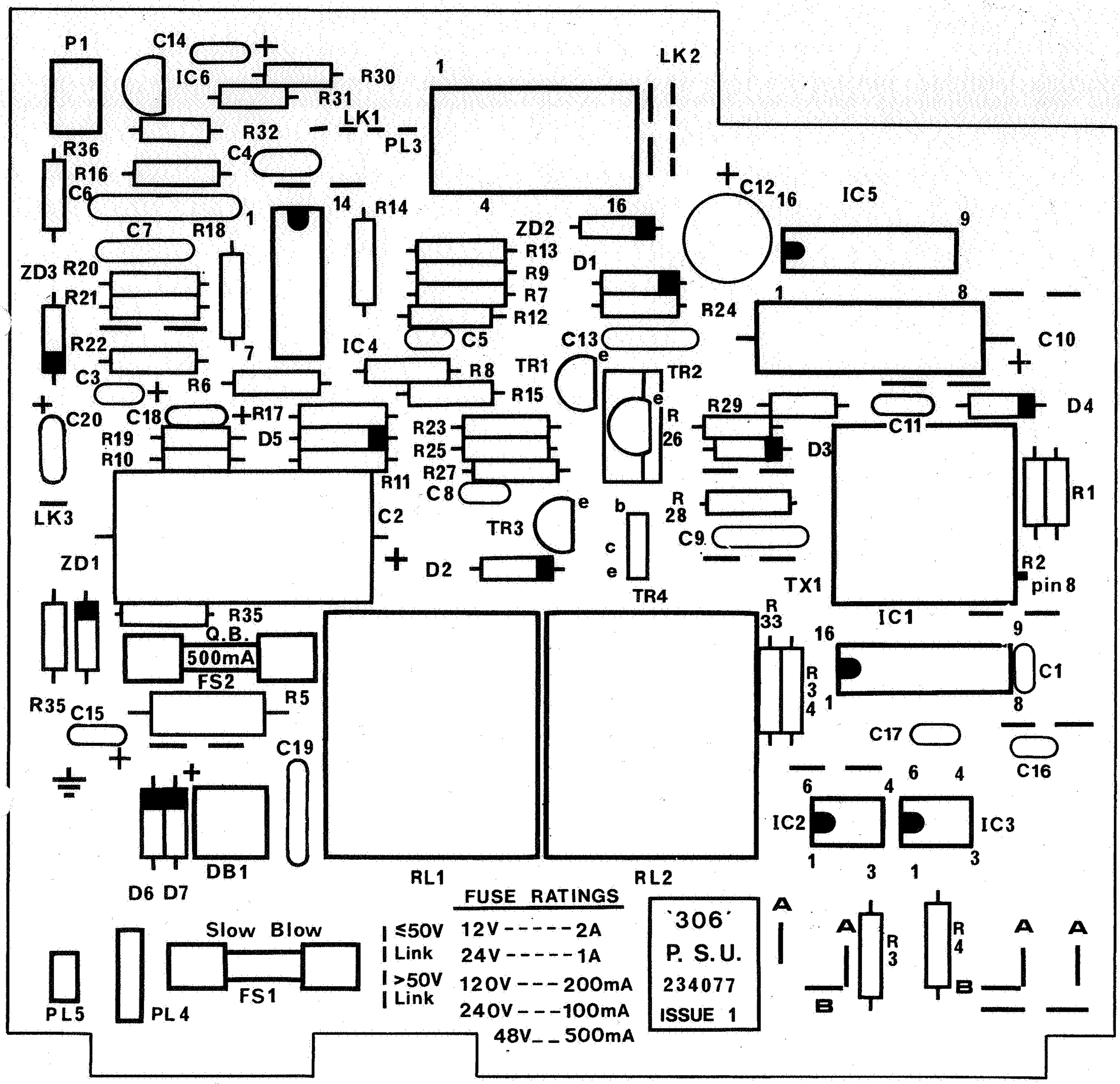


Figure PSU BOARD PCB COMPONENT LAYOUT
(Drawing. No. AH234077, Issue 1)

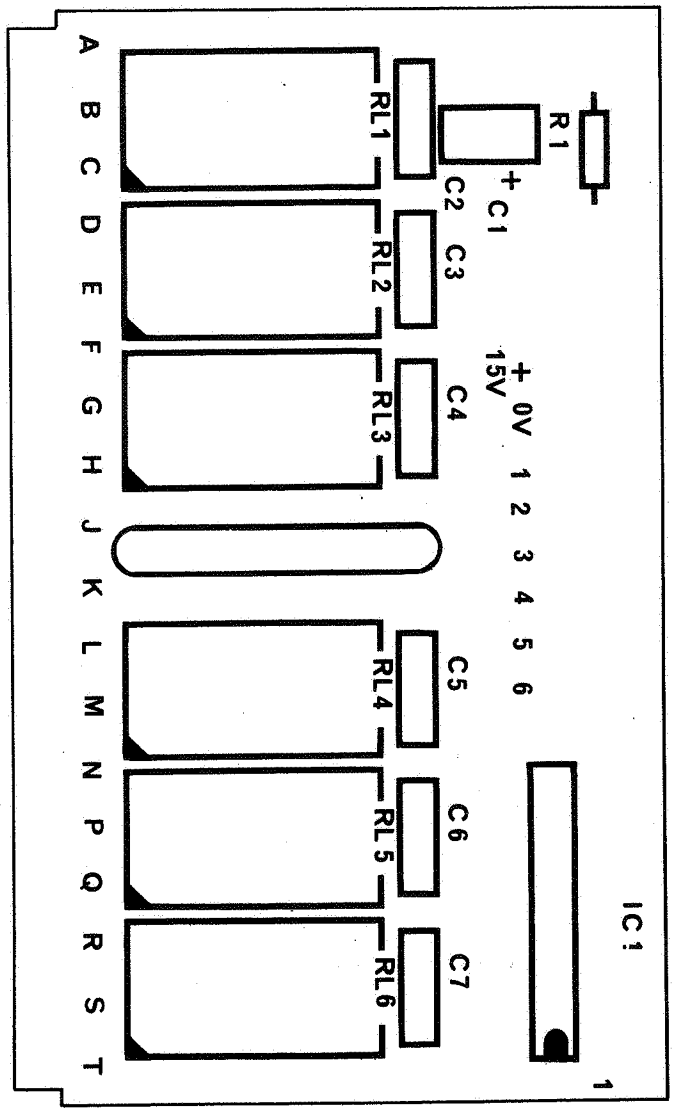


Figure ALARMS BOARD
PCB COMPONENT LAYOUT
(Drawing No. AH234211, Issue 1)

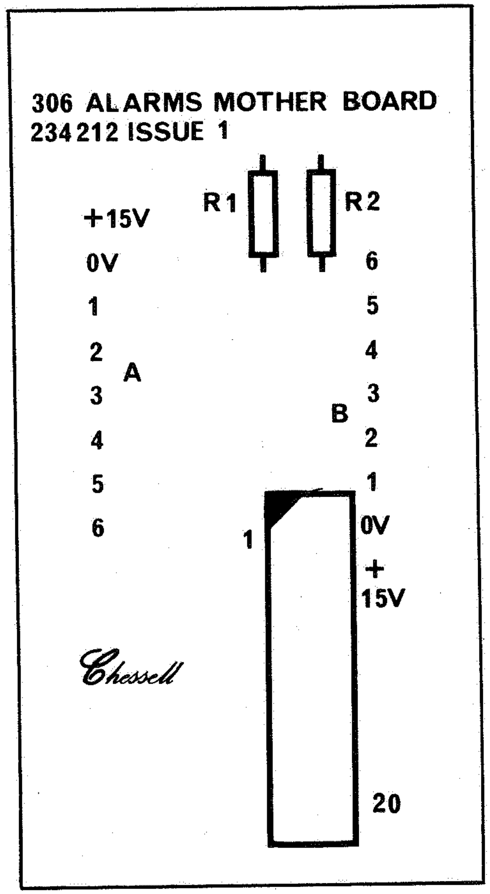


Figure ALARMS MOTHER BOARD
PCB COMPONENT LAYOUT
(Drawing No. AH234212, Issue 1)

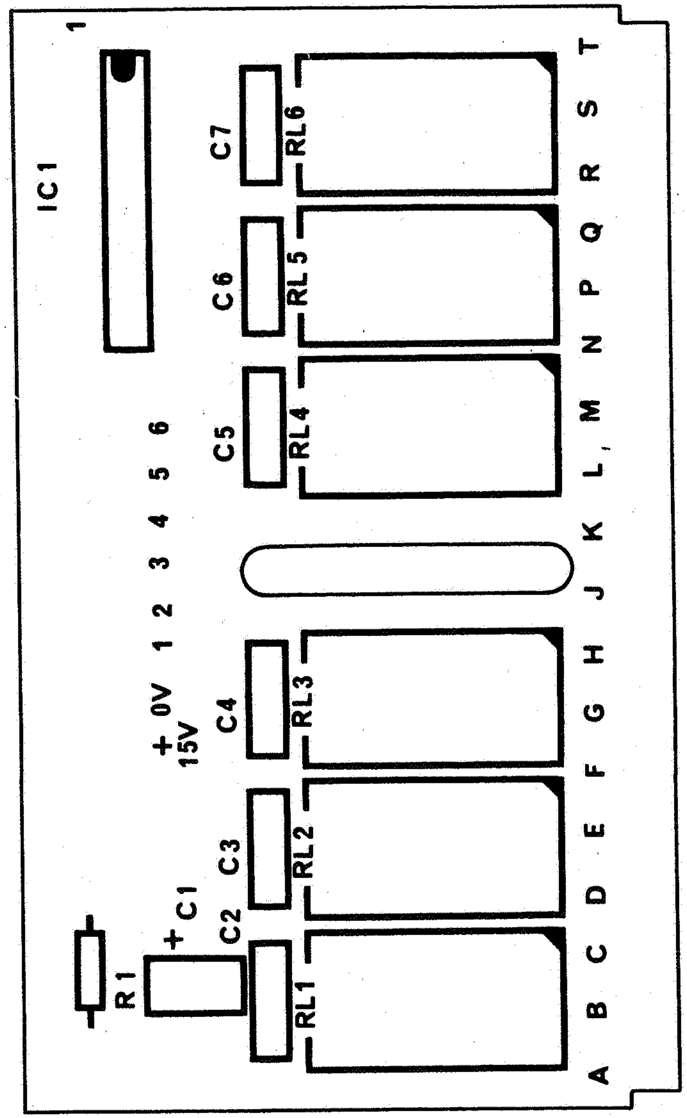


Figure ALARMS BOARD
PCB COMPONENT LAYOUT
(Drawing No. AH234211, Issue 1)

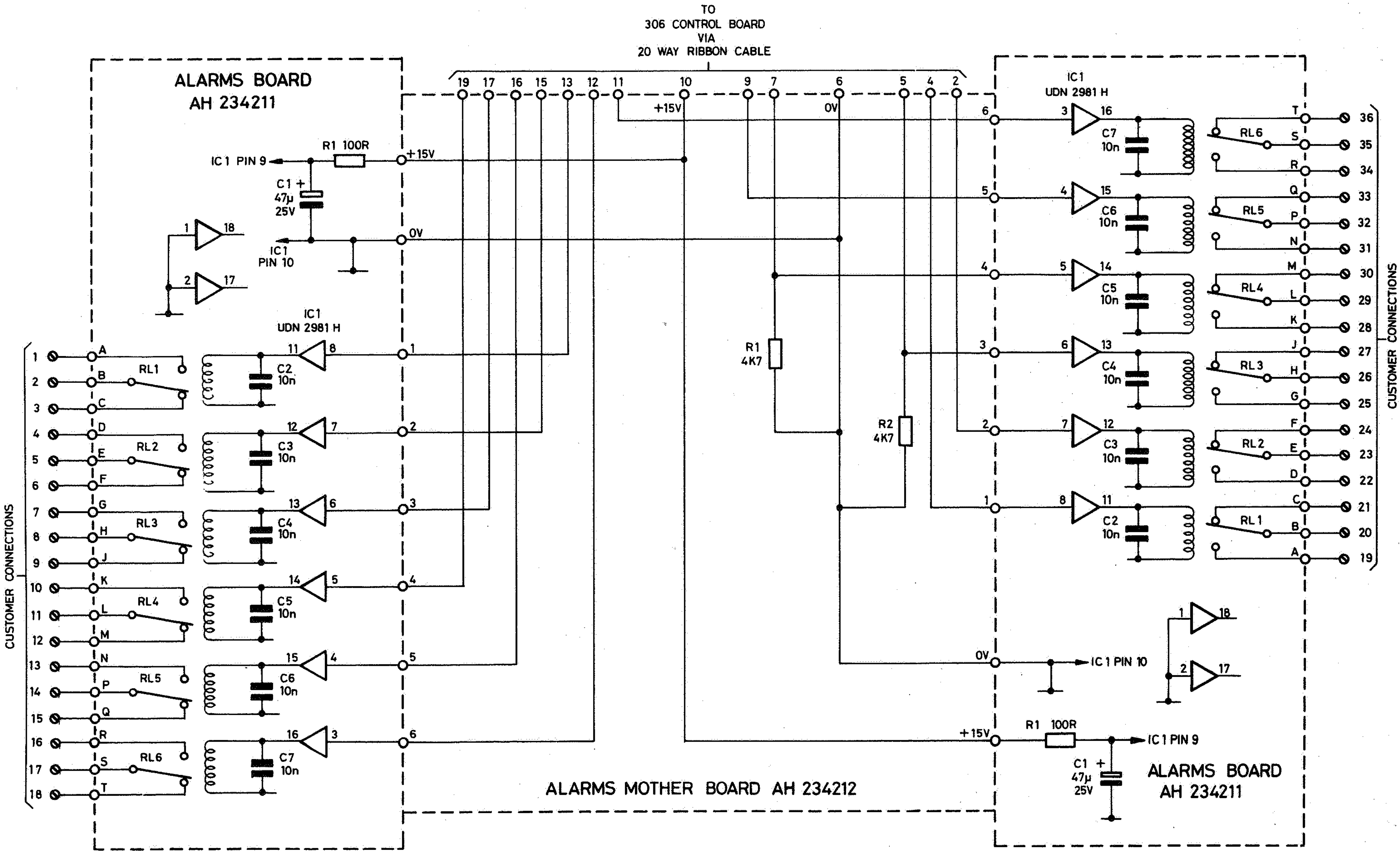


Figure ALARMS BOARD CIRCUIT DIAGRAM (Drawing No. AI 234 211, Issue 1)

Figure ALARMS MOTHER BOARD CIRCUIT DIAGRAM (Drawing No. AI 234 212, Issue 1)

Figure ALARMS BOARD CIRCUIT DIAGRAM (Drawing No. AI 234 211, Issue 1)

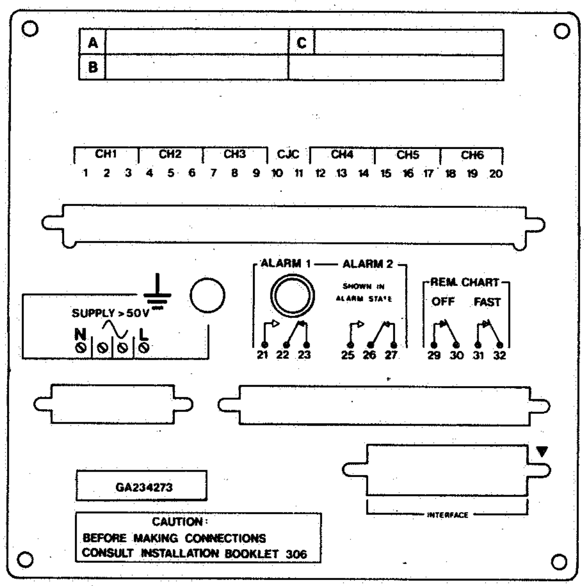


Figure REAR TERMINALS

INSTALLATION OPERATION & MAINTENANCE INSTRUCTIONS

MODEL 306

SIX CHANNEL ANNOTATING MULTI-POINT CHART RECORDER

CONTENTS LIST

ILLUSTRATIONS

1. GENERAL INFORMATION

1.1 Introduction

The model 306 is a 100mm multipoint recorder with six analogue recording channels and up to three independent input conditioners with matching scales. The model 306, in its advanced versions, is distinguished from the conventional multipoint recorder by many unique features such as automatic recording, in plain language, of scale data, descriptive text, instrument identification (ID) number, chart speed and time of day.

It is housed in a steel panel mounting case measuring 343mm (13.5ins) behind the panel, with cut-out dimensions 138mm (5.38ins) square. The short terminal cover version is 309mm (12.2ins) behind the panel. It has a splashproof door (with optional lock) and is designed for continuous use in industrial environments.

The model 306 has many internal features contributing to long, trouble-free operation; the unique dotting head mechanism, for example, eliminates practically all the mechanical complexities found in conventional multipoint designs.

All versions of the model 306 have the following features:-

* Choice of interchangeable roll or z-fold chart cassettes (one only supplied with each recorder). Chart length: roll 32m; z-fold 16m.

* Provision for one, two or three different plug-in input conditioners and related indicating scales. Wide choice of input signal conditioner types, available pre-characterised for most process signals: mV dc, V dc, mA dc, all thermocouples, all 3-wire RTD's. Scale zero can be left, right, centre or offset up to three times the span.

* Electronic linearisation available for thermocouples, RTD's, thermometers and flow transducers, allows the simultaneous presentation of up to three different non-linear functions on a single linear chart.

* Print skip facility, allowing the model 306 to record selected channels and omit others. With the alarms option installed, a channel is monitored for alarm conditions and these are recorded when they occur, even though it may be omitted from the print cycle.

* On-site reconfiguration of inputs and scales. Switches allow the user to reassign some of the input signals to different input conditioning cards.

* Six chart speeds: 120, 60, 30, 20, 10 and 5mm/h.

* Choice of options: pair of independent 0-100% alarms; internal crystal synchronisaion; remote chart control (speed-up and on/off); non-standard chart speeds; short terminal cover; glass or polycarbonate window and alternative instrument housings.

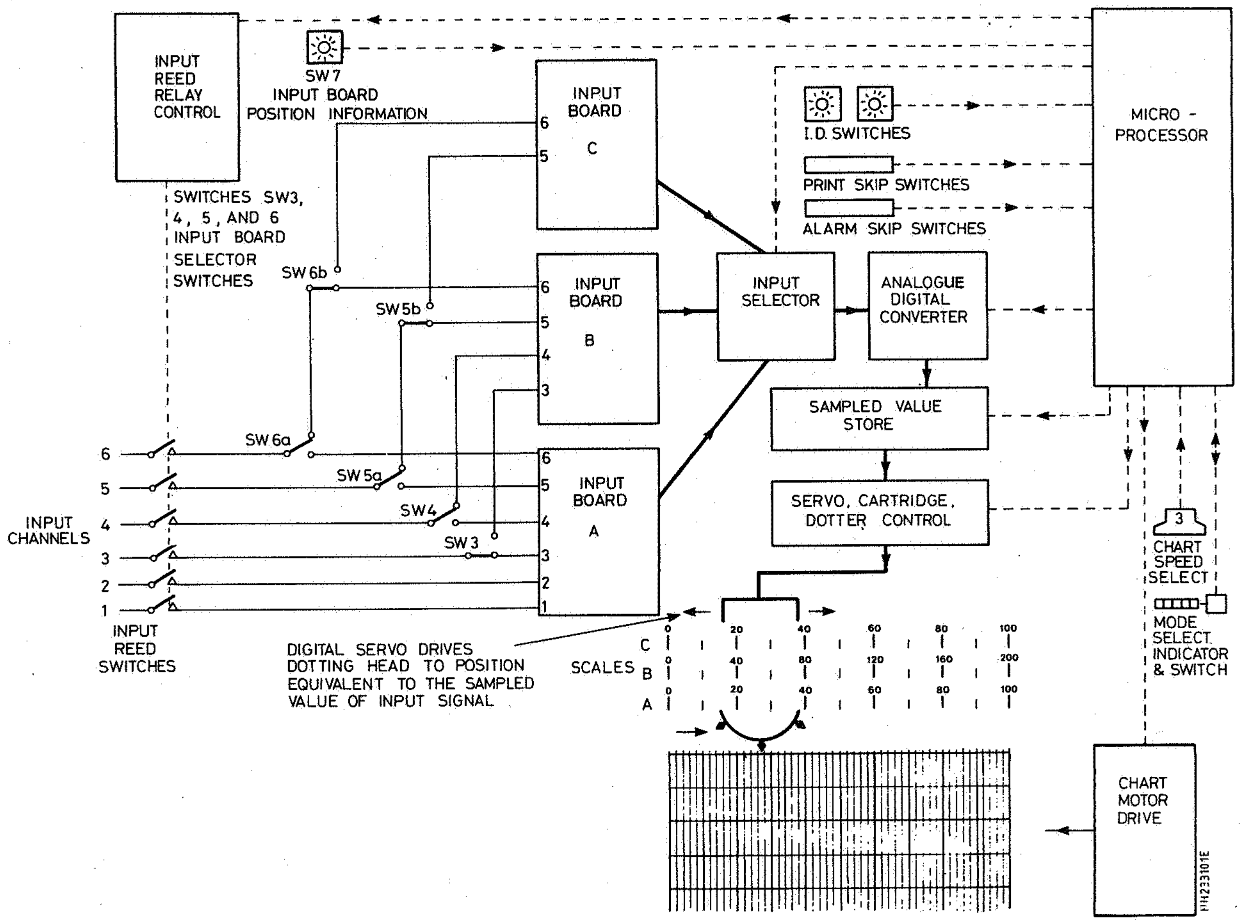


Figure 1.1 FUNCTIONAL ELEMENTS OF MODEL 306

The Model 306 recorder is available in three versions:-

Level 1

The basic six channel multipoint recorder, with all the features listed above, but no alphanumeric printing facility.

Level 2

As Level 1, with the additional capability of printing at regular intervals on the chart a line of status information including instrument ID number, alarms configuration, chart speed, day number and time of day. Time of day is taken from an AC supply synchronised clock, with a crystal control option.

Level 3

As Level 2, with the automatic printout feature extended to include scales, units of measure and descriptions of the variables to be recorded. This data, specific to the recorder's intended application, is stored in the Level 3 memory (PROM) during manufacture. The PROM is a plug-in item, and can be replaced if the model 306 is later used for a different application.

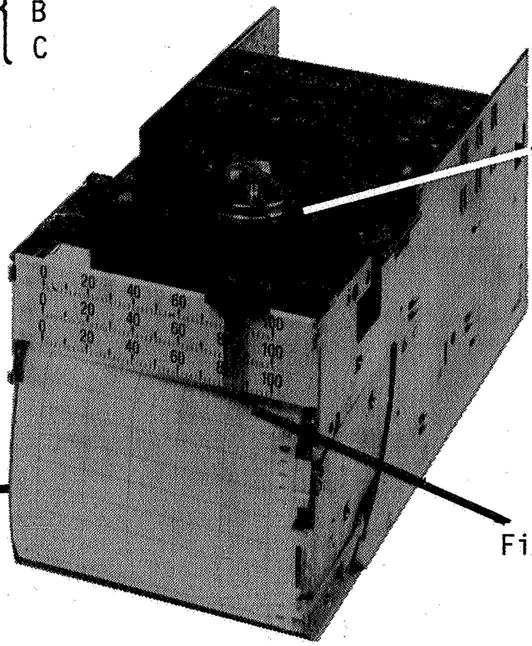


Figure 1.2 RECORDER REMOVED FROM CASE

1.2 Outline of Recording Method

In multipoint recorders, as compared with continuous writing instruments, a single servo is shared by a number of input channels. The inputs are addressed in turn by a sampling system, and for each sampled value the recording head is driven to a corresponding position along the horizontal scale. Each sample is recorded as a single dot, the colour of which identifies a particular input channel.

In the model 306 recorder all six inputs are sampled in a total of 5 seconds (i.e. a dwell time of approximately 800ms per point), and the sampled values are temporarily stored in digital form. At the end of the 5 second sampling cycle the stored values are transmitted to the servo in order of ascending magnitude, and the dotting head is electrically indexed to the appropriate channel colour as required. All six inputs are thus recorded in a single pass of the servo.

A recording pass is completed every 0.5mm of chart movement, i.e. at 15 second intervals with a chart speed of 120mm/h, increasing to 6 minutes at 5mm/h. Regardless of chart speed, however, the input sampling cycle is 15 seconds; so although the time between recordings may be as long as 6 minutes, the inputs are tested for alarm conditions at 15 second intervals.

Depending on the number of different variables to be recorded, the model 306 can be equipped with one, two or three independent input conditioning boards (i.e. range boards) each calibrated at the factory for a particular span and zero offset. The conditioning boards can be assigned to the six input channels in all possible combinations, for example; all six channels to a single board, or five channels to one board and one to a second, and so on.

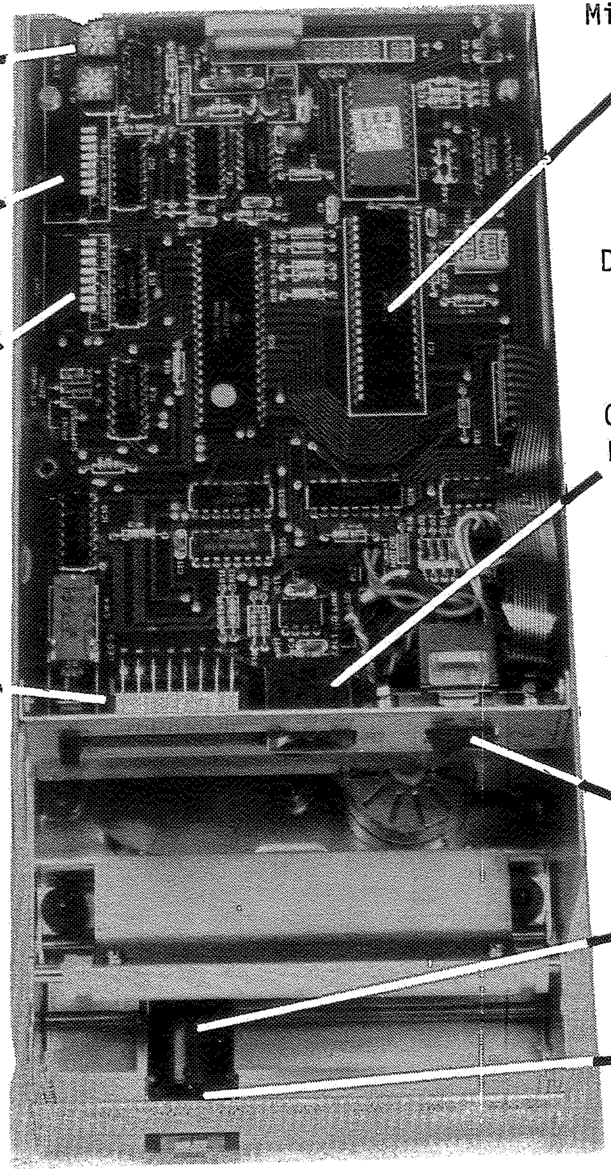


Figure 1.3 306 - BOTTOM VIEW, SHOWING CONTROL BOARD

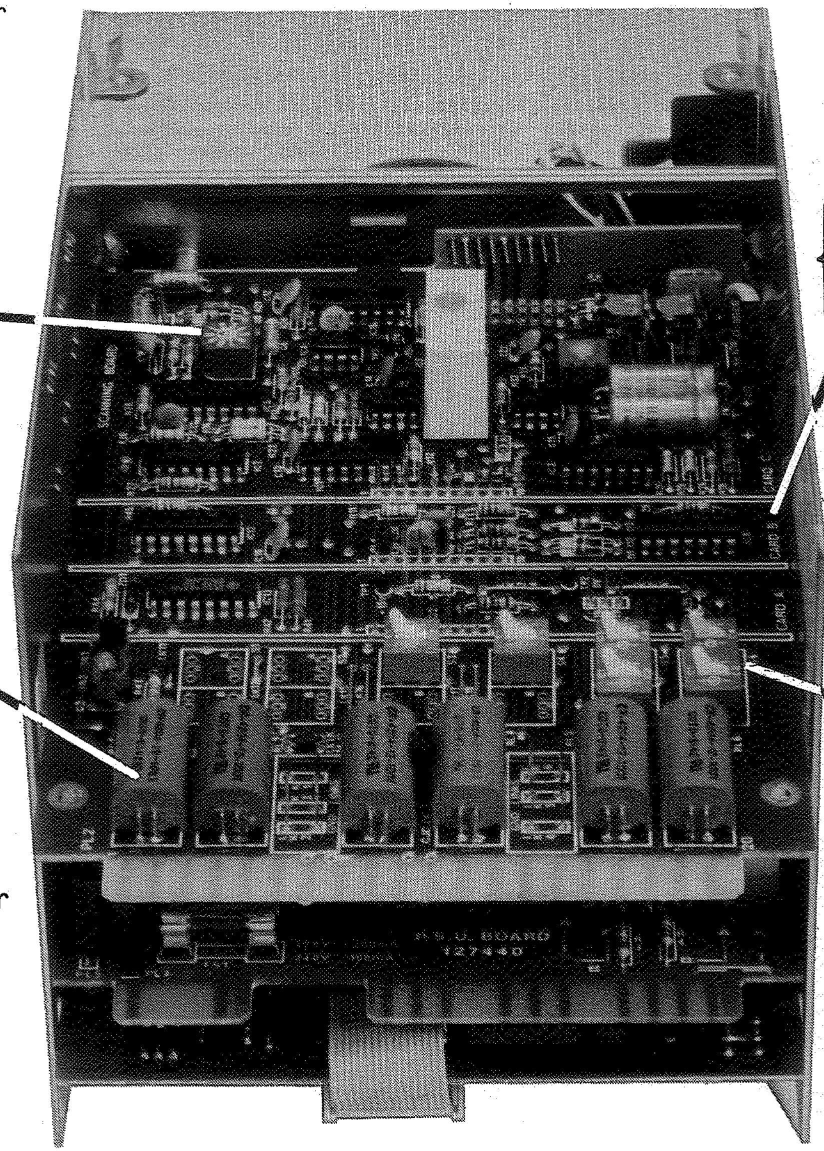


Figure 1.4 306 - TOP VIEW, PEN TRAY REMOVED

1.3 Inking System

The dotting head, a snap-on disposable unit, is a six chambered turret with fibre tip marker nibs at 60° intervals. Each chamber contains a different colour ink, always related to a specific input channel:-

Input Channel:						
	1	Violet	3	Black	5	Blue
	2	Red	4	Green	6	Brown

A miniature six-position stepper motor indexes the chambers sequentially into position, marker nib down, at which point the head assembly pivots downward to mark the chart with a single dot.

1.4 Alphanumeric Character Printing

Model 306 recorders with Levels 2 and 3 software have the capability of combining alphanumeric character printing with analogue trace recording.

Level 2:

This feature is limited to a printout of instrument status.

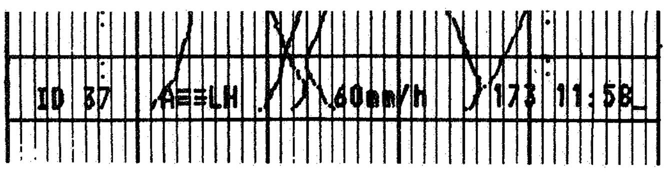
The full status printout comprises the following:

* Instrument ID code (00-99, AA-FF or combination). Configuration of alarms, if installed

* Chart speed (mm/h or in/h)

* Day number (three digits)

* Time datum mark and time of day in 24-hour format. (the time printed on the chart is read to the nearest minute from the internal clock at the instant the datum mark is made)



FULL STATUS PRINTOUT

The full status is printed, initially at power-on or whenever the chart cassette is removed and replaced as part of a control adjustment procedure; or may be programmed, for example, to print out only on the hour (i.e. 12:00, 13:00). An abridged status may be printed out, at interim periods, which comprise chart speed, day number, time of day and datum mark, see below.

ABRIDGED STATUS PRINTOUT

Level 3:

Each Level 3 recorder includes a customised PROM (Programmable Read Only Memory) in which are stored scale data and descriptive statements specific to the intended application of the recorder, together with the user's choice of special character font, if required. The PROM is a permanent data store and cannot be modified on site. If the user wishes to change scale data, or change the assignment of inputs to scales, a re-placement PROM is usually required. Some reconfiguration is possible without changing the PROM (see section 3).

1.5 The Message Set

The Level 3 PROM holds a set of up to six pairs of message lines, composed by the user to describe a particular set of input signals. One line of each pair contains scale data and the other a descriptive statement. The number of message pairs in the set depends on the variety of inputs handled by one recorder. A set can be as short as a single pair if all the input channels are to record a single variable.

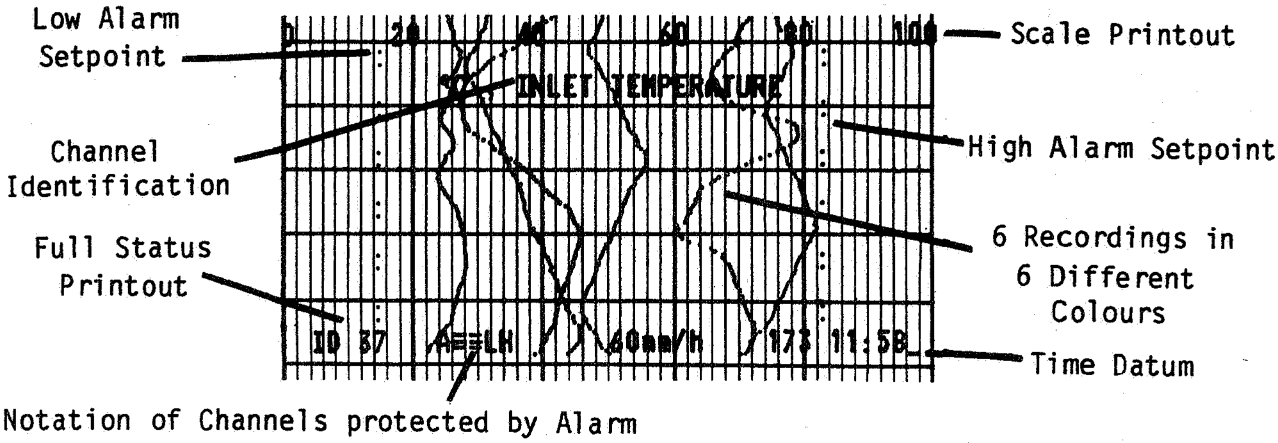


Figure 1.5 SECTION OF CHART SHOWING RECORDINGS & MESSAGES

1.6 Assignment of Message Pairs To Input Channels

Scale data and text pairs can be linked to the six input channels in two ways, permanent and flexible.

