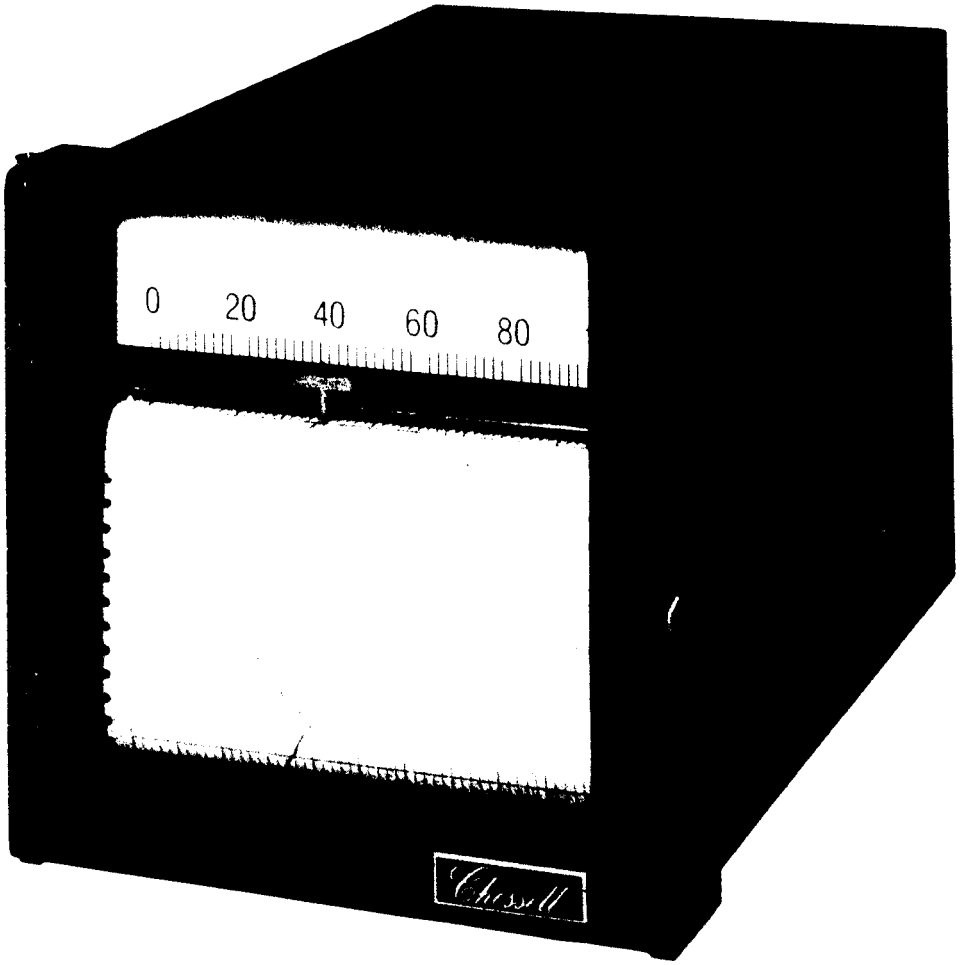
Model 300 100mm Servo Recorder
Installation & Operating Instructions



Part No. 200 795

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 serivce 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.

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Chessell

MODEL 300

INSTALLATION AND OPERATING INSTRUCTIONS

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SECTION 1

GENERAL INFORMATION

1-1 Introduction

Chessell Model 300 is a single-pen, single-speed 4 inch (100 mm) servo recorder housed in a lockable steel case with gasket-sealed door. The Model 300 provides a choice of three writing systems (capillary ink, disposable ink cartridge or electric etch), choice of roll or z-fold chart, plus a range of over 4000 off-the-shelf input conditioning modules and matching scales. Other options include; chart speed selection, HI/LO alarms, event marker pen, re-transmission output, chart tear-off, acrylic window.

This manual contains installation, operating and basic maintenance instructions, with schematics and selected calibration procedures for the input modules. Model 300 is similar in most respects to the Model 301, for which a full Maintenance Manual (Chessell No. 124 508) is available. This manual should be referred to if more detailed information is required (especially Principles of Operation and Replaceable Parts Lists).

1-2 Model 300 specifications

Writing system Capillary ink: writing length typically 6500 ft (2000 m) each 3 ml ink capsule. Disposable ink cartridge: writing length typically 2600 ft (800 m) with chart speeds of 12 cm/hr and greater. Electric: unlimited writing length.

Chart speed One speed chosen from: 12 cm/min, 6 cm/min, 3 cm/min, 2 cm/min, 1 cm/min, 5 mm/min, 4 mm/min, 12 cm/hr, 6 cm/hr, 3 cm/hr, 2 cm/hr, 1 cm/hr, 5 mm/hr, 4 mm/hr.

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 0.5 seconds.

Servo linearity Linearity, from pen servo input to recording pen, excluding input conditioner, $\pm$ 0.2% full scale.

Pen repeatability $\pm$ 0.1% full scale.

Input conditioning module Table of specifications on page 1-2

Environment Ambient temperature, zero to +50 ^{o}C; humidity, zero to 90% non-condensing.

Power requirement 115, 220 or 240 Vac, +5%, -10%, 50 or 60 Hz, 8 VA typical.

Dimensions Diagrams, page 1-3. Weight (net): 8.8 lb (4 kg).

Finish Matte paint, dark gray.

Connectors Rear panel connectors are screw-type terminals, stud diameter 3.5 mm, for No. 6 or No. 8 spade lugs and 1/4 inch (6 mm) Faston lugs. Terminal rating: maximum voltage 500 V, maximum current 2 A.

1-3 Model 300 options

Event marker Option EVP. 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.

Re-transmission Option RSO. Linear signal, zero to 10 V full scale. Not available with 3 or 4 wire RTD or potentiometric transducer input. Maximum current available 1 mA.

Alarms Option HLL. Pair of electronic HI and LO alarms independent of the pen servo. Alarm relays are single pole/double throw; switching capability 120 V, 2 A.

Acrylic window Option PLG. For pharmaceutical and food processing applications. Acrylic substituted for glass.

Chart tear-off Option CRO. Roll chart only. Hold-down fingers are added to the cassette, and a tear-off edge is fitted to the lower edge of the door. Not available with electric writing

Input Signal Conditioning
Performance Specifications
Dedicated Single-Range Modules for 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 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	≤50 pA/°C	≤5 nA/°C	—	—	—	—	—	≤5 nA/°C [a]	—	—	—	—
Common Mode Rejection 1k Ω 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 ≅1μA.
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 or 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 5 kΩ; input signal is nominally 10 V full scale.

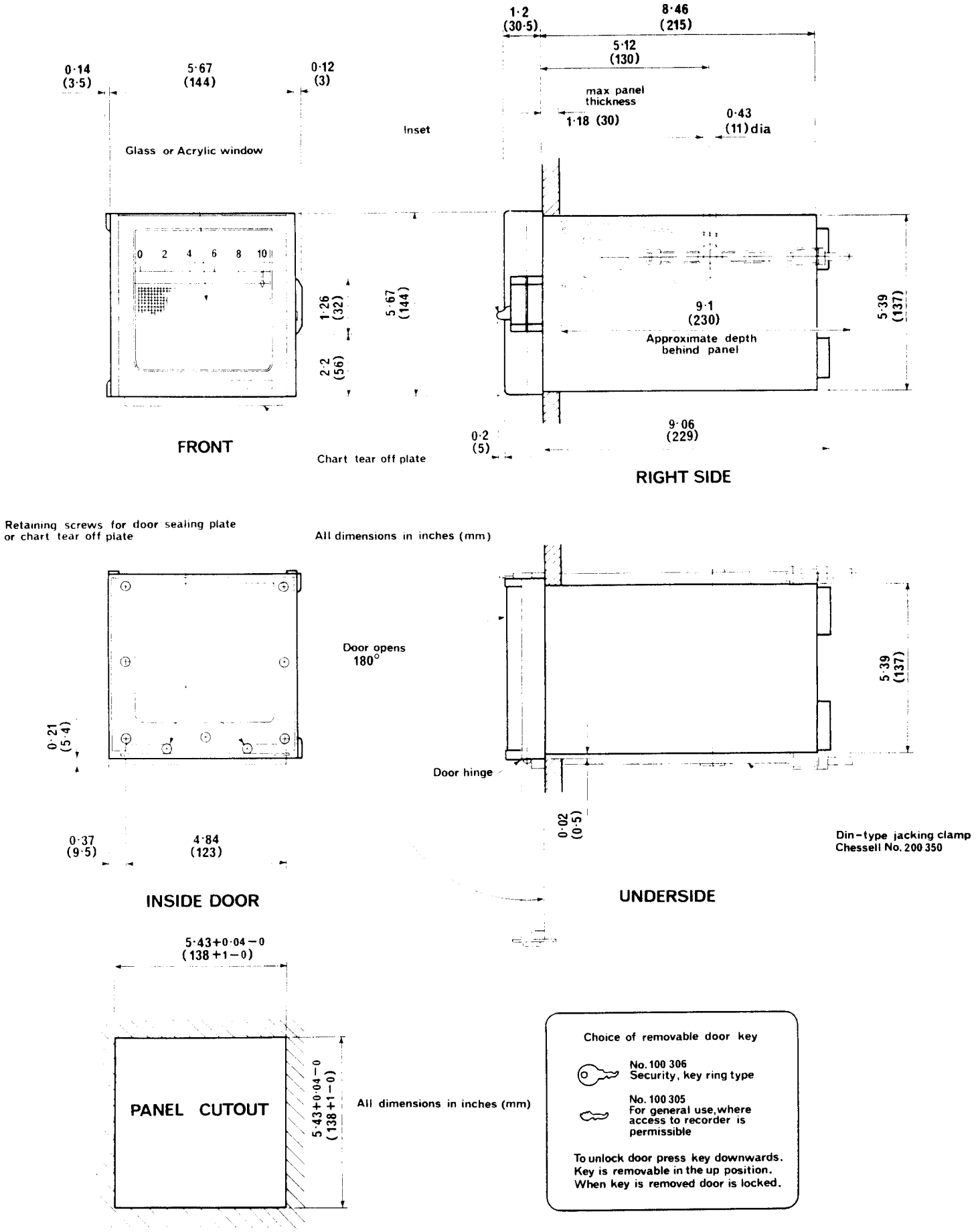


Figure 1-1 Model 300 dimensions

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 Panel installation

The Model 300 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. The panel elevation should not exceed 35 degrees, forward or back, if the instrument is fitted with a capillary pen. The instrument is secured to the panel by DIN-type jacking clamps, which are clipped into either side of the case and tightened with a screwdriver as shown in Figure 2-1.

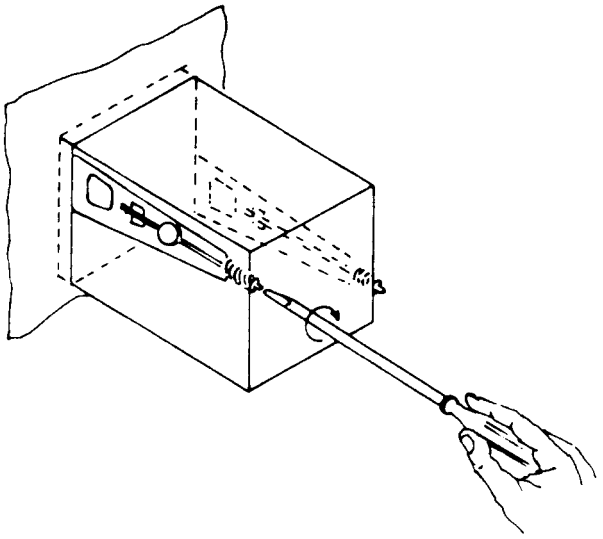


Figure 2-1 DIN-type jacking clamp
Avoid overtightening. The buffer spring should be only slightly compressed: continued rotation of the jacking screw beyond that point could distort the case.

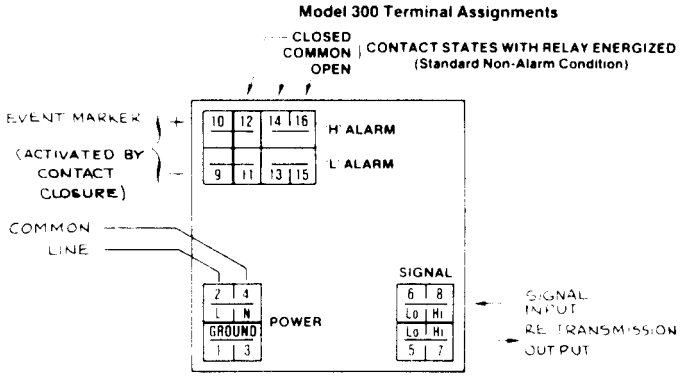


Figure 2-2 Rear terminal assignments
Includes connections for options HLL (alarms), EVP (event marker) and RSO (re-transmission).

2-4 Electrical connections

All electrical connections to the Model 300 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 panel label match the requirements of the installation.

2-5 Power 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 (page 3-2).
(3) Remove, check and replace the fuse (holder at the rear of the chassis). Fuse type Metric 5 mm diameter, 20 mm long. Slo-blo type, rating 1 A. Chessell No. 205 055.
(4) Remove the insulating cover from the power terminals, Figure 2-2, and connect wiring for the ac supply:

Line (L)	Terminal No. 2
Common (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.

2-6 Signal connections - general Signal input and re-transmission output terminals are contained in a four-way block at the right of the rear panel. The insulating cover over this block must be installed if the signal voltage is high.

Use terminal numbers 6 and 8 for most applications; 6 is low and 8 is high. The input is floating, i.e. terminal 6 is not grounded.

2-7 Small signals Check that gold-plated terminals have been installed at positions 6 and 8 if the input is a thermocouple, or dc less than 4 mV. For all low signal applications Mallory-9 Faston male lugs, No. 100 418. Matching female connector, all applications, No. 126 420. For less critical applications use nickel plated Faston male lugs, No. 200 032.

2-8 High current signals DC and ac spans up to 1 A are accommodated by a factory-installed shunt across terminals 6 and 8. For spans greater than 1 A an external shunt or current transformer is required (not supplied by Chessell).

