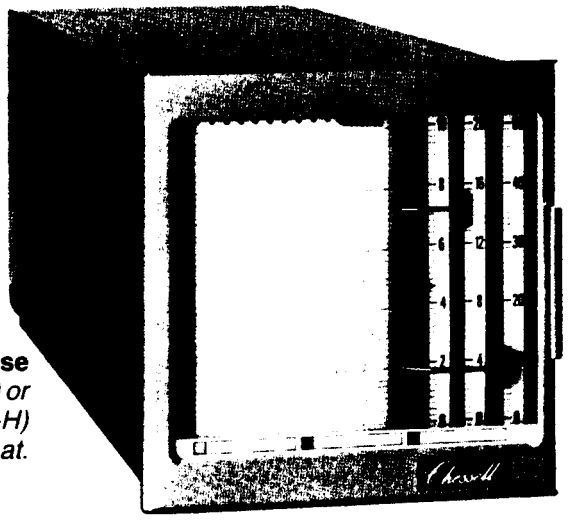
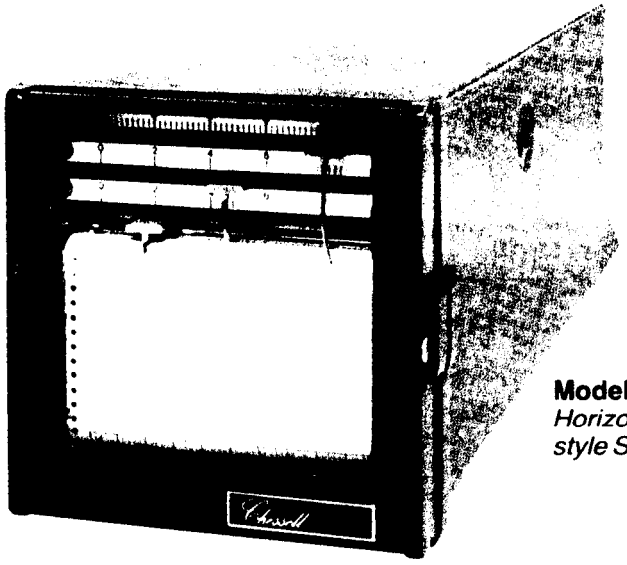
Model 301 100mm Servo Recorder
Installation & Operating Instructions



Model 301 in compact case
Vertical (DIN-V) or horizontal (DIN-H) scale format.



Model 301 in standard case
Horizontal scales only, style SPC.

Part No. 201 464

Chessell

Warranty Statement

This Chessell product is warranted against defects in materials and workmanship for twelve months from the date of shipment. During the warranty period Chessell Corporation will, at its option, either repair or replace products which prove to be defective.

Within areas designated for service travel by Chessell or its representatives, warranty service will be provided at the buyer's facility at no charge. Outside the service travel areas warranty service at the buyer's facility can be provided only upon prior agreement by Chessell or its representative, and the buyer may be required to pay round-trip travel expenses.

In all cases the buyer has the option of returning the product for warranty service to a facility designated by Chessell or its representatives. The buyer shall prepay shipping charges for products returned to a service facility, and Chessell or its representatives shall pay for return of the products to the buyer.

Limitation of Warranty

The foregoing warranty shall not apply to defects arising from:

Improper or inadequate maintenance by the user;

Improper or inadequate site preparation;

Unauthorized modification or misuse;

Operation of the product in unfavorable environments, especially high temperature, high humidity, corrosive or other damaging atmospheres.

Disclaimer

No other warranty is expressed or implied. Chessell Corporation specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Exclusive remedies

The remedies provided above are the buyer's sole and exclusive remedies. Chessell Corporation shall not be liable for any direct, indirect, special incidental, or consequential damages.

Calibration Accuracy

This Chessell product was thoroughly tested to ensure compliance with published specifications. All instruments used in production and final test are regularly inspected to maintain accuracy of calibration, traceable to the National Bureau of Standards. The user should be satisfied that the performance of the product as received meets expectations and, as part of a program of planned maintenance, should periodically check calibration accuracy against reliable standards.

CAUTION

The product cover(s) should not be removed by other than qualified service personnel. High or lethal voltages may be present at exposed points on the chassis if power is applied. Chessell Corporation shall not be liable for personal injury or property damage suffered in servicing the product. The product should not be modified or repaired in a manner at variance with procedures established by Chessell.

Model 301
Installation and Operating Instructions

Publication No. 201 464

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Section 1
General Information

1-1 Introduction

Chessell Model 301 is a one, two or three-pen, 4 inch (100mm) servo recorder housed in a lockable steel case with gasket-sealed door. The Model 301 provides a choice of roll or z-fold chart format, three writing systems (capillary ink, disposable ink cartridge or electric etch), plus a choice of over 4000 off-the-shelf input conditioning modules and matching scales. In its standard form the Model 301 has a fixed-speed (synchronous) chart motor driving through a train of exchangeable gears on the chart cassette. Two types of motor and seven gear ratios are available, providing a choice of 14 final drive speeds. An electronic gearbox/stepper motor option provides 10 switch-selectable chart speeds. Other options include: HI/LO alarms, dc operation, two-wire transmitter power supply, integrating totalizer, event marker pen, retransmission outputs.

This manual contains installation, operating and basic maintenance instructions, with schematics and calibration procedures for selected input modules. Additional information (especially Principles of Operation) is provided in an earlier publication (Maintenance Manual, Chessell No. 124 508).

1-2 Model 301 specifications

Available writing systems Capillary ink (version 'C'): writing length typically 6500 ft (2000 m). 3 ml ink capsule. Choice of red, green, blue or black inks.

Disposable ink cartridge (version 'D'): writing length typically 2600 ft (800 m) with chart speeds of 12 cm/hr and greater. Upper pen (No. 3) green; middle (No. 2) and lower (No. 1) cartridges available in either red or blue.

Electric (version 'E'): Spark erosion of aluminized paper. Unlimited writing length.

Chart length Roll, ink writing, 49 ft (15 meters); roll, electric writing, 40 ft (12 meters); z-fold, ink writing only, 26 ft (8 meters).

Chart speed (standard version) One speed chosen from:

Time/cm	5s cm	10s cm	20s cm	30s cm	60s cm	2m cm	2.5m cm
Cm/time	12cm	6cm m	3cm m	2cm m	1cm m	5mm m	4mm m
Time/cm	5m cm	10m cm	20m cm	30m cm	60m cm	2h cm	2.5h cm
Cm/time	12cm h	6cm h	3cm h	2cm h	1cm h	5mm h	4mm h

s = second m = min h = hour

Overrange protection Pen servo is electronically limited at −1.5 mm and +1.5 mm (−1.5% and +101.5% full scale).

Pen response time Zero to 90% full scale in less than 0.5 seconds.

Servo linearity Linearity, from servo amplifier to recording pen, excluding input conditioner, ±0.2% full scale.

Pen repeatability: ±0.1% full scale

Input conditioning modules Table of specifications on page 1-2.

Environment: Ambient temperature range, zero to +50°C; humidity (non-condensing), zero to 90%.

Power Requirement (standard version) 115, 220 or 240 Vac, +5%, −10%, 50 or 60 Hz, 15 VA typical.

Dimensions Diagrams, figures 1-1 and 1-2. Weight (net): 14 lb (6 kg).

Finish Matte paint. Standard colors: dark gray, blue, black, cream.

Connectors Rear panel connectors are screw-type terminals, stud diameter 3.5 mm, for No.6 or No. 8 spade lugs and ¼ in. (6 mm) Faston lugs. Terminal rating: maximum voltage 500 V, maximum current 2 A.

1-3 Model 301 Options

DC power (option DCS) Internal dc-dc converter (replaces power transformer) operating on any dc supply between 12 and 36 V. Available only on recorders with electronic chart drive (options EGLS, EGHS and DS). Not recommended for electric writing Model 301.

Low voltage ac power (option ACL) Recorder powered by either 24 or 50 Vac, 50/60 Hz.

10-speed chart drive (options EGLS and EGHS) Choice of line synchronized electronic chart drives, low speed and high speed versions, each giving 10 switch-selectable speeds.

LS	10s cm	20s cm	30s cm	1m cm	2m cm	5m cm	10m cm	20m cm	30m cm	1h cm
	6cm m	3cm m	2cm m	1cm m	30cm h	12cm h	6cm h	3cm h	2cm h	1cm h
HS	1s cm	2s cm	3s cm	6s cm	12s cm	30s cm	1m cm	2m cm	3m cm	6m cm
	60cm m	30cm m	20cm m	10cm m	5cm m	2cm m	1cm m	30cm h	20cm h	10cm h

s = second m = min h = hour

Two-speed chart drive (option DS) From the above table, choice of any two LS or HS speeds from the same group. With this option the chart on/off switch becomes the speed selector switch on the front panel.

Externally-triggered drive (option ESD) Available only with options EGLS, EGHS or DS. As an alternative to line frequency synchronization, the chart drive may be triggered by pulses from an external source (e.g. where the chart speed is to be synchronized to a process speed, or where the length of chart recorded is to be proportional to the length of material produced). Chart speed depends on pulse rate and the nominal speed selected. For example, on the fastest LS setting (10 sec/cm), the chart moves 1 mm every 120 pulses; on the next setting (20 sec/cm) chart movement is 1 mm every 240 pulses, and so on. The HS group is ten times faster than LS, so chart movement at the 1 sec/cm nominal setting is 1 mm every 12 pulses. Input specifications: rate, up to 240 pps; pulse width 10 μs to 2.5 ms, amplitude 1 V to 100 V p-p; input impedance approximately 100 kΩ.

Remote chart advance (option RCA): Available only with options EGLS, EGHS and DS. An external contact closure shifts the chart drive into a selected faster speed. For example, if the normal speed is 30 cm/hr (option EGLS), the chart-

advance speed could be 6 cm/min. Chart advance is normally used to produce a high resolution segment of recording e.g. in turbine or other machine and process run-up situations. Chart advance can also be used for aligning the pens with a pre-printed time of day on the chart.

Remote chart control (option RCS): For 1982 and later production models, this option is available only with 10-speed or dual speed electronic chart drives EGLS, EGHS and DS. Option RCS allows the chart drive to be switched on by an external contact. Not available with externally triggered chart drive (if option ESD is installed, the chart drive is switched off simply by interrupting the triggering pulse train).

Re-transmission (option RSO) Linear zero to 10 V re-transmission output, with 1 mA maximum current. Not available with 3 or 4-wire RTD's, potentiometric transducer inputs,or option TWS.

Totalizer (option INT) Option INT converts any channel of the Model 301 into an integrating recorder. Used mainly in ***flow*** and ***power*** applications, the totalizer option integrates the signal applied to the recording pen and displays the running total on an electromechanical counter. Option INT is ***not*** available (1) on any channel fitted with the alarms option, HLL, and (2) on electric writing recorders having more than one channel.

Alarms (option HLL) Available on any or all channels of the recorder, option HLL is a pair of independent HI and LO alarms, each controlling a changeover relay with 120 V, 2A (resistive load) switching capability. The relays are energized in the normal, non-alarm condition. Only two of the three contacts of each relay are wired out to the rear terminals (***common*** and ***closed/energized*** (i.e. open in alarm) contacts are used unless otherwise specified). Option HLL is ***not*** available with the two-wire power supply option TWS, or with electric writing, or on any channel fitted with the totalizer option INT.

Two-wire transmitter power supply (option TWS) Internal 24 Vdc power supply for three separate 4-20 mA two-wire systems. Option TWS is ***not*** available on any electric writing recorder, or any recorder with options HLL, DCS or ACL, or any channel with the retransmission option, RSO.

Event marker (option EVP) Available in capillary ink, disposable cartridge or electric etch versions. A solenoid operated pen mechanism traces a continuous line just to the right of the chart grid. When energized by an external contact closure, the solenoid deflects the pen 2 mm to the left.

Plexiglass (option PLG) Acrylic window in place of glass, mostly for pharmaceutical and food processing applications.

Chart tear-off (option CRO) For roll chart only. Hold-down fingers are added to the cassette, and a tear-off plate is fitted to the lower edge of the door. Not available with electric writing.

Color Case is dark gray, unless otherwise specified. Blue, black and cream are alternative colors.

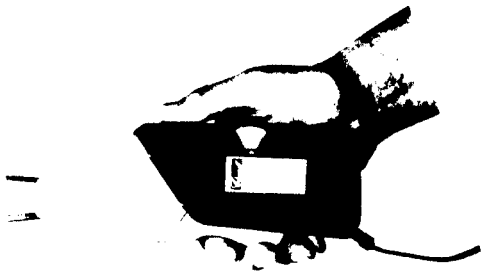
Case Wood finish (option WCH), and Compact cases (options DIN-H and DIN-V, figure 1-2) are alternatives to the standard case, style SPC, figure 1-1.

Input Signal Conditioning
Performance specifications for dedicated single-range modules [4 inch (100 mm) recorders]

TYPE NO.	1018-01	1025-01	1025-05	1020-01	1020-02	1021-01	1021-02	1025-02	1006-01	1023-01	1025-03	1025-04
INPUT	DIRECT VOLTAGE AND CURRENT			ALTERNATING CURRENTS TO 1 AMP VOLTS TO 30 V	ALTERNATING VOLTS 30 V to 250 V	FREQUENCY		THERMO-COUPLE[k] SPANS ≥ 4 mV	RTD		POT-TYPE TRANSDUCER	SQUARE ROOT
	SPANS UP TO 4 mV & 100 μA	SPANS 4 mV to 2 V 100 μA to 1 AMP	SPANS 2 V to 50 V			SIGNAL UP TO 500 kHz	LINE 50/60 Hz NOMINAL		4 or 2 WIRE	3 WIRE		
Accuracy (including linearity): % of span	±0.25% ±5 μV	±0.25% ±5 μV	±0.25%	±1%[g]	±1.5%[g]	±0.3%[h]	Better than ±0.2 Hz	±0.5% ±5 μV typical[f]			±0.25%	±1.5%
Input Impedance	>10MΩ	>1 MΩ	100 kΩ/V	1 MΩ/V but ≥ 10 MΩ	>10MΩ	>10 kΩ	>100 kΩ	>1 MΩ	—	—	>1 MΩ[j]	c
Bias Current	<10 nA	<150 nA	<150 nA	AC Coupled	Transformer Coupled (50:1)	AC or DC Coupled	Transformer Coupled (50:1)	<150 nA[a]	Current through RTD <2 mA		<100 nA	c
Minimum Span	1 mV 1 μA[e]	4 mV 100 μA[e]	2 V	50 mVrms 1 mArms[e]	30 Vrms	Note 'd'	2 Hz	4 mV[b]	25°C 50°F	25°C 50°F	3 V	c
Maximum Input	100 mV	20 V	50 V	50 Vrms	350 Vrms	100 V p-p	250 Vrms	20 V	20 V	20 V	50 V	c
Gain/Temp Coefficient	100 ppm/°C	100 ppm/°C	200 ppm/°C	200 ppm/°C	200 ppm/°C	—	—	100 ppm/°C	100 ppm/°C	100 ppm/°C	200 ppm/°C	200 ppm/°C
Offset Voltage Drift	<0.5 μV/°C	<4 μV/°C	—	—	—	—	—	<4 μV/°C	<4 μV/°C	<4 μV/°C	—	—
Bias Current Drift	<50p A/°C	<5n A/°C	—	—	—	—	—	<5n A/°C[a]	—	—	—	—
Common Mode Rejection 1kΩ unbalance	120 dB			—	—	—	—	120 dB				
Normal Mode Rejection	55 dB up to ½ span			—	—	—	—	55 dB up to ½ span				

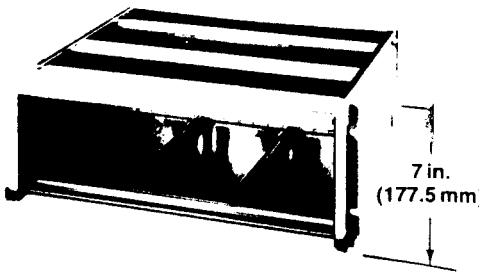
nA = 10^{-9}A pA = 10^{-12}A

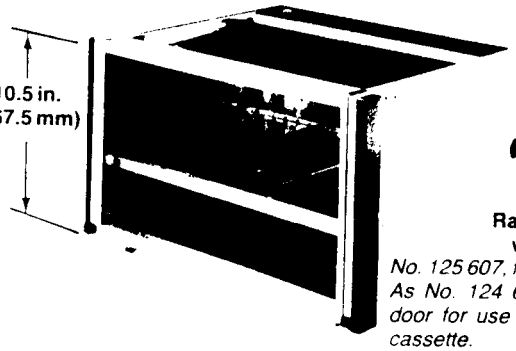
a Unless break protection fitted, when bias current 1 μA.
b Approximately 100°C for a base metal couple.
c Generally supplied for 4-20 mA loop use with a 250Ω shunt.
d Ratio of zero offset to span must not exceed 15:1; also low-end frequency must be at least 20 Hz if full-scale frequency is 1 kHz of less.
e Current is converted to voltage, usually 75 mV span, by shunt resistor; 4 V span (1 to 5 V) is usual for 4-20 mA and 10-50 mA inputs.
f Plus instrinsic errors in the temperature sensor.
g Accuracy is as stated provided input exceeds 5% of span.
h Accuracy is ± 0.3% of full scale frequency, not span.
j Full scale resistance of transducer must be between 480Ω and 5kΩ; input signal is nominally 10 V full scale.
k Thermocouple inputs usually include automatic cold junction compensation for changes in ambient temperature. Error in the measured temperature can be up to 1° for each 10° change in ambient temperature.



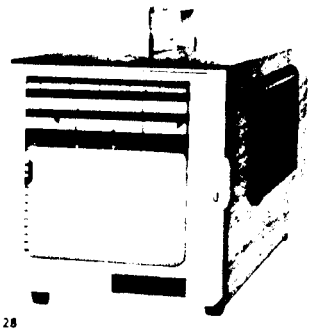
Clamp-on current probe *No. 200 272. For alternating current measurements without breaking the circuit. The probe hooks around either insulated or non-insulated conductors up to 1.25 in. (3.2 cm) diameter, rectangular sections up to 1.5 sq. in. (9.7 sq. cm) and foils up to 0.1 in. thick by 3 in. wide (2.5 mm x 7.6 cm). Six current ranges: 10, 20, 50, 100, 200 and 500 A rms. For use with line voltages up to 600 V rms. Probe output: 5 V rms full scale. Chessell recorders can be supplied pre-calibrated for use with this probe.*

Rack mounting case *No. 124 673 for Model 301, and No. 200 025 for Model 300. Provides plug-in accommodation for three recorder chassis. Pre-drilled brackets for 19 inch relay rack.*

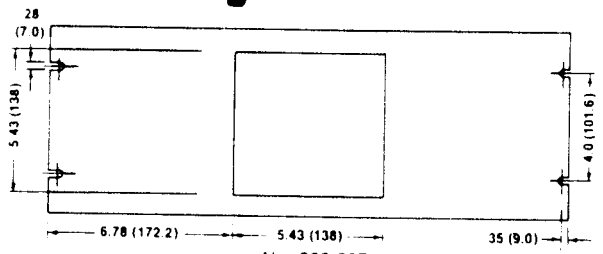




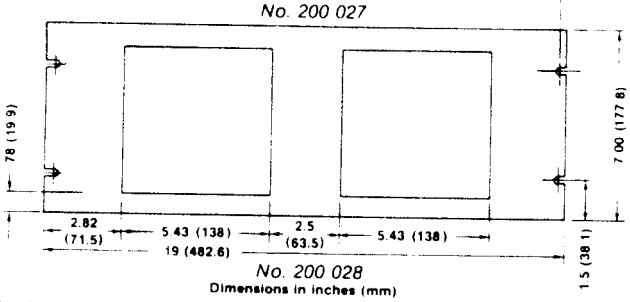
Rack mounting case with oversize door *No. 125 607, for Model 301, only. As No. 124 673, with enlarged door for use with extended roll cassette.*



Wood finish carrying case *Option WCH. Teak veneer, with cream door surround. No. 100 977 if ordered separately from recorder.*



No. 200 027

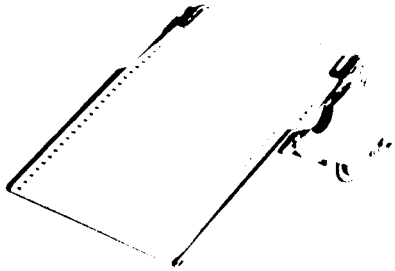


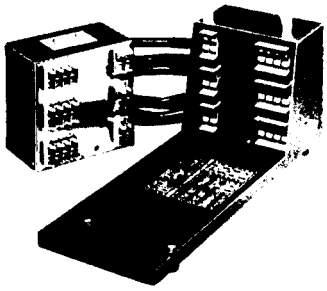
No. 200 028

Dimensions in inches (mm)

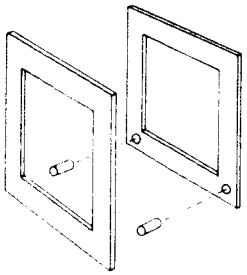
Rack mounting frames *for 19 inch relay rack. 0.2 in. (5 mm) alloy plate. Light gray paint finish.*

Extended roll cassette *No. 124 664, for Model 301 only, ink or electric writing. Provides 4 in. (100 mm) additional chart visibility. Total chart viewing area 4 x 6.5 in. (100 x 165 mm). Requires rack mounting case No. 125 607.*





Service connector assembly *No. 200 029, allows recorder to be withdrawn from case for bench operation. For either model, 300 or 301.*



Panel adaptor kit *No. 201 031, for installing Model 300 and 301 recorders in 6 inch square cutout (e.g. for Leeds and Northrup and Esterline Angus recorders). Kit comprises two 7 inch square plates, for front and back of panel, with two locating pins.*

Faston lugs *for rear panel terminal blocks. Gold plated Mallory-9 alloy No. 100 418 for thermocouple inputs. Nickel plated brass No. 200 032 for all other connections. Plain brass wire-crimp female connectors, No. 126 420, fit both types of Faston lug.*

Service extender board *No. 200 030, for input conditioning modules.*

Service extender board *No. 200, 031, for servo amplifier (pen drive) modules.*

The following are not illustrated:

Capillary flushing bulb *Service accessory, for cleaning capillary ink systems. Rubber bulb and 2 foot length of flexible capillary tubing, No. 127 163.*

Capillary pen tool *Service accessory, No. 123 218 facilitates removal and replacement of capillary pen tips, No. 200 305.*

Wall mounting bracket *No. 201 105, for all Chessell 100 mm recorders. Welded 14 gauge box construction, open at underside and rear, with 138 mm square cutout in front panel. Dark gray textured paint finish. Dimensions: 9 in. high, 8 in. wide, 15.5 in. deep (229 x 203 x 394 mm).*

Model 301 accessories

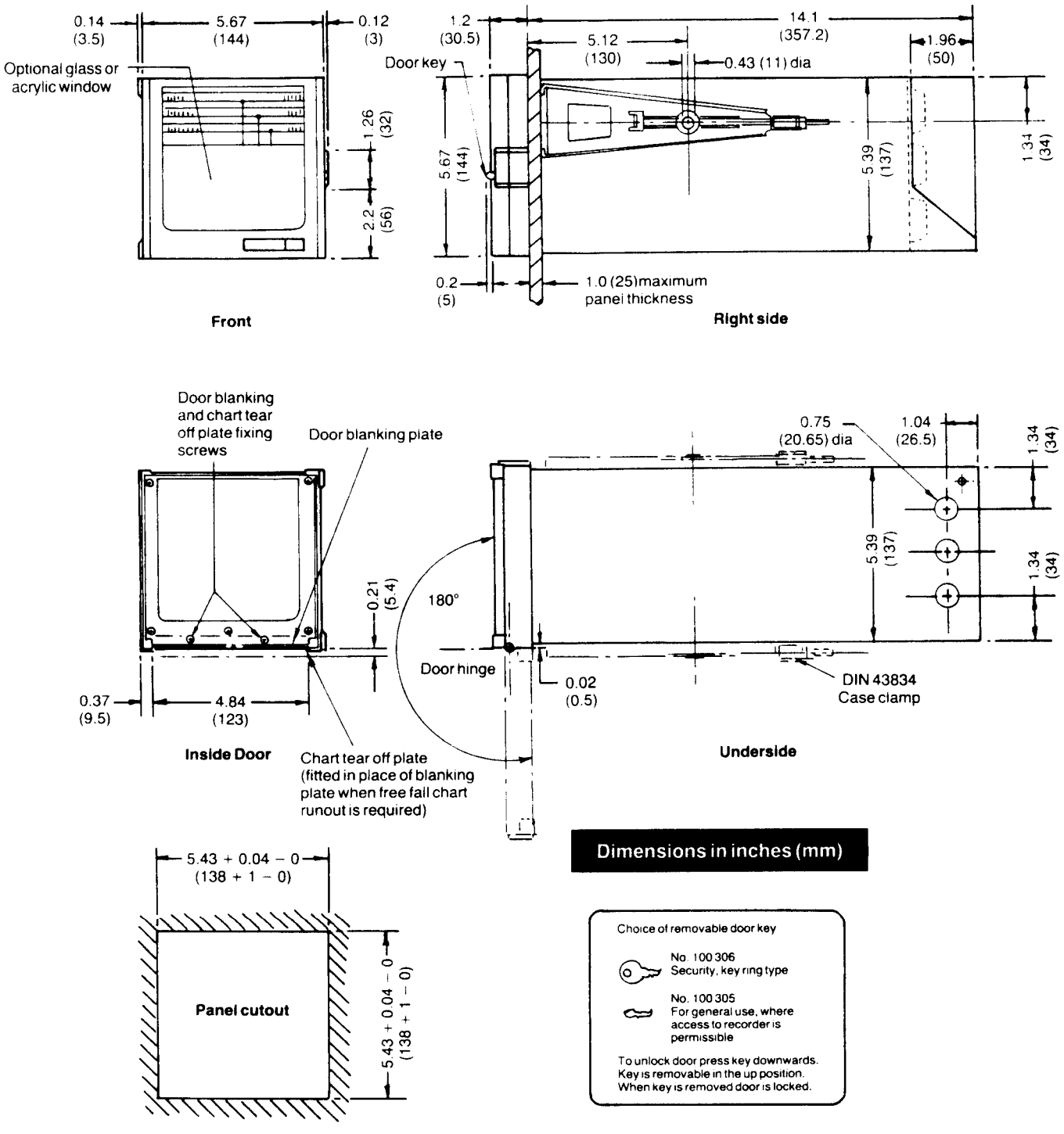
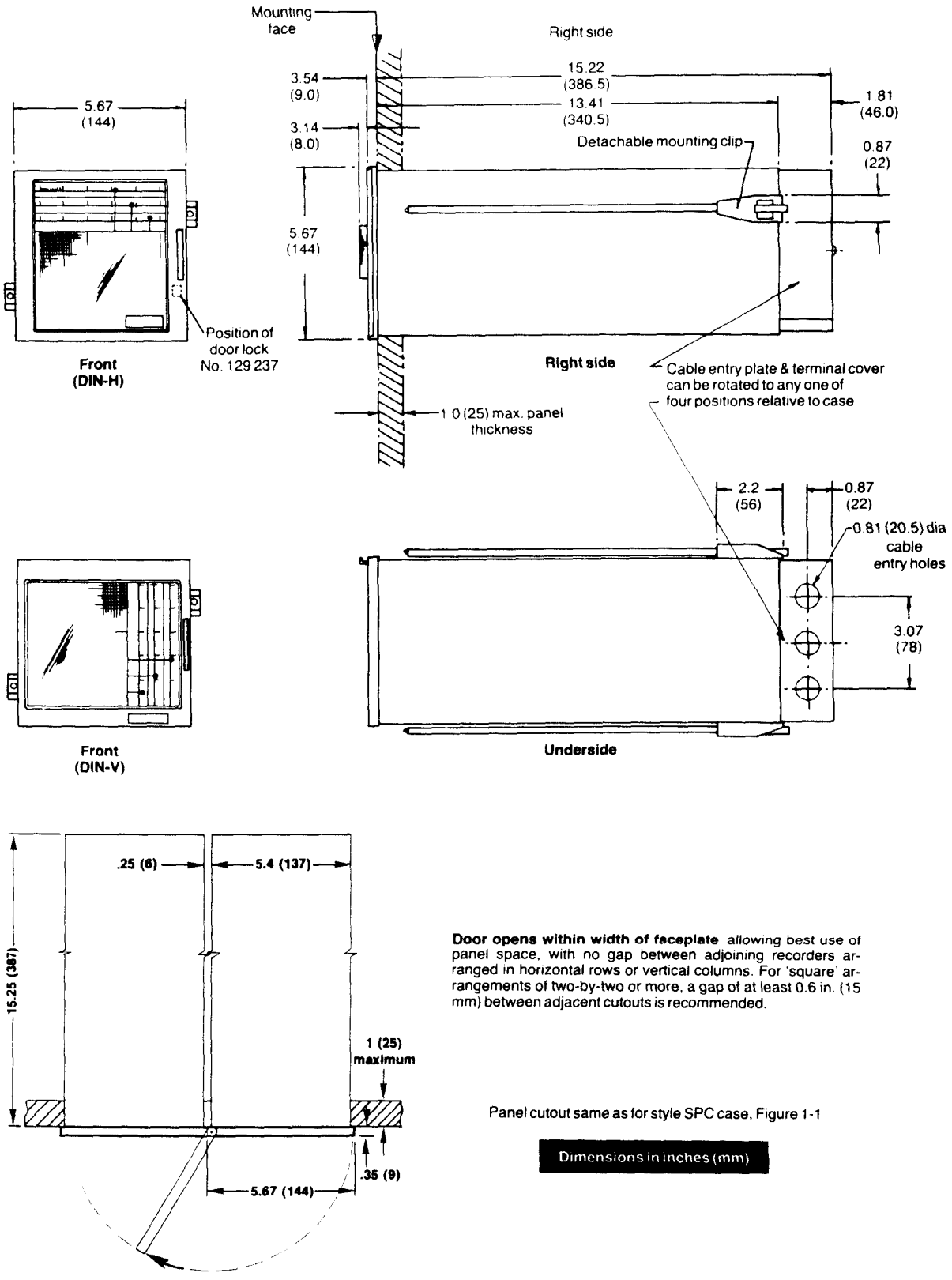


Figure 1-1 Model 301 dimensions *Case style SPC*



Door opens within width of faceplate allowing best use of panel space, with no gap between adjoining recorders arranged in horizontal rows or vertical columns. For 'square' arrangements of two-by-two or more, a gap of at least 0.6 in. (15 mm) between adjacent cutouts is recommended.