1. Permanent Linking (PL)

   In this arrangement each input is unalterably assigned a particular pair of message lines, i.e. scale data and descriptive statement.

   For a PL defined recorder, therefore, the type and range of each signal must be known in advance, and any change in configuration will necessitate replacement of the PROM.

   Permanent linking is the only choice where more than three different scales are required, often the case if several inputs are electrically similar but represent several different physical parameters, e.g. four 4-20mA inputs representing 0°-500°C; 200°-250°C; 2-12pH and 900-1000 psig.

2. Flexible Linking (FL)

With flexible linking the PROM is organised so that the scale data is linked specifically to input board locations A, B and C and not to the numbered input channels as in the PL format.

This allows the user to re-assign input channels to different input boards and their related scales without changing the customised PROM.

The message information is printed in a colour unrelated to the input together with a colour key (coloured dashes) to identify which input channel is assigned to that scale. The message printout colour is automatically changed periodically to balance ink usage.

The colour key changes automatically during reconfiguration of inputs and scales. If an input board is replaced with one of a different signal type, span or offset, the indicating scale and PROM must be changed.

1.7 Character Generation

The printed characters are developed in an 8 x 8 dot matrix by repeated passes of the dotting head. Each message line, either statement or scale date, can contain up to 24 characters, freely positioned in a space 42 characters wide (i.e. the overall length of the printed line is 42 characters, but the content is limited to 24).

1.8 Characters Available

All Level 3 recorders have access to the following standard font of 74 characters:

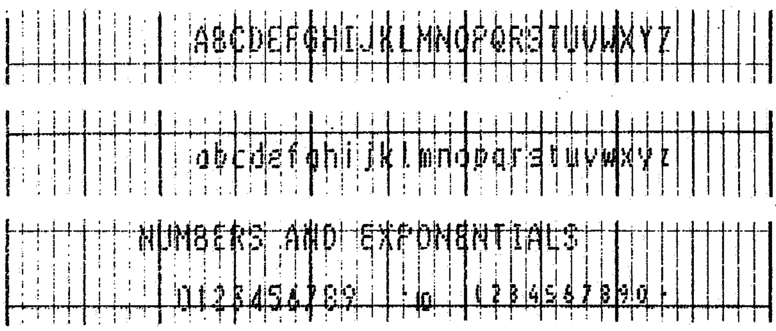


Figure 1.6 EXAMPLE OF CHARACTERS AVAILABLE

Kana (Japanese) or Greek fonts can be substituted for the standard character set. Additionally, if required, the Level 3 recorder can be provided with a special supplementary font of up to 16 characters chosen by the user to meet specific local needs. The 16 characters can be freely composed within the 8 x 8 dot matrix.

1.9 Charts & Indicating Scales

Because non-linear inputs can be linearised electronically, the selection of scales and chart grids is simple. Six standard scale grids and matching charts are available, ex-stock, and non-standard grids are available on special order.

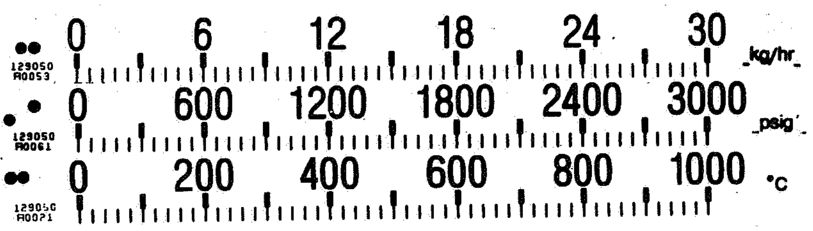


Figure 1.7 EXAMPLE OF 306 SCALES

Up to three scales can be fitted. Each scale is annotated for range and type of measured variable based on the six stock linear grids 30, 40, 45, 50, 60 and 70 divisions. Left hand, right hand, centre or offset zero versions are available. Each scale grid is defined by calibration numerals, engineering units and scale factor.

1.10 Technical Specification

General

Writing System:	Discontinuous ink trace, disposable six colour cartridge
Number of Input Channels:	Six
Input Channel Colours:	1 Violet, 2 Red, 3 Black, 4 Green, 5 Blue, 6 Brown Choice of left or right hand zero.
Accuracy:	Class 0.5 (IEC484) (intrinsic error less than 0.5% span)
Resolution:	0.2%
Chart Print Interval:	0.5mm
Chart Width:	100mm calibrated, 120mm overall
Visible Chart Area:	100mm x 80mm
Chart Drive:	µP controlled stepping motor synchronised to the a.c. supply frequency or crystal oscillator
Chart Speed:	120, 60, 30, 20, 10 and 5mm/h
Power Requirement:	110,120,220,240V ±10%, 50 or 60Hz a.c. 15VA

Options

Alarms:	Two independently adjustable set points - can be configured for Hi/Lo: one alarm above a set point, one alarm below a set point; Hi/Hi; or Lo/Lo operation. One single pole changeover relay for each set point; failsafe: alarm = relay released. Switching capability: 2A at 240V a.c. with resistive load.

Chart Type:	Interchangeable cassettes accommodate 32 metre roll or 16 metre z-fold charts. Scale calibration: 30, 40, 45, 50, 60 or 70 divisions.
DC Power:	12 or 24V ±15% DC 25W.
Low V AC Power:	24 or 48V ±10% 50 or 60Hz 15VA.
Remote Chart Control:	a) Chart off (chart motion and printing ceases). b) Chart speed-up: chart drive changes to a predetermined speed specified by the customer. Both functions initiated by voltage-free contact closure or 5V TTL input.
Window:	Polycarbonate (glass is standard)
Terminal Cover:	Choice of two types, with or without cable entry support.

Input Conditioning Boards

General:	The input conditioning board converts the signal from the transducer to a linear 0-10V output. There are three basic boards as described below. Left hand, right hand, centre or offset zero (up to three times span) is available. Worst case total of tolerances gives accuracy for linear inputs of 0.25% and for linearised inputs of 0.50% of span. Common mode rejection is 120dB d.c., 60dB 50Hz. Normal mode rejection is 40dB, providing the interfering signal a.c. component is less than half the calibrated signal span. Isolation - between inputs or from input to ground isolation is at least 250V a.c. rms. Isolation is not provided when a 3-wire RTD is used.
Multi-purpose:	Used mainly with thermocouples. Upscale thermocouple break protection is fitted as standard (after May 1982). Choice of external or automatic terminal block cold junction compensation. Linearised input including square root extraction is also available.
Linear mV mA:	Used where a linear input signal or conditioned signal is available. A suitable shunt resistor is required for mA, mounted on rear terminal block.
Resistance Thermometer: (RTD)	Used with 3-wire resistance thermometer transducers.

2. INSTALLATION

2.1 Unpacking

The instrument is shipped in a specially designed pack to ensure adequate protection during transit. If the outer case shows signs of excessive damage, the pack should be opened and the instrument examined. If there is evidence of damage do NOT put the instrument into operation; call your local representative and inform the carrier.

The standard pack of accessories contains the following:-

1 off 32 metre roll chart OR 16 metre z-fold chart
2 off Panel mounting clamps
1 off Six colour disposable ink cartridge
2 off Door keys (LOK option only)
1 off Pack of labels (optional)

CHECK PACKAGING TO ENSURE THAT ALL ACCESSORIES HAVE BEEN REMOVED

2.2 Storage

The instrument is packed in a polythene bag, which should be left intact if the instrument is to be stored.

2.3 Panel Installation

The model 306 recorder is intended for installation in a 138mm x 138mm (+1mm) cut-out in a vertical or sloping panel.

The instrument is secured to the panel by DIN type jacking clamps, which are clipped to either sie of the case and tightened with a screwdriver as shown in Figure 2.1. Under unusual circumstances it may be necessary to centre-punch the panel to prevent the tip of the clamp wandering as it is tightened down.

DO NOT OVERTIGHTEN THE CLAMPS

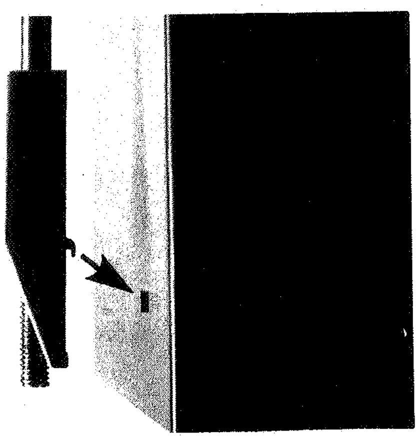


Figure 2.1 FIXING CLAMP

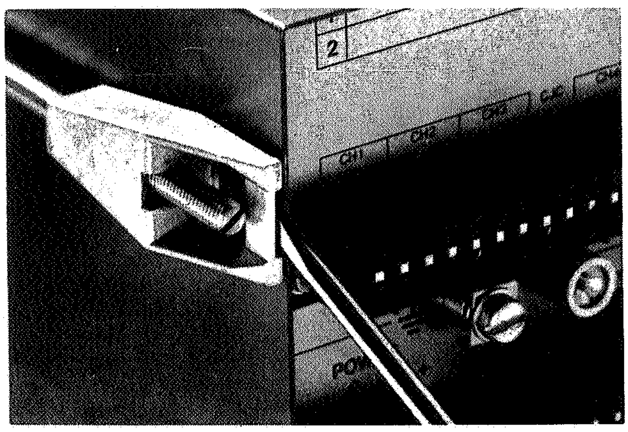


Figure 2.2 REMOVING CLAMP

To remove the clamp, loosen the screw and gently pry the clamp from the case as shown in Figure 2.2.

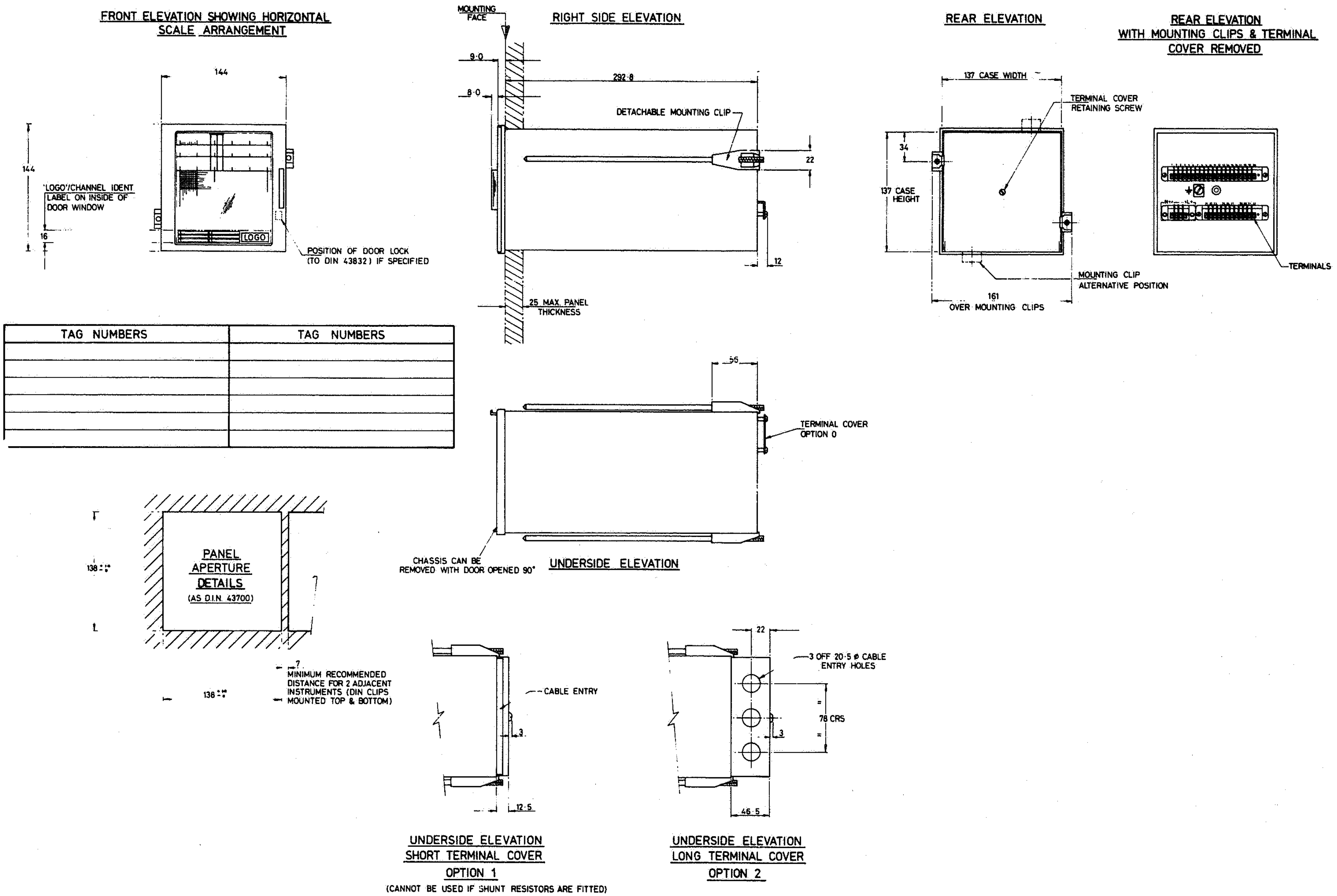


Figure 2.3 INSTALLATION & CUT-OUT DIMENSIONS - DIN CASE
(Drawing No.HG128839, Issue 3)

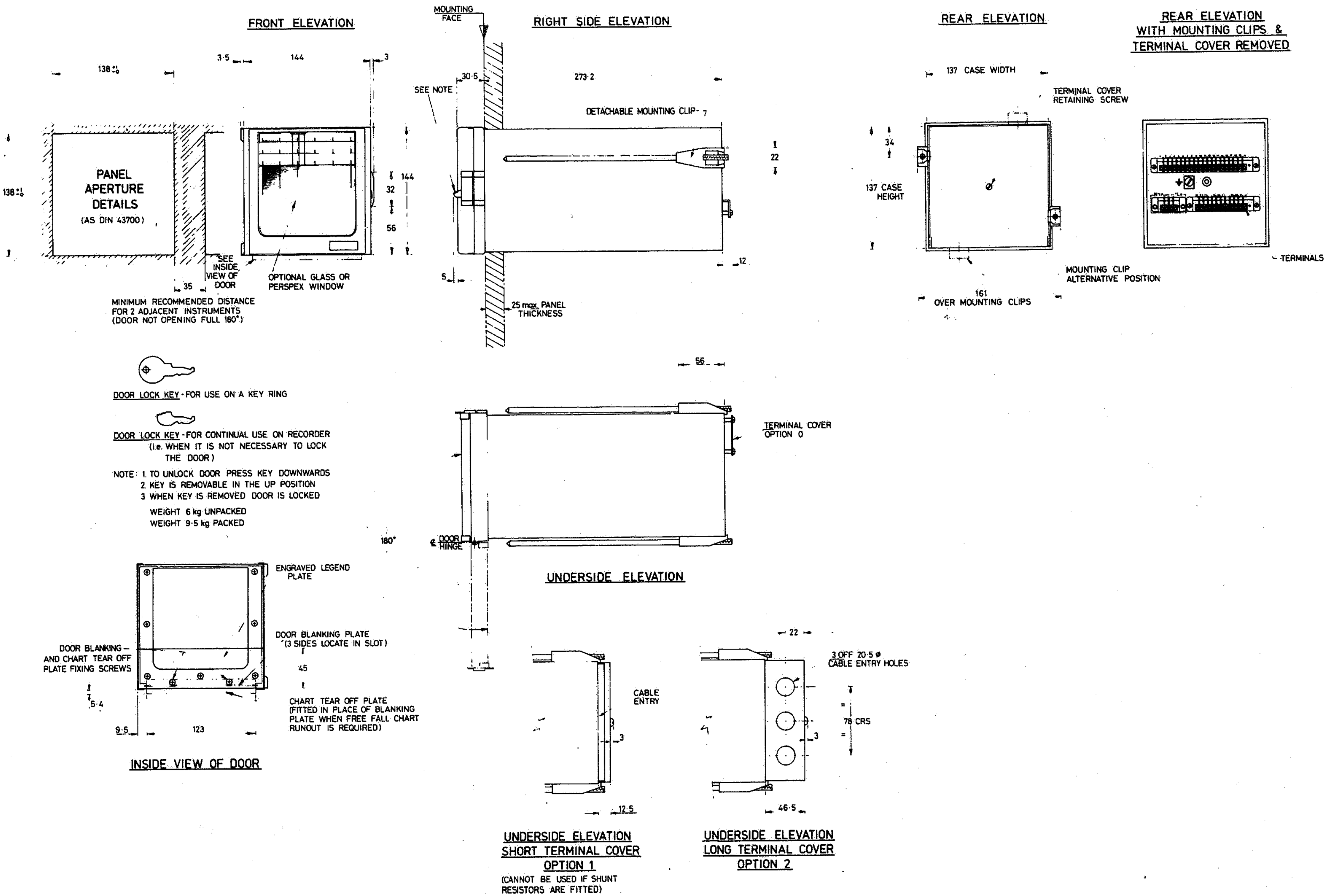


Figure 2.4 INSTALLATION & CUT-OUT DIMENSIONS - HD (HEAVY DUTY) CASE (Drawing.No.HG230335, Issue 1)

3. ELECTRICAL CONNECTIONS

> WARNING
> HIGH VOLTAGES MAY EXIST ON THE TERMINALS

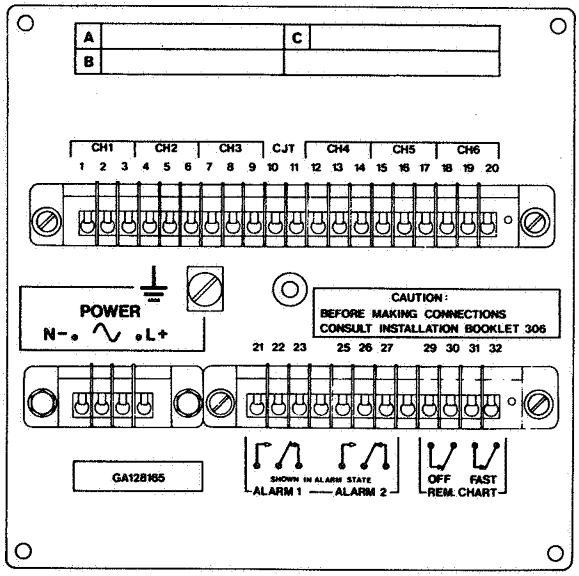


Figure 3.1 REAR TERMINALS

3.1 Terminals

The 306 is normally supplied with a rear cover. Access to the terminals is gained by releasing the single retaining screw and removing the cover. Ensure that the supply voltage and input range are correct as shown on the rear panel label.

3.2 AC Supply Voltage Selection

> WARNING
> DO NOT SWITCH ON UNTIL THE VOLTAGE SELECTOR AND THE FUSE RATINGS HAVE BEEN CHECKED

Remove the instrument from the case. The a.c. voltage selector switches are located on the left-hand side, viewed from the front.

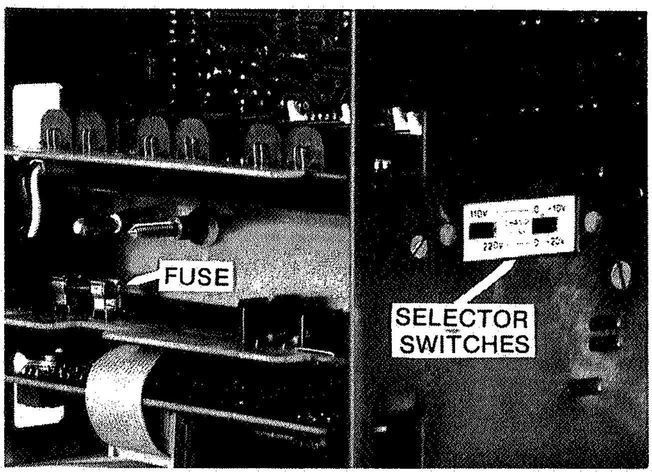


Figure 3.2 AC SUPPLY SELECTOR SWITCHES & FUSE

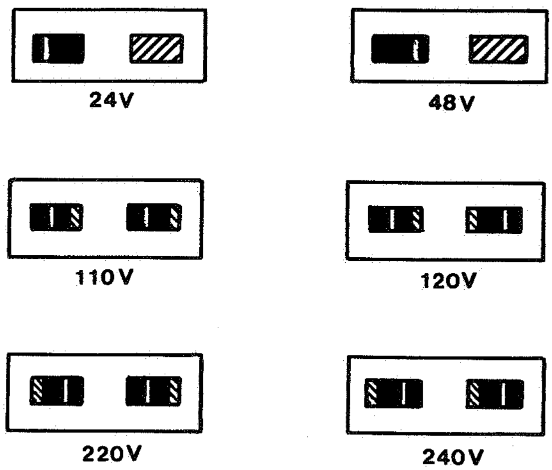


Figure 3.3 AC SUPPLY VOLTAGE SELECTOR SWITCH SETTINGS

To select an instrument voltage setting that is nearest to the actual mains voltage, use a small screwdriver and set the switches as shown in Figure 3.2. The instrument will operate to specification with up to 10% variation in mains supply, therefore a mains supply of 115 or 230V can be accommodated with the switches set to either 110V/120V or 220V/240V respectively. Ensure that the correct fuse is fitted for the selected voltage. The appropriate fuse ratings are:-

110/120V	200mA slow-blow	20 x 5mm	Part No: CH050022
220/240V	100mA slow-blow	20 x 5mm	Part No: CH050012

The instrument adjusts to the mains frequency automatically: below 55Hz, 50Hz is selected; if above 55Hz, 60Hz is selected.

3.3 AC Supply Wire Size

Minimum wire size:	7/0.2mm	7/007in	23 A.W.G.
Maximum wire size:	19/0.3mm	3/029in	16 A.W.G.
Maximum diameter of solid connector:	2mm	.040in	

3.4 AC Supply Connections

Remove the protective cover retained by two captive screws. Insert the cable through the terminal support plate, if fitted.

Connect:	LIVE	to	Terminal L
	NEUTRAL	to	Terminal N
	EARTH	to	Earth Clamp

3.5 Low Voltage AC Version

Remove the instrument from the case. The a.c. voltage selector switches are located on the left-hand side, viewed from the front. The right-hand switch is not connected. Use a small screwdriver to set the switches as shown in the upper part of Figure 3.3. Ensure the correct fuse is fitted for the selected voltage as follows:-

24V	1A slow-blow	20 x 5mm	Part No: CH050013
48V	0.5A slow-blow	20 x 5mm	Part No: Ch050252

3.6 DC Supply Connections & Voltage Selection

The DC Option PCB is located inside the rear cover. Power connections to PCB are made via a plug and socket and the connections are made as shown in Figure 3.5. Access to the PCB is gained by undoing the single retaining screw and removing the cover. Ensure that the supply voltage is correct as shown on the rear panel label.

The voltage selector switch is located on the left-hand side, viewed from the front (with the case removed).

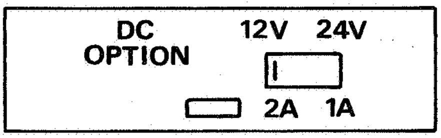


Figure 3.4 DC SUPPLY SELECTOR SWITCHES

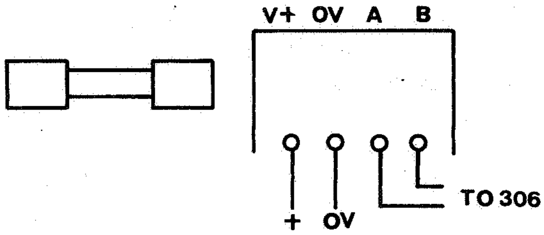


Figure 3.5 DC SUPPLY CONNECTIONS & FUSE - DC OPTION PCB

Use a small screwdriver to set the switches for 12 or 24V. Ensure that the correct fuse (position shown in Figure 3.2) is fitted for the selected voltage. The appropriate fuse ratings are:

12V	2A slow-blow	20 x 5mm	Part No: CH0500023
24V	1A slow-blow	20 x 5mm	Part No: CH0500013

3.7 Signal Connections, General

A 20-way terminal block accommodates up to six 3-wire input signals and a cold junction temperature sensor.

3.8 Signal Connections, mV, Volt & mA DC

2-wire input signals are connected to terminals as shown below.

Channel Number	1	2	3	4	5	6
+ve Terminal	1	4	7	12	15	18
-ve Terminal	2	5	8	13	16	19

The input source impedance presented to the input conditioning board should not exceed 250 ohms on spans less than 200mV, and 2000 ohms less than 2V. Above 2V the input impedance of the input board is 100 kilohms per volt.

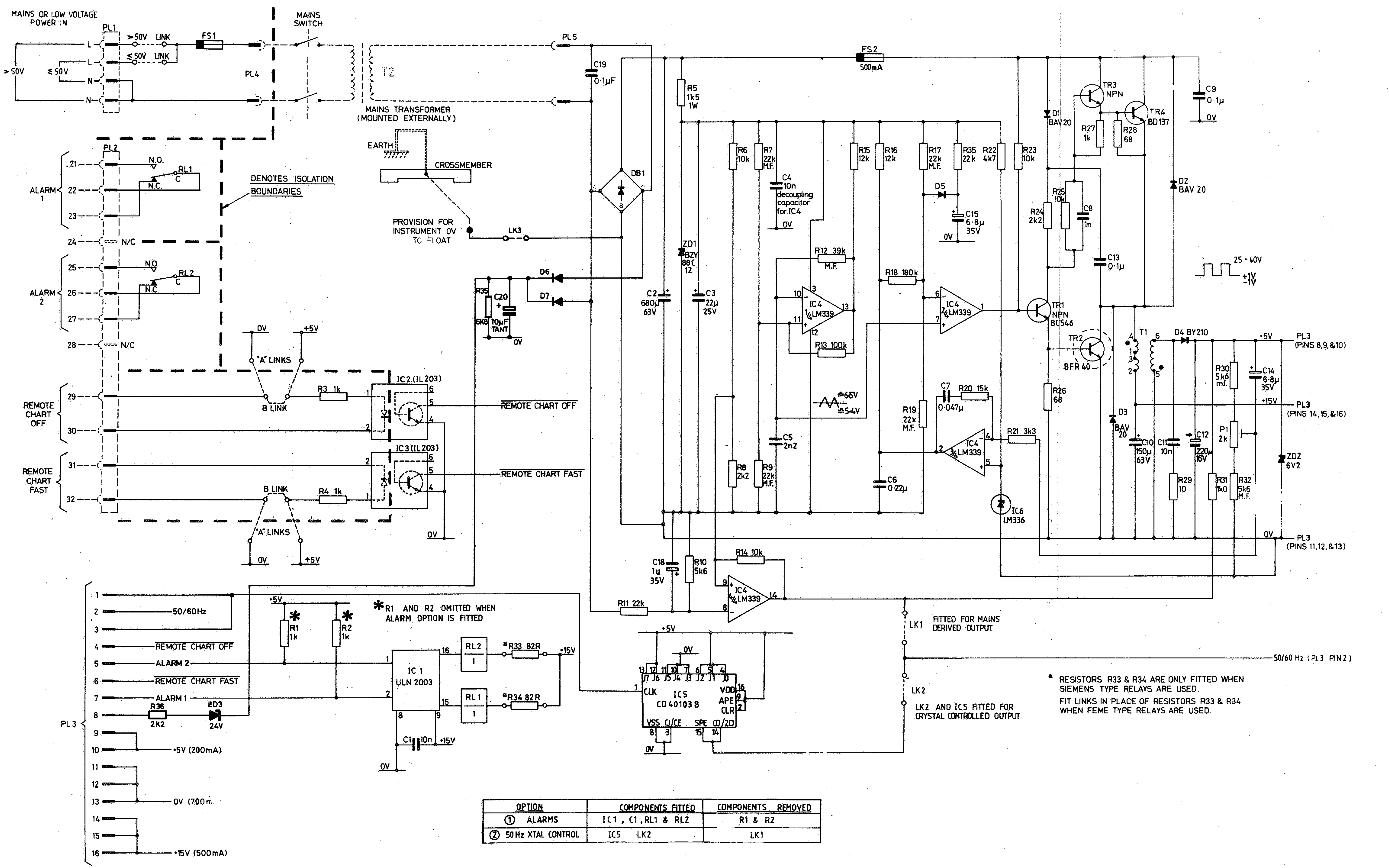
The mA d.c. signals are measured via a shunt resistor assembly mounted on the rear terminal block, ensuring the integrity of the current loop in the event of the instrument being removed from its case.

Input conditioning boards for mA d.c. signals are marked with their calibrated range (e.g. 0-100mV, 1-5V), and should be considered in conjunction with their associated rear terminal shunt resistors.

3.9 Signal Connections, Thermocouple

Thermocouples are connected to the same terminals as other 2-wire systems, (see Table in section 3.8).

Normally, cold junction compensation is required on the instrument. This is achieved with a semi-conductor temperature sensor connected to terminals 10 and 11. To avoid errors due to temperature variation across the width of the terminal block - especially with low span temperature ranges - INSTRUMENTS WITH THERMOCOUPLE INPUTS SHOULD BE FITTED WITH A REAR TERMINAL COVER.



OPTION	COMPONENTS FITTED	COMPONENTS REMOVED
① ALARMS	IC1 , C1 , RL1 & RL2	R1 & R2
② 50Hz XTAL CONTROL	IC5 LK2	LK1

Figure PSU BOARD CIRCUIT DIAGRAM (Drawing No. AI234077, Issue 1)

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3.10 Thermocouple Compensating Cables

Compensating cables should be selected with caution; there is no international agreement regarding colour codes for polarity or millivolt calibration.

If copper wire is used the instrument will show an error equal to the difference between thermocouple and the instrument. If the thermocouple is hotter than the instrument environment - and it usually is - the instrument will read low, usually dangerous to the process.

If the correct compensating cable is used but the connections crossed at both ends, the instrument will show an error equal to twice the temperature difference between the thermocouple and the instrument environment. There may be no error until the process and the thermocouple warm up, then the instrument error increases with process temperature.

3.11 Signal Connections, Resistance Thermometer

The resistance thermometer input card fitted to the instrument is designed specifically for use with 3-wire sensors. It can be modified to operate with a 2-wire sensor, but the accuracy can be adversely affected (see Figure 3.6). Isolation is not provided when a 3-wire RTD is fitted.

3-WIRE SYSTEM:
This system provides automatic lead resistance compensation, provided that the two leads I and C have the same total resistance. The percentage error caused by these two leads having different resistances is:

$$\frac{\text{Mismatch between I and C leads (ohms)}}{\text{Input Span (ohms)}} \times 100\%$$

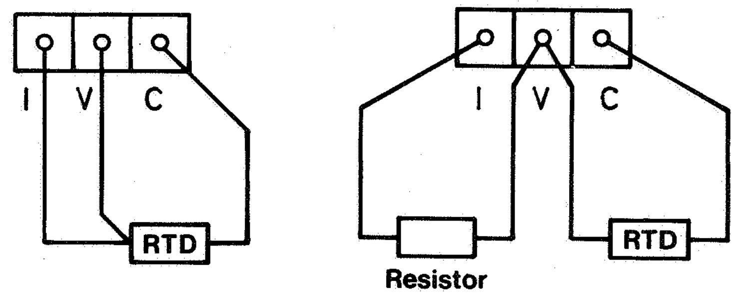
For example, A 1 ohm lead mismatch between I and C using a standard Pt100 thermometer will cause:

$$\frac{1}{38.5} \times 100 = 2.6\% \text{ error on a 0-100°C range}$$

There is no practical limitation on the lead resistance since the constant current source will not be affected until the individual lead resistance is in the order of 1000 ohms (equivalent to 16km of 16/0.2mm copper wire).

2-WIRE SYSTEM:
If the instrument is to be used with a 2-wire sensor, connect V and C to the sensor and connect a resistor between V and I, whose resistance is equal to the resistance of both of the leads to the sensor. A fine adjustment can be made with P1 on the RTD input board. In practice, it is preferable to keep the leads short to reduce lead temperature/resistance error and to short V and I.

	CHANNEL					
	1	2	3	4	5	6
I	1	4	7	12	15	18
V	2	5	8	13	16	19
C	3	6	9	14	17	20



Resistance Thermometer Signal Connections

3-wire

2-wire

Figure 3.6 RTD CONNECTIONS

3.12 Limit Alarm Option

Two alarm set points are fitted to the instrument, each with an associated single pole changeover relay. The sense of the alarm (high or low) is determined at the insrument. The alarm can be wired normally open (NO) or normally closed (NC). Normal is defined as the state of the relay with power removed from the instrument.

The relay contacts are rated at 2A at 250V a.c. with a resistive load. The instrument relay remains in the alarm condition for up to 30 seconds after the input signal has returned to the non-alarm condition.

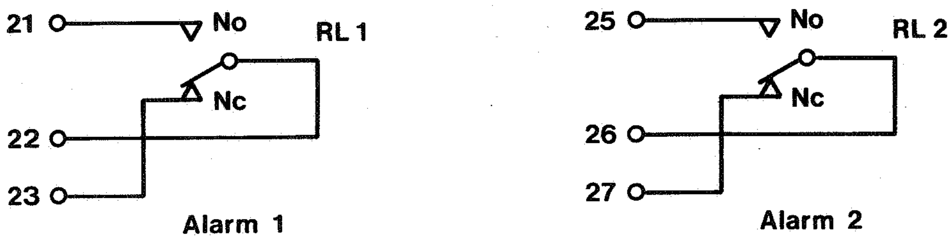


Figure 3.7 LIMIT ALARM RELAY CONNECTIONS

3.13 Remote Chart Control Option

The CHART HOLD and CHART FAST facilities are controlled by a voltage-free contact or TTL signals. The instrument will accept TTL signals direct, provided isolation is not required. If isolation is required this can be provided if links at the rear of the power supply board are altered (see circuit and board layout under "Circuit Description".

