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FM 3 Stereo Tuner Service Manual

QUAD FM 3 TUNER

service supplement

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The Acoustical Manufacturing Co. Ltd
St Peters Road, Huntingdon, Cambs, England
Telephone: 0480-52561/2 Huntingdon

ALIGNMENT PROCEDURE – 1

General

To achieve the specified performance this alignment procedure should be followed closely. Alignment should not be attempted without the equipment listed below.

Equipment required

- 1 10.7 MHz wobbulator with a maximum output of 100mV rms.
- 2 Oscilloscope with a maximum Y sensitivity of 10mV/cm and D.C. coupled Y amplifier.
- 3 VHF signal generator covering the range 88-108MHz, with AM and FM modulation facilities and an attenuator accurate at signal levels of $2\mu\text{V}$. (e.g. the Radiometer MS27).
- 4 Stereo signal generator with both multiplexed audio and multiplex RF outputs (e.g. the Radiometer SMG1).
- 5 Harmonic distortion meter or 19KHz notch filter.
- 6 Detector probe (a suitable circuit is shown in fig. 1).

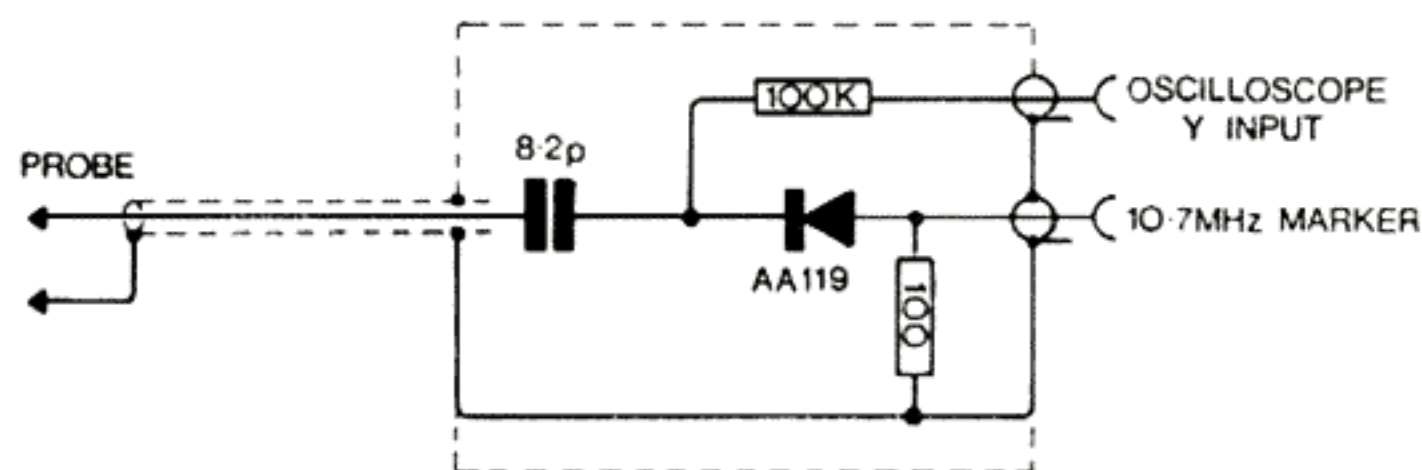


Fig. 1 Suggested Circuit of Detector Probe

Filter coding

Two versions of the ceramic filter have been used and can be interchanged providing the necessary alignment adjustments are made. The original type CFP10.7MA has a black body and is colour coded to indicate centre frequencies as follows:

Green	$10.62 \pm .03\text{MHz}$	White	$10.74 \pm .03\text{MHz}$
Blue	$10.66 \pm .03\text{MHz}$	Yellow	$10.78 \pm .03\text{MHz}$
Red	$10.70 \pm .03\text{MHz}$		

The later types SFG10.7MA (chromium plated body) and SFJ10.7MA2 (plastic coated body) are colour coded:

Black	$10.64 \pm .035\text{MHz}$	Blue	$10.67 \pm .035\text{MHz}$
Red	$10.70 \pm .035\text{MHz}$	Orange	$10.73 \pm .035\text{MHz}$
White	$10.76 \pm .035\text{MHz}$		

Note that types CFP and SFG carry the colour code spot at their input end but type SFJ carries it at its output end. The lead-out wires of SFJ are in line but may be bent to fit without redrilling board for service replacement.

HT Voltage adjustment

From serial number 5885 onwards no HT voltage adjustment is provided. On earlier models positive and negative supplies were adjusted to 14 volts by means of RV102 and RV104 respectively.

IF Alignment—before serial no. 10,000

Connect the detector probe to test point D, inject a wobbled 10.7MHz signal at test point C, and observe the probe output on the oscilloscope. Throughout the following procedure progressively reduce the wobulator output as necessary to maintain an oscilloscope display amplitude of approximately 50mV peak to peak.

If a 10.7MHz crystal oscillator is available it may be injected at the appropriate probe terminals to provide a marker. Adjust both cores of IFT1 simultaneously for a maximum response.

Adjust the core of L5 for maximum response.

Make small adjustments to IFT1 and L5 cores as necessary to obtain the response shown in fig. 2.

Remove detector probe from test point D and transfer oscilloscope input lead to point B (Pink interconnecting lead). Adjust core of discriminator coil L6 for maximum slope of the centre portion of the discriminator characteristic.

Transfer probe to test point A and unsolder the filter input pin (pin 1). This is necessary since the response at this point (fig. 5) is dominated by the filter input impedance. It should be noted that the peak response at this point does not correspond with the filter centre frequency.

The response at test point A with filter removed is shown in fig. 4 and should show no signs of double humping. If it does it will be necessary to replace IFT1.

IFT 1

L5

L6

IFT 1

IF responses: As a rough check of performance after completing the IF alignment, increase the input signal to obtain the amplitude shown in fig 4, when the amplitudes shown in figs 2, 3, and 5 should also be obtained.

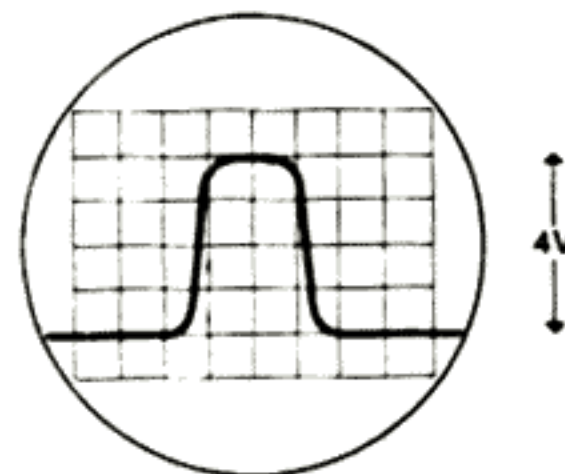


Fig. 2 Response at output of IC1 (Test point D)