Panel cutout same as for style SPC case, Figure 1-1

Dimensions in inches (mm)

Figure 1-2 Model 301 dimensions *Case style DIN-H and DIN-V*

Section 2
Installation Instructions

2-1 Unpacking

This instrument was shipped in a special pack designed to ensure adequate protection in transit. If the outer box shows signs of excessive damage, the pack should be opened and the instrument examined. If there is evidence of damage, do NOT operate the instrument. Call your local Chessell representative or the Chessell plant, and notify the carrier.

Before discarding the packing materials, check that all accessories have been removed.

2-2 Storage

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

2-3 Transit bolt

As shipped, the recorder chassis is secured to the rear of the case by a M5 screw which should be removed when installation is complete. For access to the screw, remove the red rear terminal cover.

2-4 Door lock

Two types of panel mounting case are available for the Model 301. The standard case, style SPC, has a protruding door with a locking latch operated by a detachable key; to open the door insert one of the keys supplied, then press down on the key head. The compact case, style DIN, has a flush fitting door secured by ball catches at top and bottom. A knockout at the right-hand edge of the door is provided for an optional security lock No. 129 237.

2-5 Visual inspection

Before installation the transit bolt should be removed and the recorder chassis withdrawn from the case. Inspect for mechanical integrity. For access to the chassis, first remove the chart cassette as shown in Section 3, Figures 3-1 and 3-2. Replace the transit bolt to avoid damage when installing.

2-6 Panel installation

The Model 301 recorder is intended for installation in a panel, and may be tilted at any elevation when fitted with an electric etch or disposable cartridge writing system. Panel tilt should not exceed 30 degrees, forward or back, if the instrument is fitted with a capillary pen. The instrument is secured to the panel by jacking clamps (Figures 2-1, 2-2), which are clipped into either side of the case and tightened with a screwdriver.

2-7 Electrical connections

All electrical connections to the Model 301, figure 2-3, are made at the rear of the case. Before making any connections, ***be sure*** that the supply voltage and input range shown on the rear label match the requirements of the installation.

Figure 2-1 Clamps for case style SPC *Clamp locations are provided on the two vertical sides of the case. Tighten the jacking screw to the point where the buffer spring is only slightly compressed. Continued tightening beyond that point could distort the case.*

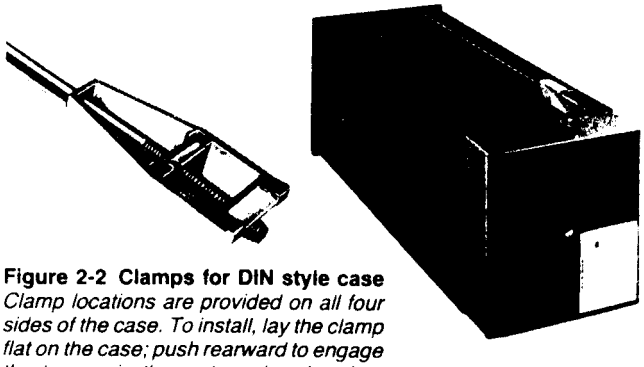
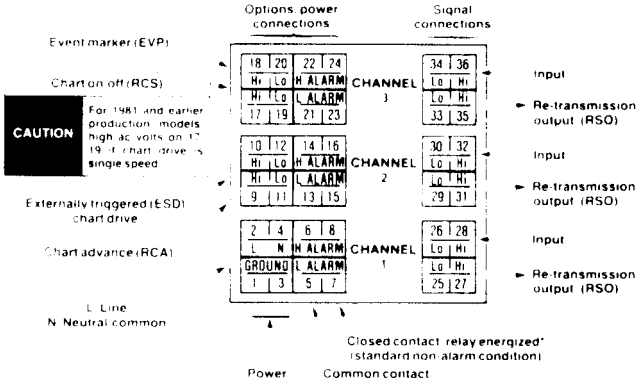


Figure 2-2 Clamps for DIN style case *Clamp locations are provided on all four sides of the case. To install, lay the clamp flat on the case; push rearward to engage the tongue in the rectangular slot, then hook the clamp shoulder over the edge of the case.*



* Changeover relays installed, but only the common and energized closed contacts are wired out to the rear terminals. Energized open contact can be substituted (special order)

Figure 2-3 Model 301 rear terminal assignments *Shown here is the standard configuration of terminals with all the options installed. The two-wire transmitter power supply (TWS) is not normally available with signal re-transmisstion (RSO), and vice versa: other input or options terminals must be sacrificed if these options are required together. Also, because each channel with option RSO has only two input terminals available, RSO is not normally available with three and four wire inputs. For the alarms option, HLL, only the common and closed energized contacts of each relay are wired to the rear terminals: the third contact, open energized is also available if other terminals can be sacrificed. This, and the other deviations from standard, will be noted **only** on the inside of the rear terminal cover.*

2-8 Supply connections

Follow this procedure carefully:

(1) Check the supply voltage on the rear panel label.

(2) Open the recorder case door, remove the chart cassette and withdraw the chassis from the case (Section 3, figure 3-1).

(3) Remove, check and replace the fuse (holder at the rear of the chassis).

Fuse type Metric 5 mm diameter, 20 mm long.
For 115/220/240 Vac, use 1 Amp Type T (slow-blow) No. 205 055.
For 24/50 Vac use 3.15 Amp Type T (slow-blow) No. 205 058.
For dc powered recorders use 5 Amp (high rupture current) No. 205 051.

(4) Remove the insulating cover from the power terminals, Figure 2-3, and connect wiring for the ac supply:

Line/hot	Terminal No. 2
Common/neutral (N)	Terminal No. 4
Ground (earth)	Separate grounding terminal on case

(5) Replace the insulating cover over the power terminals.

(6) Visually check the chassis for secure installation of printed circuit boards, etc.

(7) Replace the chassis in the recorder case.

2-9 Signal connections – general

Each recording channel has a separate four-way block on the right side of the rear panel. For each four-way block the ***signal input*** is connected to the upper pair of terminals, and the ***re-transmitted output*** (if option RSO is installed) is available from the lower two terminals. Check the signal polarity: the right hand input terminal is high, left hand low (but not grounded). Within each channel the low line is common to the input and re-transmitted output.

2-10 Signal isolation

Input conditioning modules and their related pen servo circuits are supplied by separate secondary windings on the power transformer. The input circuits will withstand 100 Vdc between any input terminal and ground, or between any two input terminals. Recorders intended for high voltage ac inputs are supplied with isolating transformers (Figure 2-4), which will withstand 500 Vac p-p between either transformer input and ground, or across the transformer primary.

CAUTION

Because the signal conditioning and servo circuits are floating with respect to chassis ground, care should be taken to avoid touching ***any*** internal components, such as potentiometric feedback elements, while any input signal is present. This precaution applies especially to signals exceeding 15 V.

2-11 Small signals

Check that gold-plated input terminals have been installed if the input is a thermocouple, RTD or dc less than 4 mV. Faston cable terminations are available from Chessell. Male lugs: Mallory-9 alloy No. 100 418 for all low signal applications, nickel plated brass No. 200 032 for less critical applications. Matching female connector, all applications, No. 126 420.

2-12 High current signals

DC and ac spans up to1 A are accommodated by a factory-installed shunt across the input terminals. For spans greater than 1 A an external shunt or current transformer is required (not supplied by Chessell).

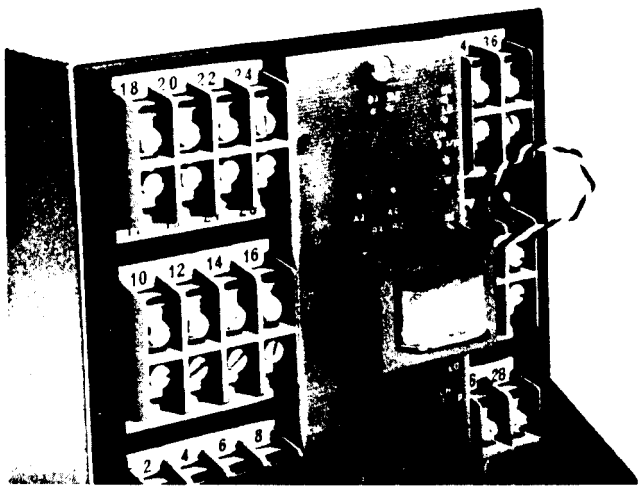


Figure 2-4 Isolating transformer for ac inputs over 30 V *Depending on the number of high voltage ac inputs to be handled, one, two or three isolating transformers are installed on a printed circuit board at rear of the case. Shown here is the transformer for channel 2 only.*

2-13 High voltage ac signals

AC inputs greater than 30 Vrms (e.g. for line voltage or frequency monitoring) require a 50:1 step-down transformer which is factory-installed at the rear of the case. The signal is connected to the terminals on the transformer panel, NOT to the four-way block (Figure 2-4).

2-14 Resistance thermometers

Connections for RTD's are shown in Figures 2-5, 2-6 and 2-7. Terminal numbers given in these illustrations are for channel 1 only; the disposition of the terminals is the same for channels 2 and 3. The ***four wire*** configuration gives highest accuracy and easiest set up; for rated accuracy without on-site adjustment, none of the leads should have a resistance greater than 6Ω. If the RTD is located near the recorder, i.e. if the connecting wires are short, the ***two wire*** configuration may be used, with the voltage and current terminals on the recorder connected together; this arrangement introduces a zero offset of approximately 1 C for each 0.4Ω of lead resistance.

Chessell ***three wire*** input modules provide automatic compensation for lead resistance, up to 50Ω per lead, provided the two V leads are equal (each 0.4Ω difference between the V leads introduces approximately 1°C zero offset).

2-15 Potentiometric transducers

For channel 1 (Figure 2-8) the 12 Vdc, 25 mA (maximum) potentiometer supply is at terminals 27 (+ ve) and 26 (– ve). The disposition of terminals for channels 2 and 3 is similar. The end-to-end resistance of the transducer must be between 480Ω and 5 kΩ.

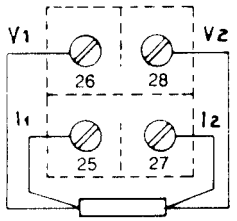


Figure 2-5 *Four wire RTD*

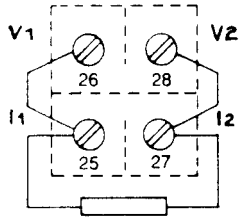


Figure 2-6 *Two wire RTD*

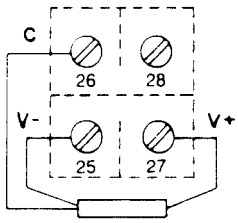


Figure 2-7 *Three wire RTD*

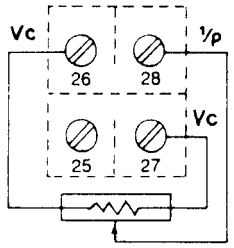


Figure 2-8
Potentiometric transducer

2-16 Optional features/connections – general

Some options are mutually exclusive, e.g. the alarms option HLL is not available in a recorder fitted with the two-wire transmitter power supply, option TWS. For more information refer to Section 1-3 and Figure 2-3. Selected options are described in paragraphs 2-17 through 2-23 below.

2-17 DC Power

Available only on recorders with electronic chart drive (options EGLS, EGHS, DS). Any dc power input between 12 and 36 V can be connected to terminals 2 (positive) and 4 (negative). Average power consumption for single channel recorder, 4 VA; for each additional recording channel, 2.6 VA; for each pair of HI/LO alarms (option HLL), 1.7 VA.

CAUTION

DC power is not normally recommended for electric writing recorders, or for recorders with externally triggered chart drive. Serious damage to the dc-dc converter can result if the negative rail (terminal 4) of the dc power input is connected to chassis ground or to the low rail (terminal 12) of the external trigger input.

2-18 Re-transmission output (option RSO)

Option RSO provides a zero to 10 V full scale re-transmission of the input signal, as modified (e.g. linearized) by the input conditioning module. Maximum current 1 mA. RSO is available at the pair of terminals immediately below the related input terminals. The left hand terminal (e.g. 25) is the low rail, right hand (e.g. 27) high. There is ***no isolation*** between an input and its related re-transmission output.

2-19 Externally triggered chart drive (option ESD)

Available only on recorders fitted with the electronic chart drive options EGLS, EGHS or DS. Triggering input specifications: rate, up to 240 pps; pulse width 10 μs to 2.5 ms; amplitude 1 V to 100 V p-p; input impedance, terminals 10 and 12, approximately 100 kΩ. Terminal 10 is the high rail, terminal 12 low.

2-20 Remote chart advance (option RCA)

Available only with electronic chart drive options EGLS, EGHS or DS. An external contact closure shifts the chart drive into a faster speed, as selected by the user. Provided the external circuit is ***isolated from chassis ground,*** solid state switching may be used. Terminal 9 is the high rail, terminal 11 low.

2-21 Remote chart control (option RCS)

Closing of an external contact switches the chart drive on. With recorders having electronic chart drive options (EGLS, EGHS or DS) installed, solid state switching may be used provided the external circuit is ***isolated from chassis ground.*** Terminal 17 is the high rail, terminal 19 low. Solid state switching is ***not recommended for use with single speed*** synchronous chart motors (CAUTION note below).

CAUTION
For recorders manufactured in 1981 and earlier

In a single speed synchronous motor installation with option RCS, 220 Vac is present across terminals 17 and 19. Take care to ensure that the rear cover is always in place, and that the external components are adequately specified and protected.

2-22 Two-wire transmitter power supply (option TWS)

This option (Figure 2-9) makes available three separate, isolated 25.5 Vdc supplies for use with two-wire 4-20 mA transmitter systems. Maximum output is 22 mA each channel. Wiring information and schematics, Section 5.

2-23 Event marker (option EVP)

Available in capillary ink, disposable ink cartridge or electric writing versions, the event marker is a solenoid operated pen which writes a continuous trace at the right hand edge of the chart grid, marking each event by a 2 mm shift to the left. The solenoid is energized by an external contact closure across terminals 18 (+18 Vdc nominal) and 20 (zero volts). Solid state switching may be used provided the external circuit is ***isolated from chassis ground.***

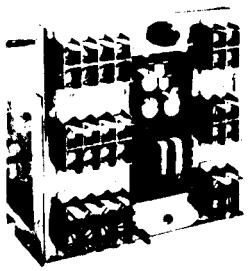


Figure 2-9 Power supply for 4-20 mA two-wire systems *Three 25.5 Vdc supplies, one for each recording channel, are normally brought out to the terminals allocated to signal re-transmission, option RSO. Other terminals can be used, if available, allowing the two-wire power unit to be installed together with RSO.*

2-24 On-site modifications

Qualified service personnel can perform the following modifications on site:

- Retrofit the following options: alarms (HLL), event marker (EVP), re-transmission (RSO); for regular case, style SPC ***only***, plexiglass (PLG), and chart tear-off (CRO).
- Exchange and adjust input modules
- Exchange scales
- Change supply transformer tappings
- Exchange cassettes, e.g. roll to z-fold
- Change chart speed by exchanging cassette gear sets and/or motor assemblies

2-25 Adding options to the Model 301

Component kits including instructions are available for all retrofittable options listed above.

2-26 Input module exchange

(1) Withdraw the chassis from the case.
(2) Remove the retaining fixture from the top of the vertical printed circuit assemblies.
(3) Remove the blank white retaining strips from the appropriate four way plug at right of the chassis rear panel.
(4) Remove the selected input module assembly (PCB, harness and four way plug).
(5) When installing the exchange module, be sure that orientation of the four way plug is correct (input leads at top; red and black RSO leads, if fitted, at bottom) and that the retaining strips are installed firmly.

2-27 Input module adjustments

Calibration procedures are together with the input module schematics in Section 4.

2-28 Scale exchange

HANDLE SCALES GENTLY – AVOID FINGERMARKS AND OTHER MECHANICAL DAMAGE

(1) Remove one of the 2.5 mm scale retaining screws; loosen the other.
(2) Install the exchange scale, leaving the screws part tightened.
(3) By rotating the gray plastic capstan on the pen servo assembly, align the pen with the chart zero (left or right limit of the chart grid, depending on scale direction).
(4) Slide the scale to left or right to set the scale zero under the pen position indicator. Gently tighten the two retaining screws.

2-29 Supply transformer tappings

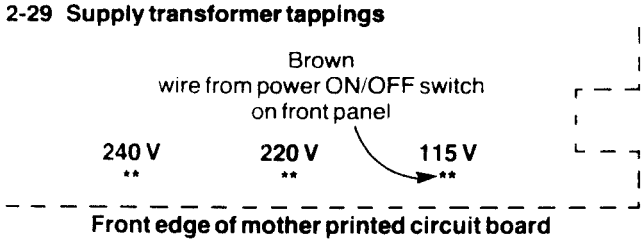


Figure 2-10 Supply transformer tappings *The asterisks indicate holes on the motherboard.*

To change the supply transformer tapping, remove the chassis from the recorder case, then follow this procedure carefully:

(1) Unsolder and transfer the brown wire to the PCB hole matching the available supply voltage.
(2) Modify ***both*** labels on the recorder to indicate the supply voltage for which the instrument is now wired.

CAUTION

> Check the line frequency also. It may be necessary to exchange the motor/gearbox assembly to suit the new supply. Procedure, para 2-32.

2-30 Exchanging cassettes

If changing from one cassette to another – as opposed to reloading the cassette originally installed – the following procedure applies:

(1) Depress the cassette retaining latch at the bottom right corner of the chassis, allowing the cassette to swing upward.
(2) Swing the cassette upward to the point where it can be removed from the chassis forks.
(3) Withdraw the chassis from the case.
(4) Install the exchange cassette by the exact reverse of the above procedure. Do ***not force*** the pivot studs into the forks; the cassette slips easily into place provided the front plate is tilted slightly upward from the horizontal.
(5) Check the security of the cassette; the latch, when hooked over the cassette tab, should permit a very small (but detectable) movement of the cassette. The latch can be adjusted by bending the tab with smooth-jaw pliers.
(6) With the cassette latched in place, check the mesh between the chart motor/gearbox and the first cassette gear. The ideal mesh is 75%, i.e. a ***gap*** equal to one quarter the tooth depth should be visible between the gears. A tighter mesh could cause the drive to seize; a looser mesh could cause excessive wear.

Adjust the mesh by very slightly loosening the lower screw holding the motor/gearbox plate in position; then move the motor/gearbox assembly forward or back to correct the mesh. Re-tighten both screws.

2-31 Chart tear-off (option CRO)

This option is available for roll chart, ink writing only. Hold-down fingers are added to the cassette, and a tear-off plate is fitted to the lower edge of the door. A retrofit kit is available, but users are recommended to return their cassettes to the factory for exchange or modification. The tear-off plate can be installed on site.

2-32 Changing chart speed

Detail information on the chart drive system is contained in the following pages. Following ***any*** modifications to the chart drive system, the mesh between the motor and the first cassette gear must be checked as outlined in paragraph 2-30 above.

To remove a ***synchronous-type*** (single speed) chart motor, detach the two-wire motor supply harness and socket from the two-pin plug on the mother PCB, adjacent to the supply transformer. Then remove the two 2.5 mm countersunk screws securing the motor/gearbox plate to the chassis. (An anchor nut is installed in the chassis for the upper screw; the lower screw is secured by a lock washer and nut.)

To remove a ***stepper-type*** (10 speed electronic) chart motor, detach the 11-way molded plug from the right side (viewed from front of recorder) of the "electronic gearbox" PCB located behind the supply transformr compartment. Detach the knurled nut from the pen tray pillar, then lift the pen tray(s) sufficently to free the motor harness. Mechanical removal of the motor is as described above for the synchronous motor.

To exchange the ***cassette gears,*** remove the screw and lock washer securing the gear cover plate to the right side of the cassette (2 mm screw for roll cassette, 2.5 mm for z-fold). Detach the cover plate and install the exchange gear set as diagrammed on pages 2-6, 2-7 and 2-8. Do ***not*** lubricate the gear teeth. Check that the gears rotate freely, and are not buckled. Replace the cover plate. Secure the retaining screw with Loctite 222. Check the inspection procedures in Section 3.

2-33 Chart drive system

Chart speed in the Model 301 recorder is established by (1) the type of motor/gearbox installed on the chassis, and (2) the set of gears installed on the chart cassette.

Four single-speed ***synchronous*** motor/gearbox assemblies are available:

High speed (M1) 1 revolution in 15 seconds
No. 124 651 (M1/60 Hz) or 124 650 (M1/50 Hz)
Low speed (M2) 1 revolution in 15 minutes
No. 124 655 (M2/60 Hz) or 124 654 (M2/50 Hz)

Four 10-speed ***stepper*** motor/gearbox assemblies are available:

High speed (M3, for option EGHS)
No. 124 647 (M3/60 Hz) or 124 644 (M3/50 Hz)
Low speed (M4, for options EGLS)
No. 124 646 (M4/60 Hz) or 124 645 (M4/50 Hz)

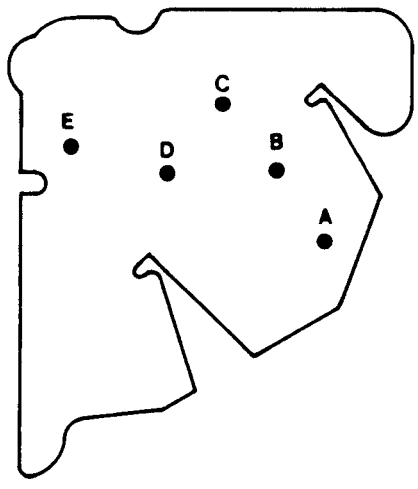


Figure 2-11 Cassette right-hand plate *Stub shafts are installed at gear positions A, B, C and D on the right-hand plate of the cassette. Gear position E is a bearing hole for the drive transfer spindle. Gear ratios in the diagrams on the following pages are overall,* ***from*** *the motor/gearbox output* ***to*** *the drive transfer spindle at E.*

Gear set No. 125 241

Gear set No. 125 237

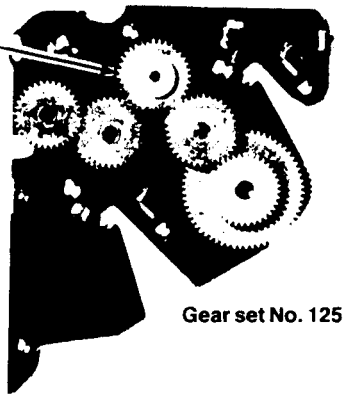
Gear set No. 125 240

Gear set No. 125 236

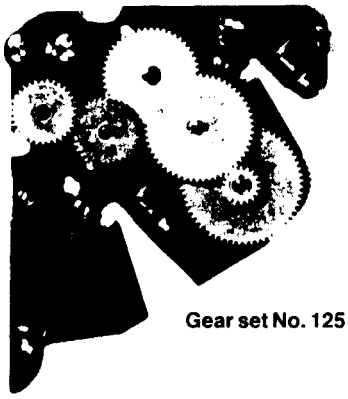
Gear set No. 125 239

NOTE

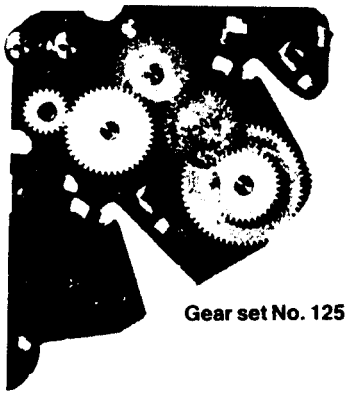
In cassettes manufactured after March 1982, spacer No. 201 466 is fitted to ***all*** gear sets, between gear 'C' and the cover plate.



Gear set No. 125 235



Gear set No. 125 238



Gear set No. 125 242

Figure 2-12 *Arrangement of cassette gears*

Chart speeds 4 mm/hr (150 min/cm) with M2 and 4 mm/min (150 sec/cm) with M1
Gear set No. 125 241 Ratio 30:1

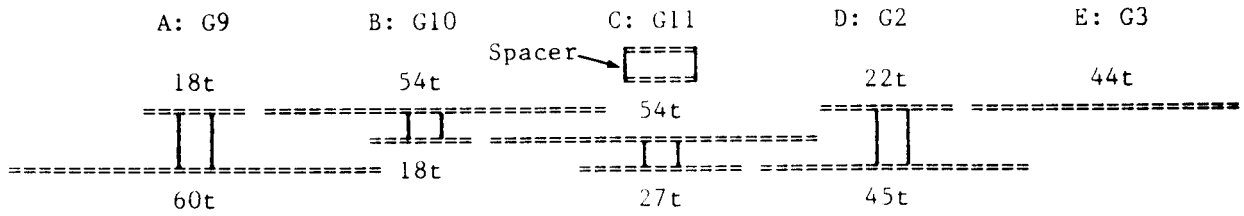


Chart speeds 5 mm/hr (120 min/cm) with M2 and 5 mm/min (120 sec/cm) with M1
Gear set No. 125 240 Ratio 24:1

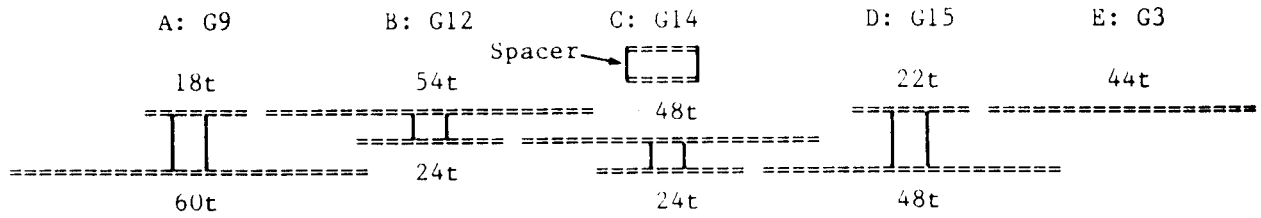


Chart speeds 1 cm/hr (60 min/cm) with M2 and 1 cm/min (60 sec/cm) with M1
Gear set No. 125 239 Ratio 12:1

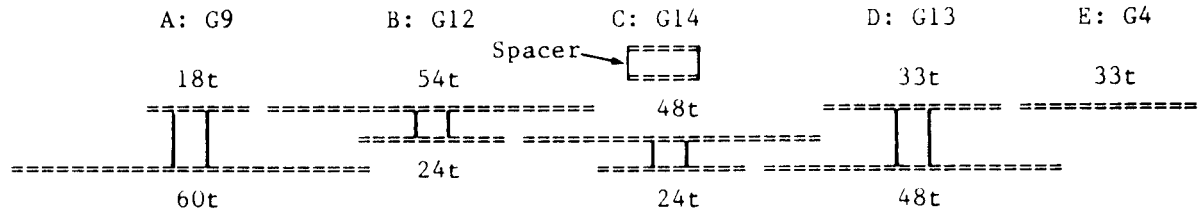


Chart speeds 2 cm/hr (30 min/cm) with M2 and 2 cm/min (30 sec/cm) with M1
Gear set No. 125 238 Ratio 6:1

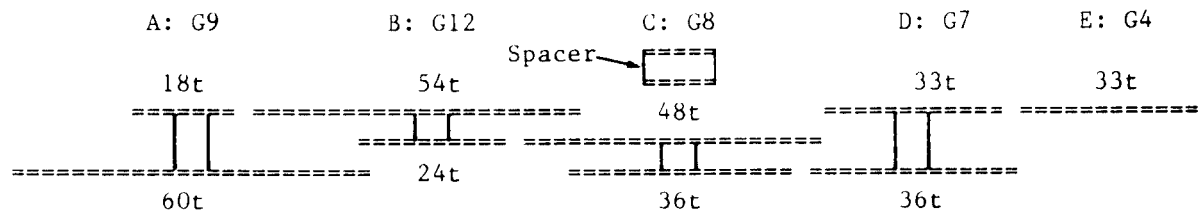


Chart speeds 3 cm/hr (20 min/cm) with M2 and 3 cm/min (20 sec/cm) with M1
Gear set No. 125 237 Ratio 4:1

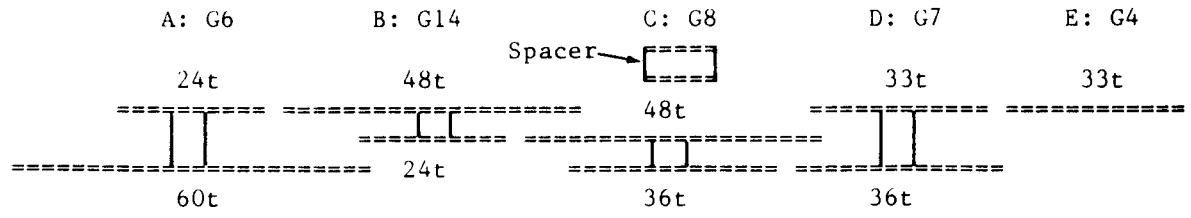


Chart speeds 6 cm/hr (10 min/cm) with M2 and 6 cm/min (10 sec/cm) with M1:

