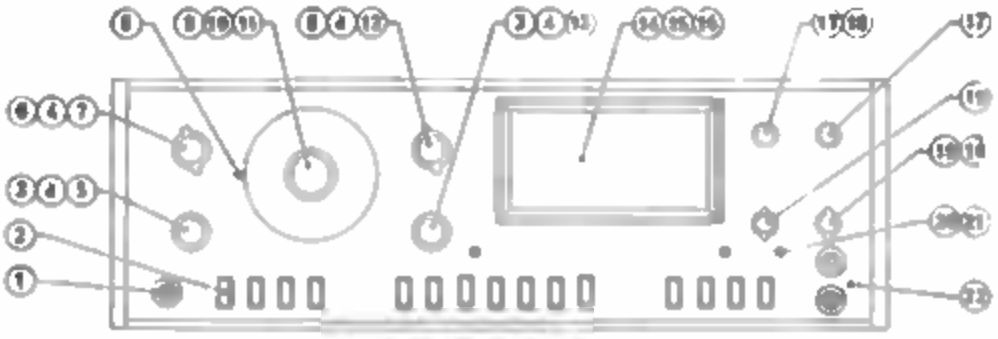
Appendix

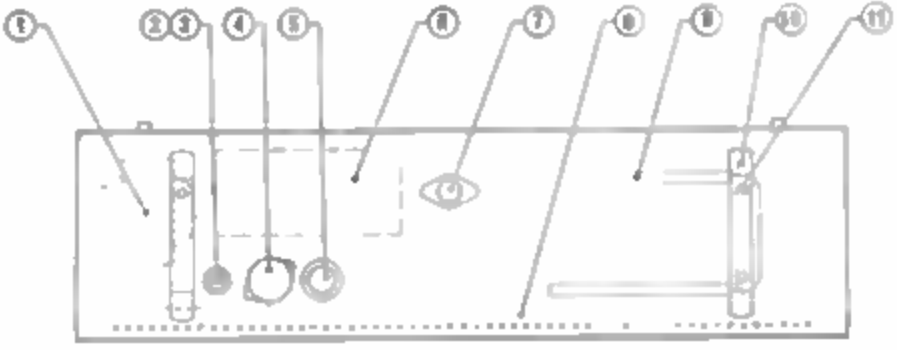


FRONT VIEW

Ref. Number	Item	RTS 2 Qty.	Part No.
1	Socket	3	692-030
2	Button	15	448-019
3	Knob K2	2	448-021
4	Bush	4	100-037
5	Extension Spindle	1	705-028F
6	Knob K2W	2	448-023
7	Extension Spindle	1	705-028D
8	Zero Stud	1	666-071
9	Knob K3	1	448-025
10	Dial	1	295-004
11	Potentiometer 10kΩ Logarithmic	1	582-033
12	Extension Spindle	1	705-028C
13	Extension Spindle	1	705-028E
14	Meter	1	512-005
15	Lamp Holder	1	455-008
16	Lamp Festoon 3W	1	455-010(12V)
17	Knob K1	2	448-022
18	Extension Spindle	2	705-028A
19	Knob K1W	2	448-026
20	Bush	3	100-038
21	Extension Spindle	3	705-029
22	Front Panel	1	573-178

World Radio History

FERROGRAPH
RECORDER TEST SET

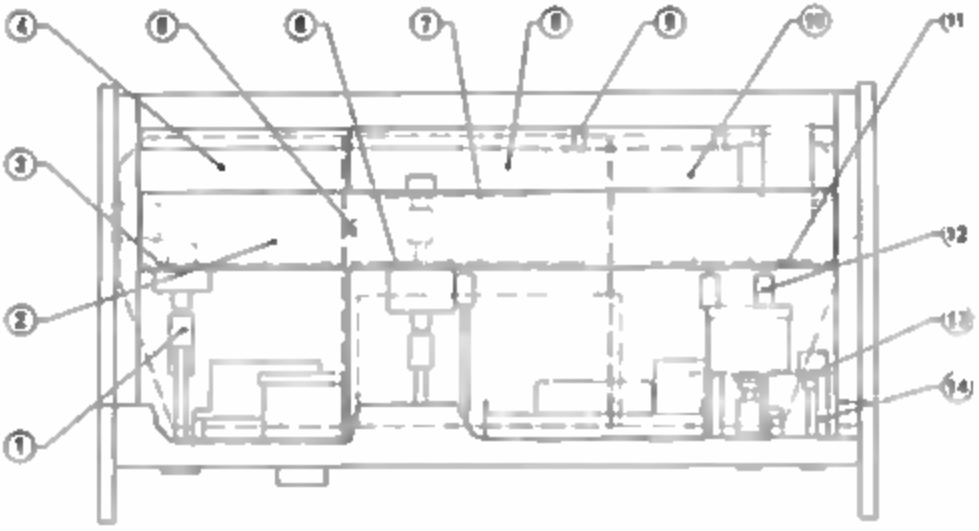


REAR VIEW

Ref. Number	Item	Qty.	RTS 2 Part No.
1	Mains Transformer	1	T1731
2	Fuse Holder	1	380-005
3	Fuse (0.75A, 20mm x 5mm dia.)	1	380-008
4	Voltage Selector	1	920-001
	Grommet	1	398-014
6	Power Board	1	025-310
7	Transistor (type 40312)	1	825-002
8	P.C. Board Support Bracket	1	035-355
9	Power Supply Lead	1	110-017
10	Cable Clip	2	196-011
11	Spacer	4	698-079

World Radio History

FERROGRAPH
RECORDER TEST SET

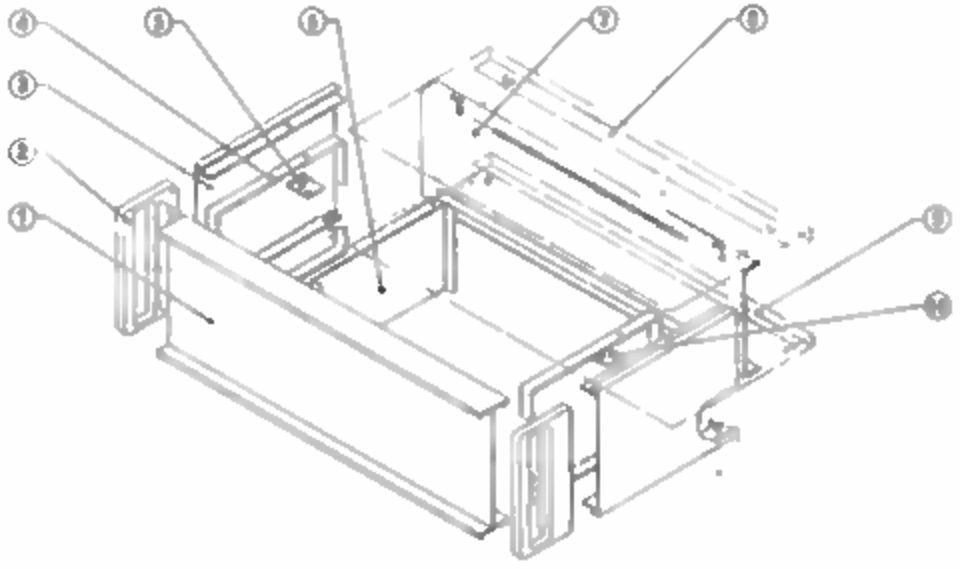


PLAN VIEW

Ref. Number	Item	RTS 2 Qty.	Part No.
1	Coupling	6	687-029
2	P.C. Board Fixing Strap	1	025-256
3	Oscillator Board	1	025-245
4	Oscillator Mother Board	1	025-247
5	Terminal Nut 4BA	1	BP/2025/N
6	Millivolmeter Board	1	025-246
7	Distortion Meter Board	1	024-244
8	Millivolmeter Mother Board	1	025-248
9	Spacer	9	690-068
10	Wow & Flutter Mother Board	1	025-311
11	Wow & Flutter Board	1	025-312
12	Coupling	3	202-005
13	Potentiometer Mounting Board	1	025-309
14	Spacer	4	690-069