The operation of the links is as follows:-

LINK CONNECTIONS	29	30	31	32	REMARKS
A to +5V					Pins shorted; activate
A to 0V	0	TTL	TTL	0	"0" to activate.
B fitted	5V	TTL	TTL	5V	Isolated "0" to activate. Sink 5mA.
B fitted	TTL	0V	0V	TTL	"1" to activate. Source 5mA.

4. USING THE RECORDER

This section deals with the day-to-day operation of the recorder, how to change charts and pens, and to make checks and changes to the instrument via the controls available to the operator.

4.1 Control Panel Access

The operator controls are situated on the control panel bulkhead behind the chart cassette. To gain access to these controls it is necessary to remove the chart cassette.

4.2 Chart Cassette Removal & Replacement

Open the door and press the cassette release latch on the bottom right. Place the hand under the cassette, swing up through 90° and pull forward to remove. Replacement is the reverse procedure.

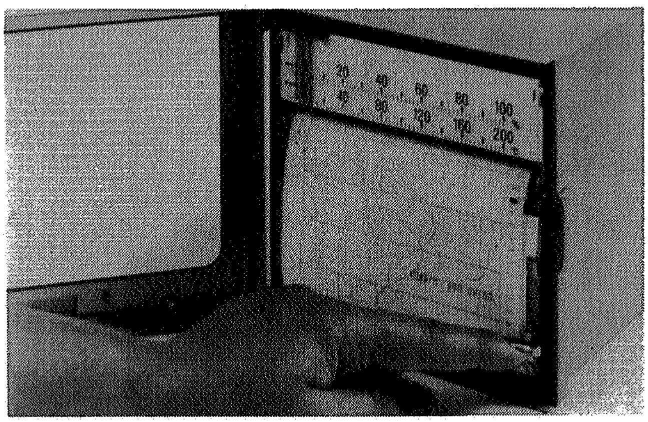


Figure 4.1 RELEASING CASSETTE

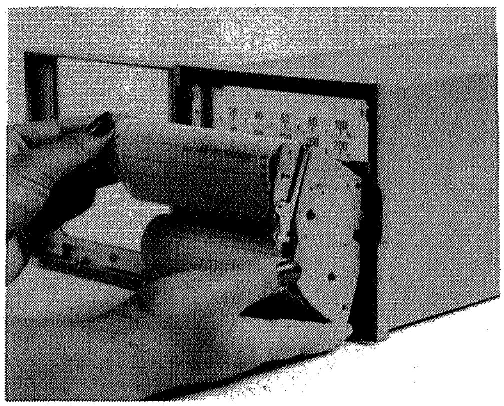


Figure 4.2 REMOVING CASSETTE

4.3 Control Panel Switches & Indicators

ON/OFF SWITCH:
This switch is located on the left of the control panel. When the instrument is switched on it automatically follows an initialising routine which includes moving and rotating the printhead and moving the chart forward. It then enters the normal RUN mode. Recordings are produced every 0.5mm of chart. When the instrument is not printing the printhead is stationary above the left-hand side of the chart.

FUNCTION INDICATORS:
Eight L.E.D.'s situated at the bottom right-hand side are used to indicate which mode the recorder is in. Their functions will be detailed later, but they are as follows:-

RUN	AL1	TIME	REMOTE
PEN	AL2	DAY	
	CAL		

SELECT/ENTER PRESS SWITCH:
When the SELECT/ENTER switch is held down, all measurements are suspended and the function indicators light up one at a time. When an indicator associated with a particular mode is illuminated, the switch should be released and that control function is then accessible. This switch is also used to enter data selected by the CHART SPEED/SET TIME DAY digit switch.

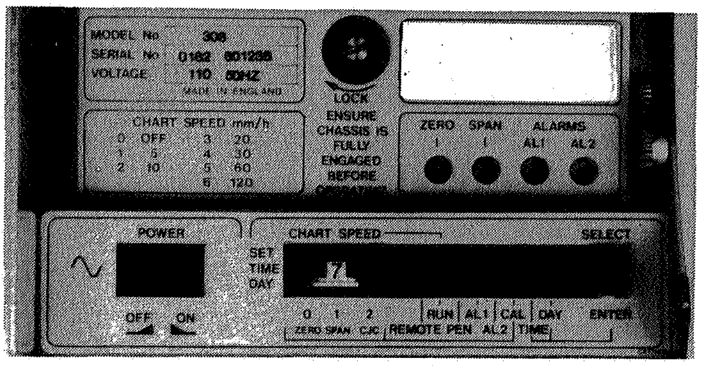


Figure 4.3 CONTROL PANEL

CHART SPEED/SET TIME DAY DIGIT SWITCH:
Used to:-
Select chart speed (when in the RUN mode), set the day and time clock and, during calibration, to select the channels to check signal level, and to set servo zero and span.
Change the chart speed (the recorder has six chart speeds and OFF).
Select, enter RUN, if the instrument is not already in that mode, by using the SELECT/ENTER press switch.
Select the chart speed from the chart speed table above the control panel and enter via the CHART SPEED digit switch and press SELECT/ENTER.

On Level 2 and 3 versions the alphanumeric printing is suppressed at the 120mm/h speed.

DO NOT FORGET TO RESET THE CHART SPEED IN ALL CASES WHEN RETURNING TO THE RUN MODE.

TIME/DAY SETTING (NOT LEVEL 1):
When the TIME/DAY is set, the instrument will log the day number (0-999) and the hours and minutes (24-hour clock) at intervals specified on the original order form.

To set a time of 1605 hours for example, select the TIME mode. Set the digit switch to 1, press ENTER and release. All the L.E.D.'s will blink once to acknowledge that the number is entered. Set digit switch to 6, press ENTER and release. Repeat for 0 and 5. When the L.E.D.'s start flashing, press the SELECT/ENTER button to return to RUN mode, reset chart speed and replace cassette.

To set the day number, select the DAY function. Set the first figure of the day number on the digit switch then press and release ENTER. When the L.E.D.'s blink once repeat for the other two day numbers. When the L.E.D.'s start flashing, press the SELECT/ENTER button to return to RUN mode, reset chart speed and replace cassette.

All digits must be specified, for example day 5 is 005, 1a.m. is 0100. An hour setting of greater than 23 and a minute setting of greater than 59 will cause the L.E.D.'s to flash rapidly, after which the complete time must be re-entered.

With the exception of the crystal clock option, the electronic clock which produces the DAY/TIME numbers is synchronised to the mains supply. ANY INTERRUPTION OF THE SUPPLY 15mS WILL CAUSE THE CLOCK TO RESET TO ZERO, UNLESS THE SUPPLY INTERRUPT PROTECTION OPTION IS FITTED. See Section 18.

ZERO & SPAN POTENTIOMETERS:
Used to set the recorder servo system zero and span. This adjustment affects the pen position only (see Section 7 for input board zero and span adjustments). It enables any differences between the alignment of the pen and chart to be corrected, which may be necessary after a new chart has been fitted. Select the CAL mode as shown below and adjust zero and span if required. This adjustment can be set to suit scale OR paper. Press the SELECT/ENTER button to return to RUN mode, reset chart speed and replace cassette.

ALARMS AL1 & AL2 POTENTIOMETERS:
Used to set the alarm levels. When the instrument is in either the AL1 or AL2 mode, the head and cursor will move to the alarm 1 or alarm 2 levels respectively, and these levels can be adjusted with the alarm AL1 or AL2 potentiometers. Enter CAL, select 8 (AL1) or 9 (AL2) on thumbwheel to set these.

N.B. The set points have 100% scale adjustment, which means that the alarm set points can be crossed over, resulting in an illogical chart record and a permanent alarm condition.

4.4 CAL Mode

The pen position servo zero and span, and signal levels of all six channels can also be checked using the CAL function.

Set the digit switch (CHART SPEED/SET TIME DAY) to 8 and select CAL mode. All the L.E.D.'s will flash until a number from the table below is selected on the digit switch:-

Digit Switch Number	Pen & Cursor Move to Position
0	Zero
1	Channel 1 signal level
2	Channel 2 signal level
3	Channel 3 signal level
4	Channel 4 signal level
5	Channel 5 signal level
6	Channel 6 signal level
7	Span 100% scale
8	AL1 setting
9	AL2 setting

4.5 Cold Junction Temperature (CJT) Check

When the instrument is fitted with thermocouple input conditioning which requires cold junction compensation, a CJT unit is fitted to the rear terminals. This CJT unit can be checked as follows:-

Set the digit switch to 2 and select the CAL mode. The cursor and pen takes up a position which is a percentage of full scale where 0-100% is equivalent to 0-100°C. This is the cold junction temperature. Thus, a cursor position of 25% of F.S.D. represents a CJT of 25°C. This feature allows the operation of the sensor to be checked. Press the SELECT/ENTER button to return to RUN mode, reset chart speed and replace cassette.

4.6 Pen Cartridge Replacement & Part Number

The six colour disposable pen cartridge is a snap-fit to the printhead. Select the PEN mode. This positions the head off the end stop and orientates the head so that the procedure for changing the cartridge is always the same.

Pen cartridges are available from stock - part number LA128969.

Remove spent cartridge by pulling it firmly forward. Remove the new pen from its container but NOT its holder. Align the new cartridge to the head key-way, rotating anti-clockwise, and press into position using the holder. Remove the cartridge holder.

N.B. If the recorder is not to be used for an extended period, the pen cartridge should be removed and stored in its original packing. This is to reduce ink loss due to evaporation.

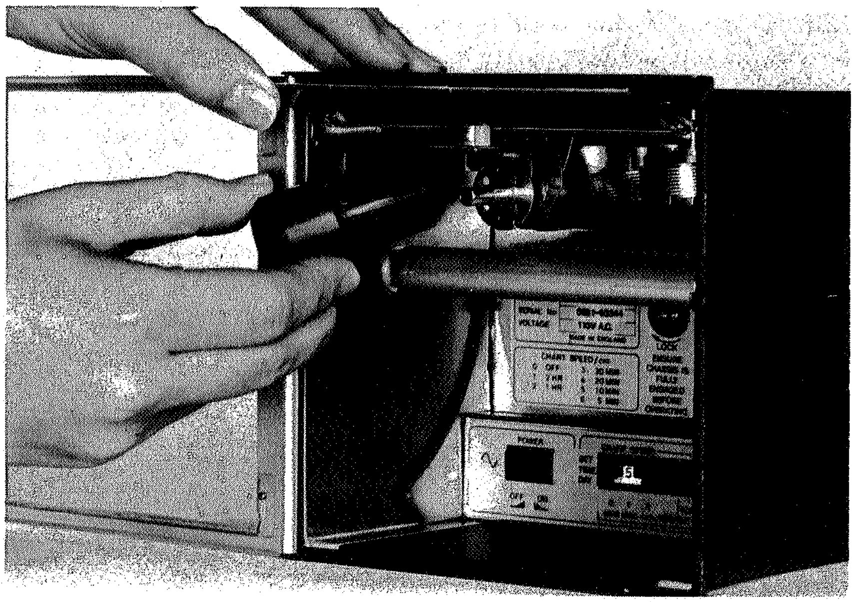


Figure 4.4 PEN CARTRIDGE REPLACEMENT

4.7 Roll Chart Removal

Remove the cassette from the instrument (see 4.2). Wind back some of the used part of the chart until it is slack enough to clear the sprockets. Pull each end of the chart off each spool a little at a time to avoid tearing. (There is a groove across the face of the chart cassette to aid tearing off sections of used chart). For recorders with plastic take-up spool: place a finger inside the chart roll and the thumb outside. Pull the roll off the take-up spool.

4.8 Roll Chart Loading

Remove the cassette from the instrument. Place the cassette on a flat surface, face down. Push the new chart roll over the chart feed spool, (Figure 4.5). Early series instruments were not fitted with the plastic take-up spool, part number LA129208, which may be retrofitted.

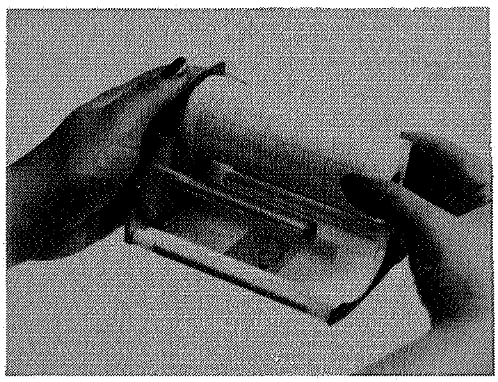


Figure 4.5 ROLL CHART REPLACEMENT 1

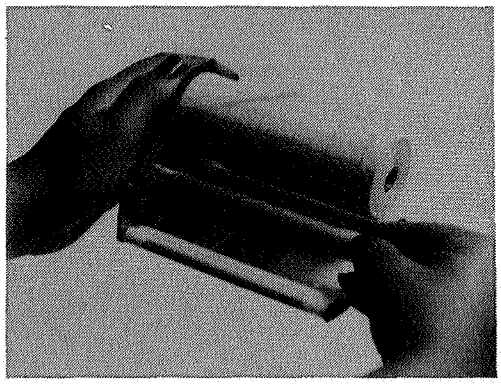


Figure 4.6 ROLL CHART REPLACEMENT 2

Fit a card tube over the take-up spool (Figure 4.6) if no plastic take-up tube is fitted. Take the end of the chart and pull off about 30cm (12in) of paper (Figure 4.7).

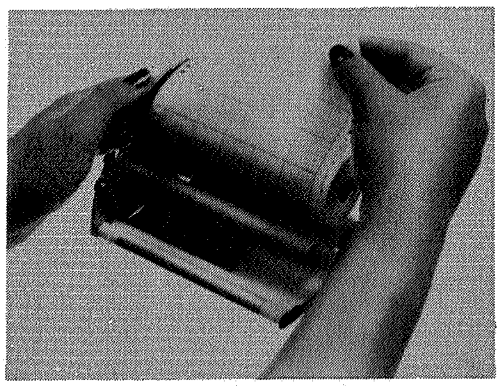


Figure 4.7 ROLL CHART REPLACEMENT 3

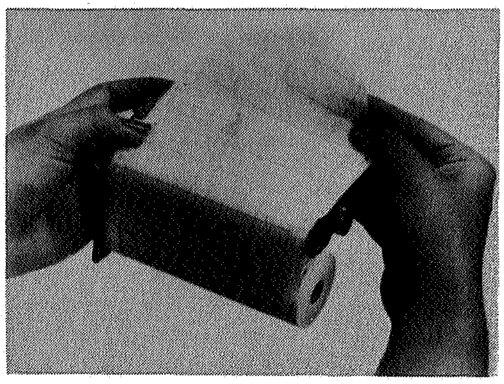


Figure 4.8 ROLL CHART REPLACEMENT 4

Pass the chart over the top of the cassette, across the front (Figure 4.8) and fix it to the card tube of the take-up spool with adhesive tape, (Figure 4.9) or tear the paper diagonally and slot into the plastic take-up tube.

Check that the paper is correctly located on the upper and lower sprockets.

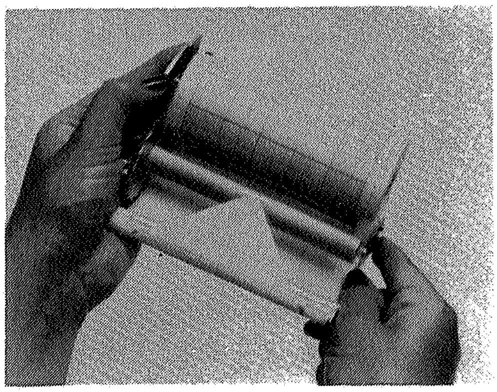


Figure 4.9 ROLL CHART REPLACEMENT 5

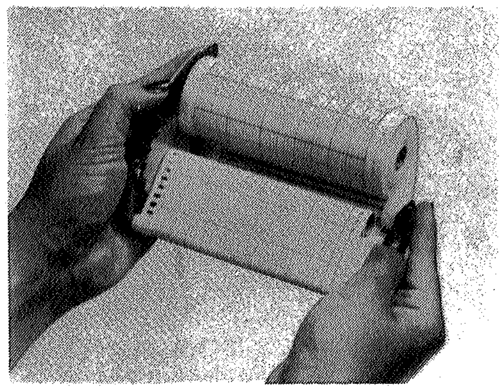


Figure 4.10 ROLL CHART REPLACEMENT 6

Replace the cassette in the instrument and take up any slack in the paper with the drive gear.

4.9 Z-fold Chart Removal

The chart is removed by simply lifting it out of the front compartment. If only part of the chart is removed, tear off the chart below the retaining bar and lift free. Ensure that the chart folds correctly by winding the chart on a few folds with the drive gear.

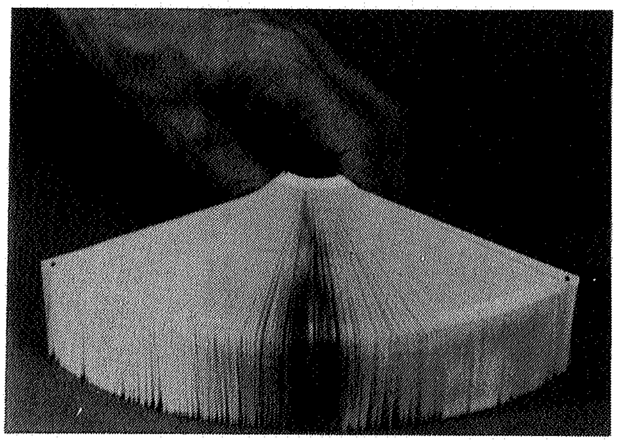


Figure 4.11 Z-FOLD CHART PREPARATION

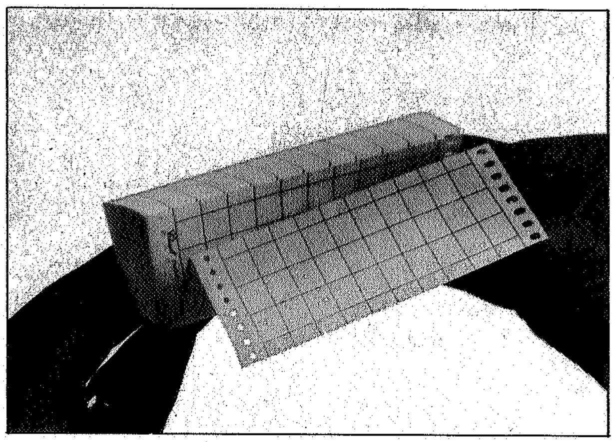


Figure 4.12 Z-FOLD CHART REPLACEMENT 1

4.10 Z-fold Chart Loading

Remove the cassette from the instrument. Unwrap the new chart and fan each end as in Figure 4.11. Place the chart in the rear compartment with the first fold at the top and pull the chart retaining bar forward. Pass the chart over the drive sprockets as in Figure 4.13, and under the retaining bar and ensure the chart has engaged sprockets. Flip the retaining bar down as in Figure 4.14, and advance the chart with the drive gear ensuring that the paper begins folding in the lower tray in accordance with the folds already in it.

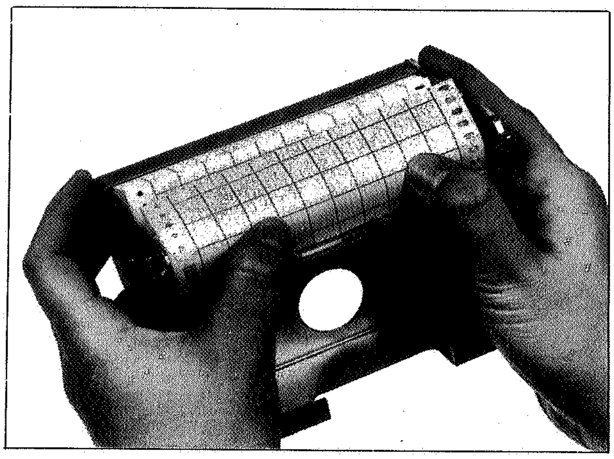


Figure 4.13 Z-FOLD CHART REPLACEMENT 2

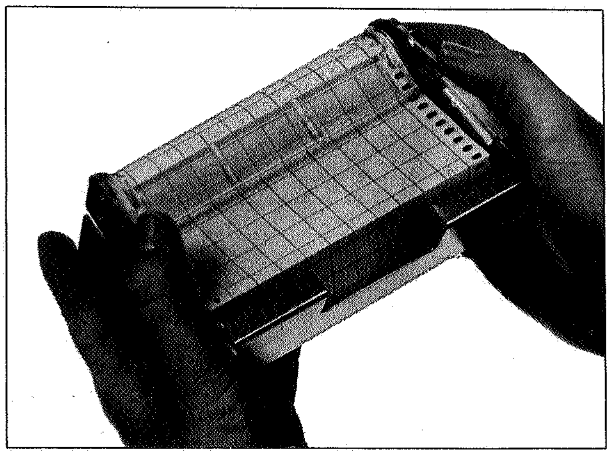


Figure 4.14 Z-FOLD CHART REPLACEMENT 3

Roll & Z-fold Chart Part Numbers

The following 32 metre roll charts and 16 metre z-fold charts are available from stock:-

Calibration Divisions	Roll Chart	Z-fold Chart
30	GD128971U030	GD128970U030
40	GD128971U040	GD128970U040
45	GD128971U045	GD128970U045
50	GD128971U050	GD128970U050
60	GD128971U060	GD128970U060
70	GD128971U070	GD128970U070

Other charts can be supplied to special order.

5. RECONFIGURATION; CHANNELS, RANGFS & ALARMS

5.1 Range Changing; Input Boards/Channel Selection

The input conditioning circuits are plug-in fixed range boards. Each input board is factory calibrated to convert the input signal span to a 0-10V output signal; consequently all input boards of the same input range are interchangeable between recorders. To change the range only requires the replacement of one board with another, with a possible change of scale.

5.2 Resistance Thermometer Input Board; Plug-in Links

When a channel is used with a resistance thermometer transducer a plug-in link (GND LINK, LK1 to LK6) must be fitted to the appropriate channel.

5.3 CJT Link

If a thermocouple is used with any channel the plug-in CJT link (CJC, LK23) must be fitted.

N.B. RTD and CJT links have different pin spacings and the plug-in links are not compatible.

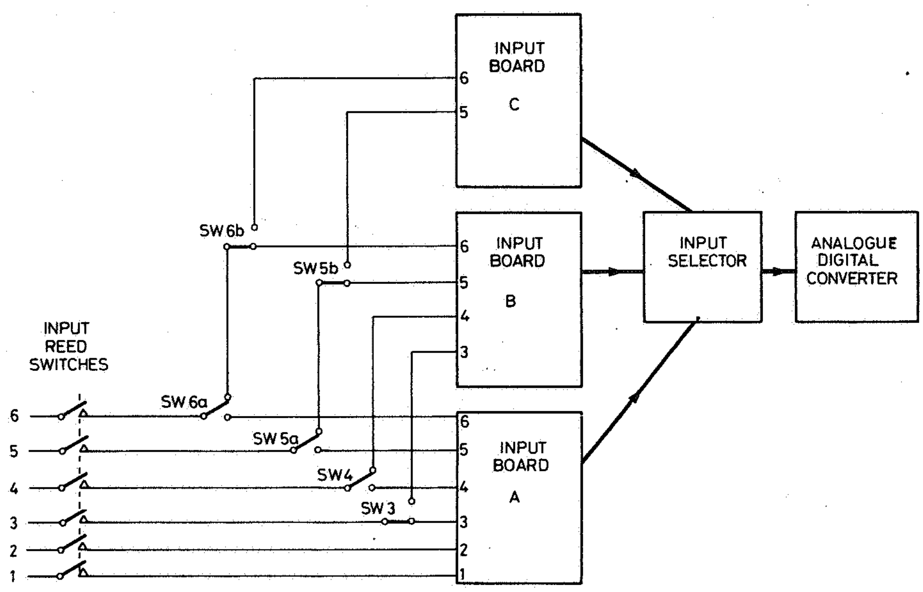


Figure 5.1 INPUT BOARD SELECTOR SWITCHES DIAGRAM

5.4 Input Board Position

The 306 will accept up to three different input conditioning boards and these plug in to the top of the instrument in positions A, B or C, which are identified on the scanning board. A single input range instrument always has the board in position A, a dual range in A and B, and a three range in A, B and C.

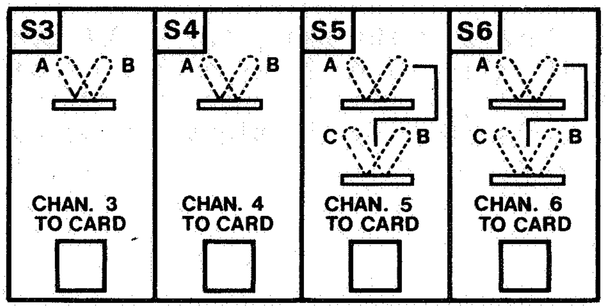


Figure 5.2 INPUT BOARD SELECTOR SWITCHES

5.5 Input Channel Switches

The input signals are routed to the input board by S3, 4, 5 and 6, see Figure 5.1. Channels 1 and 2 are connected directly to board A. S3 and 4 select channels 3 and 4 respectively to boards A or B. S5 and 6 select channels 5 and 6 respectively to boards A or B or C. Although many switch combinations are possible, only the board positions and channel numbers shown below are valid.

	Input Board Position			Switch SW7 Position
	A	B	C	
Channel Number	1 to 6	-	-	0
	1 to 5	6	-	1
	1 to 4	5,6	-	2
	1 to 3	4,5,6	-	3
	1 to 4	5	5	4
	1 to 3	4,5	6	5
	1,2	3,4	5,6	6

5.6 Input Board Channel Assignment BCD Switch SW7

Input board position information is transmitted to the microprocessor by the setting of digit switch SW7 so that it will gate the output from the input boards in the correct sequence as the input relays are scanned. SW7 must be set as shown in the above table.

5.7 Print Skip Switch SW1

As already stated, if the instrument is set up for less than six channels all six channels are still scanned and the unwanted channels are not printed. Located on the control board on the underside of the instrument are a bank of PRINT SKIP switches. Each switch lever is numbered 1 to 6, one for each input channel number. If a switch lever is moved towards the printed circuit board, the channel relating to that switch is not printed.

5.8 Limit Alarm Switch SW2

Switch bank ALARM SKIP, located next to SW1 on the control board, is used to select the limit alarms for each channel. If any lever from 1 to 6 is moved towards the printed circuit board the alarm relating to that channel is disabled.

The last two switch levers in the bank, 1.2. ALARM Low, are used to select the sense of limit alarm 1 or 2 respectively. When a switch lever is moved towards the printed circuit board the alarm is set low; i.e. the alarm relay is de-energised as the signal decreases below the alarm set point. If the switch lever is in the raised position, the alarm is set high; i.e. the alarm relay de-energises as the signal increases above the alarm set point. The set points for the alarm limits are set at the front panel.

5.9 ID Number Selector Switches SW5 & SW6

The ID number, the first two characters of the status printout on a Level 2 or 3 instrument, is selected via the ID switches. The lever switches to the right of the PRINT SKIP switches determine whether the ID number digit switches select figures or letters as follows:-

Lever Switch Position		Digit Switch Setting		Chart Printout
MS	up	SW6	2 to 7	A to F
MS	down	SW6	0 to 9	0 to 9
LS	up	SW5	2 to 7	A to F
LS	down	SW5	0 to 9	0 to 9

Lever switch down means towards the PCB. MS is the left-hand most significant character.

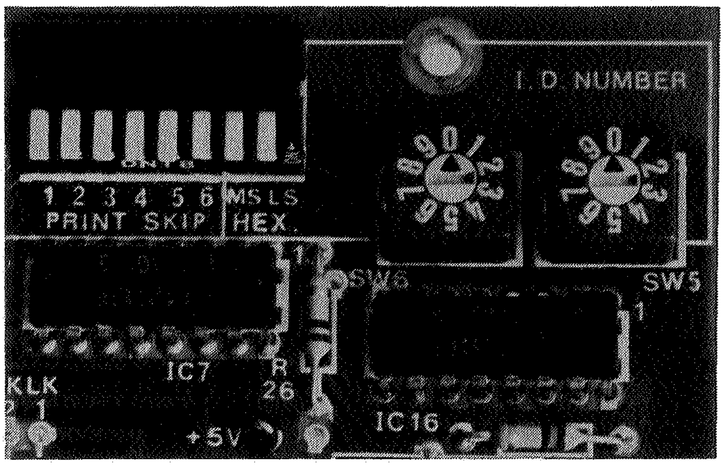


Figure 5.3 PRINT SKIP & ID NUMBER SWITCHES

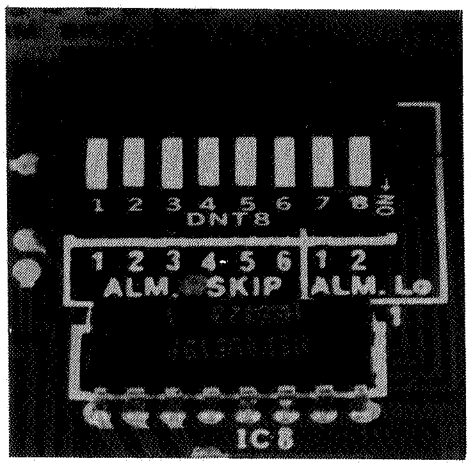


Figure 5.4 ALARM SKIP SWITCHES

5.10 Print Suppress Link LK10

When link LK1 is fitted on the control board of a Level 2 or 3 instrument, the printing is suppressed. This feature enables a Level 2 or 3 instrument to be used even if the printed messages are inappropriate, i.e. the PROM is programmed for a different application to the one for which it is currently used.

5.11 Right Hand Zero LK9

Link LK9, on the control board, is fitted if a right hand zero scale and recording is required. This link affects all channels.

5.12 Demonstration PROM LK8

Link LK8, on the control board, is fitted when a demonstration PROM is used.

5.13 Time/Day Clock Synchronisation

On the power supply board; wired link LK1 enables supply frequency synchronisation, and wired link LK2 enables the crystal control.

See Figure 16.1, PSU Board Circuit Diagram, for table of components for each type of control.

6. INSTRUMENT TESTING USING TEST PROM

The 306 instrument can be extensively tested using a diagnostic PROM (part number RD230520) which plugs into the socket normally occupied by the system control PROM (see Figure 6.1).

==

CAUTION

THE INSTRUMENT MUST BE SWITCHED OFF WHEN REPLACING PROMS

TAKE THE NORMAL PRECAUTIONS AGAINST STATIC

==

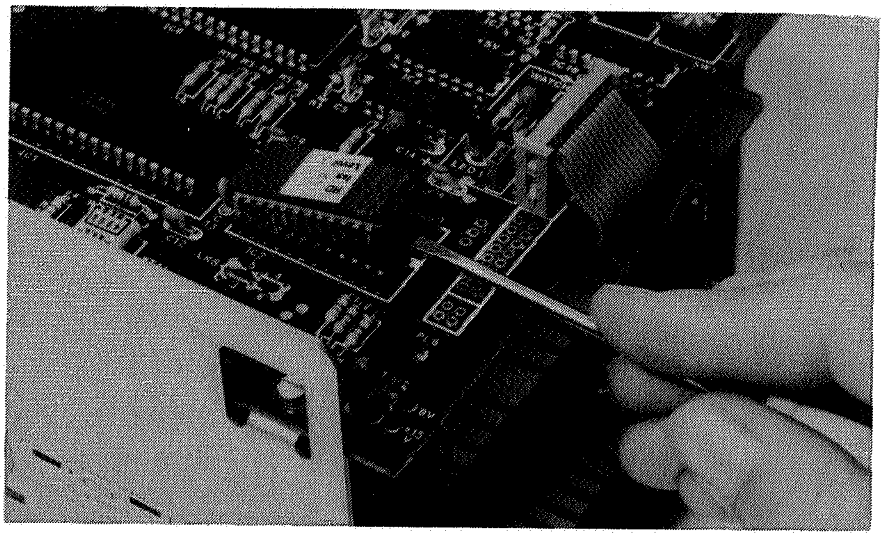


Figure 6.1 REMOVING PROM

To remove PROM from base, insert a small screwdriver (approximately 3mm), between the PROM and base and lever up gently.

When a diagnostic PROM is fitted and the instrument is switched on it will initialise itself, driving the carriage fully to the right and then to the left, incrementing the chart 1cm and selecting colour 6.

To select a TEST, switch the instrument off, select the appropriate number on the control panel digit switch, then switch on. Each test descriptior assumes the cassette is removed.

6.1 Test 0, Head Pressure

In this test, the dotting force is measured using a 2-15 gram correx gauge as described in section 8.2. The head comes to rest in the mid-position of the scale and the cartridge is energised down for 3 seconds and de-energised for 12 seconds. Ensure that the measurement is made during the energised period.

6.2 Test 1, Lateral Dot Alignment

This test is to check the lateral alignment of dots across the width of the paper. (Axial position of nibs on the cartridge or axial movement of the motor shaft). Select the test, replace the cassette and switch on. After initialisation a row of sequential dots should be produced across the width of the paper. This test should not be allowed to run for more than 5 minutes as it can cause the indexing motor to overheat.

6.3 Test 2, Vertical Dot Alignment

This test checks for radial errors in nib position or eccentricity in motor assembly. A row of sequential coloured dots are produced along vertical axis of paper with carriage held in one position. Select the test, insert the cassette and switch on.

After initialisation a row of sequential dots should be produced along vertical axis of paper. Slight deviation from nominal position is usually noticed as a result of variation in radial nib positions. These variations should not exceed 0.2mm peak-to-peak. Note: As with Test 1 the time this test is allowed to run should be limited.

6.4 Test 3, Servo Motor Phasing

In order to provide consistent calibration results the relationship of the servo motor phase and capstan end stop is important. Test 3 used in conjunction with Test 9 provides a relatively easy way of selecting the correct plug to pin (PL3) configuration to achieve desired phase selection. When this test is selected, the carriage will traverse left to right and back to left side if plug 3 is correctly orientated. (If carriage stops at RH side plug 3 is reversed, i.e. RH zero).

With carriage stationary at LH side, it should be possible to rotate the capstan approximately half a tooth anti-clockwise to end stop. After a short period carriage will traverse to RH side and the same end play (clockwise rotation) should be evident. This procedure is best used in conjunction with Test 9.

6.5 Test 4, Chart Drive System

This test is used to check the integrity of the chart drive system. Select the test, insert the cassette and switch on. After the initialisation sequence the instrument will dot at 2mm and 10mm intervals along vertical axis of paper.