Gear set No. 125 236 Ratio 2:1

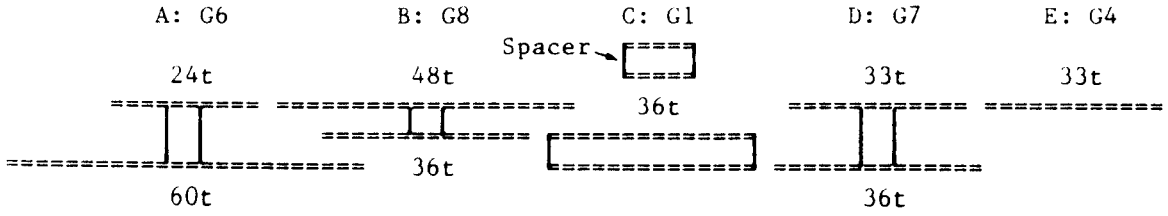
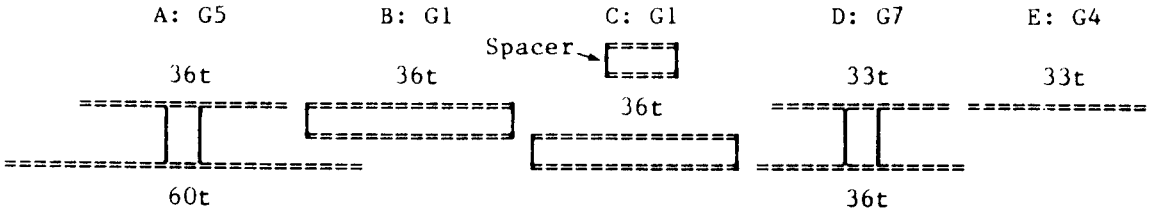


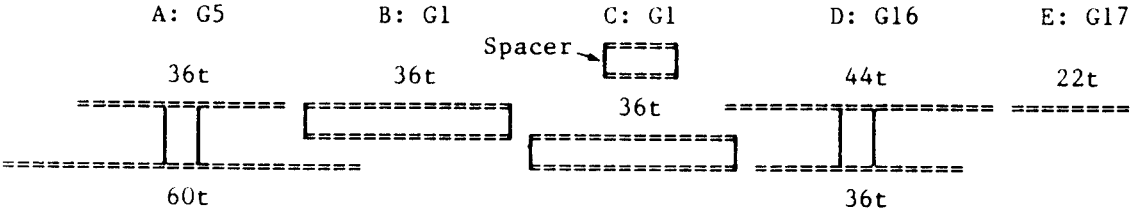
Chart speeds 12 cm/hr (5 min/cm) with M2 and 12 cm/min (5 sec/cm).with M1. Also for M3, option EGLS:

Gear set No. 125 235 Ratio 1:1



For M4, option EGHS, only:

Gear set No. 125 242 Ratio 1:2



REPLACEMENT GEARS

Gear reference		Chessell No.	Gear reference		Chessell No.
G1	36t	100 841	G10	54/18t	101 156
G2	22/45t	101 148	G11	54/27t	101 157
G3	44t	101 149	G12	54/24t	101 158
G4	33t	101 150	G13	33/48t	101 159
G5	36/60t	101 151	G14	48/24t	101 160
G6	24/60t	101 152	G15	22/48t	101 161
G7	33/36t	101 153	G16	44/36t	101 181
G8	48/36t	101 154	G17	22t	101 182
G9	18/60t	101 155	Spacer (shaft C)		201 466

Section 3
Operation and Maintenance

3-1 Cassette removal

Figure 3-1 Free the cassette *Depress the latch at the bottom right corner of the recorder.*

Figure 3-2 Remove the cassette *Swing the cassette upward until it can be freed from the chassis forks.*

3-2 Roll cassette loading

Figure 3-3 Load the feed roller *Place the cassette on a flat surface with the front plate face down and the sprocket roller facing forward. Pull the feed roller forward against the springs, then lift the roller clear of the cassette. Insert the feed roller into the chart roll. NOTE: the chart roll shown here is intended for right-hand scale zero, with the datum (circular) sprocket holes at right.*

Figure 3-4 Install the feed roller *Insert the feed roller into the cassette with the flange on the left. Be sure that both pins on both ends of the roller click into the bearing slots and are held firm by the springs. NOTE: the chart roll shown here is for right-hand scale zero.*

Figure 3-5 Under tie bar; over sprockets *Re-position the cassette with platen facing forward and the sprocket roller at the top. Pull out approximately 15 inches (375 mm) of chart, then pass it* ***under*** *the tie bar and over the sprocket roller; swing the chart "fingers" (if fitted) forward, engage chart squarely on the sprocket roller, then return the chart fingers to their normal position. (Recently manufactured cassettes have been modified to eliminate the need for chart fingers when the chart run-out feature is not required.) NOTE: the chart roll shown here is for right-hand scale zero.*

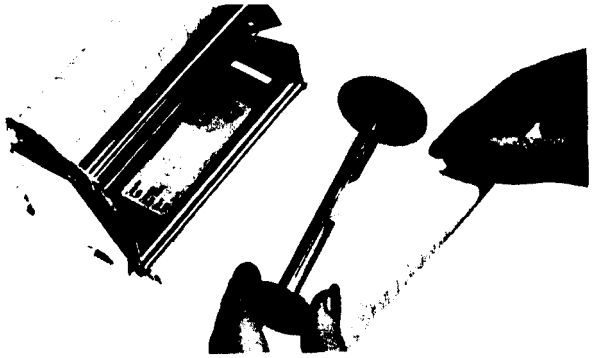


Figure 3-6 Prime the take-up roller *Again re-position the cassette with the front plate face down and the take-up roller facing forward. By folding or cutting into a V-shape, prepare the chart for insertion into the slotted roller* ***with the printed side up.*** *If desired the take-up roller may be unclipped to facilitate threading. With the chart centralized between the take-up flanges, roll up surplus chart by rotating the knurled flange.*

3-3 Z-fold cassette loading

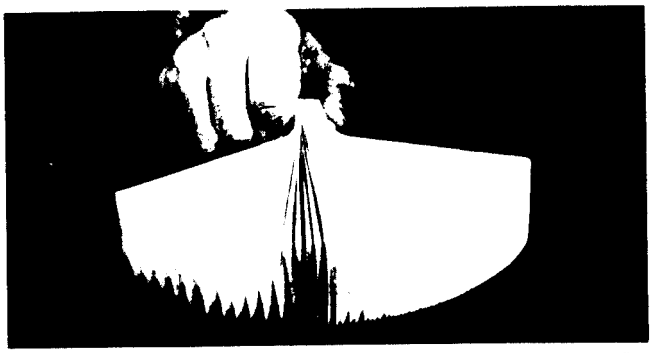


Figure 3-7 Prepare the z-fold chart *Place the z-fold chart on a flat surface and check that the edges are square and smooth; if not, the chart should be rejected. To ensure that the chart leaves will separate freely when feeding through the cassette, hold the chart as shown and gently move the hand from side to side. Repeat, holding the other end of the chart; then repeat with the chart inverted. This process shakes out perforation dust and separates sprocket hole perforations in adjacent leaves.*

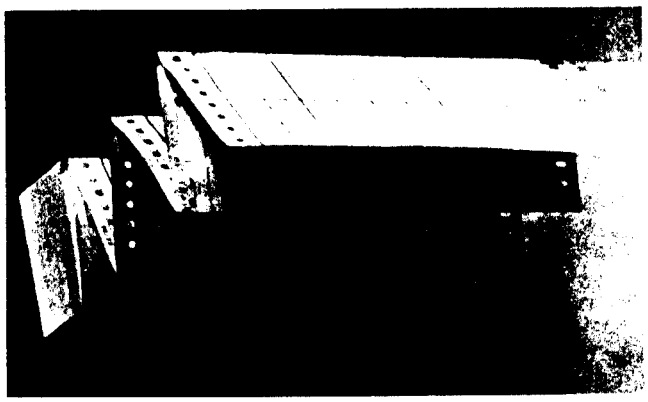


Figure 3-8 Check orientation of chart *Position the chart with the red finishing line face down. The top leaf should be printed side upward; if not, remove the first 4 cm leaf to expose the next printed surface. Unfold the first few leaves of the chart. NOTE: the chart shown here is intended for left-hand scale zero, with the datum (circular) sprocket holes at left.*

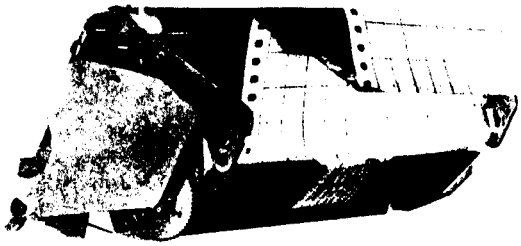


Figure 3-9 Load the feed tray *Place the cassette on a flat surface with the platen face down and the sprocket roller facing forward. Load the chart into the feed tray with the* ***printed side face up.*** *Be sure the chart is seated squarely. NOTE: the chart shown here is for left-hand scale zero.*

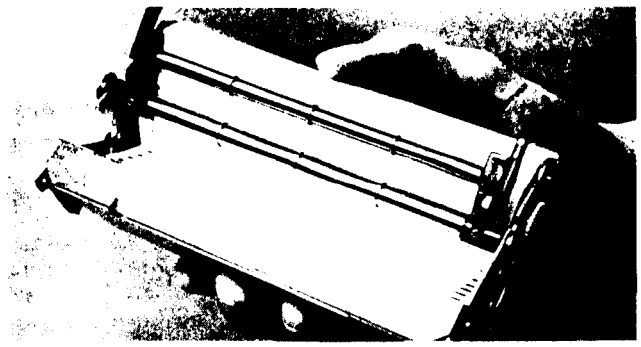


Figure 3-10 Over sprockets, under bars *Re-position the cassette with the guide bars facing forward. Swing the chart "finger" and guide bar assembly forward, engage the chart squarely on the sprocket return the chart fingers to their normal operating position. NOTE: the chart shown here is for left-hand scale zero.*

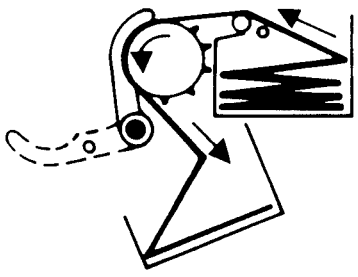


Figure 3-11 Check the paper feed *Check for correct operation by clockwise rotation of the first gear in the drive train, i.e. the gear which meshes with the chart drive motor. Be sure the paper folds are exactly as shown in this illustration; if they are reversed, the paper will not stack correctly in the receiving tray.*

3-4 Cassette replacement

Re-install the cassette with the platen tilted slightly upward from the horizontal. Do ***not force*** the cassette pivot studs into the chassis forks; the cassette slips easily into place provided the platen is at the correct angle.

3-5 Capillary ink system

CAUTION

A capillary ink system is at its best in a stationary recorder installation. Prolonged vibration and mechanical shock, or operation with the recorder tilted by more than 30 degrees from the horizontal can cause ink leakage. If the instrument is to be ***shipped, the ink capsule(s) should be removed***, and the capillary system flushed with water (Figure 3-16).

Figure 3-12 Prepare the ink capsule *Before installing the ink capsule, gently press the steel sealing ball into the capsule. If the capsule is not fitted with a ball-seal use a safety pin or other pointed object to pierce the diaphragm in the 1/8 inch cavity at one end of the capsule. Do* ***not*** *attempt to install the capsule on the dip tube without first perforating the diagragm.*

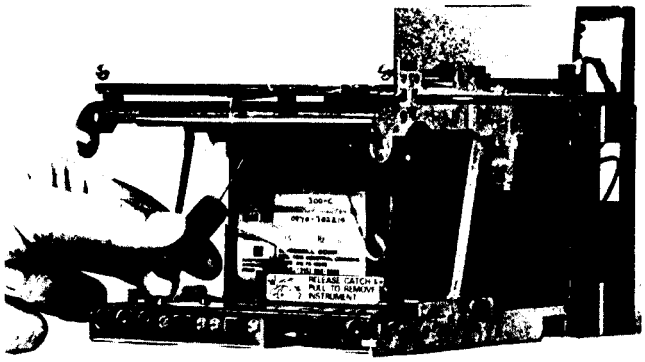


Figure 3-13 Install the ink capsule *Remove the chart cassette. Pivot the ink carrier assembly forward, pass the ink capsule over the dip tube, then press the capsule firmly into place on the dip tube shoulder; a twisting motion helps ensure a leakproof fit. Do* ***not squeeze*** *the capsule, and do not allow ink into the priming tube. Return the ink carrier assembly to its original postion. With the capsule installed, do not turn the recorder on its side – to do so would cause ink to enter the priming tube.*

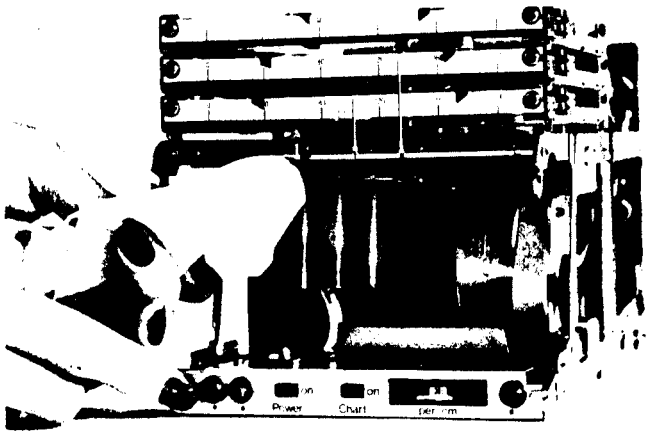


Figure 3-14 Priming the ink system *While covering the air inlet with the finger, compress the priming bulb (push, don't squeeze); then release the bulb completely. Repeat this pumping action until ink appears at the pen tip. Remove surplus ink with tissue, then replace the chart cassette.*

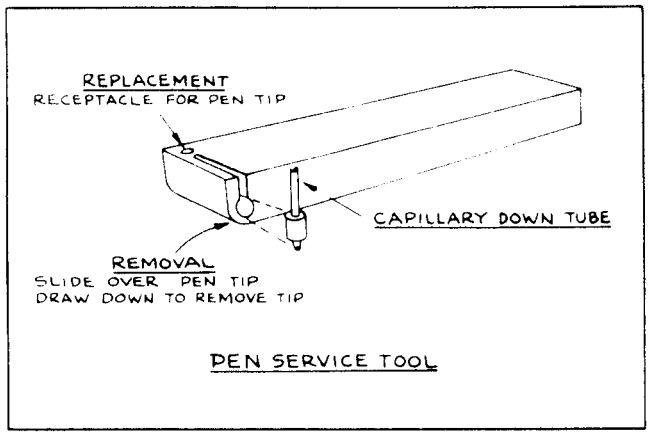


Figure 3-15 Pen tip replacement *Line width increases with pen wear. If the line becomes unacceptably wide, remove the chart cassette and* ***gently*** *pull the pen tip away from the pen tube. Install a fresh tip, ensuring that the* ***metal tube touches the tip fibers.*** *Be sure not to distort the pen assembly during this operation. Installation of the pen tip is facilitated by the Pen Service Tool, No. 123218.*

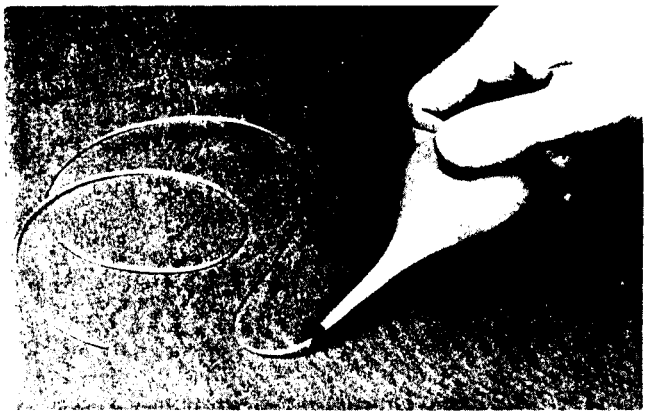


Figure 3-16 Cleaning the ink system *Capillary systems allowed to dry out through intermittent use or storage may require flushing with water. Flushing Bulb No. 127 163 is fitted with a capillary tube which may be attached to any part of the recorder ink system. Detach the nozzle from the bulb before filling. Complete the flushing operation so that, when the bulb is released for the last time, the flushing water is drawn out of the recorder capillaries. When flushing is completed, reassemble the ink system, install a fresh ink capsule, then prime repeatedly until* ***full strength*** *ink appears at the pen tip.*

3-6 Disposable ink/pen cartridge

Disposable cartridges are available in sealed packs of three, one color. Warranted shelf life of the pack with seal unbroken is 12 months. Colors available are:

125433	Pen No. 3	Green
125432	Pen No. 2	Red
126852	Pen No. 2	Blue
125431	Pen No. 1	Blue
126851	Pen No. 1	Red
127178	Event marker cartridge (sold singly)	Purple

The above part numbers apply to ***single units***, not packs.

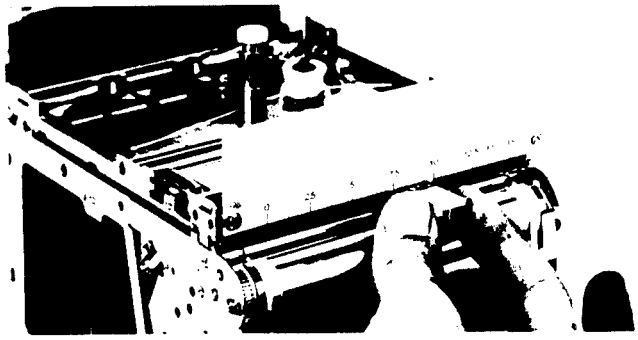


Figure 3-17 Installing the pen cartridge *Remove the protective cap from the pen tip, and the sealing plug (if fitted) from the rear of the cartridge. If no sealing plug is fitted, and* ***only*** *if so directed in the instructions supplied with the cartridge, pierce a small hole at the rear of the cartridge. Carefully install the cartridge in the holder, avoiding sideways movement. Do not force the cartridge beyond the stop, as this could disturb the pen pressure and damage the pen carriage.*

3-7 Conversion from capillary ink to disposable pen cartridge

This conversion can be performed on site, if desired. Conversion kit and instructions are available from Chessell.

3-8 Operation of the recorder

Power on With the input signal and power connected, set the POWER switch (on the lower front ledge of the chassis) to ON. The pen should drive to a position depending on the input amplitude. If not, remove the chassis from the case and check the security of the printed circuit assemblies, harnesses and fuse. If unsuccessful, check the fuse and replace if necessary. If the visual and fuse check fails to rectify the problem, ***qualified service personnel*** should perform detailed electrical checks with reference to the schematics in Section 4.

Chart on Set the CHART switch to ON. With a quartz-controlled timing device check that the chart speed is correct (a stopwatch is not adequate for this purpose). If the chart fails to move, remove the chassis from the case and check security of the two wire harness and plug connecting the chart motor with the mother PCB. If the chart speed is incorrect, check the speed at the output shaft of the motor/gearbox assembly. For single-speed (synchronous) motors, this should be 1 revolution in either 15 seconds or 15 minutes, depending on the choice of motor; for 10-speed stepper motors, the speed depends on the thumbwheel switch setting, e.g. at the fastest speed setting the LS motor gear completes 1 revolution in 30 seconds, the HS motor 6 seconds. If the motor speed is correct, check the gears installed on the cassette. Gear diagrams and corrective procedures are outlined in Section 2.

Input module calibration Zero and span adjustment procedures are together with the schematics in Section 4. To locate the appropriate schematic, check the ***type*** of input and the signal ***span*** for which the recorder was calibrated at the factory (label on rear panel of the recorder). Example: No. 1018-01 for small dc spans, No. 1025-02 for thermocouples (table, page 1-2).

3-9 Maintenance procedures

Six month inspection

(1) Remove the chassis from the case. Check for cleanliness and security of sub-assemblies.
(2) Check the ink capillary tubes, if fitted, for flexibility and replace any tube showing sign of hardening.
(3) Clean the viewing window.

Twelve month inspection

(1) Complete the six month inspection outlined above, then remove the pen servo trays and chart cassette for cleaning as follows:
(2) Pen Servo tray
  (i) Unscrew the knurled nut from the post at the center of the uppermost pen servo tray, remove the spacing collars, if any, then detach the tray from the chassis.
  (ii) Unplug the pen servo and alarms (if fitted) harnesses from the printed circuit boards.
  (iii) Remove ink spills and other deposits using a non-linting cloth moistened with isopropyl alcohol, only. (Other solvents may damage plastic components such as the conductive plastic feedback potentiometer.) Using a soft brush and air line, remove all traces of dust. ***Do not lubricate*** any bearing surface on the pen servo tray.
  (iv) Inspect the drive cord for wear, then check ***cord tension*** (details later in this section). Replace or adjust the cord, as required.
  (v) Using a cotton swab and isoproryl alcohol ***only*** clean the plastic feedback track and allow to dry.
  If reduced performance or sensitivity is apparent when the recorder is re-assembled and tested, this may be due to feedback contact wear. In that case replace the contacts as outlined in paragraph 3-13.
  (vi) Re-assemble the pen servo tray to the chassis.
  (vii) Re-connect the servo wiring to the printed circuit boards; arrange harnesses carefully to give clearance from metal edges, circuit components, etc.
(3) Chart cassette
  (i) Remove the chart cassette and unload any remaining paper.
  (ii) Remove the screw and lock washer securing the gear cover plate to the right side of the cassette. Lift off the gears, noting their positions carefully.
  (iii) Without disassembling the cassette, use a non-linting cloth moistened with isopropyl alcohol to remove old lubricant.
  (iv) Using a soft brush and air line, remove all dust.
  (v) Lubricate all bearings with a ***minute*** quantity of Nye PML 163 or other "nonmigrating" lubricating oil, applied very carefully with an eye dropper or tooth pick. ***Do not lubricate*** take-up roller clutch or gear teeth.
  (vi) Re-assemble the gears and replace the cover plate. Secure the retaining screw with Loctite 222.
  (vii) Re-install the cassette; check the mesh of the chart motor with the cassette as outlined in Section 2.
  (viii) If a capillary ink system is fitted, and the pen is showning signs of wear (wide line), replace the pen tip as shown in Figure 3-15.
  (ix) For all writing systems, check the pen pressure as outlined later in this section.

3-10 Checking pen pressure

Pen pressure is checked with a force gauge calibrated form zero to 15 grams, such as Correx (available from Chessell, No. 208 520). Alternatively, a laboratory-type spring balance may be used, but this must first be calibrated by the user with weights (especially in the range 5 to 10 grams).

Check and adjust the pen pressure as follows:

Place the tip of the force gauge under the leading edge of the cartridge holder, then raise the gauge gently until the pen tip is just lifted clear of the paper; note the force indication at that point.

The pressure ***must*** be between 5 and 7 grams, and the pen tip should be vertical. If not, adjust the two 2 mm set screws in the pen block, ***checking frequently that the upper surface of the cartridge holder blade bears on the points of the screws,*** and not on the lower surface of the pen block (Figure 3-18).

If the pressure remains too high throughout the range of adjustment, i.e. if the blade of the holder exerts too much downward force, this can be corrected by screwing down the two set screws to the limit, then returning the screws to the point where they hold the blade just clear of the pen block. Be ***sure not to strip*** the threads from the triangular cavities in the pen block.

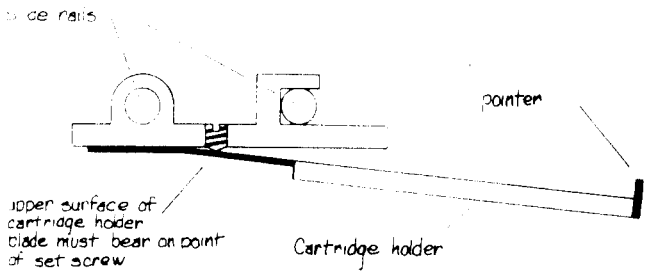


Figure 3-18 *Cartridge pressure adjustment*

On ***electric writing*** recorders using paper purchased in the U.S.A. the stylus pressure must be between 6 and 7 grams. For European paper, set the pressure between 4 and 5 grams.

3-11 Electric writing – grounding block pressure

Remove the chart cassette and pen tray. "Weigh" the grounding block with a laboratory-type spring balance; raise the balance to the point where the front edge of the block, hooked onto the balance pan, is exactly 2.5 inches (63 mm) above the chassis. The reading should be 100 ± 10 grams for American paper, or 145 ± 15 grams for European paper. If the reading is high, gently stretch the spring; if low, replace the spring.

3-12 Replacing servo drive cord

The servo drive cord is very durable and has a practically infinite life; the most likely cause of failure is accidental damage by burning or cutting. In the event of failure, the entire pen servo tray should be returned to the nearest Chessell service facility for repair. If that is impracticable, ***emergency*** repair can be successful if the procedure given below is followed carefully.

The drive cord is a 0.02 inch (0.5 mm) diameter woven polyester suture, factory treated to prevent stretch. For emergency purposes, any non-stretching cord of similar thickness can be used.

(1) Slacken the two pen motor securing screws so that the motor can be moved back and forth.
(2) Slacken the cord retaining screw on the white molded pen block; remove the cord from the block.
(3) Remove the grip ring #1, Figure 3-19, from vertical shaft #2, then remove the circlip #3, from the phosphor bronze outer shaft #4.
(4) Construct a measuring jig by tapping two panel pins 8.25 inches (210 mm) apart into a wooden bench top. Loop the replacement cord round one pin; then knot very firmly the two ends round the other pin to give a continuous loop of 16.5 inches (420 mm) total length. Cut off the surplus cord and seal the knot with quick drying varnish.

(5) Using a length of fine-gauge wire as a threader, feed the cord loop with the knot to the inside through the hole in the side of the gray plastic capstan; pull the cord tight against the knot.

(6) Reassemble the capstan components exactly as originally installed: the number and location of the acetate washers is critical in determining the slipping torque of the clutch.

(7) Hold pen tray with scale plate forward. With the hole in the capstan facing the scale plate, wind the left hand half of the cord loop ***three times clock-wise*** round the capstan, and then round left hand pulley, Figure 3-19. Run the other half of the cord loop round the right hand pulley.

(8) Position the pen block to the left side of the pen servo tray; then run the cord round and under the clamp bush on the pen block. Lightly tighten the clamp screw.

(9) Slide the pen block to the right side of the tray to ensure that full traverse of the block is not impeded and the cord winds evenly on the capstan. If necessary adjust the position of the pen block in relation to the cord. Tighten the cord clamp screw.

(10) Cord tension is checked with a force gauge calibrated form zero to 15 grams, such as Correx (available form Chessell, No. 208 520). Position the force gauge so that blade deflects the cord when the gauge is moved toward the front of the pen tray. The force indication should be between 9 and 11 grams with the cord deflected 3 mm (approximately 0.1 inches). Move the pen motor forward or back as necessary, then tighten the motor securing screws.

3-13 Replacing the feedback potentiometer (slidefilm) and contacts

(1) Slide the white molded pen block to the right side of the tray, then remove the countersunk zero adjust screw from the chassis tab at the left hand end of the slidefilm assembly.

(2) Remove the leafspring located between the tray sidewall and the left hand end of the slidefilm assembly. Lift out the slidefilm assembly.

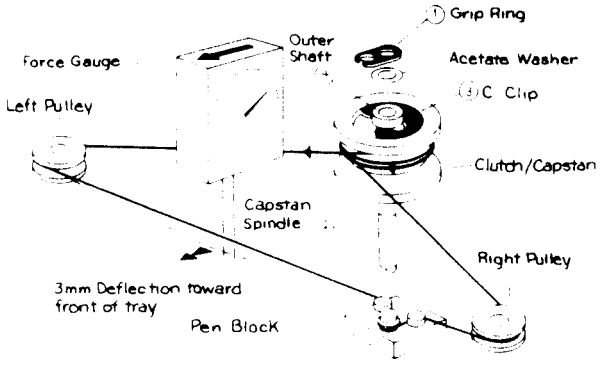


Figure 3-19 *Servo drive cord installation*

(3) If the slidefilm assembly is to be replaced, unsolder the feedback and alarm setpoint wires, noting their positions for reassembly. Use low melting point solder, taking care ***not to overheat*** the printed circuit pads. New contacts should be fitted if the slidefilm assembly is replaced.

(4) Remove the screw securing the contact set to the pen block; remove the contact set.

(5) Install the replacement contact set, taking ***care not to distort*** the contacts (the contacts are jigged to give the correct pressure when installed, and do not require adjustment)

(6) Replace the slidefilm assembly, leaf spring and zero adjust screw.

(7) Refit the pen servo tray to the chassis.

(8) Install a loaded chart cassette. Apply power to the recorder; then, with zero level input signal, adjust the slidefilm zero screw to set the pen tip to the zero line on the chart. Adjust the scale position if necessary to set the pen pointer at scale zero.

3-14 Alarm contacts

The alarm contact securing screws are accessible only with the slidefilm assembly removed. When replacing alarm contacts, be sure that the ***assymetrical*** contact pair is fitted to the ***right*** block.

Section 4
Calibration Procedures for Input and Pen Drive Modules

Input Conditioning Modules

No. 1018 High sensitivity dc
No. 1025 General purpose dc and thermocouples
No. 1020 General purpose ac
No. 1006 Two and four wire RTD's
No. 1023 Three wire RTD
No. 1001 Direct input (10 V f.s.) module for Model 3003

Pen Drive

No. 1002 Pen drive module

Calibration Procedures

Re-calibration of a Model 301 recorder should always be checked in the following sequence:

(1) Input module
(2) Pen drive module
(3) Alignment of feedback element
(4) Scale alignment

Model 301 input conditioning modules are characterized at the factory to match the user's original signal specifications. For users wishing to modify recorders in the field, component selection procedures are given for the three commonly encountered linear ac and dc modules, Nos. 1018, 1020 and 1025.

ESSENTIAL for input modules . . . Before starting any calibration procedure, ***always*** check the 12 Vdc reference supply at the input module. The permissible range is ± 10 mV.

Service aids

Service connector No. 200 029 is a cable harness assembly which brings all power and signal lines from the case rear panel connectors out to a duplicate set of connectors mounted on a bench stand. This allows the exposed recorder chassis to be checked with the regular input signals (usually hard-wired to the case) or with locally injected test signals. Service extender boards are available for both input conditioning modules, No. 200 030, and servo amplifier (pen drive) modules, No. 200 031.

