

MODEL 9923
RANGE EXTENDER
TECHNICAL MANUAL

NOTICE

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TM9923-B-01

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Model 9923

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SECTION 1

INTRODUCTION

1.1 SCOPE

This manual contains service, operating and technical information for the Guildline Instruments Model 9923 Range Extender. It is intended for personnel who are familiar with laboratory grade electronic measuring instruments, analog circuits and measurement techniques using common service instruments.

1.2 GENERAL DESCRIPTION

The Model 9923 Range Extender was designed to extend the range of the Guildline Instruments Model 9975 Current Comparator Resistance Bridge downward by allowing it to measure resistors at currents of up to 100 A at full accuracy and resolution. The extender is essentially a DC-DC Transformer with three primary windings which produces an output current (0-100 mA) that varies directly with the input current. The three windings provide transformation ratios of 10:1, 100:1 and 1000:1, allowing the input current to be as large as 1A, 10 A and 100 A respectively.

This instrument is normally supplied with a Formica case and is intended to be installed on a bench as a free-standing unit. If the case is removed, the Model 9923 can be mounted in a standard 19-inch RETMA rack without any modifications. All controls, indicators and test lead terminals are on the front panel. The mains input socket, GND link and fuse are on the rear panel.

1.3 SPECIFICATIONS

Table 1-1 details the Model 9923 specifications.

TABLE 1-1

MODEL 9923 RANGE EXTENDER SPECIFICATIONS

Transformation Ratios	:	1000:1, 100:1, 10:1
Maximum Input Current	:	100 A at 1000:1, 10 A at 100:1 and 1 A at 10:1
Maximum Output Current	:	100 mA (all ranges)
Maximum Output Voltage	:	20 V (all ranges)
Maximum Load Resistance	:	200 Ω (all ranges)
Transformation Ratio Accuracy	:	1000:1 1 parts in 10^6 100:1 5 parts in 10^7 10:1 5 parts in 10^7
Mains Input Power	:	115 V 60 Hz or 230 V 50 Hz (switch selected) at less than 150 VA.
Dimensions	:	20 3/16" (408 mm) wide X 11 1/8" (283 mm) deep X 4 5/8" (118 mm) high
Weight	:	66 lb (30 kg)

SECTION 2

OPERATION INSTRUCTIONS

2.1 CONTROLS AND INDICATORS

TABLE 2-1

MODEL 9923 RANGE EXTENDER CONTROLS AND INDICATORS

Item	Function
1) RATIO 1000 RATIO 100 RATIO 10	The current to be divided is connected to one of these three sets of terminals. CAUTION: Do not exceed the input currents marked on the front panel.
2) NULL	This meter indicates the presence of flux in the core of the Range Extender comparator. It is used to set the HIGH and LOW TRACK controls. (See Item 5).
3) ZERO ADJ	Adjusts the instrument output current to zero when the input current is zero.
4) OSC	This lamp indicates that the flux detector oscillator is operating. CAUTION: If at any time the OSC indicators should extinguish, the power should be switched off immediately. This condition indicates the oscillator has stopped due to an overload. About 30 s should be allowed to elapse before switching the power on again. If the OSC lamp is not illuminated, switch the power off and ascertain the cause of the overload before switching on again. The cause of the overload is usually a gross ampere-turn out of balance due to the turns-ratio being widely out or one of the current circuits being

disconnected.

5) HIGH TRACK
LOW TRACK

These two controls adjust the instrument to ensure that the ratio of output current to input current is correct at zero and maximum.

6) RANGE

This switch selects the input terminals and gain resistors for the HIGH TRACK amplifier.

7) OUTPUT

The output current appears at these two terminals.

8) POWER

This switch controls the mains input power.

2.2 INSTALLATION

This instrument was thoroughly tested and inspected before shipment and should be free from electrical and mechanical damage when received. The customer should inspect it carefully, verify that all items on the packing list are present and check the instrument operation as soon as possible. Refer to the warranty card at the front of this manual if any damage or deficiencies are found. The installation procedure is as follows:

- a) Remove the four screws in the face plate, slide the chassis out of the case and remove the top cover.
- b) Check the settings of the 3-section rocker switch in the right front corner of the circuit board against the information in Table 2-2.

TABLE 2-2
INPUT POWER SELECTOR SWITCH SETTINGS

	INPUT POWER 115 V	INPUT POWER 230 V
S1	Closed	Open
S2	Closed	Open
S3	Open	Closed

- c) Replace the chassis in the case or mount it in a rack, as required.
- d) Connect the power line cord to the mains input power and plug it into the socket on the instrument rear panel.
- e) Turn the HIGH TRACK Control fully counterclockwise.
- f) Switch on the 9923 power by depressing the POWER switch (8). If the OSC lamp (4) does not light immediately, switch off the power and remove the fault before continuing.
- g) Adjust the ZERO ADJ control (3) to center the NULL meter (2) reading.
- h) Connect a 0 - 10 A current supply to the RATIO 1000 terminals (1) and set the RANGE switch (6) to 1000.
- i) Connect a DC ammeter capable of measuring 100 mA across the OUTPUT terminals (7).
- j) Adjust the LOW TRACK control (5) to centre the NULL meter (2) reading.
- k) Set the current supply to 1 A and adjust the HIGH TRACK control to centre the NULL meter (2) reading.
- l) Set the current supply output to 10 A and adjust the HIGH TRACK Control (5) to center the NULL meter (2) reading. The ammeter reading should be 10 mA.
- m) Switch off the current supply.
- n) Switch off the Model 9923.