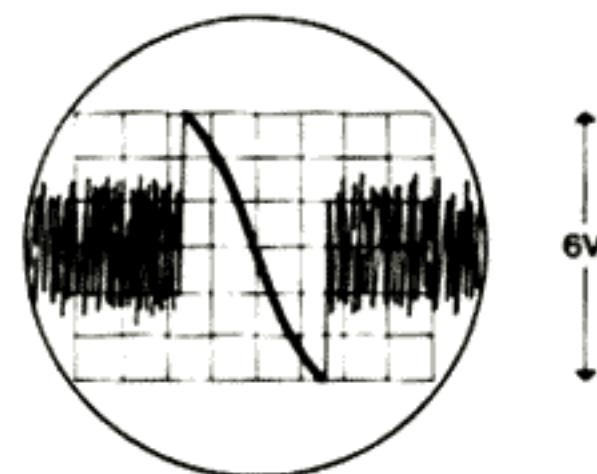


Fig. 3 Discriminator response (Test point B)

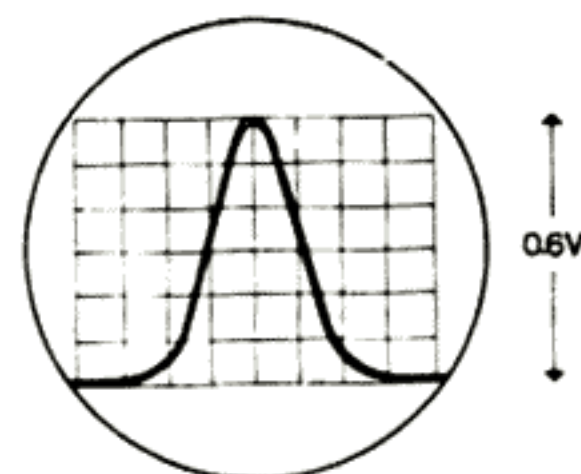


Fig. 4 Response at test point A, with filter removed

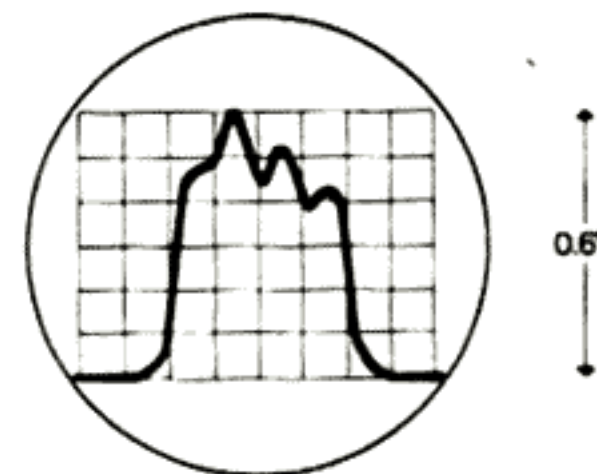


Fig. 5 Response at test point A, with filter present

IF Alignment—serial no. 10,000 onwards

Connect an oscilloscope to Test Point Q (pin 13 of CA3089), and inject a wobbled 10.7MHz signal at test point P. Adjust the core of IFT1 for maximum amplitude at test point Q. Fine adjustment of the core will then enable the maximum width of the flat top to be obtained as shown in fig. 2, with a minimum of generator output.

Transfer oscilloscope lead to test point R and adjust core of L6 for maximum slope of the linear centre portion of the discriminator characteristic.

RF Circuit Alignment—before serial no. 10,000

After completing IF alignment remove wobbulator input but leave detector probe at test point A.

Connect the RF generator to the aerial socket and inject a $300\mu\text{V}$, 75% amplitude modulated signal at 90MHz. Preset the cores of L1, L2, L3 level with the tops of the formers, and the trimming capacitors C1, C9, C20 approximately three threads out. Check that pointer travel is symmetrical about end scale markings, and that pointer is fixed to string. (If necessary secure with spot of Durofix or similar adhesive).

Set the tuner to 90MHz and adjust the cores of L3, L2, L1 in that order for maximum amplitude of oscilloscope display. If the front end of the tuner is badly misaligned it may be necessary temporarily

to increase the generator output slightly. Caution should be exercised since it is possible to align to a spurious response if too high an input level is used. It should be possible to obtain about 10mV peak to peak at the probe output for an RF input of $300\mu\text{V}$ or less. Necessity to apply an input signal greater than 1mV should be treated as a fault condition.

L6 Retune generator and tuner to 104MHz and adjust C20, C9 and C1 in that order for maximum response.

C1
C9
C20

Repeat adjustment of cores and trimmers until no further improvement is possible.

L1 Remove probe, resolder filter pin 1 and connect
L2 oscilloscope to test point B, together with valve
L3 voltmeter. Inject $2\mu\text{V}$ 90MHz 30% FM at aerial
C1 socket.
C9
C20

Retune tuner to 90MHz observing the oscilloscope. The correct tuning point occurs with noise just showing in equal amounts on positive and negative peaks of the audio output.

Make small adjustments to the core of L6 to obtain maximum audio output level as observed on the voltmeter. Set RV2 for equal brilliance of the tuning lamps.

L6
RV2
LPI-
LP2

RF Circuit Alignment—serial no. 10,000 onwards

Since a demodulated output is available at test point Q, no detector probe is required with these sets unless a fault is suspected prior to the CA3089. RF circuit alignment then follows the procedures outlined above as for earlier models.

Adjustment of Noise sensing coil L4

Adjustment of this core should be unnecessary unless it is not possible to mute signals below $100\mu\text{V}$.

If alignment is necessary, connect a suitable amplifier to the audio output socket and the FM generator to the aerial socket. Unscrew the core of L4 until level with top of can.

Inject an FM signal of $10\mu\text{V}$ and advance the mute control to the point just prior to muting. Screw the core of L4 in until muting occurs. Increase the signal level until the tuner comes out of muting and re-adjust L4. Repeat adjustments of L4 progressively increasing signal level until no further improvements are possible.

This completes the RF board alignment with the exception of L7 which must be aligned in conjunction with the decoder.

Decoder—before serial no. 5885

Remove the pink inter-board lead from the decoder and inject a 19KHz pilot tone at a level of 30mV from the multiplex generator.

Connect the valve voltmeter by means of un-screened cable, to the tap on L101. Adjust the core of L101 for maximum output. L102 and L103 are aligned in a similar manner with the valve voltmeter connected to their respective taps.

L101
L102
L103

Connect the distortion meter input to the output socket Pin 5 and tune the distortion meter to 19KHz. Observe the distortion meter output on the oscilloscope which will show the residual 38KHz switching components together with smaller quantities of harmonics. Adjust the core of L104 for minimum display amplitude. Similarly connect the distortion meter to Pin 3 and adjust L105.

L104
L105

With the distortion meter still connected to Pin 3, apply a stereo signal modulated with 1KHz on right channel only and adjust RV101 for minimum crosstalk. Slight adjustments of L101 in conjunction with RV101 should now enable the crosstalk to be reduced to a small second harmonic component. Remove the multiplex input and reconnect the pink interconnecting lead. Inject at the aerial an FM stereo signal carrying right channel modulation at 1KHz.

Again observing the distortion meter output adjust the core of L7 for minimum crosstalk.

L7

As a check on these last three separation adjustments apply 10KHz right channel modulation and measure crosstalk which should be better than -30dB .

Decoder—serial no. 5885 onwards

The decoder now fitted uses a phase-locked loop integrated circuit providing improved stereo separation and lower distortion.