CAUTION

> Lethal voltages may be present at accessible points within the recorder ***whether or not*** ac power is connected; this is because there is no isolation between the input signal and internal circuit components, including the potentiometric feedback element.

DC Input Module No. 1018

Range component selection procedures

The following are fitted for all spans < 4 mV:

R9 270K carbon 5%, R10 10Ω ½% 50 ppm metal film, R18 100Ω ½% 50 ppm metal film, P3 100Ω Cermet, R21 1K carbon 5%.

End zero signal ranges: R45 is not fitted, R19 is 4.7M carbon; R26 and R27 are calculated values, procedure below.

Offset-zero ranges: In addition to R26 and R27, R19 and R45 are also calculated values. The zero ***offset*** must not exceed ***3 times*** the span.

All "A" suffix resistors are fixed values, always fitted.

End-zero scale calculation

$$(R26 + R27) = \left[\left(\frac{10{,}000}{\text{Span in mV}}\right) - 1.5\right] \times 0.875 \times R18$$

The result is in ohms if the value of R18 is in ohms. For R27, select the preferred resistor value closest to but less than the calculated ***combined*** value R26 + R27; then for R26 select the preferred resistor value which, added to R27, gives the closest approximation (above or below) to the calculated value.

Example: Calculated value 136K
Nearest preferred value ***below*** is 120K = R27
Supplementary value ***closest to*** 16K is 15K = R26

Offset-zero scale calculation

(1) **Down-scale offset** Example: range − 0.5 mV to + 1 mV; span 1.5 mV, offset (V_O) is − 0.5 mV.

General method: Calculate R26 and R27 for the desired signal span, as in the "end zero" calculation above; then calculate the value of R45, which defines the coarse offset. Use the absolute value of V_O, i.e. ignore the sign.

$$R45 = \frac{(12{,}000 - V_O) \times R9 \times R10}{V_O \times (R9 + R10) - (6{,}000 \times R10)}$$

The result is in ohms if the values of R9 and R10 are in ohms. For R45, select the preferred resistor value closest to but less than the calculated value. The required temperature coefficient for R45 is given by: Span/Offset x 50 ppm.

Now calculate the value of R19, the component which compensates for the difference between offset required V_O and the offset achieved by the selection of R45.

V_A = Actual offset achieved with R45

$$= \frac{6{,}000\ [(R45 \times R10) + (2 \times R9 \times R10)]}{(R9 \times R45) + (R10 \times R45) + (R9 \times R10)}$$

V_A is in mV if the resistor values are all in the same units

V_E = Difference between ideal and actual offsets

$= V_A - V_O$

R19 is chosen to minimize V_E, as follows:

$$\text{Ideal value of R19} = \left(\frac{12{,}000}{V_E} - 1\right) \times 0.917 \times R18$$

The ideal value of R19 is in the same units as R10. For R19 choose the nearest preferred value to the ideal value. The required temperature coefficient for R19 is given by:

Span/V_E x 50 ppm

(2) Up-scale offset

Example: range + 5 mV to + 8 mV; span 3 mV, offset (V_O) is + 5 mV.

General method: Calculate R26 and R27 for the signal span, as in the "end zero" calculation above; then calculate the value V_Z, which includes the offset introduced by zero potentiometer P2.

$$V_Z = V_O \text{ in mV} + \frac{6{,}000 \times R10}{R9 + R10}$$

$$\text{Ideal value of R19} = \left(\frac{12{,}000}{V_Z} - 1\right) \times 0.917 \times R18$$

The ideal value of R19 is in ohms if R18 is in ohms. R19 is the nearest preferred value ***less*** than the ideal value. The required temperature coefficient for R19 is given by:

$$\text{Span}/V_Z \times 50 \text{ ppm}$$

Now calculate the value of R45, the component which compensates for the difference between the offset desired (V_Z) and the offset achieved (V_A) by the selection of R19:

$$V_A = \frac{12{,}000 \times 0.917 \times R18}{(\text{actual value of R19}) + (0.917 \times R18)}$$

V_A is in mV if the resistor values are in ohms

$$V_E = V_A - V_Z$$

$$R45 = \left(\frac{12{,}000}{V_E} - 1\right) \times R10 \quad \text{(valid because R8} \cdots \text{R10)}$$

The result is in ohms if the value of R10 is in ohms. For R45, select the preferred resistor value closest to the ideal value, above or below. The required temperature coefficient for R45 is given by: $\text{Span}/V_E \times 50$ ppm.

Calibration Procedure for Module No. 1018

Linear direct voltages up to 4mV and currents up to 100μA

These instructions apply to standard ranges only. Special features provided at customer request may require a different procedure to be followed.

Current inputs usually incorporate a shunt resistor on the rear terminals of the case, which allows the instrument to be withdrawn without breaking the current loop. Ensure this component is in place before attempting to pass current through the input module. If an additional error of 0.15% can be tolerated, the current input module can be calibrated to the nominal (i.e. theoretical) shunt voltage without using the actual shunt resistor intended for the particular input.

Equipment Required

(1) Signal source covering the desired range, with overall accuracy of ±0.02%.
(2) DVM covering the range zero to 10 Vdc, with overall accuracy of ±0.02%.

Procedure

(1) Check the seal on P4 (offset null); if broken, center the potentiometer. No further adjustment is necessary.
(2) Adjust ***input bias current*** as follows:
With the module input terminals otherwise open-circuit, connect a 10kΩ 1% 50 ppm metal film resistor across the terminals, then measure the voltage accross the resistor. Adjust P1 for less than ±10μV. Remove the resistor.
(3) Adjust electrical ***zero*** as follows:
Apply the low scale (most negative, smallest) input voltage to the input terminals and adjust P2 (zero) for 0.0V ±10 mV between connector pins 6 (0V) and 2 (output).
(4) Adjust ***span*** as follows:
Apply the high scale (most positive, largest) input voltage to the input terminals and adjust P3 (span) for 10.0V ±10 mV between connector pins 6 (0V) and 2 (output).
(5) Apply low and high scale inputs once more checking that the respective outputs are 0 and 10 volts ±10 mV. If not, slight re-adjustment of P2 and P3 will correct.
(6) Check the mechanical zero, i.e. pen position in relation to the zero grid line on the chart, with the input signal at low scale value. Adjust the slide film position screw if necessary. Tapping the pen tray lightly during this operation will assist in overcoming drag between paper and pen tip.
(7) Check the pointer position at low scale taking care to avoid parallax errors. If necessary slacken the scale retaining screws and slide the scale to achieve an acceptable reading.
(8) At low and high scale settings, check pen and pointer positions on scale and chart, again avoiding parallax errors. The position should be within ±0.25% (0.25 mm or 0.01 inch) of true. At extreme humidities, ignore the chart and refer only to the scale.
(9) Other factors such as pen pressure, pen/holder alignment, servo board calibration, and so on can affect calibration. If the above does not produce acceptable results, or if the instrument has been disassembled, these factors must be corrected before starting the calibration procedure.

DC Input Module No. 1025

Range component selection procedures

Table 1

Input Signal Span			Range No.
≥ 4 mV	and ≤ 8 mV		0
> 8 mV	and ≤ 20 mV		1
> 20 mV	and ≤ 50 mV		2
> 50 mV	and ≤ 100 mV		3
> 100 mV	and ≤ 200 mV		4
> 200 mV	and ≤ 500 mV		5
> 500 mV	and ≤ 1 V		6
> 1 V	and ≤ 2 V		7
> 2 V	and ≤ 50 V		8

Table 2
Range-dependent components in Module No. 1025
(Range No. refers to Table 1)

Range No.	R4B*	R5B	R8B*	R10B	R11B	P2B	P3B	C2B**	"C" Offset
0	47Ω	270K	10Ω	33Ω	470Ω	47Ω	22K	1000 μF 5 V	0.917
1	100Ω	270K	22Ω	68Ω	1K	100Ω	22K	470 μF 5 V	0.916
2	220Ω	270K	47Ω	150Ω	2.2K	220Ω	22K	220 μF 25 V	0.914
3	470Ω	270K	100Ω	330Ω	4.7K	470Ω	22K	100 μF 25 V	0.911
4	1K	270K	220Ω	680Ω	10K	1K	22K	50 μF 25 V	0.906
5	2.2K	270K	470Ω	1.5K	22K	2.2K	22K	22 μF 25 V	0.892
6	4.7K	270K	1K	3.3K	47K	4.7K	22K	10 μF 25 V	0.864
7	10K	270K	2.2K	6.8K	47K	4.7K	22K	4.7 μF 25 V	–
8	10K	270K	2.2K	Link	47K	4.7K	22K	0.1 μF 100 V	–

* Metal film ½%, 50 ppm (all others, carbon film 5%). R3B is normally a wire link.
** C2B must be sub-miniature, low leakage electrolytic (except for 0.1 μF, metalized film). C3B is not normally fitted.

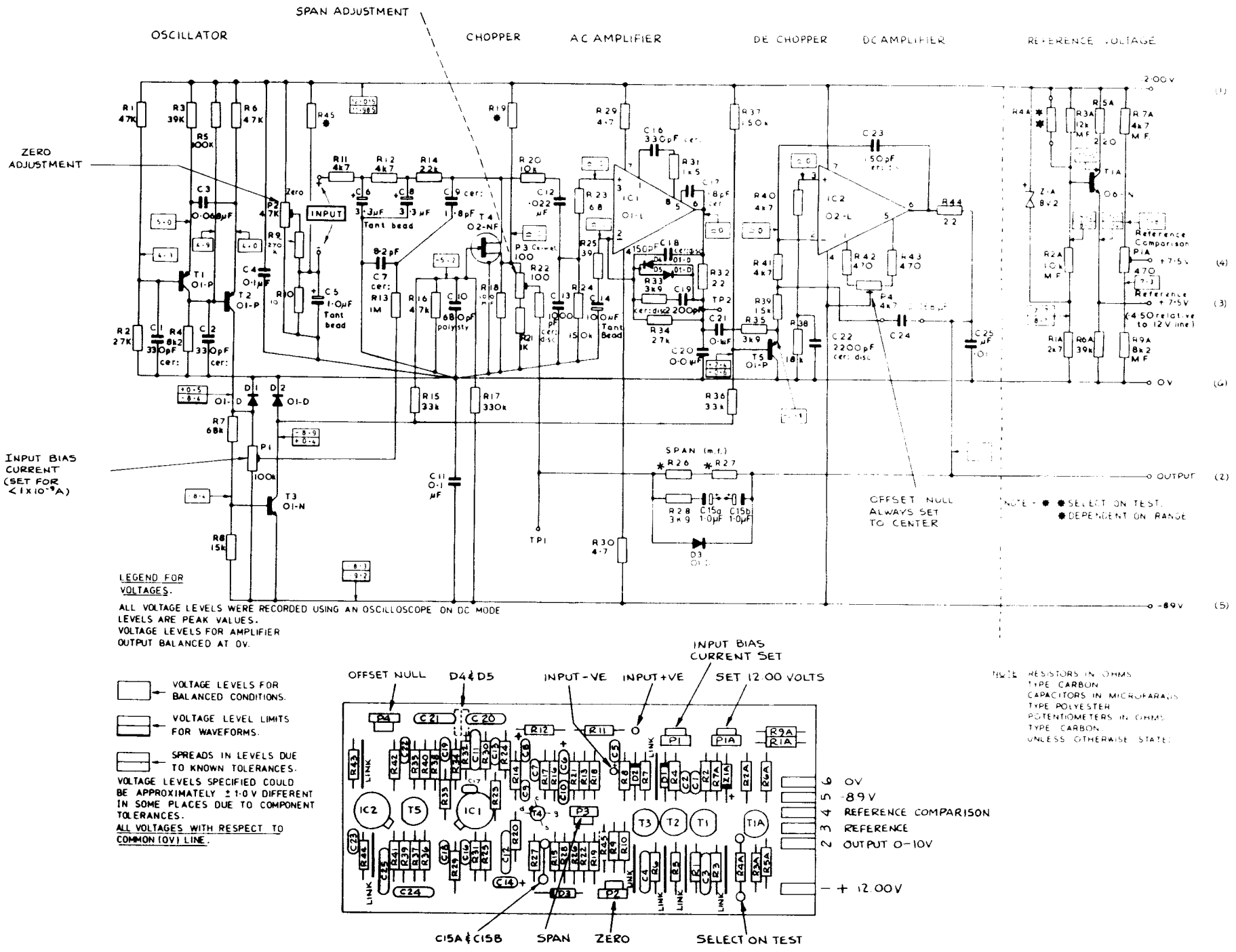


Figure 4-1 *High impedance D.C. module no. 1018*

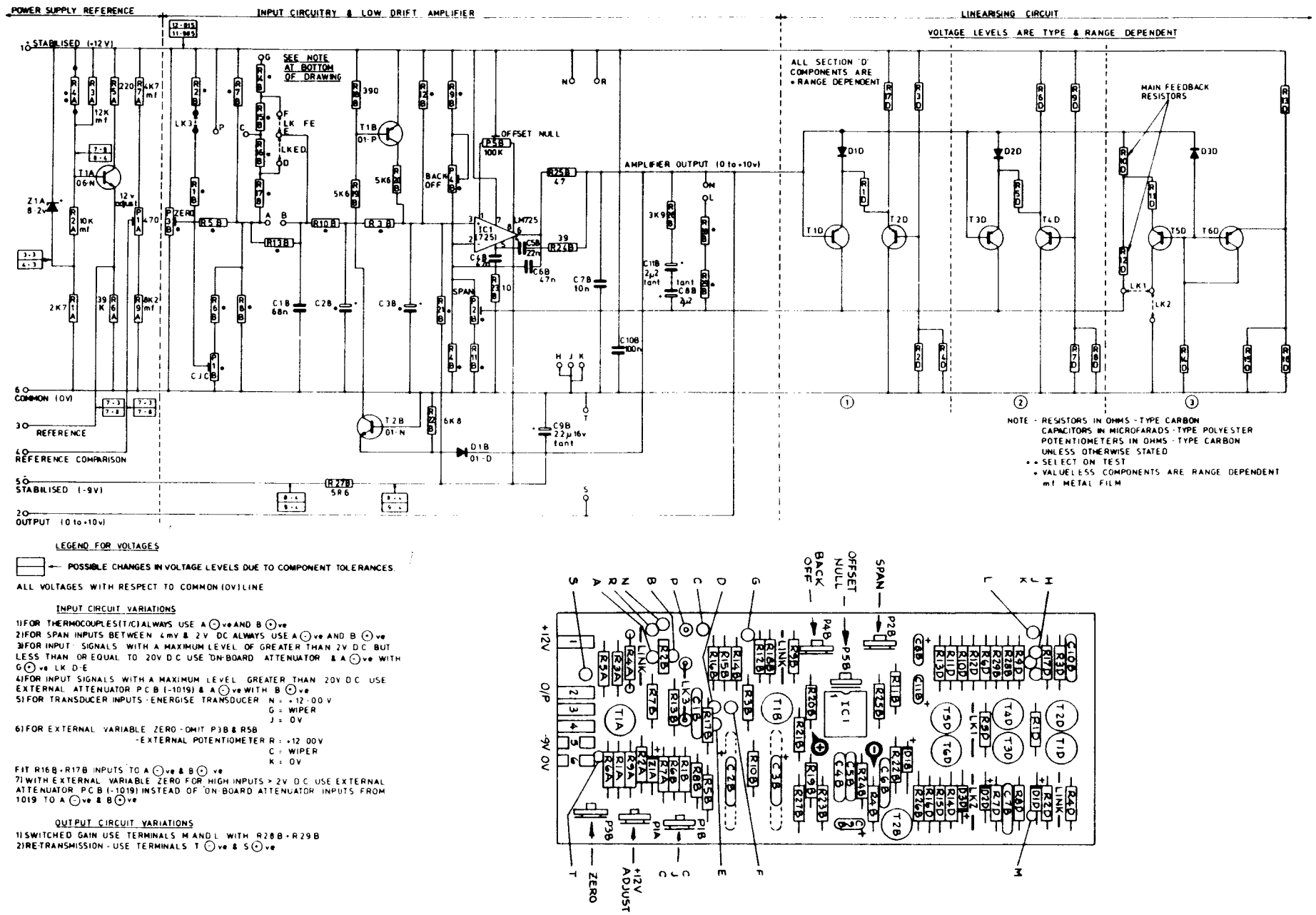


Figure 4-2 *mA, mV, V and thermocouples module no. 1025*

End-zero signal ranges: P4B is a wire link, R7B is not fitted, and R9B is always 2.2M. Select R4B, R5B, R8B, R10B, R11B, P2B, P3B and C2B from Table 2, according to the desired signal span. R10D and R12D are calculated values (procedure below).

Offset-zero ranges: Select R4B, R5B, R8B, R10B, R11B, P2B, P3B, and C2B from Table 2, according to the desired signal span. In addition to R10D and R12D, the following values are calculated (procedure below): P4B, R7B, R9B. The zero ***offset*** must not exceed ***3 times*** the span.

All signal spans over 2V (Range No. 8): Require the following additional calculated values: R14B, R15B and R16B. R17B is 200K, ½%, 50 ppm metal film. Pad "D" is linked to pad "E", and the ***white*** input wire (high) is transferred from "B" to "G". For ranges ± 10 V, R14B should have a voltage coefficient ± 5 ppm/V.

General information on resistors

All "A" suffix resistors are fixed values, always fitted. The following are ***cold junction compensation*** components, required only when the module is calibrated for thermocouple use: R1B, R2B, R6B, P1B and Link 3.

Also for ***thermocouple*** use are R12B (up-scale break protection), and R21B (down-scale break protection).

R13B is used (***rarely***, and with caution) when the shunt resistor for current inputs is required to be installed on the input module as opposed to the normal location for this component on the rear panel terminals.

There are no components suffixed "C".

Components suffixed "D", except R10D and R12D, are required only in ***linearized*** modules. Where ***temperature coefficients*** are noted in the following calculations, select wirewound resistors for coefficients less than 50 ppm; otherwise select metal film.

End-zero calculation

$$(R10D + R12D) = \left[\left(\frac{10{,}000}{\text{Span in mV}}\right) - A\right] \times B \times R4B$$

Where A = 1.5 for ranges 0 through 6
1.235 for ranges 7 and 8
B = 0.875 for ranges 0 through 6
0.8 for ranges 7 and 8

The result is in ohms if the value of R4B is in ohms. For R12D, select the preferred resistor value closest to but less than the calculated ***combined*** value R10D + R12D; then for R10D select the preferred resistor value which, added to R12D, gives the closest approximation (above or below) to the calculated value.

Example: Calculated value 136K
Nearest preferred value ***below*** is 120K = R12D
Supplementary value ***closest to***16K is 15K = R10D

Offset-zero scale calculation

(1) **Down-scale offset** Example: range −50 mV to +10 mV; span 60 mV, offset (V_O) is −50 mV.

General method: Calculate R10D and R12D for the desired signal span, as in the "end zero" calculation above; then calculate the value of R7B, which defines the coarse offset. Use the absolute value of V_O, i.e. ignore the sign.

$$R7B = \frac{(12{,}000 - V_O) \times R5B \times R8B}{V_O \times (R5B + R8B) - (6{,}000 \times R8B)}$$

The result is in ohms if the values of R5B and R8B are in ohms. For R7B, select the preferred resistor value closest to but less than the calculated value. The required temperature coefficient for R7B is given by : Span/Offset x 50 ppm.

Now calculate the value of R9B and P4B, components which compensate for the difference between offset required V_O and the offset achieved by the selection of R7B.

V_A = Actual offset achieved with R7B

$$= \frac{6.000[(R7B \times R8B) + (2 \times R5B \times R8B)]}{(R5B \times R7B) + (R8B \times R7B) + (R8B \times R5B)}$$

V_A is in mV if the resistor values are all in the same units.

V_E = Difference between ideal and actual offsets
$= V_A - V_O$

R9B and P4B are chosen to minimize V_E, as follows:

$$\text{Ideal value of } (R9B + \tfrac{1}{2}P4B) = \left(\frac{12{,}000}{V_E} - 1\right) \times C \times R4B$$

From Table 2, use the value of offset coefficient "C" appropriate to the range in question. For ranges 7 and 8, calculate "C" as follows, using ***actual*** values of R10D and R12D:

$$C = \frac{(\tfrac{1}{2}P2B + R')}{R4B + \tfrac{1}{2}P2B + R'}$$

$$\text{where } R' = \frac{(\tfrac{1}{2}P2B + R11B) \times (R10D + R12D)}{\tfrac{1}{2}P2B + R11B + R10D + R12D}$$

The ideal value of (R9B + ½ P4B) is in the same units as R4B. If the Span/Offset ratio is greater than or equal to 1, P4B is a wire link, and R9B is the nearest preferred value ***less*** than the ideal value. If the Span/Offset ratio is less than 1, calculate the value of P4B from:

Ideal value of P4B = 0.1 x (ideal value of R9B + ½P4B)

Choose the preferred value of Cermet potentiometer closest to but ***greater*** than the ideal value of P4B. For R9B, select the preferred resistor value which, added to half the actual value of P4B, most closely approximates the ideal (R9B + ½P4B).

The required temperature coefficient for R9B is given by Span/V_E x 50 ppm.

(2) **Up-scale offset** Example: range +50 mV to +90 mV; span 40 mV, offset (V_O) is +50 mV.

General method: Calculate R10D and R12D for the signal span, as in the "end zero" calculation above; then calculate the value V_Z, which includes the offset introduced by the zero potentiometer P3B.

$$V_Z = V_O \text{ in mV} + \frac{6.000 \times R8B}{R5B + R8B}$$

$$\text{Ideal value of } (R9B + \tfrac{1}{2}P4B) = \left(\frac{12{,}000}{V_Z} - 1\right) \times C \times R4B$$

From Table 2, use the value of offset coefficient "C" appropriate to the range in question. For ranges 7 and 8, calculate "C" as follows, using ***actual*** values of R10D and R12D:

$$C = \frac{(\tfrac{1}{2}P2B + R')}{R4B + \tfrac{1}{2}P2B + R'}$$

$$\text{where } R' = \frac{(\tfrac{1}{2}P2B + R11B) \times (R10D + R12D)}{\tfrac{1}{2}P2B + R11B + R10D + R12D}$$

The ideal value of (R9B + ½ P4B) is in ohms if R4B is in ohms. If the Span/V_Z ratio is greater than or equal to 1, P4B is a wire link, and R9B is the nearest preferred value ***less*** than the ideal value. If the Span/V_Z ratio is less than 1, calculate the value of P4B from:

Ideal value of P4B = 0.1 x (ideal value of R9B + ½P4B)

Choose the preferred value of Cermet potentiometer closest to but ***greater*** than the ideal value of P4B. For R9B, select the preferred resistor value which, added to half the actual value of P4B, most closely approximates the ideal (R9B + ½P4B).

The required temperature coefficient for R9B is given by Span/V_Z x 50 ppm.

Now calculate the value of R7B, the component which compensates for the difference between the offset desired V_Z and the offset achieved V_A by the selection of R9B and P4B.

$$V_A = \frac{12{,}000 \times C \times R4B}{(\text{actual values of } R9B + \tfrac{1}{2}P4B) + (C \times R4B)}$$

V_A is in mV if the resistor values are in ohms

$V_E = V_A - V_Z$

$$R7B = \left(\frac{12{,}000}{V_E} - 1\right) \times R8B \quad (\text{valid because } R5B \gg R8B)$$

The result is in ohms if the value of R8B is in ohms. For R7B, select the preferred resistor value closest to the ideal value, above or below. The required temperature coefficient for R7B is given by: Span/V_E x 50 ppm.

Attenuation for large signals (Range No. 8)

For signal spans exceeding 2 V, link pads "D" and "E", transfer the ***white*** input wire from "B" to "G", then fit attenuating resistors R14B through R17B calculated as follows:

(R17B is ***always*** 200K, ½%, 50 ppm metal film)

R_T = (R14B + R15B + R16B) = (Span in volts − 2V) x 100K

The combined resistor value R_T is in kΩ. For R14B, select the preferred ½% 50 ppm metal film resistor closest to, but less than the calculated value R_T. For R15B, select the preferred resistor value which, added to the selected R14B, gives the total closest to but again below the calculated value R_T. Finally, for R16B select the resistor value which, added to the combined actual value of R14B + R15B, most closely approximates R_T, above or below.

Select component values from Table 2, Range 8. Additionally, R10D is 3.3K, and R12D is 27K.

If the input signal has a zero offset (e.g. range 30 V to 40 V; span 10V and offset +30 V), up-scale or down-scale correction must be applied in the usual way. For this purpose, the post-attenuator offset, V_O, is given by:

$$V_O = \frac{R17B}{R14B + R15B + R16B + R17B} \times V_U$$

Where V_U is the "raw" signal offset at the recorder terminals.

Shunt selection for current measurements

In Chessell recorders, a current input is converted into a voltage signal, which is then treated conventionally by the Module No. 1025. The shunt resistor is selected (typically) to give a span of 75 mV full scale; for 4 to 20 mA signals, the option of 4 V span (i.e. range of 1 to 5 V) is offered. Commonly specified shunt resistor values are listed below.

For most applications, the shunt resistor is fitted to the input terminals on the rear panel of the recorder case; the current circuit thus remains intact if the recorder chassis is withdrawn from the case.

Signal range in mA	Shunt value in ohms	Voltage range
0 to 1.0	75	0 to 75 mV
0 to 10.0	7.5	0 to 75 mV
0 to 20.0	3.75	0 to 75 mV
− 1.0 to + 1.0	37.5	− 37.5 to + 37.5 mV
− 0.5 to + 0.5	75	− 37.5 to + 37.5 mV
4 to 20	4.688	18.75 to 93.75 mV
4 to 20	250	1.0 to 5.0 V
10 to 50	1.875	18.75 to 93.75 mV

Calibration Procedure for Module No. 1025

Equipment Required

(1) Signal source covering the desired range, with overall accuracy of ± 0.02%.

(2) DVM covering the range zero to 10 Vdc, with overall accuracy of ± 0.02%.

Note: For thermocouple inputs, Mallory-9 alloy contacts should be fitted to the male and female gray molded connectors at rear of the recorder chassis and case. These special contacts are distinguished by gold plating on their mating surfaces. If the input requires cold junction compensation, then the appropriate compensating cable and temperature reference chamber accurate to ± 0.1°C (or ± 0.02% whichever is greater) are necessary.

(A) LINEAR DIRECT VOLTAGES AND CURRENTS

These instructions apply to standard ranges only. Special features provided at customer request may require a different procedure to be followed.

Current inputs usually incorporate a shunt resistor on the rear terminals of the case, which allows the instrument to be withdrawn without breaking the current loop. Ensure this component is in place before attempting to pass the input current through the input module. If an additional error of 0.15% can be tolerated, the current input module can be calibrated to the nominal (i.e. theoretical) shunt voltage without using the actual shunt resistor intended for the particular input.

Exceptionally, R13B may be fitted as an internal shunt resistor on current inputs. When this is the case, unplugging the instrument will break the input current loop.

Procedure

(1) Adjust the ***offset null*** as follows:
Apply to the input terminals a voltage within the range for which the module is calibrated. Adjust the input to give 1.0V ± 10 mV between pins 6 (OV) and 2 (output). Adjust P5B for OV ± 20μV between IC1 inputs, accessible at R4B (−) and R2OB (+).

(2) Adjust electrical ***zero*** as follows:
Apply the low scale (most negative) input value to the input terminals and adjust P3B (zero) for 0.0V ± 10 mV between connector pins 6 (OV) and 2 (output). If P4B (coarse zero) is fitted, center P3B, adjust P4B for 0.0V ± 100 mV, then set P3B as above.

(3) Adjust ***span*** as follows:
Apply the high scale (most positive) input to the input terminals and adjust P2B (span) for 10.0V ± 10 mV between connector pins 6 (OV) and 2 (output).

(4) Apply low and high scale inputs once more checking that the respective outputs are 0 and 10 volts ± 10 mV. If not, slight re-adjustment of P3B and P2B will correct.

(5) Check the mechanical zero, i.e. the pen position in relation to the zero grid line on the chart, with the input signal at low scale value. Adjust the slide film position screw if necessary; tapping the pen tray lightly during this operation will assist in overcoming drag between paper and pen tip.

(6) Check the pointer position at low scale taking care to avoid parallax errors. If necessary slacken the scale retaining screws and slide the scale to adjust.

(7) At low and high scale settings, check pen and pointer positions on scale and chart, again avoiding parallax errors. The positions should be within ± 0.25% (0.25 mm or 0.01 inch) of true. In high humidities, ignore the chart and refer only to the scale.

(8) Other factors such as pen pressure, pen/holder alignment, servo board calibration, and so on can affect calibration. If the above does not produce acceptable results, or if the instrument has been dis-assembled, these factors must first be corrected.

(B) ELECTRONICALLY LINEARIZED THERMOCOUPLE INPUTS

Thermocouple curves are linearized by a "straight line approximation", with four segments corresponding to four different amplifier gains (section "D" of the schematic). All component values in the linearizing section are calculated in manufacture for the temperature range and thermocouple type specified by the user. To check calibration of a particular module, ***essential data*** are the input voltages corresponding to 10% and 90% scale indications. These values (available from Chessell Corp.) differ from the ASTM thermocouple reference tables by a specific amount, i.e. the linearizing offset voltage. The ***signal source*** used for calibration must be one specifically intended for thermocouple work, with built-in cold junction compensation (e.g. Eurotherm Model 239), and must be connected to the recorder by an extension wire matching the thermocouple for which the input module is calibrated.

Procedure

(1) Adjust the ***offset null*** as in (1) above for linear versions of the 1025 module.

(2) Adjust electrical ***zero*** as follows:
Apply to the input terminals the voltage corresponding to 10% of the temperature span for which the module is calibrated. Adjust P3B for 1.0V ± 10 mV between connector pins 6 (0V) and 2 (output). If P4B (coarse zero) is fitted, center P3B, adjust P4B for 0.0V ± 100 mV, then set P3B as above.