CAUTION: To avoid magnetizing the transformer core in the Model 9923, do not allow the current supply to be on when the 9923 is off.

2.3 OPERATING PROCEDURE WITH MODEL 9975

The operator should be familiar with the operation of the Model 9975 before it is used in conjunction with the Model 9923 Range Extender.

CAUTION: When using the Model 9923 Range Extender with Model 9975 Bridge, the primary current supply to the Model 9975 must not exceed 100 mA. Currents in excess of 100 mA may cause serious errors in the fractional turn dials due to the large power dissipation in the current ratio resistor.

- a) Connect the Model 9923 as shown in Fig. 2-1, ensuring that all connections are tight. Remove the range plug ($R_s \leq 1 \text{ k}$ / $R_s \geq 10 \text{ k}$) which is located on the side panel of Model 9975 and replace it with Model 99753 plug. Store the range plug in a safe place.

Guidline 9975

Setup for 9923 Range Extender

Preset

Rev rate 16
Manual
External
PCA out
 $R_s = 100 \Omega$
 $I_x = 100 \text{ mA}$

Start

Reverse switch on

dials to approximate value with (9975 ratio) $\left(\frac{R_x}{R_s} \right) = \frac{R_x}{R_s (=1)} \times (9923 \text{ ratio})$

9975 on
9923 Hi track fully CW
9923 on
Set current minimum
Power supply on
Centre LO track
Set $\frac{1}{10}$ current

Reverse current, set 9975 track, set 9923 Hi track, set 9923 Lo track to null
PCA on
approximate balance
Auto on
Set full current
Set 9975 track, 9923 Hi track
Take reading

Off

Set galvanometer $\times 1$
Set current to zero
Power supply off
PCA off
9923 off
9975 off
Reverse switch off
Auto off.

- b) Note that the maximum inputs to the Model 9923 (due to the Model 9975 limitation) are as follows:

100 AMP terminals = 100 A

10 AMP terminals = 10 A

1 AMP terminals = 1 A

The primary current reversal is controlled by the Model 9975, which may be operated in either the automatic or manual modes.

- c) Set the switches on the 9975 side panel as follows:

REV RATE SEC to 8 or 16

AUTO/MAN to MAN

INT/EXT to EXT

PCA/OUT to OUT

$R_{S\Omega}$ to 100

- d) Set the I_x mA switch to 100 and switch on the 9975. The CURRENT REVERSING switch should activate the Model 9606 Reversing Switch.
- e) Set the 9975 R_x/R_s dials to the approximate ratio of R_x divided by the 9923 ratio, ensuring that it is always less than 1.
- f) Set the 9923 RATIO switch as required, turn the 9923 HIGH TRACK control fully clockwise and depress the POWER switch.
- g) Ensure that the R_x power supply output is set to minimum and switch it on.
- h) Adjust the LOW TRACK control on the 9923 to center the NULL meter reading and adjust the COMP BAL control on the 9975 to center the ATB meter reading.
- i) Adjust the R_x power supply to approximately 1/10 th of the required current.
- j) While reversing the current with the 9975 CURRENT REVERSING switch, adjust the 9975 HIGH TRACK control to balance the ATB meter deflections about zero. Adjust the 9923 HIGH TRACK control to balance the NULL meter deflections. Readjust the 9923 LOW TRACK control to center the meter needle.

- k) Set the PCA/OUT switch on the 9975 side panel to PCA. The MAN/AUTO switch may be set to AUTO if desired. Adjust the R_x/R_s dials to obtain an approximate balance on the GALVANOMETER with the GALVANOMETER SENSITIVITY switch set to x1.
- l) Adjust the R_x power supply to deliver the required current.
- m) Readjust the HIGH TRACK controls on the 9923 and 9975 until no change in the ATB and NULL meter readings is observed when the current is reversed. If the 9975 is in the manual mode, use the CURRENT REVERSING switch and allow enough time for the meter readings to settle before changing any control setting.
- n) Adjust the 9975 R_x/R_s dials until the GALVANOMETER indicates a balance. Greater resolution may be obtained by setting the 9975 GALVANOMETER switch to D2 and increasing the GALVANOMETER SENSITIVITY switch setting to x3.
- o) The value of R_x can be determined from the following:

$$R_x = \frac{\text{Model 9975 } R_x/R_s \text{ dial setting}}{\text{Model 9923 ratio}} \times R_s$$

- p) To switch the system off, the following procedure must be used:
- 1) Set the Model 9975 GALVANOMETER SENSITIVITY switch to x1.
 - 2) Reduce the R_x power supply output to zero,
 - 3) Turn the power supply off.
 - 4) Switch the Model 9923 off.
 - 5) Switch the Model 9975 off.

