INSTRUCTION MANUAL

Type 1003 Standard-Signal Generator

GENERAL RADIO

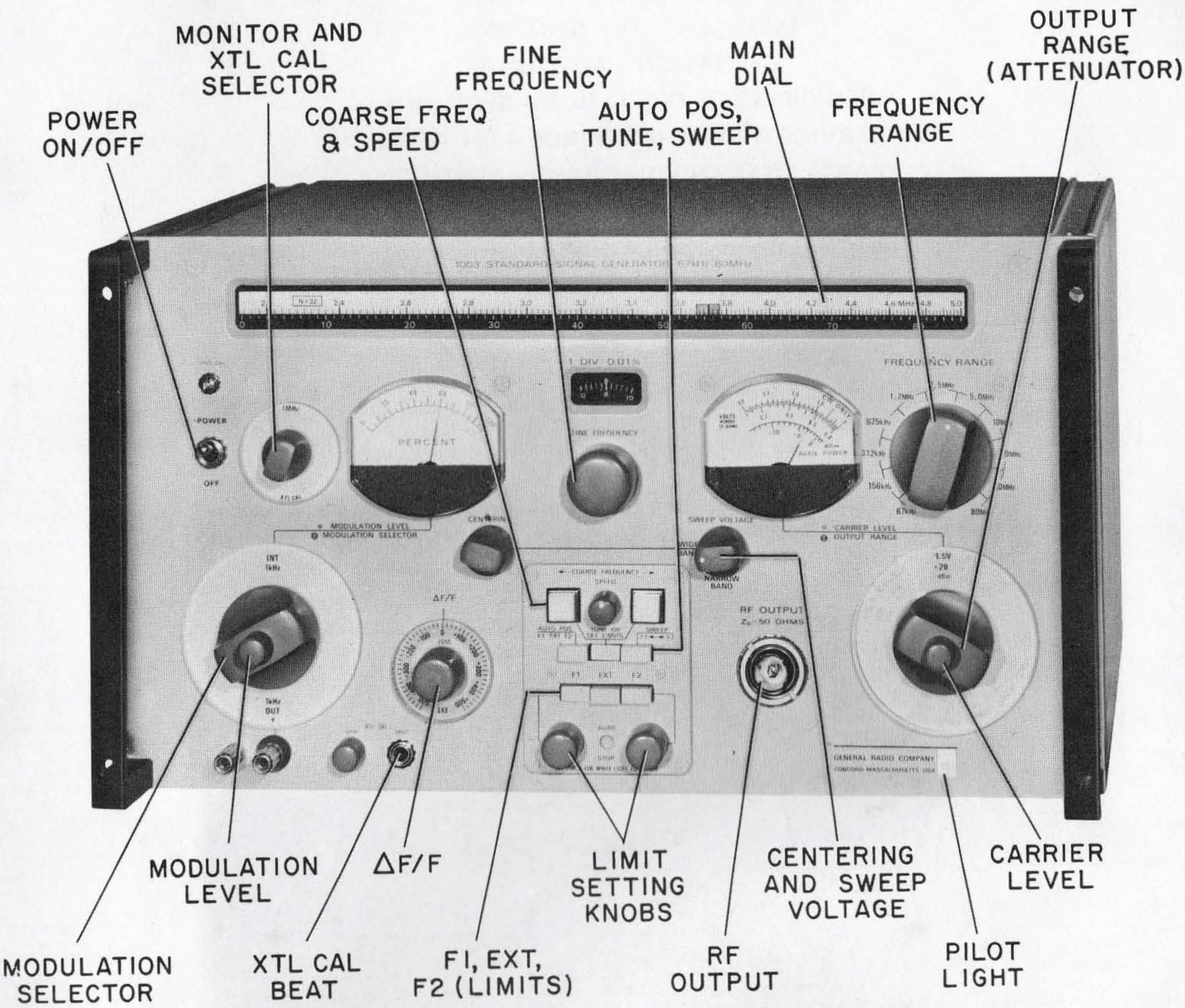
Contents

WARRANTY

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, District Office, or authorized repair agency personnel will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

Type 1003 Standard-Signal Generator

West Concord, Massachusetts, U.S.A. 01781
Form 1003-0100-B
July 1969
ID-B883



1003 Standard-Signal Generator
Model 1003-9705

Condensed Operating Instructions

CAUTION
Be sure the switch on the rear of the instrument is set for the proper line voltage.

a. Snap the POWER switch up. Pilot light indicates power is on. No warmup is required.

b. Turn MONITOR selector OFF, MODULATION SELECTOR to CW NORM, ΔF/F to 0, and depress TUNE.

c. Tune to desired frequency (main dial) by switching FREQUENCY RANGE, depressing left or right COARSE FREQUENCY button (set SPEED as desired), and turning FINE FREQUENCY control.

d. Adjust rf level with OUTPUT RANGE (step attenuator) and CARRIER LEVEL controls to desired voltage or power on meter.

e. For a-m, switch MODULATION SELECTOR to INT 1 kHz (or INT 400 Hz) and adjust MODULATION LEVEL to desired PERCENT on meter. Meter is also used in EXT AC mode; apply 2 Vac at associated terminals. Meter is not used in EXT DC mode; apply +5 Vdc (or rf output will be zero).

f. For calibration (at 1 MHz, 200 kHz, or 50 kHz, intervals) switch MONITOR selector to appropriate XTL CAL position. Listen with headphones to XTL CAL BEAT; tune for zero with FINE FREQUENCY and the finer ΔF/F controls.

g. To set a frequency limit anywhere on main dial, depress F1. Turn associated knob ccw to extinguish right COARSE FREQUENCY light, cw for left, and stop at center of "dark" zone. To set another limit; retune main dial, depress F2, and adjust its knob similarly. Several external limits may be set (refer to Section 3).

h. Tune automatically to any limit frequency by depressing AUTO POS and F1, F2, or EXT as desired. (FREQUENCY RANGE changes are made manually.)

i. Depress SWEEP for automatic sweeping between F1 and F2; control the rate with SPEED knob. SWEEP VOLTAGE and CENTERING control the frequency-analog output (rear panel). Section 3 describes centering in NARROW BAND.

SUMMARY OF MODEL DISTINCTIONS

1003-9701	Basic signal generator.
1003-9702	Auto-control system with variable-speed sweep, in addition to all basic features.
1003-9703	Crystal calibrator, in addition to all basic features.
1003-9704	Auto-control system with fixed-speed sweep, and crystal calibrator, in addition to all basic features.
1003-9705	Auto-control system with variable-speed sweep, and crystal calibrator, in addition to all basic features.

Specifications

FREQUENCY

Range: 67 kHz to 80 MHz in 10 ranges: 67 to 156, 135 to 312, 270 to 625, 540 to 1250 kHz, 1.08 to 2.5, 2.16 to 5, 4.32 to 10, 8.64 to 20, 17.28 to 40, and 34.56 to 80 MHz.

Calibration Accuracy: ±0.25%, typically ±0.1%; scale logarithmic, 140 in. total length. Logging scale with vernier, 8500 div, 0.01%/div.

Mechanical Tuning (all models): Manual fine tuning, 1% per revolution of frequency control, calibrated in .01% increments. Fast tuning by push-button-controlled drive motor.

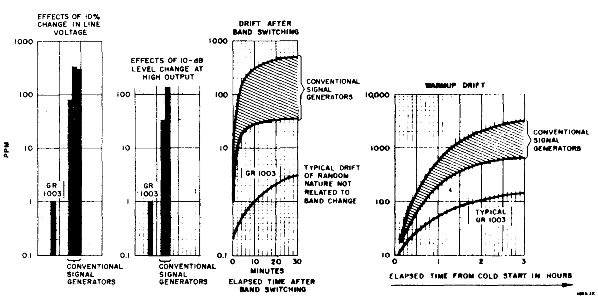
Auto-Control Tuning (in Auto-Control models only): Tunes on command to preset frequencies (two settable by front-panel controls, others by external voltages or voltage dividers). Tuning speed approx 5% per second; positioning accuracy, 0.1%.

Sweep Operation (in Auto-Control models only): Sweep width adjustable from 0.2% of center frequency to full width of selected range. Sweep rate adjustable from $\Delta f/f$ of 0.05% to 5% per second. Sweep-voltage output, 1.0 V per 1% frequency change for sweep widths up to 4% (±2% of center frequency). For wide sweeps, output is approx 65 mV for 1% frequency change. Either output can be centered with respect to ground. Blanking voltage, +9 V behind 15 kΩ (separate from sweep voltage) available during return sweep.

Analog Output (in Auto-Control models only): Voltage proportional to shaft position or logging scale, positive-going from approx −7 V behind 7500 Ω to approx 0 V or about 82 mV per 1% frequency change.

Electronic Tuning: Internal, ±500 ppm nominal , settable to better than 2 ppm; external, approx 60 ppm/volt up to ±1000 ppm typical, limited fm capability. Max input ±15 V into 15 kΩ (+ volts increase frequency).

Stability: After warmup <5 ppm per 10 min, typically 1 ppm Frequency will vary less than 1 ppm as a result of ±10% line-voltage changes, range switching (instant restabilization), rf-level adjustments, or load variations. Warmup drift typically 150 ppm in 3 h at 20°C.



The stability of the 1003 compared with that of other signal generators.

Crystal Calibrator (in some models): Markers at 50-kHz, 200-kHz, and 1-MHz intervals, accurate to 20 ppm. Beat level adjustable and suitable for sweep-calibration purposes.

Carrier Distortion: < 5% typical.

Noise: A-M due to hum and noise within 15 kHz down at least 80 dB relative to carrier. Residual fm, < 3 Hz pk at high-frequency end and < 1 Hz pk at low-frequency end.

RF OUTPUT

Range: CW, 0.05 μV to 3 V across 50 Ω; −133 to +22.6 dBm (180 mW). Modulated, 0.05 μV to 1.5 V across 50 Ω; −133 to +16.6 dBm (45 mW).

Source Impedance: 50 Ω. SWR is <1.02 with attenuator set for 0 dBm or less, <1.05 for +10 dBm, <1.20 for +20 dBm.

Level Control: Total range, 155 dB. Step attenuator, 140 dB in 10-dB steps; continuously adjustable level control, >10 dB additional.

Accuracy of Leveled Output Power: ±1 dB at any frequency and termination. Attenuator, ±0.1 dB per 10-dB step, max accumulated error, ±0.5 dB.

Level Stability: Warmup drift <0.3 dB, temperature effects <0.01 dB/°C, line-voltage variations <0.02 dB.

Meter: Reads volts across 50 Ω and dBm.

MODULATION

Level: 0 to 95%, continuously adjustable. Stable within ±1 dB independent of carrier or modulation frequency (within modulation bandwidth) and output level.

Modulation Bandwidth: At 100-kHz carrier, max modulation frequency is 500 Hz for 95% a-m and 2 kHz for 30% a-m. Above 1-MHz carrier, max is 3 kHz for 95%; above 2.5-MHz carrier, max is 10 kHz for 50%.

Meter: Reads 0 to 100%. Accuracy ±5% fs with int mod, ±10% fs with ext mod, 0 to 95% within modulation bandwidth.

Incidental Angle Modulation: <0.1 radian pk at 30% a-m.

Internal

Frequency: 400 and 1000 Hz, ±0.5%. Output of 2 V behind 100 kΩ available at panel connector.

Envelope Distortion: <1% at 50% a-m, <2% at 70% a-m.

External

AC-Coupled: 20 Hz to 20 kHz, 2 V into 2.5 kΩ for 95% modulation within modulation bandwidth.

Direct Coupled: Dc to 20 kHz. Carrier off with 0-volt input; 1.5-V output into 50 Ω with +5V into 10 kΩ. Max input 10 V pk.

AUXILIARY MONITORING OUTPUTS

Main-Output Frequency: At least 0.5 V pk-pk into 50 Ω (cw) at output carrier frequency.

Subharmonic Frequency: At least 0.3 V pk-pk (approx square wave) behind 150 Ω. Frequency (between 67 and 156 kHz) is coherent with and integrally related to carrier frequency by factor N shown on main dial.

GENERAL

Leakage: Effects negligible on measurements of receiver sensitivity down to 0.1 μV.

Environment: 10 to 50°C ambient for specified performance.

Accessories Supplied: 874-R22LA Patch Cord, power cord, two 12-terminal connectors for external controls, spare fuses, hardware for both bench and rack mounting.

Power Required: 105 to 125, 195 to 235, or 210 to 250 V, 50 to 60 Hz, 20 W (33 with motor running). Auto-Control models only, 50 to 400 Hz, 28 W with motor running.

Dimensions (width x height x depth): Bench, 19 x 11 x 15¼ in. (485 x 280 x 390 mm); rack, 19 x 10½ x 12¾ in. (485 x 270 x 325 mm).

Weight (approx): Net, 64 lb (30 kg); shipping, 87 lb (40 kg).

Catalog Number	Description
	1003 Standard-Signal Generator
1003-9701	basic model
1003-9702	with Auto-Control/Sweep Unit
1003-9703	with Crystal Calibrator
1003-9705	with Auto-Control and Crystal Calibrator

Introduction–Section 1

1.1 PURPOSE.

The 1003 Standard-Signal Generator is a versatile amplitude-modulated laboratory signal source that offers continuous coverage in the frequency range from 67 kHz to 80 MHz. Its operation is characterized by a highly stable signal output that is internally calibrated with respect to frequency, power level, and modulation depth.

The excellent frequency stability is complemented by a calibrated incremental tuning control that provides high resolution and repeatability. Thus, convenient measurements are possible even on devices with very steep attenuation slopes. Applications requiring either very low or very high test levels can be handled equally well due to the large attenuator range, from below 0.05 μV up to 3 V across 50 Ω, cw.

The nominal characteristic impedance of the coaxial output of the 1003 is 50 ohms, but the instrument can operate into any load from short to open circuit.

The generator is capable of frequency modulation and of phase-locked operation.

The instrument includes such user-convenience features as motorized high-speed tuning and large-sized easy-to-read controls and indicators for outstanding resettability. Most functions, other than frequency-band or attenuator-range settings, can be controlled remotely by analog command signals.

1.2 DESCRIPTION.

1.2.1 GENERAL.

The 1003 is an all-solid-state generator with frequency coverage spread among 10 octave bands. The primary frequency source is a tunable LC oscillator that operates in the top range only, with all lower frequency ranges obtained by division. Thus, the basic stability of the top range is imparted equally to all other bands, and range switching can be accomplished without transient instability.

Frequency selection within a range is accomplished by a tuning capacitor driven through a 200:1 worm reduction drive. Motor drive of this control makes it easy to tune rapidly. A 14-inch logarithmic slide-rule dial, with only the scale in use showing, furnishes a clear and unambiguous read-out of frequency. The tuning control is equipped with a 100-division-per-turn dial; each division corresponds to a frequency increment of 0.01%.

This dial when read in conjunction with an 85-division turn-counting logging scale on the main slide-rule dial provides 8500 logging points per frequency band. The typical frequency resettability of 0.01% in any part of any band is extremely valuable in carrying out repetitive test-frequency schedules. The logging scale can also be used to interpolate between 1-MHz, 200-kHz, or 50-kHz spaced markers, with the crystal-calibrator option. The ultimate in resolution of frequency setting is afforded by a ΔF/F control, which permits electronic adjustment of frequency in direct-reading increments of 20 ppm (parts per million), with settability to 2 ppm.

External control of the ΔF function permits the generator to be phase locked to another source, or to a frequency standard, and also allows for limited frequency modulation.