(3) Adjust ***span*** as follows:
Apply the voltage corresponding to 90% of the temperature span. Adjust P2B (span) for 9.0V ± 10 mV between connector pins 6 (0V) and 2 (output)

(4) Re-apply the 10% and 90% inputs, checking once more that the respective outputs are 1 and 9V ± 10 mV. If not, slight re-adjustment of P3B and P2B will correct.

(5) Adjust the input voltage for 0V ± 10 mV output. (This should correspond closely, but not precisely, to the low-scale voltage given in the ASTM thermocouple table for the particular temperature span in question, e.g. a module ranged for 200° to 400°C, type K, should give 0.0V output with 8.137mV input.)

The remaining mechanical procedure is as (5) through (8) for linear 1025 modules.

(C) INTERNAL COLD JUNCTION COMPENSATION (CJC)

The internal cold junction is set at 104°F (40°C), that being the average temperature within a working, cased recorder. When checking CJC calibration as outlined below, the input module should be protected from large temperature variations.

(1) Remove link LK3, if fitted, then solder a 10kΩ 1% 50 ppm metal film resistor between post "P" and the right hand pad for LK3. (The 10kΩ resistor in effect sets the junction temperature at 40°C.)

(2) Turn P1B fully clockwise, viewed from the right hand side of the PCB, component side up.

(3) With a reference voltage source connected to the input terminals, vary the input voltage to give an output of 8V ± 10 mV. Note the exact ***input*** voltage.

(4) Reduce the input voltage by the exact amount ***shown in mV*** in the following table for the value of R6B installed and the type of thermocouple in question, e.g. for R6B 12kΩ and type K thermocouple, lower the input voltage by 1.933 mV.

(5) Turn P1B counter-clockwise to restore the output to 8V ± 10 mV.

(6) Remove the 10kΩ resistor and re-install link LK3. Allow the PCB to cool for at least 15 minutes before checking 10% and 90% calibration, as in (B) above.

Value of R6B	Type of thermocouple				
	J	K	T	E	R/S
1.2 kΩ	2.439	1.904	1.951	2.897	–
4.7 kΩ	2.465	1.925	1.972	2.928	–
12 kΩ	2.476	1.933	1.980	2.941	–
27 kΩ	2.481	1.937	1.984	2.947	0.299
56 kΩ	–	–	–	–	0.299
120 kΩ	–	–	–	–	0.299

AC Input Module No. 1020

Range component selection procedures

The following describes the component selection procedures for "end zero" ac voltage ranges, i.e. ranges without zero offset.

All resistor selections should be ½%, 50 ppm metal film.

Resistors R18, R19, R20, R21, R22 and P1 are not required for end-zero ranges. R17 is 470K, metal film, ½%, 50 ppm.

Select R1, R2 and R3 as follows:

$R_T(k\Omega) = (R1 + R2 + R3) = (\text{Span in mV})$

For R1, select the preferred resistor value closest to, but less than R_T. For R2, select the preferred value which, added to the selected R1, gives the total closest to but again below the calculated value R_T. Finally, for R3 select the resistor value which, added to the combined actual value of R1 and R2, most closely approximates R_T, above or below.

Current measurement

Alternating currents are measured by conversion to voltage. The shunt resistor is selected, typically, to 75 mV span.

Calibration Procedure for Module, No.1020

Linear ac voltage and current

These instructions apply to standard ranges only. Special features provided at customer request may require a different procedure to be followed.

Current inputs usually incorporate a shunt resistor on the rear terminals of the case, which allows the instrument to be withdrawn without breaking the current loop. Ensure this component is in place before attempting to pass current through the input module. If an additional error of 0.15% can be tolerated, the current input module can be calibrated to the nominal (i.e. theoretical) shunt voltage without using the actual shunt resistor intended for the particular input.

For inputs greater than 30 Vac, a 50:1 (nominal) isolating transformer is installed on the rear panel of the recorder case. For calibration purposes, the transformer must be included in the signal loop; either detach the transformer from the case or use a service connector assembly, No. 200 029

Equipment Required

(1) Signal source covering the desired range, with overall accuracy of ± 0.2%.

(2) DVM covering the range zero to 10 Vdc, with overall accuracy of ± 0.02%.

Procedure

(1) Adjust ***zero*** as follows:
Apply the low scale (smallest) input voltage to the input terminals and adjust P2 (zero) for 0.0V ± 10 mV between connector pins 6 (0V) and 2 (output). If P1 (coarse zero) is fitted, first center P2 and adjust P1 for 0.0V ± 100 mV; then set P2 as above.

(2) Adjust ***span*** as follows:
Apply the high scale (largest) input voltage to the input terminals and adjust P3 (span) for 10.0V ± 10 mV between connector pins 6 (0V) and 2 (output).

(3) Apply low and high scale inputs once more checking that the respective outputs are 0 and 10 volts ± 10 mV. If not, slight re-adjustment of P2 and P3 will correct.

(4) Check the mechanical zero, i.e. pen position in relation to the zero grid line on the chart, with the input signal at low scale value. Adjust the slide film position screw if necessary. Tapping the pen tray lightly during this operation will assist in overcoming drag between paper and pen tip.

(5) Check the pointer position at low scale taking care to avoid parallax errors. If necessary slacken the scale retaining screws and slide the scale to achieve an acceptable reading.

(6) At low and high scale settings, check pen and pointer positions on scale and chart, again avoiding parallax errors. The positions should be within ± 0.25% (0.25 mm or 0.01 inch) of true. At extreeme humidities, ignore the chart and refer only to the scale.

(7) Other factors such as pen pressure, pen/holder alignment, servo board calibration, and so on can affect calibration. If the above does not produce acceptable results, of if the instrument has been dis-assembled, these factors must be corrected before starting the calibration procedure.

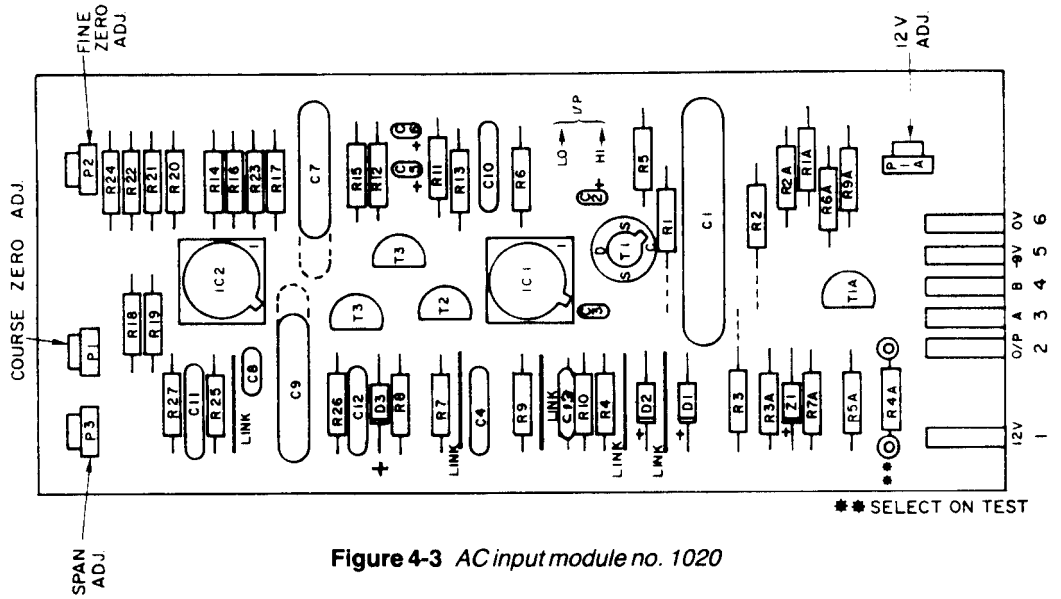


Figure 4-3 *AC input module no. 1020*

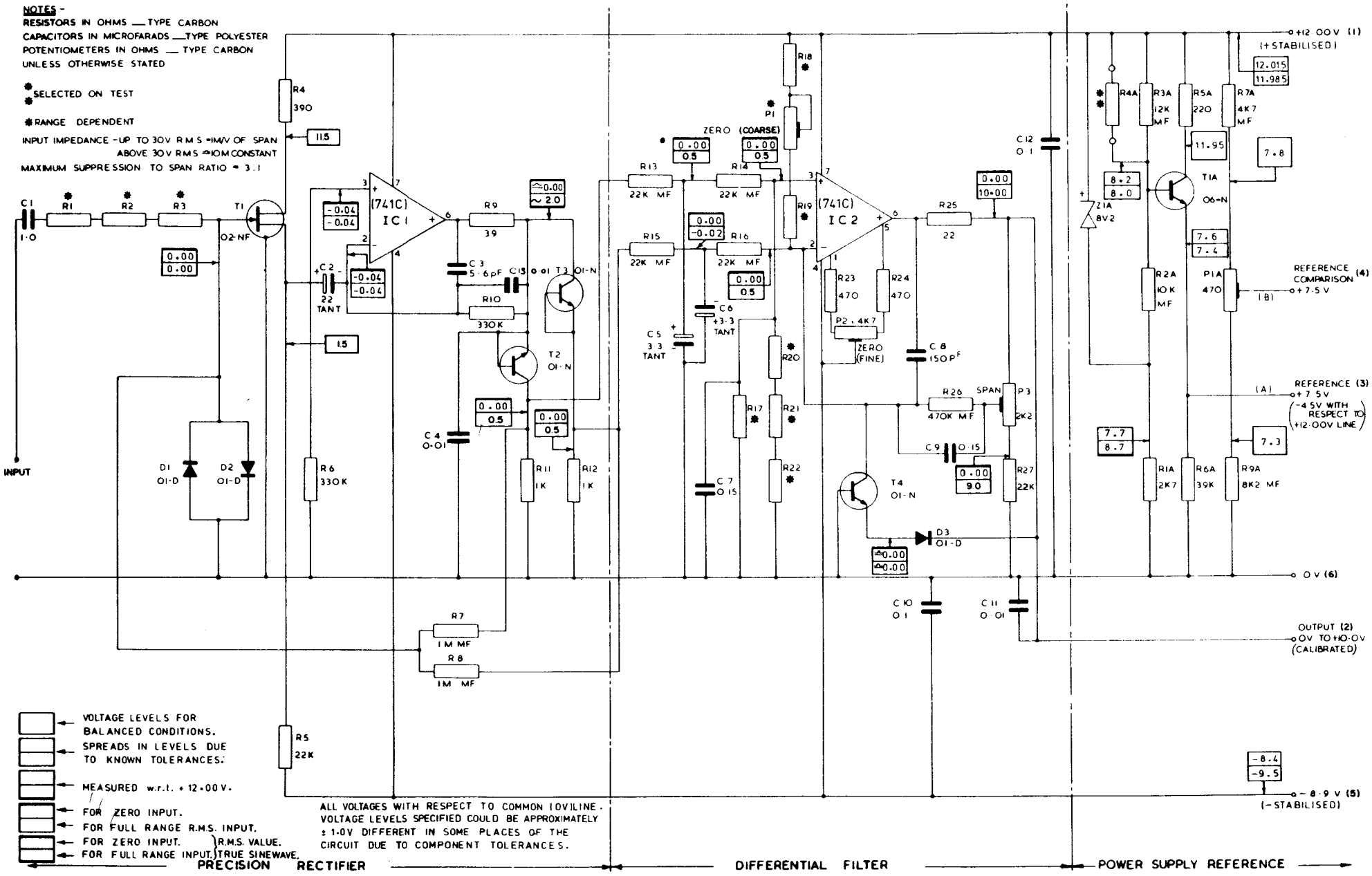


Figure 4-4 *A C input module no. 1020*

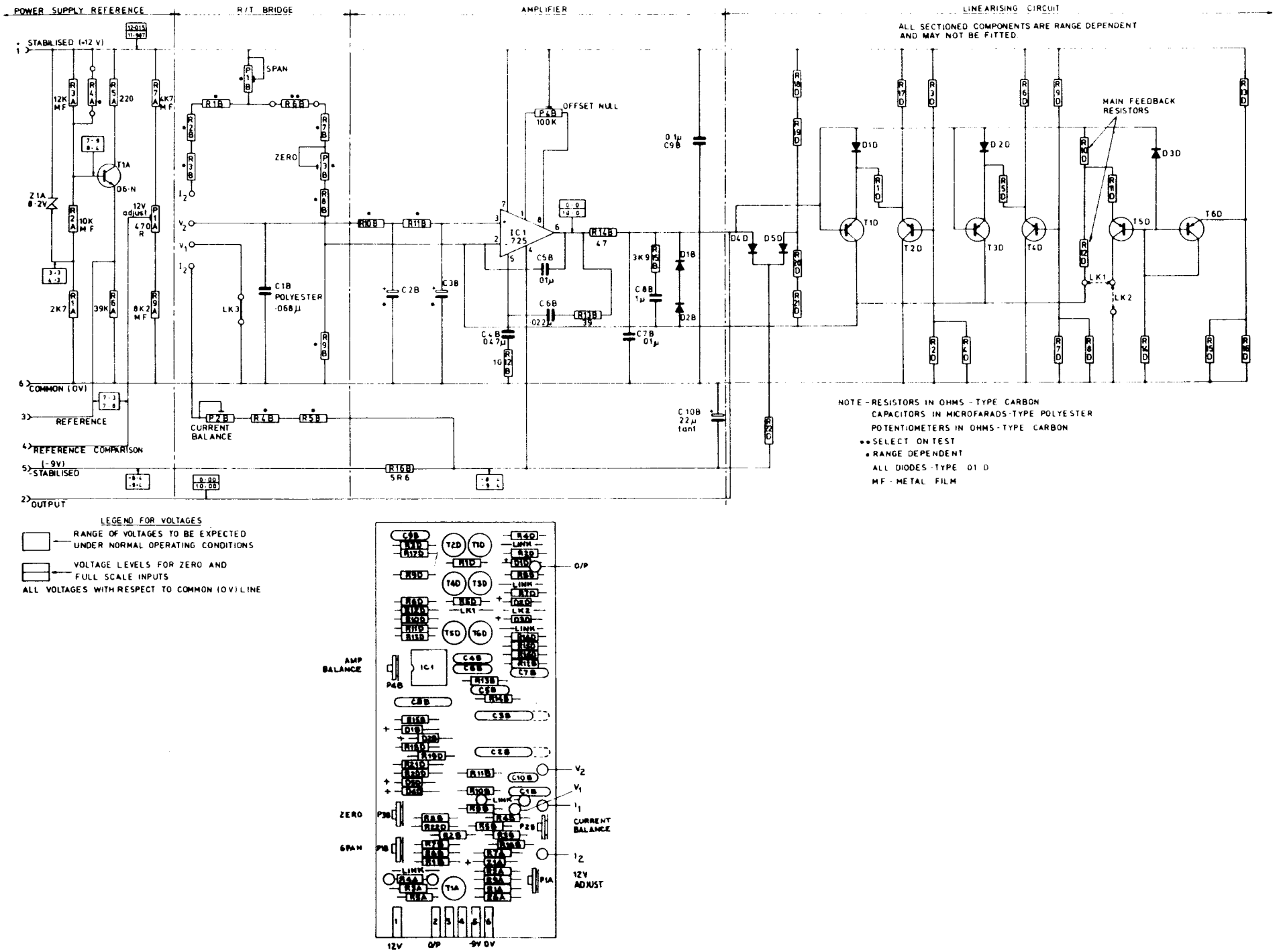


Figure 4-5 *Resistance thermometer module no. 1006*

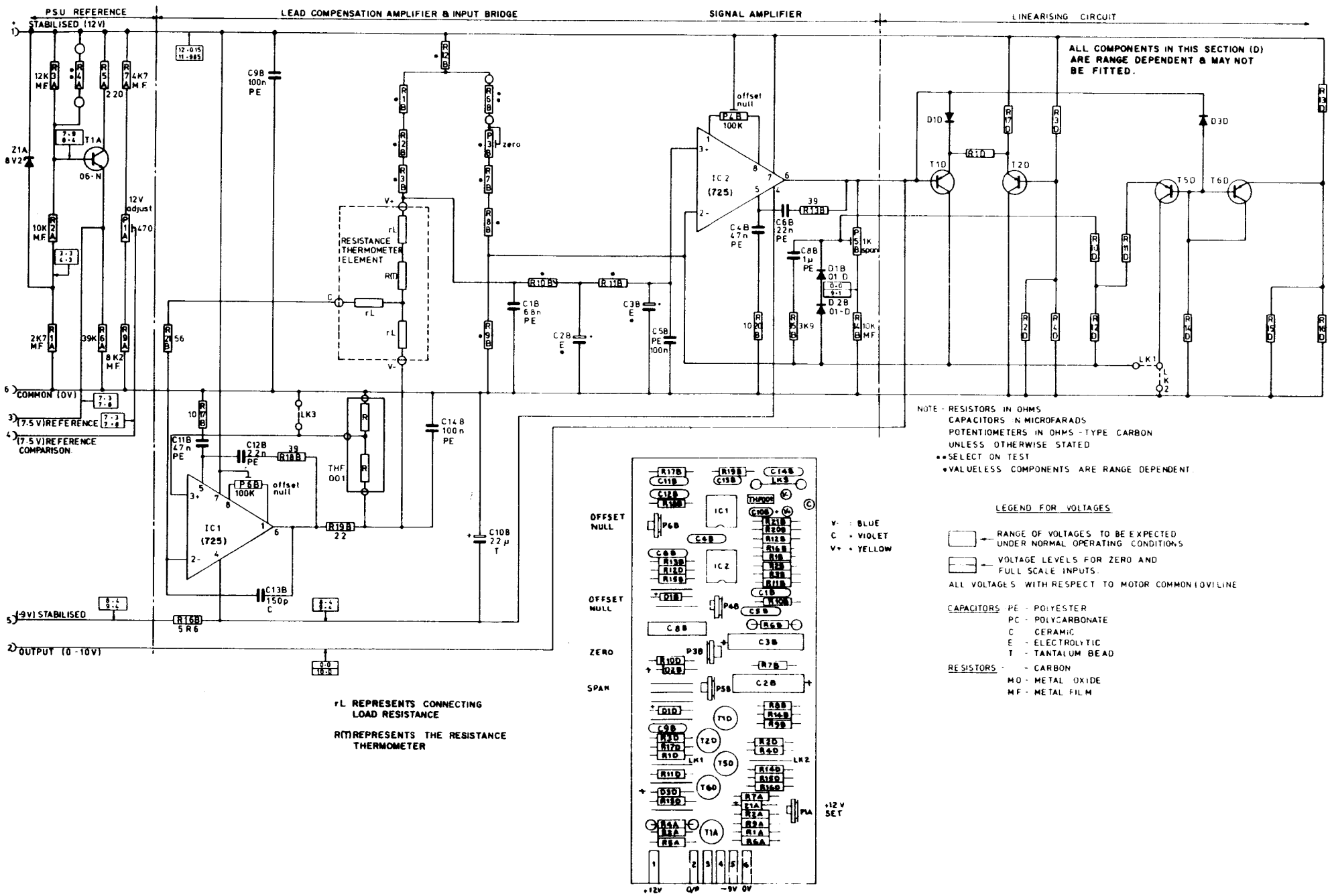


Figure 4-6 *Resistance thermometer (3-wire) module no. 1023*

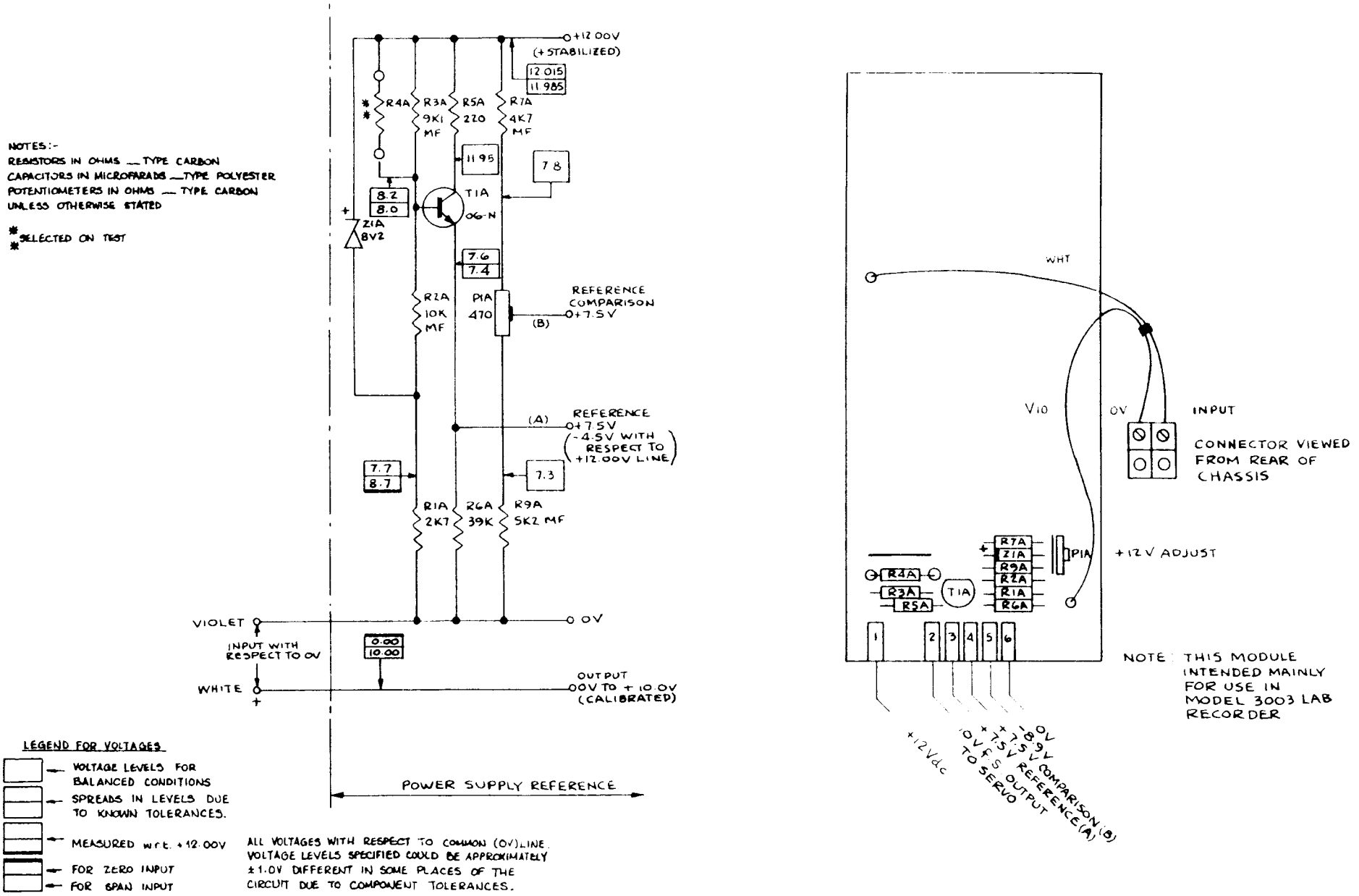
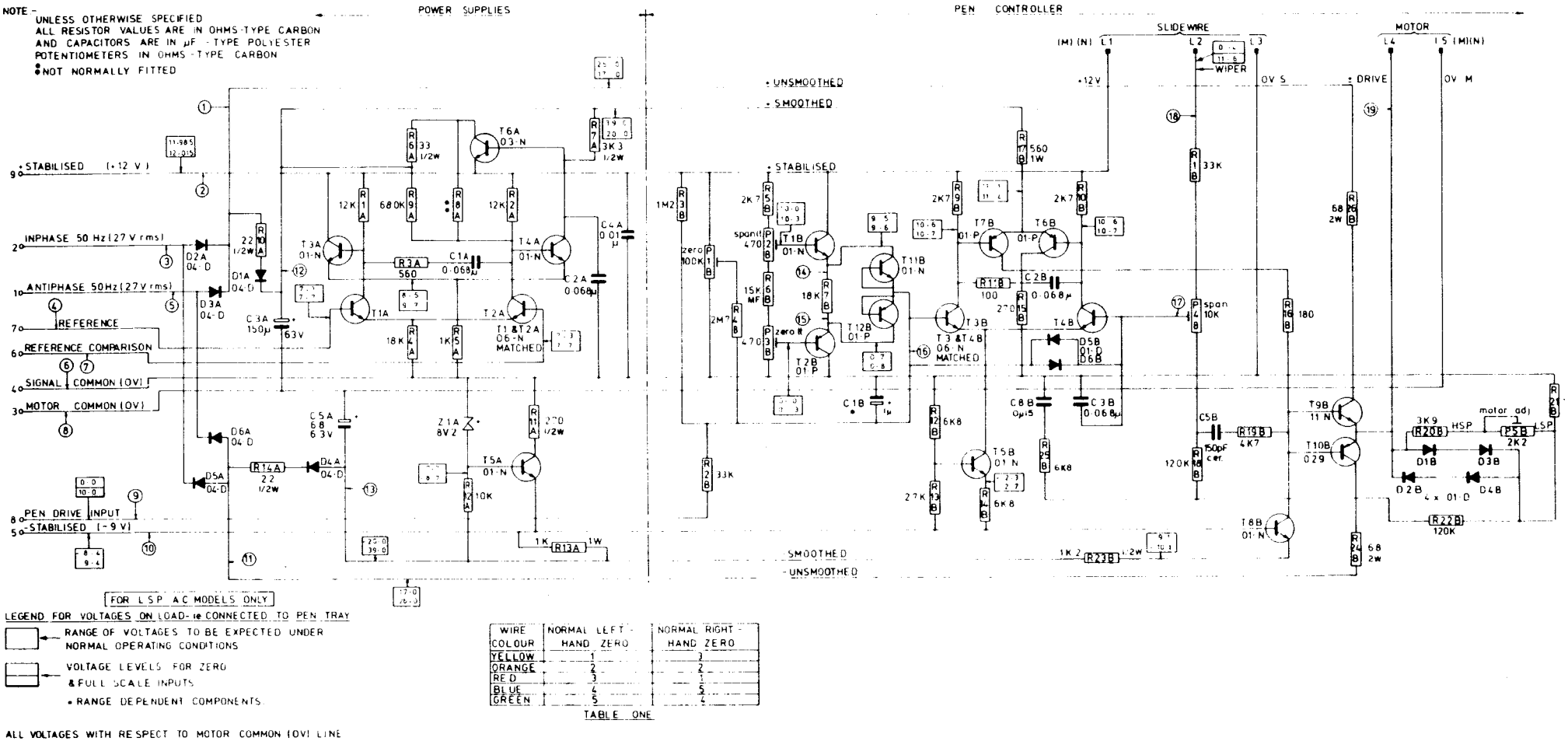


Figure 4-7 *Direct input module no. 1001*



WIRE COLOUR	NORMAL LEFT - HAND ZERO	NORMAL RIGHT - HAND ZERO
YELLOW	1	3
ORANGE	2	2
RED	3	1
BLUE	4	5
GREEN	5	4

TABLE ONE

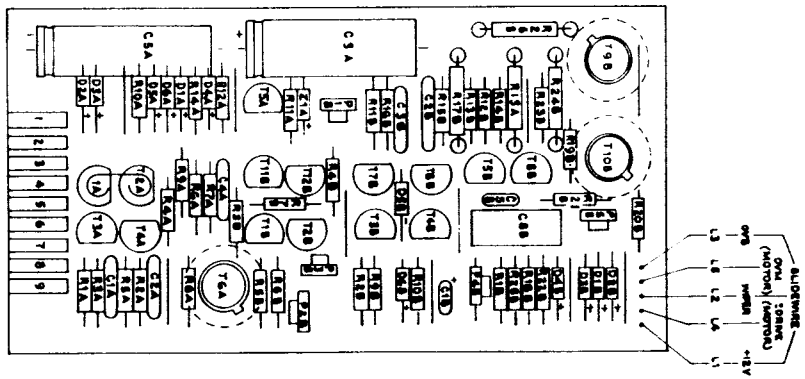


Figure 4-8 *Pen drive board no. 1002*

Pen Drive Module No. 1002

Setting-up procedure

(1) Check the dc voltage between pins 4 and 9; this should be 12.0 V ±10 mV. If in error, adjust P1A on the ***input*** module.

(2) Ensure the high-end electronic limit is well off-scale by applying a full scale signal to the input module, and adjusting P2B to bring the pointer down-scale; then turn P2B fully in the opposite direction.

(3) Repeat (2) for the low-end limit, adjusting P3B, with the input signal corresponding to scale zero.

(4) Adjust the input signal to give 10 V ±5 mV between pins 4 and 8. Measure the voltage between pen tray connector pins L3 and L2 (red and orange wires for left hand zero recorder). Adjust P4B (span) for 11.556 V ±10 mV. Be sure the pen assumes its true position by frequent gentle tapping of the pen tray throughout this procedure.

(5) Adjust the input signal to give 0 V ±5 mV between pins 4 and 8. Measure the voltage between pen tray connector pins L3 and L2. Adjust P1B (zero) for 0.444 V ±10 mV. Be sure the pen assumes its true position by frequent gentle tapping of the pen tray throughout this procedure.

(6) Repeat (4) and (5) until acceptable results are achieved.

(7) Adjust the input signal to give >10.5 V between pins 4 and 8. Measure the voltage between pen tray connector pins L3 and L2. Adjust P2B (limit) for 11.722 V ±10 mV, tapping the pen tray, as before.

(8) Adjust the input signal to give <−0.5 V between pins 4 and 8. Measure the voltage between pen tray connector pins L3 and L2. Adjust P3B (limit) for 0.278 V ±10 mV, tapping the pen tray, as before.

With some input modules, for example ac ranges without zero offset, it may not be possible to adjust the input in accordance with (8). In these instances either adjust the input module zero potentiometer to simulate a negative input, or substitute another module of suitable type.