2-9 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. The insulating cover over the transformer must be replaced.

2-10 Resistance thermometers Connections for RTD's are shown in Figures 2-3, 2-4 and 2-5. 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).

2-11 Potentiometric transducers (Figure 2-6) The 12 Vdc, 25 mA (maximum) potentiometer supply is at terminals 7 (+ve) and 6 (-ve). The end-to-end resistance of the transducer must be between 480 Ω and 5 kΩ .

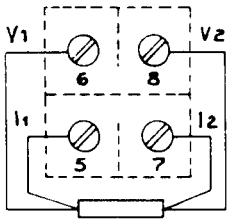


Figure 2-3
Four wire RTD

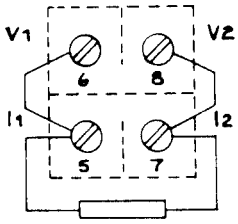


Figure 2-4
Two wire RTD

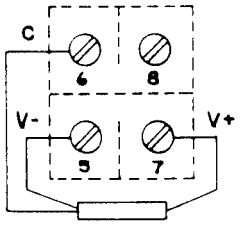


Figure 2-5
Three wire RTD

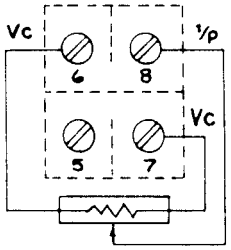


Figure 2-6
Potentiometric transducer

2-12 On-site modifications

Qualified service personnel can perform the following modifications on site:

* Exchange and adjust input module
* Exchange scale
* Change supply transformer tappings
* Exchange cassettes, e.g. roll to z-fold
* Convert from chart re-roll to chart run-out
* Change chart speed by exchanging cassette gear sets and/or motor assemblies

2-13 Input module exchange

(1) Withdraw the chassis from the case.
(2) Remove the retaining clip from the top of the two vertical printed circuit assemblies.
(3) Remove the blank white retaining strips from the four way plug at the lower right of the chassis rear panel.
(4) Remove the complete 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 (white and violet leads at top) and that the retaining strips are installed firmly.

2-14 Input module adjustments

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

2-15 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.

2-16 Power supply transformer tappings

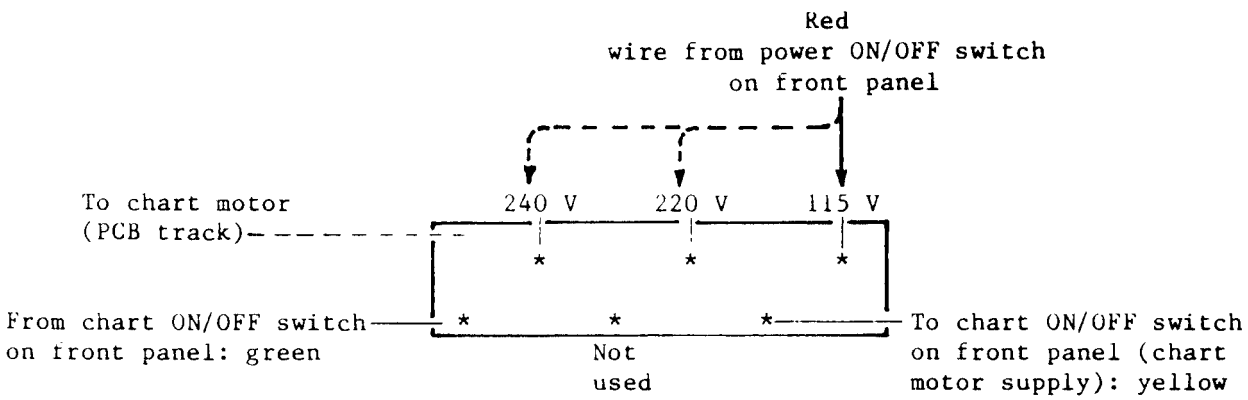


Figure 2-7 Supply transformer tappings
The asterisks indicate holes on the motherboard.

Follow this procedure carefully:

(1) Unsolder and transfer the red 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 on page 2-6.

2-17 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 platen 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.

2-18 Chart run-out (roll charts only)

In normal use, the chart is re-rolled inside the cassette, and is removed from the take-up spindle when the supply is exhausted. The Model 300 recorder offers the alternative of continuous chart run-out, with a tear-off plate installed in the lower ledge of the door. To convert the recorder for chart run-out, remove the two Philips screws from the half-round bushes inside the door, then exchange the tear-off plate (accessory supplied) for the sealing plate originally installed. Replace the two screws.

2-19 Changing chart speed

Information on the chart drive system is contained in the following three 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 2-17 above.

To remove the 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 crinkle washer and nut.)

To exchange the cassette gears, remove the screw and lock washer securing the gear cover plate to the right side of the cassette (2mm screw for roll cassette, 2.5 mm for z-fold). Detach the cover plate and install the exchange gear set as diagrammed on pages 2-8 and 2-9. 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 12 monthly inspection procedures in Section 3.

2-20 Chart drive system

Chart speed in the Model 300 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.

Two single-speed synchronous motor/gearbox assemblies are available:

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

Either motor/gearbox assembly can be used with any of the gear sets other than No. 125 242, which is for the Model 301 only.

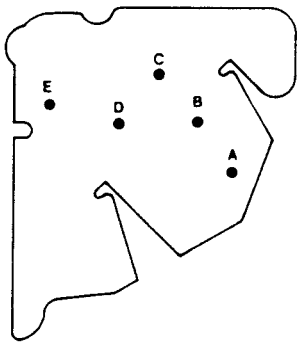
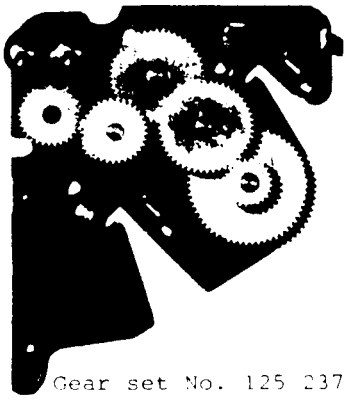
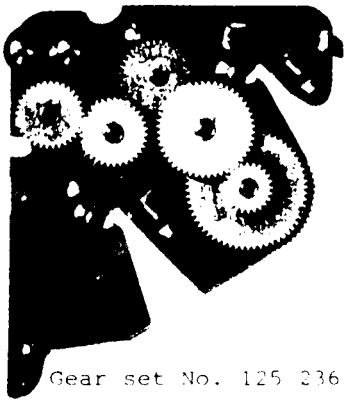


Figure 2-8 Cassette right-hand plate
Stub shafts are installed at gear positions A, B, C and D on the right-hand plate of the cassette. Gear position E is a bearing hole for the drive transfer spindle. Gear ratios in the diagrams below are overall, from the motor/gearbox output to the drive transfer spindle at E.

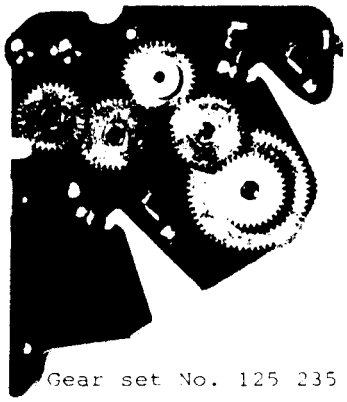

Gear set No. 125 241


Gear set No. 125 237


Gear set No. 125 240


Gear set No. 125 236


Gear set No. 125 239


Gear set No. 125 235


Gear set No. 125 238

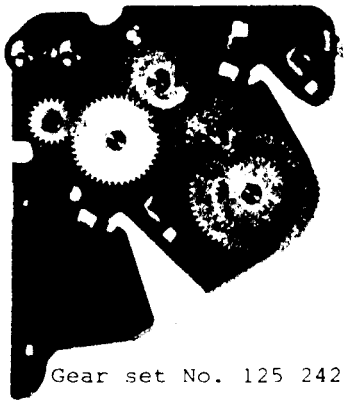

Gear set No. 125 242

Figure 2-9 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

A: G9 B: G10 C: G11 D: G2 E: G3

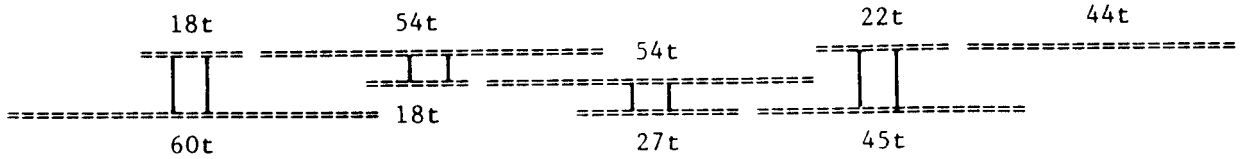


Chart speeds 5 mm/hr (120 min/cm) with M2 and 5 mm/min (120 sec/cm) with M1
Gear set No. 125 240 Ratio 24:1

A: G9 B: G12 C: G14 D: G15 E: G3

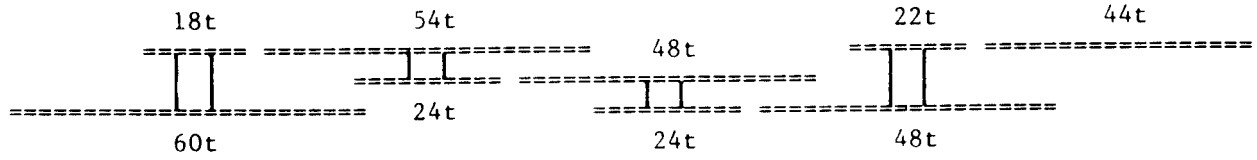


Chart speeds 1 cm/hr (60 min/cm) with M2 and 1 cm/min (60 sec/cm) with M1
Gear set No. 125 239 Ratio 12:1

A: G9 B: G12 C: G14 D: G13 E: G4

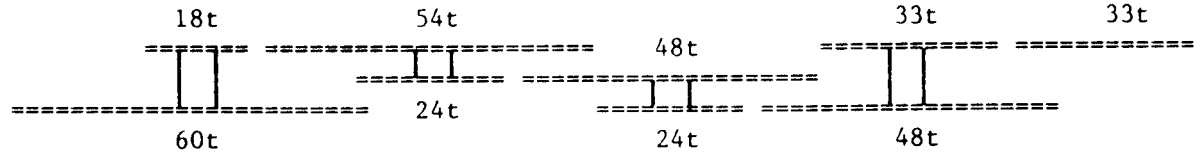


Chart speeds 2 cm/hr (30 min/cm) with M2 and 2 cm/min (30 sec/cm) with M1
Gear set No. 125 238 Ratio 6:1

A: G9 B: G12 C: G8 D: G7 E: G4

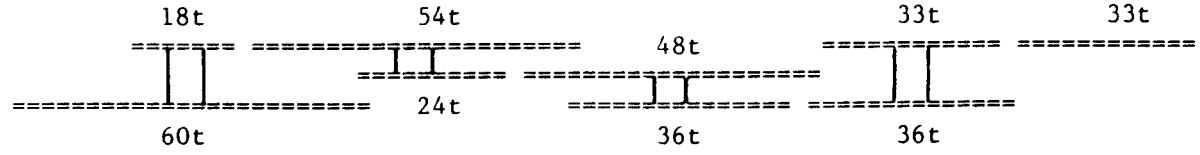


Chart speeds 3 cm/hr (20 min/cm) with M2 and 3 cm/min (20 sec/cm) with M1
Gear set No. 125 237 Ratio 4:1

A: G6 B: G14 C: G8 D: G7 E: G4

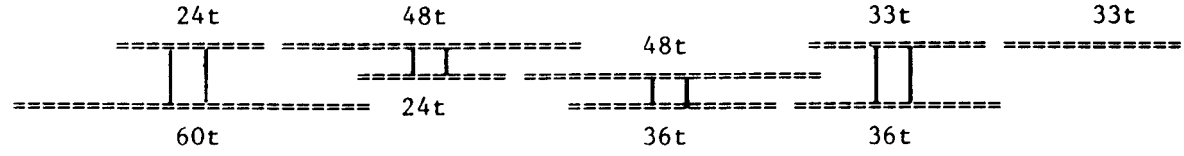


Chart speeds 6 cm/hr (10 min/cm) with M2 and 6 cm/min (10 sec/cm) with M1
Gear set No. 125 236 Ratio 2:1

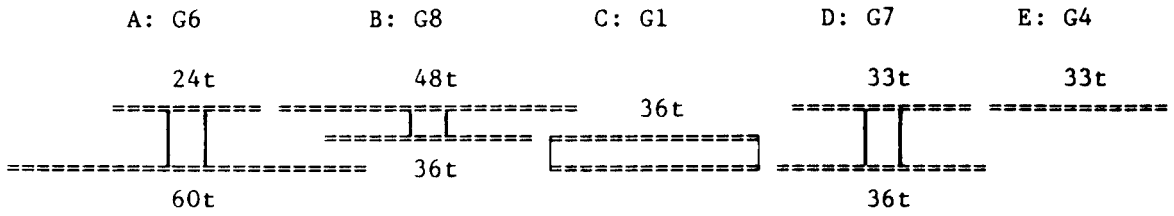
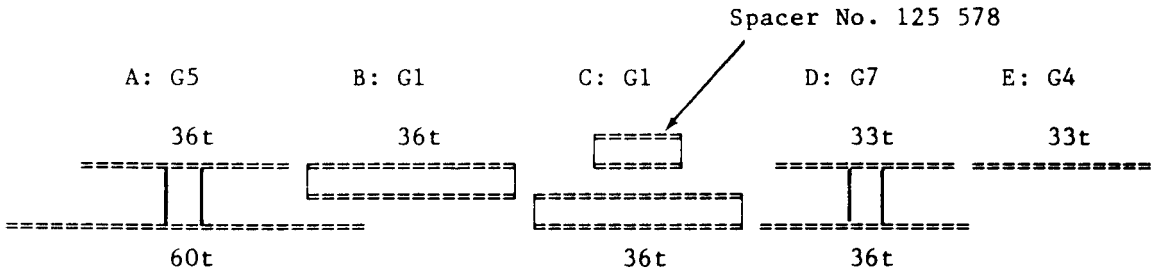


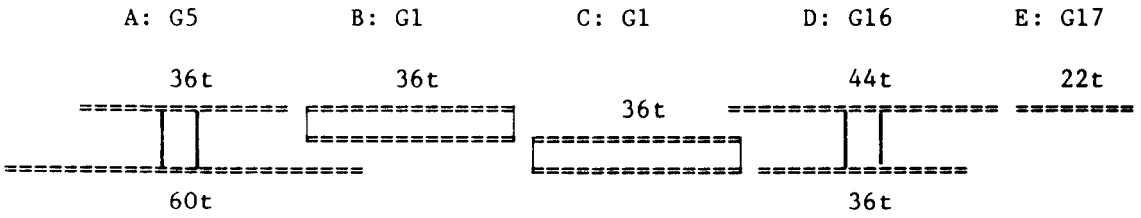
Chart speeds 12 cm/hr (5 min/cm) with M2 and 12 cm/min (5 sec/cm).with M1. Also for Model 301 with M3 (option EGLS)

Gear set No. 125 235 Ratio 1:1



Following is for Model 301, only, with M4 (option EGHS)

Gear set No. 125 242 Ratio 1:2



Replacement gears

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

2-21 Installation of disposable ink cartridge conversion kit

Kit No. 200 306 contains the components needed to convert a capillary ink writing Model 300 to accept the disposable ink cartridge. The kit includes a cartridge holder of the style fitted from January 1981 onward (slimmer than the former type).