World Radio History

FERROGRAPH
RECORDER TEST SET



EXPLODED VIEW

Ref. Number	Item	RTS2 Qty.	Part No.
1	Front Extrusion	1	573-180
2	Handle	2	412-002
3	Side Panel Extrusion	2	320-036
4	Hoop Frame	2	360-003
5	Bracket (top strap, L.H.)	1	025-254A
6	Screen	1	671-005
7	Rear Panel	1	573-177
8	Top Panel	1	573-143
9	Bottom Panel	1	573-144
10	Bracket (top strap, R.H.)	1	025-254B

World Radio History

List of Components

Ckt Ref	OSCILLATOR BOARD			Part No.
	Resistors (Ω & Potentiometers (RV))			
R1	2.2kΩ	¼W	1% High Stab.	025-26-2k2
R2	10kΩ	¼W	10%	025-13-10k
R3	10kΩ	¼W	5%	025-12-10k
R4	1.0kΩ	¼W	1% High Stab.	025-26-1k0
R5	680Ω	¼W	5%	025-12-680
R6	47kΩ	¼W	10%	025-13-47k
R7	200Ω	¼W	5%	025-12-200
R8	47kΩ	¼W	10%	025-13-47k
R9	0kΩ	¼W	1% High Stab.	025-26-0k
R10	820Ω	¼W	5%	025-12-820
R11	1.27kΩ	¼W	0.5% High Stab.	026-015
R12	4.32kΩ	¼W	0.5% High Stab.	026-014
R13	1.27kΩ	¼W	0.5% High Stab.	026-013
R14	43.2Ω	¼W	0.5% High Stab.	026-012
R15	13.7kΩ	¼W	0.5% High Stab.	026-011
R16	6.34kΩ	¼W	0.5% High Stab.	026-010
R17	100Ω	¼W	5%	025-12-100
R18	100Ω	¼W	5%	025-12-100
RV19	2.5kΩ Linear (OUTPUT + Freq)			062-030
	Capacitors			
C1	3300µF	40V	Electrolytic	130-020
C2	100µF	16V	Electrolytic	130-002
C3	100µF	16V	Electrolytic	130-002
C4	680pF	3kV	2½%	131-775
C5	0.01µF	3kV	2½%	131-774
C6	0.1µF	160V	1%	131-056
C7	1µF	160V	1%	131-015
C8	1µF	160V	1%	131-015
C9	0.1µF	160V	1%	131-056
C10	0.01µF	3kV	2½%	131-774
C11	680pF	3kV	2½%	131-775
	Miscellaneous			
VT1	Transistor BC183LB			023-013
VT2	Transistor BC184LB			023-010
VT3	Transistor BC183LB			023-013
SW1	Switch (OSC. OUTPUT control)			150-013
TH1	Thermistor ITT-K25			040-000
Ckt Ref.	PHASE PANEL			Part No.
	Potentiometers			
RV20a RV20b	50kΩ Lin.) PHASE 10kΩ Lin.)			062-031
	Miscellaneous			
M1	Meter (50-0-50µA)			510-005
LP1	Lamp 12V, 3W			055-010
SKT20	Socket BNC (1637/CB)			060-030
SKT21	Socket BNC (1637/CB)			060-030
SKT22	Socket BNC (1637/CB)			060-030

Ckt Ref	WOW & FLUTTER BOARD			Part No.
	Resistors (Ω & Potentiometers (RV))			
R31	3.3kΩ	¼W	1%	025-13-3k3
R32	1kΩ	¼W	1% High Stab.	025-26-1k
RV33	22kΩ	Linear SET ZERO		062-042
R34	4.99kΩ	¼W	1% High Stab.	025-26-4.99k
R35	4.99kΩ	¼W	1% High Stab.	025-26-4.99k
R36	3.3kΩ	¼W	5%	025-12-3k3
R37	8.6kΩ	¼W	5%	025-12-8k6
R38	10kΩ	¼W	10%	025-13-10k
R39	22kΩ	¼W	10%	025-13-22k
R40	47kΩ	¼W	5% High Stab.	026-001
R41	22kΩ	¼W	10%	025-13-22k
R42	3.3kΩ	¼W	5%	025-12-3k3
R43	200kΩ	¼W	1% High Stab.	025-26-200k
R44	22kΩ	¼W	10%	025-13-22k
R45	3.3kΩ	¼W	5%	025-12-3k3
R46	22kΩ	¼W	1% High Stab.	025-26-22k
R47	22kΩ	¼W	5%	025-12-22k
R48	22kΩ	¼W	10%	025-13-22k
R49	22kΩ	¼W	10%	025-13-22k
R50	1kΩ	¼W	10%	025-13-1k
R51	6.8kΩ	¼W	5%	025-12-6k8
R52	2.2kΩ	¼W	1% High Stab.	025-26-2k2
R53	10kΩ	¼W	10%	025-13-10k
RV54	10kΩ	Linear OMIT T		062-032
R55	22kΩ	¼W	10%	025-13-22k
RV56	22kΩ	Linear OMIT		062-031
R57	22kΩ	¼W	1% High Stab.	025-26-22k
R58	22kΩ	¼W	1% High Stab.	025-26-22k
R59	22kΩ	¼W	1% High Stab.	025-26-22k
R60	100kΩ	¼W	1% High Stab.	025-26-100k
R61	220kΩ	¼W	5%	025-12-220k
R62	1.0kΩ	¼W	1% High Stab.	025-26-1k0
R63	1kΩ	¼W	10%	025-13-1k0
R64	6.8kΩ	¼W	5%	025-12-6k8
R65	200kΩ	¼W	1% High Stab.	025-26-200k
R66	100kΩ	¼W	1% High Stab.	025-26-100k
R67	1.0kΩ	¼W	1% High Stab.	025-26-1k0
R68	22kΩ	¼W	10%	025-13-22k
R69	22kΩ	¼W	10%	025-13-22k
RV70	47kΩ	¼W	10%	062-029
C31	1000µF	63V	2½%	131-760
C32	1000µF	63V	2½%	131-760
C33	0.22µF	100V	10%	131-253
C34	0.22µF	100V	10%	131-253
C35	0.22µF	100V	10%	131-253
C36	680pF	63V	2½%	131-775
C37	680pF	63V	2½%	131-775
C38	680pF	63V	2½%	131-775
C39	680pF	63V	2½%	131-775