6.6 Test 5, Overlap at Zero & Span

This test checks the number of spaces below zero and above span. Select the test and switch on. Wait until the cursor has returned to the left-hand side and a dotting action has occurred.

Select 0 on the digit switch. The cursor will go to zero and the dotting action will occur for 10 seconds. During this period the zero may be set using the ZERO potentiometer on the control panel. This period may be terminated early by pressing SELECT. At the end of this period, or if the period is terminated early, press SELECT again to nudge the cursor to the left. Count the number of steps that occur before the carriage hits the end stop. There should be at least two.

Select 7 on the digit switch. The cursor will go to span and the SPAN can be adjusted during a 10 second period. This period can be terminated early by pressing SELECT. Press SELECT again, noting how many steps occur before the carriage hits the right hand stop; there should be at least two.

THIS ZERO AND SPAN ADJUSTMENT RELATES ONLY TO THE PEN POSITION SERVO. SEE SECTION 9 FOR CHANNEL ZERO AND SPAN ADJUSTMENTS.

6.7 Test 6, Individual Channel Integrity

This test provides the facility to calibrate channels individually (i.e. instrument ignores all other input signals) and also to set zero and span. THE ZERO AND SPAN TEST MUST BE SELECTED FIRST, EVEN IF ONLY THE CHANNEL TEST IS REQUIRED. Select test, insert cassette and switch on.

ZERO & SPAN:
After initialisation, allow the instrument to dot once only then select 0 or 7 for servo or span respectively. THIS ZERO AND SPAN RELATES TO THE PEN POSITION SERVO ONLY AND NOT TO THE INPUT BOARD.

CHANNELS 1 TO 6:
After initialisation, allow the instrument to dot more than once, then select any number from 1 to 6 on the digit switch for any channel 1 to 6.

6.8 Test 7, Head Rotation

If the performance of the indexing motor is suspect this test can be used to detect any tendency of the motor to stick on one colour. Select test, insert cassette and switch on. The instrument should produce 11 rows of 125 dots before changing colour. Failure of the motor to rotate after 11 rows indicates a sticking motor.

6.9 Test 8, Lateral Alignment of Cassette/Tray

This test permits the alignment of the tray and cassette to be checked. Select test, insert cassette and switch on. The instrument produces continuous lines across the width of the chart 2mm apart; the lines are produced sequentially and should be parallel to the chart lines.

6.10 Test 9, Servo Motor Phase

When connecting servo motor plug (yellow/grey) PL3 to control PCB, it is important that the position is such that the motor phase to end stop relationship is correct. This can be checked by determining the exact number of steps available between the capstan end stops. Use of this test enables the number of steps to be determined.

After the initialisation sequence, the carriage will move to approximately full span position (500 steps). Once in this position it can be nudged to the right by pressing SELECT and holding it in. The carriage will move to the right one step at a time. note the number of complete steps before the capstan end stop is reached. The correct number of steps is 504 and the plug 3 (yellow/grey) may have to be moved to achieve this.

Due to component part tolerances, it is possible to achieve 504 steps but still have a condition which is not ideal. Therefore, having determined the most suitable position for plug 3 using this test, Test 3 should be used to ensure that no vibration of the servo motor exists at either zero or span. (Allow Test 3 to run without interference). If vibration exists using Test 3, repeat Test 9 and determine the plug position which will provide 505 complete steps (504 or 505 steps are acceptable). If it is not possible to achieve a vibration-free condition with either 504 or 505 steps, there is a fault with either the servo motor or capstan end stop position.

7. INPUT BOARD CALIBRATION, TESTING & FAULT DIAGNOSIS

7.1 Introduction

The flowchart in Figure 7.1 gives a possible check procedure for a suspect input board. The most practical way of deciding where a single channel fault lies is by input board or transducer substitution.

An input board should be tested using the 5-point calibration check.

If the board is out of calibration then the 2-point calibration procedure should be followed.

Allow 5 minutes warm-up time before calibration check or calibration procedure.

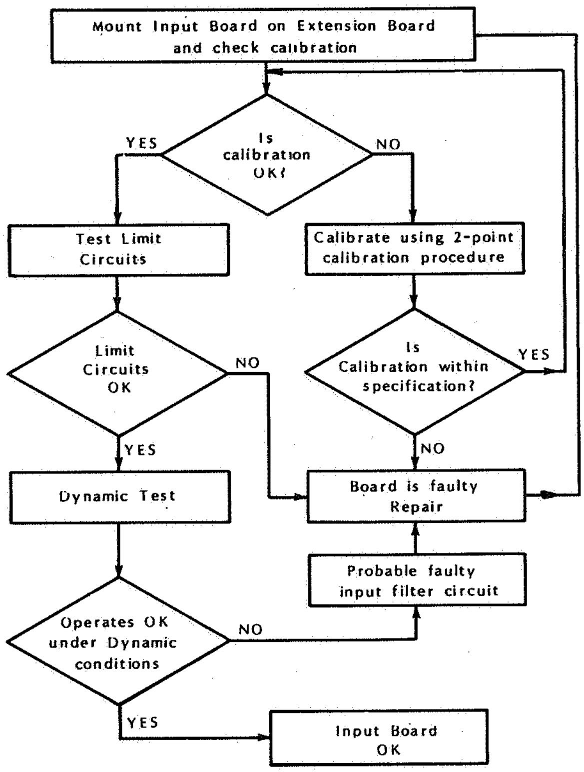


Figure 7.1 FLOW CHART FOR INPUT BOARD CHECK PROCEDURE

7.2 2-Point Calibration

The overall linear compensation gain curve is affected by the zero and span adjustment settings. It is possible to adjust the zero and span potentiometers so that the compensation curve is correct at both ends of the range. However, such an adjustment would result in the calibration being incorrect at points in-between zero and span.

The span and zero potentiometers are set during manufacture using a calibration procedure which is designed to give optimum performance over the whole measurement range. In order to duplicate this procedure, two calibration points (referred to as the 1 and 9 volt calibration points), are used. These points are chosen to obtain optimum linearisation and cannot be taken from the transducer characteristics. The calibration point information is obtainable upon request.

7.3 Equipment Required

The following equipment is required for testing and calibration of input boards:-

1. Voltage calibrator, Time Electronics 2003S voltage source.
2. Back-plate fitted with mains connector and CJT element.
3. Digital voltmeter (DVM) 4½ or 5½ digit.
4. Input extender card, part number AH320150.
5. Bulletin TT2-1 Thermocouple & Resistance Thermometer Tables.
6. Resistance box, resistance thermometer boards only.

7.4 Extender Card Description

The input board must be mounted on an extender card for calibration and service; all components and test points are then accessible. The extender card also provides the necessary voltage and input/output test points.

Link A to 1---TP8BE---3.131V
Link A to 2---TP8BE---2.732V (simulated CJT volts)
Link A to 3---TP8BE---connected to TP8A, 2.7-3.2V from CJT

Link B to 2 Upscale Drive connected
Link B to 1 Upscale Drive disconnected

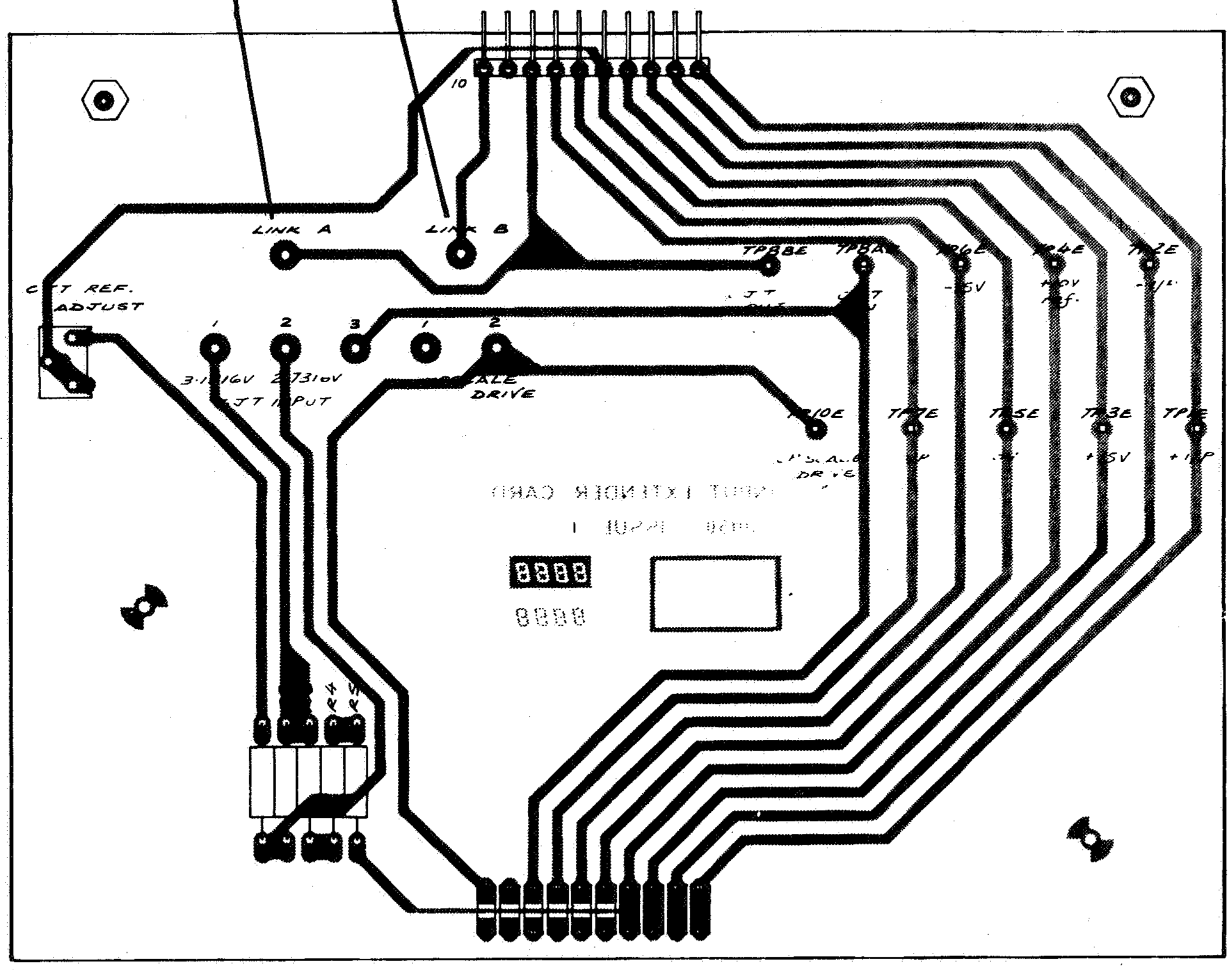


Figure 7.2 EXTENDER CARD
(Drawing No.AH230150, Issue 1)

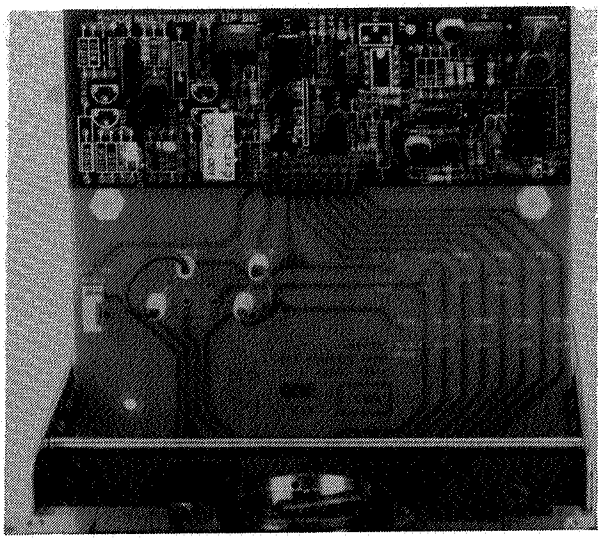


Figure 7.3 INPUT BOARD MOUNTED ON TOP OF EXTENDER CARD

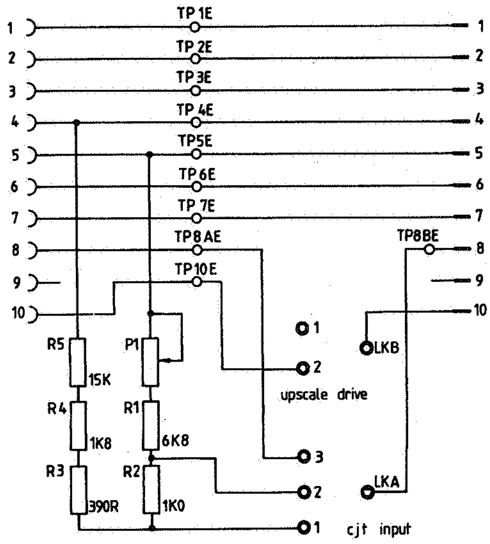


Figure 7.4 CIRCUIT DIAGRAM OF EXTENDER CARD (Drawing No.AI230150, Issue 1)

7.5 5-Point Calibration Check, General Purpose Board 128204 (see 7.1)

a) Mount input board on extender card as shown in Figure 7.3.

b) Set link A on extender card to 2. Check that the voltage between TP8BE and TP5E is 2.732V. Adjust the potentiometer on the extender card for the correct voltage if necessary.

c) Set link B to position 1, which disconnects the upscale drive.

d) The DVM provides an accurate measurement of the input board output voltage. 10.00V would be equivalent to 100% span. Connect the DVM to measure 0-10V output from the board at TP7E (positive) and TP5E (negative) of the extender card.

e) Connect the voltage calibrator positive lead and negative lead to extender card TP1E and TP2E respectively.

f) At the control panel, set to CAL and select channel appropriate to board under test. Insert a cassette. Take care not to touch the print turret or it may be knocked out of synchronisation with the pen position control signal.

g) Check 20% of span. For example, if the span is 0-100°C, look up the voltage that would cause 20% of span in the appropriate type (e.g. T or S) in the TT2-1 book and set the 20% span voltage at the voltage calibrator. Check that the output at TP5E and TP7E is 2V ±30mV. Note that the pen marks the chart at 20% of span 0.5% (20°C in this example). Note that the chart paper may give a variation of 1% due to changes in humidity.

h) Repeat for 40,60,80,100 and 0% of span. The allowable error is usually ±30mV but can be greater in certain cases. If the error is outside the limits see "2-Point Calibration".

i) Connect the DVM between test point 2 of the input card and TP5E of the extender card. Transfer link A from 2 to 2 and back to 2 and check that the reading changes by the VCJ voltage (data obtainable from Chessell or indicated on label on later issues of TC boards). Adjust potentiometer P2 if necessary to achieve the correct voltage change.

7.6 5-Point Calibration Check, Resistance Thermometer Board 129243 (see 7.1)

a) Mount the input board on the extender card as shown in Figure 7.3.

b) Connect TP1E and TP2E on the extender card to one terminal of a resistance box using two separate identical leads.

c) Connect the other terminal of the resistance box to TP5E, using a lead identical to those in 2.

d) Connect the DVM to measure 0-10V output from the input board at TP7E (positive) and TP5E (negative) at the extender card.

e) At the control panel, set to CAL and select channel appropriate to board under test. Insert a cassette. Take care not to touch the print turret because it is possible to adversely affect the synchronisation between the cursor position control signal and the stepper motor.

f) INPUT BOARDS WITHOUT ZERO ELEVATION: Test at 0,20,40,60,80 and 100% of span. For an instrument with a straightforward span of 0-100°C, select the appropriate values of resistance from the RT table on page 24 of Book TT2-1 appropriate to 0,20,40,60,80 and 100°C.

g) The first value of 100 ohms input should give a DVM reading of 0V and the second of 107.79 ohms a reading of 2.0V, etc., throughout the range. The DVM readings should be within ±30mV and pen record of the percentage of span should be within ±0.5%. The chart paper can give a variation of 1.0% due to changes in humidity so the pen record can only be checked accurately if the humidity is stable.

h) INPUT BOARDS WITH ZERO ELEVATION: The RT table given in book TT2-1 gives test points at 10°C intervals. If a range is, say, 10°C to 70°C then suitable test points may not exist at 20%, 40%, etc. of span.

i) A method of finding suitable test points is described, using a range -10°C to +70°C as an example. This range has a span of 80°C and an elevation of -10°C.

j) Find 20% of span = percentage x span + elevation
= 20/100 x 80 + (-10)
= 6°C = 20% of span

k) From the RT table in TT2-1, select the nearest test point to 6°C which in this case is 10°C.

l) Divide 10V (the input board output at 100% span) by the input span (80°C in this example) to obtain volts output per °C input (0.125V in this example).

m) Multiply the step of span, 0% to the test point (-10°C to 10°C = 20°C in this example) by the volts output per °C input (0.125V from (c)). This gives a board voltage output (1.25V) for 10°C (103.9 ohms) input.

n) Repeat j) to m) for the next test point 40% of span. For example:-

$$\frac{40}{100} \times 80 + (-10)$$

o) The nearest test point is 20°C. From -10°C to +20°C is 30°C. 30 x 0.125 = 3.75. An input of 20°C (107.97 ohms) gives an output on the DVM of 3.75V.

p) Repeat i) to l) for nearest test points to 60%, 80%, 100% and finally 0% of span. DVM readings should be within ±30mV and pen record of the percentage of span should be within ±0.5%. The chart paper can give a variation of 1.0% due to changes in humidity.

Note: The best approach to items h) to o) is to do the calculations of the check-points first and then to do the actual checks. This is because the instrument reverts back to the RUN mode after 5 minutes when in the CAL mode and this suggestion would prevent having to reset to CAL.

7.7 Calibration Check & Calibration, Linear Board 129654

a) Connect up the input board, extender card and test equipment as described in a) to f) of the General Purpose Board 5-Point Calibration Check (7.5).

b) Set a value of 10%, then 90% at the voltage calibrator. Note that the DVM reads 1V ±0.5mV and 9V ±0.5mV respectively.

c) If the input board is not within calibration adjust the offset by shorting pins 2 and 3, adjusting P4 for a reading at the DVM of between 0 and 10V.

d) With the voltage calibrator set for 10% of span, adjust P1 for 1V ±0.5mV at the DVM. Repeat at 90% of span for a DVM reading of 9V ±5mV.

7.8 2-Point Calibration, Multipurpose Board 128204 (see 7.1)

a) Connect up the input board, extender card and test equipment as described in a) to f) of the 5-Point Calibration Check.

b) ADJUST OFFSET: 0V reading at the DVM. Use a small short screwdriver to short-out pins 2 and 3 of IC3 and at the same time adjust P4 for a DVM reading of between 0 and 10V.

c) ADJUST 10%: Set a value at the voltage calibrator, from the label on the back of the input board, which should give a reading of 1V at the DVM. Adjust P1 for 1V ±5mV at the DVM.

d) ADJUST 90%: Set a value at the voltage calibrator, from the label on the back of the input board, which should give a reading of 9V at the DVM. Adjust P3 for 9V ±5mV at the DVM.

e) Adjustments c) and d) are interactive. Repeat c) and d) until there is no further improvement.

7.9 2-Point Calibration, Resistance Thermometer Board 129243 (see 7.1)

a) Connect up the input board, extender card and test equipment as described in a) to f) of the 5-Point Calibration Check.

b) ADJUST OFFSET: Set a value at the resistance box that should give 0V reading at the DVM. Use a small short screwdriver to short-out pins 2 and 3 of IC2 and at the same time adjust P2 for a DVM reading of between 0 and 10V. Repeat for IC3 and IC4 adjusting P3 and P4 respectively.

c) ADJUST 10%: Set a value at the resistance box, from the label on the back of the input board, which should give a reading of 1V at the DVM. Adjust P1 for 1V ±5mV at the DVM.

d) ADJUST 90%: Set a value at the resistance box, from the label on the back of the input board, which should give a reading of 9V at the DVM. Adjust P5 for 9V ±5mV at the DVM.

e) Adjustments c) and d) are interactive. Repeat c) and d) until there is no further improvement.

7.10 Limit Circuit Test, All Input Boards

a) Connect up the input board, extender card and test equipment as described in a) to f) of the 5-Point Calibration Check.

b) GENERAL PURPOSE BOARD: This board has upper and lower limits. Set a value at the voltage calibrator to give 100% span. Increase the voltage, in small steps, and note that the DVM reading does not increase above +11.5V as the input voltage continues to be increased. Set the voltage calibrator to 0% span; then adjust, in small steps, so that span goes below 0%. Note that the DVM reading does not go below -1.5V.

c) LINEAR BOARD: This board has a lower limit only. Adjust the voltage calibrator level, in small steps, so that the span goes below 0% and note that the DVM reading does not go below -1.5V.

d) RT BOARD: Issue 1 boards have a lower limit only. Set the resistance box to 0% span then adjust, in small steps, so that the span goes below 0%. Note that the DVM reading does not go more negative than -1.5V. Issue 2 boards have an upper limit only. Set the resistance box to give 100% span; then increase, in small steps, and note that the DVM reading does not increase above 11.5V.

e) Adjustments c) and d) are interactive. Repeat c) and d) until there is no further improvement.

7.11 Dynamic Test, All Input Boards

a) Connect up the input board, extender card and test equipment as described in a) to f) of the appropriate 5-Point Calibration Check.

b) Perform a 5-point calibration test if this has not already been done.

c) The pen record should relate to DVM reading. If it does not, a fault may exist on the scanning board. A fault in the MUX or the analogue/digital converter will normally affect all channels.

d) Set to RUN mode, select speed 6 and repeat c).

e) Remove the voltage calibrator, or resistance box, leads from the extender card and connect to an input appropriate to the board under test. Repeat the 5-Point Calibration Check.

f) If the result of this test is unsatisfactory, a fault could exist in the input selector relay or the input board filter, if appropriate. Capacitors C1 and C2, 47μF tantalums, should be replaced if the filter is suspect.

8. MECHANICAL MEASUREMENTS & ADJUSTMENTS

8.1 Pen Gap

This measurement and adjustment is done with the instrument switched off and the cassette in place.

MEASUREMENT: Measure the distance between the tip of the pen and the paper using a feeler gauge. The gap should be 1.5mm 0.5mm.

ADJUSTMENT: Lift the scale. Hold the cursor block clamping screw witn a screwdriver and rotate the nylon stop with the thumb and forefinger, see Figure 8.2

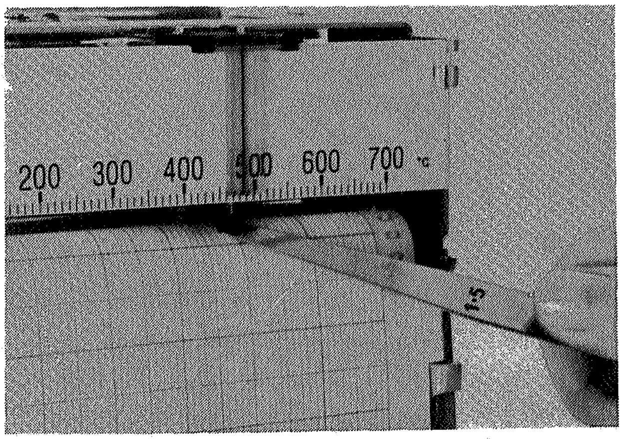


Figure 8.1 PEN GAP MEASUREMENT

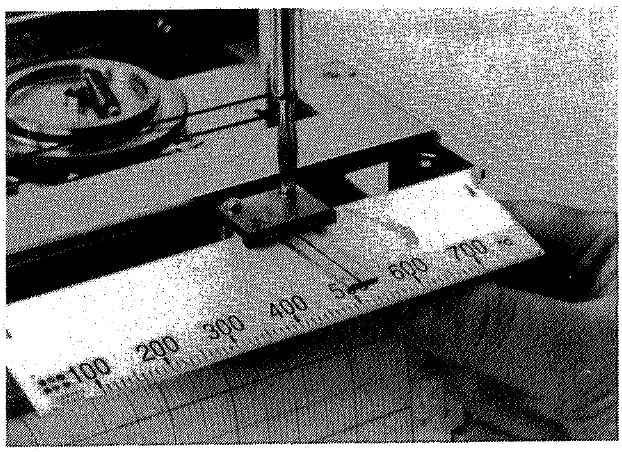


Figure 8.2 PEN GAP ADJUSTMENT

8.2 Pen Dotting Force

MEASUREMENT: Remove the cassette, switch on the instrument and select position 9 on the digit switch. Replace the cassette. The cursor will come to rest in the centre of the chart after the initialisation phase is completed. The cartridge will energise downwards for 3 seconds and go back to the raised position for 12 seconds. Place the blade of a 2-15 gram correx gauge at the bottom of the cartridge and lift it while it is in the energised down position. It should lift at a force of 11 grams ±3 grams. Repeat the measurement until the readings are consistent.

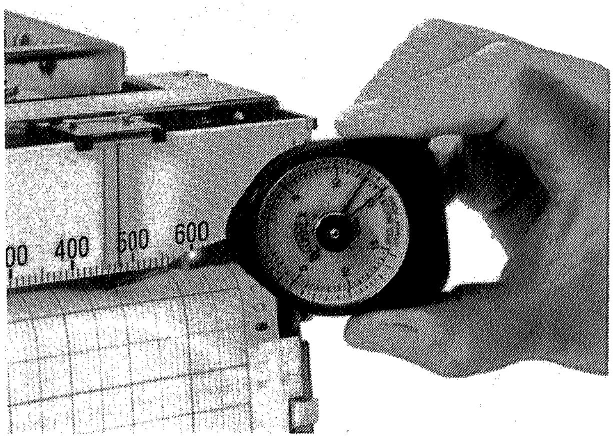


Figure 8.3 PEN DOTTING FORCE MEASUREMENT

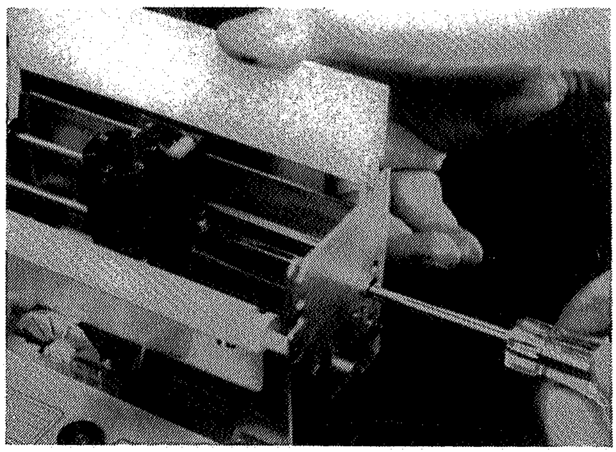


Figure 8.4 PEN DOTTING FORCE ADJUSTMENT

ADJUSTMENT: Ideally, this adjustment should be made with a full cartridge. Slacken the head retraction spring screw via the hole in the right-hand side of the pen tray (see Figure 8.4).

Re-position the spring, moving it backwards at the top increases the spring force and decreases the dotting force. Tighten the head retraction spring screw and measure the dotting force. The adjustment usually requires more than one attempt before the dotting force is correct.

8.3 Drive Cord Tension

Check that the tension spring on the capstan is set correctly. If the spring is not under tension the tow cord will be too slack, and if the spring is stretched until it is in contact with the capstan rim the tension will be excessive. The tension spring should be replaced if the end connected to the drive cord is not 3mm (±1.5mm) from the inside of the capstan rim. If replacement of the spring does not give the correct clearance, the drive cord should be replaced. For part numbers see the exploded views at the end of this manual.

8.4 Capstan Bearings

Lift tension spring from capstan anchor point and disconnect tow cord from spring. Rotate capstan on its bearing and check that it runs freely and quietly. If the capstan is binding on the needle bearings, apply two or three drops of microtime oil (available upon request, EB127750). Check that the axial float is between 0.5mm and 0.3mm (see Figure 8.5). Reconnect the tow cord and spring.

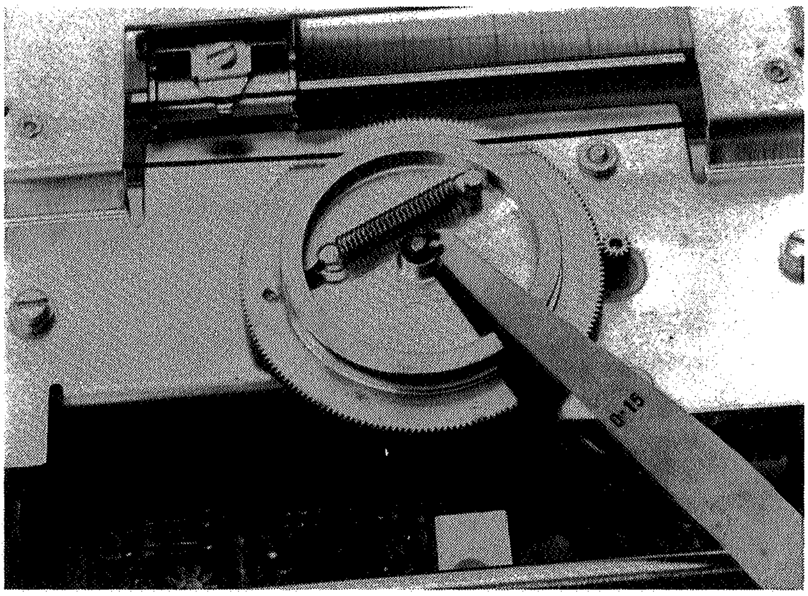


Figure 8.5 CAPSTAN AXIAL FLOAT CHECK

8.5 Cursor/Scale Clearance

When the scale and cursor are lifted as shown in Figure 8.2, the cursor will remain in the horizontal position after the scale has been returned to the vertical position. When the cursor is pressed down, it should snap into the vertical operating position which should be between 0.3mm and 1.5mm from the scale.

The unit and multiplier labels on the scales are 0.2mm thick, so 0.1mm is the minimum clearance between the labels and the cursor. This clearance should be checked as shown in Figure 8.6.

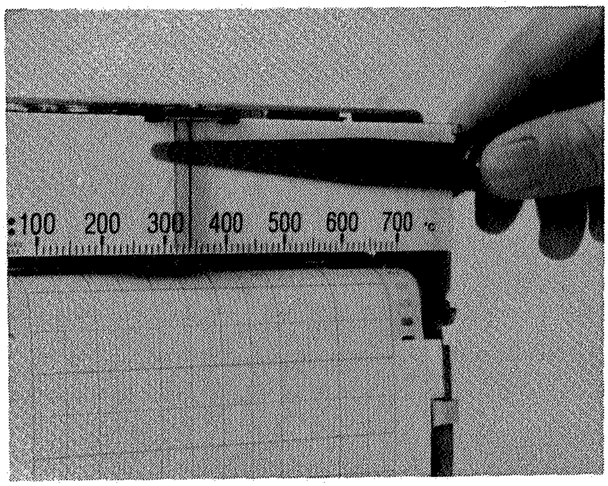


Figure 8.6 CURSOR/SCALE CLEARANCE MEASUREMENT

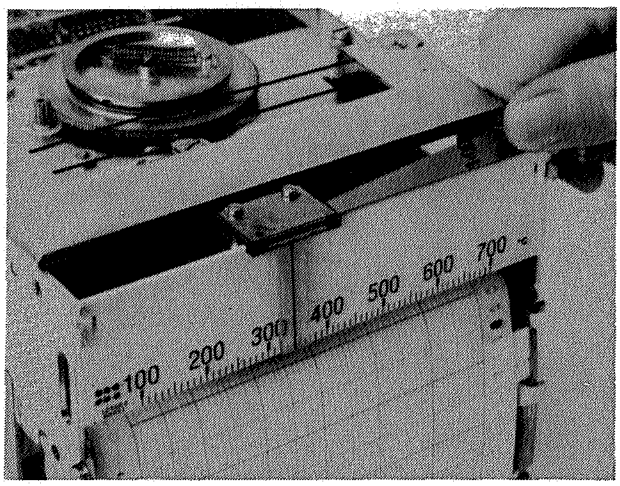


Figure 8.7 CARRIAGE SCALE PLATE, VERTICAL CLEARANCE MEASUREMENT

8.6 Cursor Vertical Alignment

MEASUREMENT: The vertical alignment of the cursor with the scale should not exceed 0.2mm for the length of the cursor. (The fine lines on the scale are approximately 0.2mm thick).

ADJUSTMENT: Turn the left-hand cursor block clamping screw (see Figure 8.2) approximately one-eighth clockwise and the right-hand one-eighth anti-clockwise. If the alignment is made worse, make the above adjustment but start with the right-hand screw. Continue the adjustments until the alignment is correct.

8.7 Miscellaneous Items

CARRIAGE/SCALE PLATE VERTICAL CLEARANCE:
Any mis-alignment of the rear and front guide rails can result in a locking action as the carriage moves from side to side.

This dimension can be checked by measuring the clearance between the top of the scale and the underside of the carriage, with the instrument switched off. This clearance should be 0.8mm ±0.6mm. Even if the carriage does move freely, if the clearance is too small the front guide bearing should be replaced.

END PULLEY:
Lift the tension spring from the capstan anchor point and the tow cord off the end pulley. The pulley should rotate freely and have an axial movement (float) of between 0.2mm and 2.0mm. Free, or replace as necessary. Replace cord on pulley and tension spring on capstan.

OUTER CASE DAMAGE:
Check that the outer case has not been bent inwards so that it impedes the carriage movement. Repair or replace case.

CAPSTAN TEETH:
Replace capstan if the teeth show sign of wear or damage.

CARRIAGE SHAFT:
Look for visible signs of damage. Replace if necessary.

9. DISMANTLING INSTRUCTIONS

The following instructions describe a method for removing sub-assemblies for maintenance and is not a sequence for stripping the instrument down.

9.1 Instrument Chassis

The instrument is held in its case by a single locking screw located above the control panel behind the cassette. The chassis is removed from the case by unscrewing LOCKSCREW and then withdrawing the chassis from the case.

9.2 Plugs & Sockets

The printed circuit boards are connected via miniature plugs and sockets. Pull the plugs out by the body of the plug and not by the connecting wires. If the plugs are tight and inaccessible, use an insulated screw-driver and gently prise the plug from the socket.

CAUTION: TAKE CARE NOT TO SHORT COMPONENT CONTACTS TOGETHER, EVEN IF THE INSTRUMENT IS SWITCHED OFF AS THIS MAY DAMAGE THE L.S.I. CIRCUITS.