Replacement cartridges for the later style of cartridge holder should be ordered by part numbers as follows:

No. 125 431	Blue (as supplied with conversion kit)
No. 126 851	Red

(1) Remove the chart cassette, then withdraw the recorder chassis from the case.

(2) Remove all capillary tubing, the ink capsule carrier, priming bulb and related fitments.

(3) Turn the recorder chassis upside down; then move the white molded plastic pen block to the side away from the chart drive motor. Remove the 2 x 3 mm screw and washer securing the capillary pen arm to the pen block.

(4) Install the cartridge holder in place of the capillary pen arm. The fore-aft position of the holder is not important provided the pen tip, with the cartridge installed, points toward the axis of the sprocket roller, i.e. the pen tip should be radial with respect to the roller axis, and there should be clearance between the pointer and the scale plate.

(5) Install a blanking grommet in place of the priming bulb.

(6) With the recorder in the upright position, install a loaded chart cassette; then check the pen tip pressure with a force gauge calibrated from zero to 15 grams (Correx gauge available from Chessell, No. 208 520). Check the pressure by placing 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 2-10).

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.

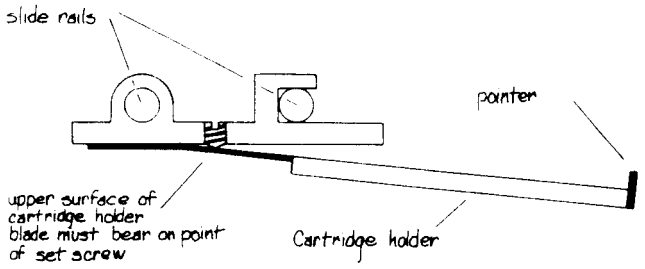


Figure 2-10 Cartridge pressure adjustment

SECTION 3

OPERATION AND MAINTENANCE

3-1 Cassette removal

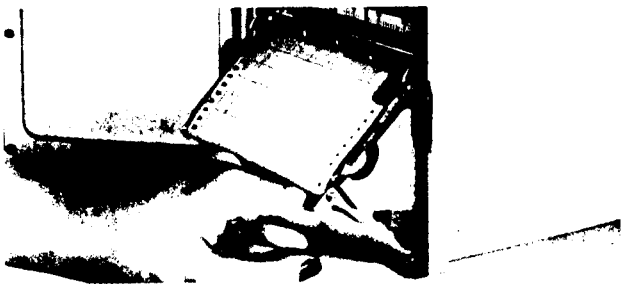


Figure 3-1 Free the cassette
Depress the latch at the bottom right corner of the recorder.

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 platen 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.

Figure 3-4 Install the feed roller
Insert the feed roller into the cassette with the flange on the left. Be sure that pins on both ends of the roller click into the bearing slots and are held firm by the springs.

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 pass it under the tie bar and over the sprocket roller; swing the chart 'fingers' 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.)

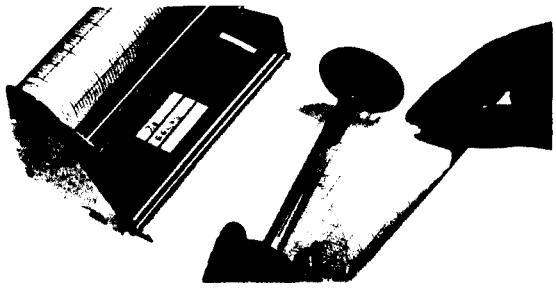


Figure 3-6 Prime the take-up roller
Again re-position the cassette with the platen face down and the take-up roller facing forward. By folding or cutting into a V-shape, prepare the chart for insertion into the slotted roller with the printed side up. If desired the take-up roller may be unclipped to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

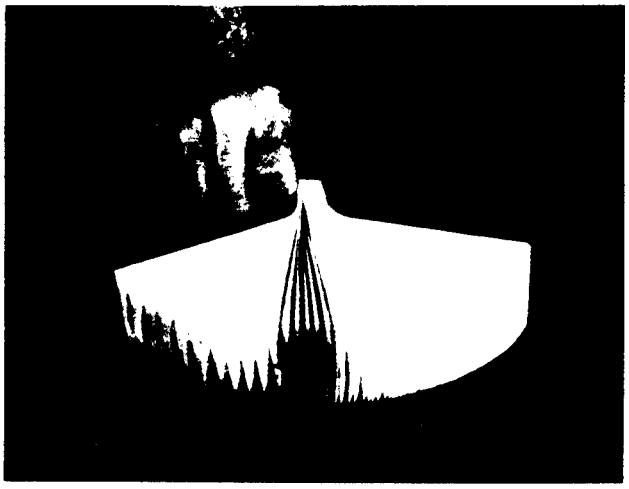


Figure 3-7 Prepare the z-fold chart
Place the z-fold chart on a flat surface and check that the edges are square and smooth; if not, the chart should be rejected. To ensure that the chart leaves will separate freely when feeding through the cassette, hold the chart as shown and gently move the hand from 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.

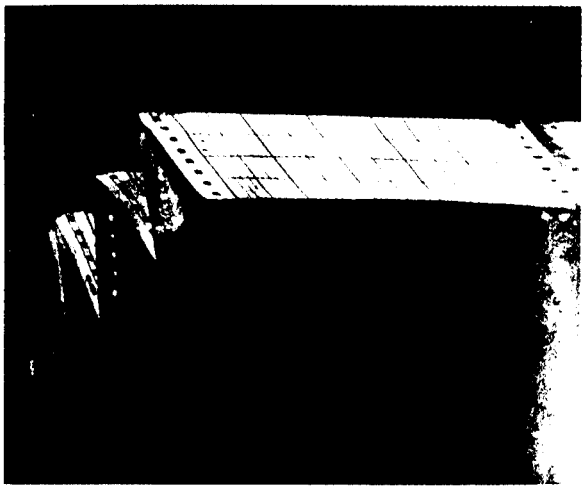


Figure 3-8 Check orientation of chart
Position the chart with the red finishing line face down. The top leaf should be printed side upward; if not, remove the first 4 cm leaf to expose the next printed surface. Unfold the first few leaves of the chart.

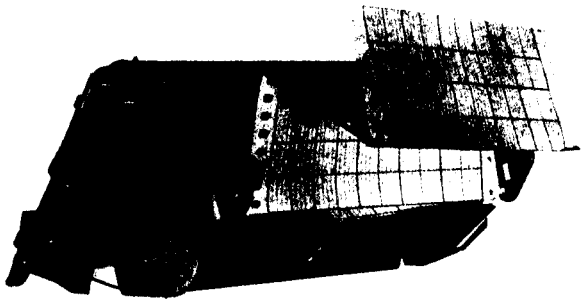


Figure 3-9 Load the feed tray
Place the cassette on a flat surface with the platen face down and the sprocket roller facing forward. Load the chart into the feed tray with the printed side face up. Be sure the chart is seated squarely.

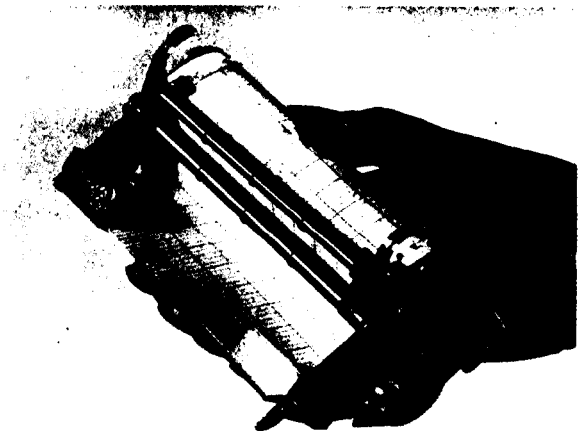


Figure 3-10 Over sprockets, under bars
Re-position the cassette with the guide bars facing forward. Swing the chart 'finger' and guide bar assembly forward, engage the chart squarely on the sprocket return the chart fingers to their normal operating position.

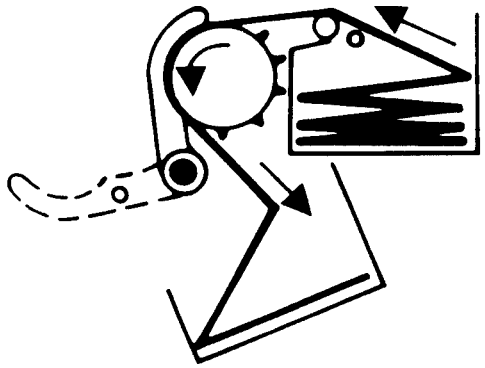


Figure 3-11 Check the paper feed
Check for correct operation by clockwise rotation of the first gear in the drive train, i.e. the gear which meshes with the chart drive motor. Be sure the paper folds are exactly as shown in this illustration; if they are reversed, the paper will not stack correctly in 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 35 degrees from the horizontal can cause ink leakage. If the instrument is to be shipped the ink capsule 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 1/8th inch cavity at one end of the capsule. Do not attempt to install the capsule on the dip tube without first perforating the diaphragm.

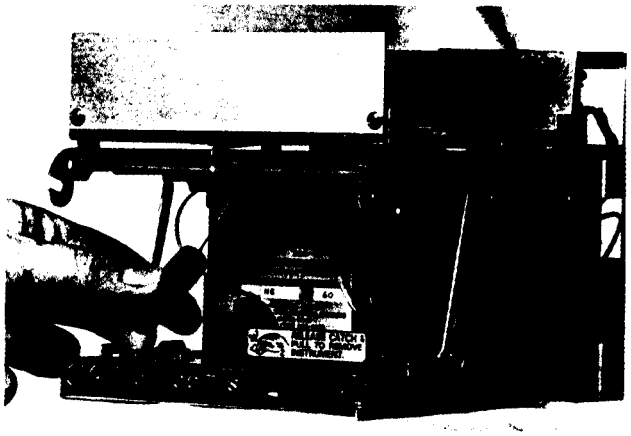


Figure 3-13 Install the ink capsule
Remove the chart cassette. Pivot the ink carrier assembly forward, pass the ink capsule over the dip tube, then press the capsule firmly into place on the dip tube shoulder; a twisting motion helps ensure a leakproof fit. Do not squeeze the capsule, and do not allow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

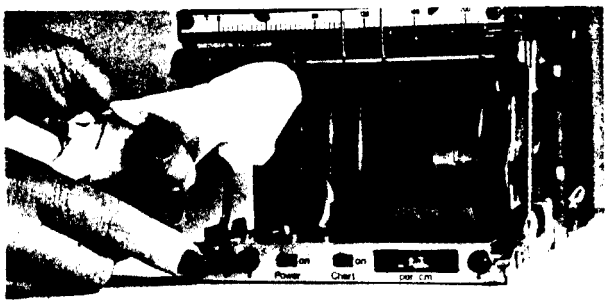


Figure 3-14 Priming the ink system
While covering the air inlet with the finger, compress the priming bulb (push, don't squeeze); then release the bulb completely. Repeat this pumping action until ink appears at the pen tip. Remove surplus ink with tissue, then replace the chart cassette.

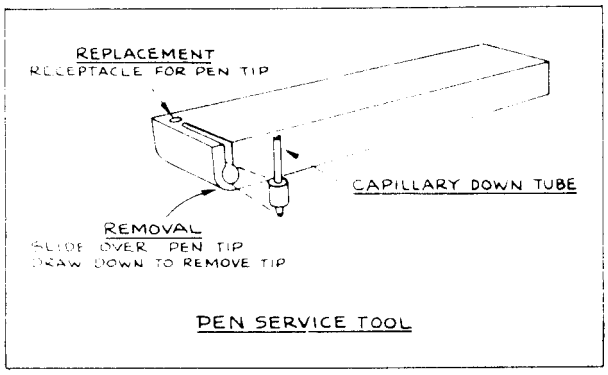


Figure 3-15 Pen tip replacement
Line width increases with pen wear. If the line becomes unacceptably wide, remove the chart cassette and gently pull the pen tip away from the pen tube. Install a fresh tip, ensuring that the metal tube touches the tip fibers. Be sure not to distort the pen assembly during this operation. Installation of the pen tip is facilitated by the Pen Service Tool, No. 123 218.