The generator can be operated as a pure cw source, or it can be amplitude modulated internally, at either 400 Hz or 1 kHz, or externally from 0 to 20 kHz, in either ac- or dc-coupled modes. Modulation

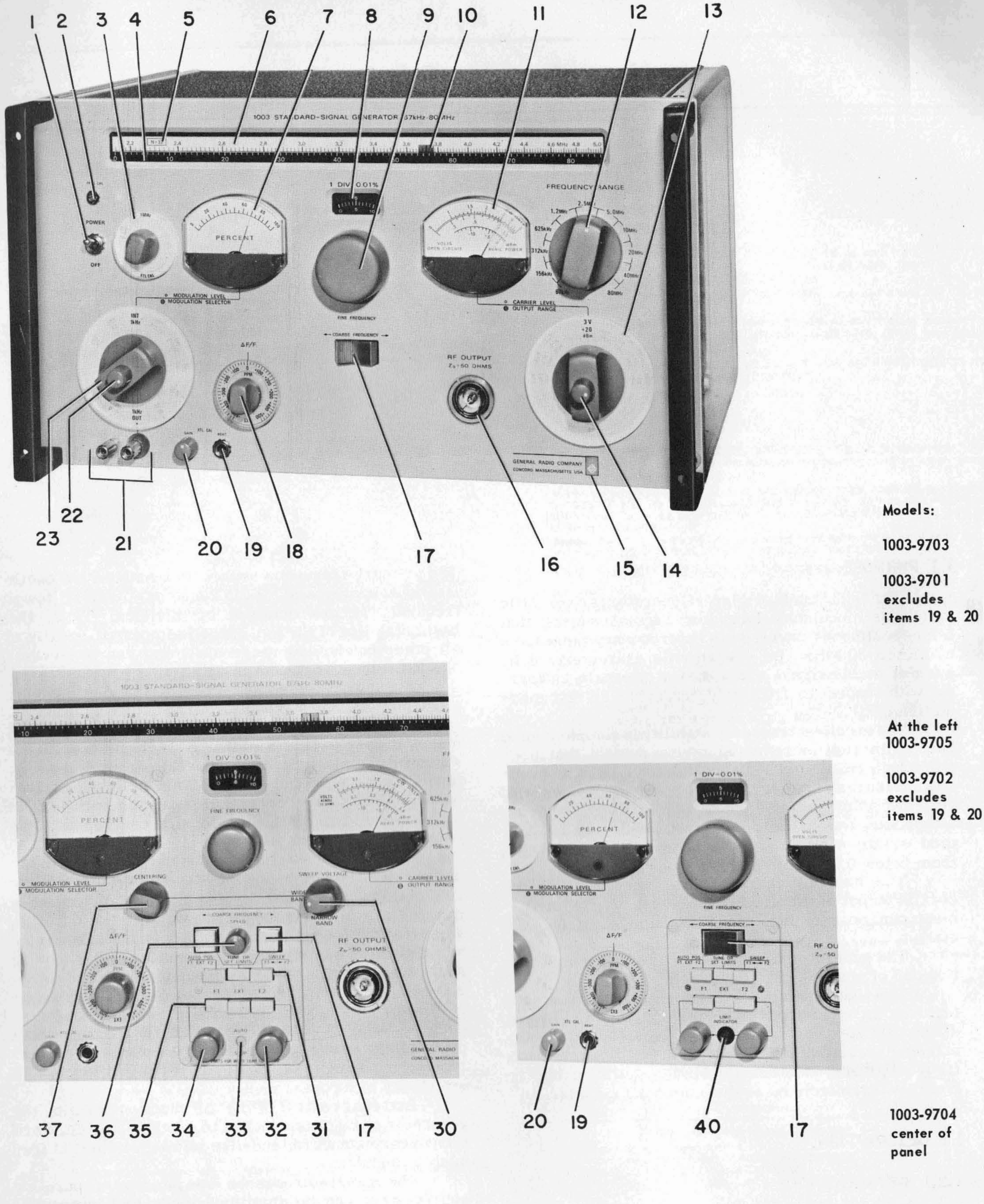


Figure 1-1. Front-Panel Controls, Indicators, and Connectors.

Table 1-1

FRONT-PANEL CONTROLS, CONNECTORS AND INDICATORS

Figure 1-1 Ref.	Name	Description	Function
1	POWER	Toggle switch, DPDT	Applies ac power to generator in up position.
2	FREQ CAL	Screwdriver adjustment	Used to adjust cursor at frequency cal points.
3	MONITOR selector	Rotary switch, 3-position including OFF	Applies rf output signal at rear panel via: F/N MONITOR connector** F MONITOR connector.
	XTL CAL*	Additional 3 positions	Selects 1-MHz, 200-kHz, 50-kHz internal calibration frequencies.
4	Logging Scale	Logarithmic, white on black	Used to reset freq to 0.01% with items 8, 9, 10.
5	N number	Freq. divisor	Used with F/N connector (rear) and item 3.
6	Main Frequency scale (units in Hz at right)	Slide-rule dial, black on white Correct scale brought into view by item 12.	Use with items 8, 9, 10 to set cw or carrier frequency to ±0.25% accuracy.
7	MODULATION LEVEL meter	Meter calibrated 0-100% at 5% intervals	Indicates modulation depth for internal/ external ac sources (used with item 23).
8	Vernier dial	Scale attached to item 9	0.01% per division (1% per turn).
9	FINE FREQUENCY	Frequency vernier; rotary control, continuous	Manual fine tuning.
10	Cursor (red)	Hairline on tab. Controlled by items 9, 17, 31.	Indicates frequency along scale (item 6).
11	CARRIER LEVEL meter	Meter calibrated in rms voltage*** and available power in dBm (-12 to +2 dB; add to item 13 indication)	Indicates RF OUTPUT level with item 13.
12	FREQUENCY RANGE selector	Rotary switch - 10 position	Selects one of 10 frequency bands.
13	OUTPUT RANGE (full scale)	Rotary switch - 15 position, 10 dB/step attenuator (-120 to +20 dBm; add to item 11 indication)	Coarse level control; range switch for item 11, volts and dBm.
14	CARRIER LEVEL control	Rotary potentiometer, concentric with item 13.	Used with item 11 to set rf output level, also with item 23 in EXT DC mode.
15	Pilot light	GR tab	Indicates power on.
16	RF OUTPUT connector	Coaxial GR874, locking type	Zo = 50 Ω.
17	COARSE FREQUENCY	Three-position rocker switch or pair of push buttons	Controls motor drive for tuning (used with item 10 and 31).
18	ΔF/F Control	Rotary potentiometer 20 ppm/div., and (at extreme ccw rotation) a switch	1. Offsets carrier from main frequency dial indication up to ±500 PPM.† 2. In EXT position, permits external FM via SO101 on rear panel.
19	XTL CAL BEAT*	Phone jack for headphone	Monitor of beat between carrier frequency and internal crystal oscillator.
20	XTL CAL GAIN.*	Rotary potentiometer	Controls amplitude of beat note at item 19.
21	Modulation input/ output jack	Binding post pair - GR938 (left-most is case ground; right, J108)	Brings out internal 1-kHz and 400-Hz signals or injects external ac or dc signal; selection by item 23.
22	MODULATION LEVEL control	Rotary potentiometer (concentric with item 23)	Continuous control of MODULATION LEVEL in each of 3 modes (used with item 7); not effective in EXT DC.
23	MODULATION SELECTOR	Rotary switch — 6-positions: CW HIGH, CW NORM, INT 400 Hz, INT 1 kHz, EXT AC, EXT DC††	Determines mode of amplitude modulation.
30	SWEEP VOLTAGE†††	Rot switch/clutch, 2 positions: WIDE BAND, NARROW.	NARROW selects high slope for 0-4% sweeps.
31	AUTO POS/TUNE OR SET LIMITS/SWEEP	Push-button control (set of 3)	Selects tuning modes - automatic or manual.
32	F2 LIMIT	Rotary potentiometer control - 5 turn	Stores discrete frequency setting (F2).
33	AUTO STOP	Lamp (Yellow)	Indicates completion of auto-positioning; warns against manual tuning when lit.
34	F1 LIMIT	Rotary potentiometer control - 5 turn	Stores frequency setting (F1).
35	Limit Selector F1/EXT/F2	Push-button control (set of 3)	Selects references for automatic tuning (with item 31). EXT also enables use of external frequency programming.
36	SPEED†††	Rotary potentiometer	Controls rate of COARSE-FREQ TUNE or SWEEP.
37	CENTERING†††	Rotary potentiometer	Sets dc level of WIDE-BAND sweep voltage.
40	LIMIT INDICATOR	Lamp	Indicates coincidence of tuning and limit.

*Found only on models 1003-9703, -9704, and -9705.
**See Note in paragraph 3.3.5 about spurious output components.
****Voltage across 50 ohms,* except some early versions calib. in *volts open circuit (see paragraph 3.5).*

†Each 100 ppm = 0.01% = 1 minor division on item 8.
††In the EXT DC mode there is no output unless a positive-going voltage is applied externally.
†††Found on models 1003-9702 and -9705 only.

depth can be controlled from 0 to at least 95%, and is shown on a directly calibrated meter. Envelope distortion is less than 2% for 70% modulation.

The levelled rf output of the generator can be set to any desired amplitude over a 155-dB range by means of a dual control. The main bar knob controls a 10-dB-per-step resistive attenuator, while the smaller concentric knob provides a continuous control with a 15-dB range of adjustment. The output is monitored on an associated meter, calibrated both in terms of volts and dBm of available power. The range of calibrated cw output levels is 0.05 μV - 3 V across a 50-Ω load, or 0.1 μV - 6 V open circuit. Modulated carrier levels are limited to half of these voltage maxima.

The output is frequency stable typically to 1 ppm in 10 minutes after warm-up. Also, changes in range, load, rf-load settings, or line-voltage fluctuations have negligible effect. The output power is accurate to ±1 dB at any frequency and termination. The modulation-level indication is accurate to ±5%, at depths between 0 and 90% (within bandwidth limitations).

Terminals are available for the external monitoring of band selection and of modulation-signal characteristics.

The 1003 Standard-Signal Generator is available in several versions as follows:

Model 1003-9701 is a complete standard-signal generator, characterized by the preceding description.

Model 1003-9702 is the same with the addition of programmable automatic control of tuning and variable-speed sweep. Precision of automatic tuning is ±0.1%, to any number of preselected frequencies (two of which can be stored internally, others externally).

Model 1003-9703 is the same as -9701 with the addition of a crystal-controlled calibrator, which provides accurate references at all multiples of 1 MHz, 200 kHz, and 50 kHz that fall within the tuning range of the generator.

Model 1003-9705 combines all the features of -9702 and -9703: auto-control, variable-speed sweep, and crystal calibration.

Model 1003-9704 is like -9705 except that its sweep speed is fixed. It has auto-control, sweep, and crystal calibration. (It is no longer in production).

1.2.2 CONTROLS, INDICATORS AND CONNECTORS.

Table 1-1 lists the panel controls, indicators and connectors on the Type 1003 Standard-Signal Generator, with separate columns for description and function data.

1.2.3 REAR-PANEL CONNECTORS AND FUSES.

Table 1-2 lists the Type 1003 Standard-Signal Generator's rear panel connectors and fuses.

1.2.4 ACCESSORIES SUPPLIED.

Table 1-3 lists items supplied with each model of the generator:

1.3 ACCESSORIES AVAILABLE.

1.3.1 GENERAL.

General Radio has available a well-rounded grouping of accessory instruments and devices to facilitate introduction of the output signal of the 1003 in most usual measurement systems, to ensure full utilization of the many versatile features of the instrument, and to permit convenient external monitoring of its performance. Instruments and devices that most readily fall into this category are listed or briefly described in paragraphs that follow.

1.3.2 EXTERNAL MODULATION SOURCES.

Table 1-4 lists (with pertinent characteristics) instruments recommended to meet the very wide range of signal-source requirements presented by the external modulation modes of the 1003.

1.3.3 DIGITAL COUNTERS.

To make precision frequency settings on the 1003, a digital-reading frequency counter, attached to the F/N MONITOR connector on the rear panel, is a valuable ancillary equipment. The GR Type 1191 frequency counter covers the necessary frequency range and can be connected directly with a Type 874-R22LA Coaxial Patch Cord. Counters with higher frequency response are available for direct frequency readout at the F-MONITOR connector. A GR Type 1191 is suitable up to 20 MHz. Beyond that an additional decade scaler, GR Type 1156, is required.

1.3.4 COAXIAL ADAPTORS.

The 1003 uses the low-VSWR, quick-connect, GR874 coaxial connector for all rf outputs. A comprehensive assortment of special coaxial devices and instruments, based on the GR874 50-ohm design, is available to complement them.

For the user who has components fitted with coaxial connectors of other leading coaxial series, GR874 adaptors are available to convert the rf connectors to the desired type of plug or jack. Recommended adaptors, suitable for the frequencies involved, are listed in Table 1-5. All the types listed here can be locked to the 1003 for a rigid installation and minimum rf leakage at the junction.

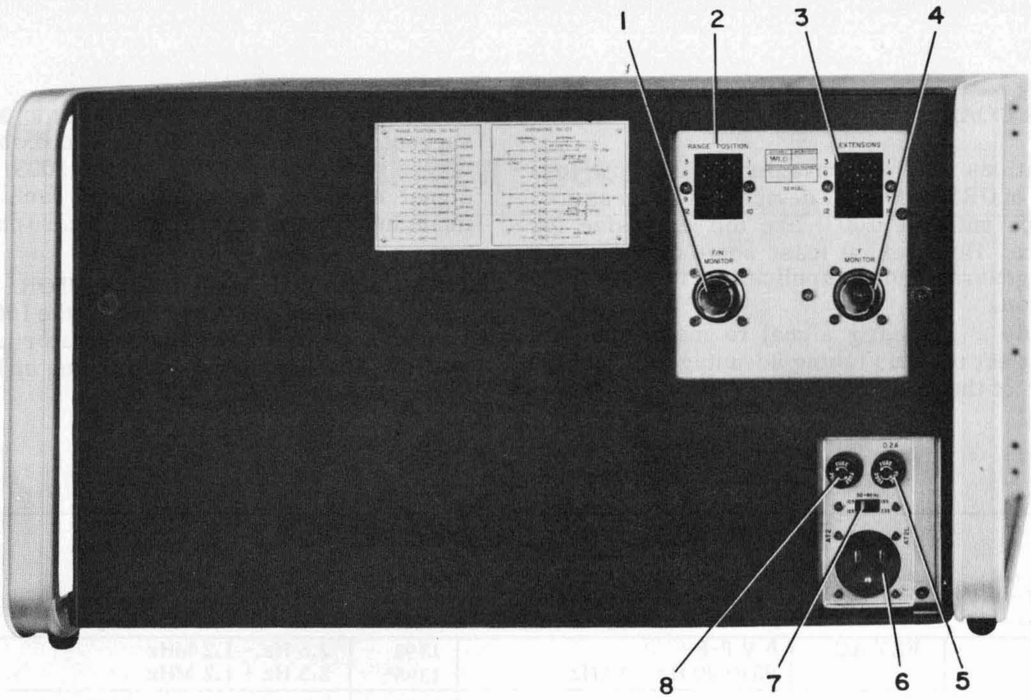


Figure 1-2. Rear panel details of the 1003 Standard-Signal Generator.

Table 1-2
REAR-PANEL CONTROLS AND CONNECTORS

Figure 1-2 Ref.	*Name*	*Description*	*Function*
1	F/N MONITOR	GR874 Coaxial Connector	Connection for external digital counter to observe submultiple carrier output frequency; controlled by item 3 on Figure 1-1. (Refer to para. 3.3.5.)
2	RANGE POSITION	Cinch-Jones Connector 12 pin* SO302	Provides electrical readout of selected frequency range for remote indication.
3	EXTENSIONS	Cinch-Jones Connector 12 pin* SO101	Access to external control and monitor points (Refer to para. 3.7 for details).
4	F MONITOR	GR874 Coaxial Connector	Connection for external digital counter to observe carrier output frequency; controlled by item 3 on Figure 1-1.
5	0.2 A	3AG extractor-post fuse	Protects input line for 230-V operation.
6	Ac line connector	Recessed, 3-wire power plug	Accepts jack on power cord supplied.
7	Ac input selector	Slide switch	White marker left for 105-125 V, right for 195-235 V.
8	0.4 A	3AG extractor-post fuse	Protects ac input line for 115-V operation.

*Mating plug is an accessory supplied (Mfg. P/N P-312-CCT).

Table 1-3
ACCESSORIES SUPPLIED

Quantity	*Item*	*Function*	*GR Part Number*
1	7-foot, 3-wire line cord	Connects instrument to ac power line	4200-9622
1	3-foot GR874 coaxial patch cord	Connects generator to load	0874-9683
2	12-pin Jones connector	For connection to external controls or monitors	4220-5100
2	3AG Slo-Blo fuse, 0.4 amp.	Spares for 115-V use	5330-0800
2	3AG Slo-Blo fuse, 0.2 amp.	Spares for 230-V use	5330-0600
1	Rack Support Set	Used to rack mount generator	7863-9662

1.3.5 OTHER COAXIAL DEVICES.

Applications of the convenience and low-loss performance of GR874 coaxial devices, in rf measurement hook-ups with the 1003, are too extensive for coverage here. However, at least some of these devices are of general enough application to merit particular mention.

To apply a standard signal to more than one point in a test set up, thus taking advantage of the high output power of the 1003, use of the Type 874-TPDL Power Divider, singly or in cascade arrangement, is suggested. The 874-TPDL is a coaxial tee that, connected to the RF OUTPUT of the 1003, splits the input signal into two equal portions, each 6 dB below the input, matched within 0.3 dB, with zero phase difference.

1.3.6 LINE-VOLTAGE REGULATOR

Although not required for the 1003, the GR 1591 Variac® Automatic Voltage Regulator is recommended for any measurement system using up to 1 kVA of 60-Hz ac power.