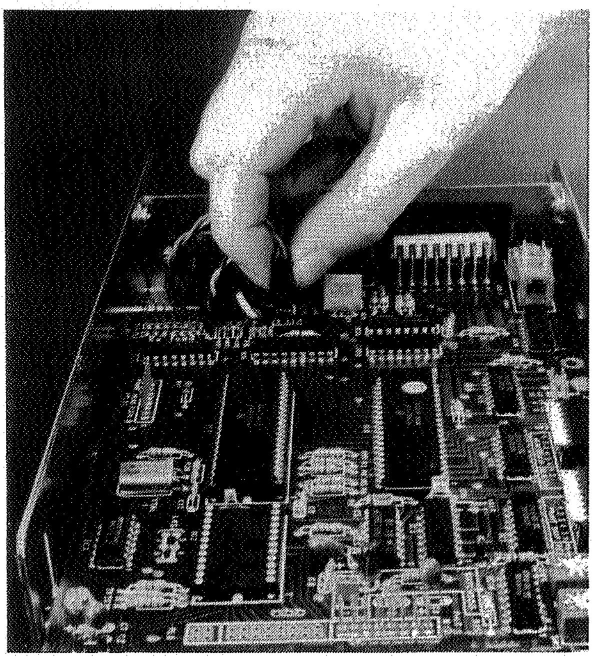


Figure 9.1 CORRECT WAY TO REMOVE PLUGS

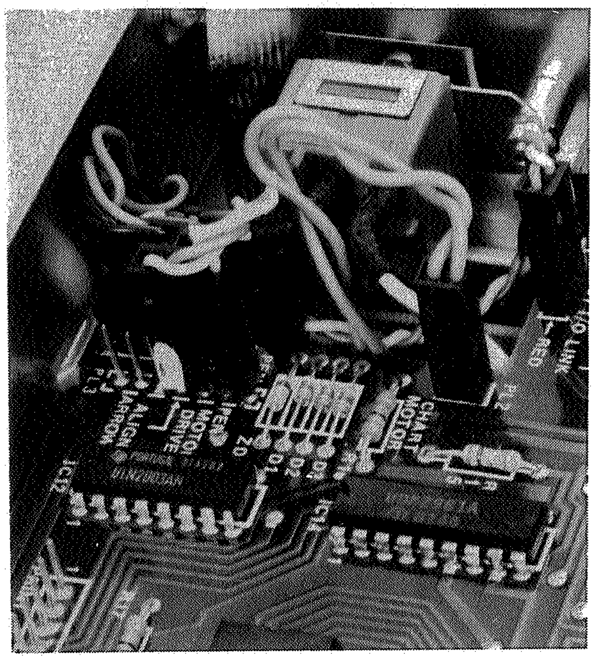


Figure 9.2 PL3 ALIGNMENT

N.B. When connecting the control board ensure that the white mark on the side of PL3 aligns with the arrow on the control board.

9.3 Control Board

Turn the chassis upside down. Unplug PL1,2,3,4 and 5. Unscrew the two retaining screws and pull the board out towards the rear of the instrument.

9.4 Scanning Board

Remove the input boards. Unscrew the two retaining screws at the rear and pull the board out backwards. When assembling and replacing the scanning board, take care when engaging SKT1 to the scanning interface board.

9.5 Pen Tray

Turn the chassis upside down. Disconnect PL5, the flexistrip plug on the control board, PL3 (yellow/grey wires) and PL4 (black/red wires).

Turn the chassis the right way up and remove the pen tray screws. Gently pull the pen tray cables through as the pen tray is withdrawn.

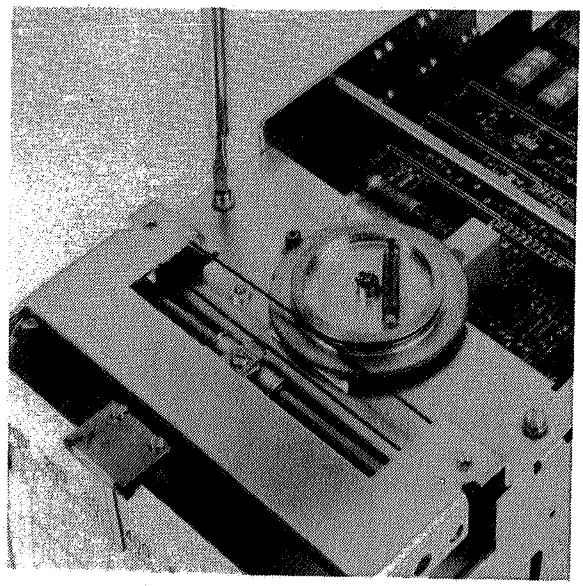


Figure 9.3 RELEASING PEN TRAY FIXING SCREWS

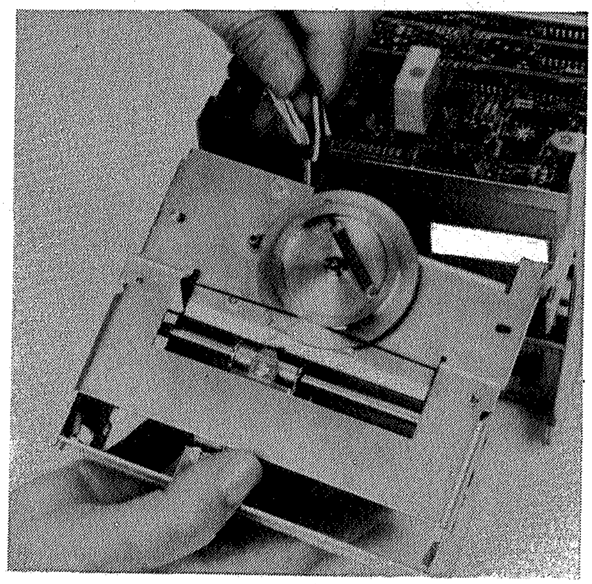


Figure 9.4 REMOVING PEN TRAY

9.6 Power Supply Board

Remove the scanning board. Unplug PL4 and PL5. If the control board has not been removed, unplug PL6 from the control board. Unscrew the two retaining screws at the side of the instrument and remove the power supply board.

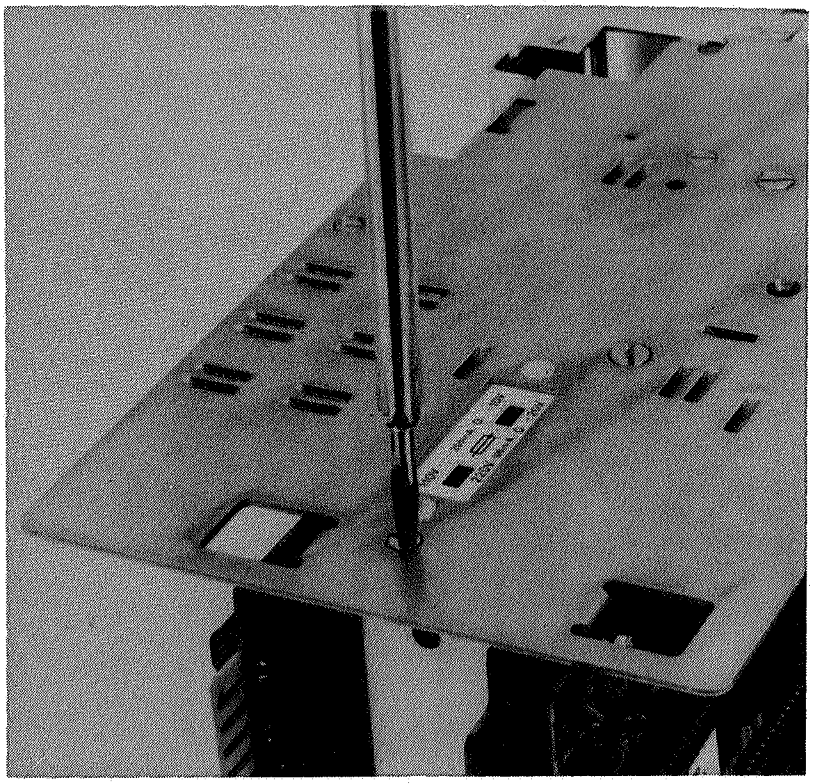


Figure 9.5 POWER SUPPLY RETAINING SCREW LOCATION

9.7 AC Supply Transformer, Chart Drive Motor & Scanning Interface Board

Remove control, scanning and power supply boards, and pen tray.

In all cases where wires are unsoldered, a sketch should be made beforehand clearly identifying each wire and its connecting point so that the assembly can be reconnected without error.

TO REMOVE TRANSFORMER:
Unplug lead from interface board. If switch is not removed at this stage, unsolder coloured leads. Remove transformer nuts and bolts.

TO REMOVE SCANNER INTERFACE BOARD:
The transformer and motor must be removed to gain access to the board retaining screws.

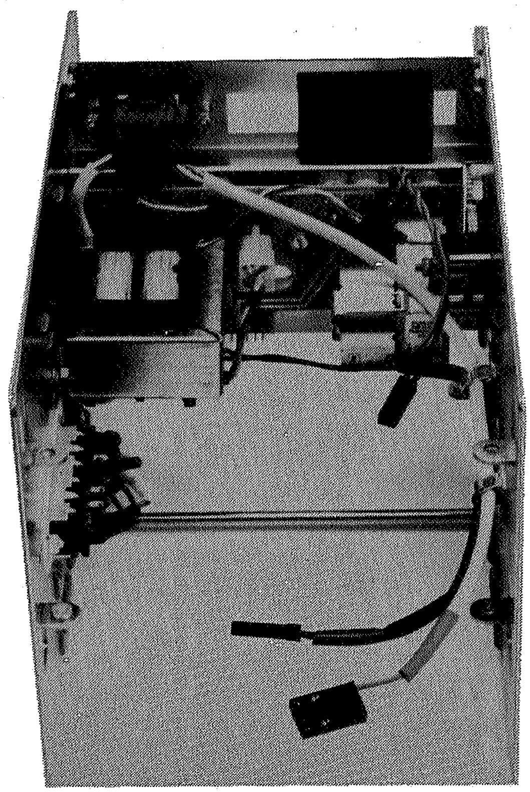


Figure 9.6 TRANSFORMER & SCANNER INTERFACE BOARD REPLACEMENT

CAUTION: WHEN REPLACING AC SUPPLY SWITCH USE NYLON SCREWS AND NUTS, AND CHECK SWITCH MOVEMENT IS UNRESTRICTED.

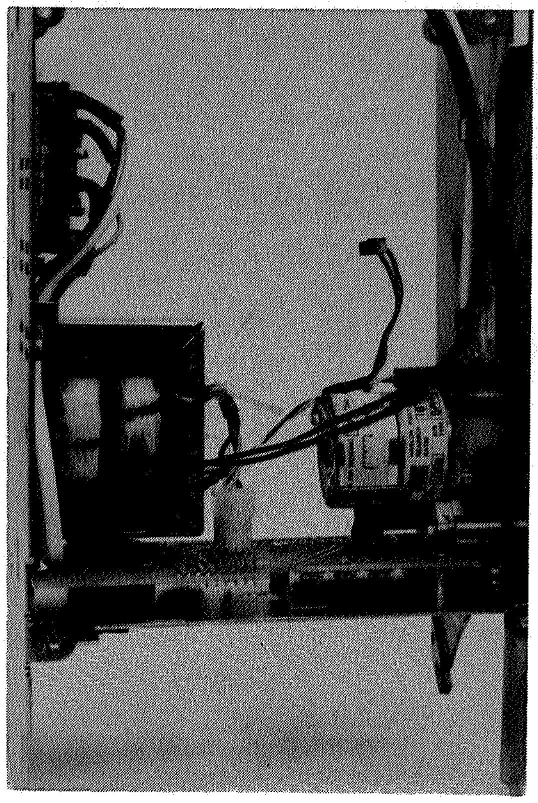


Figure 9.7 CHART DRIVE MOTOR REPLACEMENT

To remove chart drive motor, unscrew screws and nuts. When replacing ensure cogs are meshed correctly. Adjust so that neither backlash nor tightness is excessive.

10. 306 GENERAL CIRCUIT DESCRIPTION

Refer to Figure 10.1, 306 Detailed Block Diagram.

10.1 General

Overall control of the 306 recorder is exercised by a 6802 microprocessor system. It ensures that the input signal is switched to its appropriate input conditioning board; converted to a digital signal which is then used to drive the pen indexing and pen position motors.

10.2 Input Conditioning Board Isolation

The scanning and input boards are isolated, and at the potential of the input that is momentarily connected during the scanning sequence; providing a high degree of common mode and series mode rejection. This isolation is achieved by using an isolated power supply and an isolated signal and control path between the scanning board and the control board.

10.3 Input Switching & Conditioning

The input signals are switched, in turn, to pre-determined input conditioning boards. This switching is achieved with reed relays operated by the 8-bit register under control of the microprocessor. Up to three of these input boards are used which will accept a range of thermocouple inputs, RTDs, voltage or current sources and provide a linear 0-10V analogue voltage output.

The outputs from the conditioning boards, plus potentiometer values such as zero offset, span and alarm set points, are selected by the multiplexer (MUX), again under the control of the 8-bit control register.

The analogue signal from the multiplexer is then converted to a digital signal with the dual slope analogue to digital converter and routed to the control board via the isolated transmission link.

10.4 Control

The microprocessor system comprises a 6802 uP, a 6821 2 x 8-bit peripheral interface adaptor (PIA), and a 2732 4K x 8 EPROM. The functional configuration of the 6821 PIA is programmed by the µP, with the instructions in the PROM, during initialisation. The input/output lines (I/O), of the PIA are used as follows:-

a) To control and interrogate the scanning board via the isolated two-way transmission link so that the channel data can be read into the microprocessor system.

b) To read in data from the operator controls, preset option switches and remote control opto-isolators, via a 4 x 1 of 8 multiplexer and to drive mode indicator LED's via a decode circuit.

c) To drive the chart drive, carriage drive and indexing stepper motors via driver circuits and decoding circuits where necessary.

10.5 Chart Drive, Carriage & Indexing Motors

Stepping motors are used for chart drive, carriage position (cursor/pen) and pen indexing (pen nib colour). No feedback exists on these drives and, where necessary, provision has to be made to ensure that the motor is in agreement with the control signal. The carriage motor synchronisation is checked every scan when the carriage hits the end stop, which is equal to zero in the control signal code.

The indexing motor rotor will only follow the control signal, which is applied to the motor field, if it is synchronised. If the motor starts out of synchronisation the rotor will wait until the field rotates round to the rotor position.

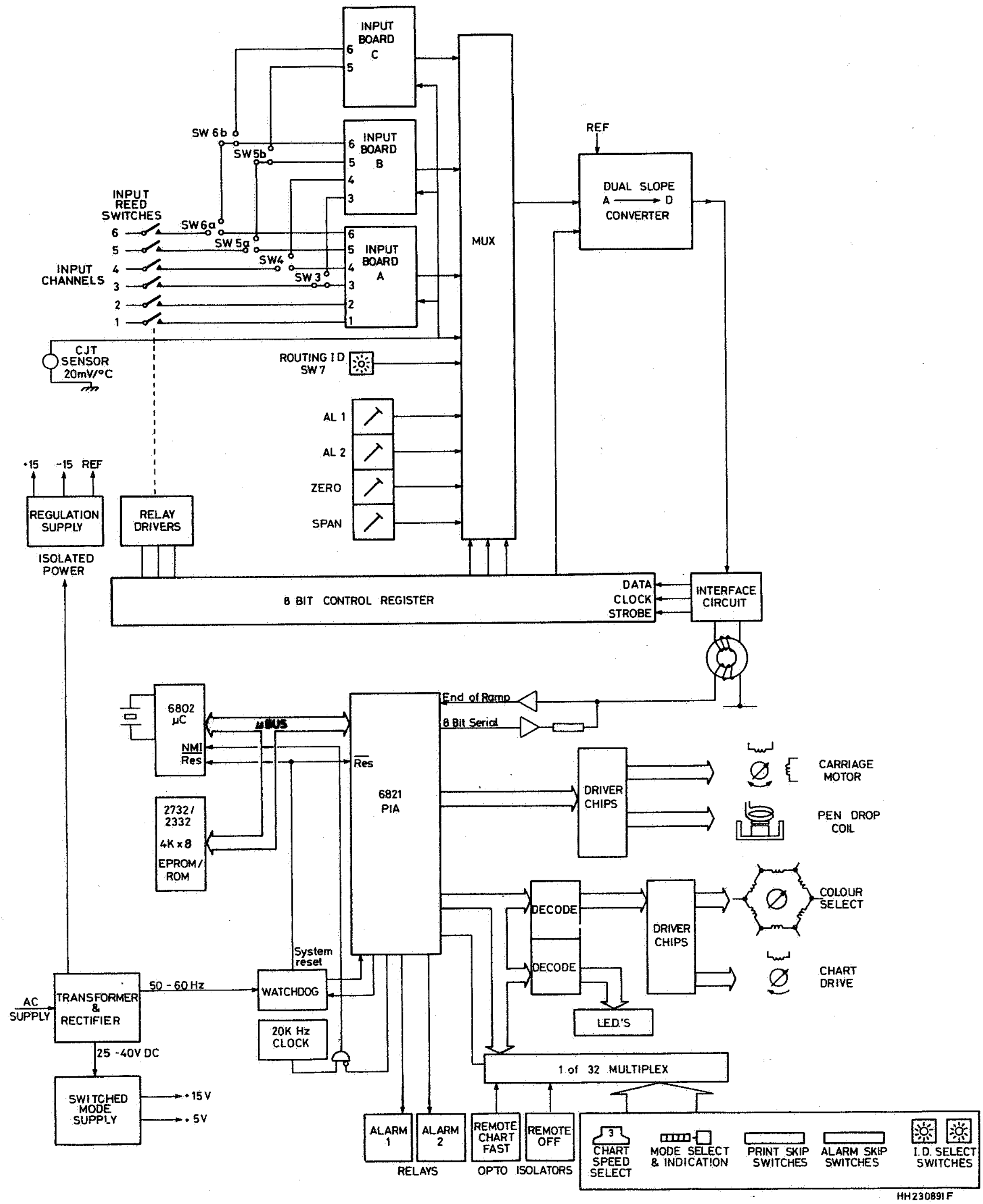


Figure 10.1 306 DETAILED BLOCK DIAGRAM

11. MULTI-PURPOSE INPUT BOARD 128204 CIRCUIT DESCRIPTION

11.1 Introduction

The input amplifier is designed for ranges of 4mV to 24V. The circuit may be divided into four functional sections; these are:-

1) An inverting amplifier stage that uses the incoming +10V reference to produce a stable -10V reference, the unity gain of the circuit being defined by two equal value, high accuracy, low drift resistors.

2) A cold junction compensating circuit that buffers and conditions the remote cold junction thermometer signal to produce a voltage in series with the input, that has a temperature co-efficient over the ambient range equivalent to the thermocouple in use.

3) A low drift high gain amplifier stage that has output level clamps along with resistance networks that allow trimming of amplifier span and zero.

4) A gain defining circuit which allows the production of a four section linear approximation to the inverse characteristics of any non-linear input signal.

11.2 Reference -10V

The on-board -10V reference is achieved by buffering and inverting the incoming +10V reference by the use of an LM741 operational amplifier (IC1) which is configured in an inverting mode. The unity gain of the circuit is determined by the resistors R1 and R2. R3 is included to eliminate error caused by the input bias current to the amplifier.

11.3 Cold Junction Compensation

The 10mV/°Kelvin output of the remote cold junction thermometer is fed to the non-inverting input of an LM741 operational amplifier (IC2) which is connected as a voltage follower. The output of IC2 is fed to a resistive network consisting of R4, R5, R12, P2 and R8 to produce a voltage calibrated in millivolts/°C across R8 that increases with increasing temperature. The combinational value of R12 and P2 is selected such that when added to the equivalent source impedance at the junction of R4 and R5, the change of voltage across R8 with temperature is equal to that produced by the thermocouple in use, over a 0-60°C range. P2 is included for fine adjustments of the compensation voltage.

11.4 Amplifier Stage

An LM725 or equivalent (standard for spans 10mV) or OP05EJ or equivalent (high grade for spans 10mV) operational amplifier is employed to provide high open loop gain and low input voltage drift with temperature. The components R10, C3, C4 and R22 fitted to the standard board are to provide the necessary frequency compensation for the amplifier. An input drift with temperature not exceeding 2μV/°C (standard) or 0.6μV/°C (high grade) is achieved by using P4 to adjust the offset voltage, between the inverting and non-inverting input to zero.

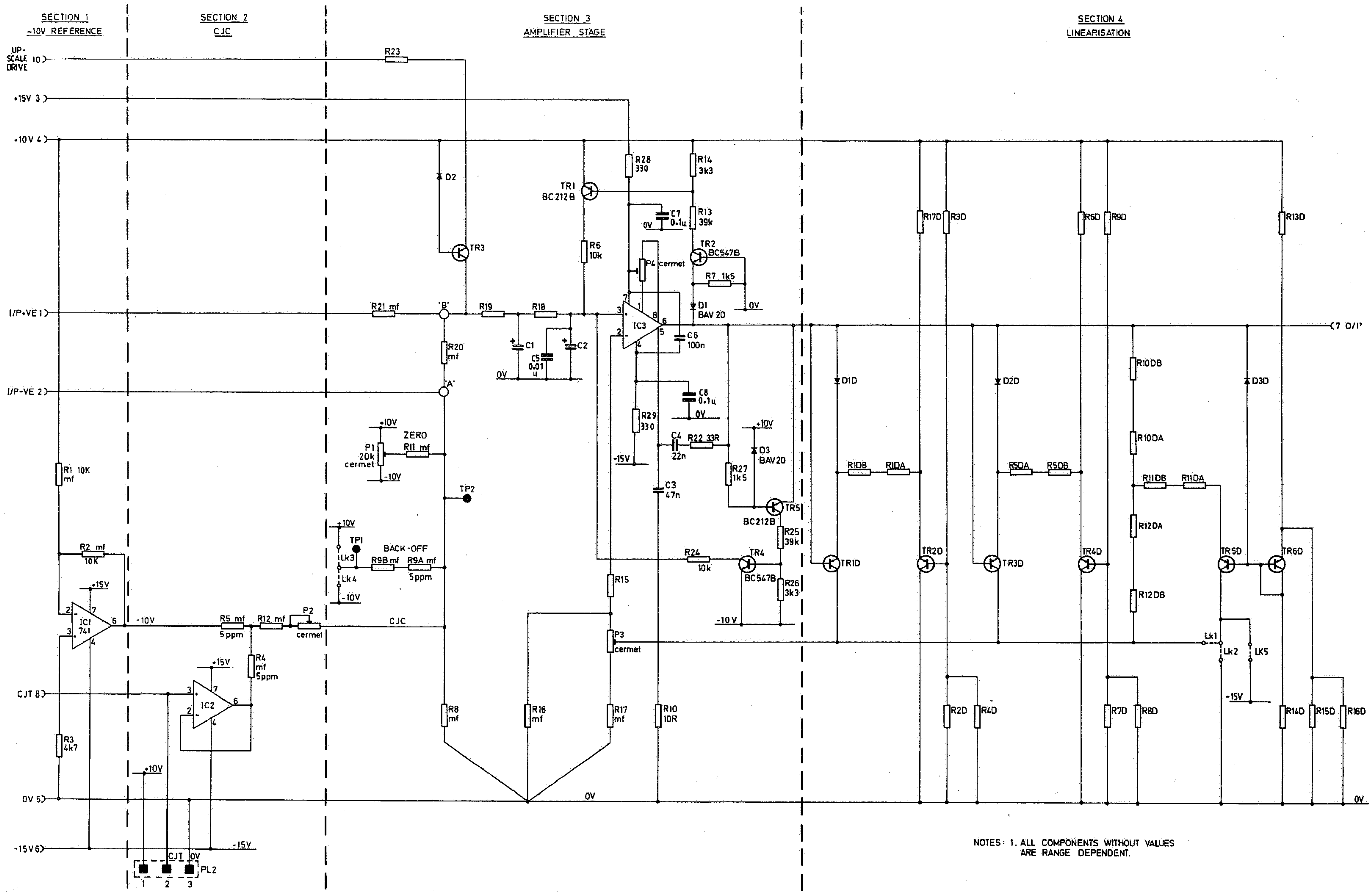


Figure 11.1 MULTIPURPOSE INPUT BOARD, CIRCUIT DIAGRAM
(Drawing No.AI128204, Issue 3)

In the event of an overloading negative input signal being applied, the output level clamp formed by TR1, TR2, D1, R13, R14, R7 and R6 prevents the output from becoming negative by more than 1V. When the output reaches this voltage D1 conducts, drawing current into the base of TR2 which then turns 'on', current flows through R13 and R14 deriving sufficient voltage across R144 to turn TR1 'on'. This then allows current to enter the non-inverting input of IC3 via R6 causing the output voltage to rise, counteracting its tendency to drive negative.

The positive clamp formed by TR4, TR5, R25, R26, R27 and R24 functions in a similar fashion to the negative clamp by limiting the output voltage, when the input is overloaded by a positive signal, to about 11V.

The inverting input to the amplifier is returned via R15 to the span trimming network R16, R17 and P3. P3 is used to set the span during calibration and allows some ±5% span adjustment. R15 is included to reduce input bias current errors.

11.5 Input Networks

The common side of the input signal, A in Figure 11.1, is connected to the 0V rail via R8. By injecting currents into R8 a voltage is produced which appears to be in series with the input signal as far as the amplifier is concerned. The current in R8 can be split into three distinct parts, but not all need to be present:-

1) There is a contribution, via R11, from the zero adjustment control P1; this is always present and has a range of about ±5% of measurement span.

2) A fixed contribution from R9A, R9B may be found; this enables elevated or suppressed zero ranges to be presented to the amplifier.

3) A temperature dependent current may be caused by the CJC circuitry.

At the high side of the input signal, B in Figure 11.1, there is a two stage low pass filter network comprising of R19, C1, R18 and C2 which gives some 40dBs of attenuation to interference at power supply frequencies. The value of R19 is selected so that when added to R8 and a nominal source impedance of 50 ohms, the total approximates to R18.

11.6 Upscale Drive

Components R23, D2 and TR3 cause the output to be deflected fully upscale in the event of a thermocouple failure. A 15V pulse, of 20mS duration, is applied to pin 10 at the beginning of each input sample period (nominally 1 second). TR3 turns 'on' and current defined by R23 flows into the high signal input. The majority of the injected current will normally flow to '0' volts through the low impedance path created by the thermocouple and R8, producing a negligible error at the output. However, in the event of thermocouple failure the injected current will charge the input filter to produce full scale deflection at the output.

11.7 Spans Greater Than 2V

Spans of up to 24V can be achieved by selecting the appropriate values of R20 and R21. The value of these components is selected to ensure an input impedance greater than 100,000 ohms/volt.

11.8 Linearisation Circuits

The gain defining circuit produces a four section straight line approximation to the inverse of a non-linear input characteristic. R10DA, R10DB, R12DA and R12DB are the main feedback resistors and define the nominal amplifier gain. The three linearising circuits allow deviations from this nominal gain over portions of the amplifier output swing. Sections 1 and 2 are similar. Transistors T2D, T4D, T1D and T3D switch on at different levels of output from IC3; effectively changing the total feedback resistor value as individual feedback resistors are switched in or out. The effect of this is to give an increased amplifier gain at low output levels, the amount of increase being dependent on the ratio of R1DA, R1DB, R5DA and R5DB as appropriate, to (R10DA + R12DA + R10DB + R12DB).

Section 3 can operate in one of two modes, depending on whether LK1 or LK2 is fitted. The circuit comes into operation when the proportion of the amplifier output at the junction or R10DA and R12DA is greater than that set on the emitter of T6D. With LK1 selected, the circuit is operated to switch R11DA, R11DB and the amplifier gain is increased. As it is possible to exceed the reverse breakdown voltage of the transistors, diodes D1D, D2D and D3D are included to prevent any spurious gain changes due to this effect.

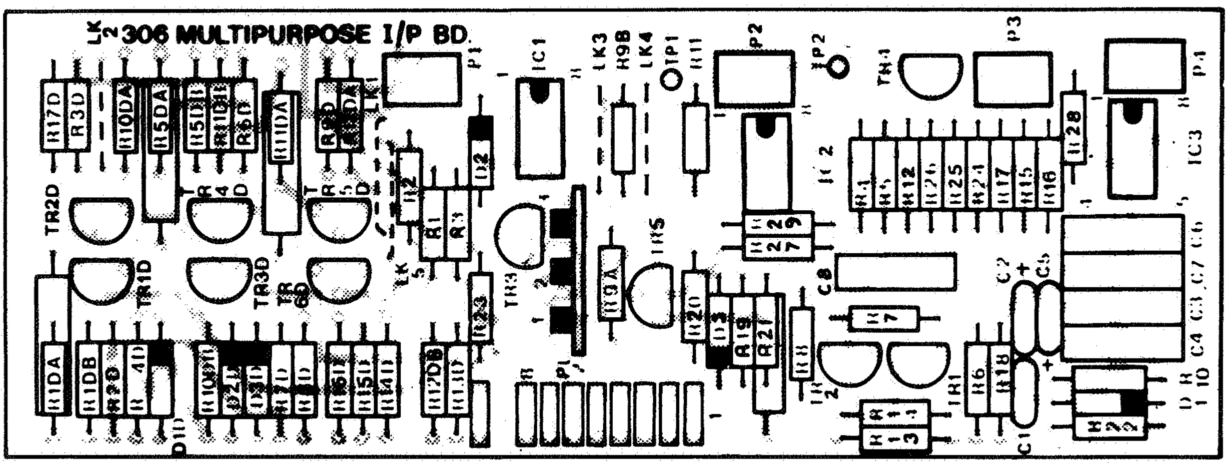


Figure 11.2 MULTI-PURPOSE INPUT BOARD, PCB COMPONENT LAYOUT
(Drawing No.AH128204, Issue 3)

12. LINEAR INPUT BOARD 129654 CIRCUIT DESCRIPTION

12.1 Introduction

The input amplifier is designed for ranges of mV to 24V. The circuit may be divided into two functional sections, these are:-

1) An inverting amplifier stage that uses the incoming +10V reference to produce a stable -10V reference, the unity gain of the circuit being defined by two equal value, high accuracy, low drift resistors.

2) A low drift high gain amplifier stage that has output level clamp along with resistance networks that allow trimming of amplifier span and zero.

12.2 Reference -10V

The production of an on-board -10V reference rail is achieved by buffering and inverting the incoming +10V reference by the use of an LM741 operational amplifier (IC1) which is configured in an inverting mode. The unity gain of the circuit is determined by the resistors R1 and R2 (0.1% accuracy). R3 is included to eliminate any error caused by the input bias current of the amplifier.

12.3 Amplifier Stage

An LM725 or equivalent (standard for spans 10mV) or OP05EJ or equivalent (high grade for spans 10mV) operational amplifier is employed to provide high open loop gain and low input voltage drift with temperature. The components R10, C3, C4 and R22 fitted to the standard board are to provide the necessary frequency compensation for the amplifier. An input drift with temperature not exceeding 2μV/°C (standard) or 0.6μV/°C (high grade) is achieved by using P4 to adjust the offset voltage, between the inverting and non-inverting input to zero. The inverting input to the amplifier is returned via R15 to the span trimming network R16, R17 and P3 which allows some ±5% span adjustment. R15 is included to reduce input bias current errors.

12.4 Input Networks

The common side of the input signal, A in Figure 12.1, is connected to the 0V rail via R8. By injecting currents into R8 a voltage is produced which apears to be in series with the input signal as far as the amplifier is concerned. The current in R8 can be split into two distinct parts, but not all need to be present:-

1) There is a contribution, via R11, from the zero adjustment control P1; this is always present and has a range of about ±5% of measurement span.

2) A fixed contribution from R9A, R9B may be found; this enables elevated or suppressed zero ranges to be presented to the amplifier.

At the high side of the input signal, B in Figure 12.1, there is a two stage low pass filter network comprising of R19, C1, R18 and C2 which gives some 40dBs of attenuation to interference at power supply frequencies. The value of R19 is selected so that when added to R8 and a nominal source impedance of 50 ohms, the total approximates to R18. The provision of attenuating components R20 and R21 allows for ranges of up to 24V span to be fitted on the board.