Section 5
Major Option Schematics

Electric writing
DC power (Option DCS)
10-speed chart drive (Options EGLS, EGHS)
Totalizer (Option INT)
HI/LO alarms (Option HLL)
Two-wire transmitter (Option TWS)

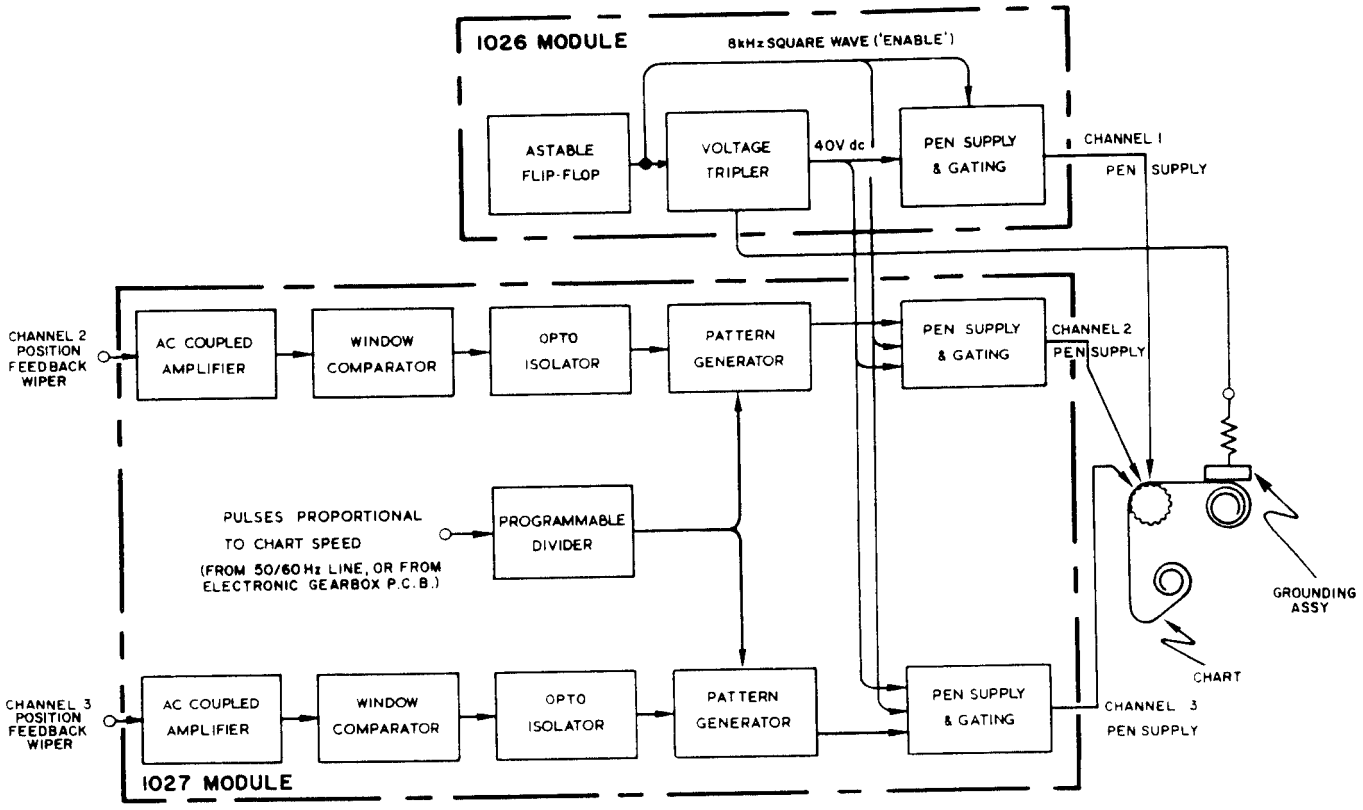


Figure 5-1 Electric writing *Schematic*

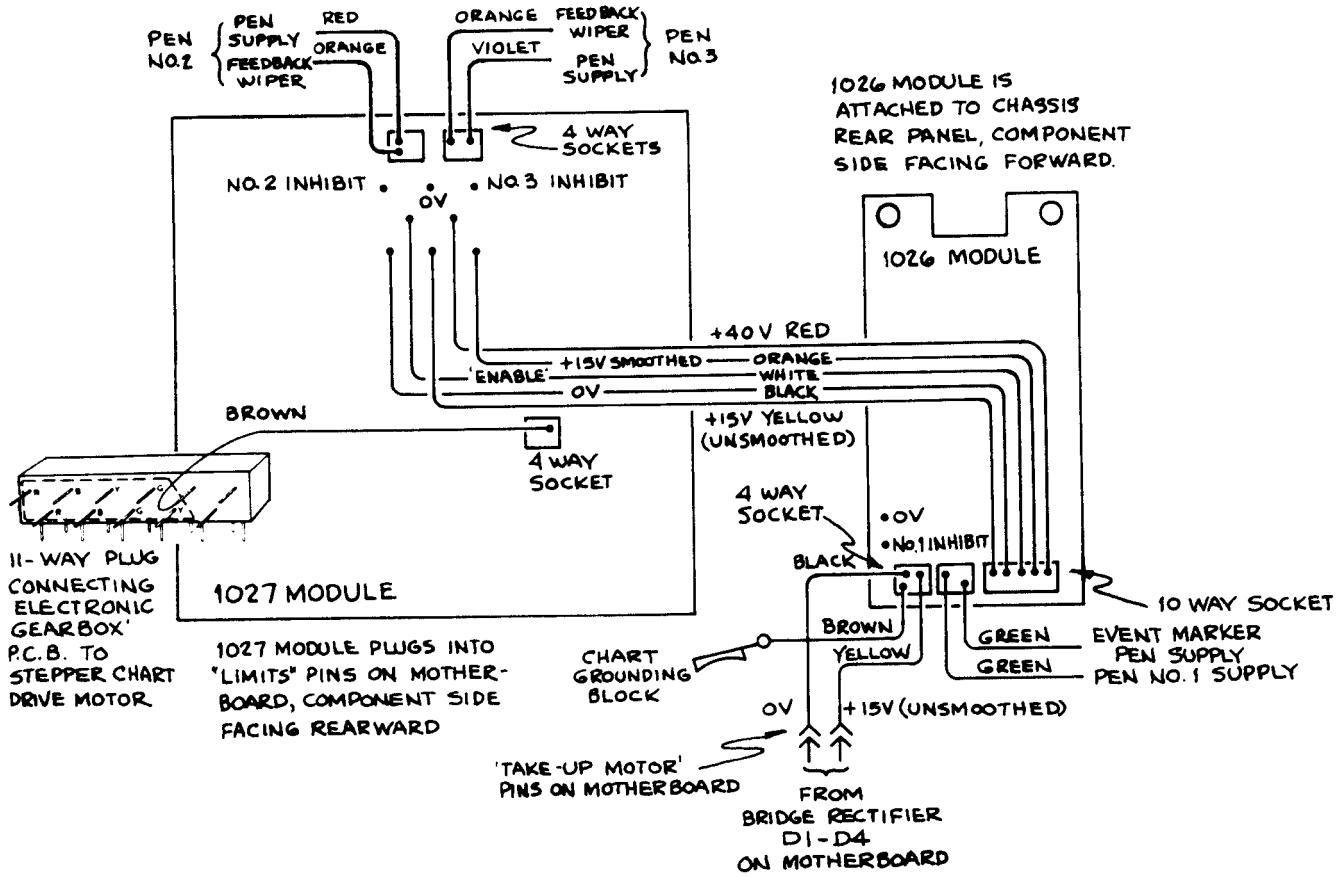


Figure 5-2 Electric writing *Wiring*

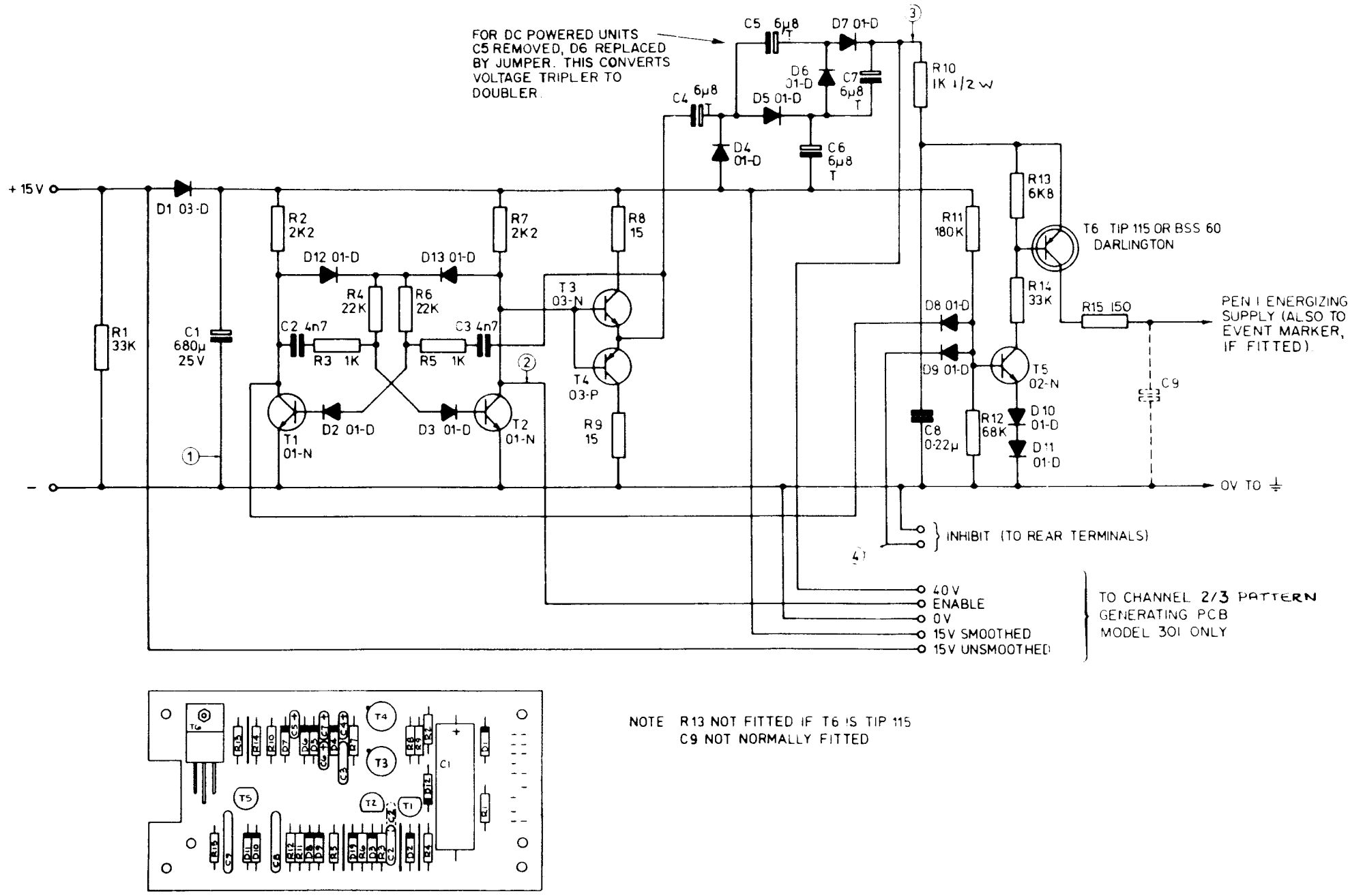


Figure 5-3 *Electric writing module no. 1026*

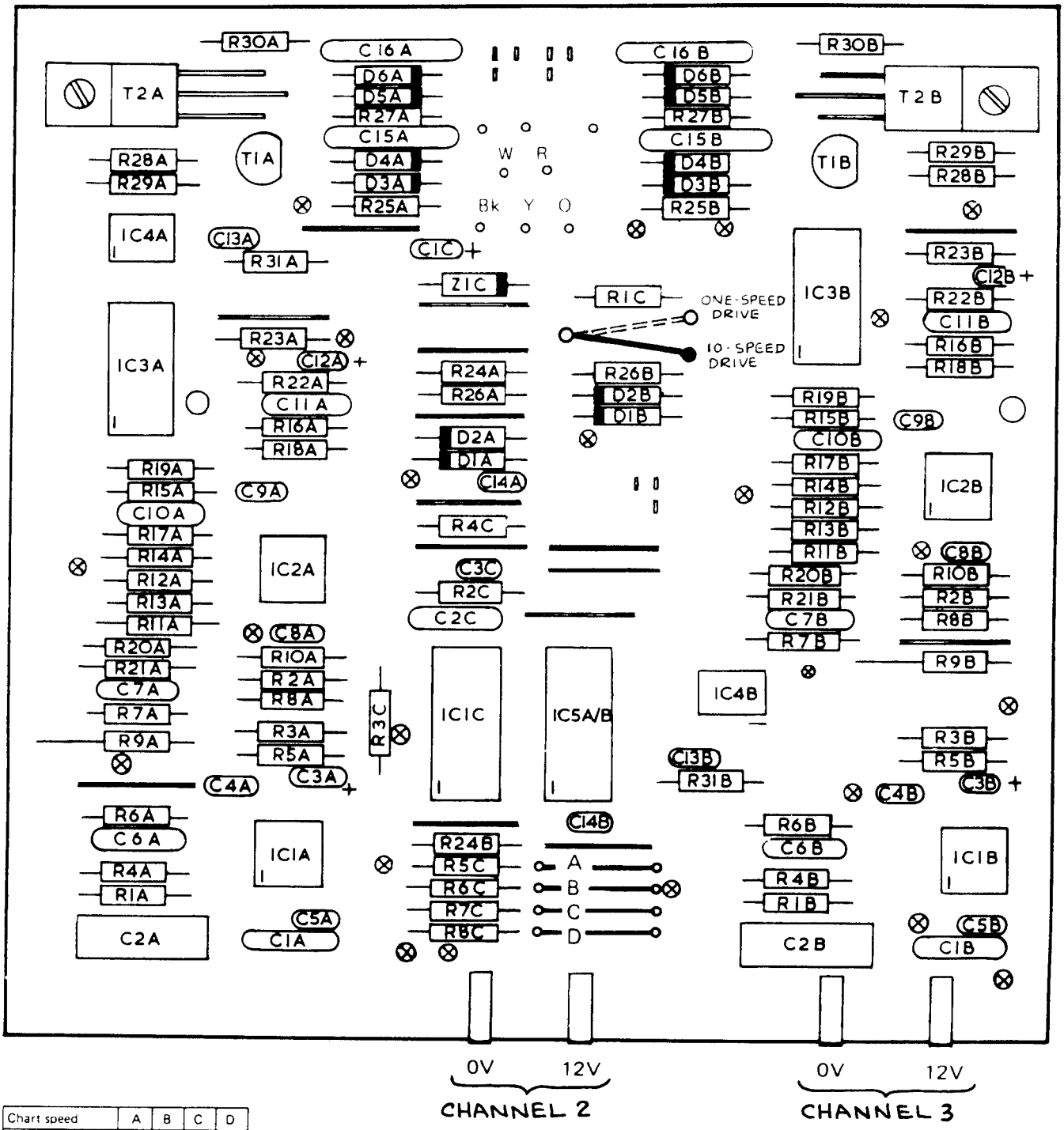


Chart speed	A	B	C	D
EGHS				
EGLS	√	√		
1cm in 5 sec			√	
" 10 sec	√		√	
" 20 sec		√	√	
" 30 sec	√	√	√	
" 1 min				√
" 2 min	√			√
" 5 min		√		√
" 10 min	√	√		√
" 20 min			√	√
" 24 min			√	√
" 30 min	√		√	√
" 1 hr		√	√	√
" 2 hrs	√	√	√	√
" 2·5 hrs	√	√	√	√

10-SPEED CHART DRIVE (STEPPER MOTOR)

ONE-SPEED CHART DRIVE (SYNC MOTOR)