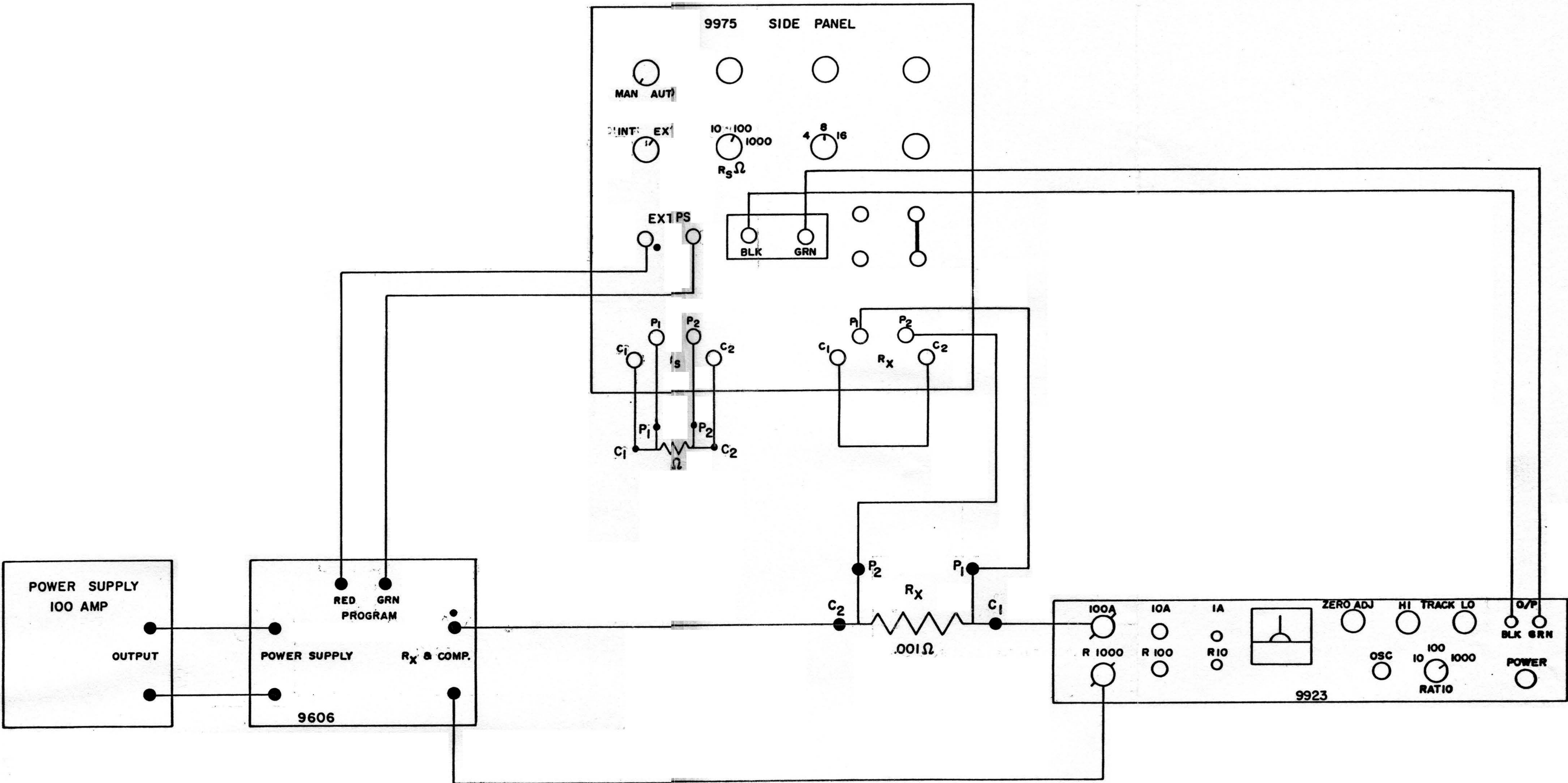


FIG. 2.1
INTERCONNECTIONS
TO MODEL 9975

SECTION 3

PRINCIPLES OF OPERATION

3.1 INTRODUCTION

The Model 9923 Range Extender is a precision, variable ratio, direct current transformer based on the principle of the direct current comparator. Figure 3-1 illustrates the instrument circuits in block diagram form. The circuit in each block is discussed in the text following figure 3-1. The instrument schematic is drawing 16159.01.04.

As an aid to understanding the Model 9923 and 9975 operation, a simplified schematic (dwg. 01.04) is also provided.