World Radio History

List of Components

Ckt Ref.	WOW & FLUTTER BOARD				Part No.
	Capacitors				
C30	910pF	63V	2%		131-775
C31	0.01µF	35V	2%		131-776
C32	0.047µF	250V	10%		131-250
C33	0.22µF	100V	10%		131-253
C34	0.22µF	100V	10%		131-253
C35	0.1µF	100V	10%		131-252
C36	0.047µF	250V	10%		131-255
C37	0.047µF	250V	10%		131-255
C38	0.047µF	250V	10%		131-255
C39	25µF	25V	Electrolytic		130-010
C40	1µF	250V	10%		131-260
C41	25µF	25V	Electrolytic		130-010
C42	0.22µF	100V	10%		131-253
C43	13 5µF	25V	Electrolytic		130-006
C44	13 5µF	25V	Electrolytic		130-006
	Semiconductors				
VT11	Transistor	BC184L.C			025-006
VT12	Transistor	BC184L.C			025-006
VT13	Transistor	BC184L.C			025-006
VT14	Transistor	BC183L.B			025-015
VT15	Transistor	BC183L.B			025-015
VT16	Transistor	BC183L.B			025-015
VT17	Transistor	BC184L.C			025-006
VT18	Transistor	BC184L.C			025-006
VT19	Transistor	BC184L.C			025-006
VT20	Transistor	BC183L.B			025-015
MR1	Diode MAK10				200-001
MR2	Zener Diode BZY88C12				200-017
MR3	Diode RCT 3A4L20				200-019
MR4	Zener Diode BZY88C5V6				200-015
MR5	Zener Diode BZY88C6V7				200-016
MR6	Zener Diode BZY88C6V7				200-016
MR7	Zener Diode BZY88C6V7				200-016
MR8	Diode RCT 3A4L20				200-019
MR9	Diode RCT 3A4L20				200-019
L1	Coil				Spec. 000

Ckt Ref.	POT. MOUNTING BOARD				Part No.
	Resistors(W) & Potentiometers(RV)				
R91	10kΩ	¼W	1%	High Stab.	035-26-10k
RV92	2kΩ 10 turn	BAL. ANGE		phase	202-005
R93	3.9kΩ	¼W	5%		035-13-3k9
RV94a	10kΩ Lin.	(freq.		course)	202-033
RV94b	10kΩ Lin.				
R95	3.9kΩ	¼W	5%		035-13-3k9
R96	33kΩ	¼W	5%		035-13-33k
RV97a	10kΩ Log.	(freq.	fine)		202-036
RV97b	10kΩ Log.				
R98	33kΩ	¼W	5%		035-13-33k

Ckt Ref.	POT. MOUNTING BOARD				Part No.
	Capacitors				
C81	0.033µF	250V	1%		131-260
	Miscellaneous				
SW10	Switch SUPPLY on				730-004

Ckt Ref.	DISTORTION METER BOARD				Part No.
	Resistors(W) & Potentiometers(RV)				
RV101	22kΩ	Linear	SET	1kΩ CAL	202-015
R104	47kΩ	¼W	5%	High Stab.	035-001
R105	47kΩ	¼W	5%	High Stab.	035-001
R106	39kΩ	¼W	1%	High Stab.	035-26-39k
R107	36kΩ	¼W	1%	High Stab.	035-26-36k
R108	10kΩ	¼W	10%		035-13-10k
R109	4.7kΩ	¼W	1%	High Stab.	035-26-4k7
R110	10kΩ	¼W	1%	High Stab.	035-26-10k
R111	6.8kΩ	¼W	1%	High Stab.	035-26-6k8
RV112	22kΩ	Linear	SET	Meter CAL	202-015
RV111	100kΩ	Log.	SET	100%	202-032
R113	1kΩ	¼W	10%		035-13-1k
R114	22kΩ	¼W	1%	High Stab.	035-26-22k
R116	33kΩ	¼W	1%	High Stab.	035-26-33k
R133	1.8kΩ	¼W	5%		035-13-1k8
R134	22kΩ	¼W	1%	High Stab.	035-26-22k
R117	47kΩ	¼W	5%	High Stab.	035-001
R118	100Ω	¼W	5%		035-13-100
R119	3.3kΩ	¼W	5%		035-13-3k3
R120	1.8kΩ	¼W	1%	High Stab.	035-26-1k8
RV121	1kΩ	Linear	SET	PHASE BAL.	202-002
R122	1kΩ	¼W	1%	High Stab.	035-26-1k
R123	1.8kΩ	¼W	5%		035-13-1k8
R124	10kΩ	¼W	10%		035-13-10k
R125	100kΩ	¼W	5%	High Stab.	035-003
R126	270Ω	¼W	5%		035-13-270
R127	47kΩ	¼W	5%	High Stab.	035-001
R128	10kΩ	¼W	10%		035-13-10k
R129	1.8kΩ	¼W	5%		035-13-1k8
	Capacitors				
C81	0.1µF	100V	10%		131-250
C82	0.1µF	100V	10%		131-250
C83	560µF	25V	Electrolytic		130-006
C84	25µF	25V	Electrolytic		130-010
C85	0.01µF	250V	10%		131-250
C86	0.033µF	250V	10%		131-256
C87	25µF	25V	Electrolytic		130-010
C88	4700pF	35V	2%		131-770
C89	0.47µF	250V	10%		131-260

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List of Components

Ckt Ref	DISTORTION METER BOARD	Part No.
	Miscellaneous	
VT34	Transistor BC169LB	035-001
VT35	Transistor BC169LB	035-001
VT36	Transistor 2 SC 1000 BL	035-035
VT37	Transistor BC183LB	035-015
VT38	Transistor 2 SC 1000 BL	035-035
VT39	Transistor 2 SC 1000 BL	035-035
VT37	Transistor 2 SC 1000 BL	035-035
MR31	Zener Diode BZY 88 C 5V6	350-013
MR32	Diode MAJ 10	350-001

Ckt Ref	MILLIVOLTMETER BOARD	Part No.
	Resistors (5% & Potentiometers unless otherwise stated)	
R141	22k ¼W 5%	020-13-23
R142	2kΩ ¼W 0.1% High Stab.	020-010
R143	200Ω ¼W 0.1% High Stab.	020-007
R144	1kΩ ¼W 5%	020-13-1k
R145	100k ¼W 5% High Stab.	020-20-100
R146	1kΩ ¼W 5%	020-13-1k
R147	10kΩ ¼W 5%	020-13-10k
R148	1kΩ ¼W 5% High Stab.	020-20-1k
R149	270kΩ ¼W 5%	020-13-270k
R150	1 kΩ ¼W 5% High Stab.	020-20-1k0
R151	470Ω ¼W 14%	020-13-470
RV152	2kΩ Level Preset 0.5W	030-030
R153	6.34Ω ¼W 0.1% High Stab.	020-010
R154	13.7Ω ¼W 0.1% High Stab.	020-011
R155	43.2Ω ¼W 0.1% High Stab.	020-012
R156	137Ω ¼W 0.1% High Stab.	020-011
R157	432Ω ¼W 0.1% High Stab.	020-014
R158	1.37kΩ ¼W 0.1% High Stab.	020-011
R159	470Ω ¼W 14%	020-13-470
R160	10kΩ ¼W 14%	020-13-10k
R161	100kΩ ¼W 5% High Stab.	020-002
R162	100kΩ ¼W 5% High Stab.	020-002
R163	47Ω ¼W 5% High Stab.	020-20-47
R164	470kΩ ¼W 14%	020-13-470k
R165	620Ω ¼W 5%	020-13-620
R166	10kΩ ¼W 5%	020-13-10k
R167	1 kΩ ¼W 14%	020-13-1k0
R168	1kΩ ¼W 5% High Stab.	020-20-1k
R169	1kΩ ¼W 5% High Stab.	020-20-1k
R170	100k ¼W 5%	020-13-100
R171	220kΩ ¼W 14%	020-13-220k
R172	470kΩ ¼W 14%	020-13-470k
R173	1kΩ ¼W 5%	020-13-1k
R174	10kΩ ¼W 5%	020-13-10k