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 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, re-assemble 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

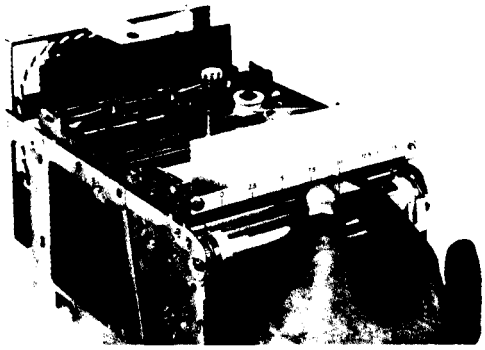


Figure 3-17 Installing the pen cartridge
Remove the protective cap from the pen tip, and the sealing plug (if fitted) from the rear of the cartridge. If no sealing plug is fitted, and only if so directed in the instructions supplied with the cartridge, pierce a small hole at the rear of the cartridge. 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.

Disposable ink/pen cartridge (continued)

The cartridge style may differ from that shown. On units shipped from the USA plant before January 1981, the cartridge is a larger (typically white) molding, and the holder is a blade type as opposed to the box style in later models.

For pre-1981 models, replacement cartridges are:

Blue	No. 200 015
Red	No. 200 016
Green	No. 200 017
Black	No. 200 018

For recorders with serial numbers starting 81 and up, replacement cartridges are:

Blue	No. 125 431
Red	No. 126 851

3-7 Conversion from capillary ink to disposable pen cartridge

This conversion can be performed on site, if desired. Details in Section 2.

3-8 Operation of the recorder

Power on With the input signal and ac supply 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; this should be 1 revolution in either 15 seconds or 15 minutes, depending on the range of chart speeds selected. 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 signal span for which the recorder was calibrated at the factory (label on rear panel of the recorder).

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 signs of hardening.
(3) Clean the viewing window.

Twelve month inspection

(1) Complete the six month inspection outlined above, then remove the pen servo tray and chart cassette for cleaning as follows:

(2) Pen servo tray

(i) Unscrew the knurled nut from the post at the center of the pen servo tray, remove the two spacing collars, 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 isopropryl 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 this 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 the 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 traces of dust.
(v) Lubricate all bearings with a minute quantity of Nye PML 163 or other 'non-migrating' lubricating oil, applied very carefully with an eye dropper or tooth pick. Do not lubricate the take-up roller clutch or the 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 showing 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 from 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 described on page 2-10. The pen pressure must be between 5 and 7 grams (9 to 10 grams for the pre-1981 disposable cartridge when used with Z-fold chart).

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 ins (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 too high, gently stretch the spring; if too 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 fore and aft.
(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 3-18, from vertical shaft #2; then remove the circlip #3 from the phosphor bronze outer shaft #4.

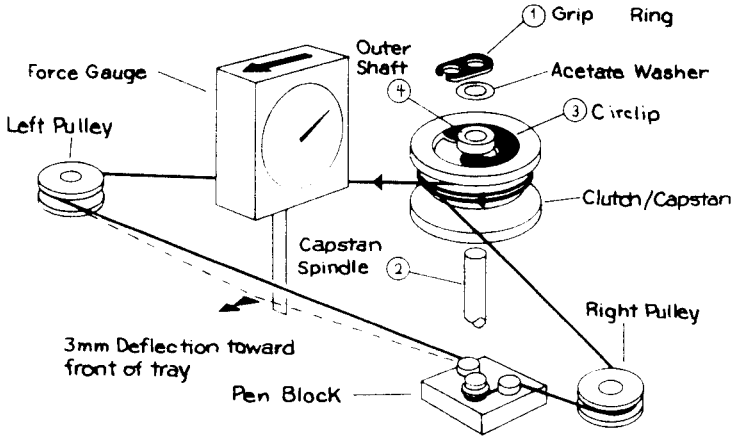


Figure 3-18 Servo drive cord installation

(5) Construct a measuring jig by tapping two panel pins 8.25 ins (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 ins (420 mm) total length. Cut off the surplus cord and seal the knot with quick drying varnish.
(6) 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.
(7) 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.
(8) Hold the pen tray with the scale plate forward. With the hole in the capstan facing the scale plate, wind the left hand half of the cord loop three times clockwise round the capstan, and then round left hand pulley, Figure 3-18. Run the other half of the cord loop round the right hand pulley.
(9) 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.
(10) 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.
(11) Cord tension is checked with a force gauge calibrated from zero to 15 grams, such as Correx (available from 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.
(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

SCHEMATICS AND CALIBRATION PROCEDURES

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

Pen Drive
No. 1002 Pen drive module

Electric Writing
No. 1026 Electric writing module

Alarms
Low alarm comparator
High alarm comparator

Wiring Information
Model 301 chassis schematic

Construction
Pen tray
Roll cassette
Z-fold cassette

Part number conversion
U.S.A. and European equivalents

Calibration Procedures
Re-calibration of a Model 300 recorder should always be checked in the following sequence: (1) Input module (2) Pen drive module (3) Alignment of feedback element (4) Scale alignment.

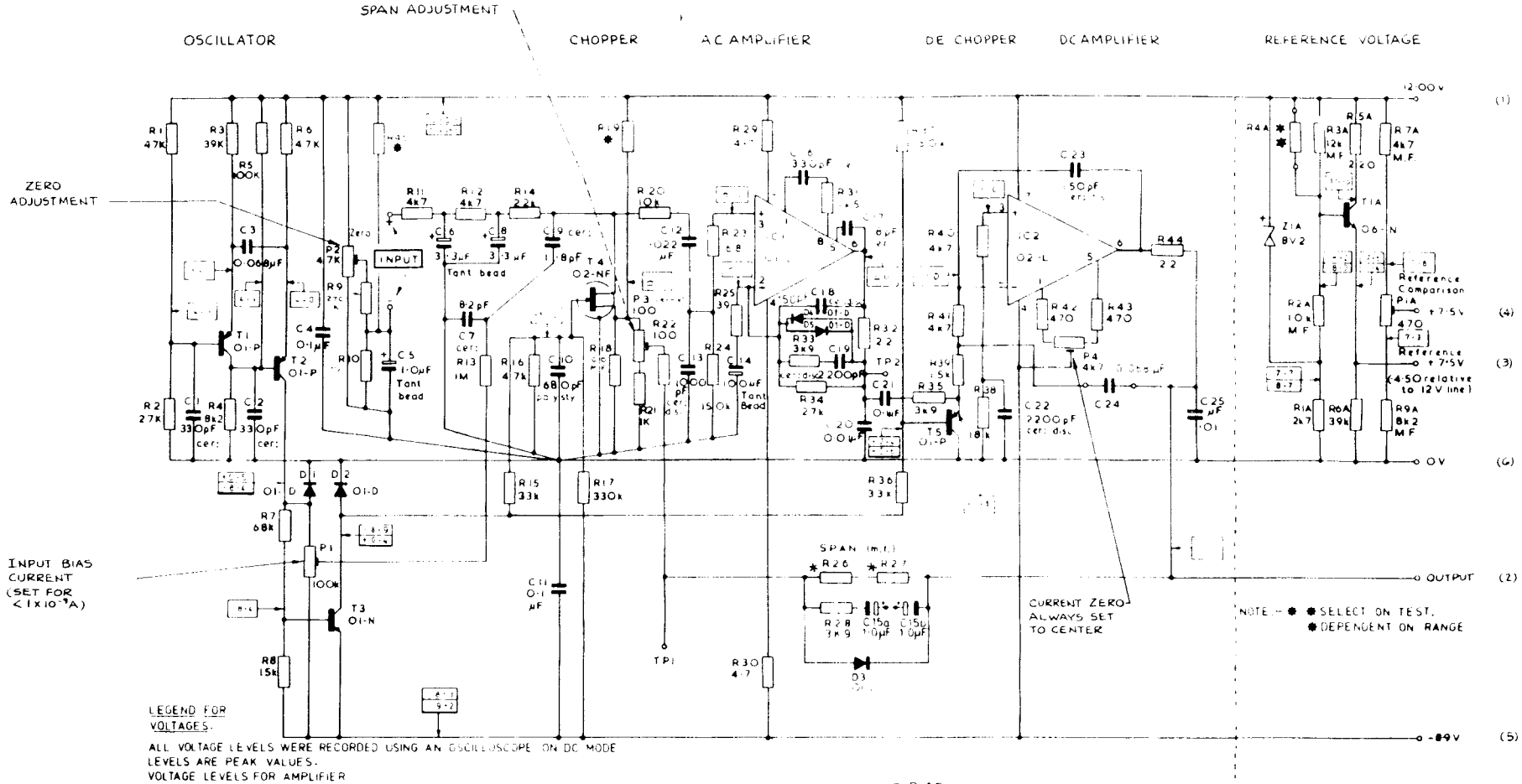
Model 300 input conditioning modules are characterized at the factory to match the user's original signal specifications. For users wishing to modify recorders in the field, component selection procedures are given for the three commonly encountered linear ac and dc modules, Nos. 1018, 1020 and 1025.

ESSENTIAL for input modules...Before any calibration procedure, always check the 12 Vdc reference supply at the input module; permissible range is ± 10 mV, adjusted by P1A.

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 conn- *
* ected; this is because there is no isolation between *
* the input signal and internal circuit components, *
* including the potentiometric feedback element. *
****



LEGEND FOR VOLTAGES.

ALL VOLTAGE LEVELS WERE RECORDED USING AN OSCILLOSCOPE ON DC MODE
LEVELS ARE PEAK VALUES.
VOLTAGE LEVELS FOR AMPLIFIER OUTPUT BALANCED AT 0V

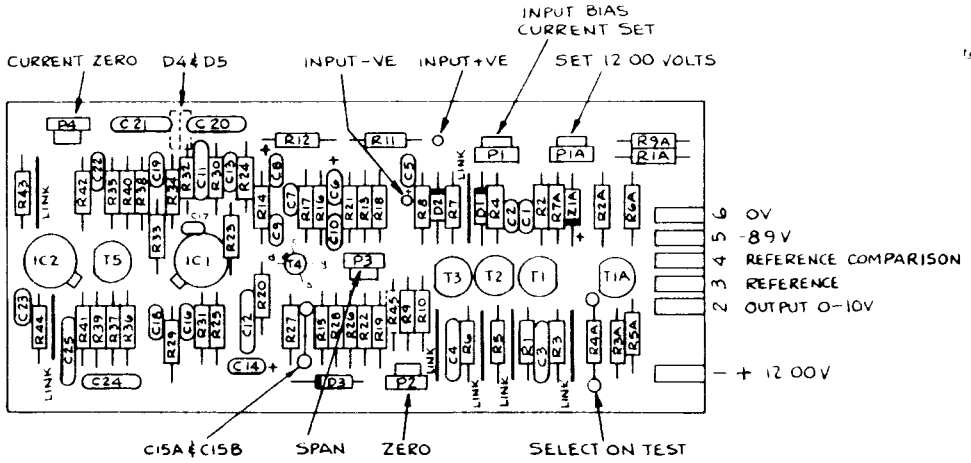
VOLTAGE LEVELS FOR BALANCED CONDITIONS.

VOLTAGE LEVEL LIMITS FOR WAVEFORMS.

SPREADS IN LEVELS DUE TO KNOWN TOLERANCES.

VOLTAGE LEVELS SPECIFIED COULD BE APPROXIMATELY ±1·0 V DIFFERENT IN SOME PLACES DUE TO COMPONENT TOLERANCES.

ALL VOLTAGES WITH RESPECT TO COMMON (0V) LINE.



NOTE RESISTORS IN OHMS - TYPE CARBON
CAPACITORS IN MICROFARADS - TYPE POLYESTER
POTENTIOMETERS IN OHMS - TYPE CARBON
UNLESS OTHERWISE STATED

High Impedance D.C. Amplifier 1018

DC INPUT MODULE No. 1018

Range component selection procedures

The following are fitted for all spans < 4 mV:

R9 270K carbon 5%, R10 10R 1/2% 50 ppm metal film, R18 100R 1/2% 50 ppm metal film, P3 100R Cermet, R21 1K carbon 5%.

End zero signal ranges: R45 is not fitted, R19 is 4M7 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:

$\text{Span}/V_E \times 50$ 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 the 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:

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

$V_E = V_A - V_Z$

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

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 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.

Procedure

(1) Check the seal on P4 (current zero); 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% 50ppm metal film resistor across the terminals, then measure the voltage across 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 ±10mV 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 ±10mV between connector pins 6 (0V) and 2 (output).