Table 1-4
EXTERNAL MODULATION SOURCES AVAILABLE

Desired Modulation Mode	*Modulation Selector Position*	*1003 Characteristic Range*	*Recommended Accessories GR Type*	*Accessory Range*
Pulse	EXT AC	6 V P-P PRF: 20 Hz - 1 kHz	1398 1395*	2.5 Hz - 1.2 MHz 2.5 Hz - 1.2 MHz
	EXT Dc	0 to 10 V peak positive going PRF: Dc to 1 kHz	1395*	2.5 Hz - 1.2 MHz (1395-P1)
Sine or Square Wave	EXT Ac	20 Hz to 20 kHz	1310	2 Hz - 2 MHz sinewave
		20 Hz to 2 kHz	1210-C	20 Hz - 0.5 MHz sinewave + square wave
DC	EXT DC	0 to +10 V peak for dc or composite signal		Variable dc source. Additional ac source if required.
FM	ΔF/F-EXT	0 - 1 kHz 30 V P-P max	1210-C 1310	20 Hz - 0.5 MHz 2 Hz - 2 MHz

*Additional plug-in modules required depend on desired waveform.

Table 1-5
GR874 LOCKING ADAPTORS TO OTHER SERIES

Mates	*Type*	*Contains GR874 and . . .*	*Connects GR874 to . . .*	*Catalog Number*
Type BNC	874-QBJL	BNC Jack	BNC Plug	0874-9701
Type C	874-QCJL	C Jack	C Plug	0874-9703
Type MICRODOT	874-QMDJL	Microdot Jack	Microdot Plug	0874-9721
Type N	874-QNJL	N Jack	N Plug	0874-9711
Type SC	874-QSCJL	SC Jack	SC Plug (Sandia)	0874-9713
Type TNC	874-QTNJL	TNC Jack	TNC Plug	0874-9717
GR900®	874-Q900L	GR900	GR900 Precision 14-mm connector	0874-9709
Type OSM*/BRM	874-QMMJL	OSM/BRM Jack	OSM/BRM Plug	0874-9723
AMPHENOL APC-7	874-QAP7L	APC-7	APC-7 Precision 7-mm connector	0874-9791

*Registered trademark of Omni Spectra, Inc.

Installation—Section 2

2.1 POWER INPUT CONNECTION.

The Type 1003 generator is normally wired for operation from power sources of 105-125 V, and 195-235 V ac, 33 W (max). Models 1003-9701, -3, and -4 require 50 to 60-Hz power; models 1003-9702 and -5: 50 to 400 Hz. Set S501 on the rear panel (see Figure 1-2) to the appropriate position: it is a slide switch that can be activated with the tip of a screwdriver blade.

Using the power cord supplied, connect the 1003 to a source of power.

If the instrument must be adapted for operation from a 210 to 250-Vac source, rearrange the jumper lead between F502 and solder terminal AT2 on the rear surface of the power-supply assembly. Move the lead from AT2L to AT2. The cabinet must be removed and input power disconnected. See Figures 5-3 and 6-21 for details.

2.2 MOUNTING.

The 1003 Standard-Signal Generator is supplied equipped for bench use, with rubber-footed aluminum end frames attached to the sides of the cabinet. Each frame is held in place by two panel screws (with Nylon cup washers) and four 10-32 Phillips-head screws in the side of the cabinet. There are no special mounting requirements beyond the need for sufficient space to accommodate the dimensions of the 1003, shown in Figure 2-1.

For rack mounting, special brackets and a kit consisting of attaching hardware are supplied. Table 2-1 lists the contents of the kit. The brackets permit either cabinet or instrument to be withdrawn indepen-

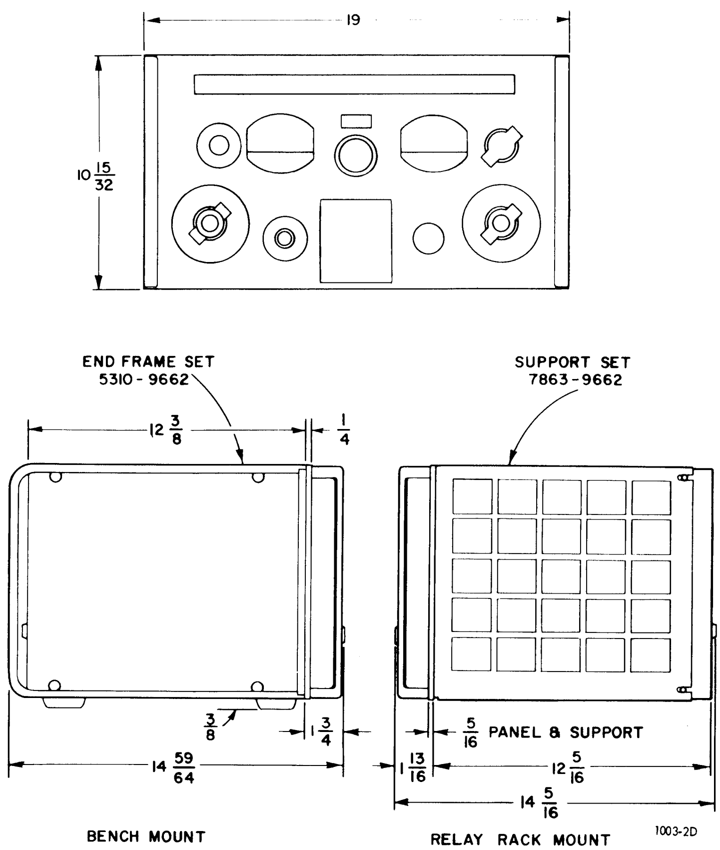


Figure 2-1. Overall dimensions.

dently of the other. Figure 2-2 illustrates both bracket attachment and rack mounting.

To install the instrument in a relay rack:

a. Release the two screws centered near the edges of the rear wall of the cabinet. Remove the cabinet from the instrument and the end frames from the cabinet.*

b. Lay the cabinet on its left side (looking at it from the front) with the front-panel end forward.

c. Place the right side rack support (A) on the right side of the cabinet. Be sure that the flange with the mounting holes is forward and flush with the front of the cabinet (see Figure 2-2) when the other flange (without holes) is resting against the bottom of the cabinet.

d. Assemble two pairs of flat washers (D) and thumbscrews (E).

e. Install these as shown in the figure and tighten.

f. Turn the cabinet on its right side.

g. Place the left side rack support on the left side and align it in the same manner as the right side.

h. Repeat steps d and e for this side.

i. Install the cabinet, with supports, in the desired rack position by use of the four No. 10-32 washerless screws (B). The flange holes to be used are second in from the extreme outside, at the top and bottom.

j. Reinstall the instrument in its cabinet and attach it to the rack with the Nylon-cupped screws (C).

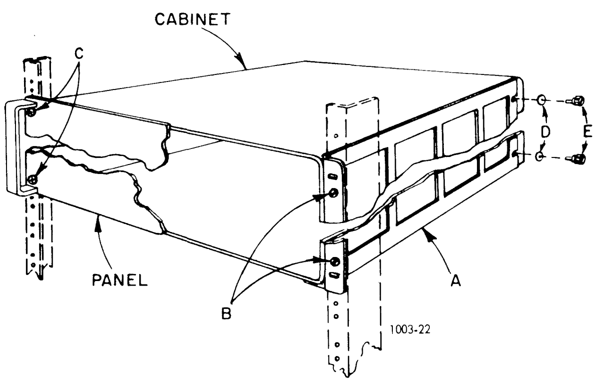


Figure 2-2. Relay rack mounting.

Table 2-1

RACK-MOUNT KIT (P/N 7863-9662) CONTENTS (INCLUDING HARDWARE SET P/N 7863-3002)

Quantity	*Description*	*Index, See Figure 2-2*	*Part Number*
1	Rack-support frame set, left and right	A	7863-9664
4	Screw, No. 10-32, slotted-head, 5/8 inch, steel	B	7160-0325
4	Panel screws, No. 10-32, Phillips-head 5/8 inch, nickel gray, with cupwasher	C	7270-6210
4	Flatwasher, No. 10, 1/16 inch thick	D	8100-1517
4	Thumbscrew, No. 10-32, 1/4 inch	E	7270-3800

NOTE

Omit the cabinet-to-chassis screws in the rear.

When the instrument is to be removed from the rack, remove the panel screws (C) and pull the instrument forward by the handles on the front panel.

To remove the cabinet and leave the instrument mounted, loosen the thumbscrews (E) and slide the cabinet off, through the back of the rack.

2.3 ENVIRONMENTAL CONSIDERATIONS.

The 1003 is intended for customary shop, laboratory and test-facility applications. The instrument should not be subjected to ambient temperatures outside the range 10-50°C in its operation. In addition, since the 1003 contains variable tuning capacitors, it should be afforded isolation from vibration, to avoid microphonics.

*If the generator is to be shipped, it is necessary to reassemble instrument in cabinet, with end frames, as well as to provide suitable packaging.

Operation – Section 3

3.1 GENERAL.

The 1003 Standard-Signal Generator furnishes an output rf signal directly calibrated in frequency, power level, and modulation depth. It is supplied in several versions, depending on whether auto-control (frequency programming) and/or crystal calibration capabilities are provided. Refer to the front of this book for catalog numbers and descriptions.
Differences in operating procedures for these models will be indicated in the paragraphs that follow.

As supplied, the instrument is fitted for bench use. To rack mount the generator, consult the instructions packed with the rack-mount set furnished and paragraph 2.2.

3.2 TURN-ON AND WARM-UP.

Be sure that the rear-panel input-selector is set for the available line voltage, connect the generator to the power line, and place the POWER switch in the up position. The pilot light should glow to indicate the presence of power.

Owing to the all-solid-state design, the instrument is ready for immediate use. The frequency drift during warm-up is so small, typically 150 ppm, that it can be disregarded for many applications. Thereafter, typical frequency drifts are in the order of 1 ppm in 10 minutes, under stable ambient conditions.

3.3 FREQUENCY SELECTION.

3.3.1 GENERAL.

Rf output frequency can be controlled manually in all models, and automatically in models with the auto-control feature.

3.3.2 MANUAL.

The procedure for manual frequency setting is as follows:

a. Set the FREQUENCY RANGE switch to the desired band, the MODULATION SELECTOR switch to CW NORM, and proceed immediately to step b; no range-change stabilization time is required.

NOTE
Identification of the selected range is also available, in terms of a contact closure, through a 12-pin rear connector, RANGE POSITION. Refer to paragraph 3.7.

b. Depress the TUNE push button (not used on models 1003-9701 and -9703). Then with the COARSE FREQUENCY control, actuate the tuning motor until the desired frequency is shown on the main scale. The motor speed is adjustable on models 1003-9702 and -9705; use the SPEED control.

c. Rotate the FINE FREQUENCY control for greater precision in selecting the wanted frequency. Settings reached in this manner are accurate to ±0.25% of the dial reading in any band.

d. Adjust the ΔF/F control for ultra-fine tuning, in calibrated increments of 20 ppm (parts per million), if desired. Otherwise leave it at the zero position.

NOTE

Full-scale accuracy of the ΔF/F dial is typically ±10%.

e. To repeat any given setting with four-digit accuracy, note the corresponding logging number. The first two digits are the number of divisions on the black dial to the left of the cursor (00 to 85), two more are read on the vernier dial sequentially in the small center window: The last digit represents a 0.01% increment (see Figure 3-1).

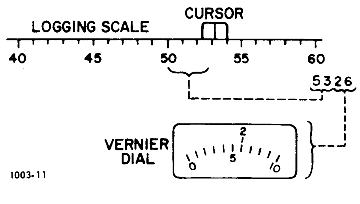


Figure 3-1. Logging dial interpretation.

f. To obtain the natural logarithm of the frequency (relative to the low end of the band) simply place a decimal point in front of the logging number.

3.3.3 REMOTE FINE TUNING.

To adjust the fine tuning to parts-per-million resolution by external means, a circuit capable of controlling the bias voltage on the varactor diode in the oscillator assembly can be connected to SO101 on the rear panel, in accordance with the adjacent wiring label. The ΔF/F switch must be placed in the EXT position to permit this type of control.

3.3.4 ELECTRONIC SWEEP OPERATION.

For very narrowband swept-frequency operation place the ΔF/F control in the EXT position. This permits a useful sweep width (peak-to-peak) of approximately 1500 parts per million within the band in use. The sweep voltage has to be supplied externally through the rear panel connector SO101. Frequency changes linearly at the rate of 60 ppm/volt. The sweep rate should be adjusted according to bandwidth limitations of the unknown under test.

Use the sweep voltage taken from the ΔF monitor output (rear, SO101, pin 6) for the frequency axis of scope or recorder. Sweep calibration is then simply obtained (to about 10% accuracy) by using the ΔF/F control temporarily in its PPM range.

3.3.5 PHASE-LOCKED OPERATION.

General.

When phase-locked operation is desired, to stabilize the carrier frequency against an external reference, the GR Type 1040 Synchronizer/Sampling Detector should be used. With it, the 1003 can be rapidly and unambiguously locked to any desired one of a set of discrete frequencies without the use of an auxilliary counter. Operation at arbitrarily chosen frequencies is also described in the 1040 instruction manual, which gives instructions for interconnection and details of operating procedures.

Control Input.

Connect the control signal from the synchronizer to the ΔF Control terminals at the rear (SO101, pins 1 and 2). Set the ΔF/F control to EXT. The control signal is nominally ±10 V. If it is necessary to use an unbalanced signal (0 to -20 V) a suitable d-c offset can be provided with a Zener diode, connected to pin 3 of SO101.

Direct Frequency Output.

Place the MONITOR switch in the F ON position and take the output from the F MONITOR connector to the synchronizer. This signal, at the same frequency as the rf output, is independent of the level set by the OUTPUT RANGE switch. Using it will not introduce side bands related to the F/N MONITOR. However, any established lock may be lost if the FREQUENCY RANGE is changed.

F/N Frequency Output.

Place the MONITOR switch in the F/N position and take the output from the F/N MONITOR connector to the synchronizer. This signal is unaffected by level controls and amplitude modulation. It is always in the range of the lowest band (67 to 156 kHz). A lock established in this mode will not be lost by a change of FREQUENCY RANGE. However, signal purity is degraded slightly, as follows:

NOTE

When the MONITOR selector is in the F/N ON position, discrete spurious sidebands at multiples of the subharmonic frequency F/N must be expected at the RF OUTPUT, typically 80 dB down. Otherwise, such spurious sidebands do not exist.

3.3.6 AUTOMATIC TUNING.

These procedures apply only to models 1003-9702 and -9705.

General.

Either push button AUTO POS or SWEEP initiates automatic operation of the tuning mechanism (whereas TUNE establishes manual control). Frequency limits, designated F1 and F2, can easily be set as required; they serve as references for sweeping and automatic tuning, or as markers. Any number of additional automatic-tuning limits can be provided by simple external (remote) circuitry.

An analog voltage is always available for remote indication of frequency. For sweep applications, a similar but specially modified sweep voltage is also provided.

Limit Setting.

a. Depress the TUNE push button. Manually tune the generator to a selected frequency, as described in para. 3.3.2.

b. Depress push button F1 and adjust the corresponding LIMIT knob (total range = 5 turns) until the white light (in a COARSE FREQUENCY button) goes off. Turn cw if the left light is on, ccw if the right; stop in the center of the region where both stay off.

c. To set up a second limit, repeat steps a and b using push button F2 and the corresponding LIMIT knob.

d. If more than two limits are needed, connect external circuitry as described in the paragraph headed External Frequency Control. Then proceed as in step c, except depress push button EXT and adjust the appropriate external potentiometer.

Auto Position.

To set the frequency automatically:

a. Depress the push buttons AUTO POS and either F1 or F2. The generator will tune itself to within 0.1% of that limit, always at full speed, 5% frequency change per second.

b. To reach the other internal limit, automatically, depress the other F push button.

c. To reach externally set limits, depress the EXT push button.

NOTE

Whenever the chosen limit is reached by auto-control action, the yellow AUTO STOP light shines as an indication *not* to tune manually. To extinguish this light and return to manual control, depress the TUNE push button.

External Frequency Control.

When the EXT and AUTO POS push buttons are depressed, the generator will tune to the frequency analogous to any suitable limit voltage applied to SO101, pin 9, rear panel. With appropriate external switching, any number of frequency-dial positions can be programmed sequentially. The required voltage for each position is equal to the corresponding analog output voltage (SO101 pin 7).

For optimum stability, set each external voltage as a fraction of the bias supplied at SO101 pin 10 (rather than using an independent voltage source). Figure 3-3 shows a suitable external circuit for setting five limits and switching among them.