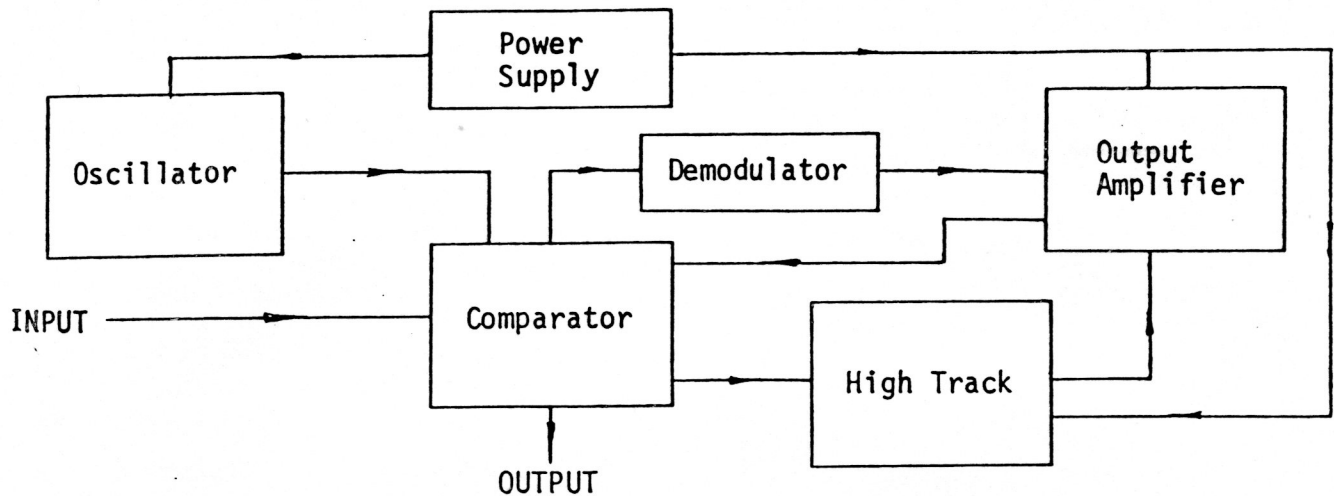


Figure 3-1
Model 9923 Block Diagram

3.2 DIRECT CURRENT COMPARATOR

The Direct Current Comparator is a multiple winding toroidal transformer device (Figure 3-2A) in which the primary and secondary windings carry direct currents and in which modulator and detector windings are used for the detection of d.c. flux in the core. When the primary and secondary ampere-turns are equal and opposite there is zero resultant d.c. flux in the core. This balance condition can be detected by modulation of the core permeability using the principle of the second harmonic modulator (Figure 3-2B). The amplitude of the double-frequency positive and negative voltage peaks induced in the detection windings are compared by a peak detector. The d.c.

output of the detector is proportional to their difference. The presence of d.c. flux in the cores due to primary-secondary ampere-turns unbalance is indicated by the detector output both in magnitude and polarity.

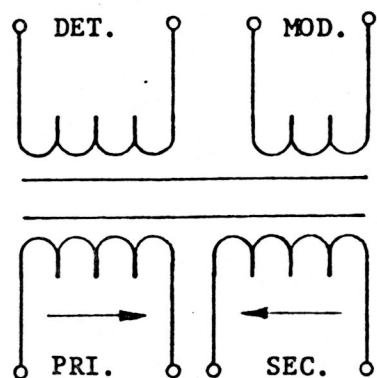


Figure 3-2A
Current Comparator Windings

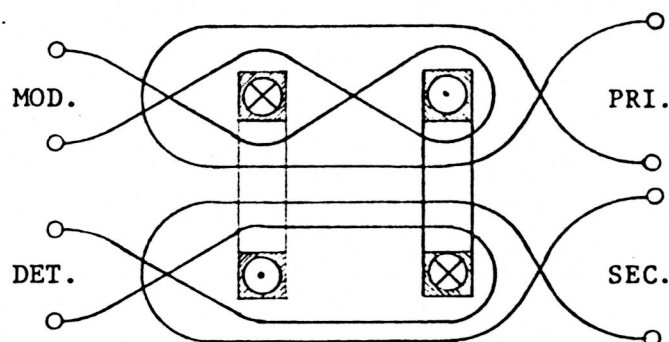


Figure 3-2B
Current Comparator Cross Section

3.3 POWER SUPPLY

The power supply is a conventional transformer/bridge-rectifier/capacitor circuit which generates approximately ± 40 V (+A and -A) with less than 1 V of ripple. Regulated voltages to power the operational amplifiers throughout the circuit and the oscillator are provided by voltage regulators A1, A2 and A3. The output from A1 drives transistor Q6 for extra current compliance. The transistor output is adjusted to -20 V ± 1 V by resistor R19. The output from A2 is adjusted to $+20$ V ± 1 V by resistor R17. The oscillator power is provided by regulator A3 and transistor Q3. It is set at $+18$ V ± 0 V, -2 V by resistor R3.

3.4 OSCILLATOR

This circuit is a free running square wave oscillator which comprises transistors Q1 and Q2, a toroidal transformer (OSC TOROID), a feedback transformer (T1) and the resistors, capacitors and diodes associated with these components. When power is applied to the circuit, the waveform at each of the detector winding inputs (WT3 and WT5) with respect to ground (WT1) should be a square wave with an amplitude of approximately 450 V and a frequency of approximately 700 Hz. The exact values in a specific instrument depend on the circuit parameters and are not critical.

This voltage is applied to the detector windings in the current transformer which are wound on individual cores and connected in series opposition. The output from the detector windings (WT4) is a series of positive and negative pulses as the detector cores are driven into saturation by the oscillator.

3.5 PEAK DETECTOR

This circuit is connected to the output from the detector windings to store the difference in amplitude between positive and negative peaks. Any ampere-turn difference between the primary and secondary windings produce flux in the detector cores which aids one polarity of peaks and opposes the other. Diodes CR3 and CR4 steer the peaks to capacitors C9 and C10, causing the difference in amplitude to appear across capacitor C11.