Ckt Ref	MILLIVOLTMETER BOARD	Part No.
	Resistors (5% & Potentiometers unless otherwise stated)	
R175	10kΩ ¼W 5%	020-13-10k
R176	100Ω ¼W 5%	020-13-100
	Capacitors	
C61	5000pF 100V 10%	131-706
C62	0.01µF 30V 2½%	131-776
C63	Variable Ceramic	130-004
C64	100µF 25V Electrolytic	130-011
C65	125µF 16V Electrolytic	130-002
C66	1µF 64V Electrolytic	130-007
C67	25µF 40V Electrolytic	130-013
C68	0.12µF 100V 10%	131-253
C69	0.1µF 400V 10%	131-516
C70	0.022µF 250V 10%	131-258
C71	0.12µF 100V 10%	131-253
C72	0.12µF 100V 10%	131-253
C73	1µF 64V Electrolytic	130-007
C74	0.047µF 250V 10%	131-258
C75	0.1µF 100V 10%	131-250
C76	100pF 100V 10%	131-706
C77	25µF 25V Electrolytic	130-005
C78	25µF 25V Electrolytic	130-005
C79	25µF 25V Electrolytic	130-005
C100	12.5µF 25V Electrolytic	130-025
C101	0.12µF 100V 10%	131-253
C102	125µF 25V Electrolytic	130-002
C103	100µF 25V Electrolytic	130-011
	Miscellaneous	
VT51	Transistor 2 BM2907	035-005
VT52	Transistor BC109LC	035-005
VT53	Transistor BC183LB	035-015
VT54	Transistor BC183LB	035-015
VT55	Transistor BC183LB	035-015
VT57	Transistor BC183LB	035-015
MR31	Zener Diode BZY 88 C5V6	350-013
MR32	Diode MAJ10	350-001
MR33	Diode MAJ10	350-001
MR34	Diode MAJ10	350-001
MR35	Zener Diode BZX 79 C3V	350-011
spare	Switch MILLIVOLTMETER	150-014

Ckt Ref	POWER BOARD	Part No.
	Resistors (5% & Potentiometers unless otherwise stated)	
R101	33kΩ ¼W 5% High Stab.	020-20-33k
RV102	1kΩ Level Preset 25V D.C.	030-032
R103	4.32kΩ ¼W 5% High Stab.	020-20-4k3
R104	3.3kΩ ¼W 5%	020-13-3k3
R105	100kΩ ¼W 14%	020-13-100k
R106	10kΩ ¼W 14%	020-13-10k

World Radio History

List of Components

Ckt Ref	POWER BOARD	Part No.
	Capacitors	
C131	100µF 40V Electrolytic	130-089
C132	0.01µF 100V 10%	131-999
C133	220µF 6V Electrolytic	130-010
	Miscellaneous	
VT71	Transistor BC183L-B	035-015
VT72	Transistor BC461	035-033
MR84	Zener Diode BZY 88C 5V6	200-013
MR85	Bridge Rectifier WO8	200-002

Ckt Ref	REAR PANEL	Part No.
VT71	Transistor 40212	035-007
T1	Transformer, Power Supply	T1731
FS1	Fuse 0.75A, 20mm x 5mm dia	200-008
VS1	Voltage Selector	030-001

Ckt Ref	19 & 9" MOTHER BOARD	Part No.
RJ11	68k	1% High Stab.	035-30-680
RJ12	137k	0.5% High Stab.	035-013
SW25	Push Button Switch 19 inch & 9"	700-001
SKT20	P.C. Board Socket - 28 way	002-028

Ckt Ref	OSCILLATOR MOTHER BOARD	Part No.
SW15	Push Button Switch FREQUENCY	700-001
SKT1	P.C. Board Socket - 28 way	002-028

Ckt Ref	VOLUME TRACKER MOTHER BD.	Part No.
SW30	Push Button Switch	700-001
SKT10	P.C. Board Socket - 28 way	002-028
SKT11	P.C. Board Socket - 28 way	002-028

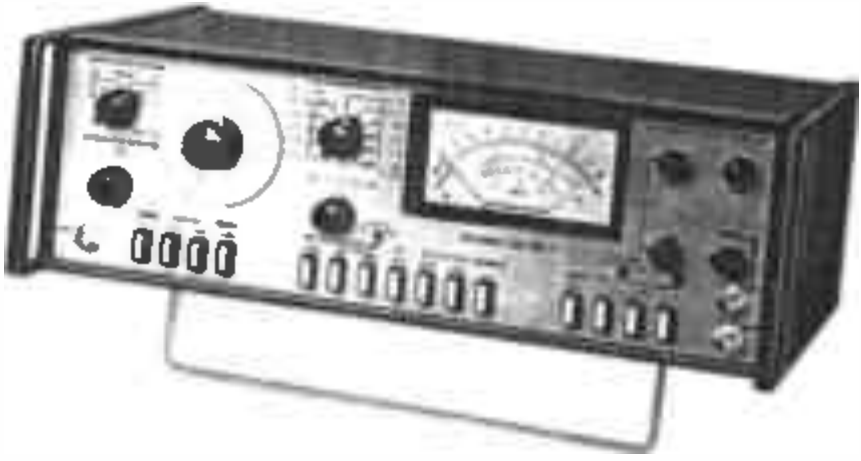
REPLACEMENT BOARD SERVICE

Where it is found necessary to change an electronic component, the RTS2 should be checked and re-calibrated using test equipment which is several times more accurate than the Test Set itself. If this equipment is not available or if difficulty is experienced, the relevant P.C. board(s) can be sent for checking or replacement to the Ferrograph 'Replacement Board Service'.

When returning the board(s) to the appropriate overseas agent, or in the U.K. to the South Shields Service Department, it is <u>essential</u> to include the SERIAL NUMBER of the Test Set.