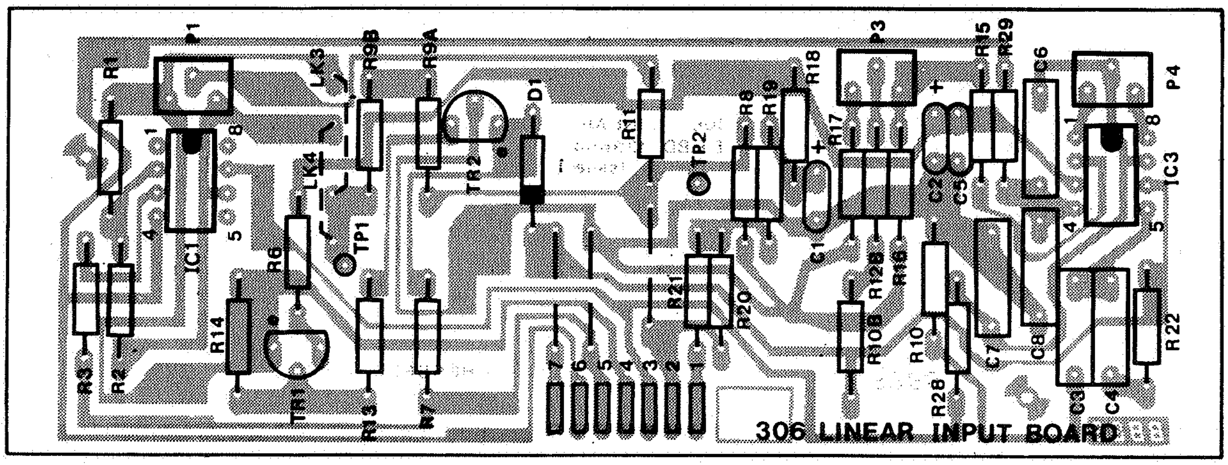


Figure 12.1 LINEAR INPUT BOARD, PCB COMPONENT LAYOUT
(Drawing No.AH129654, Issue 1)

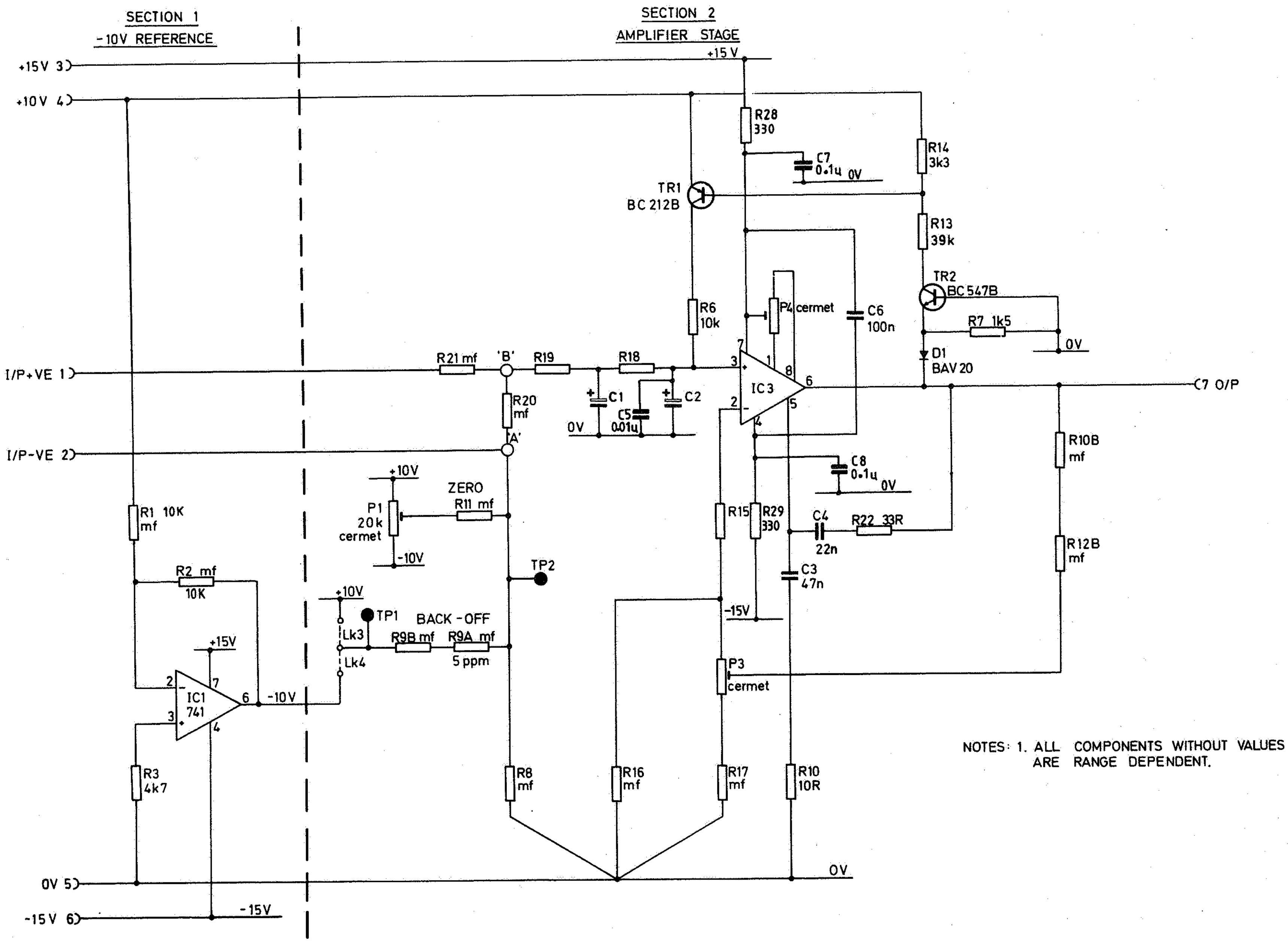


Figure 12.2 LINEAR INPUT BOARD, CIRCUIT DIAGRAM
(Drawing No.AI129654, Issue 1)

13. RTD INPUT BOARD 129243 CIRCUIT DESCRIPTION

13.1 Introduction

The resistance thermometer input conditioning board, when connected to a 3-lead platinum resistance thermometer assembly with one lead commoned, generates a linear output voltage between 0 and 10V as the sensor resistance increases. The circuit supplies a stable current (2mA nominal) to the sensor independent of sensor and lead resistances, subtracts the voltage drop across the sensor from that across a zero-set resistor connected in series and amplifies the difference in voltage to provide the output. A diode linearisation circuit is used and allows a five section approximation of the inverse of the non-linear characteristic of the resistance thermometer.

13.2 Current Source

The 10.00V reference is used to define a stable voltage Va at pins 3 and 2 of ICI. The source current of the P-channel FET TR1 is thus given by -

$$I_o = (10.00 - Va) / R8 \text{-------------} (1.0)$$

Since the gate current is almost zero, the drain current (i.e. the sensor current) is equal to the source current.

13.3 Zero Adjust & Lead Compensation

The zero adjust and lead compensation circuits are implemented using IC2 and IC3. If Rz denotes the equivalent resistance of the network comprising R4, R5, R6, R7 and P1, then the output voltage V_1, of the buffer amplifier IC2 is expressed as -

$$V_1 = I_o(R_s + 2R_\ell + R_z) \text{---------------} (1.1)$$

where, R_l = Resistance in each lead
R_s = Sensor resistance

The voltage V_2 at pins 3 and 2 of IC3 is given by:

$$V_2 = I_o(R_s + R_\ell) \text{-------------------} (1.2)$$

If R12 and R13 are identical, the output voltage V3 of the subtractor amplifier IC3 can be simplified to -

$$V_3 = 2V_2 - V_1 = I_o(R_s - R_z) \text{---------} (1.3)$$

Equation (1.3) can be seen to be independent of the lead resistances and indicates that the zero can be elevated or suppressed by adjusting Rz.

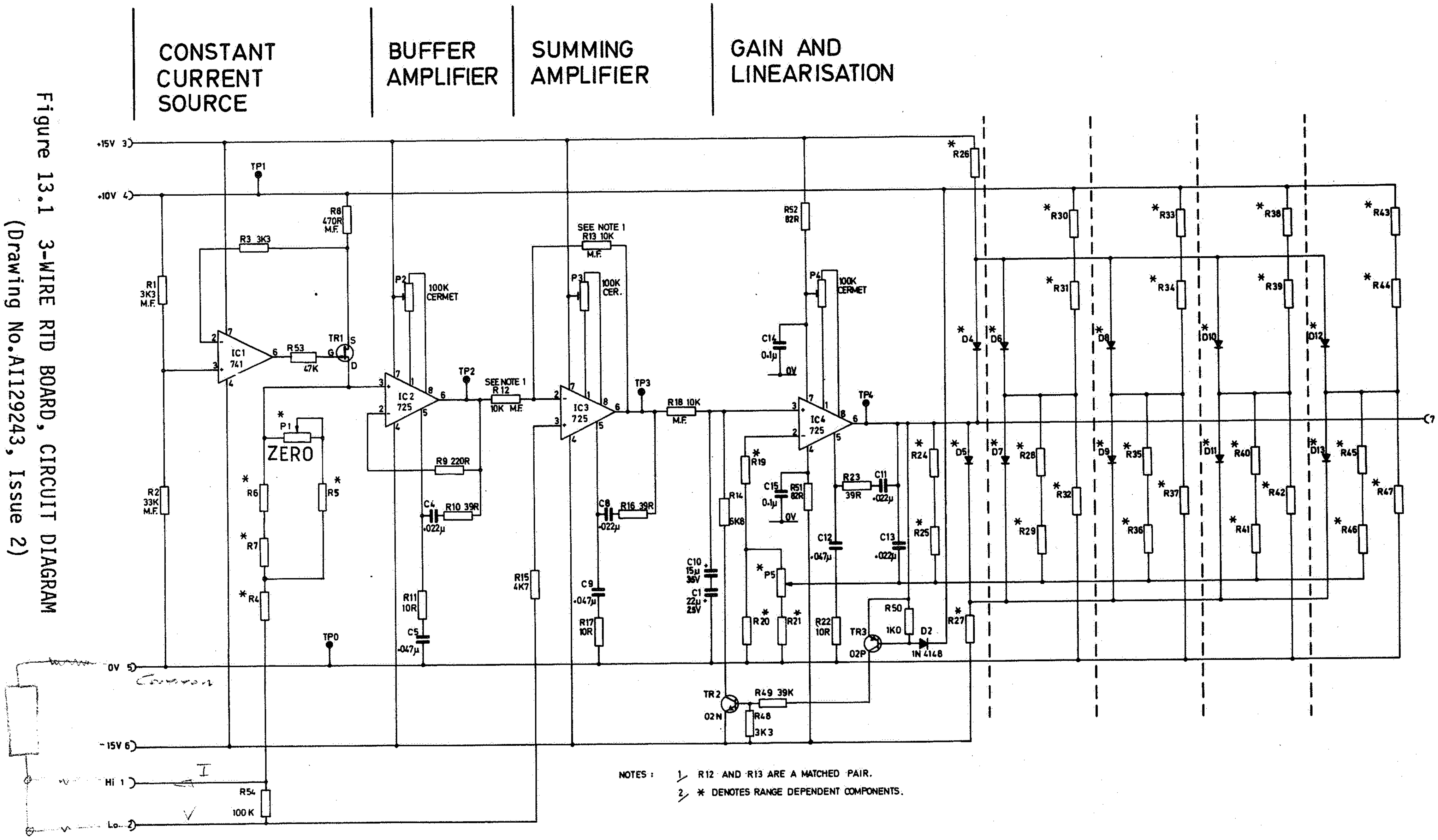


Figure 13.1 3-WIRE RTD BOARD, CIRCUIT DIAGRAM
(Drawing No.AI129243, Issue 2)

13.4 Main Amplifier & Diode Linearisation

A low pass filter (R8, C1, C10) attenuates a 50Hz disturbance by 30dB. With the circuit operating linearly, the gain of IC4 is defined by R24, R25 and R20, P5. A non-linear characteristic is obtained by adding one or more sections as shown. For example, with one breakpoint and for an increased gain D4, D5, D7, R26 to R32 are fitted and D6 not fitted. With the output voltage low, the feedback resistance is the parallel combination of (R24 + R25) with (R28 +R29). When the output voltage exceeds a breakpoint defined by R30, R31 and R32, the feedback resistance increases to (R24 + R25) and the gain is thereby increased.

13.5 Upscale Limit Circuit

Diode D2, transistors TR2, TR3 and associated resistors form a circuit which limits the maximum voltage on pin 3 of IC4. This ensures that the response time of the assembly is within the settling time allowed by the instrument. Resistor R50 provides upscale drive in the event of an input being open circuit.

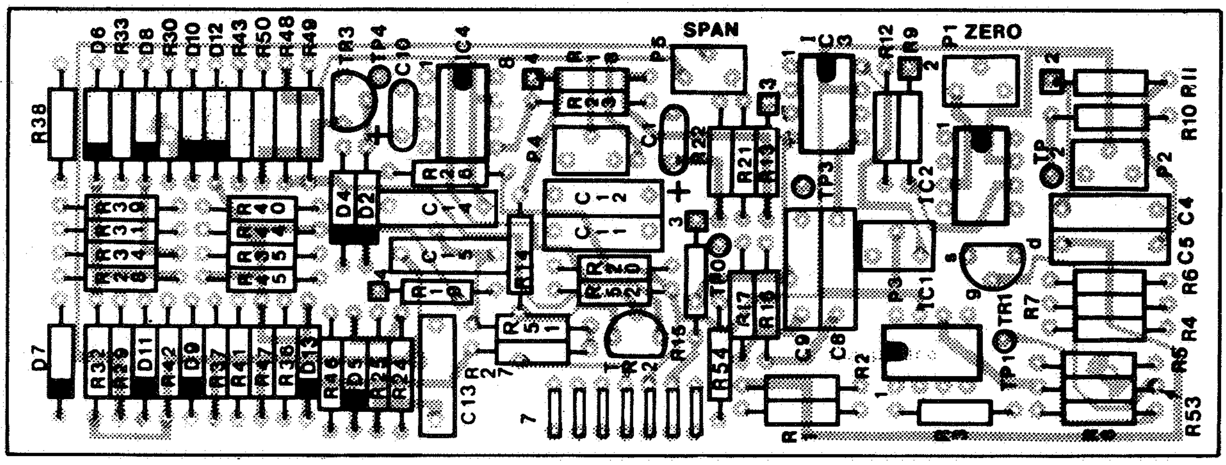


Figure 13.2 3-WIRE RTD BOARD, PCB COMPONENT LAYOUT
(Drawing No.AH129243, Issue 2)

14. CONTROL BOARD 127424 CIRCUIT DESCRIPTION

14.1 Functional Descriptions

The main element of the control board is a microprocessor (μP) which controls the sequencing of the instrument according to various operator (and remote) controls (interpreted by software).

The microcomputer (μC) is a 3-chip minimum system using 6802 (μP and RAM), 6821 (peripheral interface: 2 x 8-bit port) and 2732 (4K x 8 EPROM).

Two facilities have been added to this minimum system:-

a) The combined "watchdog" and elapsed time reference. The watchdog resets the 6802 and 6821 in the event of a malfunction caused by RF interference or power disturbance. See Supply Interrupt Protection, Section 18.

b) A 20KHz clock for implementing a counter-timer function in software via the NMI interrupt. The 20KHz is generated by dividing down from the system clock (IC4).

The remaining I/O lines of the 6821 are used as follows:-

a) To drive the alarm relays and motors via Darlington driver chips (the colour select and chart advance motors, which require bi-polar drive, have some hardware decoding to protect against short circuit conditions and reduce the number of lines required for the 6821).

b) To read the operator and remote controls and installation options via a 1 of 32 analogue multiplexer and indicate the mode of operation on 1 or 8 LED's.

c) To control and interrogate the scanning board via a voltage isolated pulse transformer. The control board and all its peripherals are at chassis potential and not channel input potential.

14.2 Detailed Operation

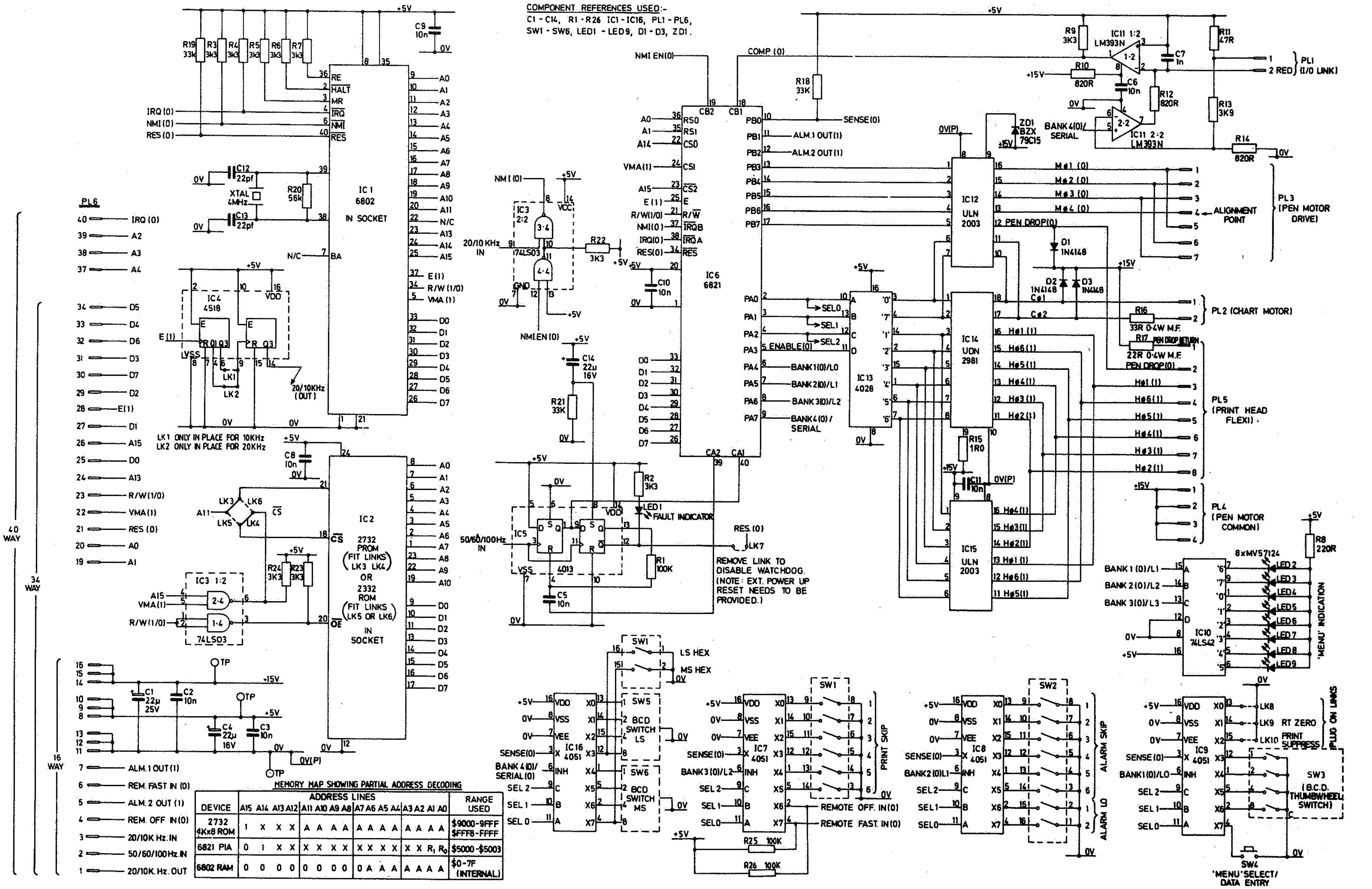
μP RESOURCES:
The CPU has the 6800 instruction set and operates with a 1ms cycle time. All memory and I/O occupy address space as follows:-

- Read/write memory, 128 bytes RAM ($0000 - $007F)

- Inut/output 6821 PIA 4 registers:
  partial address decoding ($4000 - $7FFF)
  address range used ($5000 - $5003)

- PROGRAM memory 4K x 8 PROM/ROM:
  partial address decoding ($8000 - $FFFF)
  address range used ($9000 - $9FFF)
  ($FFF8 - $FFFF)

- Address space available for future use ($0080 - $8FFF).



MEMORY MAP SHOWING PARTIAL ADDRESS DECODING

DEVICE	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	RANGE USED
2732 4Kx8 ROM	1	X	X	X	A	A	A	A	A	A	A	A	A	A	A	A	$9000-9FFF $FFF8-FFFF
6821 PIA	0	1	X	X	X	X	X	X	X	X	X	X	X	X	R_1	R_0	$5000-$5003
6802 RAM	0	0	0	0	0	0	0	0	0	A	A	A	A	A	A	A	$0-7F (INTERNAL)

Figure 14.1 CONTROL BOARD, CIRCUIT DIAGRAM
(Drawing No.AI127424, Issue 3)

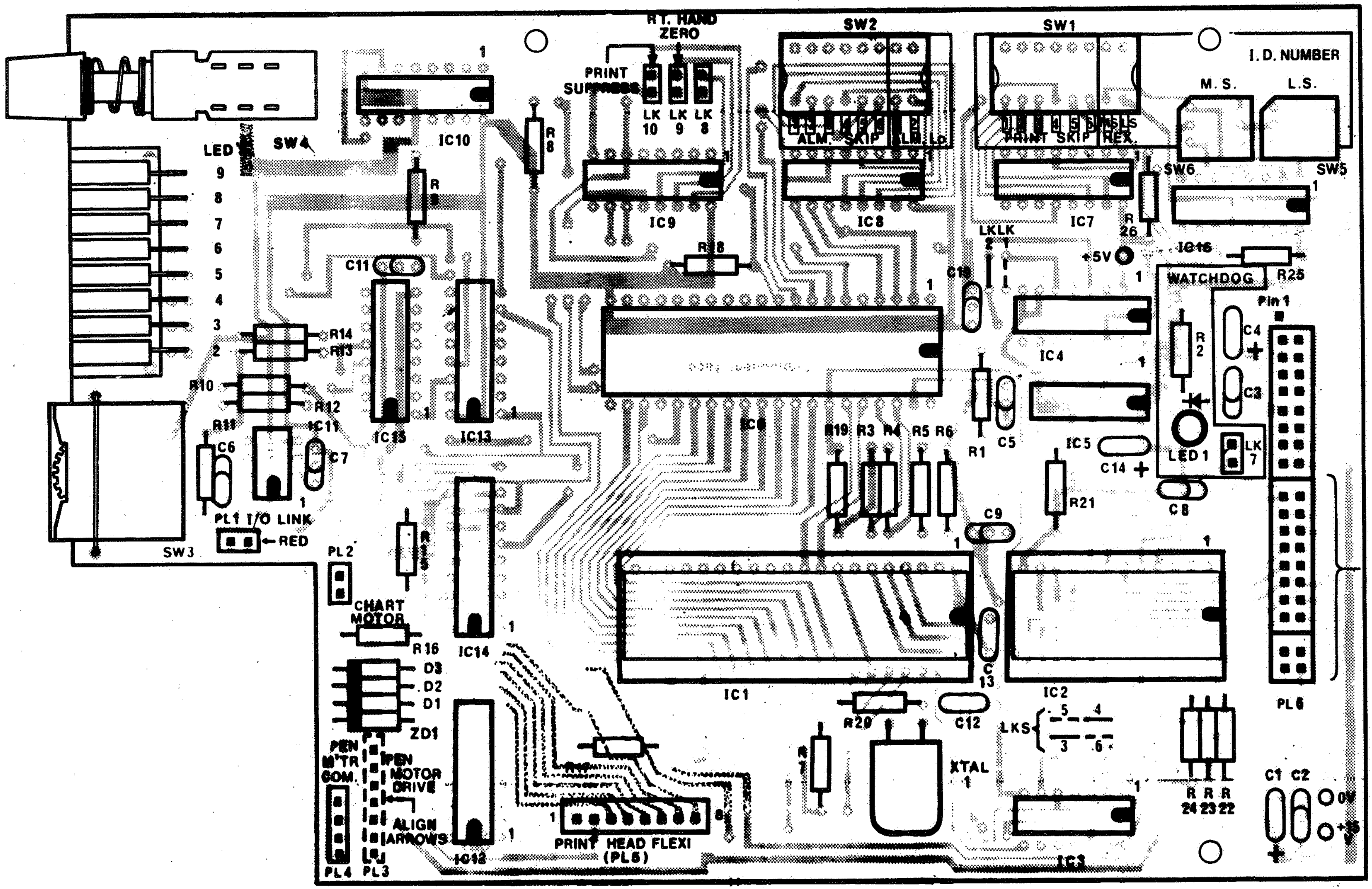


Figure 14.2 CONTROL BOARD, PCB COMPONENT LAYOUT
(Drawing No.AH127424. Issue 3)

14.3 Interrupt Uses

Description	Source	Use
IRQ	Mains zero crossing 50/60/100Hz	Watchdog handshake time of day, elapsed time, real time executive.
SWI	Software breakpoint	Software error detection.
NMI	20KHz*	Software timer for A-D.
RESET	+5V power on or watchdog default	System reset.

*Determined by wirelink position, can also be 10KHz.

14.4 I/O Link to Scanning PCB

This is a bi-directional serial link via a pulse transformer. The interface circuitry (IC11, etc) allows the µP to drive the pulse transformer with a binary serial code (levels 0mA-6mA) the transitions of which are recovered and decoded on the scanning PCB.

The timing informaton for "end of ramp" is conveyed back to the control PCB by a similar current transition in the pulse transformer. This is recovered by IC11 as a voltage pulse which exceeds 50mV for 500ns and latches a software readable flag in IC6. The threshold of 50mV is set by R11, R13 and R14 and requires that drive through R12 is switched off. C6 and C7 provide additional noise immunity.

14.5 Chart Drive

The chart drive is a bi-polar two wire drive to a uni-directional stepper motor (shaded pole type). The drive can take up three states under software control:-

1) Off - high impedance
2) Phase 1 + volts on C01 with respect to C02
3) Phase 2 - volts on C01 with respect to C02

The source impedance when driving is 40 (R15 + R16) and the motor has a 37 ohm coil resistance. Inductive voltage spikes are limited by catch diodes within the drive chip IC14 and diodes D2 and D3. Normal operation is a burst of 25 alternate phases every 15 seconds or greater.

14.6 Pen Motor Drive

The pen motor drive is a four phase uni-polar drive whose phases are completely under software control. Transformer action and inductive spikes in the motor require that the motor drive lines be allowed to rise up to 30 volts (2 x rail volts) before clamping. PL3 is a seven in-line connector to allow phase reversal and/or rotation when connecting up to the motor. The common returns are via PL4.

The normal operating mode is two out of four drive (full step) with acceleration and deceleration of the motor between 250 steps/second and 550 steps/second, with about 20% duty.

14.7 Print Head Drive

PL5 serves two devices via a flexible circuit connection.

a) DROP COIL:
This is a simple on/off drive to a "voice coil" which applies a downward force to the pen tip. A series resistor R17 is included to set the design current and hence writing pressure. It also reduces the change in drive current with coil temperature rise.

The normal operating mode is to lower the pen tip gradually by applying pulse width modulation to the on/off drive. A flywheel diode D1 ensures that the average d.c. current in the coil is proportional to duty cycle. At a constant frequency of 16KHz the duty cycle is varied from 50% to 100% in 6% increments over a 200ms duration. 100% current is then held for 50ms to ensure adequate ink transfer before lifting the pen.

b) COLOUR SELECT MOTOR:
This is a three phase bi-polar drive stepper with a 60° step angle such that with a single phase drive the six unique positions corresponding to colour tip may be selected directly.

The winding arrangement is a closed ring as in the armature of d.c. motor. In this case, phase connections are diametrically opposite within the ring. Since the excitation is one phase at a time the lack of isolation between phases is not a problem.

The phase drive is selected by software via the decode and drive ICs. Inductive spikes are clamped by catch diodes in IC14 and IC15.

The normal operating mode is to step the motor in a single direction by applying the next phase drive for 125ms and then waiting for 25ms with no phases energised to allow the motor to settle.

14.8 Switch Multiplexer & LED's

In all there are the equivalent of 32 switch contact states to be read by the uP at one time or another (pushbutton, thumbswitch, option links, alarm and print skip, ident number and remote chart control).

The switch contacts are routed individually to a single sense line (PB0 of the PIA) via four 8-bit multiplexers IC7, 8, 9 and 16. The analogue multiplexers allow a single pull-up resistor to be used on the common sense line.

The 32 switches are arranged in 4 banks of 8 corresponding to the 4 ICs. The 'bank select' lines are PA4-7 of the PIA, while the "one of eight" address is provided by PA0-2 of the PIA.

Note that all of these lines serve a dual function. PA0-2 define the drive phase for chart and colour motors which are enabled when PA3 is LOW; Bank 4 select (PA7) is used as the serial link to the scanner card; and Bank 1 to 3 select (PA4-6) also define which one of eight LED's will be illuminated on the control panel via IC10.

Thus, Bank 4 is only read at power on before initialising the scanner card and the other lines are read in a way that minimises the disturbance to the LED's and motors.

15. SCANNING BOARD 128996 CIRCUIT DESCRIPTION

15.1 Introduction

The 306 scanning PCB is a fully isolated board floating at the potential of the input connected. It performs the function of connection and routing of input channels to associated signal conditioning cards. The output of the signal conditioning board is a nominal 0-10V analogue value, which is converted to a digital value (time delay) and transmitted to the control board via an isolated two-way communication link. Up to three input signal conditioning boards may be accommodated, which will accept a range of thermocouple inputs, RTDs, voltage and current sources.

Overall control of the mode of operation of the scanner board is exercised by the microprocessor (µP) on the control PCB. An 8-bit control word is transmitted across the serial link and latched into a shift register which defines the detailed operation. A sequence of such control words are required to acquire the value of a particular transducer input. Various parameters are set up by reading the values of potentiometers mounted on a separate plug-in PCB, these include a zero offset, span multiplier and two alarms.

15.2 Serial Link Signal Recovery

PULSE TRAIN RECONSTRUCTION: The circuit consists of a 12.5mm diameter ferrite toroid, resistors R28, R29, R30, capacitors C10, C17 and a comparator on IC5.

With a primary and secondary of 3 turns each around the toroid, a current step of 6mA produces a voltage pulse. This pulse rises to a peak of 120mV in 200ns across the secondary winding of the toroid, which forms the inductor of an LCR tank circuit.

The voltage across C10 rises as energy flows from the inductor into the capacitor via the damping resistor R29. This produces a pulse on the input of the comparator which rises to a peak value of 66mV after 0.8µs, with a relatively flat top, sustaining a 40mV value for 1.3µs, decaying to give an undershoot of some 20% of peak value after 3.5us.

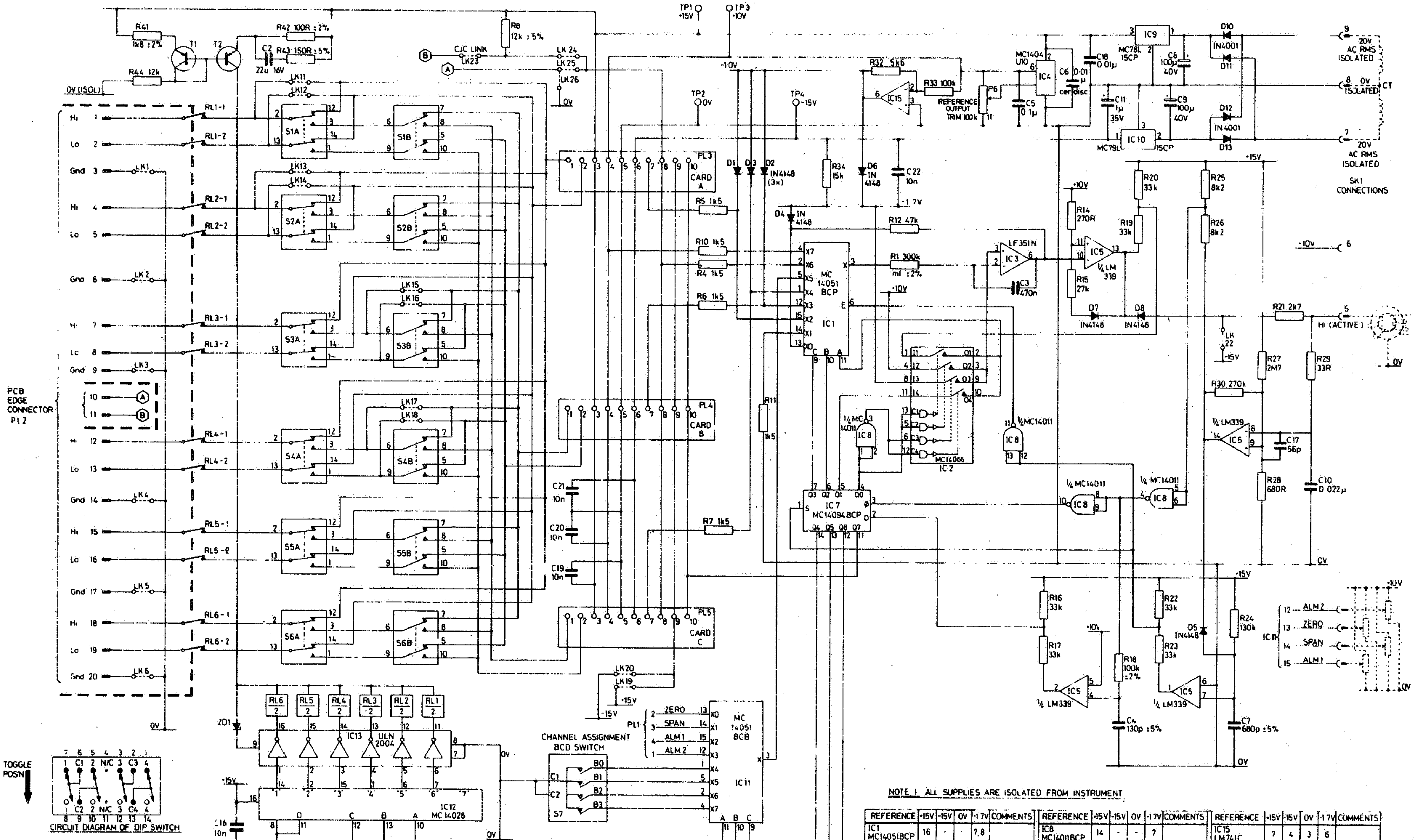
Resistors R28 and R30 provide positive feedback (hysteresis). This places a decision threshold of +40mV and -36mV on the comparator which will switch in 1us. C17 slugs the response of the hysteresis waveform to provide some noise immunity. Hence the output of the comparator reconstructs the original pulse train applied to the serial link from the control board.

15.3 Self-Clocking Code Circuit

A self-clocking and latching circuit derives the necessary control lines from the serial data line in order to convert the serial data to parallel data.

The self-clocking and latching circuit comprises a serial to parallel converter IC7, logic 1 or 0 decoder IC5 (pins 2, 4 and 5) plus associated components; and a data signal detector IC5 (pins 1, 6 and 7) plus associated components. Sequential inverters IC8 (pins 4 to 10) provide buffering and inverted input data waveforms.