3.6 OUTPUT AMPLIFIER

The amplifier drives the secondary winding and the instrument output. The voltage across capacitor C11 is summed with a voltage provided from the ZERO ADJ control to correct for thermal emf in the load. The corrected voltage is amplified by A4, A5, A6, Q4 and Q5 to increase the current in the secondary winding, thus reducing the flux in the detector cores to that which is caused by the oscillator. In this condition, since the effective gain of the circuit is greater than 10^8 , the ratio of the primary and secondary currents is set by the current transformer turns ratio.

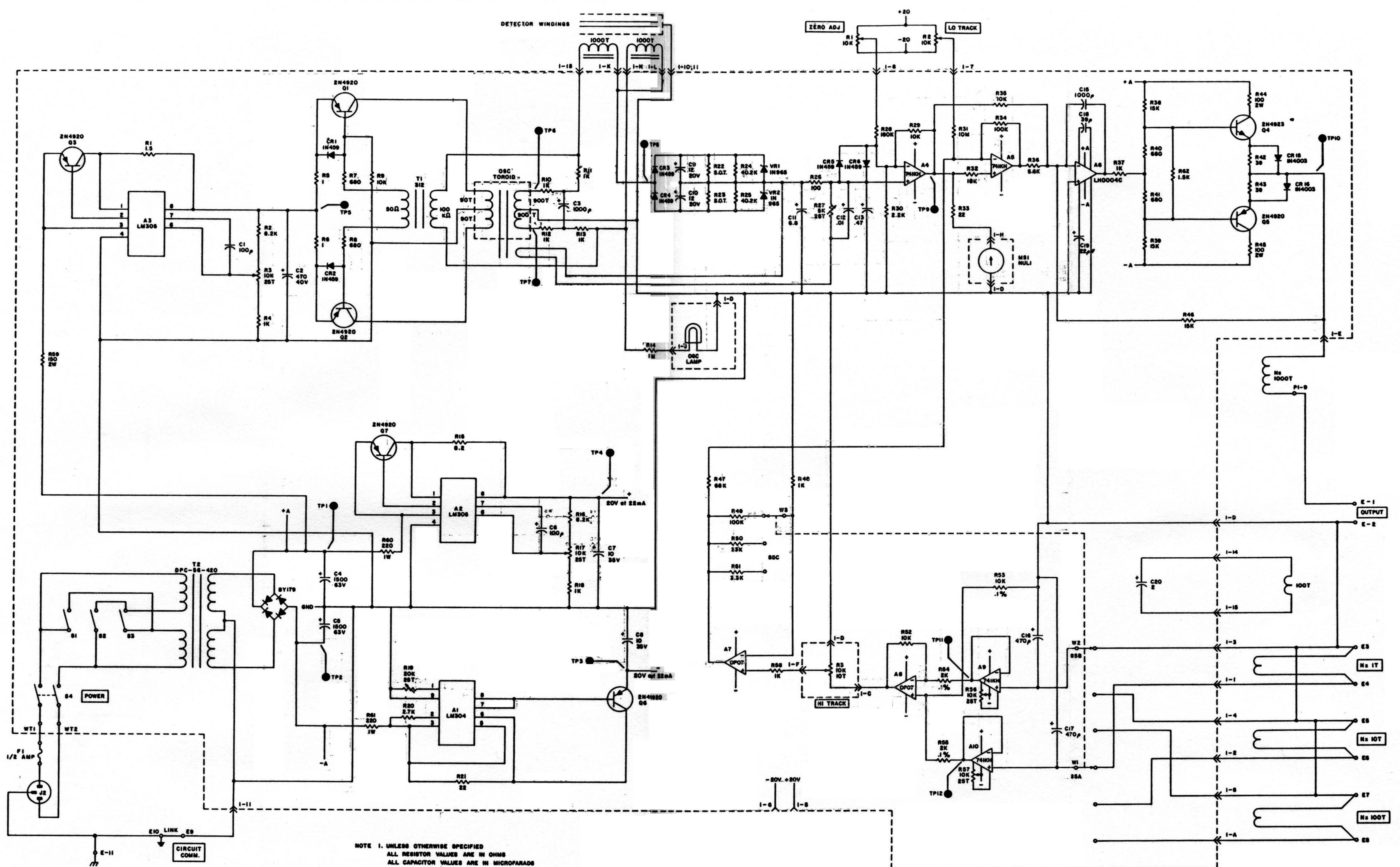
3.7 HIGH TRACK AND LOW TRACK

These two controls adjust the output amplifier zero and gain. The output of amplifier A4 is displayed on meter MS1. This meter indicates the amount of flux in the detector cores and has a sensitivity equivalent to $10 \mu\text{AT/division}$. The zero of this meter is adjusted by the LOW TRACK control. The HIGH TRACK control adjusts the system gain by applying a portion of the voltage across the primary winding to the negative input of A5. The control is adjusted to minimize the deflection of the meter needle when the primary current is reversed.

SECTION 4

DRAWINGS

NUMBER	TITLE
16159.01.04	Range Extender Schematic
16187.01.02	Range Extender Assembly
PL 16187.01.02	Range Extender Parts List
16196.01.03	Range Extender Wiring
16616,01.06	Simplified Schematic - Models 9975 & 9923



REV 1240
REV 1391
REV 1432
REV 1447
REV 2030
REV 2035

HEATSINK (3)
13537-01-10

(2) CAMBION PINS
155B-02-01-00

PCB SUPPORT BAR
16188-01-10
FOAM PAD - TOP &
BOTTOM (15467-01-10)
PILLAR
15231-01-10
WASHER
15232-01-10

(2) 'P' CLAMPS
1" DIA.