World Radio History

OPERATING INSTRUCTIONS



FERROGRAPH

RECORDER TEST SET

RTS2

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Contents

THE FERROGRAPH COMPANY LIMITED
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What it is

The Ferrograph Recorder Test Set, RTS2, is a compact and inexpensive instrument that enables all the essential performance parameters of a magnetic tape recorder to be measured. It is supplied complete with a power supply lead, signal input and output leads, a 40 dB attenuator and a test tape. Except for a power supply, nothing extra is needed in order to make a wide range of measurements, including :—

Frequency Response	Signal-to-noise Ratio
Distortion	Wow and Flutter
Drift	Gain
Sensitivity	

The Test Set is equally useful for carrying out similar measurements on other audio apparatus, including amplifiers, disc reproducers and sound-on-film equipment.

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What it does

The Recorder Test Set, RTS2 is intended primarily for use by those concerned with operating and maintaining tape recorders and similar equipment. It provides them with a ready means of determining the standard of performance reached by a given machine or item of equipment in all the respects mentioned in the preceding section.

To enable so many different kinds of measurement to be carried out by a single inexpensive instrument, it has been necessary to rationalise the design so that the essential minimum of electronic circuitry is re-arranged into various circuit configurations by means of push-buttons. This also has the effect of making the Test Set notably simple and quick to operate.

In the interest of simplicity and cheapness, it has also been necessary to eliminate a number of features that, desirable though they may be for laboratory standardisation or investigational measurements, are not essential for the purposes for which this Test Set is intended. Thus, both input and output circuits are unbalanced† and the single indicating instrument is an average meter calibrated in r.m.s. values for sinusoidal signals. Also, total harmonic distortion is measured by means of a fundamental-rejection filter - this is all that is required for determining whether mid-band distortion is within proper limits and for establishing the 2% or 3% distortion levels from which signal-to-noise ratios are usually reckoned.

Nevertheless, in spite of this rigorous simplification, the Recorder Test Set contains its own built-in facilities for checking calibration in each of its various modes without the use of external equipment. In addition, the distortion and the wow and flutter signals are not only measured by the meter but are also available on a socket on the front panel. Consequently, the use of the Test Set as an investigational tool can be extended by the use of additional external equipment such as an oscilloscope, a wave analyser or filters.

†With the addition of a RTS Auxiliary Unit, balanced input and outputs are also available.

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What it contains

The Recorder Test Set, RTS2, consists essentially of three parts:—

(1) A power supply unit that enables the instrument to operate on alternating current of either 105 to 120 volts or 200 to 250 volts and at either 50 Hz or 60 Hz.

(2) A variable frequency oscillator and variable attenuator that enable a sine wave test signal (16 Hz to 150 kHz and about 0·03 mV to 3V) to be fed (from the Test Set's "oscillator" socket) to the equipment under test.

(3) A millivoltmeter which, with its associated electronics, measures either the output from the equipment under test (fed into the Test Set's "meter" socket) or the output signal of the Test Set itself.

The electronics associated with the millivoltmeter are selected by push buttons on the front panel to enable it to measure:—

(a) voltages to the range 1 mV to 100 V, full scale deflection.

(b) the distortion products of a sinusoidal test signal in the range 400 to 1100 Hz approx. For this purpose a tunable fundamental-rejection filter is switched into circuit.

(c) drift and peak wow and flutter weighted to D.I.N. 45507. When switched for these measurements, the Test Set provides a 3·15 kHz* test signal from its "oscillator" socket.

In addition, the Test Set contains built-in facilities for checking and, if necessary, adjusting calibration for each type of measurement.

* Note: Model RTS2A provides a 3 kHz test signal.

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Operating Instructions

1. CONNECTING UP AND SWITCHING ON

1.1. Power Supply Connections

Check whether the voltage selector at the back of the Test Set is set to the appropriate voltage range, 105-120 V or 200-250 V. If it is not, pull the selector knob outwards, rotate it to the required position and then press it home again firmly but gently.

No adjustment for supply frequency in the range 50-60 Hz (approx.) is required.

The power lead attached to the Test Set should be connected, through an appropriate plug, to the power supply (A.C. only).

1.2. Signal Connections

The BNC socket marked "oscillator" should be connected to the input of the equipment under test.

If the external 40 dB Attenuator is required, the 'flying' lead should be connected to the "oscillator" socket and the connecting cable to the Attenuator.

The BNC socket marked "meter" should be connected to the output of the equipment under test.

Note 1. Cables for connecting the Test Set to the Line Input and Line Output sockets of a Ferrograph Series 7 recorder are supplied. These leads are irreversible and ensure that the 'earthy' sides of the Test Set and the recorder input and output circuits are connected together. When other leads or other end connectors are used, care must be taken to ensure that this condition still obtains.

Note 2. Since the Test Set has a common earth path between input and output sockets, great care should be taken to ensure that this does not result in a small part of the audio output current flowing through the input earth. When high sensitivity inputs are being used, this could give rise to spurious noise or distortion readings. These can usually be prevented by the insertion of a small resistor (*e.g.* 100 ohm) in series with the "meter" input earth lead.

1.3. Switching On and Off

The Test Set is switched on by turning to "on" the "SUPPLY" knob at the right of the front panel. The meter is illuminated to show when power has been applied.

2. CHECKING AND ADJUSTING CALIBRATION

2.1. General

For this purpose it does not matter whether the Test Set is connected to the equipment to be tested or not. It is recommended, however, that the power supply should have been switched on for at least 5 minutes before calibration in the Drift and the Wow and Flutter modes is checked.

The adjustments are not interdependent and can be carried out individually.

After the Test Set had been switched on, the procedures are as follows :—

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2.2. Millivoltmeter Calibration

(1) Set the "MILLIVOLTMETER" switch to the "1 V" position.

(2) Press down the "read input" push button. (This releases the button to its left and the three buttons to its right.)

(3) Press down the "CALIBRATE" push button.

(4) The meter pointer should now lie on the CAL mark above the outer scale. If it does not, adjust it to do so by means of the screwdriver-operated control marked "mV meter cal (1 V range)".

(5) Press the "CALIBRATE" push button to release it.

Note: When this adjustment has been carried out, the meter, with the "MILLIVOLTMETER" switch to the "1 V" position, measures voltage on the top scale with full scale deflection of 1 V. Movement of the "MILLIVOLTMETER" switch adjusts the meter sensitivity to give full scale deflection for inputs of 1 mV to 100V, as indicated on the switch, reading on the appropriate one of the two upper scales.

For setting the meter to read arbitrarily, see 3.4. below

2.3. Drift Calibration

(1) Press down the "W & F drift" push button. This releases the two buttons on either side and applies a 3.15 kHz* test signal to the "oscillator" socket and to the meter circuits.

(2) Press down the "CALIBRATE" and the "WOW & FLUTTER drift" push buttons (thus releasing the "1%", "0·3%" and "0·1%" buttons).

(3) The meter pointer should now read 0 on the "drift %" scale. If it does not, adjust it to do so by means of the screwdriver-operated, pre-set control marked "drift set zero".

(4) Press down the "CALIBRATE" push button to release it.

The meter will now measure drift directly on the "drift %" scale.

2.4. Wow and Flutter Calibration

(1) With the "W & F drift" push button still pressed down (see above), press down the "CALIBRATE" and the "0·3%" push buttons (releasing the "drift", "1%" and "0·1%" buttons)

(2) The meter pointer should now lie on the CAL mark above the top scale. If it does not, adjust it to do so by means of the screwdriver-operated pre-set control marked "peak wow cal (0·3% range)".