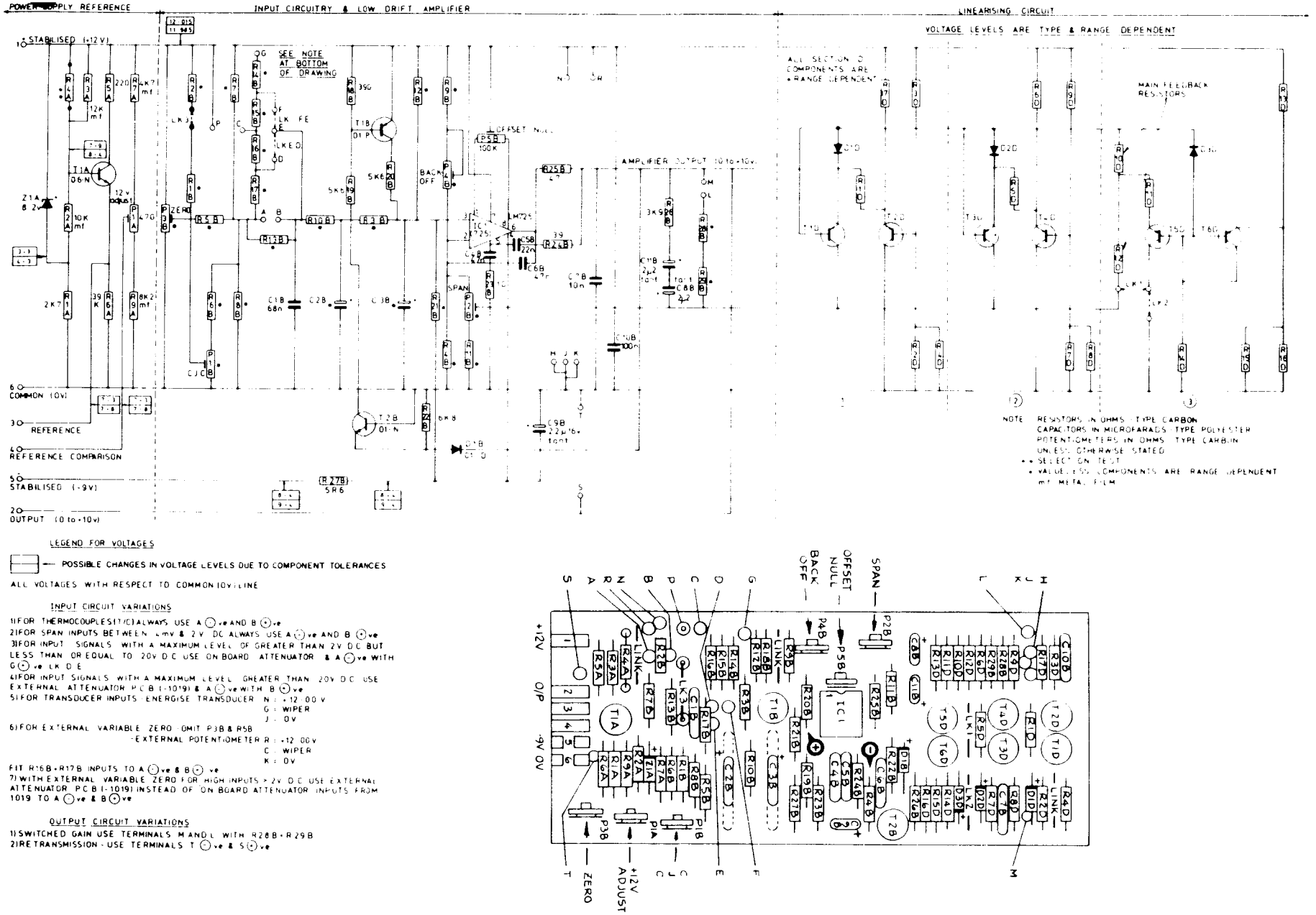
(5) Apply low and high scale inputs once more checking that the respective outputs are 0 and 10 volts ±10mV. If not, slight re-adjustment of P2 and P3 will correct.

(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.



LEGEND FOR VOLTAGES

— POSSIBLE CHANGES IN VOLTAGE LEVELS DUE TO COMPONENT TOLERANCES

ALL VOLTAGES WITH RESPECT TO COMMON (0V) LINE

INPUT CIRCUIT VARIATIONS

1) FOR THERMOCOUPLES (T/C) ALWAYS USE A (-) ve AND B (+) ve
2) FOR SPAN INPUTS BETWEEN 4mV & 2V DC ALWAYS USE A (-) ve AND B (+) ve
3) FOR INPUT SIGNALS WITH A MAXIMUM LEVEL OF GREATER THAN 2V D.C BUT LESS THAN OR EQUAL TO 20V D.C USE ON BOARD ATTENUATOR & A (-) ve WITH G (+) ve LK D E
4) FOR INPUT SIGNALS WITH A MAXIMUM LEVEL GREATER THAN 20V D.C USE EXTERNAL ATTENUATOR P.C.B (1-1019) & A (-) ve WITH B (+) ve
5) FOR TRANSDUCER INPUTS - ENERGISE TRANSDUCER N : +12.00 V
G : WIPER
J : 0V
6) FOR EXTERNAL VARIABLE ZERO - OMIT P3B & R5B
- EXTERNAL POTENTIOMETER R : +12.00V
C : WIPER
K : 0V
FIT R16B • R17B INPUTS TO A (-) ve & B (+) ve
7) WITH EXTERNAL VARIABLE ZERO FOR HIGH INPUTS > 2V D.C USE EXTERNAL ATTENUATOR P.C.B (1-1019) INSTEAD OF ON BOARD ATTENUATOR INPUTS FROM 1019 TO A (-) ve & B (+) ve

OUTPUT CIRCUIT VARIATIONS

1) SWITCHED GAIN USE TERMINALS M AND L WITH R28B • R29B
2) RE TRANSMISSION - USE TERMINALS T (-) ve & S (+) ve

D.C. Amplifier for mA, mV, V and Thermocouples 1025

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	47R	270K	10R	33R	470R	47R	22K	1000 uF 5 V	0.917
1	100R	270K	22R	68R	1K	100R	22K	470 uF 5 V	0.916
2	220R	270K	47R	150R	2K2	220R	22K	220 uF 25 V	0.914
3	470R	270K	100R	330R	4K7	470R	22K	100 uF 25 V	0.911
4	1K	270K	220R	680R	10K	1K	22K	50 uF 25 V	0.906
5	2K2	270K	470R	1K5	22K	2K2	22K	22 uF 25 V	0.892
6	4K7	270K	1K	3K3	47K	4K7	22K	10 uF 25 V	0.864
7	10K	270K	2K2	6K8	47K	4K7	22K	4.7 uF 25 V	-
8	10K	270K	2K2	Link	47K	4K7	22K	0.1 uF 100 V	-

* Metal film 1/2%, 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 uF, metalized film). C3B is not normally fitted.

End-zero signal ranges: P4B is a wire link, R7B is not fitted, and R9B is always 2M2 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, 1/2%, 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 scale 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:

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

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:

$$C = \frac{(1/2\ P2B + R')}{R4B + 1/2\ P2B + R'} \quad \text{where } R' = \frac{(1/2\ P2B + R11B) \times (R10D + R12D)}{1/2\ P2B + R11B + R10D + R12D}$$

The ideal value of (R9B + 1/2 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 + 1/2 P4B)

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 + 1/2 P4B).

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.

$$V_Z = V_O \text{ in mV} + \frac{6{,}000 \times R8B}{R5B + R8B}$$

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

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:

$$C = \frac{(1/2\ P2B + R')}{R4B + 1/2\ P2B + R'} \quad \text{where } R' = \frac{(1/2\ P2B + R11B) \times (R10D + R12D)}{1/2\ P2B + R11B + R10D + R12D}$$

The ideal value of (R9B + 1/2 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 + 1/2 P4B)

Up-scale offset (continued)

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 + 1/2 P4B).

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 P4B.

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

V_A is in mV if the resistor values are in ohms

$$V_E = V_A - V_Z$$

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

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, 1/2%, 50 ppm metal film)

$$R_T = (R14B + R15B + R16B) = (\text{Span in volts} - 2V) \times 100K$$

The combined resistor value R_T is in kΩ. For R14B, select the preferred 1/2% 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:

$$V_O = \left(\frac{R17B}{R14B + R15B + R16B + R17B}\right) \times V_U$$

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

(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 ±10mV between pins 6 (0V) and 2 (output). Adjust P5B for 0V ±20µV between IC1 inputs, accessible at R4B (-) and R20B (+).

(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 (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 high scale (most positive) input to the input terminals and adjust P2B (span) for 10.0V ±10 mV between connector pins 6 (0V) 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 neccessary; 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 neccessary slacken the scale retaining screws and slide the scale to aadjust.

(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 spec-

ific 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 ±10mV 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 modul should be protected from large temperature variations.

(1) Remove link LK3, if fitted, then solder a 10kΩ 1% 50ppm 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 ±10mV. 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 1.933mV.

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

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

(6) Remove the 10 kΩ 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.

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 1/2%, 50 ppm metal film.

Resistors R18, R19, R20, R21, R22 and P1 are not required for end-zero ranges. R17 is 470K, metal film, 1/2%, 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 give 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 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.

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.

Procedure

(1) Adjust zero as follows:

Apply the low scale (smallest) input voltage to the input terminals and adjust P2 (zero) for 0.0V $\pm$10mV between connector pins 6 (0V) and 2 (output). If P1 (coarse zero) is fitted, first center P2 and adjust P1 for 0.0V $\pm$100mV; 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 ±10mV between connector pins 6 (0V) and 2 (output).

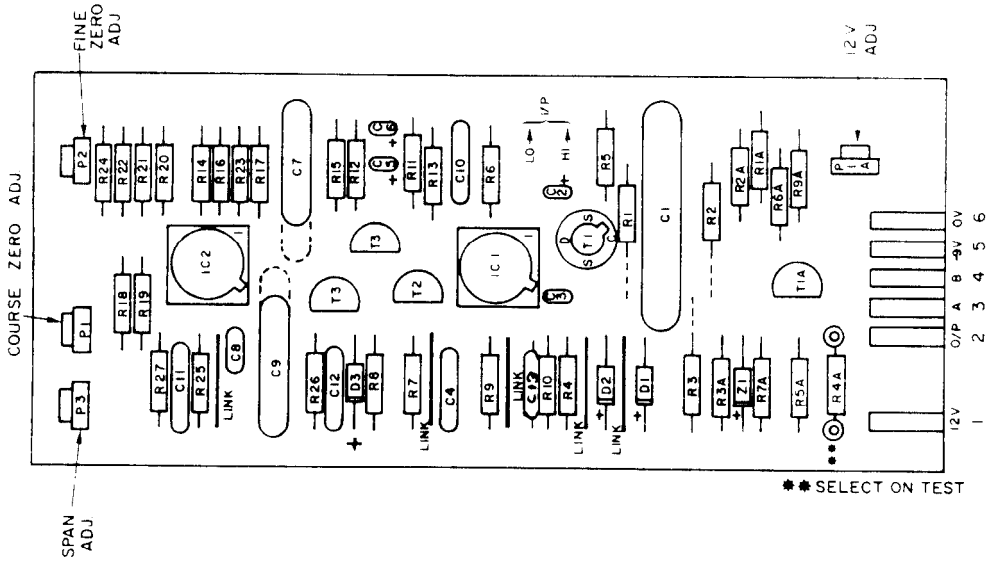
(3) Apply low and high scale inputs once more checking that the respective outputs are 0 and 10 volts ±10mV. If not, slight re-adjustment of P2 and P3 will correct.

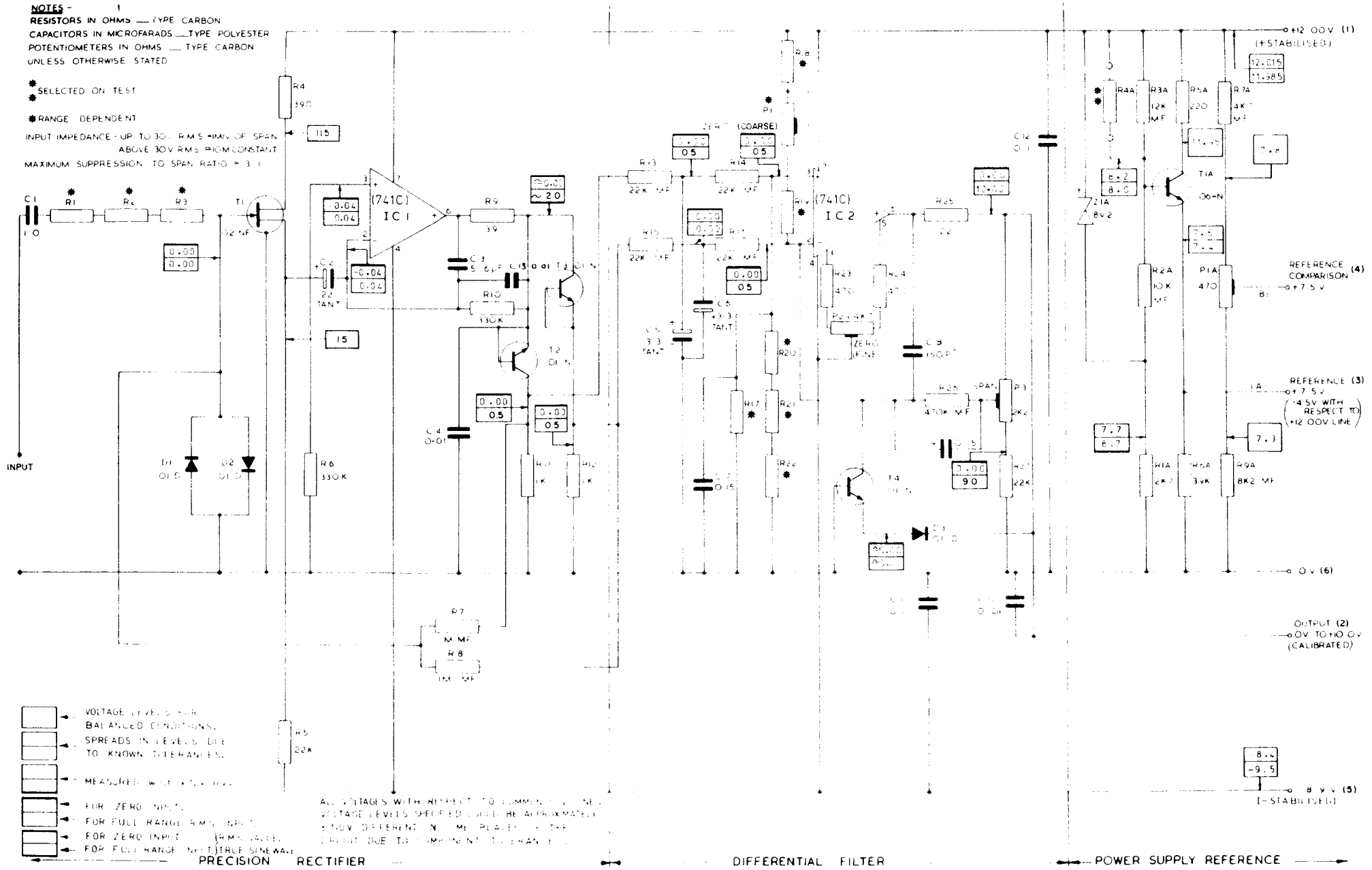
(4) Check the mechanical zero, i.e. pen position in relation to the zero grid line on the chart, with the input signal at low scale value. Adjust the slide film position screw if neccessary. Tapping the pen tray lightly during this operation will assist in overcoming drag between paper and pen tip.