√ = LINK

CHART SPEED PROGRAMMING ON 1027 MODULE

Figure 5-4 *Pattern generating module no. 1027*

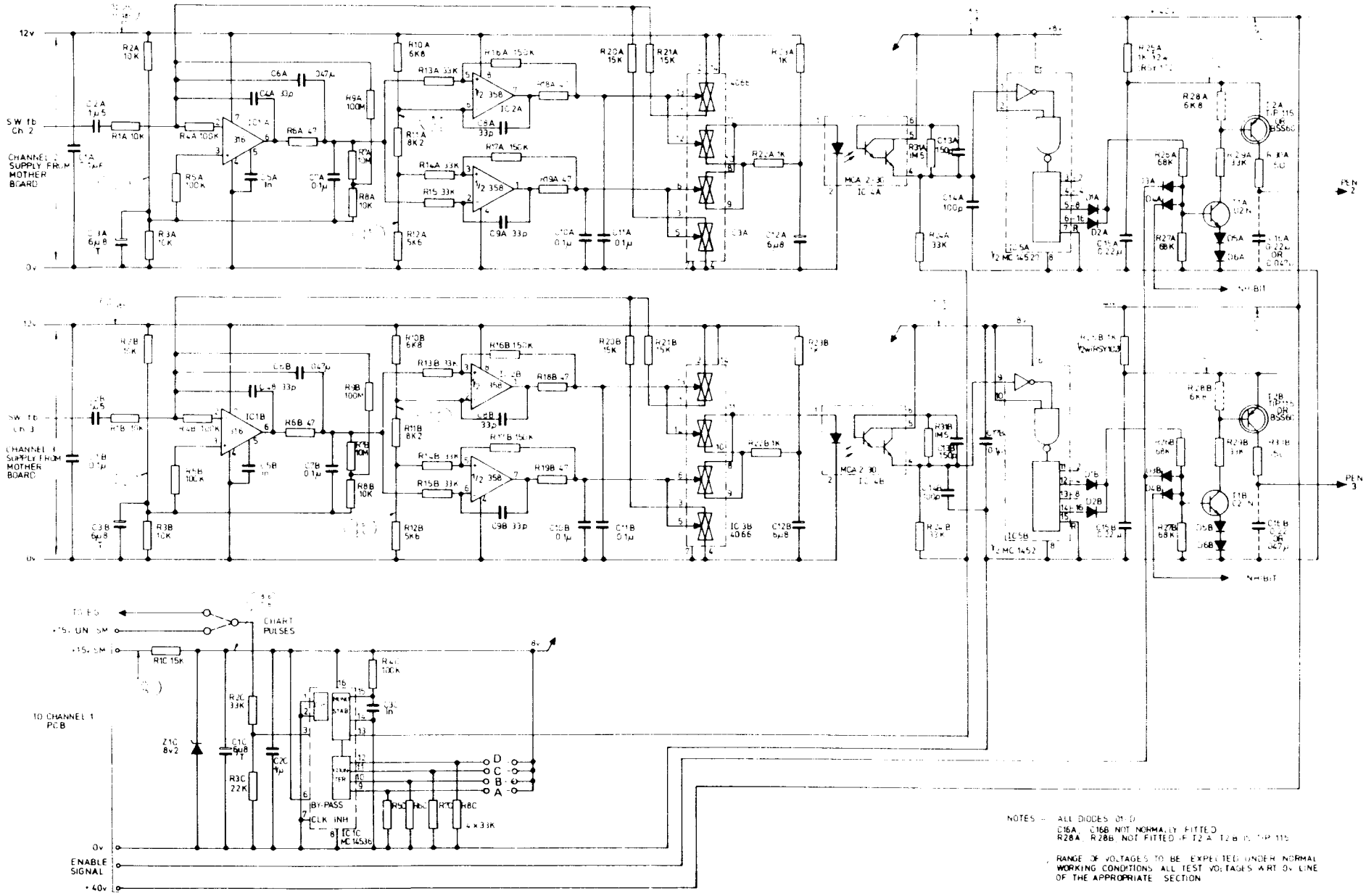


Figure 5-5 *Pattern generating module no. 1027*

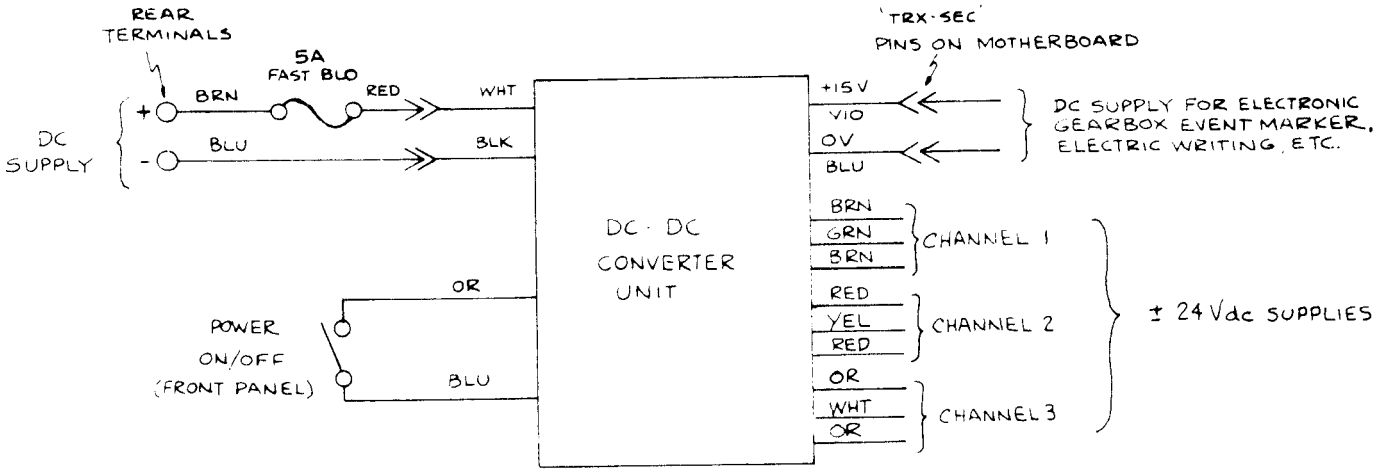


Figure 5-6 D C to D C converter unit *Chassis wiring*

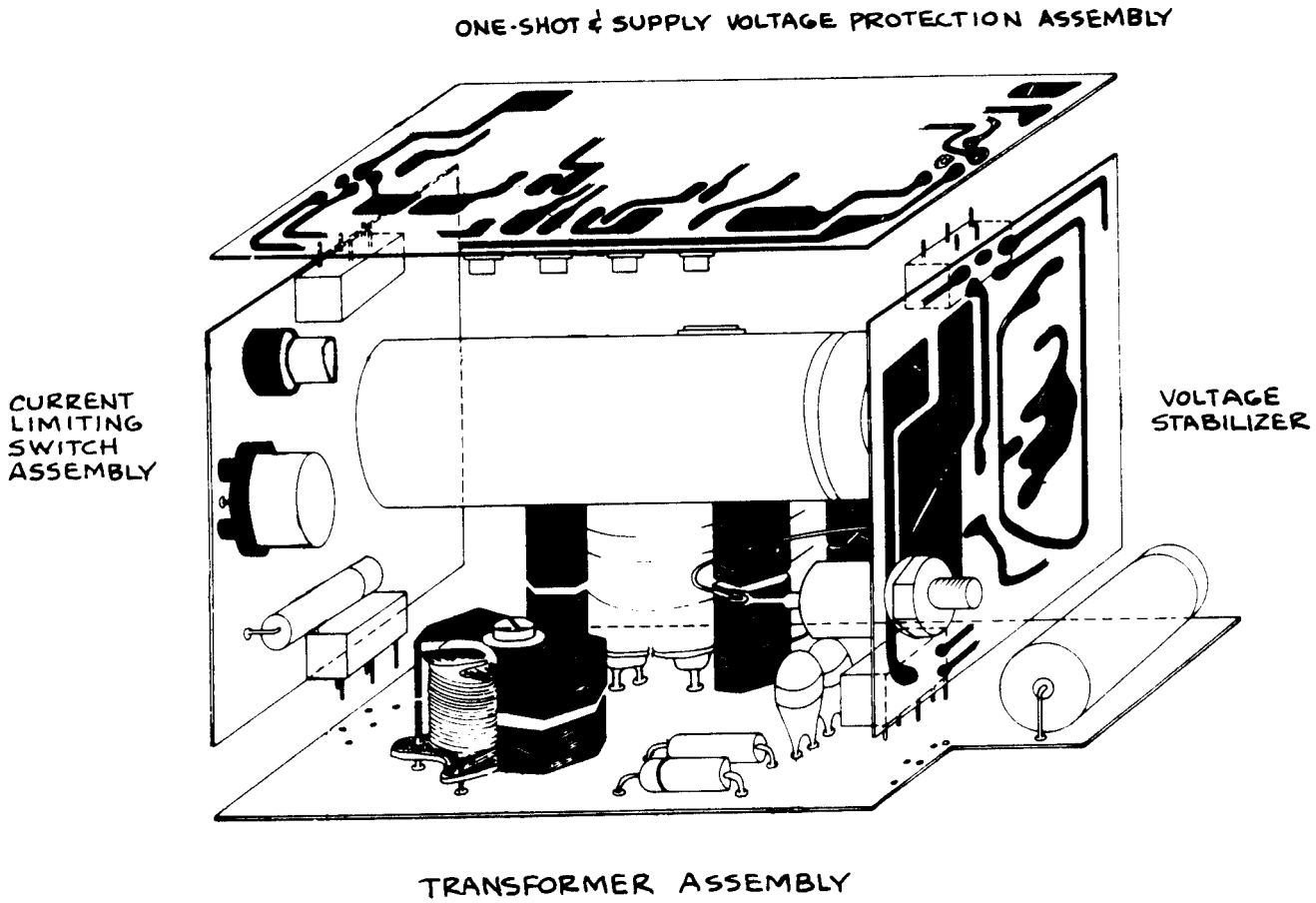


Figure 5-7 D C to D C converter unit *Sub-assemblies*

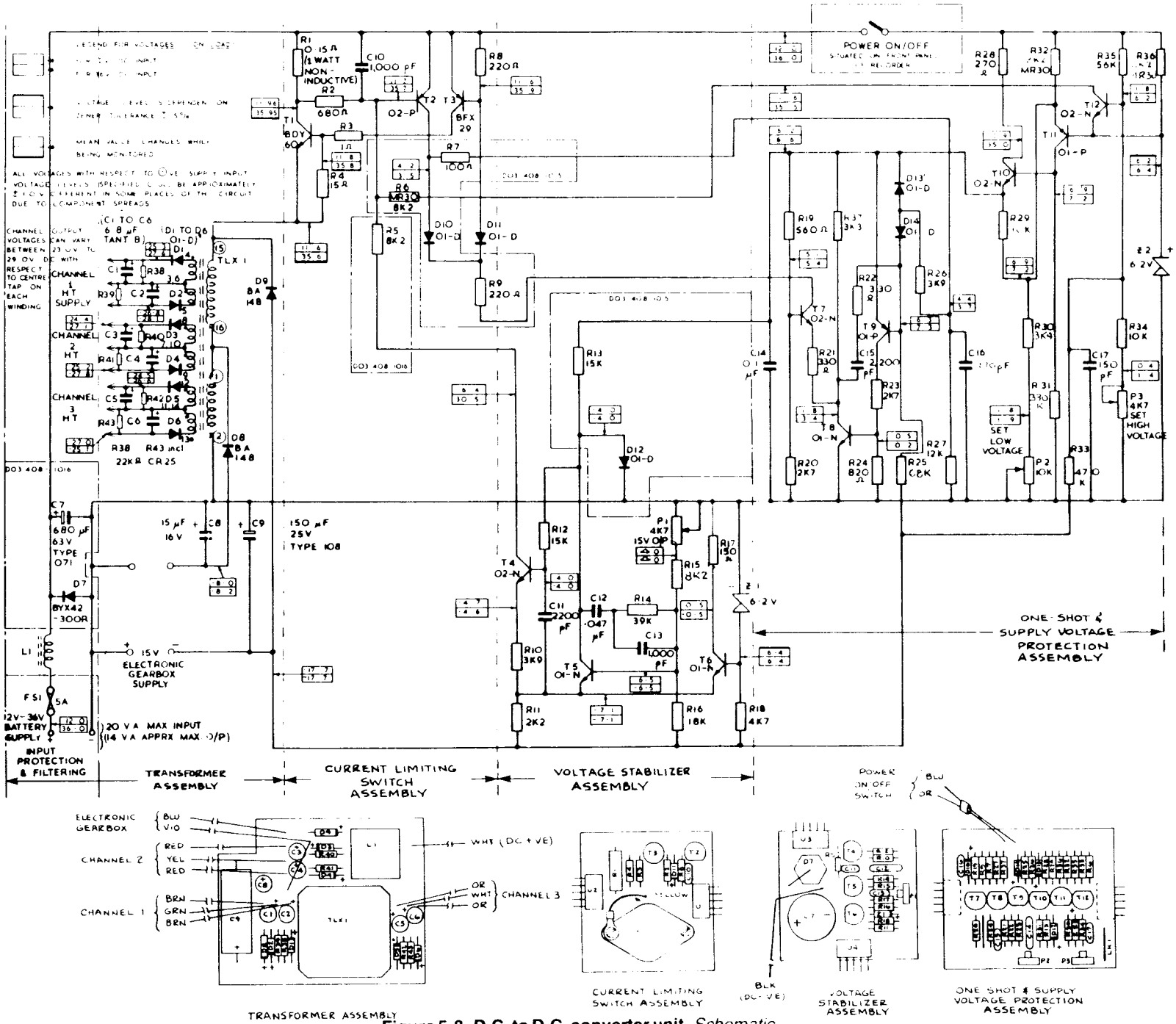


Figure 5-8 D C to D C converter unit *Schematic*

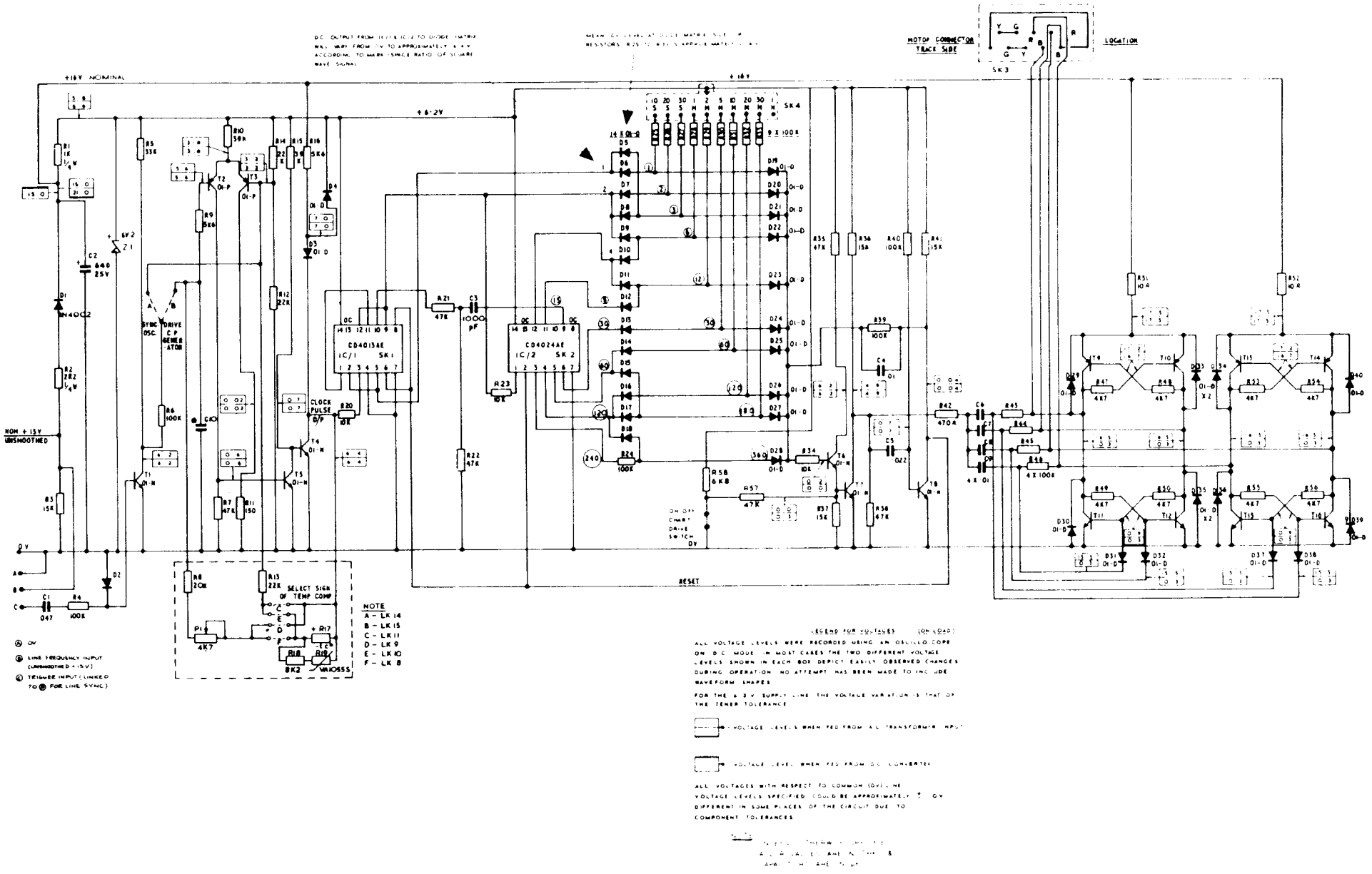


Figure 5-9 Electronic gearbox no. 1009 *Schematic*

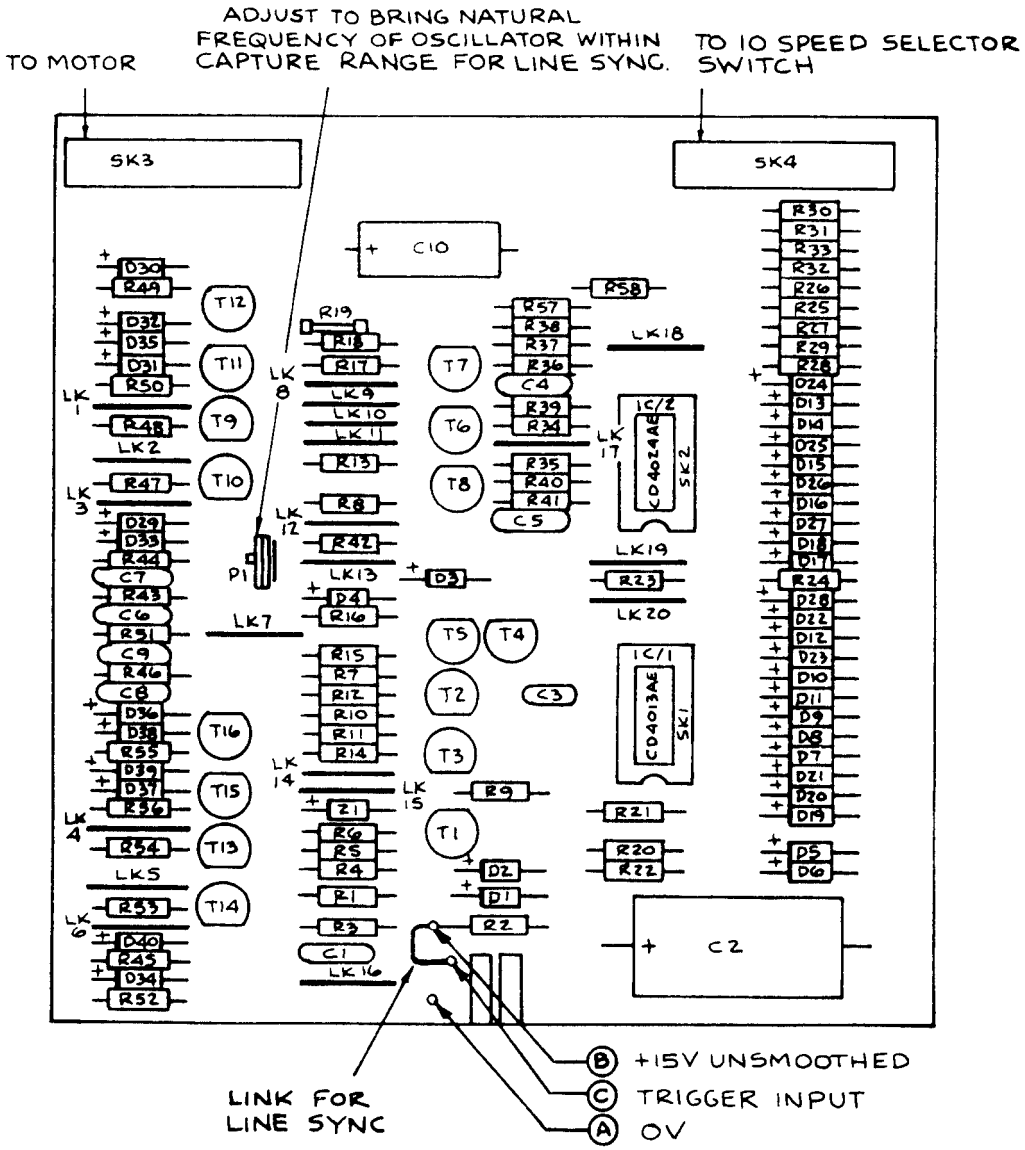


Figure 5-10 Electronic gearbox no. 1009 *Layout*

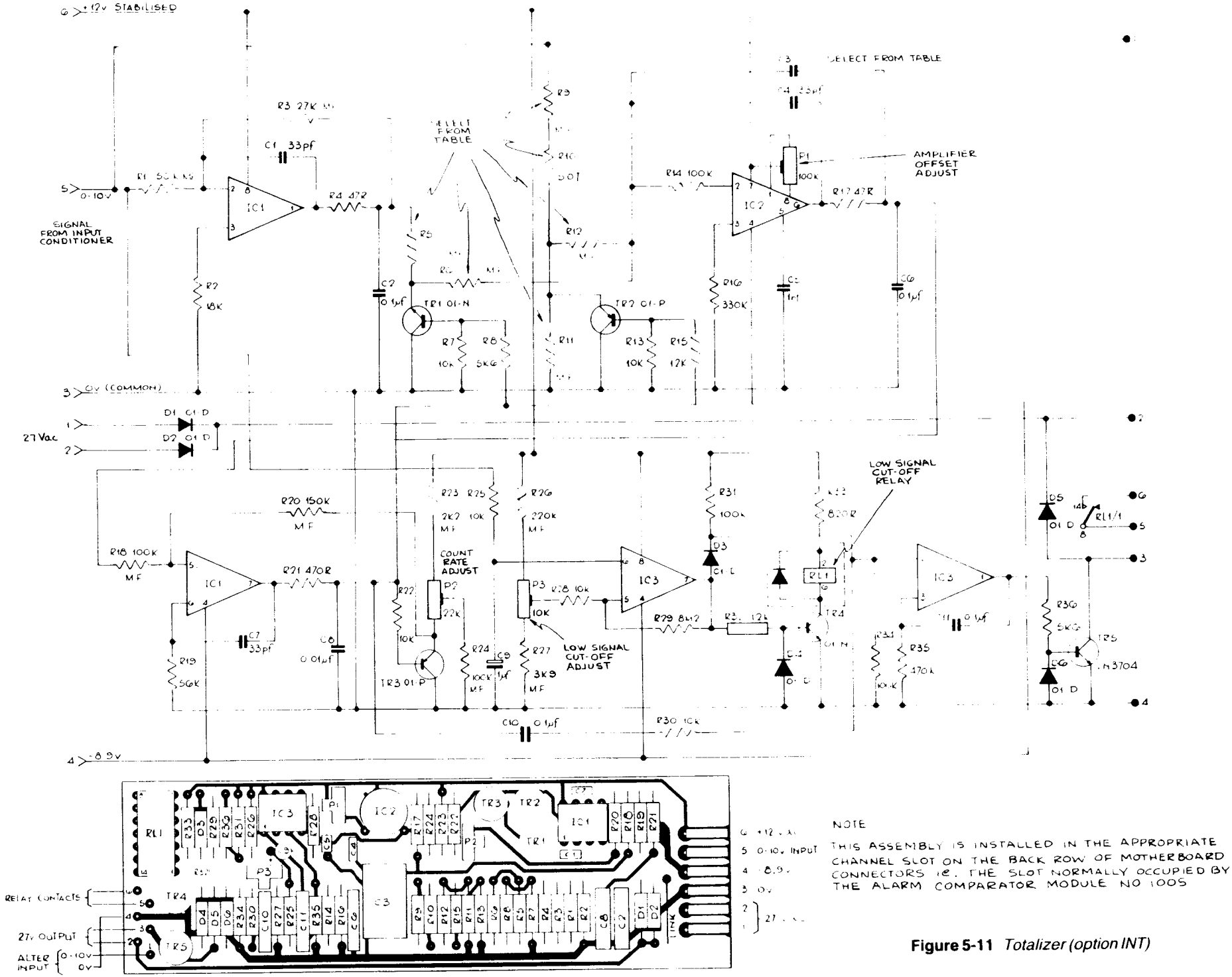


Figure 5-11 *Totalizer (option INT)*

Totalizer component selection

COUNTS PER HOUR	C3(uF)	R9	R10	R12	R11	R6	R5
360 to 391.3	1	1M5	220K	3M9	2M7	3M9	56K
391.3 to 400	1	1M5	5K6	3M9	2M2	3M9	56K
400 to 480	1	1M2	220K	3M3	2M2	3M3	56K
480 to 580.6	1	1M0	150K	2M7	1M8	2M7	56K
580.6 to 588.7	1	1M0	33K	2M7	1M5	2M7	56K
588.7 to 707.9	1	820K	120K	2M2	1M5	2M2	56K
707.9 to 720	1	820K	10K	2M2	1M2	2M2	56K
720 to 867.4	1	680K	100K	1M8	1M2	1M5	270K
867.4 to 873.7	1	680K	8K2	1M8	1M0	1M5	270K
873.7 to 1051.1	1	560K	82K	1M5	1M0	1M2	270K
1051.1 to 1066.6	1	560K	6K8	1M5	820K	1M2	270K
1066.6 to 1278.8	1	470K	47K	1M2	820K	1M0	180K
1278.8 to 1551.7	1	390K	39K	1M0	680K	820K	180K
1551.7 to 1582.4	1	330K	56K	1M0	560K	820K	180K
1582.4 to 1865.2	1	330K	27K	820K	560K	680K	150K
1865.2 to 1920	1	270K	47K	820K	470K	680K	150K
1920 to 2229.1	1	270K	27K	680K	470K	560K	120K
2229.1 to 2322.5	1	220K	56K	680K	390K	560K	120K
2322.5 to 2666.6	1	220K	27K	560K	390K	470K	82K
2666.6 to 2812.5	1	220K	2K2	560K	330K	470K	82K
2812.5 to 3200	1	180K	27K	470K	330K	390K	82K
3200 to 3348.8	1	180K	3K3	470K	270K	390K	82K
3348.8 to 3913	1	150K	22K	390K	270K	270K	120K
3913 to 4000	1	150K	1K0	390K	220K	270K	120K
4000 to 4500	1	120K	22K	330K	220K	270K	120K
4500 to 4705.8	0.47	270K	27K	680K	470K	560K	120K
4705.8 to 4904.6	0.47	220K	56K	680K	390K	560K	120K
4904.6 to 5651.5	0.47	220K	27K	560K	390K	470K	82K
5651.5 to 5940.5	0.47	220K	2K2	560K	330K	470K	82K
5940.5 to 6779.6	0.47	180K	27K	470K	330K	390K	82K
6779.6 to 7114.6	0.47	180K	3K3	470K	270K	390K	82K
7114.6 to 8314	0.47	150K	22K	390K	270K	270K	120K
8314 to 8510.6	0.47	150K	1K0	390K	220K	270K	120K
8510.6 to 10155	0.47	120K	22K	330K	220K	180K	150K
10155 to 10256	0.47	120K	4K7	330K	180K	180K	150K
10256 to 12244	0.47	100K	15K	270K	180K	150K	120K
12244 to 12500	0.47	100K	3K3	270K	150K	150K	120K
12500 to 15000	0.47	68K	27K	220K	150K	120K	100K
15000 to 15319	0.47	82K	1K0	220K	120K	120K	100K
15319 to 18461	0.47	68K	8K2	180K	120K	100K	82K
18461 to 20000	0.47	56K	8K2	150K	100K	82K	68K
20000 to 21712	0.22	120K	22K	330K	220K	180K	150K
21712 to 26451	0.22	100K	15K	270K	180K	150K	120K
26451 to 26587	0.22	100K	3K3	270K	150K	150K	120K
26587 to 32114	0.22	68K	27K	220K	150K	120K	100K
32114 to 32490	0.22	82K	1K0	220K	120K	120K	100K
32490 to 36000	0.22	68K	8K2	180K	120K	100K	82K

NOTE: C3 must be temp. stable; resistors are met. film 1/2%, 50 ppm

Figure 5-12

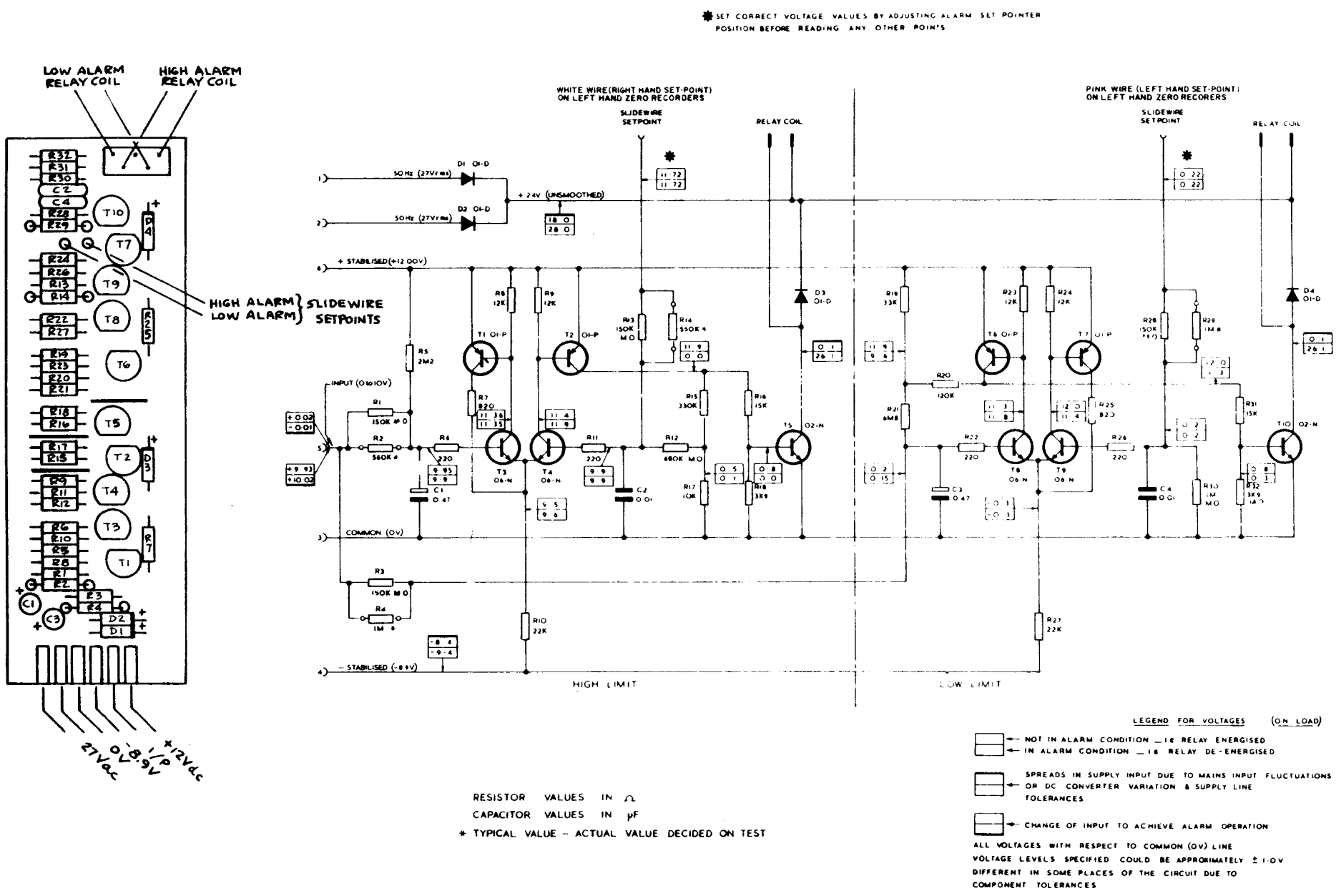


Figure 5-13 HI-LO alarm comparator board *(option HLL)*

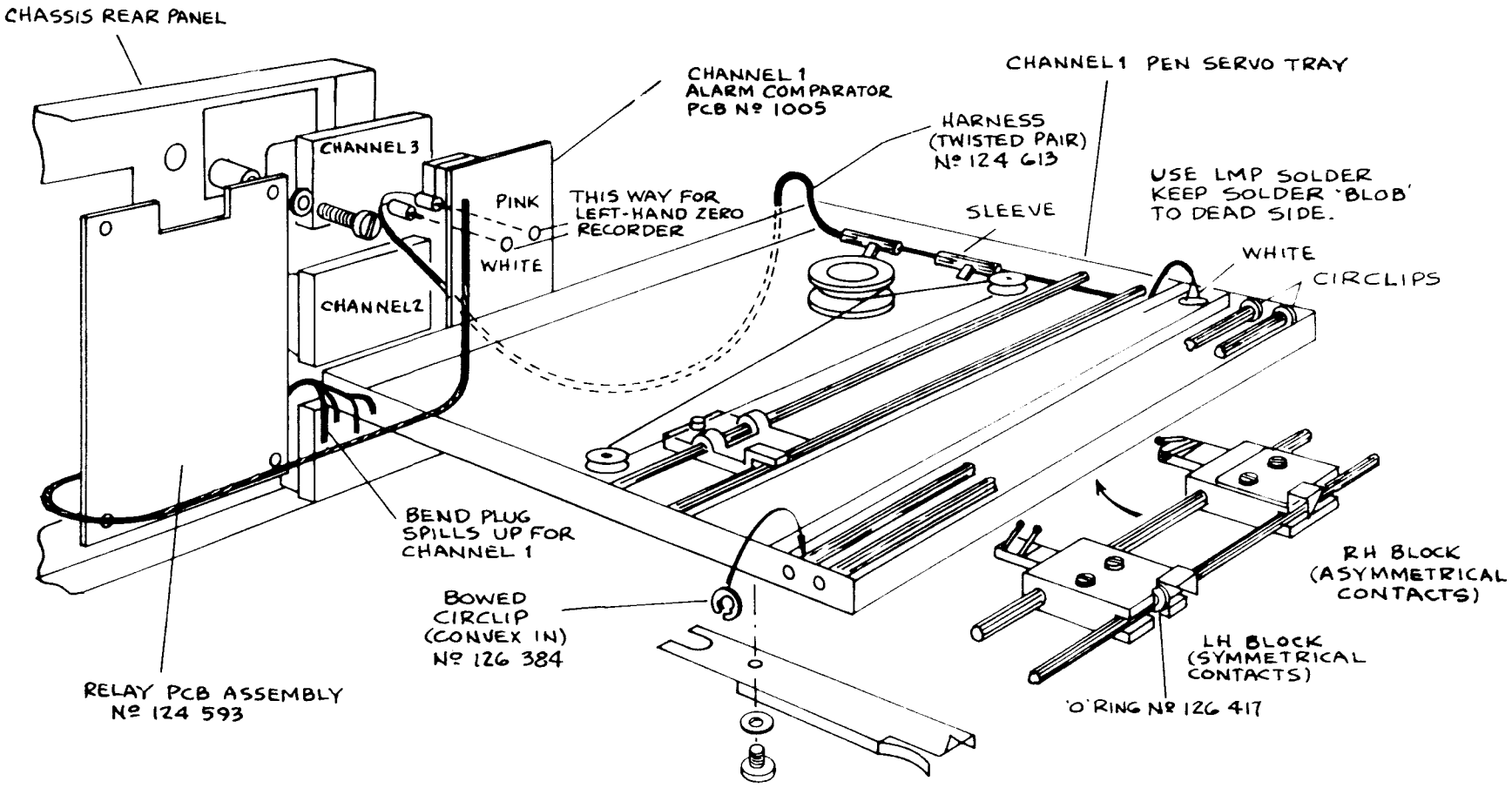


Figure 5-14 Model 301 HI/LO alarms: *Mechanical layout*

NOTE: (1) Alarm relays are energized in the non-alarm state.
(2) PCB is diagrammed below viewed from the relay, rear facing side.
(3) 5-way plugs connecting relay coils to alarm comparator PCB's are viewed from the pin side.
(4) 'T' designations refer to transistors on the alarm comparator PCB, No. 1005.
(5) In left-hand zero instruments, 'LO' relates to the left alarm set-point indicator, and 'HI'to the right. In right-hand zero instruments, 'LO' remains in the signal sense the lower set-point, but becomes the right-hand indicator. Electrically, this is arranged by transposition of the pink and white wires (twisted pair) connecting the slidefilm assembly to the alarm comparator PCB.
(6) Only the common and closed/energized contacts are wired to the rear panel terminals in the standard Model 301; the 'open/energized' wire is removed.

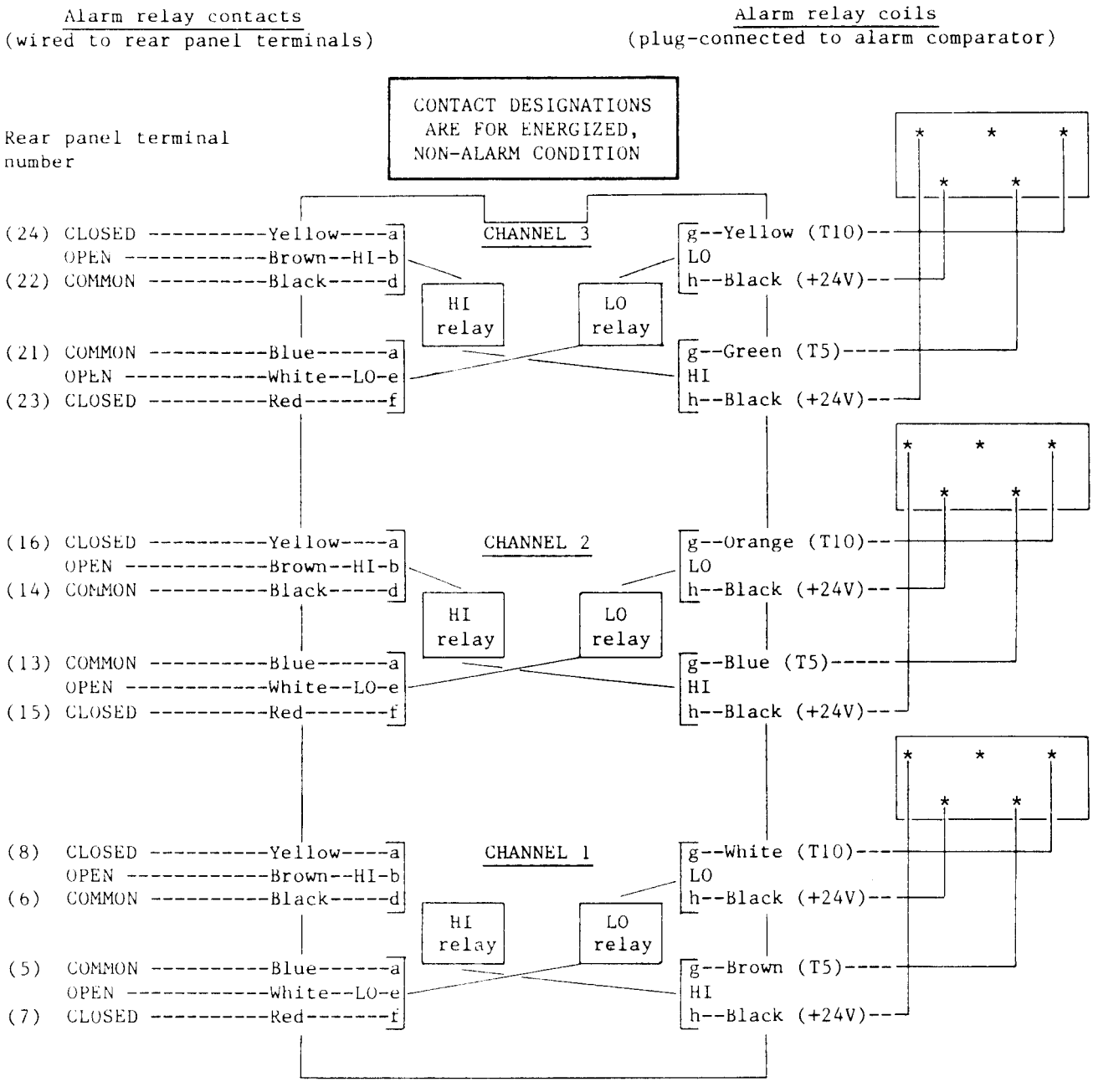


Figure 5-15 HI/LO ALARMS *PCB wiring*

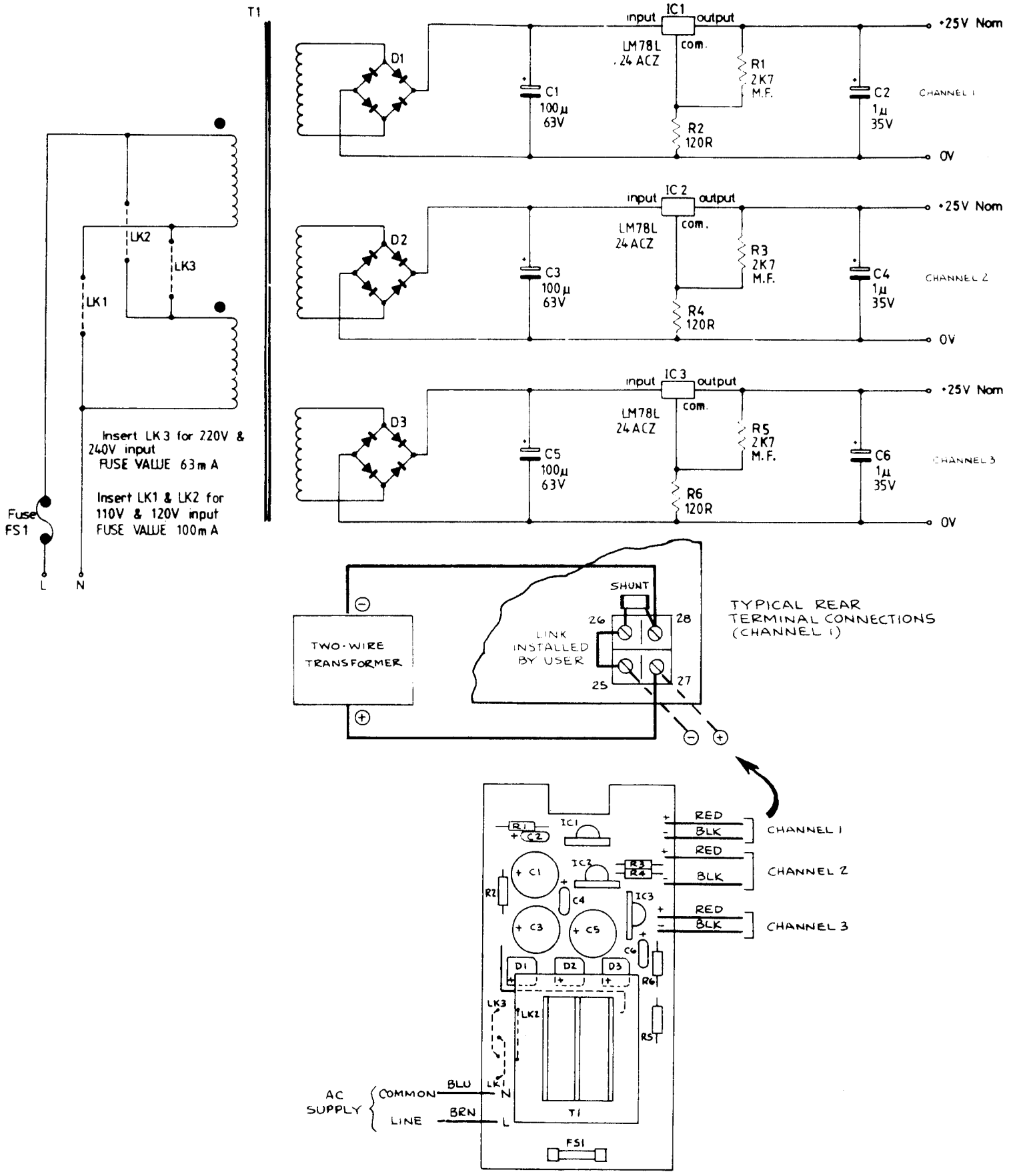
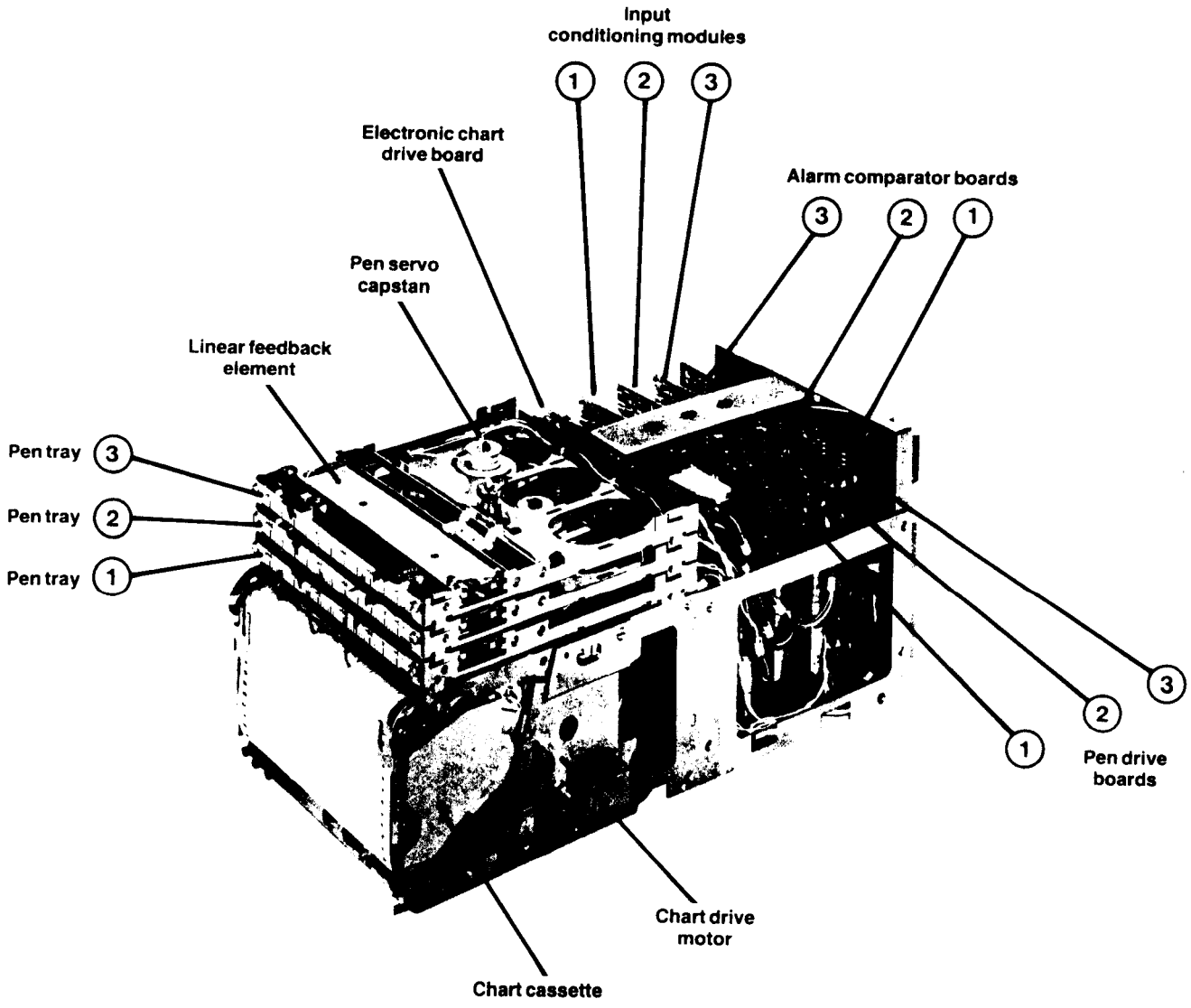