Figure 15.1 SCANNING BOARD, CIRCUIT DIAGRAM (Drawing No.AI128996, Issue 6)



NOTE LINKS 1-6, AND LINKS 23,24,2 ED

NOTE 1. ALL SUPPLIES ARE ISOLATED FROM INSTRUMENT

REFERENCE	+15V	-15V	0V	-1.7V	COMMENTS	REFERENCE	+15V	-15V	0V	-1.7V	COMMENTS	REFERENCE	+15V	-15V	0V	-1.7V	COMMENTS
IC1 MC14051BCP	16	-	-	7,8		IC8 MC14011BCP	14	-	-	7		IC15 LM741C	7	4	3	6	
IC2 MC14066BCP	14	-	-	7,8	10nF (C15) decoupling	IC9 MC78L15CP					TO-92	IC11 MC14051	16			1,2,5 6,7	(C12) decoupling
IC4 MC1404 U10	2	-	4	-	10nF (C6) decoupling	IC10 MC79L15CP					TO-92						
IC5 LM339N	3	12	6	-		IC12 MC14028BCP	16	-	-		(C16) decoupling						
IC3 [illegible]N	7	4	-	-	10nF (C14) decoupling	IC13 ULN 2004	-		8								
[illegible]4BCP	16,15	-	-	8	10nF (C13) decoupling												

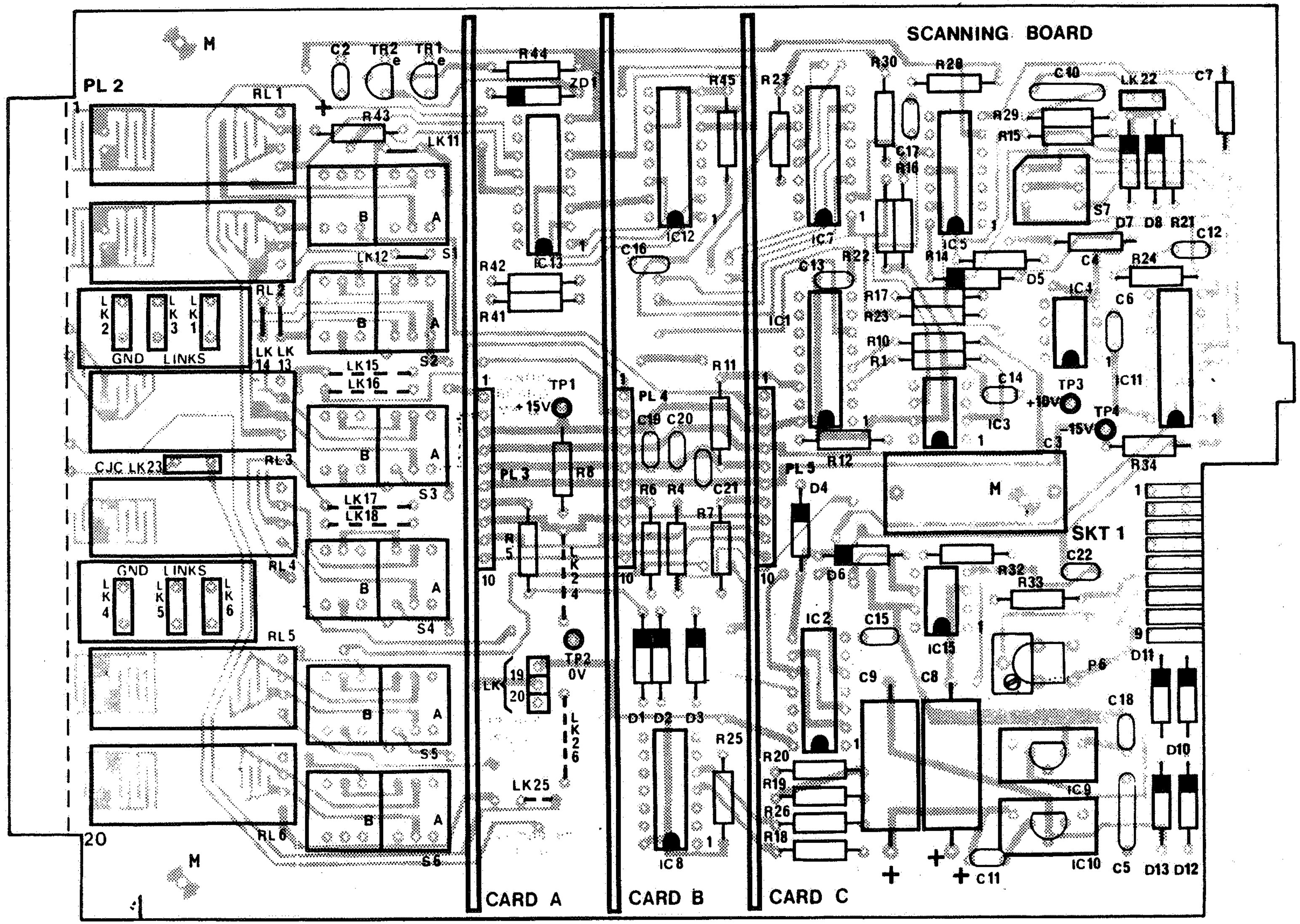


Figure 15.2 SCANNING BOARD, PCB COMPONENT LAYOUT
(Drawing No.AH128996, Issue 4)

The self-clocking code waveform has a variable mark width with a constant 22us space; the mark being 13µs for a logic 1 and 22µs for a logic 0. After signal reconstruction the mark is 15V and the space +15V at IC5 pin 14.

SIGNAL DATA DETECTOR IC5, PINS 1, 6 & 7: The 47µs CR (C7/R24) is discharged during the mark period of the data word; the space period during the data word being too short to allow the CR to charge. At the end of the data word a space occurs which is greater than 47µs; when pin 5 reaches its threshold pin 1 goes positive latching the data to the outputs of C7.

LOGIC 1/0 DECODER IC5, PINS 2, 4 & 5: The input data signal is level shifted via R25/26 and inverted at IC8 pin 4. A 17µs CR (C4/R18) at the input of the decoder (pin 4) is charged and discharged with the inverted input data pulses. A 22µs logic 1 signal will cause R18/C4 to fully charge and output a zero at IC5 pin 2.

SERIAL/PARALLEL CONVERTER IC7: When negative trailing edge of a data squarewave occurs with a positive portion of the waveform from the 1/0 decoder, a 1 is clocked into data pin 2 of IC7; while a negative part of the waveform will clock a 0 into IC7. At the end of a data word a space greater than 47µs causes IC7 pin 1 to go HI and latch in the data word.

15.4 Input Selection

The relay select and driver circuits involve the following components: IC7, IC12, IC13, T1, T2, C2, R41, 42, 43, 44 and 45.

The four most significant bits of the 8-bit code word control both the relay drivers and the selection of input to the second multiplexer. However, the output of the second multiplexer is effectively open circuit until the 4 L.S.B.'s of the word are 1010, hence unless it is desired to read the inputs of the second multiplexer, the effect of altering its select codes can be ignored.

T1, T2 and associated components form a current mirror restricting the voltage developed at T2's emitter resistor to approximately 1.8V, giving a nominal current of 18mA through the relay coil when the other end of the selected relay is pulled to 0V. C2 and R42 supplies an additional current of 12mA which then decays to zero with a time constant of 4ms, hence the characteristic hysteresis of the relay can be utilised. After the initial surge of current needed to pull in the contacts, the current is reduced to a holding value, which minimises temperature rise and associated thermal offset generated in the relay.

IC13 contains the Darlington drivers which sink current through the selected relays coil. IC12 is a BCD to decimal decoder, whose output turns on the appropriate relay driver selected by bits 6, 5 and 4 of the control word. R45 is included in the VSS supply rail of IC12 to restrict the current drawn through the substrate of the device.

15.5 Input Channel Routing

Once a channel has been selected it is routed to the appropriate input board by a series of switches. The method of determining the SW7 input board allocation is to set a routing number on a decimal switch which is read by the microprocessor at power up. The µP can then decipher the appropriate routing information when required.

15.6 Input Measurement & Analogue to Digital Conversion

A dual slope integrator is used to measure the input value. This method lends itself particularly well to this application as the R & C values drop out of the calculation leaving only the ratio of charge time to discharge time multiplied by the reference. As the charge time is set by the uP and the discharge time is detected by the µP, the digital conversion of the measured value is achieved relatively easily.

The integrator comprises IC3 using R1 & C3, 1/4 IC5 is used to detect the end of discharge phase with R14, 15, 19, 20, 21, D7 and 8. The mode of operation is determined by IC7, IC2, IC1, IC11 and IC8; other associated components are D1, 2, 3 and 4; R4, 5, 6, 7, 10, 11 and 12.

The input to be selected is controlled by IC7, seven inputs can be connected directly by IC1 using bits 1, 2 and 3 of the control word. If input 5 (IC1) is selected a further eight inputs are available via IC11 and bits 4, 5 and 6 determine the choice.

With the appropriate code latched into IC7, the unknown voltage which is to be measured is connected to R1, the LSB of the code dictates the integration mode as this places -1.7V on the non-inverting input via IC2, which also channels bit 1 onto pin A of IC1. The unknown voltage now causes the output to ramp down for a time specified by the µP; this is chosen as 100ms to reject 50Hz and 60Hz mains interference.

At the end of this period the uP transmits the deintegration code; this keeps the relay closed but places the 0V input of IC1 onto R1. Bit 0 is set, thereby causing the non-inverting input to be connected to the 10.0V reference via IC2 and the output of the comparator which is a high, to be placed on pin A of IC1.

While the code is being transmitted, IC1's enable pin is held high, effectively open circuiting R1 and holding the charge. When the end of the word is detected, the code is latched-in and the output of the integrator ramps towards 10.0V. When the output reaches within ±9mV of the reference, the comparator changes state; this changes the multiplexer connection throwing the integrator into the idle state.

The comparator driving low sinks a 6mA step of current through a winding on the toroid, the resulting voltage pulse is detected by the micro and a timer frozen. This pulse is not seen by the scanner board receiving circuitry as the hysteresis is set +ve. However, R14 and R15 impose a threshold of 25.0mV ensuring that the ±120mV uncertainty of the idle state does not cause further pulses.

The microprocessor now calculates the unknown input voltage as a ratio of discharge time to charge time, times the reference voltage. A measure of over and under-ranging is catered for by this circuitry; however, the span available is primarily to take advantage of the integrators a.c. rejection.

15.7 Sequence of Operation

Whilst the instrument is running, the inputs are scanned once every 15 seconds; this scanning takes place in a 5 second sequence therefore allowing 800ms for each input to be measured. Several variable parameters such as zero offset, alarms, etc., are set up and stored in the µP before it goes into RUN mode.

The input board/channel connection is revealed to the micro by the setting of a digit switch SW7. Information is obtained at power up, the input boards are to be pre-conditioned to drive them out of range; this is done by setting bit 7 of the code transmitted, in all but the first measurement. This is implemented during the previous final de-integration period.

The non-inverting input is connected to -1.7V during the integration period, this means that the value which is measured is Vin +1.7V. In this way it is possible to measure 0V with reference to -1.7V and this is done at the beginning of each 5 second scan sequence and its value stored. This allows each measurement to undergo an auto-zero, thereby removing most offset errors. A typical sequence of operation during the measurement of one input will then be as follows:-

The relay select code is transmitted, closing the relay and driving the signal conditioning board output into range. After a delay, each board output is measured by transmitting a sequence of commands whilst keeping the relay closed. This sequence is:

1. Integrate reference for 5ms (dummy measurement to ensure integrator in a known state).

2. De-integrate.

3. Double flush shift register (to reset all the communication circuitry into the correct state).

4. Integrate for 50ms.

5. De-integrate and check to see if within range.

This procedure is repeated on the other two boards and the relevant board is then determined. A total of 600ms is allowed for the input signal conditioning board to settle then a dummy integrate, de-integrate plus a double flush is completed to prime the integrator.

The input is then integrated for 100ms, de-integrated and the previously calculated value for 0V taken away leaving a measured value in the range 0-10V with a resolution of 5mV. Further calculations are then completed by the micro in order to apply the various parameters and produce the desired representational position value in the range 0-504.

15.8 Power Supply & Voltage Reference

The scanning board has its own power supply driven by an isolated winding on the mains transformer. The nominal output of the centre tapped winding is 20-0-20V RMS; this is rectified and capacitively filtered (D10-13, C8 and 9). IC9 and 10 are complementary +15V and -15V regulators, C18 and 11 serve to stabilise their respective IC's.

IC15, R32 and R33 provide a -1.0V rail from which the CMOS integrated circuits derive their VSS supply rail via diode D6, producing a nominal rail voltage of -1.7V.

IC4 is a 10.0V reference, whose output can be trimmed to ±0.1% using P6. The device has a thermal drift of 50ppm. C5 and C6 are for output stability and decoupling.

16. POWER SUPPLY & OPTIONS BOARD 127440 CIRCUIT DESCRIPTION

16.1 Power Supply Section

The power supply comprises a d.c./d.c. converter which provides a stable +5V rail for the control circuits and a nominal +15V to drive the motors and relays. The converter is powered from an unregulated supply T2, DB1 and C2. This supply is nominally 31V with a maximum ripple of 3V peak to peak when fully loaded.

The control circuit of the converter is supplied by a 12V zener stabilised rail formed by ZD1, R5 and C3. The control circuit consists of four basic parts:-

1) A 25KHz oscillator
2) A low frequency error amplifier
3) A voltage comparator
4) A stable 2.5V ±5% reference

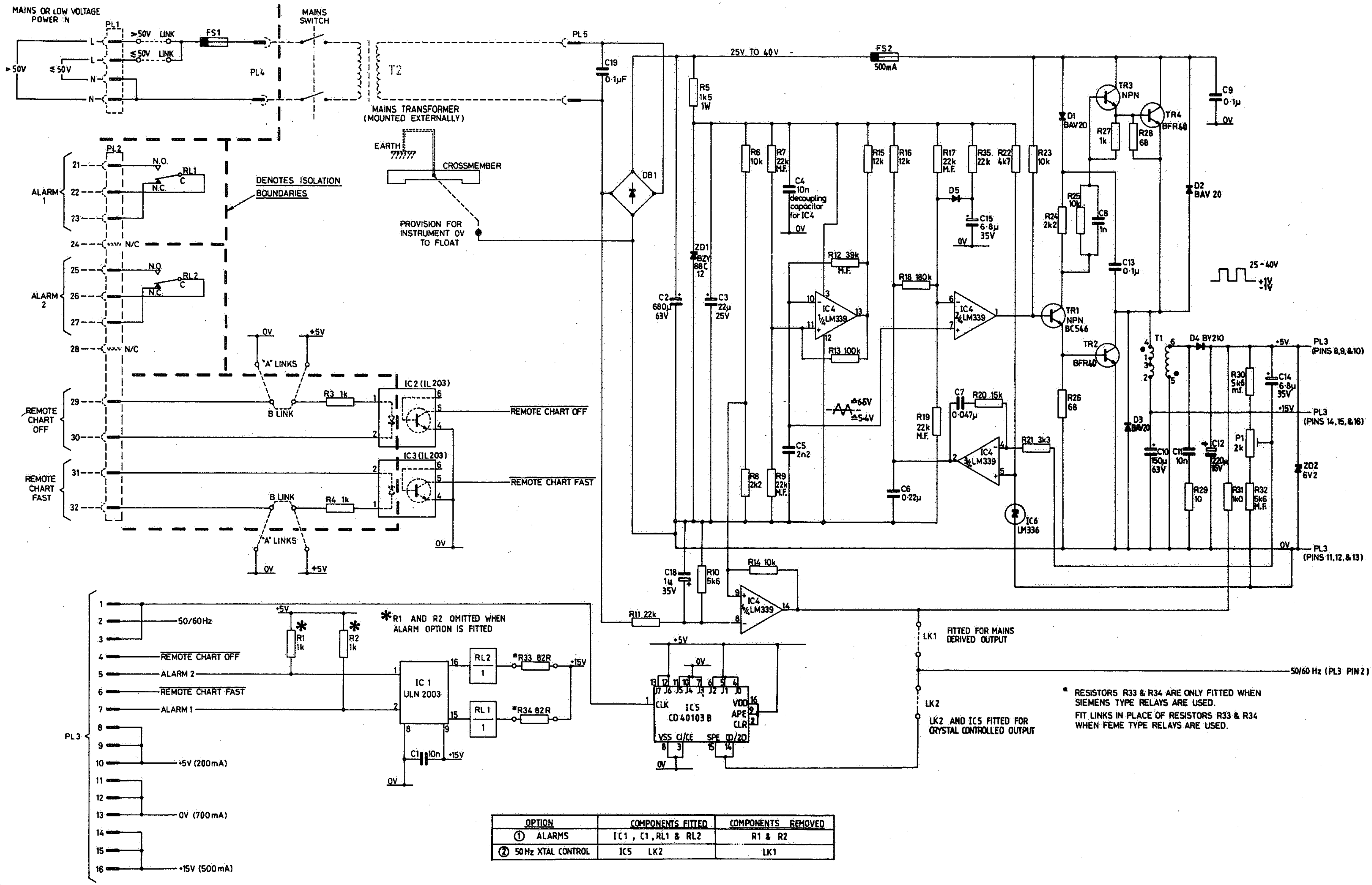
The 25KHz oscillator is formed by comparator 1 and its associated components R2, R9, R12, R13, R15 and C5. The sawtooth output of the oscillator operates between voltage limits defined by the positive feed-back resistor R13 and the 12V supply. The oscillator output is taken from the junction of R12, C5 and fed to the non-inverting terminal of the voltage comparator (comparator 2).

The amplifier circuit comprises comparator 3, C6, C7, R16, R20 and R21. The amplifier compares the 2.5V reference produced by IC6 and R22, with the feedback voltage provided by R30, R32 and P1 at its inverting input, to produce an error signal. P1 enables the initial ±5% tolerance of the reference voltage to be adjusted out. The error output is taken via R18 to the junction of R17, R19, D5 and the inverting input of comparator 2. R17, R18 and R19 ensure that the voltage at the inverting input is never greater or less than the excursion of the sawtooth waveform at the non-inverting input. D5, R35 and C15 form a soft start circuit which prevents excessive current being drawn from the unregulated supply at switch on. Comparator 2 compares the sawtooth waveform to the threshold voltage set up by R17, R19 and the error amplifier to produce a variable pulse width signal.

This pulse width modulated output drives the phase splitter (TR1) of the push-pull output stage consisting of TR2, TR3 and TR4. The Darlington arrangement of TR3 and TR4 forms a series power switch that switches the unregulated d.c. supply to the L.C. filter combination of T1 primary and C10. D3 is a free-wheeling diode that maintains current flow (due to the inductive flyback of T1 primary) to C10 and the 15V load during the power switch-off time. C13 and D1 form a bootstrap circuit that ensures fast and complete 'turn on' of the Darlington driver. D2 is incorporated to protect TR4 from inductive voltage spikes. The shunt transistor TR2 ensures that pin 4 of the primary winding is maintained at approximately '0' volts during the off time of the series power switch, which would not be the case if there were insufficient stored energy in the transformer primary, to sustain conduction of D3.

The secondary winding of T1 feeds a half wave rectifier and smoothing circuit consisting of D4, C14 and C20. R29 and C11 are included to absorb the leakage inductance flyback voltage produced when D4 turns off. Phasing is such that D4 conducts when the primary winding is connected across C10 via D3 or TR2.

The transformer can therefore be considered as being fed by a pulse train that has approximate signal levels of 0V and 15V.



OPTION	COMPONENTS FITTED	COMPONENTS REMOVED
① ALARMS	IC1, C1, RL1 & RL2	R1 & R2
② 50Hz XTAL CONTROL	IC5 LK2	LK1

Figure 16.1 PSU BOARD, CIRCUIT DIAGRAM (Drawing No.AI127440, Issue 4)

The ratio of the transformer winding is such that with a 200mA load on the stabilised 5V rail, the nominal 15V output will be between 15.0 and 16.4V depending upon its loading (i.e. 15.0V if D3 only conducts, or 16.5 if TR2 conducts). The capacitor C14 connected across the +5V rail and P1 wiper improves a.c. rejection of the control loop. ZD2 is a protection diode that prevents the 5V rail exceeding +7V in the event of a circuit malfunction.

NOTE: Ideally, if there were no losses in T1 and D4, the winding ratio would be 3.1 and the 15V rail would be insensitive to the 5V loading. However, in practice the 5V load is reasonably constant and variations of the 15V supply due to 5V load changes are within tolerable limits for this application.

16.2 50/60Hz Output

1. MAINS DERIVED: A half-wave signal provided by T2 and BD1 is fed to attenuating filter network formed by R10, R11 and C18. The filter's output is taken to an inverting comparator circuit which consists of comparator 4, R6, R14 and R31. The attenuator formed by R6 and R8 sets up a d.c. threshold and hysteresis is provided by the positive feedback resistor R14. The comparator compares the filter's output to the d.c. threshold to produce a pulse train of fundamental line frequency which has signal levels 0.4V to +5V.

2. CRYSTAL DERIVED (OPTIONAL): IC5 is an eight stage Cmos synchronous down counter that is programmed to divide by 200. The counter is clocked by a 10KHz crystal derived signal supplied from the control board to provide a 50Hz 5V Cmos level output.

Selection of either the mains or crystal derived output is made by inserting LK1 and LK2 respectively.

16.3 Alarms Option

The identical high and low alarm circuits formed by RL1, RL2 and IC1 are controlled by TTL signals provided by the control board. The relays are powered from the nominal 15V rail and are normally 'on' when in the non-alarm state. The user is provided with fully isolated, normally open and normally closed contacts. Contact changeover occurs in the event of an alarm signal from the control board, or power failure. IC1 is an array of Darlington transistor drivers that have integral suppression diodes for inductive load switching and a series input resistor that allows operation directly with TTL or Cmos operating at a supply voltage of 5V. R33 and R34 are current limiting resistors that are fitted when alternative Siemens' relays are used.

R1 and R2 are inserted when IC1 is omited to inform the microprocessor that the alarms facility is not required.

16.4 Remote Control Interface

IC2 and IC3 provide signal conditions to enable the microprocessor to accept the "remote chart off" and "remote chart fast" signals. Minimum drive levels to assert these signals are 3.5V at 2mA across the L.E.D. and series resistor. Link options A and B allow this power to be derived either internally or externally and controlled by contact closure or logic gate, etc.

The photo transistors are biased by 100K ohm pull-up resistors R25 and R26 sited on the control board.

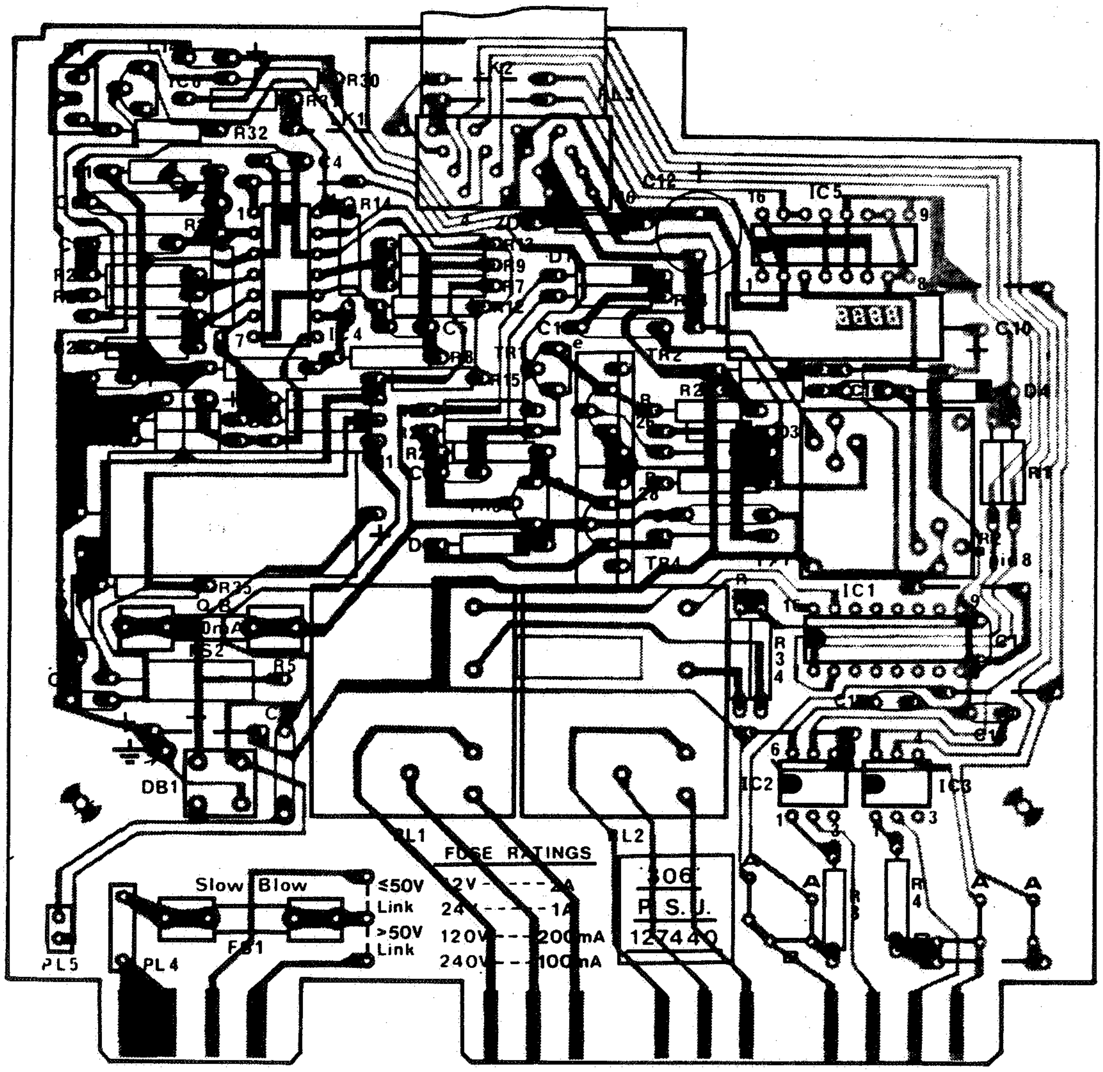


Figure 16.2 PSU BOARD, PCB COMPONENT LAYOUT
(Drawing No.AH127440, Issue 4)

17. DC OPTION BOARD 230103 CIRCUIT DESCRIPTION

17.1 Introduction

The d.c. option comprises a d.c. inverter module normally housed in the rear cover of the 306, and feeds a modified 306 transformer through the mains input block. The standard unit has undervoltage trip out with built in hysteresis for re-starting operation at a higher input voltage. As an option, the unit can be made to trip out completely on recognising an undervoltage condition.

For this circuit: Logic '1' = Vdd (9.5V); Logic '0' = 0V

17.2 Detailed Operation

The output is configured as four MOS switches in a figure of H arrangement giving a non-polarised 250Hz switched output which can be then fed into the a.c. input of the 306 using a modified transformer.

The lower two devices of the bridge (TR5 and TR8) are driven from the output of the CMOS control circuitry (IC1 pins 10 and 11) via the output regulation circuitry. The top two devices are bootstrap driven from the output via the associated components and MOS transistors (TR3 and TR6), which are driven directly from the CMOS outputs. The resistors and capacitors from drain to gate of TR5 and TR8 are to trim the transient and a.c. performance of the regulation circuit to give an optimum switching performance. The two resistors R11 and R15 are used as a current sense by the current limit detection circuitry.

The zener diodes ZD4 and ZD5 ensure that during the period of bootstrap operation, the maximum Vgs of the output devices is not exceeded.

The CMOS control logic consists of a clock generator, divide-by-two flip-flop, and a current limit flip-flop.

The clock waveform is generated by the op-amp oscillator (3/4 IC5, R43, R44, R45, R46 and C14). This waveform is then level shifted (R47 and ZD8) and squared by re-generative buffer (1/4 IC1; 3/4 IC4; R47 and C16). The waveform is then applied to the divide-by-two flip-flop (1/2 IC2 and C16) via buffer (2/4 IC4) and current limit flip-flop (2/2 IC2).

The two current limit inputs are gated together (4/4 IC4) and then fed to the current limit flip-flop (2/2 IC2), the output of which (pin 12) becomes a logic '1' if either of the current limit inputs is a '1'. This condition exists until the next clock pulse clears the current limit flip-flop. The output of the current limit flip-flop inhibits the drive output via the NOR gates (3/4 IC1; 4/4 IC1). This configuration makes the current limit operation independent of the system clock.

The undervoltage protection is implemented by comparator 2/4 IC3 which compares the input voltage (via R24, R25) to a reference voltage formed from R18, R19, C11 and the op-amp 2/4 IC5 and P2.

Op-amp (2/4 IC5) monitors the input voltage and switches P2 (via D4) into the reference if the input voltage is less than 16.5V; which gives a different reference voltage to the undervoltage comparator, depending on whether the input voltage is in the 12V or 24V range. The overvoltage threshold is subject to the long time constant of C11/R18, R19, P2 and prevents tripping caused by supply transients.

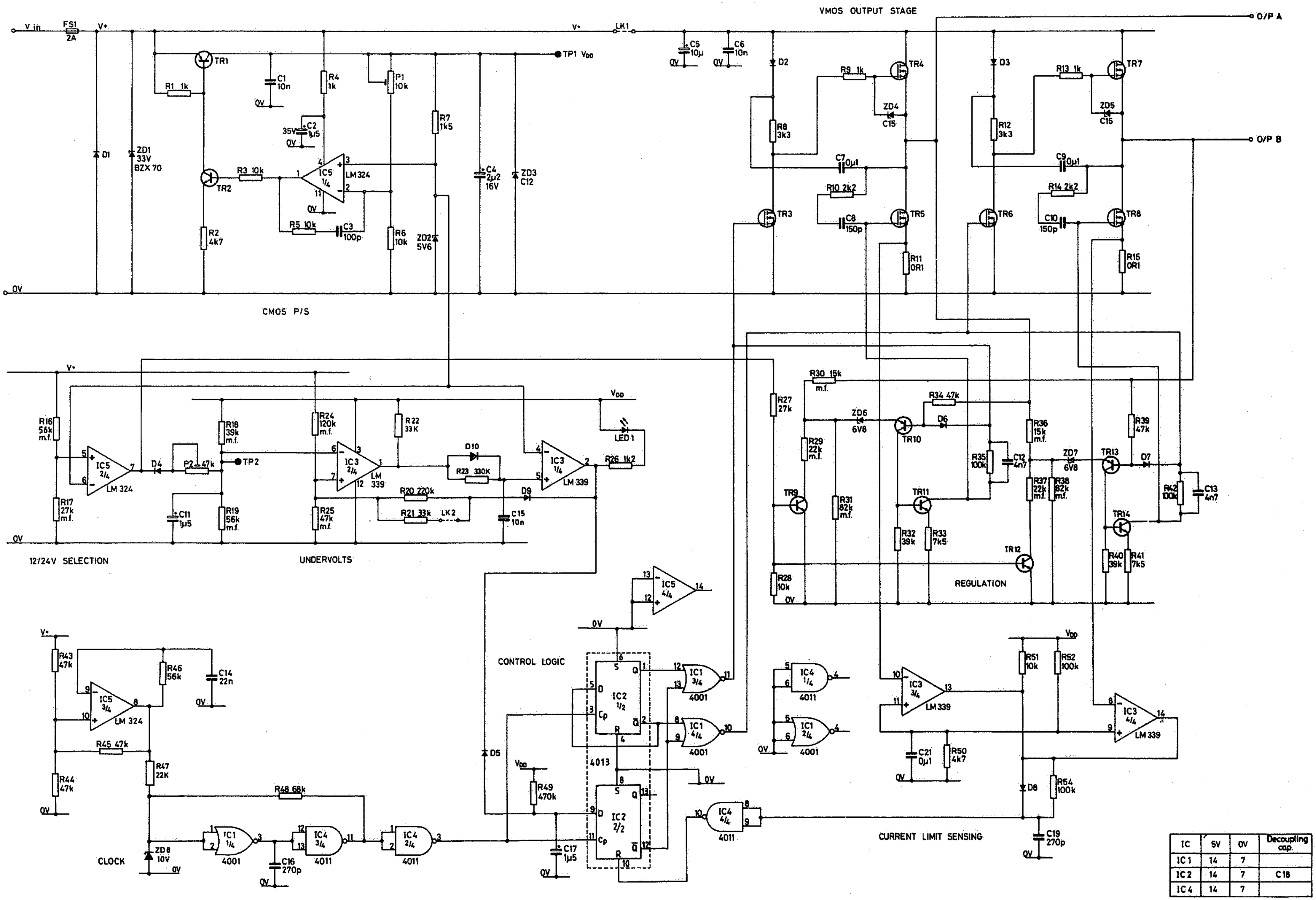


Figure 17.1 DC OPTION, CIRCUIT DIAGRAM
(Drawing No.AI230103, Issue 1)

18. SUPPLY INTERRUPTION PROTECTION (BATTERY BACK-UP)

18.1 Introduction

The battery back-up module is housed directly above the scanning board and it is supported by two hexagonal spacers. As an option this unit can be fitted to any 306 and it will sustain the 5V rail on the control card in case of a power interruption.

The electronics of the battery back-up facility can be divided into three areas for description (see Figure 18.1).

i) Resistor limited trickle battery charger
ii) Voltage regulator
iii) Watchdog monostable (see Figure 18.2)

18.2 Detailed Operation

The battery is trickle charged via the 1k resistor and diode D2. The current is limited by the resistor to 6mA when the battery is fully charged, but will be a higher value when charging a fully discharged battery.

The voltage regulator IC1 will maintain 4.90V at its output terminal. This is achieved by choosing R3 according to the formula Vout = 1.25V, $(1 + \frac{P1 + R2}{R3})$.

R3 is connected between Vout and common of IC1, and R2 + P1 is connected between common and zero volts.

When the mains is on and within the PSU limits of 10%, the voltage regulator does not conduct as the diode effectively presented by its output terminal is reverse-biased. In the event of mains failure or reduction to the extent that the 306 PSU cannot maintain the 5V rail, the battery and regulator take over and maintain a supply of 4.90V.

18.3 Watchdog Monostable

The monostable assembly LA233075 is fitted to the control PCB in place of IC5 on instruments fitted with supply interrupt protection. IC1 (555) and its ancillary components form a one-shot ($T \approx 8ms$) which protects the watchdog IC2 from spurious state changes from the power supply during power-on and off, which would otherwise cause the watchdog to reset the microprocessor unnecessarily. IC2 (4013) and its ancillary components are those normally fitted to the control PCB and their function is unchanged.