(3) Press down the "CALIBRATE" push button to release it.

The meter will now read percentage wow and flutter (0·3% f.s.d.) on the next to top scale.

Pressing down the "1%" or "0·1%" button will release the "0·3%" button and the meter will then read percentage wow and flutter on the top scale with f.s.d. 1% or 0·1%

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3. MAKING MEASUREMENTS

3.1. Preparing to Measure

In the following it is assumed that the gain controls on the equipment under test have been set for normal operating conditions. It is also assumed that the input and output signal voltages under these conditions are, at least approximately, known. If this is not the case then, initially, the "OSCILLATOR OUTPUT coarse" switch should be set to its lowest (10 mV) position and the "MILLIVOLTMETER" switch to its highest (100 V) position. When connecting to a microphone input socket, the external 40 dB Attenuator should be inserted between the Test Set and the equipment under test (see 1.2).

The "OSCILLATOR OUTPUT coarse" control should then be turned clockwise, step by step, until a proper operating level has been obtained. If this requires the "OSCILLATOR OUTPUT coarse" control to be set higher than 3V, then the 40 dB Attenuator should be removed from the output. (When testing a Ferrograph Series 7 recorder this is shown by the reading of the VU meter when it is switched to *Source*.)

With a proper output level from the equipment under test (shown on a Ferrograph Series 7 recorder by the reading of the VU meter when it is switched to *Tape*) the "MILLIVOLTMETER" switch on the Test Set should be turned *anti-clockwise* step by step, until a convenient reading on the meter is obtained.

3.2. Measuring Frequency Response

(1) Set the "OSCILLATOR OUTPUT coarse" switch to an appropriate position (see 3.1 above) and the "OSCILLATOR OUTPUT fine" control to about mid-position.

(2) Set the "FREQ" control to 100 and press down the "FREQUENCY" range selecting button below it marked "X 10".

The Test Set is now delivering a 1 kHz test signal to the equipment under test. The level of this signal can be controlled in steps by the "OSCILLATOR OUTPUT coarse" control and, continuously, by the "OSCILLATOR OUTPUT fine" control. Once adjusted at 1 kHz, the adjustment must not be varied throughout the rest of this test.

(3) Press down the "Input" push button and check that the "LF cut" and "CALIBRATE" buttons are both released.

The Test Set will now measure the output voltage from the equipment under test (see Note to 2.2.).

(4) The frequency of the test signal can be changed by means of the "FREQ" control and the range selecting push buttons below it. The output level at various frequencies can be read on the meter, its sensitivity being increased or decreased, if required, by use of the "MILLIVOLTMETER" switch (see Note to 2.2.).

A plot of output voltage against frequency shows the frequency response of the equipment under test.

Note 1: When making frequency response and similar measurements, it is usually convenient to have the meter reading 0 on the dB scale, or some other round number, at a chosen reference frequency, say 1 kHz. Normally this is done by using the "OSCILLATOR OUTPUT fine" control to adjust the level of the input signal to the equipment under test or by a fine adjustment of its gain control.

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When neither of these things can be done, as, for example, when reproducing a pre-recorded tape on equipment with no output level control, the meter reading may be adjusted to a convenient reference value by pressing down the "DISTORTION set 100%" push button (thus releasing the "Input" push button) and adjusting the meter to the required reading by use of the "DISTORTION METER set 100%" control. The meter will now indicate relative levels e.g. in decibels, at the various frequencies but it will not, of course, read in volts or millivolts.

The "MILLIVOLTMETER" control should only be used on the distortion meter ranges of "0-3%" to "100%". In view of the extreme sensitivity (100μ V) of the "0-1%" range, this should not be used for reading voltages with the "DISTORTION 100%" button pressed.

Note 2: When making frequency response measurements on magnetic tape recorders, it is essential that the input signal level shall be at least 20 dB below that which will give full level recording at 1 kHz. Similar restrictions on the permissible level of test signals apply to some other types of equipment.

Note 3: When testing a tape recorder that cannot record and reproduce simultaneously, it is necessary first to record a series of test frequencies (with a fixed input signal level) and then to measure output levels of the various frequencies when this recording is reproduced.

The above procedures will measure the overall response of a tape recorder. To determine whether the reproducing frequency response is correct, it is necessary to measure the output levels of various frequencies when reproducing a standard test tape on which the various frequencies have been recorded at the levels prescribed by the appropriate Standard.

2.2. Measuring Drift

(1) Press down the "W & F drift" button and also the "drift" button under the "WOW & FLUTTER" heading.

The Test Set is now delivering a 3·15 kHz* test signal to the recorder under test.

(2) Set the recorder controls so that this signal is recorded at a normal level for, say, 40 seconds. Stop the machine, and rewind the tape to the beginning of the recording.

(3) Reproduce this recording.

Note: The level of the signal reaching the Test Set should not be less than 75 mV. To check this, see Note 1 to 2.4.

(4) The meter will now indicate directly on the "drift %" scale the percentage difference between the frequency of the reproduced signal and the 3·15 kHz* test signal that was recorded.

Note: When testing a disc reproducer it will be necessary, and when testing a tape reproducer it may be convenient, to reproduce a test recording made on another machine. The indicated percentage drift may then be due partly to a difference in the recording and reproducing speeds and partly to the original signal not having been 3·15 kHz*.

2.4. Measuring Wow and Flutter

(1) If it has not already been done, first prepare a test recording as in (1) and (2) of 2.2. above

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(2) Press down the "1%" button under the "WOW & FLUTTER" heading (releasing the adjacent "drift" button) and reproduce the test recording (see Note 1 below).

The meter will now indicate wow and flutter on the top scale, f.s.d. 1%. If the meter reading is inconveniently small, press down the "0·3%" or "0·1%" button (releasing the "1%" button). The meter will now indicate wow and flutter on the next to top scale with f.s.d. 0·3% or on the top scale with f.s.d. 0·1%.

Note 1: For proper operation of the limiter (which ensures that amplitude variations do not affect the readings), the reproduced voltage reaching the Test Set should be more than 70 mV. This can readily be checked by pressing down the "MILLIVOLTMETER read input" button (releasing the adjacent "W & F drift" button) and determining the level from the combined readings of the meter and the "MILLIVOLTMETER" switch (see Note to 2.2.). After such a level check, the "W & F drift" button must, of course, be pressed down again to measure wow and flutter.

Note 2: For a proper measurement of wow and flutter, the frequency of the signal fed to the Test Set should be within about ±5% of the nominal value, 3·15 kHz*. When reproducing a test recording just made on the same machine, as above, it will almost always be within the ±2% indicated directly on the "drift %" scale. This may not be the case when reproducing a test recording made on a different machine or at another time but satisfactory measurements of wow and flutter can still be made. If, when measuring drift, the meter can be made to read within its ±2% range by use of the "drift set zero" control.

Note 3: Readings of wow and flutter taken while the test recording is being made usually give a fair indication of magnitude but do not give the true values since speed fluctuations that repeat in a period corresponding to the time taken by the tape to move from the record to the replay head do not appear.