The only adjustment provided is RV100 which sets the free run frequency of the oscillator contained within IC100. For this adjustment either connect a digital frequency meter to test point S (pin 10 of IC100) where the 19KHz square waveform appears, or if an accurate 19KHz source is available, such as the pilot tone from a stereo generator, connect this to the X amplifier of an oscilloscope, test point S to the Y amplifier, and use the resultant Lissajous figure. It will be found advantageous to remove the audio input to the decoder by muting the set, for this adjustment only.

With a distortion meter connected to the output socket pin 3, apply an FM stereo signal carrying pilot tone only to the aerial socket. Tune the distortion meter to remove the 19KHz from the output signal so enabling crosstalk to be measured when applying a 1KHz signal on the Right channel only. The core of L7 is then adjusted for minimum crosstalk. Alternatively this adjustment may be performed with comparable accuracy by listening to the output.

ALIGNMENT PROCEDURE – 2 USING SOUND TECHNOLOGY 1000 TEST EQUIPMENT

Alignment is in three parts: RF, discriminator and decoder.

Part 1

Connections

Sound Technology 1000 HORIZ to X–Y1

Sound Technology 1000 RF out to tuner aerial input

Test Point Q to Y–Y2 via clip lead

Crystal marker generator loosely coupled to tuner aerial input via 47 Ω Resistor

Mains to tuner

Controls

SCOPE TO XY

X—5v/cm DC coupled

Y—0.2v/cm DC coupled

Sound Technology 1000 FUNCTION—DUAL SWEEP

SWEEP WIDTH—700 to 800kHz

RF Level—30 μ V

L7 Input—Mono

(a) Tune tuner to 90MHz

Tune Sound Technology 1000 to 90MHz

Adjust L3 to locate IF response
 Adjust L2 for maximum gain
 Adjust L1 for maximum gain
 Adjust IFT1 for optimum shape and gain
 Switch on 90MHz marker, and adjust L3 to centre marker on peak of IF response
 Switch off 90MHz marker

- (b) Tune tuner to 106MHz
 Tune Sound Technology 1000 to 106MHz
 Switch on 106MHz marker
 Adjust C17 to centre marker on peak of IF response
 Switch off 106MHz marker
 Adjust C10 for maximum gain
 Adjust C1 for maximum gain
- (c) repeat a
- (d) repeat b
- (e) repeat a

When it is clear that alignment is correct and gain is optimum at both frequencies, reduce sweep width to 200kHz and confirm that sweep is centred accurately; Part 2 deals with the discriminator alignment and it is essential that the tuner and the generator are both tuned to exactly the same frequency before discriminator alignment is carried out.

Part 2

Connections

Sound Technology 1000 HORIZ to X-Y1
 Sound Technology 1000 VERT to Y-Y2
 Test Point R to RCVR via clip lead
 Right channel audio out to voltmeter input

Controls

Scope X 5v/cm DC
 Scope Y 0.5v/cm DC
 Sound Technology 1000 FUNCTION—DUAL SWEEP
 SWEEP WIDTH—200kHz
 RF level—1000 μ V
 VOLTMETER—500mV

- (a) Adjust L6 to give symmetrical display
 Adjust RV2 to obtain equal brightness of tuning lamps
- (b) Reset controls Sound Technology 1000—
 FUNCTION MONAURAL
 Sound Technology 1000—INPUT
 MONO
 Sound Technology 1000—OSC
 LEVEL TO 75%

Adjust RV3 to obtain 250mV rms audio output
 Check level is the same for left channel and mono outputs.

(c) Signal to noise check

Controls

Sound Technology 1000 RF LEVEL $4\mu\text{V}$
FUNCTION—CW

Output level should drop by 40dB

Part 3

Connections

Sound Technology 1000 19kHz to Y1

Test point S to Y2 via clip lead

Right channel audio to voltmeter input

Controls

Sound Technology 1000 FUNCTION—STEREO
OSC LEVEL MINIMUM
RF LEVEL $1000\mu\text{V}$
PILOT LEVEL MINIMUM

Scope
Y1 2v/cm
Y2 2v/cm
TIMEBASE $10\mu\text{S/cm}$
TRIGGER Y1

(a) Adjust RV100 to obtain 19kHz signal on Y2

(b) Increase PILOT LEVEL on Sound Technology 1000 and confirm that 19kHz signals lock and stereo lamp illuminates at 3 to 5% pilot level.

(c) Set PILOT LEVEL to 9%

(d) Reconnect—Y2 to voltmeter output via clip lead
Y1 to left channel audio.

Controls

Sound Technology 1000 INPUT—Left
OSC LEVEL—100%

VOLTMETER 5mV, 10Hz to 10kHz

SCOPE Y1 0.2v/cm

Y2 0.2v/cm

TIMEBASE 0.2mS/cm

TRIGGER Y1

Adjust L7 for minimum crosstalk signal in right channel
(less than 3mV)

Alignment is now complete but several checks still have to be made.

(1) Having checked left to right crosstalk, check right to left by connecting
left channel audio to voltmeter input
right channel audio to scope Y1
switching Sound Technology 1000 INPUT to RIGHT

- (2) Check the mono output
connect mono output to voltmeter input
switch Sound Technology 1000 INPUT to L + R
confirm that mono output level is approx 330mV at 100% modulation
switch Sound Technology 1000 INPUT to L – R
confirm that mono output level is less than 5mV
- (3) Check muting function
With the muting control on the tuner turned to maximum, reduce RF level on Sound Technology to 200µV and adjust L4 so that the tuner just mutes.

MODIFICATIONS

RF Board

From Serial No. 540 onwards

- 1 New L6 coil coded yellow.
- 2 L5—modified* and mounted with colour spot to R16.
- 3 MR4, MR5 removed and replaced by 4K7 resistors.
- 4 C11 removed.
- 5 R32 removed.
- 6 C32 changed from 33pF to 18pF.
- 7 R12 changed from 680Ω to 1K.
- 8 R21 changed to 2K2.
- 9 C34 changed to 47pF.
- 10 C47 .47µF added.

From Serial No. 1500 onwards

Issue 4 printed circuit board M12248

- 1 R37 added.
- 2 L5 unmodified* as pre 540.
- 3 R32 restored (see parts list re value).

* Modification to coil L5 comprised cutting off the unused centre legs to permit re-orientation.

The following modifications have been made at various stages in production from serial no. 3000 onwards.

- 1 Panel lamp series resistor changed from 10Ω to 68Ω to improve lamp life.
- 2 TR4 changed from 40244 to BFX44 or BF357K.
- 3 C13 and C15 changed to 100pF—a modification which results in improved background noise.
- 4 C26 changed from 3.3pF to 4.7pF consequent upon change of TR4 to BF357K.
- 5 TR1 may be 3N201.
- 6 TR2 may be 3N205.
- 7 TR10 and 11 may be MPSA12.

M12248 Issue 6 Printed Circuit Board

- 1 Tuning gang changed from Wingrove & Rogers CG80 to DAU 338/30.—N.B. These gangs are not inter-changeable and when ordering spares note should be made of the tuning scale fitted. With Wingrove & Rogers gangs the legend MHz appears centrally and with DAU gangs it is at the right end of the scale.
- 2 Chassis changed from Issue 6 to Issue 7.
- 3 Tuning drive changed.
- 4 Scale changed from B12233 to B12297 (see above).