Markers.

The white lights (in the COARSE FREQUENCY push buttons) serve as guides and markers in manual tuning to preset frequencies. The lights are used as follows:

a. Depress the TUNE and a LIMIT push button (like F1).

b. If the left light shines, turn to the left (decrease frequency) and vice versa.

c. The extinction of both lights marks the coincidence of the generator frequency with the preset limit. Rapid tuning past the limit causes the marker to appear as the sudden transfer of light from one lamp to the other. Only one limit can be used at a time.

Electronic "birdie" markers are also available in those models having the crystal calibrator. Refer to paragraph 3.3.7.

Remote Frequency Monitor.

For a remote electrical indication of the setting of the main frequency dial, connect a meter or other indicator to SO101, pin 7, on the rear panel. The analog voltage is proportional to the main-tuning-shaft position and varies from -7 to 0 Vdc (nominal) behind 7.5 kΩ, with an increasing frequency. Approximately 82-mV change corresponds to a 1% frequency difference.

Remote Range Indication.

For a remote indication of the frequency range in use, refer to paragraph 3.7. The combination of this function with External Frequency Control makes it possible to set up the 1003 signal generator in a production test station so that a sequence of pre-established frequencies can be selected with very little effort and a high degree of repeatability.

3.3.7 VARIABLE-SPEED SWEEP.

NOTE

All models have an electronic sweep capability (see paragraph 3.3.4), which is limited to approximately 0.15% sweep width and completely independent of the electromechanical sweep modes described below, for models 1003-9702 and -9705 only.

General.

Automatic sweep always cycles between the two limits F1 and F2. Both speed and width of sweeping are adjustable over wide ranges. During the decreasing part of each SWEEP cycle (the return trace on typical scope displays) the sweep is accelerated, the r-f output is zero, the carrier-level meter reads zero, and a voltage is available for blanking or pen lift.

A sweep voltage (analogous to frequency) is provided in either of two modes chosen by the SWEEP VOLTAGE control. The NARROW BAND choice provides higher voltage per kilohertz but is limited to sweep widths below 4%.

CAUTION

Whenever the NARROW BAND sweep voltage is *not* being used, leave the SWEEP VOLTAGE control in the WIDEBAND position to minimize wear of the associated potentiometer.

Test Set-up.

Figure 3-2 shows a typical setup for sweep measurements. The connection for sweep calibration (using birdie markers) through the XTL CAL BEAT terminal is applicable to model 1003-9705 only.

Operation.

To sweep automatically between two selected frequencies:

a. Set limits F1 and F2 (paragraph 3.3.6).

b. Depress SWEEP push button.

c. Adjust rate of sweeping with SPEED control (100:1 range).

d. Select and center the sweep voltage. (Instructions follow).

e. Calibrate, if desired. (Instructions follow later.)

To make a single sweep between the same frequencies:

a. Depress AUTO POS and starting limit (F1) push buttons.

b. Wait for AUTO STOP light.

c. Depress end limit (F2) to initiate the desired single sweep. Speed is fixed at the maximum rate.

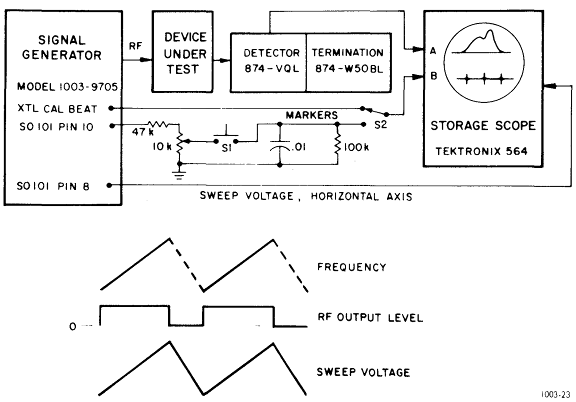


Figure 3-2. Swept-frequency measuring setup.

Sweep Voltage Control.

The sawtooth voltage representing frequency is selected and centered as follows. Figure 3-2 shows the appropriate connection to the horizontal channel of a scope.

Select the WIDEBAND position of the SWEEP VOLTAGE switch if the sweep width exceeds 4%, 4 divisions on the logging scale. The incremental component of the sweep voltage is about 650 mV for each 10 divisions. Adjust the d-c component with the CENTERING control.

Select the NARROWBAND position of the SWEEP VOLTAGE switch if the sweep width is between 0.2 and 4%, i.e., 1/5 to 4 divisions on the logging scale. The incremental component of the sweep voltage is 1.0 volt per division. Set the d-c component to zero (and avoid a possible discontinuity in the sweep) as follows:

a. Depress TUNE push button; tune manually until sweep voltage drops to zero. (Turn FINE FREQUENCY clockwise to correct a negative output, and vice versa.)

b. Switch temporarily to WIDEBAND (disengaging the narrow-band pot). Retune to center of desired sweep range, midway between F1 and F2.

c. Switch again to NARROWBAND and depress SWEEP push button.

Sweep Calibration.

There are 5 methods of calibration; use the one best suited to the sweep width, and test set-up. The last method is the most accurate.

Use the main tuning or logging scales if sweep width exceeds a few percent. Figure 3-2 shows a circuit for putting markers on a storage-scope display. Switch S2 down. Tune the generator manually through the sweep range, stopping at each desired calibration point and recording it by touching S1.

Use the vernier dial for narrower sweeps, down to about 0.2%. Its calibration is 0.01% per division or 1% per turn. So the increments in kHz depend on the value of rf frequency. Record markers as described before.

Use the $\Delta F/F$ dial for the narrowest sweeps, particularly for measurement of a bandwidth in a given display. For example: record the sweep with $\Delta F/F$ set at zero; turn the $\Delta F/F$ knob until the display shifts by the amount of the bandwidth; read the measured bandwidth on the $\Delta F/F$ scale. For wider displays, establish a calibration interval of 1000 ppm as follows: Sweep with $\Delta F/F$ set first at -500, then at +500 ppm. If the response curve has a bandwidth of X units, and the display shift is Y units, the bandwidth is (1000 X/Y) ppm.

Use the NARROWBAND SWEEP VOLTAGE calibration for sweeps in the range of 0.2 to 4%. The voltage increment is 1.0 V per 1.0% frequency change. For example, set the scope horizontal gain to 0.1 V/cm; the calibration is now 0.1% per centimeter.

Use the XTL CAL BEAT output to provide "birdie" markers (with model 1003-9705). They are accurate to ±20 ppm, and they provide increments of hertz rather than percentages. Switch S2 up (Fig. 3-2). Select the desired marker spacing with the XTL CAL switch (50, 200, or 1000 kHz). Adjust the amplitude with the XTL CAL GAIN control. When the marker spacing is 50 or 200 kHz, the larger-interval markers (200 or 1000) can easily be identified by their larger amplitude. Refer to paragraph 3.4.

3.3.8 AUTOMATIC TUNING/FIXED-SPEED SWEEP.

NOTE

These procedures apply only to generator model 1003-9704.

General.

One of the three pushbuttons in each row should always be depressed. Only when the TUNE button is depressed is the instrument under manual control.

However, even then marker indications can be obtained and limits can be set for automatic tuning. Regardless of the operating mode, there is always an analog output voltage available, with magnitude proportional to the position of the cursor along the logging scale.

Limit Setting.

Any of the internal positions set up in the manner described below can be used in one of three ways:

1. as an automatic tuning point,
2. as a sweep limit,
3. as a marker or memory.

The procedure is as follows:

a. Depress the center pushbutton of the upper row of three (TUNE). Tune the generator, as described in paragraph 3.3.2, to a selected frequency.

b. Depress the pushbotton marked F1 and adjust the left-hand LIMIT control (5-turn potentiometer) until the INDICATOR lamp glows, which indicates that the program memory is set exactly at the dial frequency.

c. To program a second frequency into the generator, repeat the above and set the memory with pushbutton F2 and the right-hand LIMIT control.

NOTE

Buttons F1 and F2 can be used interchangeably.

Auto Position.

To auto-position the frequency setting:

a. Depress the AUTO POS pushbutton and either pushbutton F1 or F2, to home the generator to within 0.1% of the respective programmed frequency.

b. To reach the other position automatically, depress the unactivated F pushbutton.

c. To return to manual control, depress the TUNE pushbutton.

Sweep.

NOTE

All models have an electronic sweep capability (paragraph 3.3.4) which is limited to approximately 0.15% sweep width and completely independent of the electromechanical sweep modes to be described below.
A storage-type oscilloscope is best suited to the sweep speeds associated with these modes.

To sweep between two selected points in a band, set F1 and F2 limits and depress the SWEEP pushbutton.

The output frequency will commutate between the two points, taking approximately 12 seconds to travel the entire width of the band one way and proportionately less at closer points. The sweep voltage, for use in an external display, is available at the rear connector (pins 7 and 8 of SO101).

NOTE

If the end points have been set closer together than 1%, the generator *may* not respond to AUTO POS or SWEEP controls.

Markers.

Select the TUNE mode. Depress F1 or F2. Whenever the instrument is tuned to the previously set limit, the indicator lights up. When tuning through the limit at the normal motor speed, the light will flash only very briefly. Activation of the limit control relay will also give an audible click.

NOTE

Only one limit can be used at one time.

Remote Frequency Monitor.

For a remote electrical indication of the setting of the main frequency dial, an indicator connected to pins 7 and 8 of SO101 on the rear panel of the generator can be used for an analog indication of output frequency. The monitor voltage is proportional to the main tuning shaft position and varies from 0 to -8 Vdc (nominal) behind 7.5 kΩ, with an approximately 90-mV change equal to a 1% frequency difference.

Remote Range Indication.

For a remote indication of the frequency band in use in the generator, refer to paragraph 3.7.

External Frequency Control.

When the EXT pushbutton is depressed, the reference input is transferred to rear connector SO101. The system will auto-tune in the same way as in the internal mode, provided a suitable voltage is applied to terminal 9.

With additional external switches, any number of auto-position points can be switched in sequentially, to set up a multipoint automatic-tuning program. The required voltage for each point is equal to the ANALOG OUTPUT voltage at the same point (between 0 and -8 V). A suitable bias voltage is also brought to the rear connector, to supply a reasonable number of potentiometers.

For optimum drift stability, use the internal bias source. A typical example for five additional tuning points is shown in Figure 3-3.

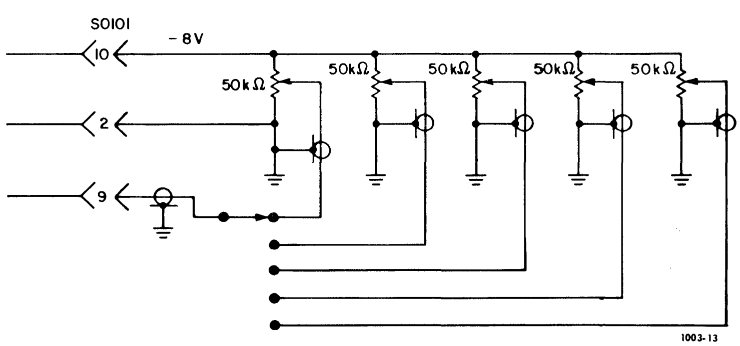


Figure 3-3. Circuit for external frequency programmer.

3.4 FREQUENCY CALIBRATION.

3.4.1 GENERAL.

When frequency-setting accuracy greater than the ±0.25% afforded by the slide-rule dial is required, either the internal crystal calibrator or an external frequency meter or counter can be used.

3.4.2 FREQ CAL ADJUSTMENTS.

The FREQ CAL screw adjusts the cursor position. It is normally used with the crystal calibrator to eliminate error in main dial reading near one frequency. The basic 0.25% calibration accuracy obtains when the FREQ CAL control is standardized as follows:

a. Adjust COARSE FREQUENCY to 85 on log scale;

b. Adjust FINE FREQUENCY to 00 on vernier dial;

c. Adjust FREQ CAL to exactly 85 on log scale.

3.4.3 INTERNAL CRYSTAL CALIBRATOR.

NOTE

This capability is found only on generator models 1003-9703, -9704, and -9705.

The calibration procedure is as follows:

a. Plug a high-impedance headphone set into the XTL CAL BEAT jack.

b. Set the XTL CAL control to 1 MHz, tune to the nearest beat, and adjust the XTL CAL GAIN control for a low audio level. Potential accuracy is ±20 ppm.

NOTE

Excessive XTL CAL GAIN can make higher-order mixing products audible, to produce beats at fractions of the marker frequency.

Above 10 MHz, the spacing of 50-kHz marker points becomes comparable to the ±0.25% scale calibration accuracy. The same is true for 200-kHz markers above 40 MHz. Therefore, start calibration with the highest marker frequency for positive identification. Then move towards the wanted frequency in 200-kHz and 50-kHz increments.

c. Tune the signal generator to the desired frequency by the method of the following example: WANTED FREQUENCY = 16.349 MHz.

1. Find the beat at 16.00 MHz with the 1-MHz marker.

2. Change the XTL CAL switch to 200 kHz, increase the carrier frequency to the next beat, i.e., 16,200 kHz.

3. Switch to 50 kHz, move the frequency dial to the third beat, i.e.,

16.00 MHz + 200 kHz + 150 kHz = 16.350 MHz.

The frequency is now 1 kHz above the wanted figure, when the generator is tuned to zero beat.

d. If maximum readout accuracy is desired at the specific operating frequency, adjust the FREQ CAL control to make the cursor hair line agree exactly with the appropriate reading on the dial.

e. The procedure for the final step depends upon how large the remaining tuning increment is.

1. For frequencies above 2.5 MHz, the nearest calibration point is always closer than 2%, i.e., 2 turns of the FINE FREQUENCY control. By use of this control for interpolation, the error will always be less than 100 ppm. In the example above, a 0.06% shift (≅ 1 kHz), i.e., 6 divisions of the FINE TUNING dial, is required to reach the desired frequency.

2. For frequencies below 2.5 MHz, the same interpolation method can result in progressively larger percentage errors. If higher accuracy is needed, other methods must be employed.

3.4.4 CALIBRATION AT LOWER FREQUENCIES.

An indirect but unique way to self-calibrate the generator exploits the exact harmonic relationship between frequency ranges. If the frequency is temporarily translated into the highest range, a maximum calibration density that lies between 0.063% and 0.15% can be realized (with 50-kHz markers).

For example, to calibrate 74.3 kHz, which is on the lowest range, use the equivalent frequency on the top range, which is 512 times higher, i.e., 38.042 MHz.

The procedure is:

a. Find 38.0 MHz with the 1-MHz marker.

b. Increase the frequency by 42 kHz = 0.11% or 11 divisions on the FINE TUNING dial.

c. Switch back to the lowest range for a setting exactly on 74.3 kHz.

For any other range it is only necessary to know the appropriate multiplier M, which is 512/N; N is shown on the frequency scale used for the wanted (low) frequency.

3.4.5 USE WITH AN EXTERNAL FREQUENCY METER.

General.

Provision is made for direct connection to the generator of a frequency meter (or digital counter), at either the actual output frequency of the generator or at a submultiple, for use as an external monitor. The indicated frequency is coherent with the output signal in all ranges, for both cw and modulated operation. If a continuous monitor of frequency is not desired, keep the MONITOR switch at OFF, to reduce the likelihood of rf leakage into the measurement system.

High-Frequency Monitor.

For a direct digital display of the output frequency over any range of the generator:

a. Connect a high-frequency unit, such as the General Radio Type 1191-Z Counter (100 MHz), to the F MONITOR connector on the rear panel of the instrument. Use of a GR Type 874-R22LA Patch Cord is recommended.

b. Set the MONITOR switch on the generator to F ON, adjust the sensitivity and trigger levels on the scaler portion of the frequency meter to appropriate settings, select convenient count and display limits, and observe the digital readout.

Low-Frequency Monitor.

This output is most likely to be used for frequency-calibration purposes, if:

1. a counter with limited frequency response (200 kHz minimum) is available, or

2. continuous monitoring, with amplitude modulation near 100%, is desired.

The operational procedure is as follows:

a. Connect a digital frequency meter, such as the GR 1191, to the F/N MONITOR connector at the rear of the 1003; use of a Type 874-R22LA Patch Cord is recommended.

b. Set the MONITOR switch to F/N ON, set the frequency meter for a 0.1 or 1-second count and a convenient display time, and observe the digital readout. The reading will always be between 67 and 156 kHz.

NOTE

The digital display will be the indicated output frequency divided by N, the divisor indicated in the box at the upper left of the frequency dial.

Remote control of the F/N MONITOR function can be achieved through SO101 on the rear panel. Consult the adjacent wiring label for details.