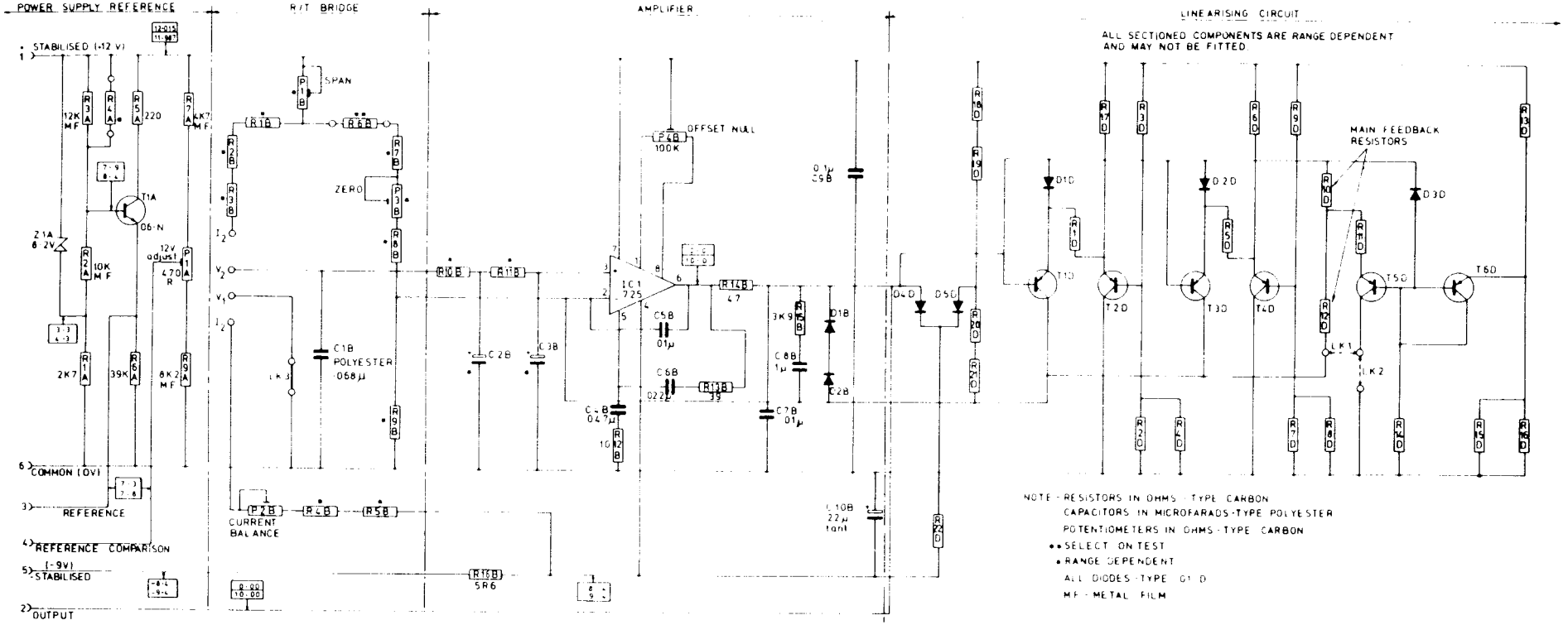
(5) Check the pointer position at low scale taking care to avoid parallax errors. If neccessary slacken the scale retaining screws and slide the scale to achieve an acceptable reading.

(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 extreme 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, or if the instrument has been dis-assembled, these factors must be corrected before starting the calibration procedure.




NOTES -
RESISTORS IN OHMS — TYPE CARBON
CAPACITORS IN MICROFARADS — TYPE POLYESTER
POTENTIOMETERS IN OHMS — TYPE CARBON
UNLESS OTHERWISE STATED
* SELECTED ON TEST
* RANGE DEPENDENT
INPUT IMPEDANCE - UP TO 30V RMS = 1MV OF SPAN
ABOVE 30V RMS = 10M CONSTANT
MAXIMUM SUPPRESSION TO SPAN RATIO = 3:1
INPUT
(741C) IC1
(741C) IC2
(COARSE)
+12.00V (1)
(+STABILISED)
REFERENCE COMPARISON (4)
+7.5V
REFERENCE (3)
+7.5V
(-4.5V WITH RESPECT TO +12.00V LINE)
0V (6)
OUTPUT (2)
0V TO +10.0V
(CALIBRATED)
8.9V (5)
(-STABILISED)
VOLTAGE LEVELS FOR BALANCED CONDITIONS.
SPREADS IN LEVELS DUE TO KNOWN TOLERANCES.
FOR ZERO INPUT
FOR FULL RANGE RMS INPUT
FOR ZERO INPUT
FOR FULL RANGE NEGATIVE SINEWAVE
PRECISION RECTIFIER
DIFFERENTIAL FILTER
POWER SUPPLY REFERENCE

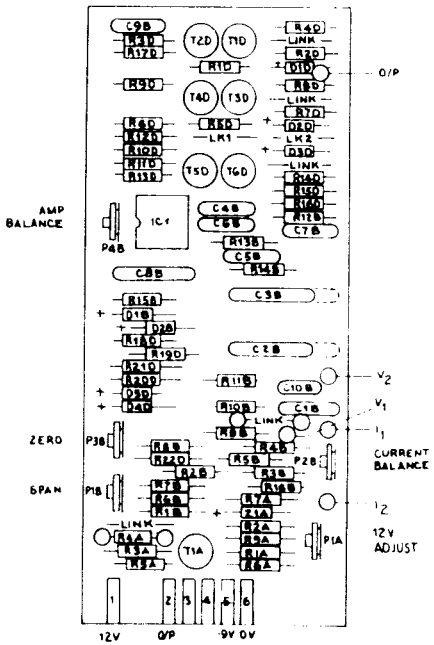


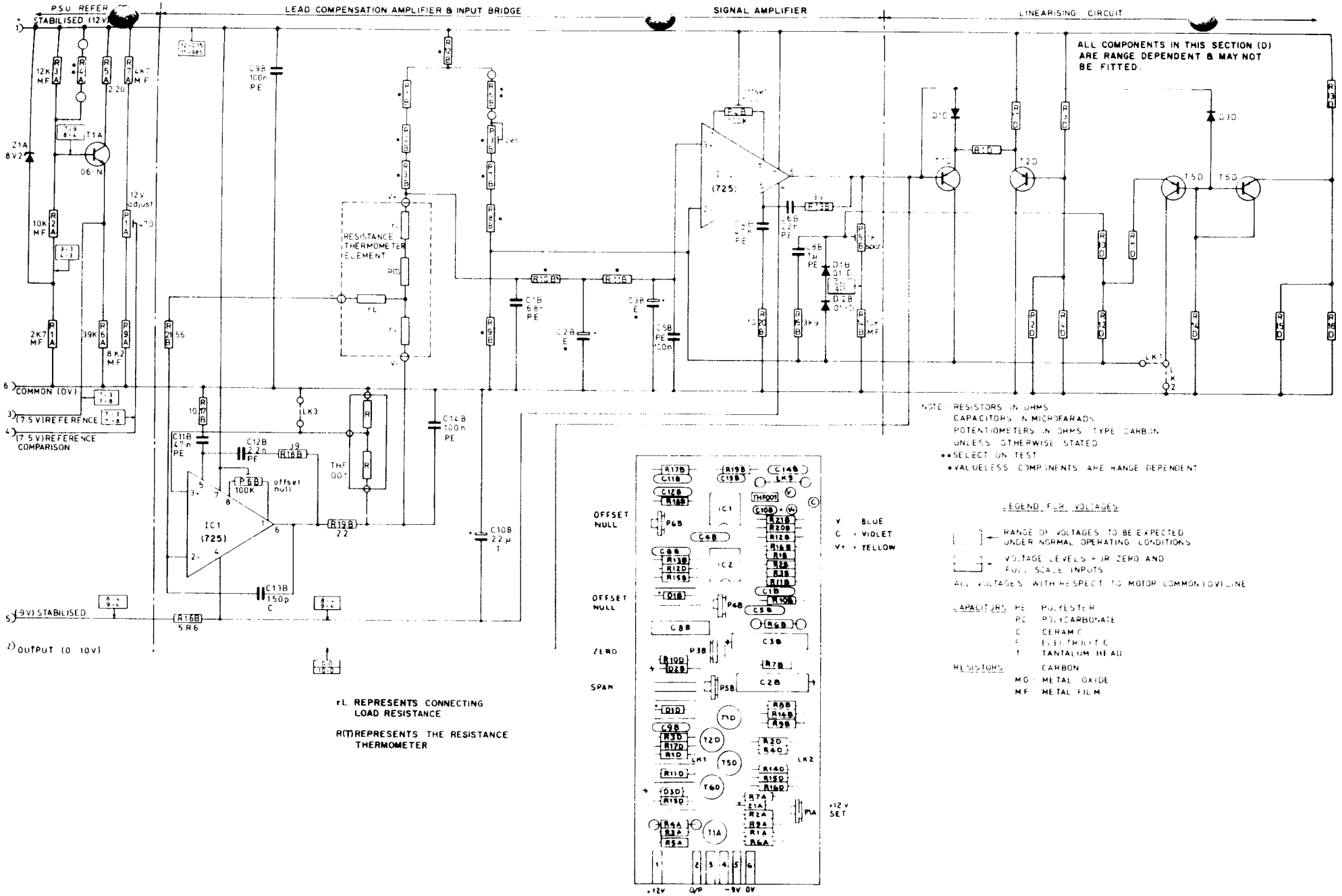
LEGEND FOR VOLTAGES

RANGE OF VOLTAGES TO BE EXPECTED UNDER NORMAL OPERATING CONDITIONS

VOLTAGE LEVELS FOR ZERO AND FULL SCALE INPUTS

ALL VOLTAGES WITH RESPECT TO COMMON (0V) LINE





Resistance Thermometer Input Amplifier (3-Wire) 1023

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.

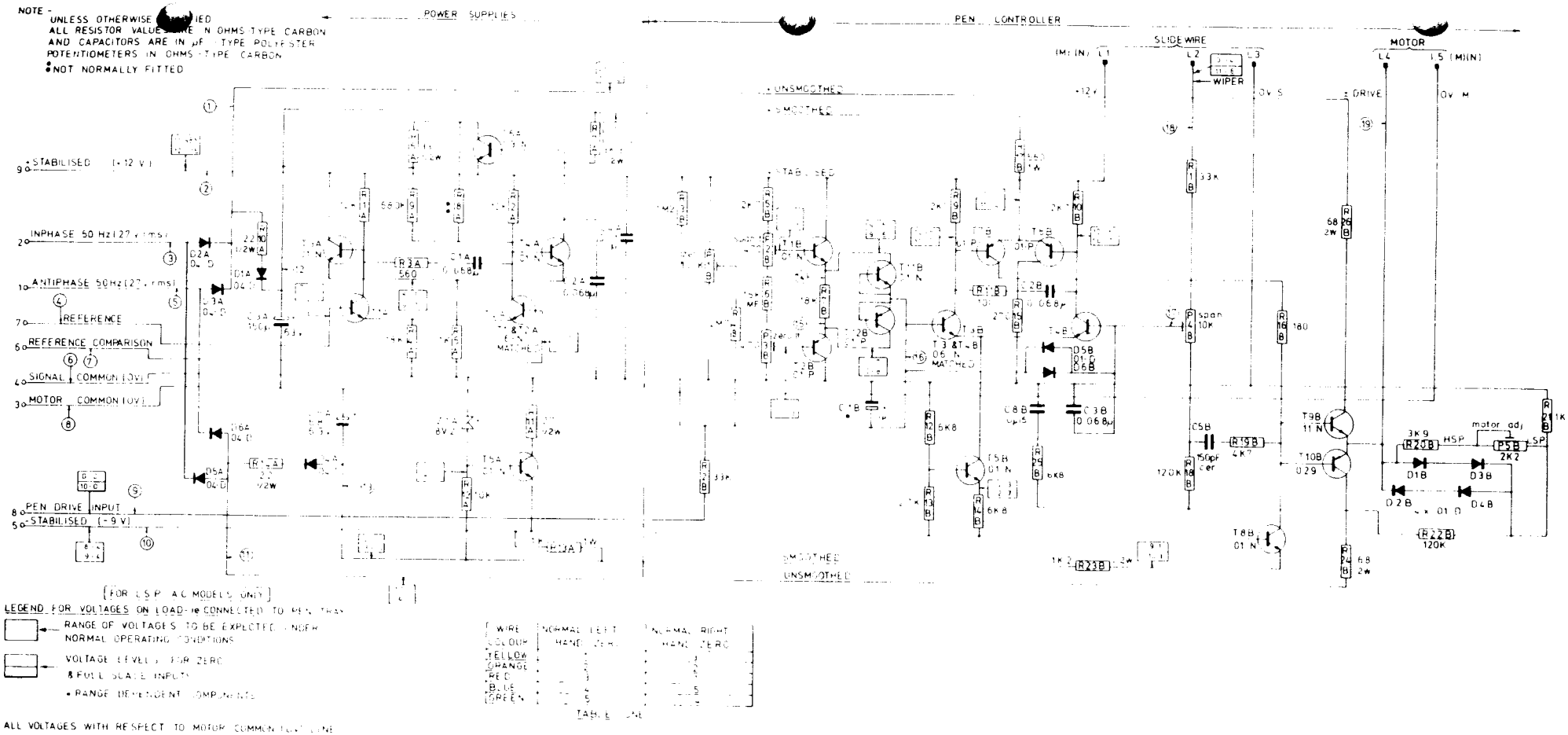
(5) Adjust the input signal to give 0 V ± 5 mV between pins 4 and 8. Measure the voltage between pen tray connector pins L3 and L2 Adjust P1B (zero) for 0.444 V ± 10 mV. Be sure the pen assumes its true position by frequent gentle tapping of the pen tray throughout this procedure.