- 5 Variable Resistor RV3 added.
- 6 R38 10K added.
- 7 Oscillator configuration altered resulting in:—
 - (a) L3 changed from 2 terminal to 3 terminal
 - (b) C25 changed from .002 to .001 μ F
 - (c) C18 changed from 20pF to 18pF.
- 8 Cores of L1, L2, L3, changed from 2 Neosid 900 and 1 Neosid 910 (L3) to 3 type 900.
- 9 L4 and L7 changed from G.B. Stock No. 750G to Toko type CAN 1980 BX. Stock No. 750Q.
- 10 C7 changed from 15pF to 13pF.

M12248 Issue 7 Printed Board

As issue 6 except tuning gang is Wingrove & Rogers CG80, Scale is B12233, C7 is 15pF and C18 is 20pF. Metalwork and tuning drive is as issue 4.

M12248 Issue 8 Printed Board

As issue 6 except TR10 and TR11 are each changed from 1 2N5306 to 2 BC109B or BC184K.

M12327 Issue 1 Printed Circuit Board, Serial No. 10,000 onwards

IC1, IC2, TR3 are removed and replaced by CA3089E as shown on relevant circuit diagram. If necessary the audio output from this board may be increased by modifying as issue 2 and setting RV3 for 100mV rms output at 22.5kHz deviation.

M12327 Issue 2 Printed Circuit Board

Link between pins 7 and 10 of CA3089E removed and pins 6 and 7 linked instead. R29 and R31 changed to 22k. This board was also redrilled to accommodate Jackson type C21 gang from serial no. 18900.

M12327 Issue 3 Printed Circuit Board

Drilling changed to accommodate Toko filter SFJ10.7 MA2.

Decoder

From Serial No. 540 onwards

R103 removed.

C105 changed to .015 μ F

L102 modified

R126 changed to 180 Ω

From Serial No. 900 onwards

R101 changed to 150 Ω

M12247 Issue 2 Printed Board

- 1 L101–5 changed from G.B. Stock No. 750G to Toko type CAN1980BX Stock No. 750Q—these are not interchangeable.

- 2 C105 changed from .015 to .01 μ F.

- 3 Diode type IS920 added between pin 2 of IC101 and Black interboard lead. (Anode of diode to pin 2). This reduces background noise when set is muted.

4 Alternative Transistors

TR103—BC143 changed to BC461 or BC303.

TR102—BC184K or BC109C.

TR103—BC154 or BC214C.

TR105—BC184K, BC109C or E5270.

IC101—MC1305P or SN76105.

M12307 Issue 2 Printed Board

From Serial No. 5885 onwards.

- 1 IC101 changed to MC1310P or SN76115.
- 2 No coils.
- 3 Power supply altered to eliminate HT setting pots.

Alternative transistors

Early tuners used type 40673 for both TR1 and TR2. For replacements use type 40822 for TR1 and 40823 or 3N205 for TR2.

INSTRUCTIONS FOR REPLACING DRIVE CORD

See Fig. 6A for tuners fitted with Wingrove & Rogers tuning capacitors or Fig. 6B for tuners with Dau or Jackson tuning capacitors.

Use nylon braided glass cored cord such as Finlayson size 20. Ensure that it does not come into contact with lubricant on pulley spindles.

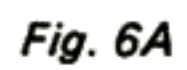
Remove front panel (4 screws) and tuning drum (2 grub screws). For tuners with Wingrove and Rogers capacitors take 16 inches (40 cm) OR for those with Dau capacitors take 26 inches (66 cm) of cord, knot one end and trim, then thread through hole (2).

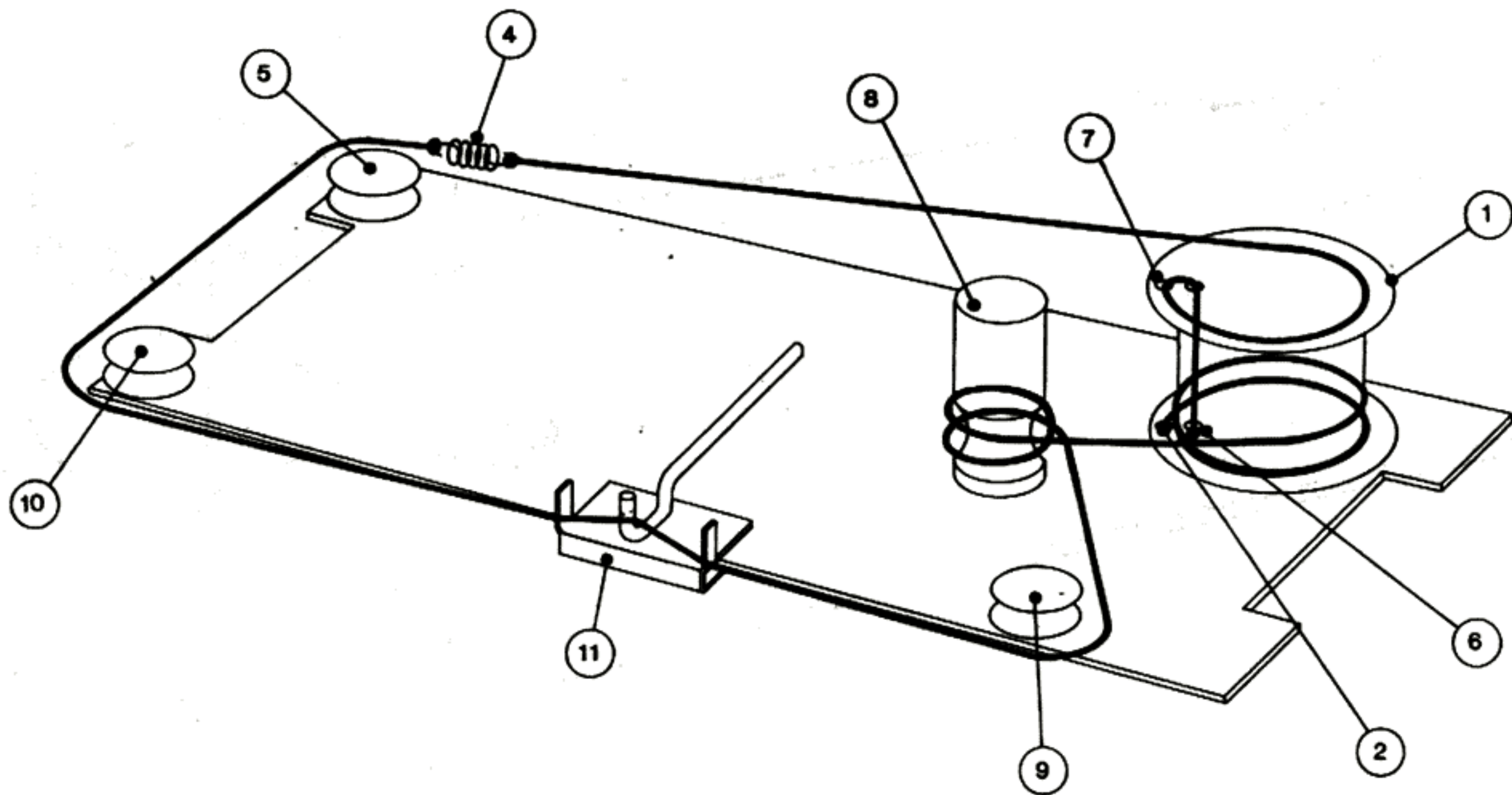
Take another length of cord, 30 inches (76 cm) long for Wingrove and Rogers OR 12 inches (30 cm) for Dau, knot one end and trim, then thread through hole (6) to outer edge of tuning drum (1) and through hole (7).