3.4.6 USE AS A FREQUENCY METER. (1003-9703, -9704, and -9705 only.)

The 1003 can be used as a heterodyne frequency meter to measure the frequency of an external source. Place the MONITOR switch in the F ON position; connect the source of the unknown frequency to the F MONITOR terminal (rear panel); plug headphones into the BEAT jack. For best accuracy, check the 1003 calibration, using the internal crystal calibrator.

If the frequency of the external source is known approximately (and is within the tuning range of the generator), its frequency can be measured directly. Tune the 1003 over the range in which the external signal lies, until a strong beat is observed, and read the frequency from the dial of the 1003. Otherwise, it will be necessary to identify the harmonic order of the observed beat as follows.

The signal generator should be tuned to zero beat with the external source at two or more points on the dial; note the frequencies of a pair of successive strong beats. Bandswitching should not usually be required, since at least one pair of beats will occur on each band, *except the band that includes the fundamental frequency of the unknown source.*

Let

f_x = unknown frequency of the external source

f_h = the higher frequency of two successive strong beats

f_ℓ = the lower frequency of two successive strong beats

$f_d = f_h - f_\ell$

The harmonic order $H = f_h/f_d$ (always an integer)

$f_x = Hf_\ell = (H - 1) f_h$

3.5 CARRIER-LEVEL ADJUSTMENT.

General.

Attach the measurement-system load to the RF OUTPUT connector. The generator can operate with any passive load ranging from open to short circuit.

CAUTION

Do not inject high-level signals at the output jack. Damage to the attenuator can occur if the level exceeds 0.25 W.

Injection of excessive signal levels at the output can result in erroneous output readings, since meter and levelling circuits respond to the detected rf voltage.

Receiver sensitivity measurements down to the 0.1-μV level can be made without interference from rf leakage from the generator.

Manual.

To control the level of the rf carrier (or cw) output:

a. Use the OUTPUT RANGE switch as the coarse control and the CARRIER LEVEL knob as the interpolation control to set the level as desired. In the CW HIGH position of the MODULATION SELECTOR, voltage can be set up to twice the maximum of other positions.

b. Read the available carrier power in decibels above 1 milliwatt by adding the indications of the OUTPUT RANGE switch and CARRIER LEVEL meter. Read the bottom scale in each case. The available range is -133 to +16.5 dBm in general, extending to +22 dBm in the CW HIGH mode. (Only this mode makes use of the red portion of each meter scale.)

This available power is actually delivered if the load impedance at the RF OUTPUT connector is a purely resistive 50-Ω load; any other load will receive less power. Even an ideally matched load will receive less power if connected by a long (lossy) cable. On the other hand, both average and peak power of a modulated signal may exceed the indication, which is *carrier* power. Alternatively, use voltage calibration as follows.

c. Read the rms carrier voltage level on the appropriate one of two upper scales of the CARRIER LEVEL meter, the one which *in its black portion* has a full-scale value like the upper number on the OUTPUT RANGE switch. The latter determines whether to multiply the meter readings by 1, 10, or 100 and whether the correct units are volts, millivolts, or microvolts.

Except for certain early models, 1003 signal generators are calibrated in VOLTS ACROSS 50 OHMS (normal output voltage or matched terminal voltage). The available range is 0.05 μV to 1.5 V, extending to 3 V in the CW HIGH mode. The indicated voltage actually appears across the RF OUTPUT connector only if it is loaded with 50 ohms, pure resistance. Otherwise, terminal voltage may be calculated. Multiply the meter readings by 2 to calculate open-circuit voltage.

Early models (1003-9701 before I.D. number B817; all 1003-9704) were calibrated in VOLTS OPEN CIRCUIT (source emf or volts behind 50 Ω). The available range was 0.1 μV to 3 V, extending to 6 V in the CW HIGH mode. Performance of the two groups of generators is identical.

d. Calculate the voltage V_1 across a load of complex impedance R+jX ohms as follows. The connecting cable, if any, is treated as part of the load. Using V_{50}, the 50-Ω voltage indication of newer generators:

$$V_1 = 2V_{50} (R + jX) / (50 + R + jX)$$

Alternatively, using E_{oc}, the open-circuit indication of older generators:

$$V_1 = E_{oc} (R + jX) / (50 + R + jX)$$

e. All voltages discussed in steps c and d are measures of carrier level. Within each cycle of modulation, the rf voltage varies about that as an average. The crests of a sinusoidally modulated rf signal reach twice the CARRIER LEVEL when the MODULATION LEVEL is 100%, dropping linearly to equal the CARRIER LEVEL at zero %.

Programmed Levels.

Output amplitude can also be controlled over a range of at least 40 dB by means of an external applied voltage, when the generator is operated in the EXT DC mode. This feature can be used for level-programming purposes. Refer to paragraph 3.6.4.

3.6 MODULATION MODE SELECTION.

3.6.1 GENERAL.

The 1003 rf output can be utilized as a cw signal, it can be sinewave modulated by either of two internal sources, or it can be modulated with a great variety of external signal sources. The internally generated modulation signal can be monitored at the MODULATION IN/OUT binding posts.

3.6.2 CW OPERATION.

To operate the generator as a pure cw source set the MODULATION SELECTOR to CW HIGH or CW NORM. The former permits setting higher output levels using the red portion of the CARRIER LEVEL meter. The latter permits switching modulation on and off without change in the carrier level.

3.6.3 INTERNAL AMPLITUDE MODULATION.

To amplitude modulate the rf output internally:

a. Set the MODULATION SELECTOR switch either to 1-kHz INT or 400-Hz INT positions to modulate the rf output with a sinewave signal.

b. Adjust the MODULATION LEVEL control in conjunction with the MODULATION LEVEL meter to any desired modulation depth, calibrated in percent, from 0 to 95.

c. At either modulation frequency, the modulation signal is available at the modulation input/output terminals (front and rear) for external monitoring, or for use to synchronize a measurement display. The output is approximately 2 V behind 100 kΩ.

3.6.4 EXTERNAL AMPLITUDE MODULATION.

General.

To introduce modulation signals from external sources, the MODULATION SELECTOR switch should be set in either the EXT AC or the EXT DC position, and the appropriate signal introduced via the modulation input/output terminals (J108) or the rear panel connections, pins 11 and 12 of SO101. The allowable bandwidth of the applied modulation signal varies inversely with the depth of modulation desired and the output-frequency setting. The max depth for calibrated meter indication is 95%, within limits of Figure 3-4.

AC-Coupled Modulation.

A source capable of supplying 2 Vac across 2.5 kΩ, in the frequency range from 20 Hz to 20 kHz, can modulate the generator properly. It should be connected to the modulation input, with the MODULATION SELECTOR set in the EXT AC position.

For various modulating frequencies, the maximum depths of modulation consistent with linear operation are shown in Figure 3-4, for a typical 1003.

With an rf output of 100 kHz, the generator can be modulated with a 500-Hz signal for 95% depth or up to 4 kHz for a 30% depth.* With a 1-MHz rf output, the maximum modulation bandwidth is 3 kHz for 95% and 10 kHz for 30% modulation depth.

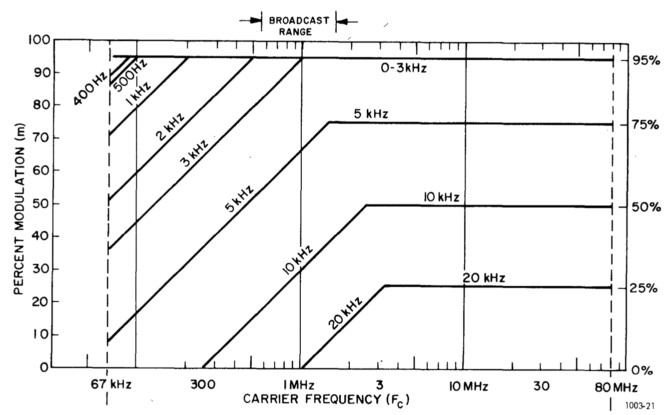


Figure 3-4. Maximum depth, m, of modulation (for linearity) vs. carrier and modulation frequencies. Typical.

Dc-Coupled Modulation.

A source capable of supplying from 0 to 10 V, peak, into 10 kΩ, in the frequency range 0 to 20 kHz, can be used to modulate the generator up to 95%, with the MODULATION SELECTOR set to EXT DC. With 0-Vdc input, the carrier is turned off; approximately +5-Vdc input is required for V_{50} = 1.5 V rf output. This is the preferred mode for square-wave modulation or for remote control of carrier level.

Modulation depth can also be programmed remotely in this mode, with appropriate external-control devices, which provide a composite signal whose dc component determines the carrier level and whose ac component sets the modulation depth.

*2 kHz guaranteed minimum.

The EXT DC mode permits higher modulated carrier levels than the normal internal or external ac modulation modes. However, percentage modulation has to be measured separately - do not depend on the MODULATION LEVEL meter - and must be limited to satisfy the relationship:

$$V_{50max}(1+m_{max}) = 3 \text{ V or:}$$

$$E_{ocmax}(1+m_{max}) = 6 \text{ V}$$

Where V_{50} max is the maximum carrier level in VOLTS ACROSS 50 OHMS; E_{oc} is the same in VOLTS OPEN CIRCUIT; and m_{max} is the maximum allowable percentage modulation. Typical limits are shown in Table 3-1.

The simplest way to obtain the dc bias for this purpose is to connect a 13 kΩ resistor between pins 3 and 12 of the rear socket SO101 and to couple an external ac source through a capacitor to the modulation input/output terminals.

Pulse Modulation.

Pulse waveforms with PRF's up to several kHz can be applied in both external modulation modes. In the dc-coupled mode, the signal must have a positive-going peak to obtain output. The pulse modulation characteristic is controlled primarily by the 20 kHz passband of the input filter circuit, which limits the rise time to about 10 μs.

NOTE

MODULATION LEVEL meter readings are not reliable when the generator is pulse modulated.

FM Operation.

To apply narrow-band frequency modulation to the generator, set the ΔF/F switch in the EXT position and apply the modulating signal to the appropriate pins of SO101 on the rear panel of the instrument, in accordance with the adjacent wiring label. The fm thus obtained appears in addition to any selected amplitude modulation.

The modulation characterisitic extends from dc to audio frequencies, dropping by 3 dB near 10 kHz. From the specified electronic tuning sensitivity of approximately 60 ppm/volt, one can calculate the frequency deviation ΔF (Hz) from the following formula:

$$\Delta F = 60 \text{ FV}$$

where F is carrier frequency (MHz) and V the modulating level (volts).

The fm linearity is typically better than 3% for frequency deviation up to 200 ppm. Maximum deviation can be extended to at least 500 ppm with less than 10% distortion.

3.7 SYSTEMS

Remote Programming and Monitoring

Connections for external control and indication of frequency and amplitude are given in Figures 1-2, 3-5, and 3-6. The functions are described in Sections 3 and 4, and summarized in Tables 3-2 and 3-3.

An external FREQUENCY RANGE indicator is desirable to supplement the analog voltage, to give an unambiguous indication of frequency. Make a cable to connect a suitable 10-station indicator to socket SO302; refer to Figure 3-5. (Power is not supplied to this circuit by the generator.) A suitable 12-pin plug is supplied.

Systems with Other Sources

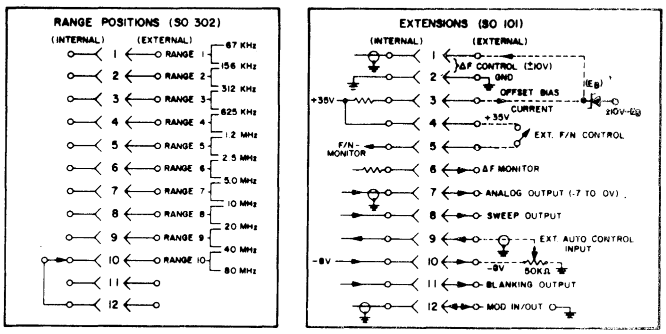
Any other source, ac or dc, which causes much power to be dissipated in the RF OUTPUT circuit of the 1003 may be harmful. Smaller signals may affect calibration and level control.

CAUTION

Do not inject signals or apply voltage to the RF OUTPUT connector above the level of 0.25 W or 3.5 V.

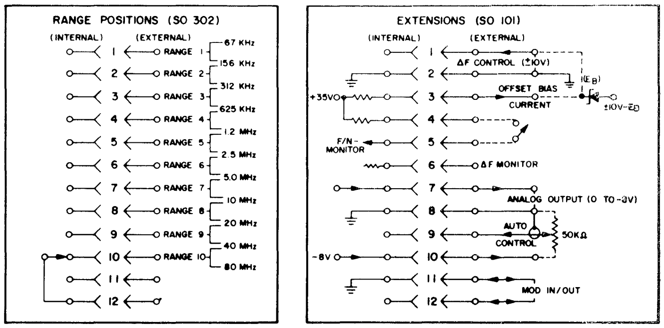
Table 3-1
MAXIMUM LEVELS FOR MODULATION IN THE "EXT DC" MODE

m_{max}	E_{ocmax}	V_{50max}	dBm
80%	3.33	1.67	+17.5
60%	3.75	1.87	+18.5
30%	4.61	2.30	+20.3
10%	5.45	2.72	+21.7
0	6.00	3.00	+22.6



1003-26

Figure 3-5. Key to remote programming and monitoring connections. Models 1003-9701 and -9703 do not use SO101 pins 7 through 11: models 1003-9702 and 9705 use them all.



1003-25

Figure 3-6. Key to remote programming and monitoring connections (early version). Applicable to model 1003-9704 and (except for SO101 pins 7, 8, 9, 10) to 1003-9701 before ID number B817

Table 3-2

USE OF EXTENSIONS SOCKET (SO101) PIN CONNECTIONS (Model 1003-9705)

Pin	*Function*
1	External ΔF CONTROL input (±10 V)
2	Ground
3	Current source used to offset the ΔF voltage by means of an external Zener diode, in order to accommodate phase detectors with negative output ranges (i.e., 0 to -30 V)
	CAUTION Terminal 4 carries +35 V. Instrument becomes inoperative if terminal is shorted to ground.
4, 5	External control of F/N monitor by SPST switch, except when MONITOR selector reads F/N ON
6	ΔF - MONITOR Output Monitors electronic ΔF voltage, whether originating at pin 1 or internally, ΔF/F
7	Analog output (-7 to 0 V) of cursor position. Proportional to logarithm of frequency
8	Sweep output voltage controlled by SWEEP VOLTAGE and CENTERING controls. High impedance source
9	External auto-position input from either a potentiometer or a voltage source
10	Bias (-8 V) for external control potentiometer
11	Blanking voltage, +9 behind 15 kΩ, during return sweep only
12	Duplicate of modulation in/out connection

Table 3-3

USE OF EXTENSIONS SOCKET (SO101) PIN CONNECTIONS (Model 1003-9704)

Pin	*Function*
1	External ΔF CONTROL input (±10 V)
2	Ground
3	Current source used to offset the ΔF voltage by means of an external Zener diode, in order to accommodate phase detectors with negative output ranges (i.e., 0 to -30 V)
	CAUTION Terminal 4 carries +35 V. Instrument becomes inoperative if terminal is shorted to ground.
4, 5	External control of F/N monitor by SPST switch, except when MONITOR selector reads F/N ON
6	ΔF - MONITOR Output Monitors electronic ΔF control voltage, whether originating at pin 1 or internally, ΔF/F
7	Analog output (0 to -8 V) of cursor position. Proportioned to logarithm of frequency
8	Ground
9	External auto-position input from either a potentiometer or a voltage source
10	Bias (-8 V) for external control potentiometer
11	Ground
12	Duplicate of modulation in/out connection

Principles of Operation—Section 4

4.1 GENERAL.

Refer to Figure 4-1, the elementary block diagram for the 1003 Standard-Signal Generator, for the following discussion. The heavy lines in this diagram show the flow of the main rf signal from its source in the oscillator assembly to the final output from the attenuator.

Completely detailed schematic diagrams covering all the circuitry discussed in this section, are shown in Section 6, and appropriate references are given. The overall interconnecting wiring diagram, Figure 6-1, can be used for detailed information on the interrelationship between the primary subassemblies of the generator.