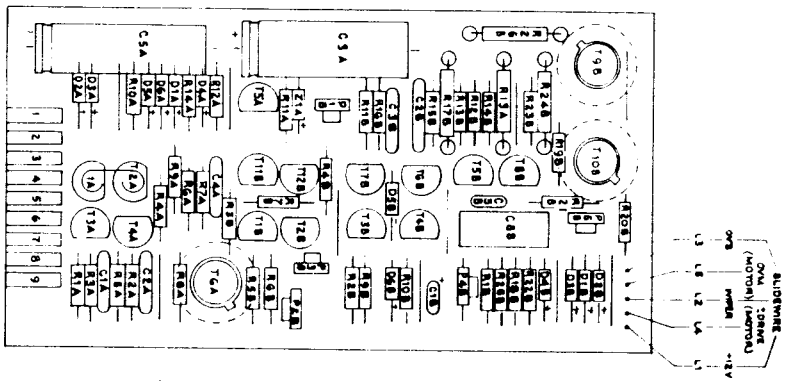
(6) Repeat (4) and (5) until acceptable results are achieved.

(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.

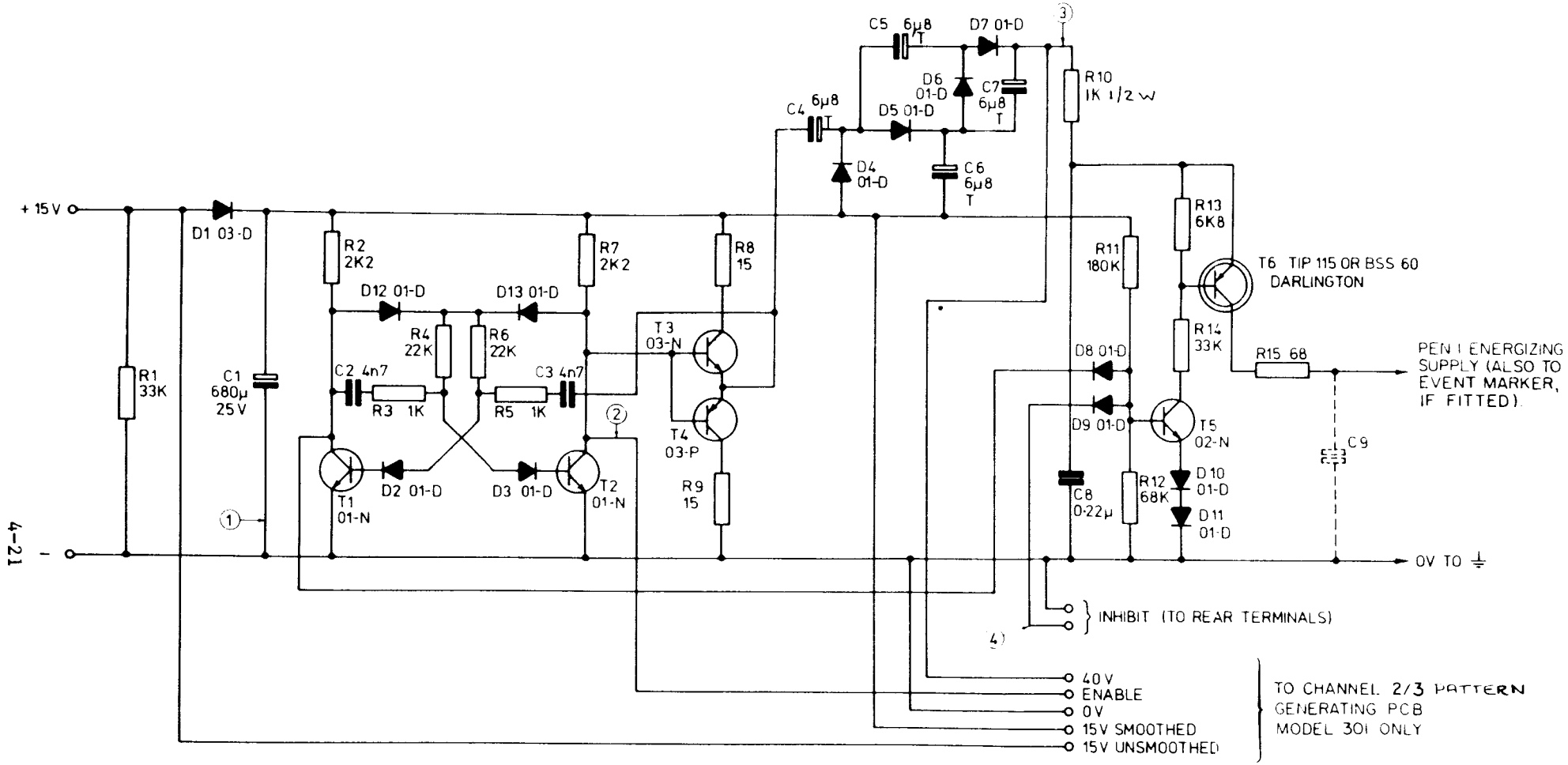
(8) Adjust the input signal to give <-0.5 V between pins 4 and 8. Measure the voltage between pen tray connector pins L3 and L2 Adjust P3B (limit) for 0.278 V ± 10 mV, tapping the pen tray, as before.

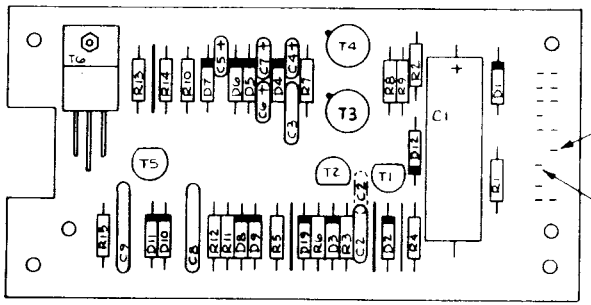
With some input modules, for example ac ranges without zero offset, it may not be possible to adjust the input in accordance with (8). In these instances either adjust the input module zero potentiometer to simulate a negative input, or substitute another module of suitable type.





Pen Drive Board 1002



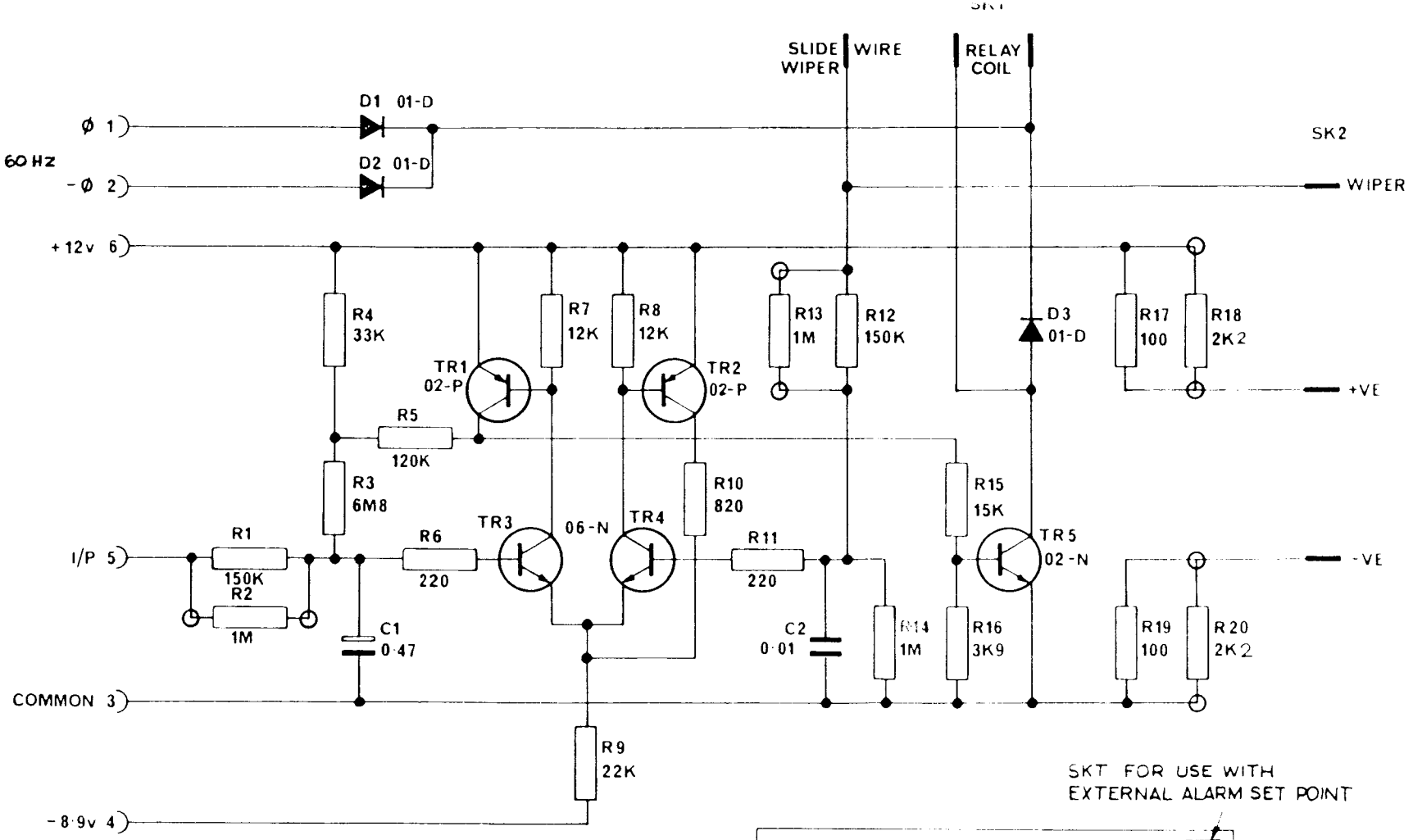


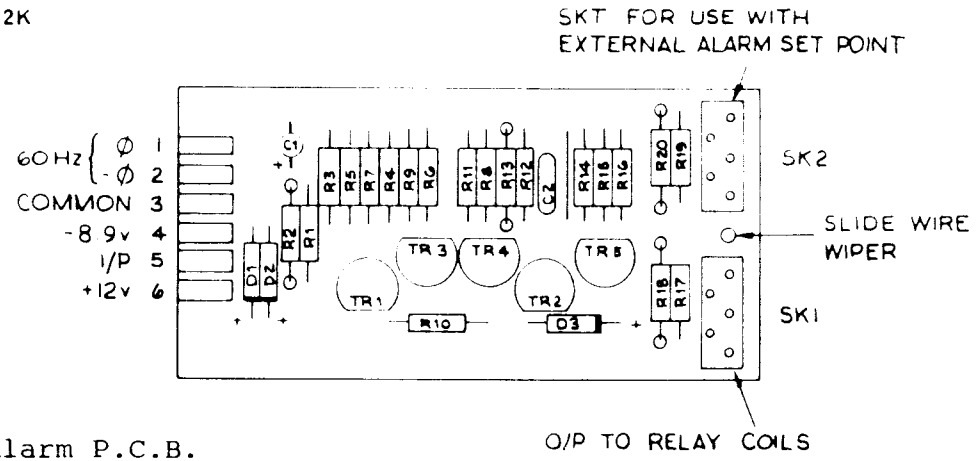
NOTE R13 NOT FITTED IF T6 IS TIP 115
C9 NOT NORMALLY FITTED