Turn tuning capacitor to fully closed position and replace tuning drum in position shown in Fig. 6. Lay the shorter length of cord around drum one turn in clockwise direction to pulley 3 for Wingrove and Rogers OR in anticlockwise direction for Dau, towards pulley (5). Attach free end of cord to spring (4), so that spring is approximately $\frac{1}{4}$ " from pulley (5). Remove surplus cord and loop free end of spring temporarily to pulley (5) spindle.

Take the other length of cord, and lay around tuning drum, $2\frac{1}{2}$ turns in anticlockwise direction for Wingrove and Rogers OR $1\frac{1}{2}$ turns in clockwise direction for Dau, to capstan (8), then 2 turns around capstan in clockwise direction to pulley (9), and around pulleys (10) and (5). Attach cord to free end of spring, extending spring about 25% and remove surplus cord.

Replace front panel, then with tuning capacitor fully closed, replace pointer (11) so that it lies at tuning knob end of scale line.





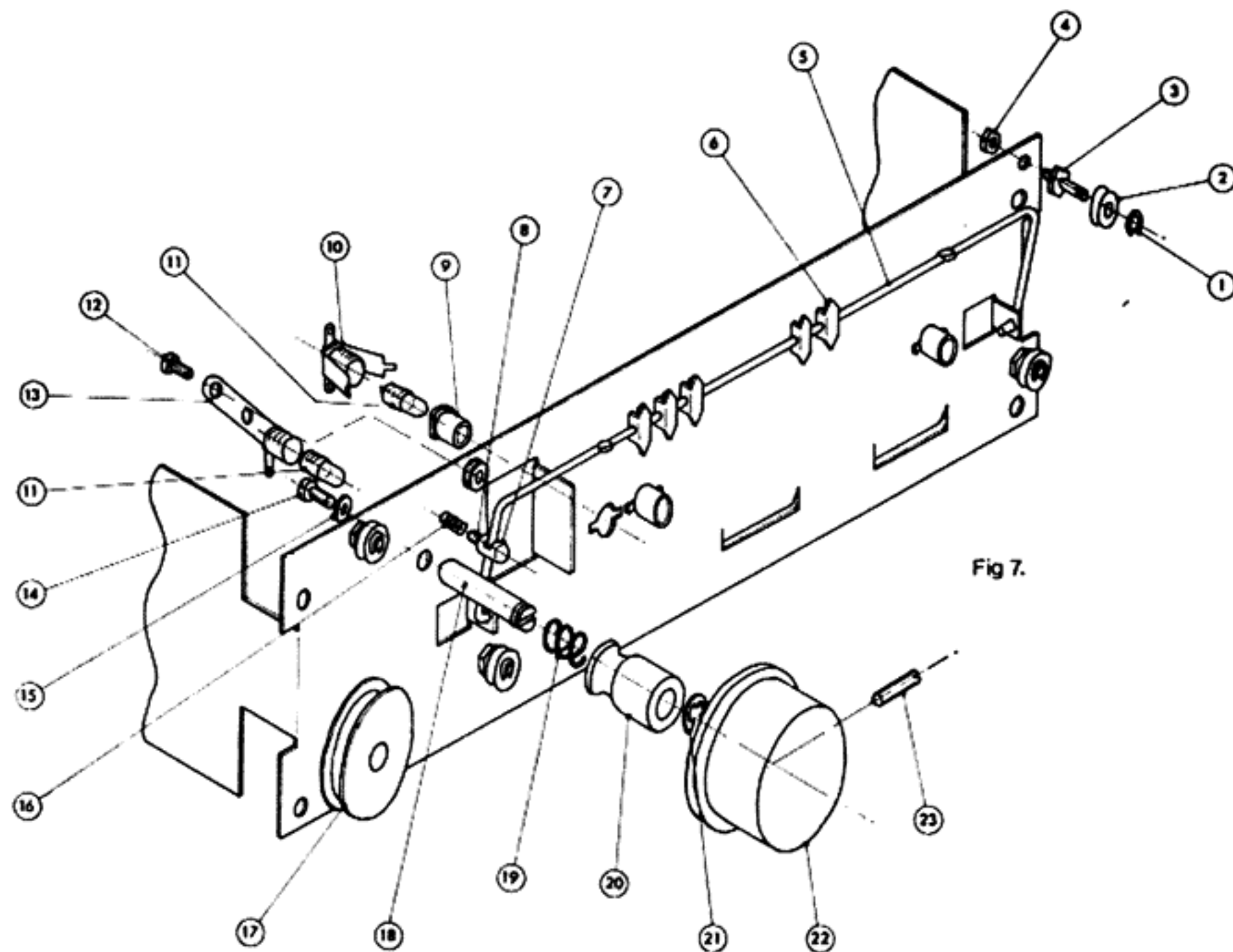
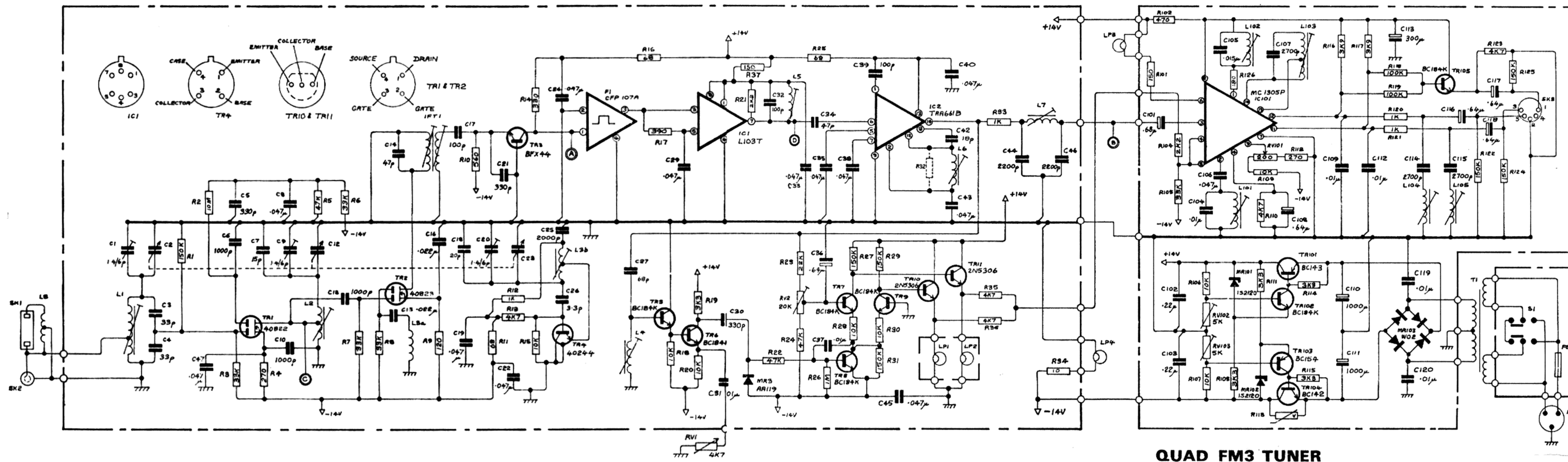


Fig 7.