Heatsink 1358701-10

(3) SCREWS 4-40

ATTACH TO BOARD SO
THAT WRITING FACES
THE FRONT

TRANSFORMER MOUNTING FRAME

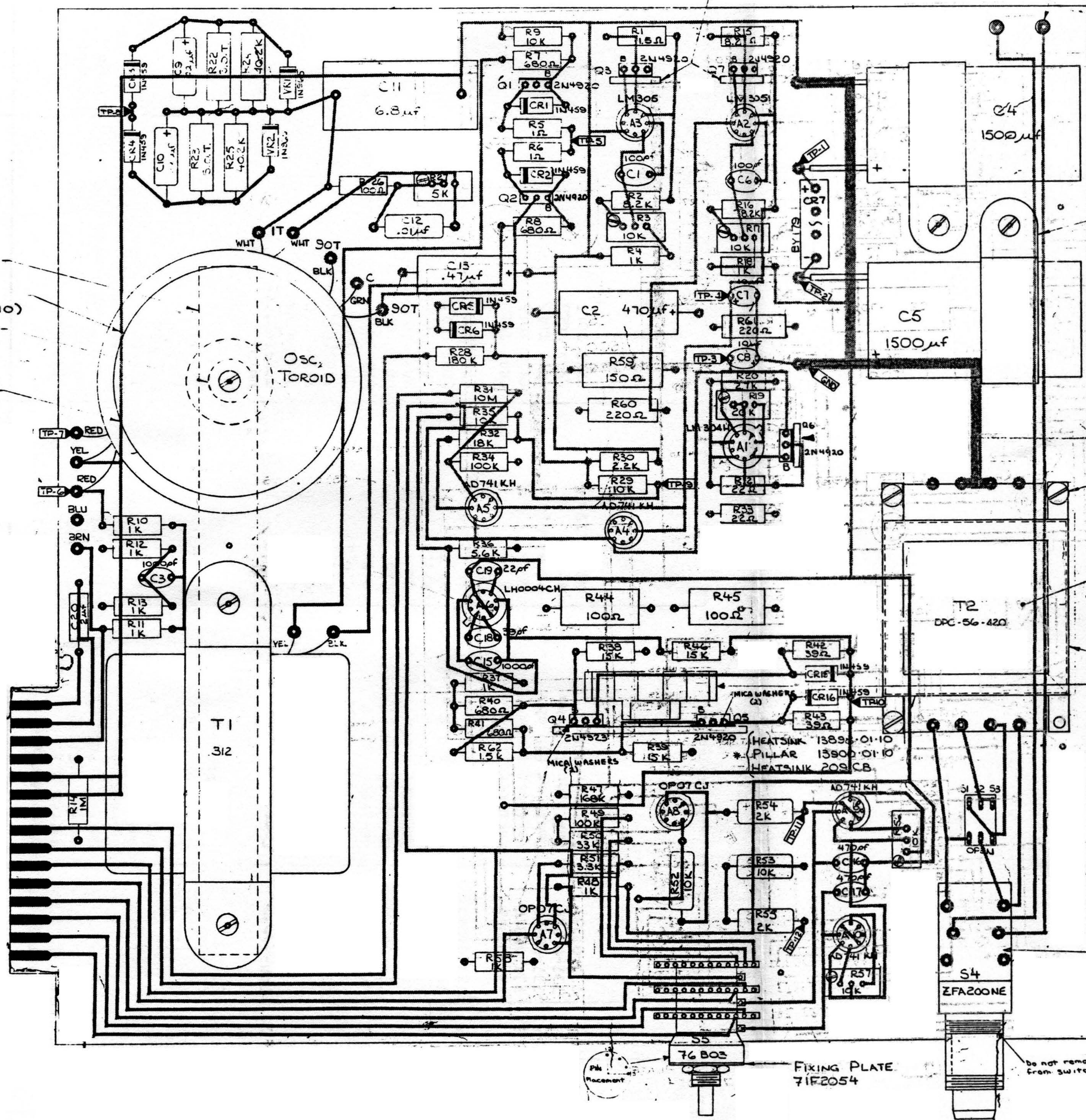
Keep up off board (KSTR6)
(Heatsink has to clear board)