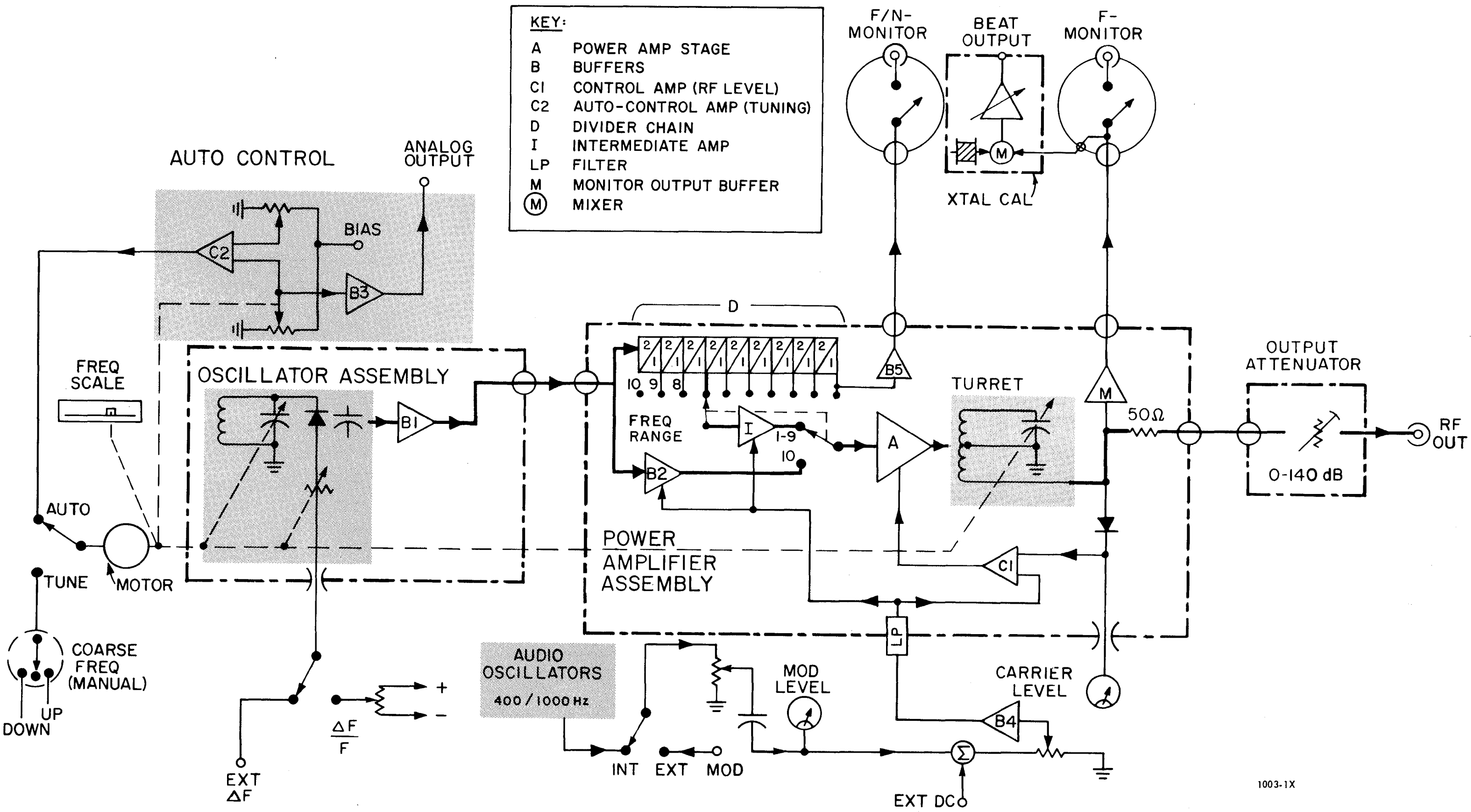


Figure 4-1. Elementary block diagram.

4.2 OVER-ALL CIRCUIT DESCRIPTION.

4.2.1 GENERAL (Figures 4-1 and 6-1).

The all solid-state circuitry for the 1003 is divided into eight major subassemblies. They are:

Oscillator Assembly
Power - Amplifier Assembly
Modulator
Power Supply
Calibrated Output Attenuator
Front-Panel Controls and Indicators
Auto-Control (Tuning) Unit - only in some models
Crystal Calibrator - only in some models

4.2.2 FREQUENCY-GENERATION FUNCTIONS.

A single-range (34 to 80 MHz) master oscillator is the source of all 10 ranges of output frequencies. The oscillator assembly is insensitive to temperature variations and is well buffered from following stages.

A varactor diode permits incremental tuning over a limited range and a compensation scheme is used to obtain constant fractional resolution, permitting calibration of the $\Delta F/F$ control in ppm.

The oscillator output, after passing through untuned buffer B1, enters the power-amplifier assembly. On the highest-frequency range, the rf signal passes through an additional untuned buffer B2 to the main amplifier A. For each lower-frequency range, the signal is applied to an appropriate number of frequency dividers and thence through untuned buffer (I), the tuned power amplifier, and the output attenuator. The nine 2:1 dividers give a maximum divisor of 512, making the lowest frequency range 67 kHz to 156 kHz.

Normally only those dividers required for the selected FREQUENCY RANGE operate; so the possibility of spurious subharmonics is eliminated. However, when the MONITOR SELECTOR reads F/N ON, the entire divider chain provides a coherent, low-frequency monitor output. (See paragraph 3.3.5.) In the F ON mode, a more conventional counter output is brought from the power amplifier, through an isolating and limiting amplifier M. This signal also feeds into the crystal calibrator, when appropriate.

4.2.3 OUTPUT SYSTEM AND LEVELING.

Modulation and output levels are controlled in the power amplifier.

The power-amplifier control voltage is supplied by a comparator circuit C1, which is part of a feedback control system. The other elements of the feedback loop are the tuned amplifier A and a detector circuit, whose dc output is compared against a composite reference signal. Any difference between these two signals generates an amplifier-correction voltage, which makes the detected output follow the reference voltage.

The detected rf is averaged and displayed by the carrier-level meter, which is calibrated in voltage and in dBm of available power. (See paragraph 3.5 for a discussion of this calibration.) Since the rf level at the sampling point is kept constant by the control circuit, this point can be considered to be a zero-impedance source; a 50-ohm series resistor provides a true 50-ohm source impedance for the generator output.

The CARRIER LEVEL control varies the reference voltage of the feedback loop and thus provides continuous adjustment of the leveled output, over a range of 15 dB. The precision attenuator "OUTPUT RANGE" further reduces the output by 0 to 140 dB in 10-dB steps.

4.2.4 MODULATION FUNCTIONS.

The basic modulating function is performed in the power-amplifier stage. This function is linearized through the feedback action, which makes the detected envelope essentially identical to the composite reference signal (carrier level and modulation voltages in several modes determined by the MODULATION SELECTOR).

There are two internal modulating frequencies, 400 Hz and 1 kHz. At either frequency, the modulating signal is stable and has low distortion. The amplitude of these modulating signals can be adjusted for 0-95% modulation. The modulation level is monitored in terms of the audio modulating voltage but is calibrated directly in percent. A compensation circuit ensures that the calibration is valid over the range of the CARRIER LEVEL control.

External modulation can be applied with either ac or dc coupling. In the EXT AC mode, any audio-frequency signal can be accepted, controlled, and monitored in the same way as for internal modulation. With sinusoidal waveforms, the modulation passband is flat within 1 dB from 20 Hz to 10 kHz. The ultimate upper limit is the 20-kHz nominal cutoff frequency of the low-pass filter used to feed external signals into the power-amplifier enclosure. On the lower-frequency ranges, however, the amplifier bandwidth also affects the highest usable modulation frequency and percentage modulation.

In the EXT DC mode, the input is coupled directly to the amplifier. With no input, the power amplifier is turned off, and a positive-going voltage is required to turn it on.

4.2.5 POWER SUPPLY.

The power supply provides the three well regulated and filtered dc sources that are required in the signal generator: +35, +9, and -15 volts.

Especially critical is the regulation of the -15-volt supply that feeds the oscillator section; variations in this supply are kept to a few millivolts under all adverse conditions by use of a temperature-compensated reference diode in a high-gain series-regulator circuit. The other two bias voltages (+9 and +35 V) are also stabilized by series regulators. All active elements are silicon, and protection against accidental damage or burnout is achieved through current limiting.

4.2.6 AUTO-CONTROL SYSTEM (Models 1003-9702, 4, and 5)

The auto-control unit permits a number of automatic tuning operations by either local or remote control. For automatic tuning, the standard frequency-control motor becomes part of a servo-positioning system. An analog dc voltage, proportional to tuning-shaft position, is compared against a reference voltage in a differential amplifier. The amplified error voltage actuates one of two relays, depending on the polarity of the error signal. The appropriate relay energizes the motor to bring the error to zero, and the relay then drops out and turns the motor off. Simultaneously, a braking function is brought into effect to bring the motor to an abrupt stop. Resolution and accuracy are within 0.1%.

The zero-error position is indicated by one or two lamps on the auto-control panel. This indication is used in the setting of the reference potentiometers to desired tuning positions or sweep limits and also serves as a frequency marker. Two internal multiturn high-resolution potentiometers (F1 and F2) permit continuous adjustment of the auto-tune positions or sweeping limits.

In sweep operation the motor is driven repetitively between the two adjustable limits, F1 and F2. A flip-flop receives a trigger pulse each time the motor reaches a limit, transferring the reference connection to the other limit to actuate the reverse sweep.

4.2.7 FREQUENCY CALIBRATOR (Models 1003-9703, -9704, and -9705).

A 1-MHz crystal oscillator is the basic reference source for the frequency calibrator. Two more frequencies, 200 kHz and 50 kHz, are derived by division and are thus coherent with the 1-MHz signal. Even the lowest marker frequency can be used up to the highest carrier frequencies.

Since the rf sample for the crystal calibrator is taken from the F-MONITOR channel (see Figure 4-1). a high degree of isolation is realized, providing a reverse attenuation of well over 100 dB between crystal calibrator and main output. As a result, the crystal calibrator can be used without fear of contaminating the main output with spurious sidebands.

When the F-MONITOR output is switched on, it is possible to feed an external reference signal through the F-MONITOR jack and to use portions of the crystal-calibrator circuitry as a heterodyne frequency meter. In this mode, only the mixer-amplifier part of the crystal calibrator is activated.

4.3 CIRCUIT DETAILS.

4.3.1 OSCILLATOR (Figure 6-5).

The single-range LC oscillator is basically a Colpitts-type circuit. It is tuned from 34 to 80 MHz by variable capacitor C603, through a precision worm-gear drive that is an integral part of the assembly. Endpoints are set by trimmer capacitor C607 and the tuning slug within the tank coil, L601. This coil has a bifilar winding, consisting of a metalized strip deposited on a very stable ceramic base. The two windings are connected in series to obtain a tightly coupled center-tapped coil, half of which is tied to the active part of the oscillator. The critical output capacitance of Q601 (as seen by the full tank circuit) is greatly reduced, contributing among other factors to good frequency stability. A number of fixed capacitors C604, C606, C611, C612, C613, all with suitable temperature coefficients, aid this process.

The main tuning capacitor provides a logarithmic frequency law and its rotor plates are slotted to permit adjustment at 11 points across the tuning range. This assures close agreement with the frequency dial on all ranges.

The full tuning range corresponds to 153° of rotation of the capacitor shaft, geared (1:200) to the FINE FREQUENCY tuning shaft, for 85.0 revolutions. Because of logarithmic relationship, each revolution changes frequency by exactly 1%.

Varactor diode CR602, serves as an incremental tuning device. It is back biased (around 10 V) via R645, which can be adjusted to obtain a specified tuning sensitivity. The lower the bias, the steeper the slope of the C-vs-voltage function, hence the greater is the sensitivity. The cathode end of the varactor diode is grounded for rf through C602 to AT673, but connects (via a shaping and compensating network and a feed-through filter) for dc to either the $\Delta F/F$ potentiometer R102 or the ΔF CONTROL pins of SO101. There the tuning sensitivity is typically 60 ppm/V. R642, coupled to the main tuning shaft, attenuates the control voltage to obtain a constant percentage frequency change per volt. (The attenuation is greatest when the tuning capacitance is least, so that $\Delta C/C$ or $\Delta F/F$ remains essentially constant.)

The oscillator board, directly attached to the capacitor frame to permit shortest possible connections, also contains the first buffer stage, Q602. On a second board are mounted two more broadband stages, Q621 and Q622, in grounded-base configuration with 2:1 coupling transformers. They have near unity gain but provide a high degree of reverse isolation, thereby reducing frequency-pulling effects to a minimum.

The entire assembly connects normally to a single-ended–15-Vdc supply, through a feedthrough filter that reduces conducted rf to the microvolt level.

The cast base contains the mechanical drive system and elements of an endstop mechanism that limit rotation of the worm-shaft to within one revolution of the normal endpoints. (The actuating arms are on the large dial-drive wheel.

NOTE

In the auto-control versions, there is also a multi-turn potentiometer, driven through a reduction gear, which generates an analog output proportional to shaft position.

4.3.2 POWER-AMPLIFIER ASSEMBLY (Figure 6-8).

General.

The power-amplifier assembly generates the final output signal from the available oscillator drive signal. This process involves buffer amplifiers, frequency dividers, and a feedback control loop, besides the actual tuned amplifier with its associated tank circuits. Also, various monitor circuits originate here.

The power amplifier has two basic modes of operation, one (without dividers) for the top band and the other (with dividers) for the 9 lower-frequency bands.

Accordingly, the rf signal, as it is received from the oscillator through J304, is fed in parallel to the divider chain and to a two-stage buffer amplifier (Q282 and Q281). The selected divider output passes through a broadband gain-controlled intermediate amplifier.

Output Stage (Figure 6-8).

Either of the two outputs is continued through a cam-actuated microswitch, S301, to the base of the output power stage, Q301. There a leveling and modulation feedback control signal is added, which determines the rf output level by influencing the collector current of Q301. In general, operation of the Type 2N3375 power stage varies from class C at low output levels to class AB at high levels.

The actual tank circuit is located on a turret, which is mechanically linked to a number of synchronously driven rotary switches (in both the divider and intermediate-amplifier circuits), with a shaft extension through the rf enclosure for actuation from the front panel.

Figure 4-2 shows a simplified schematic of the tuned power stage and the feedback control loop. The collector is shunt fed through a choke and connected to a tap of the tank coil for optimum power match. The four highest ranges also have provisions for neutralizing the collector-base capacity of Q301, by means of an inverting transformer and adjustable capacitor C_N.

Tuning is accomplished with a ganged two-section capacitor, C315, which is used in three different ways. The circuit consists of one section of C315, or the other, or both in parallel, depending on the range selected. This capacitor is mounted in a separate compartment of the base casting and normally linked mechanically to the oscillator by a steel cable.

A peak detector, CR301, rectifies the output taken from the tank-coil secondary for use in the feedback loop and for metering purposes. Comparison of the detected rf with the dc-reference voltage in the differential amplifier results in an error signal that is fed back to the base of Q301 to regulate the output level.

If, for instance, the tank circuit were off resonance, a constant output could be maintained only by increased drive or more gain in the amplifier stage, manifested by higher collector current. Optimum tracking, therefore, results in minimum current, an indication of which can be used as a means for checking tracking quality.

Since feedback action regulates the rf level at the sampling point (TP302), by keeping the rectified rf equal to the reference voltage, a change of the reference level will result in a corresponding change of carrier level. This fundamental relationship is utilized in two ways:

1. To control the carrier level continuously over a 15-dB span, through the dc component of the reference signal, "leveling".

2. To make the carrier amplitude follow a low-frequency modulation signal, through the ac component of the reference signal, "envelope feedback".

The higher the loop gain, the more faithfully will the reference be reproduced. However, there are limits, as in any feedback system, for reasons of stability and bandwidth. Most of the loop gain is provided by the control amplifier, which is described below.

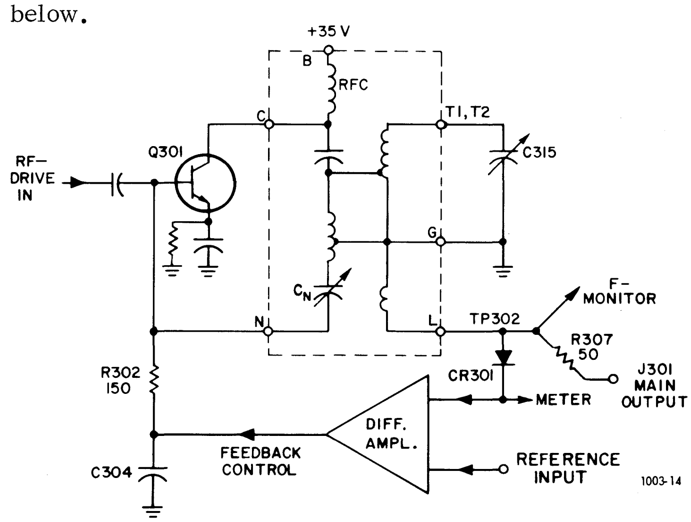


Figure 4-2. Simplified schematic of P.A. output stage.