<i>No.</i>	<i>Description</i>	<i>Stock No.</i>
1	Circlip	752/K
2	Pulley	748/Q
3	Pulley Spindle	A12208
4	6BA Nut	16/B
5	Station Marker Support	A12193
6	Station Marker	A12199
7	Tappet	A12234
8	6BA Grub Screw	7/G
9	Bush	752/L
10	Lampholder	691/H
11	Bulb	690/M
12	6BA Screw	80/D
13	Lampholder	691/K
14	4BA Screw	63/D
15	Friction Washer	103/D
16	Tappet Spring	12833
17	Tuning Drum	A12198
18	Support	A12168/3
19	Capstan Spring	31275
20	Capstan	A12168/2
21	Circlip	748/N-A
22	Knob	A12168/1
23	4BA Grub Screw	7/D

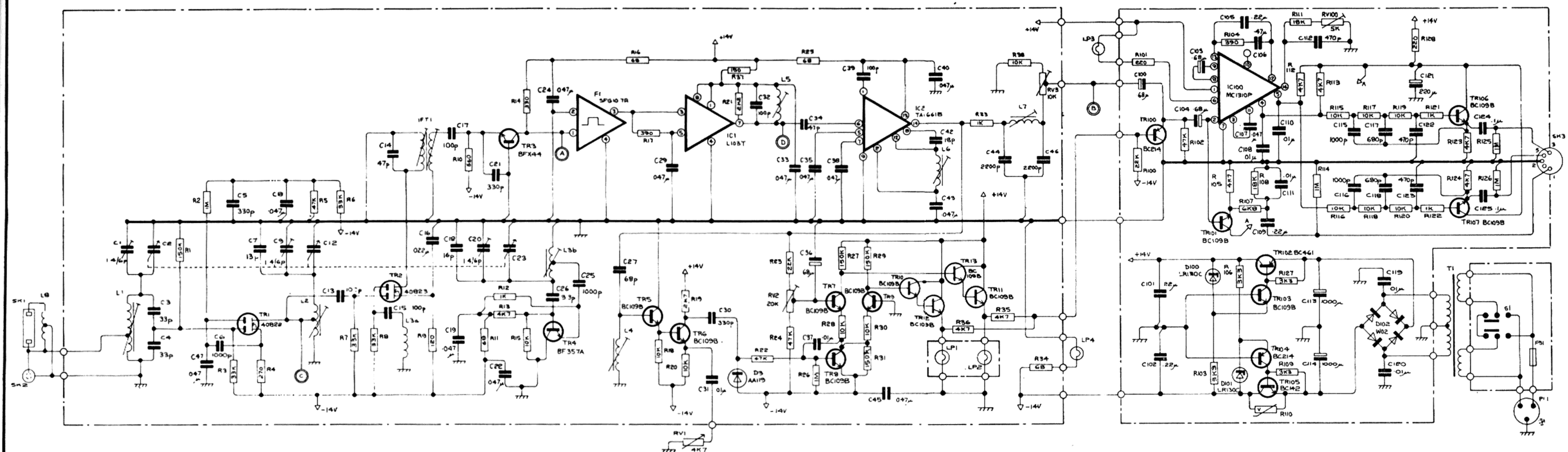


QUAD FM3 TUNER

No	VALUE	TOL	VOL	MAKERS	REFERENCE	STOCK No	No	VALUE	TOL	VOL	MAKERS	REFERENCE	STOCK No	No	VALUE	TOL	VOL	MAKERS	REFERENCE	STOCK No	No	VALUE	TOL	VOL	MAKERS	REFERENCE	STOCK No	No	VALUE	TOL	VOL	MAKERS	REFERENCE	STOCK No
R1	150K	±10%		ISKRA	UPM 1/4W	193/A	R107	10K	±10%		ISKRA	UPM 1/4W	230/M	C24	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I	C120	0.1μ			ERIE	APD	500/I	F1				MURATA	CP107A 92	506/H
R2	10M	±10%		ISKRA	UPM 1/4W	140/A	R108	3K5	±10%		ISKRA	UPM 1/4W	244/B	C25	2000p			HUNTS	8218	515/C	RVI	4K7			PLESSBY	TYPE MP 404/6/02852								
R3	53K	±10%		ISKRA	UPM 1/4W	203/D	R109	10K	±10%		ISKRA	UPM 1/4W	250/E	C26	33p			ERIE	APD	548/H	RV2	20K			MORGANITE	TYPE 62H OR PINER PTIOU								
R4	270	±10%		ISKRA	UPM 1/4W	283/A	R110	4K7	±10%		ISKRA	UPM 1/4W	260/F	C27	68p			ERIE		529/D														
R5	47K	±10%		ISKRA	UPM 1/4W	208/F	R111	3K5	±10%		ISKRA	UPM 1/4W	244/B	C28	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I	RVI01	200			MORGANITE	TYPE 62H OR PINER PTIOU								
R6	33K	±10%		ISKRA	UPM 1/4W	209/D	R112	870	±10%		ISKRA	UPM 1/4W	285/H	C29	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I	RVI02	5K			MORGANITE	TYPE 62H OR PINER PTIOU								
R7	33K	±10%		ISKRA	UPM 1/4W	209/D	R113				MULLARD	8 299 D/220	340/D	C30	330p	±20%		ERIE	APD	523/C	RVI03	5K			MORGANITE	TYPE 62H OR PINER PTIOU								
R8	33K	±10%		ISKRA	UPM 1/4W	209/D	R114	3K5	±10%		ISKRA	UPM 1/4W	244/B	C31	0.1μ		160V	TCC	PMX 1 OR ER0FOL 30 AT 1907-310/1	506/K														
R9	120	±10%		ISKRA	UPM 1/4W	300/B	R115	5K5	±10%		ISKRA	UPM 1/4W	244/B	C32	100p	±2%		IN LS																
R10	540	±10%		ISKRA	UPM 1/4W	265/A	R116	3K9	±2%		ISKRA	UPM 1/4W	241/D	C33	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I	TR1				ACA	40822								
R11	60	±10%		ISKRA	UPM 1/4W	307/B	R117	3K9	±2%		ISKRA	UPM 1/4W	241/D	C34	67p			LEMCO	7x4mm	534/A	TR2				ACA	40823								
R12	1K	±10%		ISKRA	UPM 1/4W	254/E	R118	100K	±2%		ISKRA	UPM 1/4W	200/C	C35	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I	TR3				MULLARD	BFX 44								
R13	4K7	±10%		ISKRA	UPM 1/4W	244/F	R119	100K	±2%		ISKRA	UPM 1/4W	200/C	C36	64μ			MULLARD	C246/RS/H064	489/A	TR4				ACA	40244								