PAT IN AFTER
BOARD IS CLEAN

ASSEMBLE BEFORE
SOLDERING ONTO BOARD

Do not remove parts
from switch

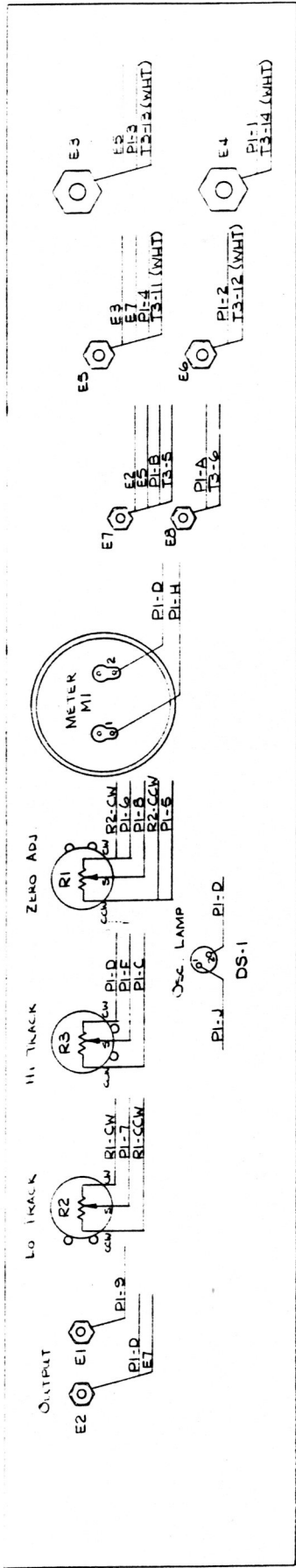
FIXING PLATE
71F2054



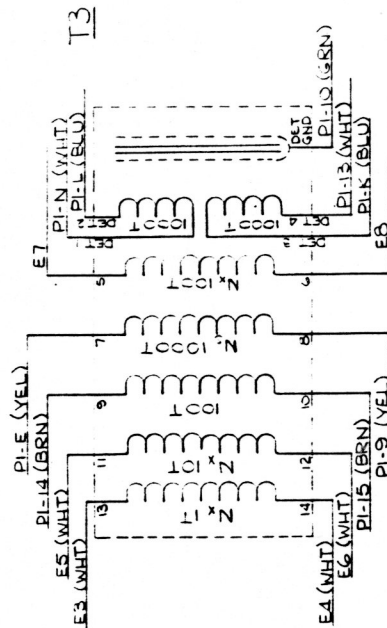
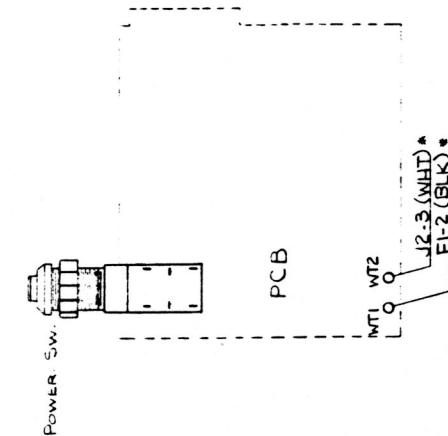
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Appr <i>B</i> Date 13/1/86		Title RANGE EXTENDER - PCB				
Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	1	16187.01.07F	Printed Circuit Board			
S	1	430-10013	Switch P.B.	S4	ZFA200NE	Shadow
S	1	430-11031	Switch 115/230 V	S1,2,3	76B03	Grayhill
S	1	430-02011	Switch 3 Pos., 3 Pole	S5	71ADF30-03-1-AJ-N	Grayhill
S	1	530-56420	Transformer	T2	DPC-56-420	Signal
S	1	530-21096	Transformer	T1	109657-312	Hammond
S	1	075-03179	Bridge Rectifier	CR7	MDA108A	
S	2	038-52789	Capacitor, 1500 uf 63V	C4,5	2222-050-18152	
F	2	049-01010	Capacitor, 100 pf	C1,6	DD101	
S	2	041-01269	Capacitor 10 uf 35V	C7,8	TAG10/35	
S	1	038-43861	Capacitor 470 uf 40V	C2	437ETG470	
F	2	049-10010	Capacitor 1000 pf	C3,15	DD102	
S	2	040-14639	Capacitor 22 uf 35V	C9,10	CSR13F226KL	
S	1	037-22332	Capacitor 6.8 uf	C11	344CHA6M8	
S	1	037-00171	Capacitor .01 uf	C12	281CGA10K	
S	1	045-00834	Capacitor .47 uf	C13	C281ABA470K	
F	2	049-04710	Capacitor 470 pf	C16,17	DD471	
F	1	049-00220	Capacitor 22 pf	C19	DD220	
F	1	049-00390	Capacitor 39 pf	C18	DD390	
F	1	737-01237	Resistor 2.7K	R20	CR37 TOL5	
F	2	737-00144	Resistor 22 ohm	R21,33	CR37 TOL5	
F	2	737-01329	Resistor 8.2 K ohm	R2,16	CR37 TOL5	
F	9	737-01200	Resistor 1K	R4,10-13,18,37,48,58	CR37 TOL5	
F	1	737-00015	Resistor 1.5 ohm	R1	CR37 TOL5	
F	2	737-00010	Resistor 1 ohm	R5,6	CR37 TOL5	
F	4	737-00866	Resistor 680 ohm	R7,8,40,41	CR37 TOL5	
F	1	737-00287	Resistor 100 ohm	R26	CR37 TOL5	
F	3	737-01351	Resistor 10K	R9,29,35	CR37 TOL5	