Figure 5-16 *Transmitter power supply (option TWS)*

Section 6
Chassis Wiring and Assembly Diagrams



MODEL 301 CHASSIS LAYOUT

PEN TRAY

Item No.	Chessell No.	Quantity	Description
1	-	1	Scale and backing plate
2	205 838	2	M2.5 x 3 mm pan head screw
3	205 865	2	M2.5 plain washer
4	200 008	1	Pen tray (includes items 5 through 11)
5	126 385	1	Circlip
6	100 684	1	Crinkle washer
7	100 570	1	Collar
8	101 242	2	M2 acetate washer
9	101 323	2	Cord pulley
10	101 242	2	M2 acetate washer
11	126 382	2	Grip ring
12	124 570	1	Disposable cartridge holder, or;
	200 371	1	Capillary pen assembly, or;
	122 081	1	Electric writing stylus assembly
13	205 861	1	M2 plain washer
14	100 584	2	Spindle: high/low alarm
15	126 384	4	Circlip
16	205 888	1	M2 x 6 mm countersunk screw
17	100 699	1	Leaf spring
18	200 012	1	Slidefilm assembly
19	101 481	1	Pen block assembly, including threaded insert (flush fastener) and two pressure adjusting screws
19A	101 845	1	Contact assembly
19B	207 054	1	M1.4 x 2 mm cheese head screw
20	100 635	1	Pillar
21	200 285	1	M1.6 plain washer
22	205 856	1	M1.6 x 5 mm screw
23	200 752	1	M2 x 4 mm pan head screw
24	126 383	4	Circlip
25	100 569	1	Spindle (fine ground finish)
26	100 650	1	Spindle (plated finish, or has identifying groove)
27	200 752	4	M2 x 4 mm pan head screw
28	205 861	4	M2 plain washer
28A	124 584	1	Alarm pointer: left hand
28B	124 585	1	Alarm pointer: right hand
29	101 842	1	Alarm contact assembly: left hand
29	101 843	1	Alarm contact assembly: right hand
30	207 054	2	M1.4 x 2 mm cheese head screw
31	125 179	2	Alarm contact block
32	126 417	2	'0' ring
33	100 564	1	Knurled nut
34	100 565	2	Spacing pillar
35	-	1	Capillary 'L' piece
36	-	1	Tube retainer
	101 030	1	Pen motor, plate and capstan assembly, complete; includes items 37 through 44, available separately
37	100 941	1	Gear and capstan assembly, complete
38	101 032	1	Motor plate assembly
39	122 471	1	Motor, including 14T pinion
40	100 630	2	Pillar
41	205 850	7	M2 x 4 mm cheese head screw
41A	205 861	2	M2 plain washer
41B	205 872	5	M2 lock washer
42, 43	101 242	2	M2 acetate washer (one above, one below item 37)
44	126 382	1	Grip ring

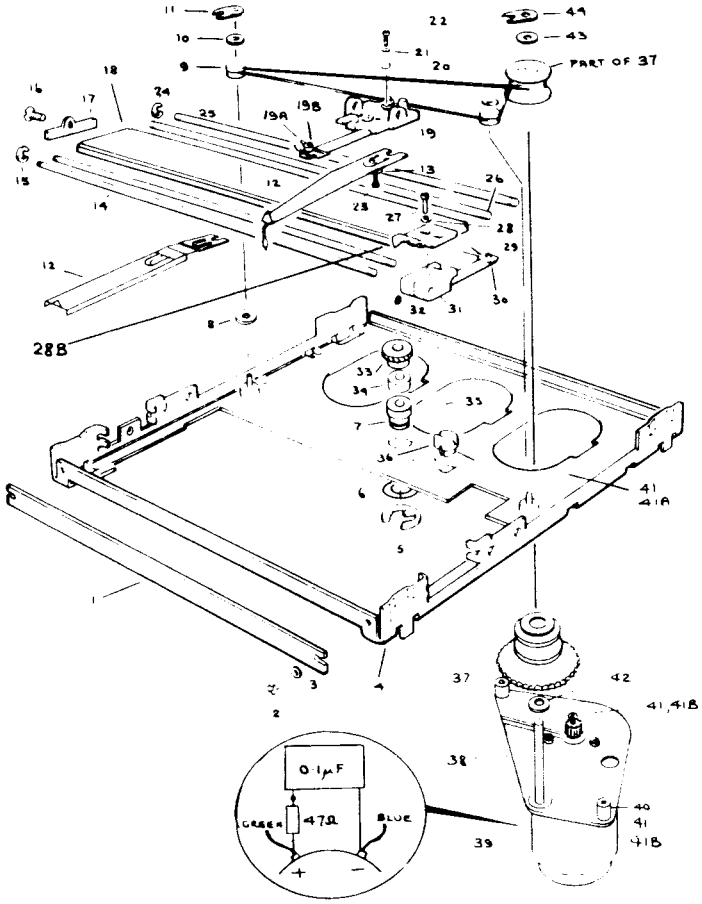


Figure 6-1 Pen tray components

ROLL CASSETTE

Item No.	Chessell No.	Quantity	Description
1	100 380	1	Front plate
2	200 292	2	M2 x 3 mm countersunk screw
3	100 587	3	Tie bar
4	100 702	2	Spring clip: right hand
	100 701	2	Spring clip: left hand
5	205 872	2	M2 lock washer
6	205 850	2	M2 x 4 mm screw
7	100 385	1	Gear cover
8	-	1	Gear set; gears, listed elsewhere, available separately
9	200 000	1	Side plate: right hand
10	200 293	4	M2 x 4 mm countersunk screw
11	100 866	1	Take-up roller end plate
12	126 390	1	Pin
13	126 387	1	Circlip
14	100 910	1	Retaining finger assembly (option CRO)
15	100 605	2	Gear stub
16	100 844	2	Idler gear
17	100 693	1	Return spring (option CRO)
18	126 387	2	Circlip
19	200 001	1	Side plate: left hand
20	100 919	1	23T gear and spindle assembly
21	100 920	1	105T gear assembly
22	101 327	1	Clutch cone
23	126 390	1	Pin
24	101 246	1	Acetate washer
25	101 521	1	Sprocket roller assembly
26	100 691	1	Clutch spring
27	126 388	1	Circlip
28	100 574	1	Take-up roller tube
29	100 884	1	Supply roller assembly
30	200 006	1	Transfer shaft assembly

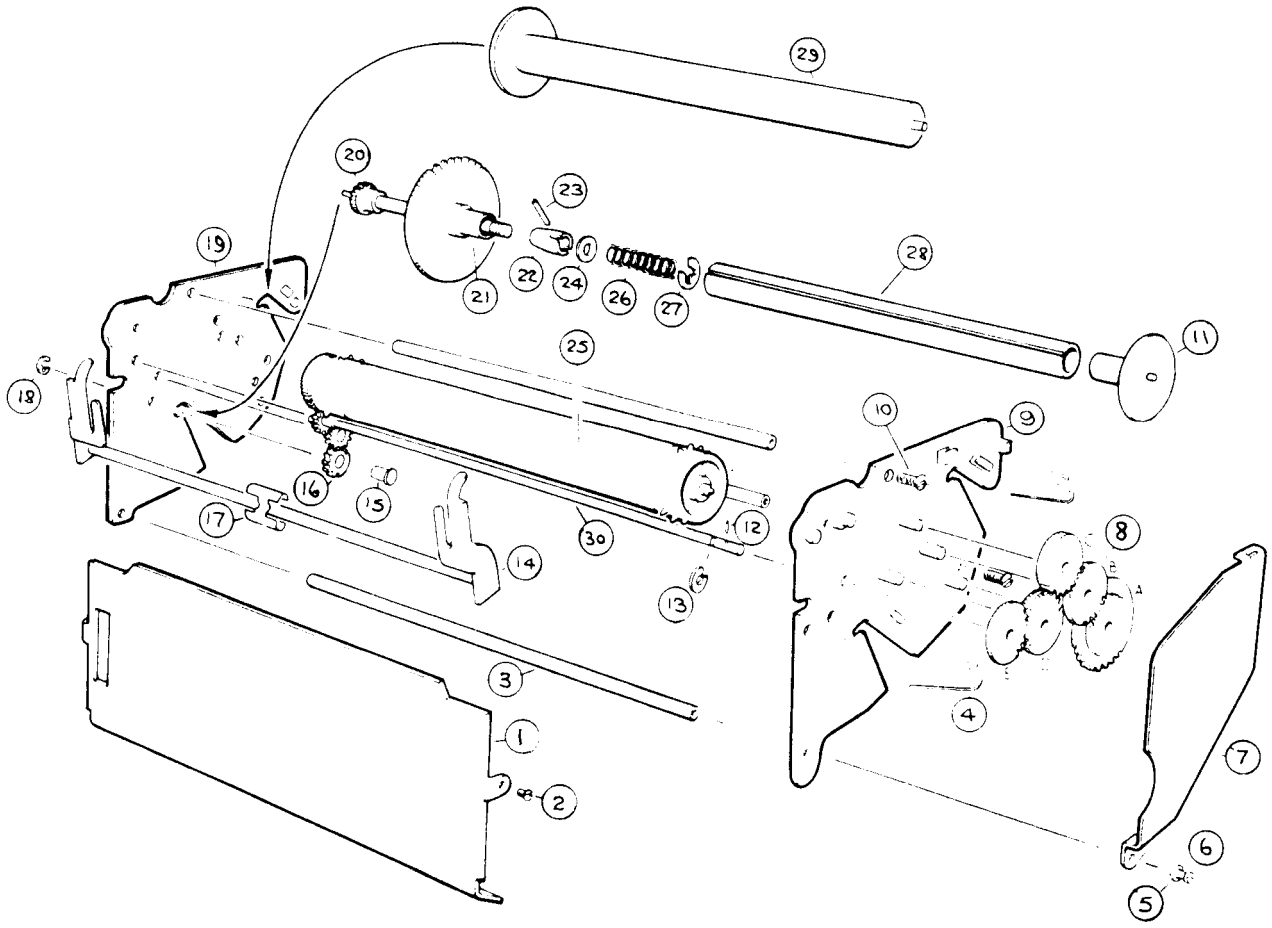


Figure 6-2 Roll cassette components

Z-FOLD CASSETTE

Item No.	Chessell No.	Quantity	Description
1	123 372	2	Guide arm pin
2	205 887	2	M2.5 x 5 mm socket screw
3	101 246	2	Acetate washer
4	123 381	1	Guide arm: left hand
5	123 397	1	Tie bar
6	123 398	1	Spacer
7	123 380	1	Guide arm: right hand
8	122 046	1	Paper receptacle
9	205 848	2	M2 x 3 mm screw
10	200 751	1	M2.5 lock washer
11	205 838	1	M2.5 x 3 mm pan head screw
12	100 385	1	Gear cover
13	-	1	Gear set; gears, listed elsewhere, available separately
14	200 293	6	M2 x 4 mm countersunk screw
15	200 000	1	Side plate: right hand
16	123 370	1	Spring clip: right hand
	123 371	1	Spring clip: left hand
17	200 001	1	Side plate: left hand
18	100 587	3	Tie bar
19	200 006	1	Transfer shaft assembly
20	101 521	1	Sprocket roller assembly
21	126 387	1	Circlip
22	126 390	1	Pin
23	123 379	1	Paper feed trough

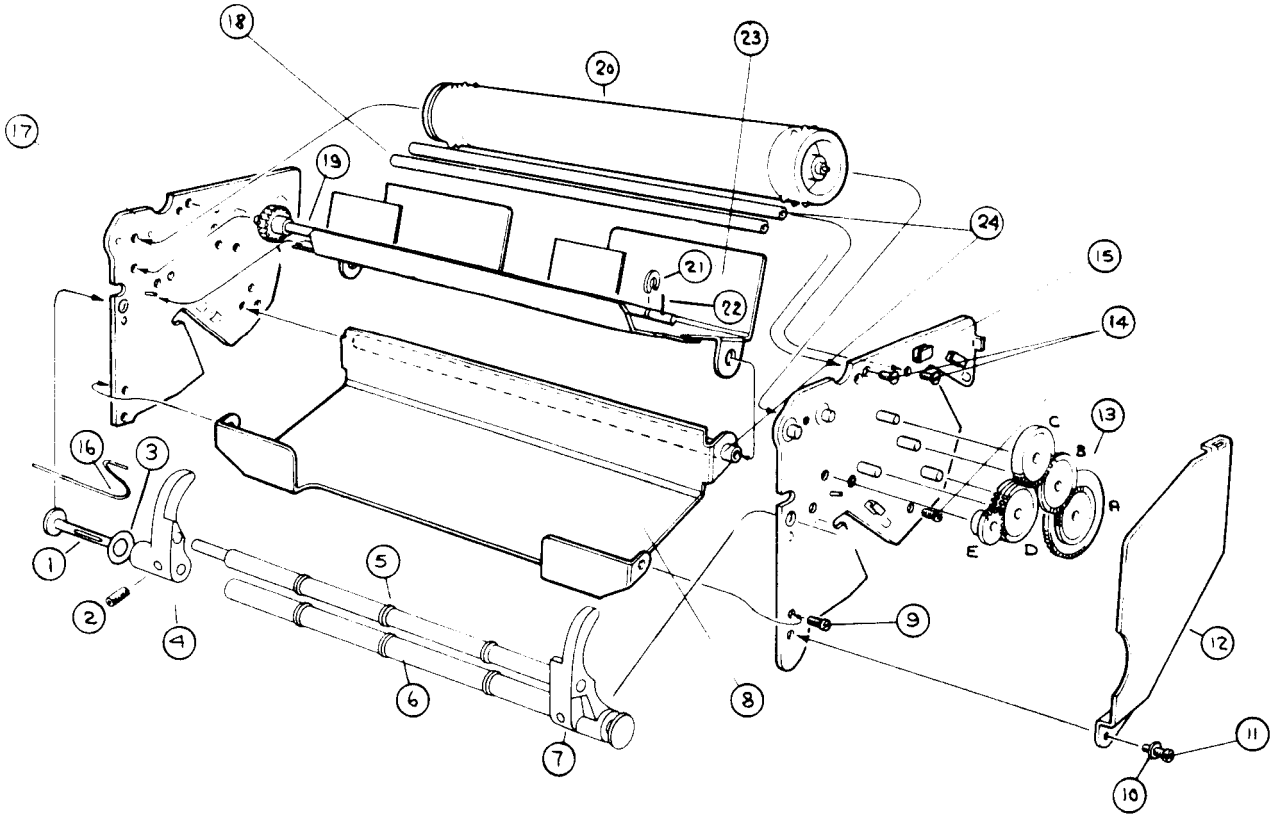


Figure 6-3 Z-fold cassette components

Chessell Corp No.	Eurotherm Int'l No.
100 305	BA100305
100 306	BA100306
100 380	BA100380
100 385	BA100385
100 418	BA100418
100 564	BE100564
100 565	BE100565
100 569	BE100569
100 570	BE100570
100 574	BE100574
100 584	BE100584
100 587	BE100587
100 605	FG100605
100 630	BE100630
100 634	BK100634
100 635	BE100635
100 650	BE100650
100 684	FC100684
100 691	BH100691
100 693	BA100693
100 699	BA100699
100 701	BA100701
100 702	BA100702
100 841	BE100841
100 844	BE100844
100 866	LA100866
100 884	LA100884
100 910	LA100910
100 919	LA100919
100 920	LA100920
100 941	LA100941
101 030	LA101030
101 032	LA101032
101 148	LA101148
101 149	LA101149
101 150	LA101150
101 151	LA101151
101 152	LA101152
101 153	LA101153
101 154	LA101154
101 155	LA101155
101 156	LA101156
101 157	LA101157
101 158	LA101158
101 159	LA101159
101 160	LA101160
101 161	LA101161
101 181	LA101181
101 182	LA101182
101 242	BT101242
101 246	FX101246
101 323	BD101323
101 327	BD101327
101 336	BD101336
101 342	BD101342
101 481	LA101481
101 483	LA101483
101 487	LA101487
101 521	LA101521
101 842	LA101842
101 843	LA101843
101 845	LA101845
101 879	LA101879
122 046	BA122046
122 081	LA122081
122 471	DK122471
123 218	BD123218
123 370	BD123370
123 371	BD123371
123 372	FG123372
123 379	BA123379
123 380	BD123380
123 381	BD123381
123 397	BG123397
123 398	BG123398
124 508	HA124508
124 570	LA124570
124 584	BA124584
124 585	BA124585
124 650	LA124650
124 651	LA124651
124 654	LA124654
124 655	LA124655
125 179	BD125179
125 235	LA125235
125 236	LA125236
125 237	LA125237
125 238	LA125238
125 239	LA125239
125 240	LA125240
125 241	LA125241
125 242	LA125242
125 330	LA125330
125 431	LA125431
126 382	FI126382
126 383	FJ126383
126 385	FJ126385
126 387	FJ126387
126 388	CI126388
126 390	CI126390
126 417	BO126417
126 420	CI126420
126 421	DQ126421
126 851	BD126851
127 163	LA127163
127 170	BG127170
127 171	BA127171
127 172	BA127172
127 173	BE127173
127 174	BA127174
127 175	BA127175
127 176	BA127176
127 177	BA127177
127 178	BE127178
127 312	BH127312
200 000	-
200 001	-
200 006	-
200 008	-
200 012	-
200 015	-
200 016	-
200 017	-
200 018	-
200 032	-
200 285	FC12301D
200 286	FC12306H
200 292	FB013F03
200 293	SXB143
200 298	-
200 314	-
200 350	CLP017
200 371	LA100901
200 432	-
200 470	SOS001
200 751	-
200 752	SXC170
200 848	FB016F03
205 055	FUB016
205 838	FB009H03
205 841	FB016F05
205 842	FB016J08
205 843	FB016H05
205 850	FB016F04
205 856	FB016D05
205 860	FC12306F
205 861	FC12335F
205 864	FC12306J
205 865	FC12335H
205 872	WMS204
205 887	SXD237
205 888	FB013F06
205 891	FB016H08
205 905	SBB871
207 054	FB016C02
208 520	-

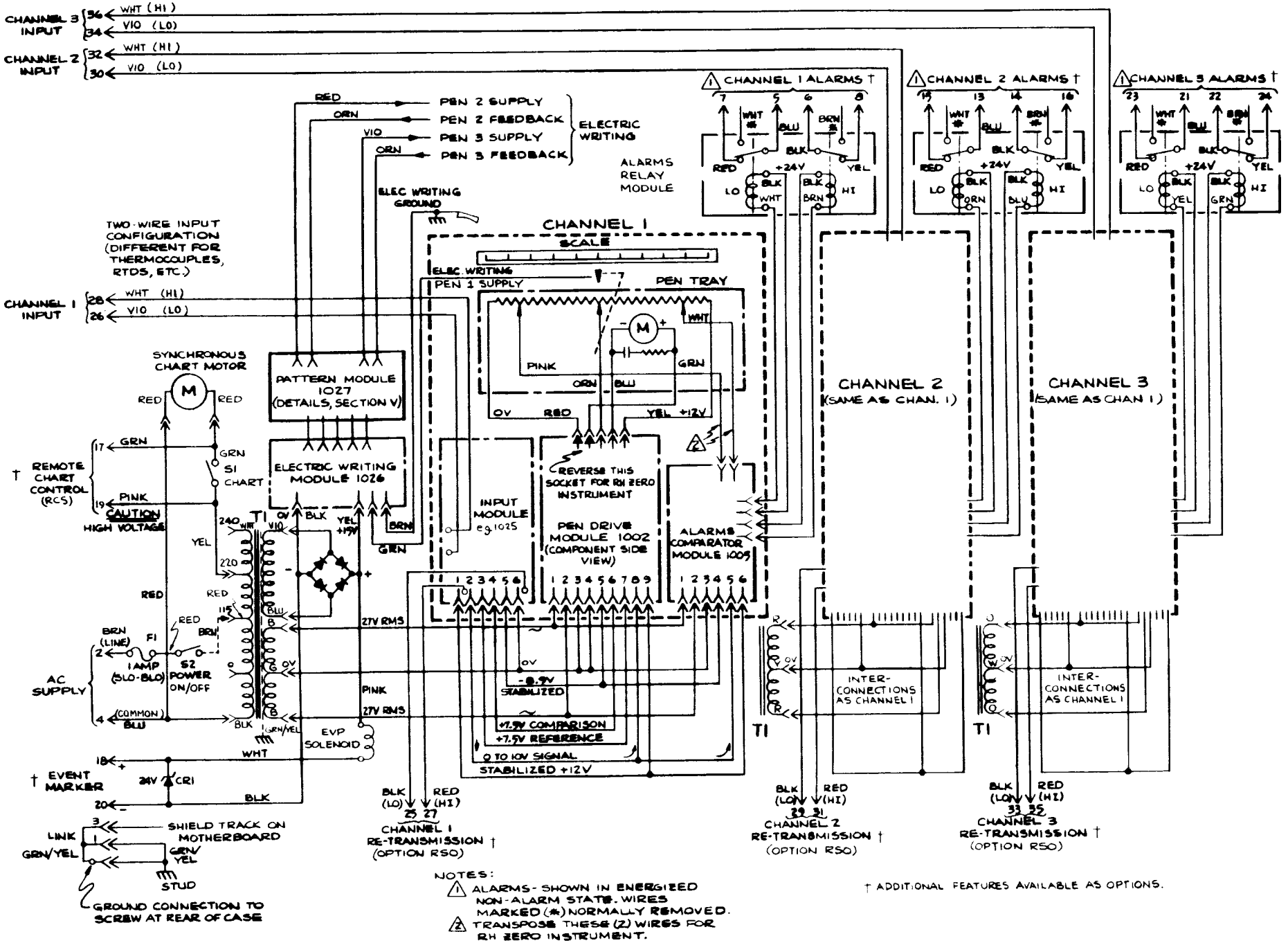


Figure 6-4 Model 301 Chassis schematic – *Single speed chart drive*

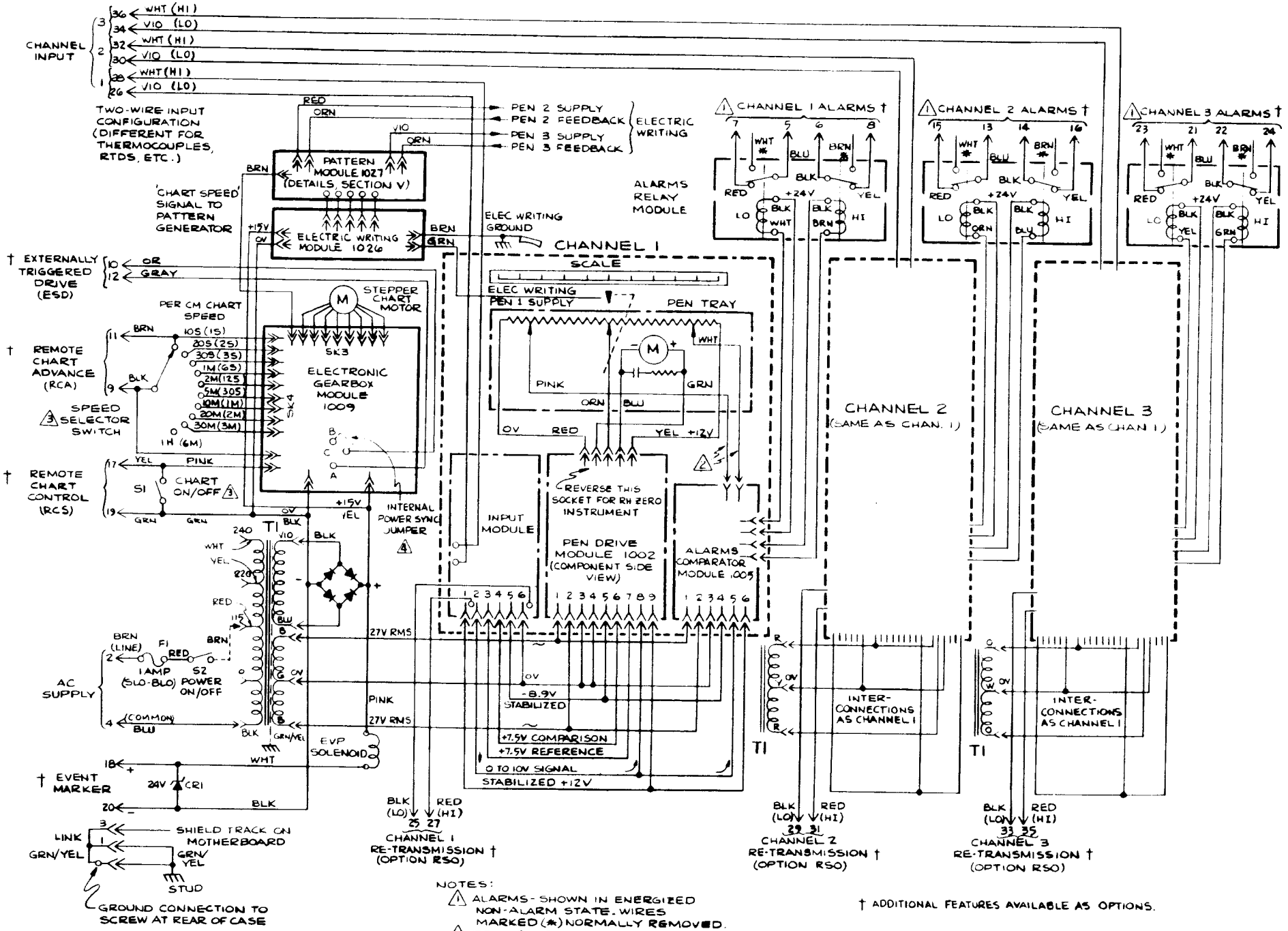


Figure 6-5 MODEL 301 Chassis schematic – *Ten speed chart drive*

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Chessell