From the sampling point the main output passes through a 50-Ω source resistor to jack, J301, leading to the attenuator. The F MONITOR output from the sampling point passes through buffer amplifier Q302 to jack J302. Signal level is adequate for a counter, i.e., 0.5 V p-p, into 50 Ω at the lowest carrier-level setting. At high levels, the output at J302 gets compressed and clipped. It is therefore not suitable for monitoring the modulation envelope. (Para 4.3.3.)

The rf detector, CR301, is forward biased through R305 for best linearity. Also, to obtain faithful envelope detection at lower carrier frequencies, the main charging capacitor, C309, is augmented by suitable shunt capacitors located on the Intermediate Amplifier.

The rectified output also feeds the CARRIER LEVEL meter through various low-pass filter sections. The meter circuit includes one adjustable resistor, R312, for calibration purposes.

A rotary switch, S302, coupled to the FREQUENCY RANGE knob, provides an electrical readout of the selected band in terms of a contact closure. The associated connections are brought out to the rear connector, SO302, for potential use in programming and similar schemes.

Frequency Dividers (Figure 6-10).

The frequency divider accepts the oscillator signal, which ranges between 34 and 80 MHz. A tunnel diode, CR401 in the input circuit, sharpens the incoming sinewave into a pulse train with the same repetition frequency, by cycling between the high- and the low-voltage states. The first transistor, Q401, turns each positive-going cycle into a short negative output pulse, which is used to trigger a following binary scaler. Output-pulse duration and amplitude are set by C_E (see Figure 4-3).

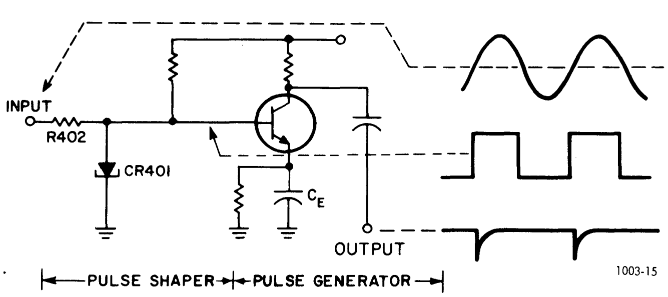


Figure 4-3. Simplified schematic of the input stage of the divider chain.

The entire divider circuit is composed of a string of nine bistable circuits interconnected by pulse-generating stages. All dividers use tunnel diodes as switching elements and employ the same basic circuit shown in Figure 4-4. Typical characteristics of diodes D_1 and D_2 are shown in Figure 4-5: the diodes may be considered to remain in either their high-voltage or low-voltage states.

If D_1 and D_2 (Figure 4-4) were both in the same state, either high or low, then inductor L can be considered to be on the diagonal of a balanced bridge, since R_1 is set equal to R_2 and the diodes are of the same type. For such balance, the current through the inductor is ideally zero. If D_1 is in its high-voltage state and D_2 is low, there is a net positive inductor current, i_L, in the direction indicated. If the states of the diodes are reversed, then i_L reverses polarity and becomes negative. The status of i_L for all four possible diode states is given in Table 4-1.

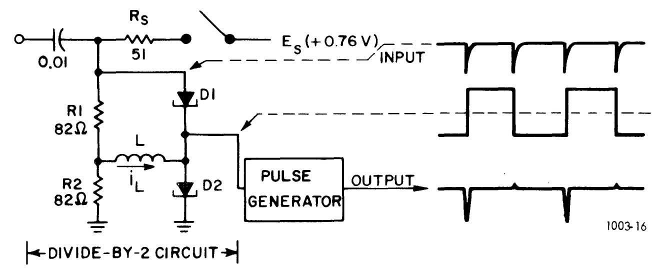


Figure 4-4. Simplified schematic of a representative divider stage.

If both diodes were in their low-voltage state, the bias supply (E_S) would pull one or the other diode into the high state. The high diode would "absorb" enough source voltage to prevent the second diode from coming on. If both diodes are high, then the source cannot maintain enough diode current and one of the diodes drops back to its low state. Thus, the bias networks eliminate two of the four states and leave only the two stable states.

A negative-going input pulse drops the bias voltage to zero for a very brief time, thus putting both diodes in the low-voltage state momentarily. The inductor current continues to flow for the input-pulse duration and causes the tunnel diodes to alternate states at each input pulse. That is, if D_1 was high and D_2 was low before the input pulse, then the inductor current is positive and tends to increase the current in D_2 and decrease the current in D_1 when the input pulse is "removed."

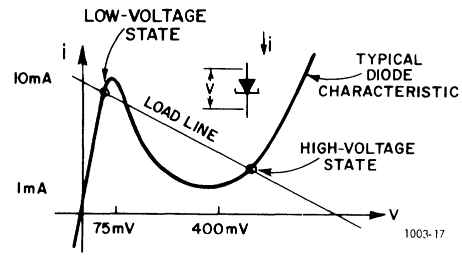


Figure 4-5. Dynamic characteristics of the tunnel diodes.

Table 4-1

OPERATING STATES OF TUNNEL-DIODE SWITCHES

D_1	D_2	i_L	
Low	Low	0	Forbidden (unstable) States
High	High	0	
High	Low	+	Stable States
Low	High	-	

Thus, as the input pulse returns the bias to its quiescent state, the current builds up faster in D_2 then D_1, and D_2 goes over into its high-voltage state. After a short period, the inductor has responded to the new diode state by reversing polarity. Each input pulse then causes an alternation of the bistable circuit from one to the other of its two states, i.e., it requires two trigger pulses before the output waveform repeats itself.

The result is a square wave at half the trigger repetition frequency. The following stage then transforms each positive-going step of the square wave into a negative-going trigger pulse. Divider outputs go through low-pass filters to round off the waveform.

Each divider section obtains its bias voltage through switch S401. At a given range setting, all circuits are biased except the one following directly behind the last divider required. Since the disabled section cannot supply trigger pulses, all the lower-frequency sections are also idle. To activate the entire chain, we need only supply bias to the missing section. This is done by the MONITOR SELECTOR in the F/N ON position (or by a circuit through rear connector SO101) indirectly, as follows.

The last divider stage connects also to buffer stage, Q410. Normally, Q410 is turned off by a negative base voltage (R482, R481, and CR420). Even when the full chain is working, no output is available at PL401/6, until a positive command voltage is supplied through this pin. Then Q410 gets turned on and simultaneously 8.2 volts are fed to the disabled divider, activating the entire chain, regardless of which range is selected. The F/N MONITOR output frequency is, however, always 1/512th the oscillator frequency, i.e., between 67 and 156 kHz.

The frequency appearing at the main output is always equal to or higher than that monitor frequency by a factor N, ranging from 1, 2, 4, 8, ... to 512, as shown in Figure 4-6.

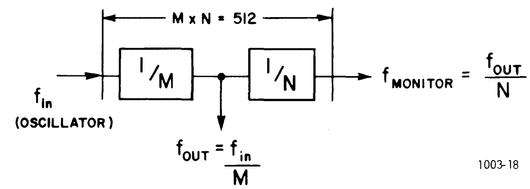


Figure 4-6. Derivation of F/N monitor output signal.

Intermediate Amplifier (Figure 6-12).

This unit amplifies the selected divider output to obtain adequate drive level for the power-amplifier stage. The three-stage amplifier, Q321, Q322 and Q323, covers a frequency band from 70 kHz to 40 MHz, with a slight rise in gain towards the high end.

The other transistors, Q324 and Q325, function as a voltage-controlled variable resistor, which regulates the gain of the amplifier portion, thereby affecting the level at which the power amplifier is driven. The gain-control voltage is derived from the CARRIER LEVEL control (which also provides the reference voltage for the control amplifier). R342 adjusts the minimum gain, for zero volts on PL221/6. This gain-control function is also applied to the rf buffer amplifier, Q282/Q283 (Figure 6-6), which acts when the highest frequency range is chosen. R346 is then connected, to reset the control range properly.

Not directly related to any Intermediate Amplifier functions are capacitors C347 through C350. They affect time constants of rf detector CR301, but are located here near switch S321, which also controls a bank of capacitors used as filter shunt elements of the input network.

Control Amplifier (Figure 6-16).

Most of the gain required for satisfactory operation of the feedback control circuit is provided by this amplifier. A differential input stage, Q361 and Q362, compares the signal level or envelope (from rf detector) against the reference (from modulator) and amplifies the difference, or error, signal. Two more single-ended stages, Q363 and Q364, boost the gain further and also shift the mean voltage into the required region of about +2 V. Zener diodes CR362 and CR363 limit the output swing between -3.9 V and +6.2 V. The negative limit protects against excessive back-biasing of the power transistor, the positive limit restricts the maximum turn-on current to a safe value.

There is another protective circuit included here, consisting of Q365 and CR364 and CR365. The diodes are normally forward biased, as long as current from the 35-V source flows into the power stage (via the turret assembly). During range switching, this current gets interrupted, turning Q365 off. As a result, the available positive bias current into the control amplifier diminishes to the point that its output is also quite low, even though the largest error input is applied in this condition. When the power stage is connected again, the turn-on voltage starts very low and builds up to its final value slowly, thereby preventing excessive current spikes in the collector circuit whenever FREQUENCY RANGE is switched.

Tank Turret Assembly (Figure 6-14).

Each of the 10 frequency bands uses a different and separate tank circuit, which connects to the transistor stage and to the tuning capacitor through spring contacts. All circuits have one or more common features and are mounted in a turret assembly with circuit boards aligned in radial planes 30° apart. Up to eight connections are available to each board.

They are designated as follows:

- B - Bias input (+35 V)
- N - Neutralizing connection to base of Q301
- G_1 - Ground #1, associated with amplifier circuit
- C - Collector (Q301)
- L - Load or output circuit (secondary of tank coil)
- T_1 - To tuning capacitor, section #1, C315A (small C)
- T_2 - To tuning capacitor, section #2, C315B (large C)
- G_2 - Ground #2, associated with output circuit.

Table 4-2 summarizes the adjustable components and the effective tuning capacitor used on each range. Each output circuit contains a low-pass filter section to further reduce harmonics. Each shunt feed circuit, from point B to point C, has a minimum resistance of 33 Ω, which limits any possible high-current condition through the power transistor to a safe value.

L231, L236, L243 and L248 are phase-inverting transformers used with neutralizing capacitors C231, C236, C242 and C247, in the four top frequency ranges.

P.A. Filtering (Figure 6-8).

The power amplifier requires three different bias voltages. They enter the rf enclosure through individual feedthrough-filter assemblies. In conjunc-

Table 4-2
ELEMENTS IN POWER AMPLIFIER TURRET ASSEMBLY

Range	*Effective Tuning Capacitor C315*	*Adjustable Tank Coil*	*Tuning Range Trimmer*	*Neutralizing Trimmer*
1	A + B	L201	C202	——
2	A + B	L206	C207	——
3	A + B	L212	C213	——
4	B	L217	C218	——
5	B	L222	C223	——
6	B	L227	C228	——
7	B	L233	C233	C231
8	B	L238	C238	C236
9	B	L242	C244	C242
10	A	L247	C303*	C247

*Not located on tank circuit board but on amplifier board.

tion with additional filtering elements inside the casting, rf signals superimposed on internal bias leads have to penetrate a 100-dB barrier before reaching other parts of the instrument, thereby reducing stray signals to the microvolt level and below.

Level-control and modulation signals are fed through a two-section low-pass filter that has a flat passband over 20 kHz, but provides sufficient stop-band attenuation to effectively suppress leakage down to the lowest carrier frequency (67 kHz).

Another filter, similar to the types used for bias feedthrough, removes residual rf from the meter circuit, which monitors the rf-carrier level.

4.3.3 FREQUENCY-MONITORING OUTPUTS (Fig. 6-1).

Two separate monitoring outputs originate in the power amplifier. However, both circuits are controlled from outside the unit.

The F-monitor signal, derived at the sampling point, is not necessarily a true replica of the main output waveform but, due to limiting action at high-level settings, approaches a square wave*. It continues through a mechanical disabling switch, S104, to the rear panel jack, J103. In the "MONITOR OFF" position, the residual level at this point is at least 80 dB down, in order to cut down unwanted radiation from the open connector or leakage from an attached device. The switch box also contains a connection (J104) for the crystal calibrator, which is plugged up if not required.

The second auxilliary output, referred to as F/N-monitor, originates at the last divider section. This output can also be disabled, but the switching process is accomplished by means of a dc-bias voltage, which is fed through the center conductor of the associated output cable. The rf signal and the dc-control voltage are separated and decoupled in a filter box integral with the output jack, J105. To activate the F/N MONITOR output, the control lead must be energized, either through S102 (MONITOR selector) or through an external link (between pins 4 and 5 of SO101). The external-control mode functions independently of the front-panel settings.

Normally, only one of the two monitor outputs can be turned on through the front-panel control. However, the above-mentioned external-control mode of the F/N output permits simultaneous operation of both monitors.

*Refer to para 4.3.2 - Output Stage

4.3.4 MODULATOR ASSEMBLY (Figure 6-18).

The main function of this unit is to generate the composite reference signal that the P.A. requires. It has six modes of operation, chosen with MODULATION SELECTOR S151. In all but the EXT DC mode, a suitable fixed dc voltage is derived from a temperature-compensated resistive divider (R183, R187 and R189) and fed to the CARRIER LEVEL control potentiometer, R107 (Figure 6-1). In the modulation modes, an ac voltage is added through C161, at which point a single-stage metering circuit, Q153, measures the amplitude of the modulating signal.

MODULATION control R181 permits 15 dB of ac adjustment. The proper ac-dc ratio ensures constant depth of modulation at all carrier-level settings. With R107 in its maximum position, a given modulation depth corresponds to a certain ac/dc ratio. As R107 is set to its lowest point, the ac component is reduced according to the resistance ratio. Maintenance of the same modulation depth requires a dc voltage somewhat higher than the resistance ratio would supply, because of an offset condition. This extra incremental voltage, developed across part of R187 from a constant-current source, is adjustable for optimum equalization.

For internal modulation a Wien-bridge-type oscillator, Q151 and Q152, can be operated at either 400 Hz or 1 kHz. Highly stable components in the bridge circuit and thermistor compensation ensure very good frequency and amplitude stability. The desired modulation level is set by R181, both for internal and external modulation. Whatever carrier level has been selected under modulation conditions is also maintained in the CW NORM mode. In the CW HIGH mode, the dc reference is higher, permitting higher carrier levels to be set.

All end-point settings are adjustable by trimmer potentiometers that are easily accessible.

In the EXT DC mode, the internal reference voltage is removed. As a result, no carrier output appears, unless a suitable positive-going voltage is applied externally through the MOD IN/OUT connectors. Zener diode CR151 limits the effective control signal to safe levels. An ac-component in the modulating voltage will cause a reading on the modulation meter, but the indicated percentage is not necessarily correct, since the ac/dc relationship is not controlled by the instrument in this mode.

A unity-gain Darlington-type buffer amplifier (Q154 and Q155), following the carrier-level control, furnishes a low-impedance drive source for the power amplifier.

4.3.5 OUTPUT ATTENUATOR (Figure 6-1).

The output attenuator contains a constant-impedance-type ladder network with a total attenuation of 140 dB in 10-dB steps. The network is housed in a circularly arranged series of cavities milled out of a heavy casting. Coaxial connectors at each end maintain the low-reflection 50-ohm impedance of the network.

The 15 level settings available are controlled by a ganged pair of switches operated by the OUTPUT RANGE knob. The switching arrangement is shown in Figure 4-7. In the maximum-output position, S2 and S1 are connected together by a-a'; in all other positions, S2 connects to point b, S1 to the ladder.

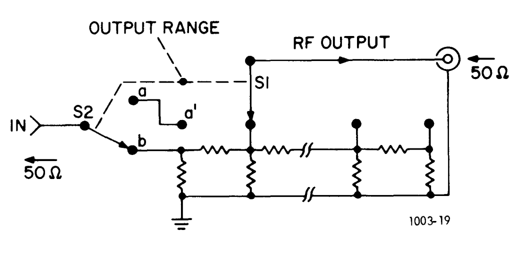


Figure 4-7 Attenuator network switching details.

4.3.6 POWER SUPPLY (Figure 6-21).

The power supply furnishes three regulated dc outputs, a low voltage ac for a pilot light, and a 115-V ac tap for the tuning-motor circuit. A simplified elementary diagram is shown in Figure 4-8, which illustrates the interdependence of the dc outputs.

Each dc output originates from a separate winding of the power transformer, goes through a full-wave bridge rectifier, and provides unregulated filtered dc to the following regulator. Normal operation of all outputs hinges on the presence of the 35-V bias, which feeds the reference diode of the 15-V regulator, whose output in turn supplies the reference voltage to the 9-V regulator. Hence, a shorted 35-V line brings all outputs down to 0; a short in the 15-V line also affects the 9-V circuit.