3.5. Measuring Distortion

For this measurement, the output signal from the equipment under test should preferably be greater than 100 mV (see Note 3 below).

The procedure is as follows :—

(1) Set the "MILLIVOLTMETER" switch to "1 V".

(2) Set the "FREQ" control to 100 and press down the range selecting push button marked "X 10".

A 1 kHz test signal is now delivered to the equipment under test.

(3) Press the "DISTORTION set 100%" button.

(4) Now use the "DISTORTION METER set 100%" control knob to adjust the meter to read 10 on the top scale.

(5) Press the "DISTORTION read" button (releasing the "DISTORTION set 100%" button). Also press down the "LF out" button.

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(6) Set the "DISTORTION METER BALANCE fine" control to about mid-position (vertical) and then use the "freq-coarse" control and the "phase" control to reduce the meter reading to a minimum.

During this process, the meter sensitivity should be progressively increased, by means of the "MILLIVOLTMETER" switch, as required to maintain a convenient reading. Complete the adjustment for minimum reading by use of the "freq-fine" control and the "phase" control.

(7) The percentage distortion can now be read on the appropriate one of the two upper scales in combination with the % markings on the "MILLIVOLTMETER" switch.

Note 1: The test signal need not be 1 kHz, as above, but it should be within the range 400 - 1100 Hz, approximately. Otherwise, a minimum will not be obtained within the range of the "BALANCE" controls.

Note 2: The meter reading includes signals of all frequencies between 30 Hz and 20 kHz except for the test frequency and a narrow band on either side of it. It therefore includes hum and other low frequencies. Pressing down the "LF cut" button cuts the lower frequencies progressively below 400 Hz.

Note 3: If a level of 100 mV or more cannot be obtained from the equipment under test, it will not be possible to adjust the meter to full scale deflection as in (4) above. The measurement may still be carried out but with the "MILLIVOLTMETER" switch set below 1V, with a corresponding allowance in the calculation of percentage and with a restriction in the lowest level of distortion that can be measured.

Note 4: When testing a tape recorder that cannot record and reproduce simultaneously it is, of course, necessary first to record the test signal and then to measure distortion while it is being reproduced.

2.6. Measuring Signal-to-Noise Ratio

(1) With the equipment under test working at normal operating levels, measure the total harmonic distortion on a 1 kHz test signal as in 2.5. above

(2) If the total harmonic distortion is less than 2%, then increase the level of the test signal by means of the "OSCILLATOR OUTPUT" "coarse" and "fine" controls (or, if testing a tape recorder, the recording gain control) until the distortion is 2%.

Note: A good idea of the rate of increase of distortion with signal level can be obtained by successively decreasing meter sensitivity and increasing signal level in steps of 10 dB but, for the final determination of distortion, the full procedure of 2.5. should be carried out.

(3) With the equipment under test adjusted so that total harmonic distortion of a 1 kHz output signal is 2%, press the "MILLIVOLTMETER input" button (releasing the "DISTORTION read" button).

(4) Adjust the "MILLIVOLTMETER" switch to give a convenient meter deflection. The reading of the meter, in combination with the switch (see Note to 2.2.), indicates the output level at which there is 2% distortion.

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(5) Remove the signal from the input of the equipment under test and apply a short circuit (But see Note 3 below)

(6) Press the "LF cut" button to release it. (But see Note 5 below)

(7) Increase the meter sensitivity, by means of the "MILLIVOLTMETER" switch, until a convenient reading is obtained. The number of millivolts indicated by the combined meter and switch readings [(see Note 2.2) is the total noise level. The ratio of this to the voltage determined in (3) above, is the Signal-to-Noise Ratio, usually stated in decibels.

Note 1 When determining the 2% distortion level of a tape recorder, care must be taken that the gain controls are so set that the distortion does not arise primarily because of overloading of the electronics. This could happen, for example, because of an excessive input level compensated by a low setting of the recorder gain control or because of an excessive output level.

It is the condition when the distortion arises primarily in the record/replay processes that is usually referred to when the signal-to-noise ratio of a tape recorder is quoted.

Note 2 In the case of a tape recorder, there are several different signal-to-noise ratios that may be considered significant, according to circumstances, but in all cases it is necessary first to determine the output level at which the total harmonic distortion of a 1 kHz test signal is 2% (see (1), (2) and (3) above).

It is with this output level that the various noise levels are usually compared (But see Note 3 below).

The signal-to-noise levels most usually quoted are those obtained by :—

(a) recording and reproducing simultaneously with the input short circuited and using a bulk-erased or virgin tape.

(b) as (a) but using a tape previously recorded to saturation level.

(c) reproducing only, using a bulk-erased or virgin tape.

(d) reproducing with the tape stationary.

In each case the noise level must be measured under the stated conditions.

Note 3: Signal-to-noise ratios are sometimes reckoned from the 3% rather than from the 2% total harmonic distortion level or from a specified tape flux level.

Note 4: Signal-to-noise ratio measurements are made with various types of meter (e.g. r.m.s. or peak indicating) sometimes with and sometimes without a frequency weighting. This Test Set measures unweighted noise using an average reading meter scaled in r.m.s. values for sinusoidal signals.

Note 5: When it is tape hiss or other high frequencies that are of most interest, it will usually be convenient to make the noise measurement with the "LF cut" button pressed down.

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3.7. Measurement of Gain

(1) First proceed with steps (1), (2) and (3) of the procedure for measuring frequency response, 3.2. above

(2) Press the "MILLIVOLTMETER read input" button and then adjust the "MILLIVOLTMETER" switch to obtain a convenient reading on the meter.

This reading, in combination with the switch, indicates the output voltage of the equipment under test. (see Note to 2.2.)

(3) Note, press the "MILLIVOLTMETER read out" button. This releases the "read input" button and connects the meter to indicate the output voltage from the Test Set oscillator that is to say the input voltage to the equipment under test.

(4) Adjust the "MILLIVOLTMETER" switch to obtain a convenient reading on the meter

This reading, in combination with the switch, indicates the input level to the equipment under test.

The ratio of the output level (2) above, to the input level (4) above, is the gain of the equipment. It may be expressed as a numerical ratio or in decibels.

Note: Gain can be measured at any frequency desired by an appropriate tuning of the "FREQ" control and the range selecting push buttons below it. Care must be taken, however, to avoid overloading. (See Note 7 to 3.2. above.)

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Technical Specification

1. VARIABLE FREQUENCY TEST SIGNAL GENERATOR

Frequency Range
15 Hz to 150 kHz in four ranges.

Frequency Response
Flat within ±0·2 dB over the range 15 Hz to 150 kHz.

Distortion
Less than 0·025% at 1 kHz
Less than 0·05% over the range 100 Hz to 20 kHz.

Maximum Output Level†
3 V (approx.) into open circuit
Not less than +9 dBm into 600 Ohm load

Output Attenuator
Coarse Six steps of 10 dB
Fine Continuous over range of 15 dB approx.
External Fixed 40 dB

Output Impedance
Independent of frequency
Dependent on setting of output attenuator coarse control: always less than 600 ohms. From external 40 dB attenuator 47 ohms.