To EVENT MARKER

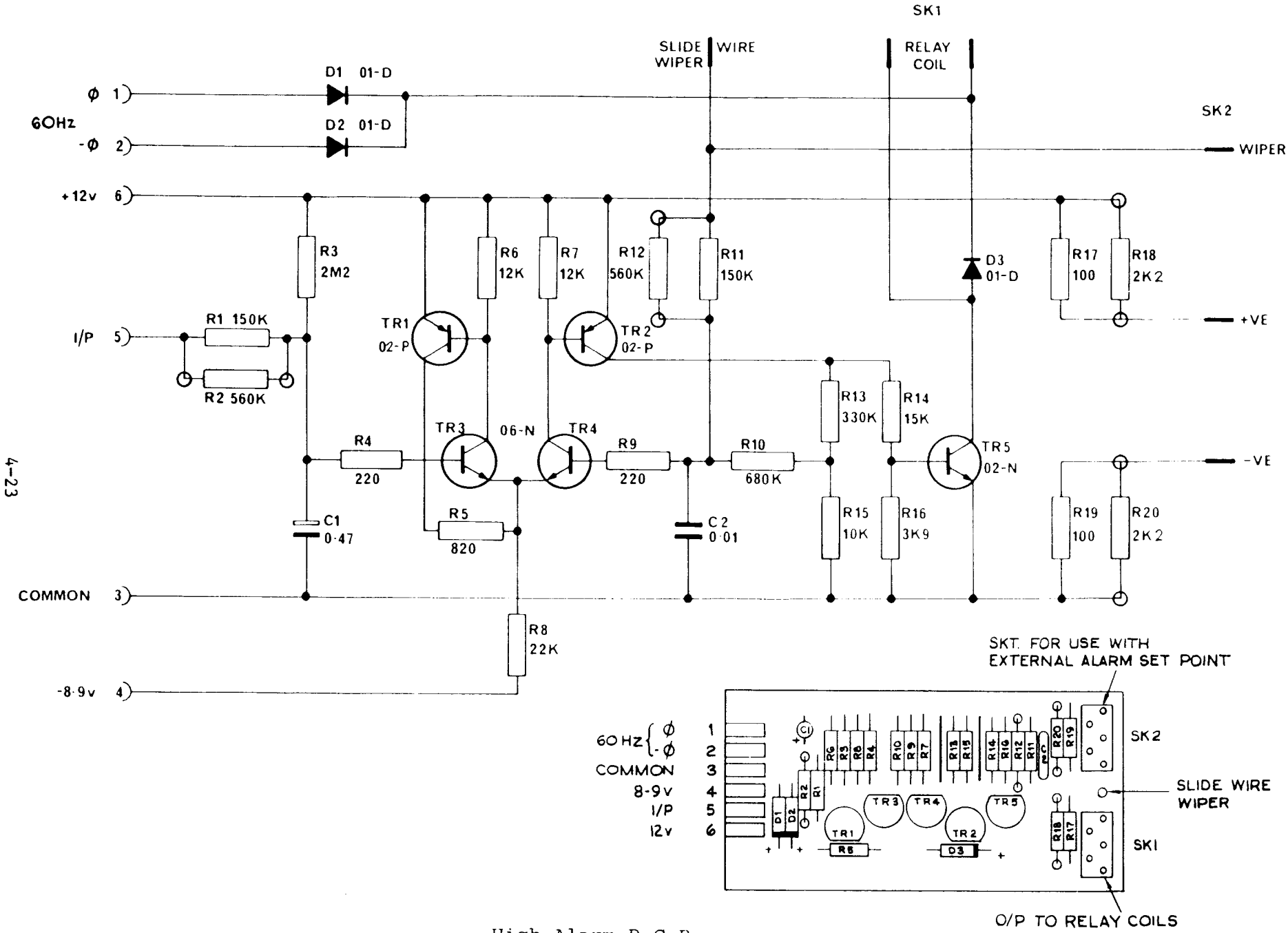
To PEN I

Electric Writing Module 1026

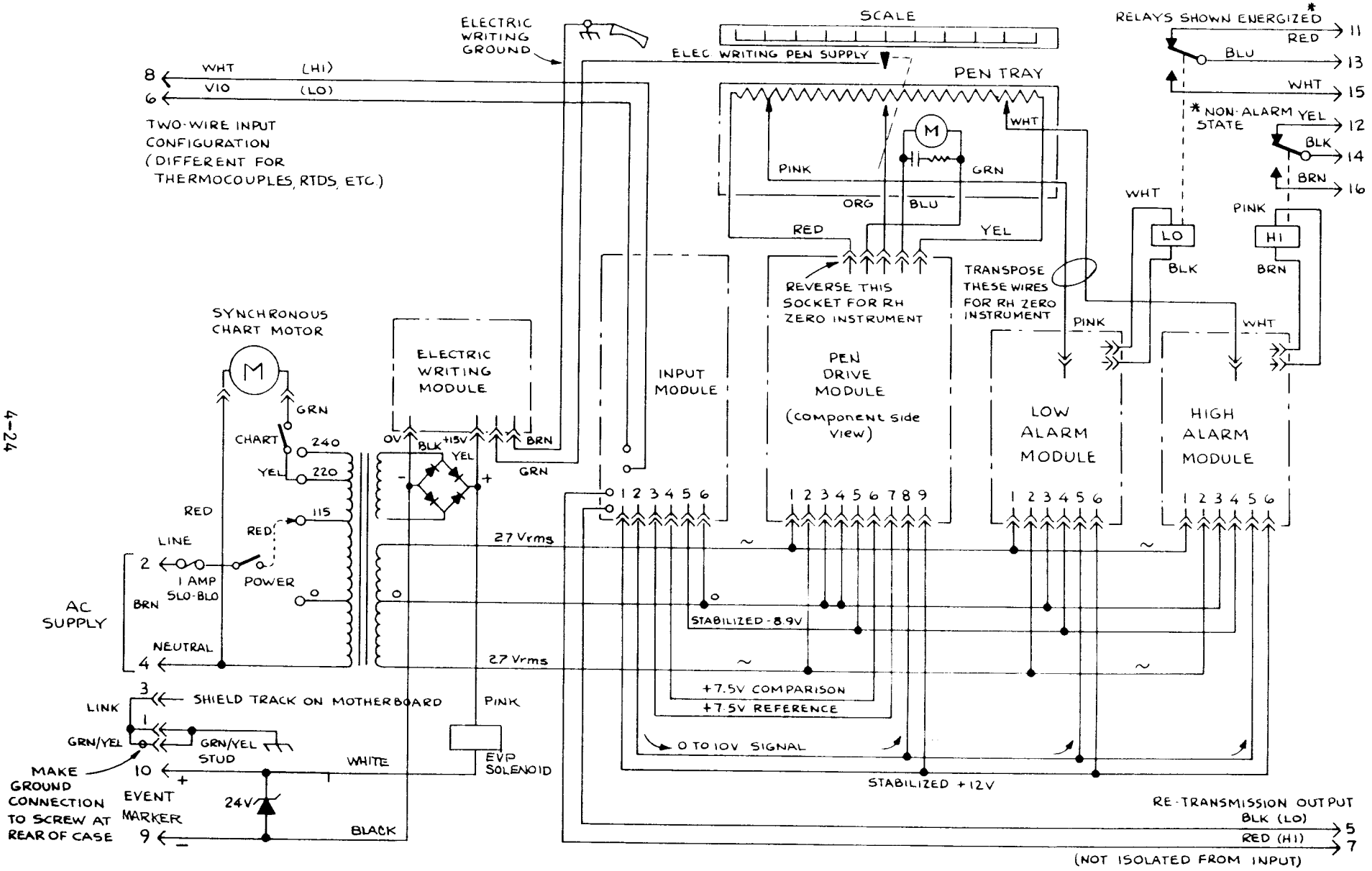




Low Alarm P.C.B.



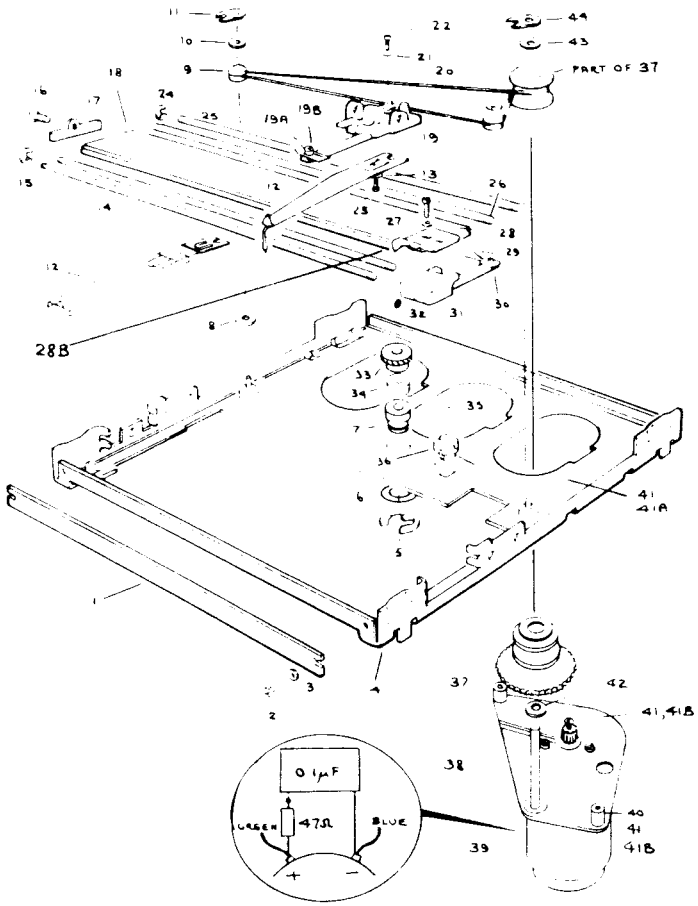
High Alarm P.C.B.



Model 300 Chassis Schematic

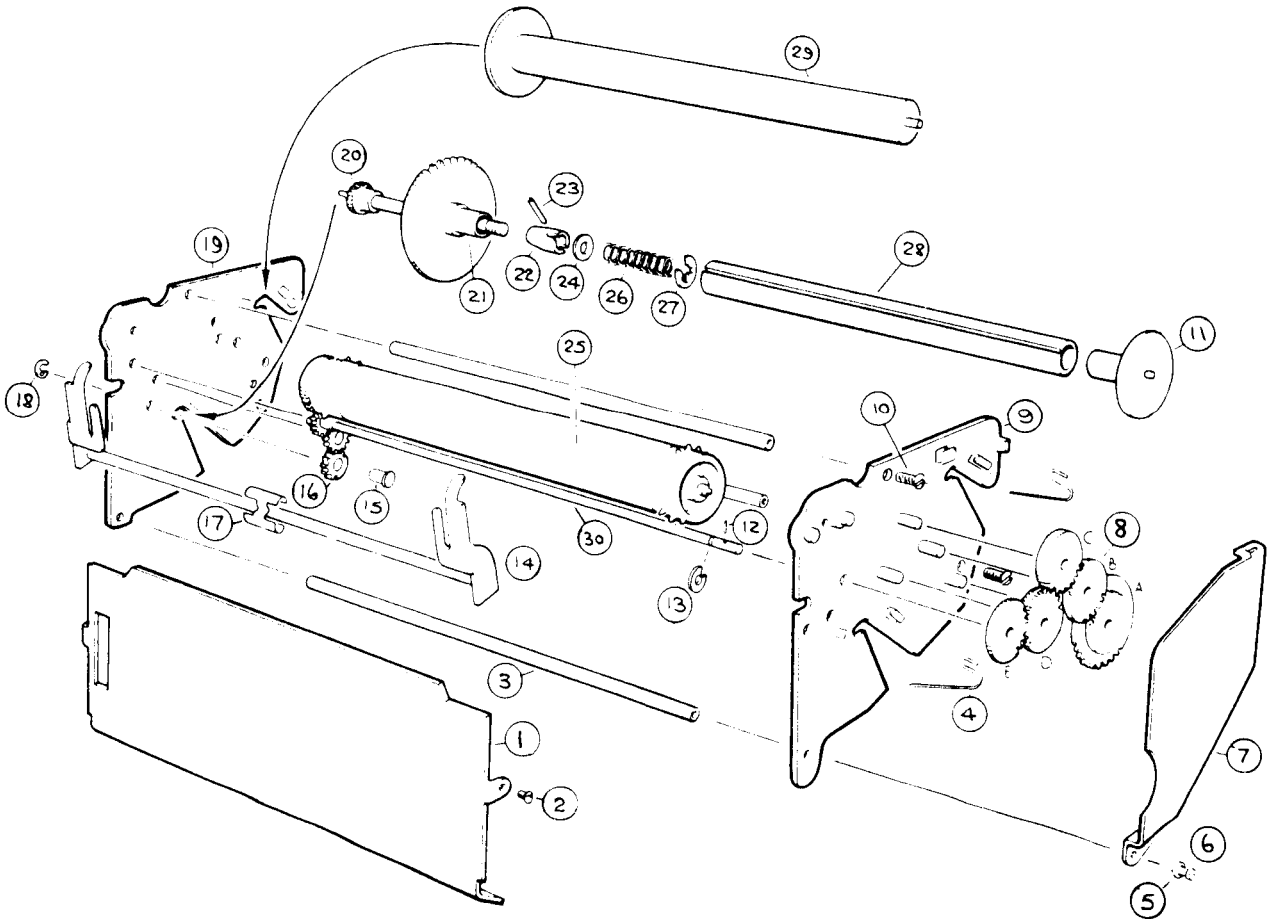
PEN TRAY

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	'O' 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



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
15	100 605	2	Gear stub
16	100 844	2	Idler gear
17	100 693	1	Return spring
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

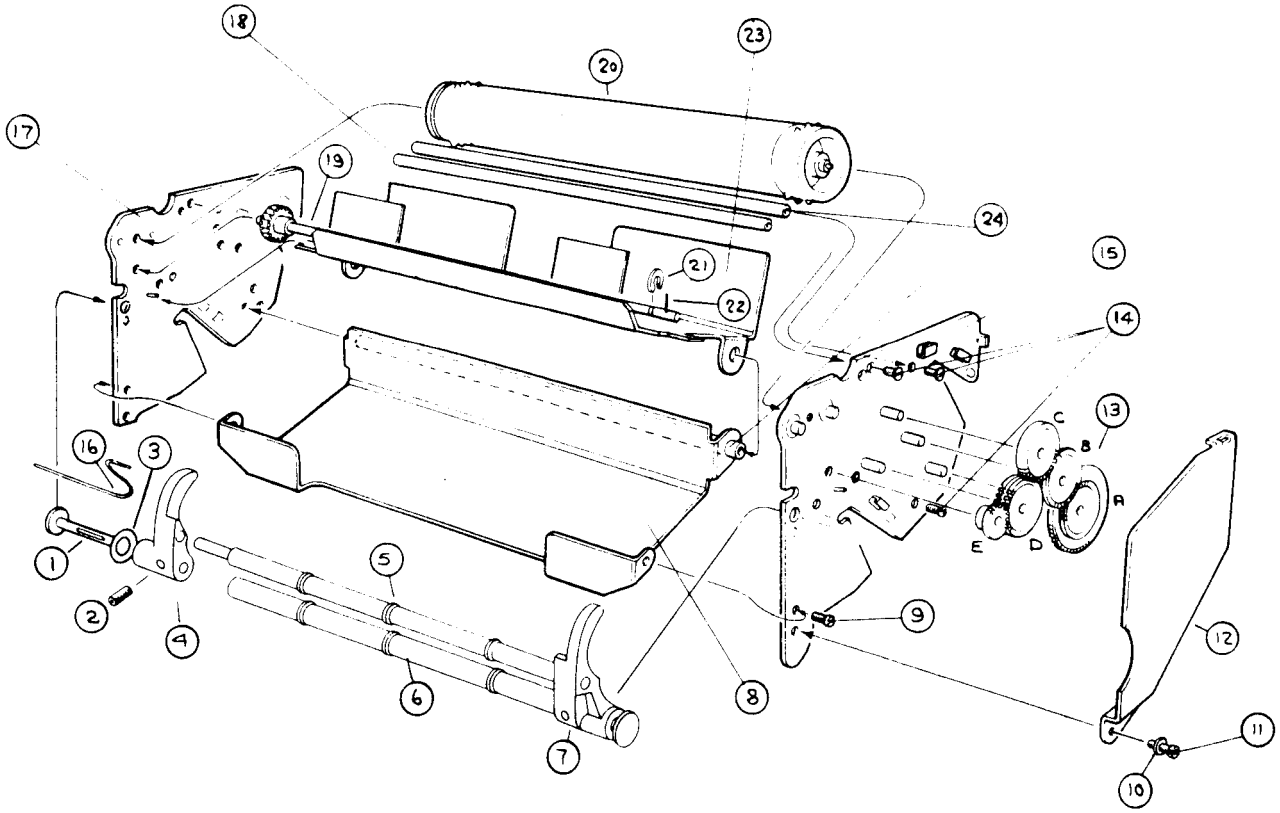


7-A10(R1)CC

Roll cassette

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



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100 574	BE100574
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100 605	FG100605
100 630	BE100630
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100 650	BE100650
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