R14	330	±10%		ISKRA	UPM 1/4W	260/C	R120	1K	±10%		ISKRA	UPM 1/4W	258/E	C37	0.1μ			TCC	PMX 1 OR ER0FOL 30NT 1807-310/1	506/K	TR5				TEXAS	INSTRUMENTS	BC 184K							
R15	10K	±10%		ISKRA	UPM 1/4W	250/E	R121	1K	±10%		ISKRA	UPM 1/4W	258/E	C38	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I	TR6				TEXAS	INSTRUMENTS	BC 184K							
R16	60	±10%		ISKRA	UPM 1/4W	307/B	R122	150K	±10%		ISKRA	UPM 1/4W	193/A	C39	100p			ERIE	APD	528/B	TR7				TEXAS	INSTRUMENTS	BC 184K							
R17	390	±10%		ISKRA	UPM 1/4W	273/A	R123	4K7	±10%		ISKRA	UPM 1/4W	244/F	C40	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I	TR8				TEXAS	INSTRUMENTS	BC 184K							
R18	10K	±10%		ISKRA	UPM 1/4W	230/E	R124	150K	±10%		ISKRA	UPM 1/4W	193/A								537/B													
R19	3K5	±10%		ISKRA	UPM 1/4W	244/B	R125	150K	±10%		ISKRA	UPM 1/4W	193/A	C41	33p	±5%		ERIE	APD	N330	500/I	TR11				QA	2N5306							
R20	10K	±10%		ISKRA	UPM 1/4W	250/E	R126	180	±10%		ISKRA	UPM 1/4W	290/B	C42	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I					QA	2N5306								
R21	2K2	±5%		ISKRA	UPM 1/4W	250/C								C43	2800p	±5%	125V	SUFLEX		514/M														
R22	47K	±10%		ISKRA	UPM 1/4W	208/F								C44	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I														
R23	28K	±10%		ISKRA	UPM 1/4W	217/A								C45	2800p	±5%	125V	SUFLEX		514/M														
R24	47K	±10%		ISKRA	UPM 1/4W	208/F								C46	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I														
R25	60	±10%		ISKRA	UPM 1/4W	307/B								C47	0.47μ	±5%	180V	LEMCO	LEMPLAC 12P	500/I														
R26	1M	±10%		ISKRA	UPM 1/4W	165/C																												
R27	150K	±10%		ISKRA	UPM 1/4W	193/A																												
R28	10K	±10%		ISKRA	UPM 1/4W	250/E																												
R29	150K	±10%		ISKRA	UPM 1/4W	193/A																												
R30	10K	±10%		ISKRA	UPM 1/4W	230/E																												
R31	150K	±10%		ISKRA	UPM 1/4W	193/A																												
R32	SELECTED ON TEST TO MATCH IC2 15K TO 150K																																	
R33	1K	±10%		ISKRA	UPM 1/4W	250/E																												
R34	10	±10%		ISKRA	UPM 1/4W	320/D																												
R35	4K7	±10%		ISKRA	UPM 1/4W	244/F																												
R36	4K7	±10%		ISKRA	UPM 1/4W	244/F																												
R37	150	±10%		ISKRA	UPM 1/4W	203/H																												
R101	150	±10%		ISKRA	UPM 1/4W	209/A																												
R102	470	±5%		ISKRA	UPM 1/4W	210/F																												
R104	2ME	±5%		ISKRA	UPM 1/4W	250/C																												
R105	33K	±10%		ISKRA	UPM 1/4W	209/D																												
R106	10K	±10%		ISKRA	UPM 1/4W	230/E																												
																																		</

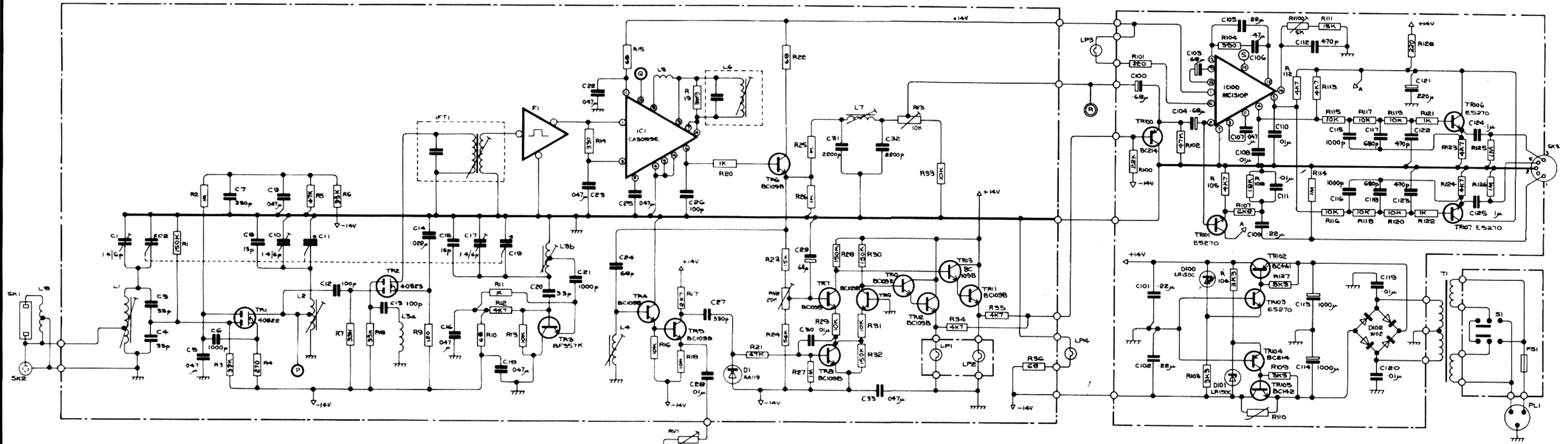
Circuit changes may be made from time to time without notice