2. FIXED FREQUENCY TEST SIGNAL GENERATOR (FOR DRIFT AND WOW & FLUTTER MEASUREMENTS)

Frequency
3 15 kHz (RTS2A models, 3 kHz)

Output Level
380 mV approx.

Output Impedance
220 ohms approx.

2. MILLIVOLTMETER

Frequency Response
Flat within ±0·2 dB over range 10 Hz to 150 kHz

Accuracy
Within ± 2% f.s.d. over range 30 Hz to 20 kHz

Sensitivity
1 mV to 100 V f.s.d. in 11 steps of 10 dB

Input Impedance
2 Megohms (approx.) Note: No D.C. path between the input leads.

Indication
Average reading meter scaled in r.m.s. values for sinusoidal signals.

†With the addition of a RTS Auxiliary Unit up to +20 dB into 600 ohm load.

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4. WOW AND FLUTTER METER

Type of Measurement
Meter measures peak wow and flutter weighted to D.I.N. 45507.

Input Signal Required
3-15 kHz (RTS2A models 3 kHz) at level not less than 75 mV.

Normally this is supplied by the Fixed Frequency Test Signal Generator of the Test Set itself (see 2 above).

If the test signal is from another source, e.g. a pre-recorded test disc or tape, then the frequency of the test signal should be within ±5% of the nominal value.

Sensitivity
Three ranges for wow and flutter measurements: 0·1%, 0·3% and 1% f.s.d.
One range, direct reading for drift measurements: ±2% f.s.d.

Input Impedance
60,000 ohms, approx.

Frequency Response for Wow and Flutter Measurements
Maximum at 4·0 Hz: 6 dB points at 0·8 Hz and 20 Hz

Alternative Output
The signal measured by the meter also appears on a BNC socket on the base panel and can be fed to an external oscilloscope, wave analyser, filters, etc.

The output level is 3 V (approx.) for meter f.s.d. from a source impedance of 15,000 ohms.

5. DISTORTION METER

Type of Measurement
Rejection of fundamental by a tuned filter.

Input Signal Required
Frequency within the range 400 to 1100 Hz (approx.). Signal normally supplied by the Variable Frequency Test Signal Generator (see 1, above)

The level of the signal from the equipment under test should be 100 mV or more. Smaller inputs may be used but with an increased minimum distortion reading.

Second Harmonic Rejection
Less than 0·25 dB

Minimum Reading (from a distortionless source)
Less than 0·05%

Bandwidth of Harmonic Distortion Measurement
15 Hz to 20 kHz

There is an optional L.F. cut (turnover 400 Hz) for the rejection of hum and other L.F. noise components.

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Input Impedance
100,000 ohms approx.

Alternative Output
The signal measured by the meter also appears on a BNC socket on the base panel and can be fed to an external oscilloscope, wave analyser, filters, etc.

The output level is 1 V (approx.) for mean f.s.d. from a source impedance of approximately 400 ohms.

6. GENERAL

Power Supply
105-120 V, 50 or 60 Hz or 200-250 V 50 or 60 Hz. 12 watts approx.

Dimensions
17½ in. (441 mm) wide
10 in. (254 mm) deep over handles
5½ in. (143 mm) high

Weight
13 lb (5·9 kg) approx.

Access
Access to the inside of the case is obtained by removing two screws from the underside of the lip above the back panel

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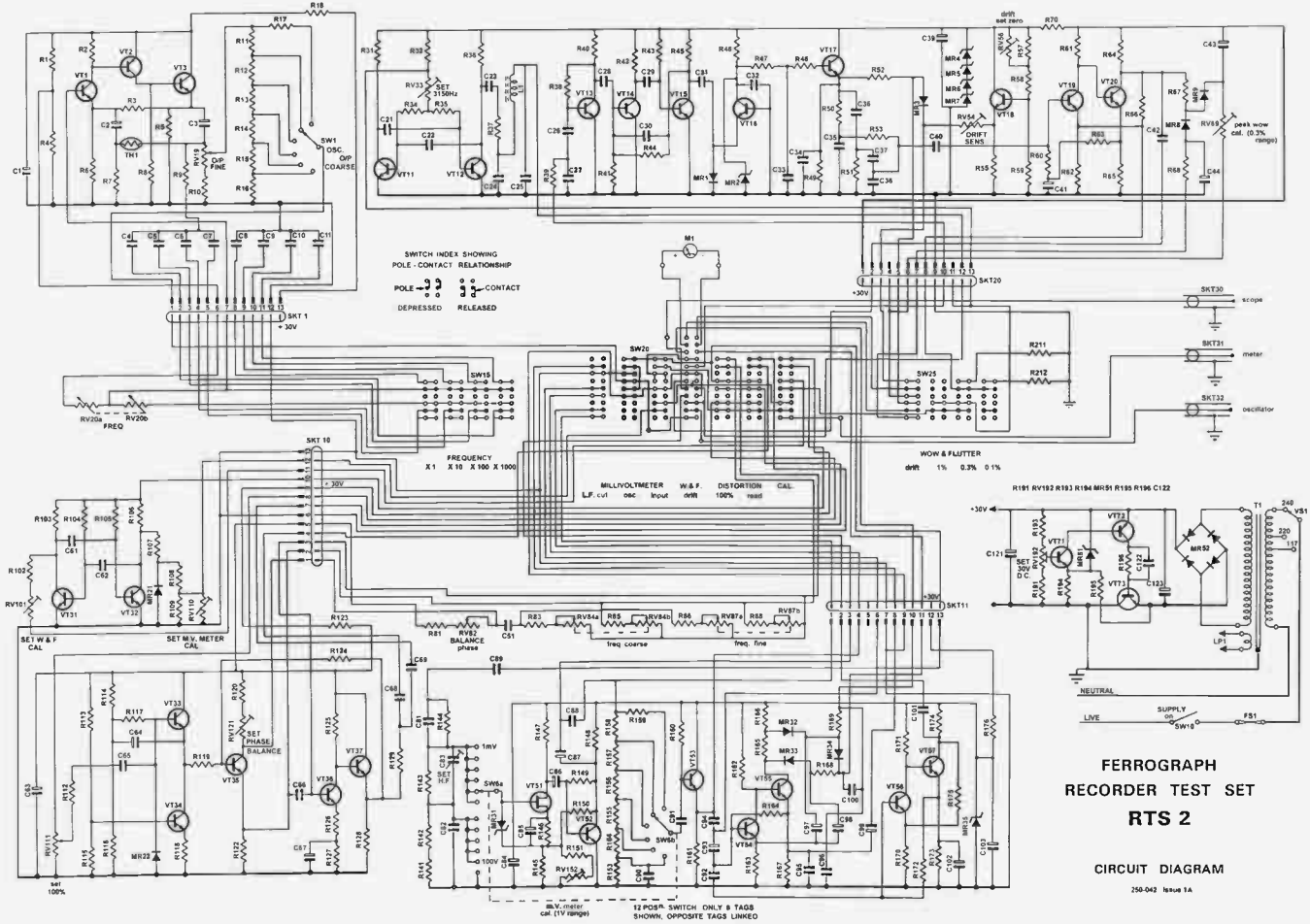

FERROGRAPH
RECORDER TEST SET
RTS 2

CIRCUIT DIAGRAM

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