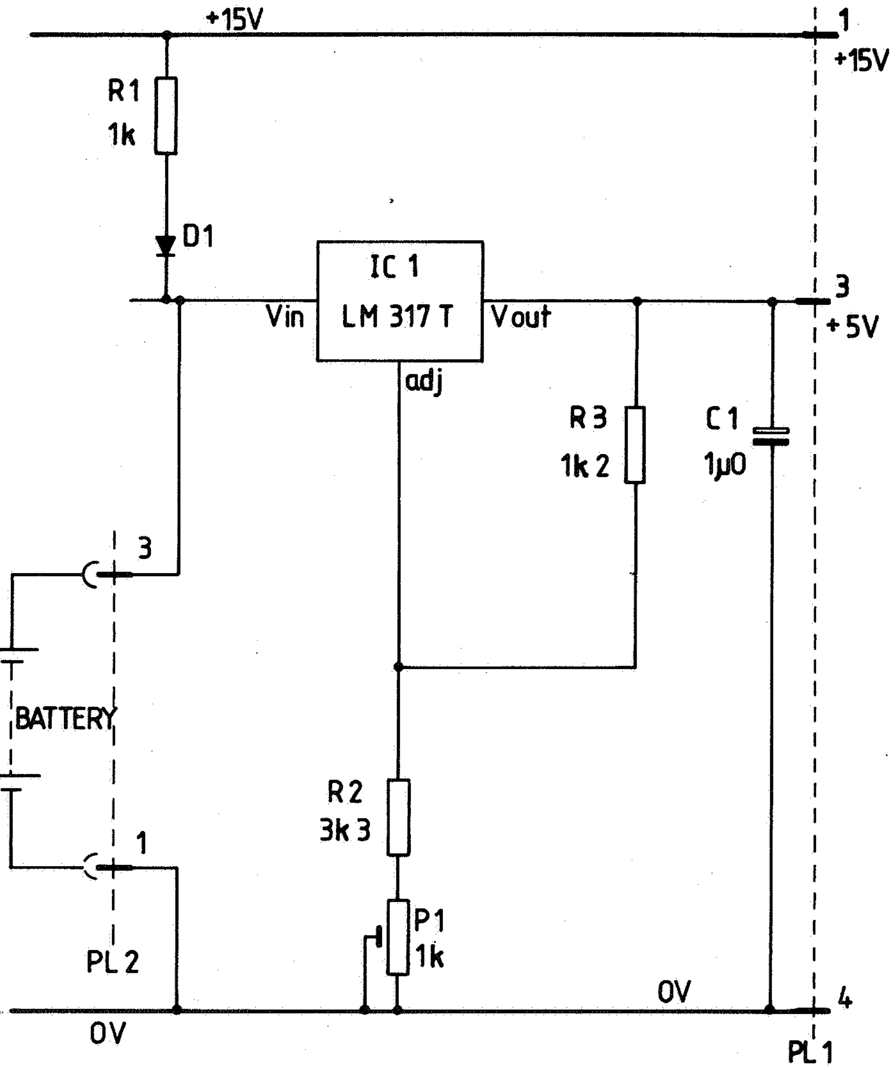


Figure 18.1 SUPPLY INTERRUPT PROTECTION, CIRCUIT & PCB LAYOUT
(Drawing No.AI230522, Issue 3)

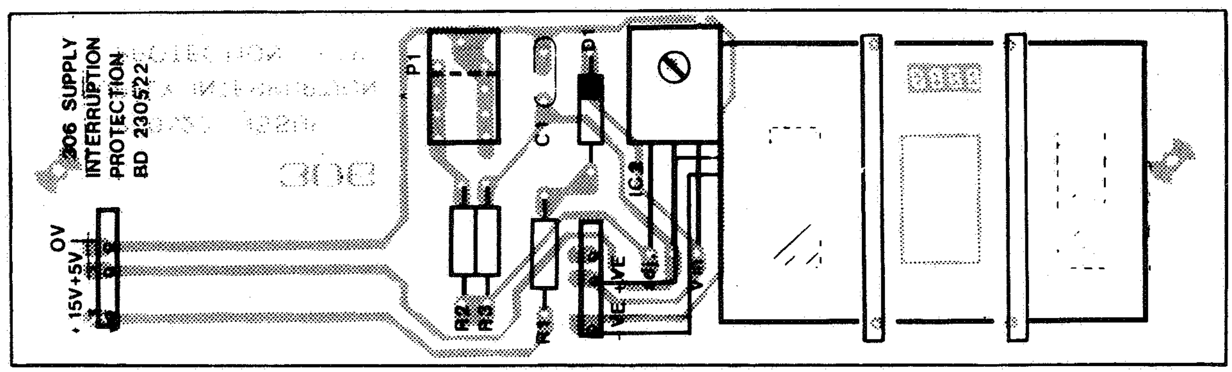


Figure 18.2 SUPPLY INTERRUPT PROTECTION, BOARD ASSEMBLY
(Drawing No.AH230522, Issue 3)

19. PARTS LIST

19.1 Chassis Assembly - Exploded View

1	Control Panel Mounting Plate	LA128993
2	Bush	BD128667
3A	Upper Control Panel Label - English version	GA129170
3B	Upper Control Panel Label - French version	GA129510
3C	Upper Control Panel Label - German version	GA129505
4A	Lower Control Panel Label - English version	GA129065
4B	Lower Control Panel Label - French version	GA129511
	Address Label - English version (not shown)	GA129722
	Address Label - French version (not shown)	GA129504
	Special Chart Speed Label (not shown)	GA129501
	Chessell Ltd Serial Number Label (not shown)	GA129172
5	M3 x 12 Countersunk Screw	FB013J12
6	Spacer	BG129344
7	Power ON/OFF Switch (without looms)	DC128972
8	M3 Crinkle Washer	FC12307J
9	M3 Internal Tooth Washer	FI12306J
10	Power ON/OFF Switch/Voltage Selector Switch Loom	DN128793
11A	Transformer Assembly: 110,120,240V 50/60Hz. Includes loom to interface board (three-way connection); loom to power supply board (two-way connection) and primary leads to selector switch (but excludes switch).	LA129260
11B	Transformer Assembly: 24,48V 50/60Hz. Includes loom to inerface board (three-way connection); loom to power supply board (two-way connection) and primary leads to selector switch (but excludes switch).	LA230170
11C	Transformer Assembly: 7,14V 250Hz. Includes loom to interface board (three-way connection); loom to power supply board (two-way connection) and primary leads to selector switch (but excludes switch).	LA230174
12	M4 Nylon Nut	FA12306L
13	M3 x 5 Countersunk Screw	FB011J05
14	M4 x 8 Countersunk Screw	FB011L08
15	M3 x 8 Countersunk Screw	FB089J08
16	Left-hand Side Plate	LA129205
17	Power Selector Switch Label	GA129190
18	Power Selector Switch (without looms)	DC129189
19	M3 Nylon Nut	FA12319J
20A	Thumbwheel Digit Switch	DG129188
20B	Switch Clamp (not shown)	CM129171
21	Pushbutton With Cap	DC129187
22A	Control Board, Level 1 (excludes EPROM, includes 19, 19A and 20A)	AH127424
22B	Control Board, Level 2 & 3 (excludes EPROM, includes 19, 19A and 20A)	AH127424U100
23	Circlip, DIN1500/4	FJ126389
24	Nylon Washer	FX128788
25	M3 x 5 Cheesehead Screw	FB016J05
26	Power Supply to Control Board Loom	DN128973
27	Alarm Relay	DB127723
28A	Power Supply Board, Non-Alarm Version	LA129175
28B	Power Supply Board, Alarms Version	LA129176

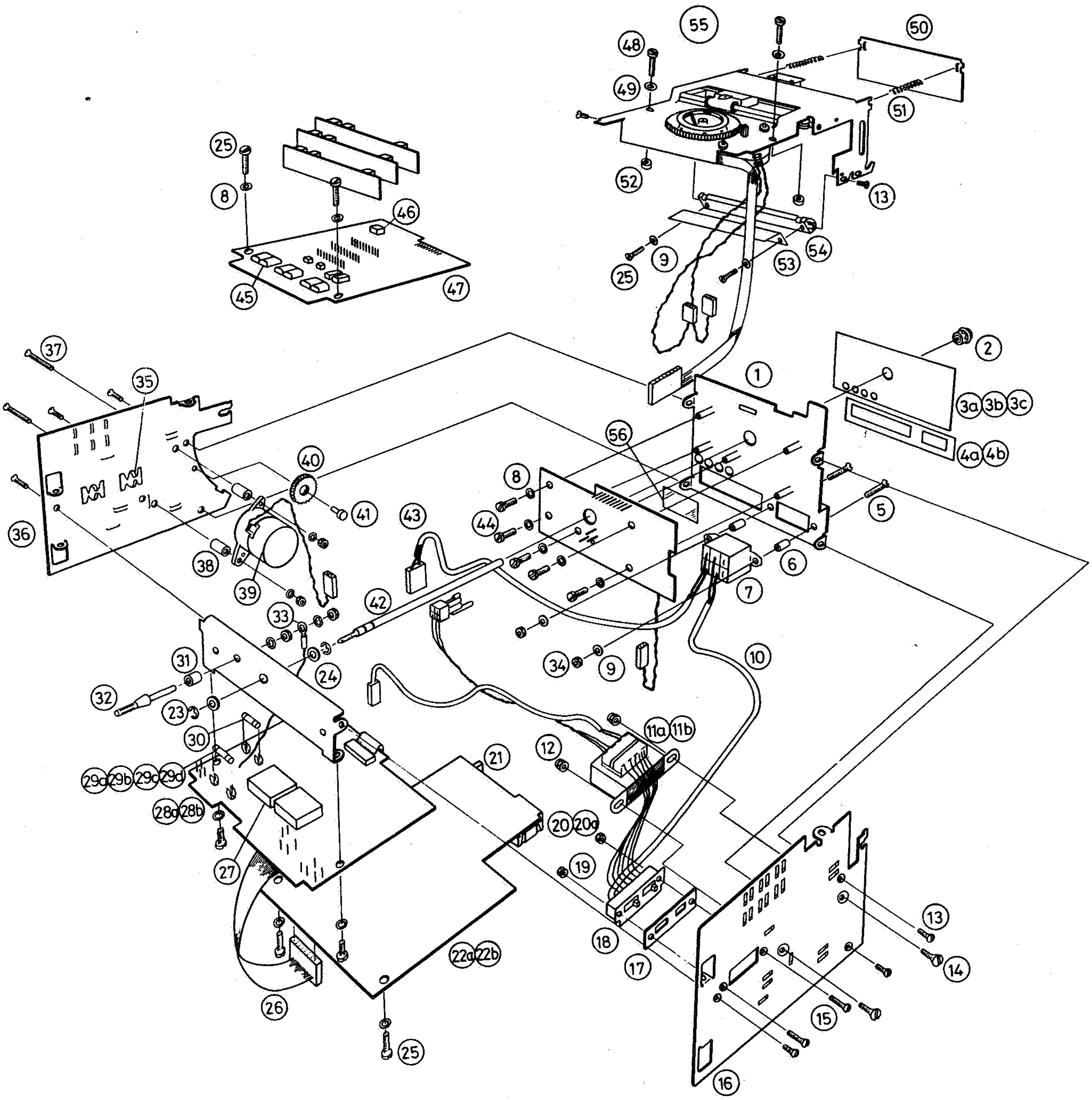


Figure 19.1 EXPLODED VIEW OF CHASSIS ASSEMBLY
(Drawing No.HC233106, Issue 1)

29A	100mA Slow-Blow Fuse (FS1: 220,240V operation)	CH050012
29B	200mA Slow-Blow Fuse (FS1: 110,120V operation)	CH050022
29C	1 Amp Slow-Blow Fuse (FS1: 24V operation)	CH050013
29D	500mA Slow-Blow Fuse (FS1: 48V operation)	CH050252
30	500mA Quick-Blow Fuse (FS2)	CH020052
31	Spacer	BG129344
32	Earthing Connector (includes 2 nuts and 2 washers)	CI129272
33	Earth Lead with Terminal	DN230003
34	M3 Nut	FA12336J
35	Self-adhesive Cable Clip	FI128791
36	Right-hand Side Plate (includes 42T gear)	LA129204
37	M3 x 25 Countersunk Screw	FB013J25
38	Spacer	BE100565
39	Chart Drive Motor/Gearbox Assembly (includes loom and connector)	LA128990
40	42T gear	BD128677
41	Gear Pin	BE128704
42	Jacking Screw	BE128790
43	Power ON/OFF Switch/Power Supply Board Loom	DN128794
44	M3 x 10 Cheesehead Screw	FB016J10
45	Reed Relay	DB129123
46	BCD Switch	DC127248
47	Scanning Board (includes 45 and 46)	AH128996
48	M3 x 8 Cheesehead Screw	FB016J08
49	M3 Plain Washer	FC12335J
50	Scale Plate	BA128722
51	Scale Retaining Spring	BH129334
52	Scale Retaining Washer	FX128666
53	Chart Retaining Plate	BA129989
54	Guide Bar Assembly (includes 54 screwed in place)	LA129162
55	Complete Pen Tray Assembly (excludes calibration scales and unit and factor labels)	LA129209
56	L.E.D. Filter	BT128703

19.2 Roll Chart Cassette (with manual paper take-up) - Exploded View

1	Roll Chart Cassette Side Plate, L/H	LA128691
2	Front Plate	LA129165
3	Circlip	FJ126387
4	End Cap	BE127912
5	Upper Chart Sprocket	LA128727
6	Lower Chart Sprocket	LA128729
7	Take-up Spool	LA129208
8	Supply Spool	BK127920
9	Friction Disc	BT128803
10	Friction Washer	BT128707
11	Spindle	BE127909
12	Clutch Spring, Take-up	BH128669
13	Clutch Spring, Pay-off	BH128838
14	Roll Chart Cassette Side Plate (includes supply shaft, take-up shaft, complete gear train and chart take-up lever)	LA129201
15	Grip Ring	FI126382
16	28T Gear	BD128679
17	45T Gear	BD128678
18	M2.5 x 8 Countersunk Screw	FB013H08
19	Plastic Chart Retaining Sleeve	BK129976

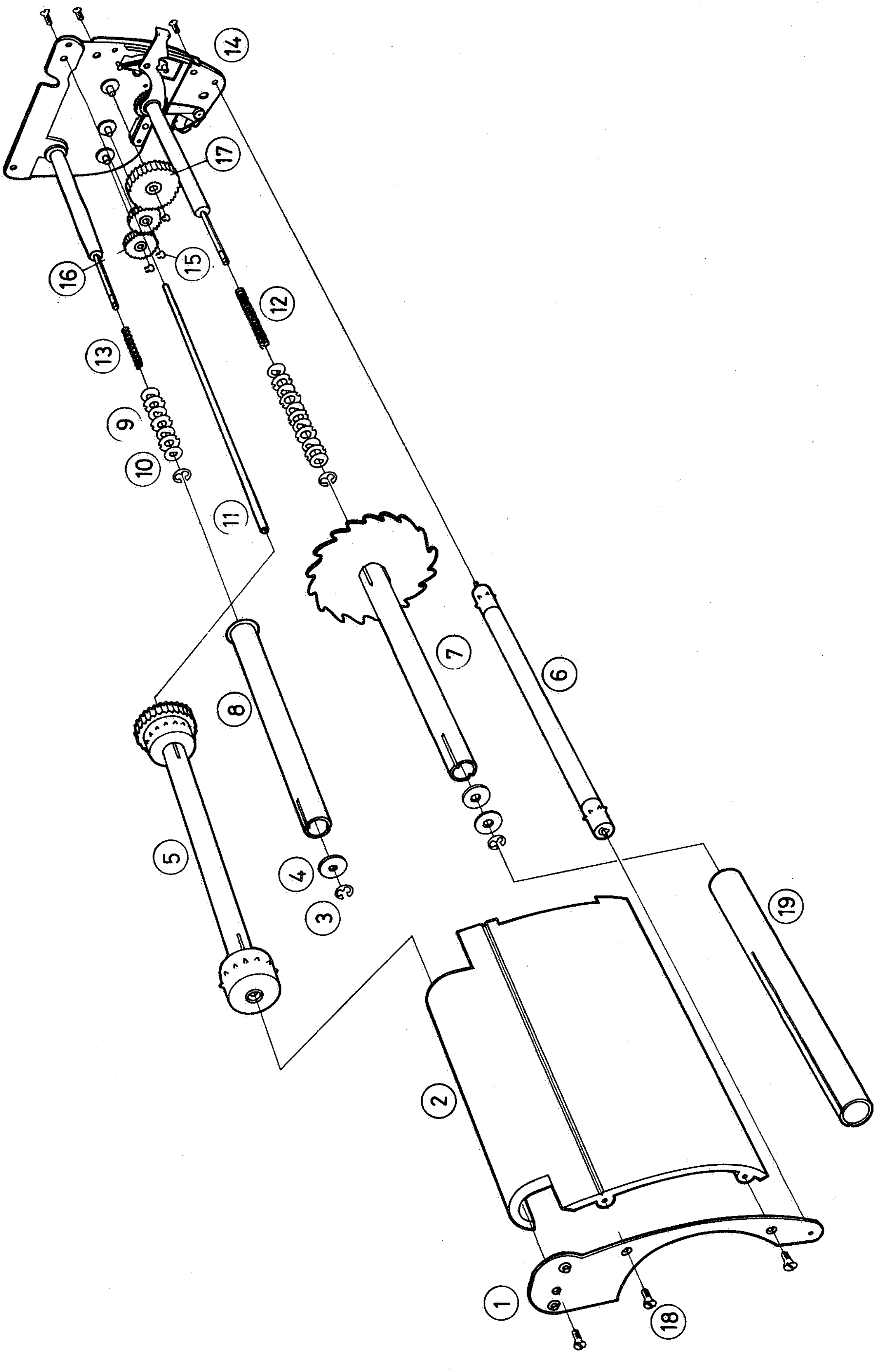


Figure 19.2 EXPLODED VIEW OF ROLL CHART CASSETTE
(Drawing No.HC233107, Issue 1)

19.3 Z-Fold Chart Cassette, LA128690 - Exploded View

1	Z-fold Chart Cassette Side Plate, L/H	LA128731
2	Top and Bottom Tray Assembly	LA128995
3	Drive Sprocket Assembly	LA128699
4	Chart Guide Moulding	BD127922
5	Spindle	BD127909
6	45T Gear	BD128678
7	Grip Ring	FI126382
8	28T Gear	BD128679
9	Z-fold Chart Cassette Side Plate, R/H (includes gear train, latch, and leaf spring for guide mouldings)	LA128692
10	M2.5 x 5 Countersunk Screw	FB013H05
11	M2.5 x 8 Countersunk Screw	FB013H08
12	Spacer	BG230257
13	Acetate Washer	BT101243
14	Guide Strip	BC232733

19.4 Pen Tray Assembly, LA129209 - Exploded View
(normally supplied as complete/tested assembly)

1	Tray Pressing	LA129245
2	Rear Carriage Shaft	BE128375
3	Front Carriage Shaft	BE128376
4	M4 Bowed Circlip	FJ126383
5	Pulley	BD128377
6	Cord Assembly	LA128694
7	Servo Motor complete with Looms	LA128366
8	M3 Internal Tooth Washer	FC12306J
9	M3 x 5 Cheesehead Screw	FB016J05
10	M2 Grip Ring	FI126382
11	M2 Plastic Washer	FB101242
12	M2.5 x 5 Pan Head Screw	FB009H05
13	M2.5 Int. Tooth Washer	FC12306H
14	M2.5 Plain Washer	FC12335H
15	Head Retraction Spring	BH128380
16	Pawl Welded Assembly	LA129993
17	Special Screw	FB128381
18	Bearing	LA128391
19	Head Drop Coil	LA128369
20	Stop Pillar	BE128718
21	Carriage Magnet Assembly	LA128362
22	Pin	BE128020
23	Indicator Block	BD128918
24	Indicator	BD128916
25	Indicator Spring	BA128919
26	M2 x 6 Cheesehead Screw	FB016F06
27	M2 x 14 Cheesehead Screw	FB016F14
28	Tow Tag	BA128933
29	M2.5 x 10 Cheesehead Screw	FB063H10
30	M2.5 x 5 Countersunk Screw	FB004H05
31	Capstan Spring	BH128347
32	M3 Grip Ring	BH128349
33	Capstan	LA128365
34	M3 Plastic Washer	FC12336J

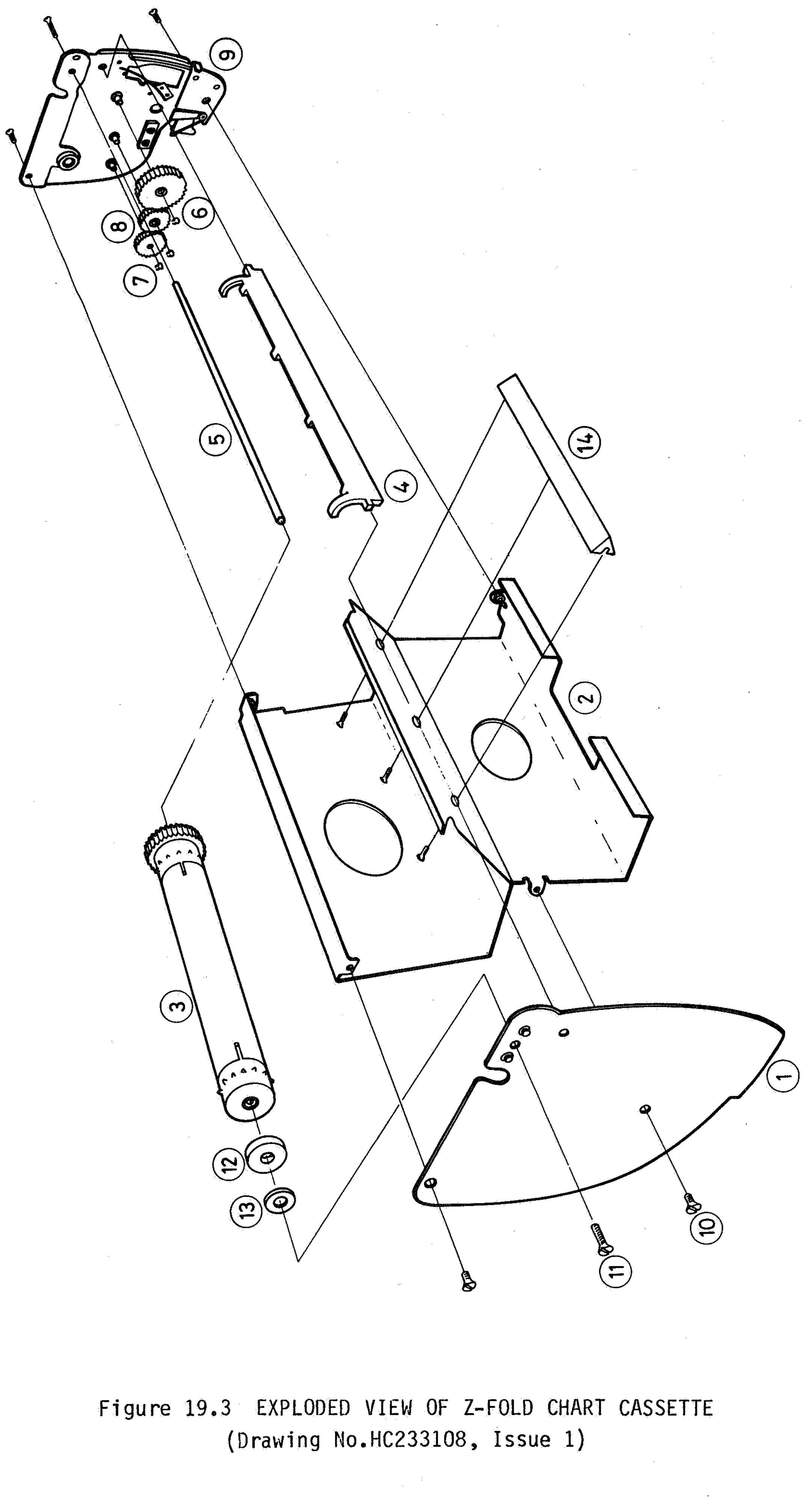


Figure 19.3 EXPLODED VIEW OF Z-FOLD CHART CASSETTE
(Drawing No.HC233108, Issue 1)

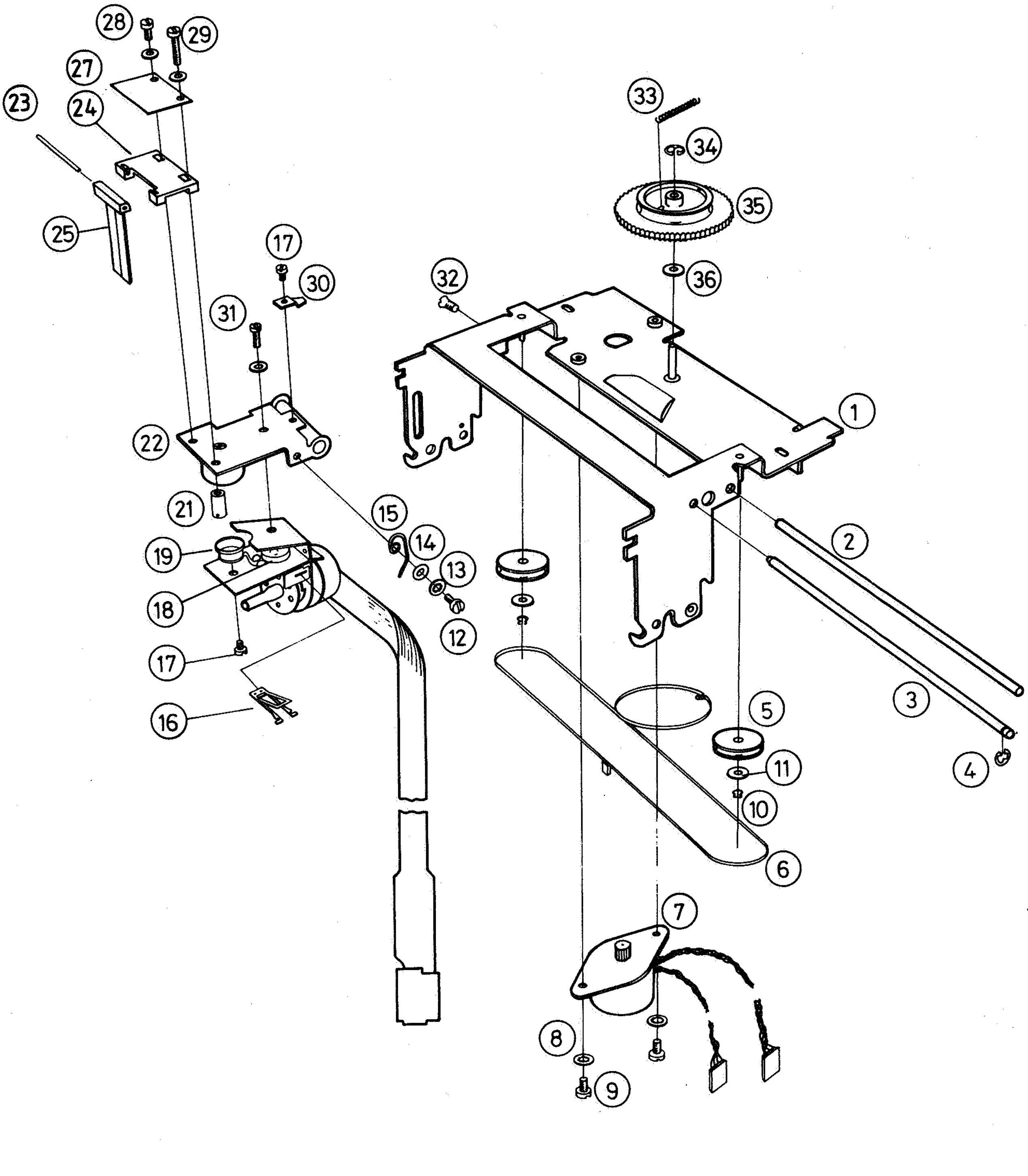


Figure 19.4 EXPLODED VIEW OF PEN TRAY ASSEMBLY
(Drawing No.HC233109, Issue 1)

19.5 DIN Case Assembly - Exploded View

1A	DIN Door Assembly (without lock option). Standard finish is Silver. Standard window material is glass. Always state finish and window material, even if standard.	LA128395
1B	DIN Door Assembly (with lock option). Standard finish is Silver. Standard window material is glass. Always state finish and window material, even if standard.	LA128397
2	Door Hinge Pin	BE128709
3	Door Hinge Pin Spring	BH126644
4	Door key for Lock Option	FI129327
5	Door Lock (optional) supplied with two keys	FI129237
6	Door Label	GA129740
	Logo (if required)	GA128219
7	Door Seal Strip	BT125410
8	DIN Case Assembly. Standard colour is Storm Grey, BS4800 00/A13, eggshell. Always state colour and finish, even if standard.	LA129539
9	DIN Case Clamp	LA129713
10	M3 Nut	FA12336J
11	M3 Int. Tooth Washer	FC12306J
12	Terminal Mounting Plate	LA128715
13	M3 x 6 Cheesehead Screw	FB016J05
14	Blanking Plate (fitted in place of 15 on non-alarms version)	BA128660
15	12-way Terminal Block	CI129219
16	M3 Plain Washer	FC12335J
17	M3 x 8 Cheesehead Screw	FB016J08
18	Power Guard	BS128786
19	Power Warning Label	GA127634
20	20-way Terminal Block	CI129220
21	Cold Junction Temperature Sensor	AH127635
22	Hexagonal Spacer	BE128921
23	4-way Terminal Block	CI129218
24	M5 x 8 Cheesehead Screw	FB016M08
25	M5 Washer	FC12301M
26	Earth Saddle Clamp	BA100415
27	M3 x 10 Cheesehead Screw	FB016J10
28	Power Warning Label - Terminal Cover	GA100201
29	Fibre Washer	BT101252
30	Retaining Screw for Long Terminal Cover	FY127144
31	Long Terminal Cover	LA128706
32	Gland Plate	BA128802
33	Bush	BD125943
34	Long Terminal Cover Assembly, complete	LA128301
35	Retaining Screw for Short Terminal Cover	FY128974
36	Short Terminal Cover	LA128777
37	Short Terminal Cover Assembly, complete	LA128300
38	Headed Drive Pin	FG129136
39	Rear Terminal Panel Assembly, complete with all connectors	LA128750
40	Chessell logo badge	GA128219

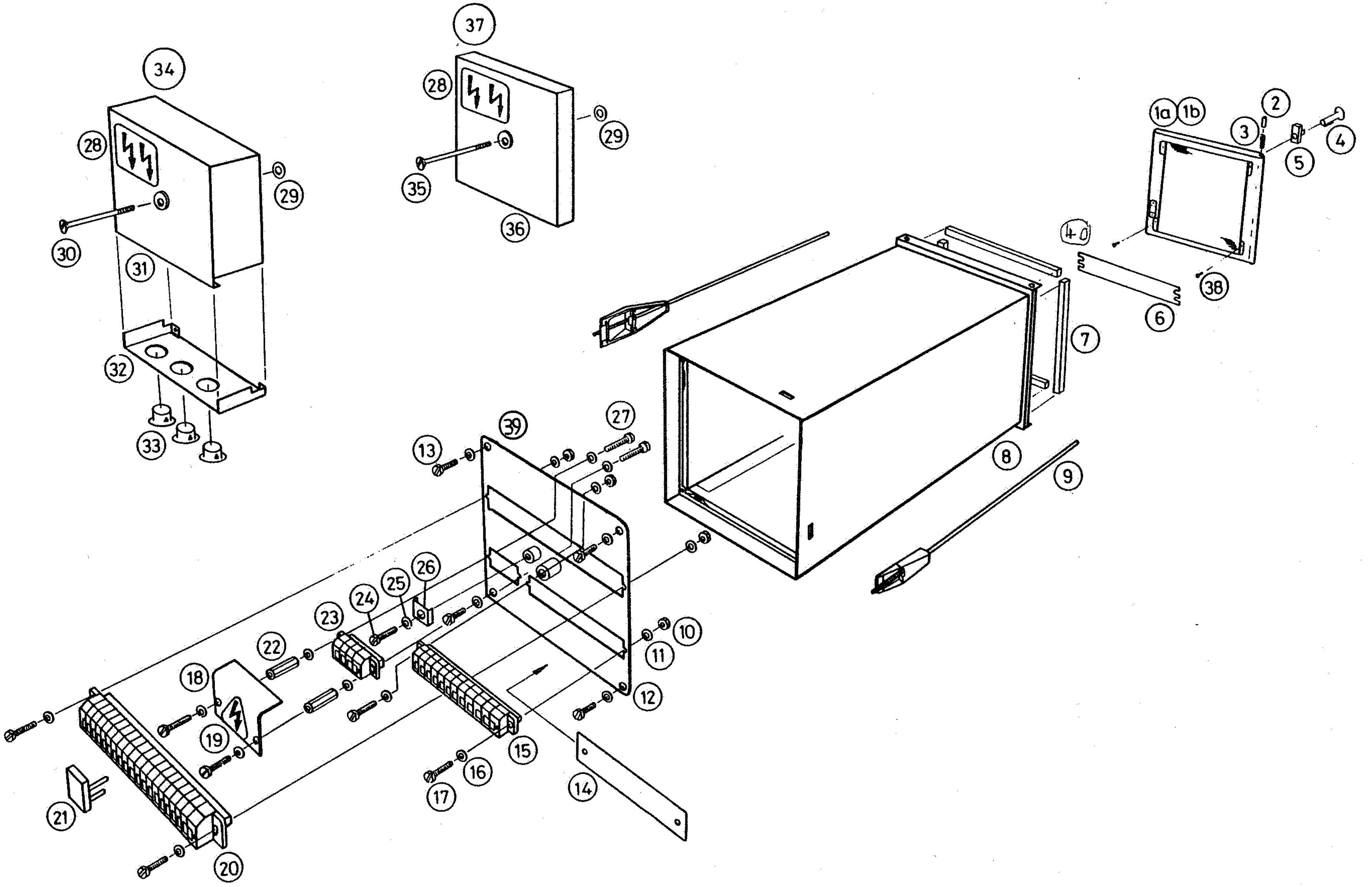


Figure 19.5 EXPLODED VIEW OF CASE ASSEMBLY

19.6 Printed Circuit Boards

State input/range/options, etc. required.

1	Control Board, Level 1 (excludes EPROM)	AH127424
2	Control Board, Level 2 (excludes EPROM)	AH127424U100
3	Power Supply Board, Non-Alarms Version	AH127440
4	Power Supply Board, Alarms Version	AH127440U100
5	Scanning Board	AH128996
6	Multipurpose Board (remote CJT board assembly required for thermocouple)	AH128204
7	Linear mV,mA Board (shunt resistor assembly required for mA)	AH129654
8	Resistance Thermometer Board	AH129243
9	DC Option Board	AH230103
10	Interruption Protection Board (battery back-up)	AH230522
11	Shunt Resistor Assembly: 1R0	LA129653U1R0
	5R0	LA129653U5R0
	7R5	LA129653U7R5
	10R	LA129653U10R
	20R	LA129653U20R
	100R	LA129653UK10
	250R	LA129653UK25
12	Remote CJT Board Assembly	AH127635
13	Extender Card (test purposes)	AH320150
14	Watchdog Monostable PCB (battery back-up)	LA233075

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