FM3
Serial numbers 5885 to 10,000



No	VALUE	TOL	VOL	REFERENCE	STOCK No	No	VALUE	TOL	VOL	REFERENCE	STOCK No	No	VALUE	TOL	VOL	REFERENCE	STOCK No	No	VALUE	TOL	VOL	REFERENCE	STOCK No	No	VALUE	TOL	VOL	REFERENCE	STOCK No
R1	150K	±10%		ISKRA UPM 050	193A	R104	330	±5%		ISKRA UPM 050	275A	C10	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C11E	470p	±5%	160V	ERIE APD HI-K	500/1	D3				MULLARD AA119	450B
R2	1M	±10%		ISKRA UPM 050	165C	R105	4K7	±5%		ISKRA UPM 050	240H	C11B	1000p	±5%	25V	ERIE 21105-104-0102-0A-0250	450B	C11C	1000p	±5%	25V	ERIE 21105-104-0102-0A-0250	450B						
R3	33K	±10%		ISKRA UPM 050	209D	R106	3K3	±10%		ISKRA UPM 050	244B	C12	047p	±5%	160V	ERIE APD HI-K	500/1	C14	1000p	±20%	25V	ERIE APD HI-K	515/1	D100				AEI LR130C	515/1
R4	270	±10%		ISKRA UPM 050	209D	R107	6K8	±5%		ISKRA UPM 050	235D	C22	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C15	1000p	±20%	25V	ERIE APD HI-K	515/1	D101				AEI LR130C	515/1
R5	47K	±10%		ISKRA UPM 050	208F	R108	1K	±5%		ISKRA UPM 050	220C	C23	047p	±5%	160V	DAU 330/30	554/B	C16	1000p	±20%	25V	ERIE APD HI-K	515/1	D102				GENERAL INSTRUMENTS W02	520A
R6	33K	±10%		ISKRA UPM 050	209D	R109	3K3	±10%		ISKRA UPM 050	244B	C24	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C17	680p	±20%	25V	ERIE APD HI-K	515/1						
R7	33K	±10%		ISKRA UPM 050	209D	R110				MULLARD 1299DD/220	220C	C25	1000p	±5%	25V	ERIE 961	514/B	C18	680p	±20%	25V	ERIE APD HI-K	515/1						
R8	33K	±10%		ISKRA UPM 050	209D	R111	18K	±5%		ISKRA UPM 050	220C	C26	33p	±5%	25V	ERIE 961	514/B	C19	01u	±25%	250V	SIEMENS MKM B 32541	495/1						
R9	120	±10%		ISKRA UPM 050	300B	R112	4K7	±5%		ISKRA UPM 050	240H	C27	68p	±10%	160V	ERIE 8D	529D	C20	01u	±25%	250V	SIEMENS MKM B 32541	495/1						
R10	540	±10%		ISKRA UPM 050	265A	R113	4K7	±5%		ISKRA UPM 050	240H	C29	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C21	01u	±25%	250V	SIEMENS MKM B 32541	495/1						
R11	68	±10%		ISKRA UPM 050	307B	R114	1M	±10%		ISKRA UPM 050	165C	C30	330p	±20%	160V	ERIE APD	529C	C22	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R12	1K	±10%		ISKRA UPM 050	258E	R115	10K	±10%		ISKRA UPM 050	230E	C31	01u	±5%	250V	EROFOL 30KT 1807-3101	506/H	C23	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R13	4K7	±10%		ISKRA UPM 050	240F	R116	10K	±10%		ISKRA UPM 050	230E	C32	100p	±2%	160V	NLS	500/1	C24	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R14	330	±10%		ISKRA UPM 050	230E	R117	10K	±10%		ISKRA UPM 050	230E	C33	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C25	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R15	10K	±10%		ISKRA UPM 050	230E	R118	10K	±10%		ISKRA UPM 050	230E	C34	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C26	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R16	68	±10%		ISKRA UPM 050	307B	R119	10K	±10%		ISKRA UPM 050	230E	C35	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C27	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R17	330	±10%		ISKRA UPM 050	275A	R120	10K	±10%		ISKRA UPM 050	230E	C36	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C28	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R18	10K	±10%		ISKRA UPM 050	230E	R121	1K	±10%		ISKRA UPM 050	258E	C37	01u	±5%	250V	UNION CARBIDE KR 688 B5	499/B	C29	470p	±20%	250V	SIEMENS MKM B 32541	495/1						
R19	2K7	±10%		ISKRA UPM 050	240D	R122	1K	±10%		ISKRA UPM 050	258E	C38	01u	±5%	250V	EROFOL 30KT 1807-3101	506/H	C30	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R20	10K	±10%		ISKRA UPM 050	230E	R123	4K7	±5%		ISKRA UPM 050	240H	C39	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C31	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R21	2K2	±10%		ISKRA UPM 050	250C	R124	4K7	±5%		ISKRA UPM 050	240H	C40	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C32	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R22	47K	±10%		ISKRA UPM 050	208F	R125	1M	±10%		ISKRA UPM 050	165C	C41	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C33	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R23	22K	±10%		ISKRA UPM 050	217A	R126	1M	±10%		ISKRA UPM 050	165C	C42	18p	±5%	160V	ERIE APD N750	514/B	C34	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1						
R24	47K	±10%		ISKRA UPM 050	208F	R127	3K3	±10%		ISKRA UPM 050	244B	C43	047p	±5%	160V	ERIE APD N750	514/B	C44	2200p	±5%	160V	SUFLEX HS15/160	514/M						
R25	68	±10%		ISKRA UPM 050	307B	R128	220	±10%		ISKRA UPM 050	208A	C45	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C46	2200p	±5%	160V	SUFLEX HS15/160	514/M						
R26	1M	±10%		ISKRA UPM 050	165C							C47	047p	±5%	160V	LEMCO LEMPLAC 12P	500/1	C47	2200p	±5%	160V	SUFLEX HS15/160	514/M						
R27	150K	±10%		ISKRA UPM 050	193A	C1	146p			STEATITE R-TAKO 12-06-50	554D	C100	68p	±5%	100V	UNION CARBIDE KR 688 B5	499/B	C101	22p	±5%	100V	SIEMENS MKM B 32541	495/1						
R28	10K	±10%		ISKRA UPM 050	230E	C2				DAU 330/30	554/B	C102	22p	±5%	100V	SIEMENS MKM B 32541	495/1	C103	68p	±5%	100V	SIEMENS MKM B 32541	495/1						
R29	150K	±10%		ISKRA UPM 050	193A	C3	33p	±5%		ERIE APD N 330	537/B	C104	68p	±5%	100V	UNION CARBIDE KR 688 B5	499/B	C105	68p	±5%	100V	SIEMENS MKM B 32541	495/1						
R30	10K	±10%		ISKRA UPM 050	230E	C4	33p	±5%		ERIE APD N 330	537/B	C106	68p	±5%	100V	UNION CARBIDE KR 688 B5	499/B	C107	68p	±5%	100V	SIEMENS MKM B 32541	495/1						
R31	150K	±10%		ISKRA UPM 050	193A	C5	330p	±20%		ERIE APD	523/C	C108	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C109	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R32	1K	±10%		ISKRA UPM 050	258E	C6	1000p	±5%		ERIE 961	516/B	C110	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C111	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R33	68	±10%		ISKRA UPM 050	307B	C7	13p	±5%		ERIE APD N330	500/1	C112	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C113	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R34	4K7	±10%		ISKRA UPM 050	240F	C8	047p	±5%		LEMCO LEMPLAC 12P	500/1	C114	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C115	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R35	4K7	±10%		ISKRA UPM 050	240F	C9	146p	±5%		STEATITE R-TAKO 12-06-50	554D	C116	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C117	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R36	150	±10%		ISKRA UPM 050	258A							C118	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C119	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
R38	10K	±10%		ISKRA UPM 050	230E							C120	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C121	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C122	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C123	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C124	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C125	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C126	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C127	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C128	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C129	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C130	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C131	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C132	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C133	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C134	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C135	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C136	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C137	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C138	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C139	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C140	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C141	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C142	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C143	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C144	01u	±5%	250V	SIEMENS MKM B 32541	495/1	C145	01u	±5%	250V	SIEMENS MKM B 32541	495/1						
												C146	01u	±															

FM3
Serial numbers above 10,000

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