REV M ECN No 2043		BILL OF MATERIALS		Bill No. 16187.01.02 Sht 2 of 3		
Appr <i>8</i> Date 13/1/86		GUILDLINE INSTRUMENTS LTD.		Model Number 9923		
Title RANGE EXTENDER - PCB						
Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
F	1	737-02674	Resistor 1M	R14	CR37 TOL5	
F	1	737-01603	Resistor 180K	R28	CR37 TOL5	
F	2	737-00177	Resistor 39 ohm	R42,43	CR37 TOL5	
F	1	737-01232	Resistor 2.2K	R30	CR37 TOL5	
F	1	737-01383	Resistor 18K	R32	CR37 TOL5	
F	2	737-01520	Resistor 100K	R34,49	CR37 TOL5	
F	1	737-01303	Resistor 5.6K	R36	CR37 TOL5	
F	3	737-01372	Resistor 15K	R38,39,46	CR37 TOL5	
F	2	760-00859	Resistor 40.2K 1% 1/4W	R24,25	RN60D	
S	2	782-01462	Resistor 10K .1%	R52,53	8E16D	
S	2	782-01259	Resistor 2K .1%	R54,55	8E16D	
F	1	737-00082	Resistor 8.2 ohm	R15	CR37 TOL5	
S	1	300-03100	Trimpot 20K 25T	R19	RV205-208 20K	
S	4	300-03090	Trimpot 10K 25T	R3,17,56,57	RV205-208 10K	
S	1	300-03080	Trimpot 5 K 25T	R27	RV205-208 5K	
S	1	200-65111	Amplifier	A1	LM304H	
S	4	200-40361	Amplifier	A4,5,9,10	AD741KH	
S	1	200-40132	Amplifier	A6	LH0004CH	
S	8	410-04002	Socket		SD5178	
S	2	410-04004	Socket		SD5170-23	
S	6	801-80450	Transistor	Q1,2,3,5,6,7	2N4920	
S	1	801-75650	Transistor	Q4	2N4923	
S	8	075-46142	Diode	CR1-6,15,16	1N459	
S	2	075-61232	Diode	VR1,2	1N965	
S	1	14824.01.02	Oscillator Toroid			
S	1	15231.01.10	Pillar			
S	1	15232.01.10	Washer			
S	2	604-06131	Pins			
S	1	154-05100	Fixing Plate			
					1558-02-01-00 71F2054	Cambion Grayhill

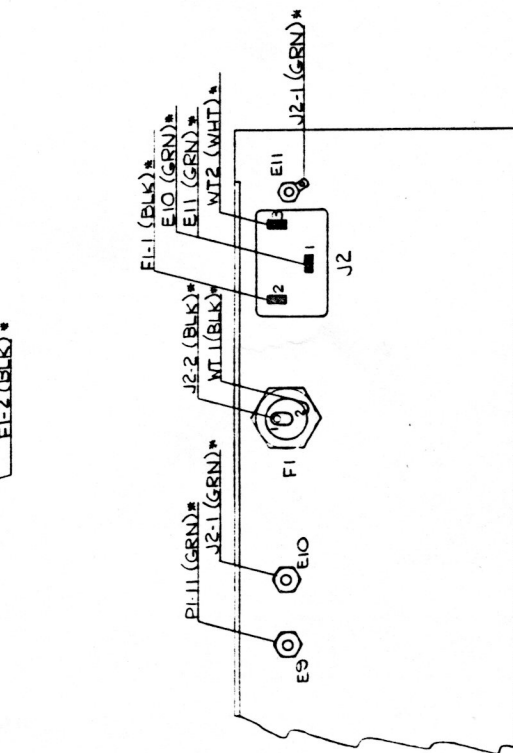
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Appr  Date 13/1/86		Title RANGE EXTENDER - PCB			Model Number 9923	
Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	3	13587.01.10	Heatsink			Motorola
F	2	150-11032	Mica Washers			Delta-T
S	1	13900.01.10	Heatsink Pillar			
S	1	158-01060	Heatsink			
F	1	737-03472	Resistor 10 M ohm	R31	209CB	
F	1	737-01426	Resistor 33K	R50	CR37 TOL5	
F	1	737-01248	Resistor 3.3K	R51	CR37 TOL5	
F	2	742-00237	Resistor 100 ohm 2W	R44,45	CR37 TOL5	
F	1	742-00288	Resistor 150 ohm 2W	R59	CR42 TOL5	
F	2	752-00956	Resistor 220 ohm 1W	R60,61	CR42 TOL5	
S	1	13898.01.10	Heatsink		CR52 TOL5	
S	1	16188.01.10	PCB Support Bar			
S	1	038-01055	Capacitor 2 uf 50V	C20	TE1301	
S	2	200-65122	Amplifier	A2,A3	LM305	
S	2	15467.01.10	Foam Pad			
F	1	737-01222	Resistor 1.5K	R62	CR37 TOL5	
F	1	737-01481	Resistor 68K	R47	CR37 TOL5	
S	1	012-00024	Transformer Mounting Bracket		24-BR	Signal
S	2	200-40165	Amplifier	A7,8	OP07CJ	
F	2	052-33119	P-clamps 1" dia.		N16B	Richco



FRONT PANEL - REAR VIEW



T3



BACK PANEL - VIEWED FROM INSIDE

NOTE: ALL WIRE IS 26 AWG BLUE EXCEPT AS NOTED.

*16 AWG HOOK-UP WIRE

REV F EGN12
REV E EGN11
REV D EGN10
REV C EGN9
REV B EGN8
REV A EGN7

GUIDELINE INSTRUMENTS LTD			
DRN M28-1175	RANGE	EXTENDER	
CAD 24	WIRING		
9929	APP	3/1	
MODEL	SHT	1 OF 1	DWG. NO 1619-01-03 REV F