The regulators are of the series type. They have either built-in short-circuit protection or can stand the overload condition. In the 35-V circuit, a shorted output results in Q503 getting turned off, leaving only a very small base current available for the series transistor, Q501. As a result, the collector (or short-circuit current) of Q501 is limited to about 0.1 A, maximum.

The 15-V regulator uses a temperature-compensated reference diode, CR515, in a high-gain circuit. The associated series transistor, Q507, draws its base current from the 9-V line, through R519. A short on either the 15-V output or the 9-V line leads to a starved condition for Q507, which reduces the available current at the 15-V line to a low value, typically less than 0.1 A.

The 9-V regulator is slaved to both the 15-V supply (to obtain the reference voltage) and to the 35-V supply (to provide base current to the series transistor, Q505). In case of a shorting condition on the 9-V output only, the current is limited basically by the β-value of Q505 and is typically about 0.7 A.

Each regulator has a potentiometer control for exact setting to the specified voltage.

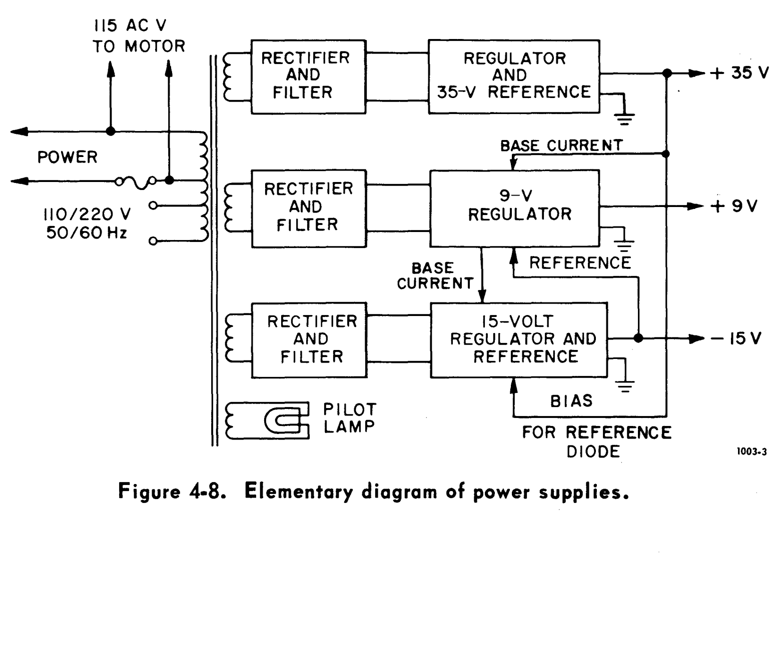


Figure 4-8. Elementary diagram of power supplies.

4.3.7 MOTOR DRIVE (Figure 6-1).

The primary function of the motor drive is to permit rapid tuning over a frequency band. (In models with auto-control circuitry, the motor may also be part of a servo system).

COARSE FREQUENCY rocker switch S105 in models 1003-9701 and -9703 controls the motor directly, except that limit switch S106 or S107 opens the circuit one revolution before the mechanical limit stop is reached.

M101 is a 115-V ac, shaded pole type, operated as a split-phase motor with capacitor C104. A 5-to-1 gear reduction provides a nominal speed of 320 rpm at the main tuning shaft. (Models 1003-9701, -9703, and -9704 only).

4.3.8 AUTO-CONTROL/VARIABLE SPEED SWEEP.

This circuitry is found in models 1003-9702 and -9705 only. See Figure 4-9, 6-30, and 6-32 .

General.

The auto-control system is an electromechanical one with two basic functions. It can position the tuning shaft to any preselected point in the tuning range of the oscillator. It can also sweep repetively between any two such points at a continuously variable rate from nearly zero to 5% frequency change per second.

In the manual mode (TUNE OR SET LIMITS) the tuning motor is controlled by either of two relays in response to the corresponding COARSE FREQUENCY push button. Speed of the motor is set by the SPEED control, and maintained constant by a feedback circuit.

In either automatic mode (AUTO POS or SWEEP) the motor relays are driven instead by the auto-control amplifier, which responds to the difference between an analog of the oscillator frequency and a programmed reference. When the difference is above a small threshold the motor is started in the appropriate direction; when the error reaches zero the motor is stopped abruptly. In the AUTO POS mode the motor holds that position until the reference (or limit) is changed.

In the SWEEP mode, the adjustable references F1 and F2 become sweep limits. Each time a limit is reached, both motor relays are momentarily deenergized. They brake the motor and provide a trigger to start the return sweep by programming the opposite limit. The analog voltage in this mode generates a triangular pattern. Two special variants of this, selected by SWEEP VOLTAGE switch S5, are available for the horizontal component of scope or recorder display. The WIDEBAND choice is a buffered replica of the analog output with the addition of a variable dc component determined by the CENTERING control R12. The NARROWBAND choice is a steeper-sided sweep-voltage triangle provided by a separate potentiometer R11 geared so its entire useful range is covered in 4 turns of the main tuning shaft (in contrast to 85 turns for the analog potentiometer). R11 turns only when NARROWBAND is chosen. During the return (counterclockwise) sweep, the motor is speeded up, the RF OUTPUT is held at zero, and a 9-V step is supplied at the rear panel (SO101, pin 11) for display blanking or pen lift.

Motor Drive Assembly.

The servo-type dc motor MO1 provides the motive power for either coarse manual or automatic tuning. MO1 includes a built-in speed-sensing generator. The assembly includes an unregulated 20-V dc power supply for the motor, the directly-associated relays, and most of the speed-regulating circuit. Special filters prevent appreciable leakage of radio-frequency noise.

The motor runs clockwise when relay K1 is energized, ccw with K2. Four poles, of the six in each relay, then connect appropriate circuits to both motor and generator. The moment both relays are deenergized these poles short each (motor and generator) to provide dynamic braking for an abrupt stop. The 5th pole of each relay works in conjunction with mechanical limit switches S106 and S107 to prevent overtravel of the tuning mechanism. The 6th one sends a step to a Schmitt trigger to initiate a return sweep (SWEEP mode) or lights the AUTO STOP lamp P3 (AUTO-POS mode). This pole in K2, in SWEEP mode, also switches the blanking voltage (which via Q3 and Pin 1 of SO1 suppresses the rf output, via pin 2 is made available for external use, and via CR5 modifies the speed control).

The speed control circuit permits settings over a 100-to-1 range. A high-gain feedback loop in which Q1 and Q2 control the motor current, keeps the generator output essentially equal to the reference voltage set by SPEED potentiometer R10, insensitive to changes in supply voltage or mechanical load.

Analog Potentiometer.

The analog of frequency is the voltage provided by 10-turn linear potentiometer R851. It is mounted in the oscillator base casting, geared to the main tuning shaft, and wired via a terminal strip.

Auto-Control Amplifier (Figure 6-34).

The heart of this subassembly is a differential amplifier with input terminals TP801/TP802 (analog and reference) and output terminals 16 and 18 of SO4 (counterclockwise and clockwise motor commands, respectively). The first stage Q807/Q808 contains a balance adjustment R823 and is fed by constant-current source Q809. The second stage Q810/Q811 uses constant-current source Q812 with adjustment R834. The final stage Q813/Q814 has emitters stabilized at 5.6 V; its dual loads appear in parallel with diodes CR807/CR808.

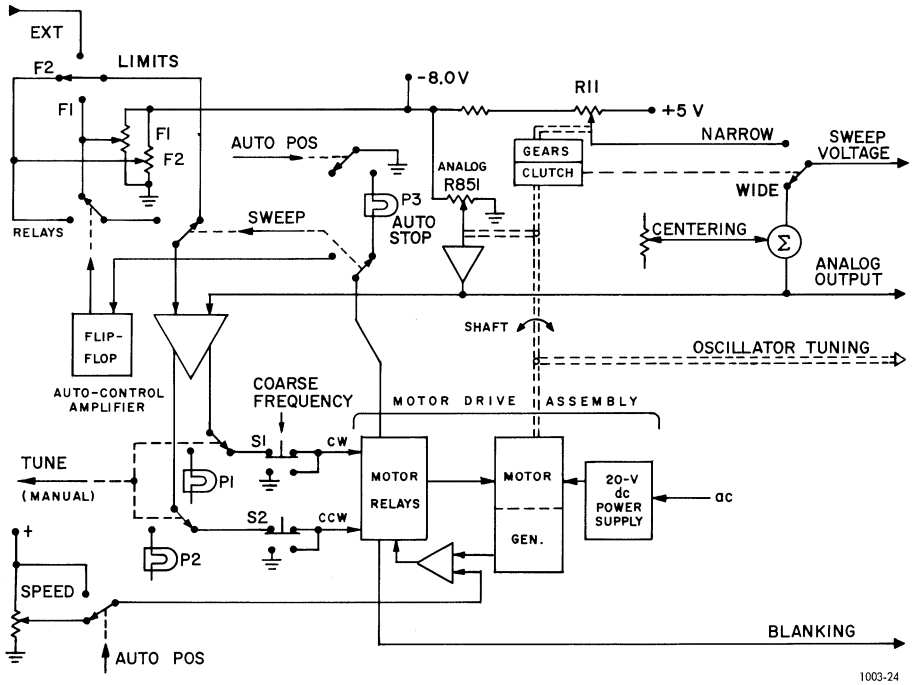


Figure 4-9. Auto-control and sweep, block diagram.

A positive error signal (TP801-TP802) upsets the normal balance throughout this amplifier, and if sufficiently large to bring the base of Q813 to 0.5 V above the emitter, causes output current to flow through pin 16. Similarly, a negative error energizes the circuit through pin 18. The respective loads (external to this subassembly) are motor-control relays K2 and K1 (ccw and cw), except when the TUNE push button is depressed the loads are white lamps P2 and P1 (in left and right COARSE FREQUENCY buttons).

Auxilliary circuits in this subassembly are particularly important in sweep operation:

a. Darlington pair Q805/Q806 provides isolation for the rear-panel replica of the analog voltage, "analog output."

b. A passive network combines a sample of this replica with a dc offset determined by CENTERING potentiometer R12, to produce the rear-panel signal "sweep output."

c. Flip-flop Q803/Q804 drives a pair of relays K801/K802 that connect either reference A or B to the amplifier input TP802. Reference B is always the limit F2; A can be F1 or EXT, depending on switches in the auto-control panel. The flip-flop is either set by switches in the auto-control panel or toggled by a pulse as follows.

d. Schmitt trigger Q801/Q802 converts the repeat-sweep command (a 9-V step when limit is reached, if SWEEP button depressed) into a sharp pulse for triggering the flop-flop.

e. A Zener-stabilized regulator, R838 and CR810, provides bias for analog and reference potentiometers via SO4 pin 5.

Auto-Control Panel (Figure 6-30).

This special insert in the front panel contains only passive elements (switches, potentiometers, lamps, etc) for control of the motorized tuning functions. It also provides interconnections, through the attached cable, among other subassemblies. Each set of three push-button switches contains interlocks to keep one button depressed at a time. However, no damage results from releasing them all simultaneously.

4.3.9 AUTO-CONTROL/FIXED SPEED SWEEP.

NOTE

This circuitry is found only in model 1003-9704. See Figures 6-22 and 6-24.

General.

The basic function of the auto-control circuitry is the automatic positioning of the motor shaft to preselected points over the full tuning range of the instrument (85 revolutions). In manual operation, the tuning motor (described in 4.3.7) is controlled by the COARSE FREQUENCY rocker switch S852. In the automatic mode, this switch is replaced by contacts of relays K803 and K804.

As in most servo-position systems, a voltage proportional to a variable shaft position (analog) is compared against a reference voltage in a differential amplifier. A difference voltage exists unless both coincide. The differential output is an "error" voltage that contains directional information in terms of polarity, while the magnitude is a measure of the distange. The differential amplifier causes the magnified error signal to energize the appropriate relay to make the motor run in a direction of diminishing error. As the desired tuning point is approached, the error voltage drops below a threshold level, causing the relay to drop out. The motor would normally coast to a stop and in the process overshoot the target, resulting in possible hunting. This is prevented by simultaneous operation of a brake circuit. It makes the motor stop abruptly, the instant the relay drops out, by discharge of a 100-μF capacitor through the motor windings.

The two adjustable built-in references, F1 and F2, can also be used as sweep limits. Repetitive sweeping simply requires automatic switchover to the other reference point, after each one has been reached. As the motor comes to a stop, both relays are temporarily deenergized and provide in this condition a trigger pulse for a flip-flop, which then effects the switchover, starting the return sweep. The analog voltage in this mode follows a triangular pattern and is available for recording purposes at pin 7 of SO101 at the rear of the generator.

Analog Potentiometer

The analog of frequency is the voltage provided by multi-turn linear potentiometer R851. Found in the oscillator base casting, it is geared to the tuning shaft and wired via a terminal strip.

Auto-Control Panel.

The demountable panel contains only passive elements, switches, potentiometers, etc, for control purposes, but provides the interconnections with other system elements through the attached cable harness. The pushbutton switches interlock to keep one button depressed at a time. However, no damage can result from the accidental release of all pushbuttons simultaneously.

Auto-Control Amplifier (Figure 6-24).

NOTE

Refer also to Figure 6-22 for a simplified block diagram.

The differential-amplifier input stage, Q807 and Q808, is fed from a constant-current source, Q809. R823 is a balance adjustment. A similar direct-coupled stage, Q810/Q811, follows; the associated constant-current source, Q812, is adjustable by R834. Under balanced conditions, i.e., error (or differential) input zero, the collector currents in Q810 and Q811 are equal. Consequently, their collector voltages are equal too, and so are the base voltages of the final stages, Q813 and Q814. Their Zener-stabilized emitter voltage (nominally 5.6 V) keeps the two transistors turned off, as long as the base-emitter voltage is less than 0.5 V, at balance. As a result, neither of the associated relays K803 and K804 is energized, and the four contacts of each relay are in the state shown in the schematic.

A positive-going error signal at TP801 energizes K803 and causes the motor to run in a clockwise direction, in the automatic mode. A negative signal actuates K804, which results in a ccw rotation, until a null is obtained. An abrupt stop is initiated when the active relay drops out, causing a number of switching functions:

1. K804S/1 or K803S/3 disconnects the motor from the ac source and prepares the brake circuit.

2. K803S/1 or K804S/2 complete the electrical brake circuit, discharging C105 (in the motor-drive assembly).

3. K803S/2 and K804S/3 close the indicator circuit to light a neon lamp, P851, on the control panel, and reduce the steady-state braking current.

4. K803S/4 and K804S/4 connect the input circuit of a Schmitt trigger (Q801/Q802) for possible use in the sweep mode.

The relays operate whether the motor is actually connected or not. Whenever an unbalance exists, one or the other relay is turned on. Apart from controlling the motor in the auto-control mode through K804S/1 or K803S/3, other switching functions are in effect:

1. K804/3 or K803/2 applies full charging current to C105, quickly establishing the voltage needed for braking at the next stop. At the same time, the indicator circuit is opened.

2. K803S/4 or K804S/4 opens the Schmitt-trigger input circuit.

Three other auxiliary circuits are integrated with the amplifier board:

1. A Darlington-type transistor pair, Q806 and Q805, provides an isolated replica of the analog input voltage.

2. Q803 and Q804 form a flip-flop, driving a pair of relays K801 and K802 that connect either reference A or B to the amplifier input. The flip-flop is either set by external control voltages to the desired state, or toggled by a pulse as follows:

3. The Schmitt trigger, Q801/Q802, converts the sweep command (a 9-V step) into a sharp pulse for triggering the flip-flop.

A Zener-stabilized bias source, R838 and CR810, is also included to feed the required -8 V to the analog and reference potentiometers.

4.3.10 CRYSTAL CALIBRATOR (Figure 6-29).

NOTE

This circuitry is found only in models 1003-9703, -9704, and -9705.

The Crystal Calibrator is a beat-frequency device that mixes a sample of the rf signal with crystal-controlled marker frequencies and produces an amplified beat signal. Once the difference frequency becomes audible, the generator can be tuned easily toward a zero-beat condition for precise calibration.

Figure 4-10 shows the arrangement simplified. A 1-MHz crystal oscillator, as the primary frequency source, is activated by a dc bias voltage via XTL CAL switch S102. It is followed by a divider circuit that produces 200-kHz multiples, also upon application of a dc voltage. In a similar way, 50-kHz multiples are available to the mixer circuit, as well. A low-pass filter passes the low-frequency products of the mixer to an audio amplifier, with up to 60 dB of gain.

Referring to the detailed schematic one can easily recognize the major blocks. Q701 is the actual oscillator stage, with C702 as a small-range trimmer.

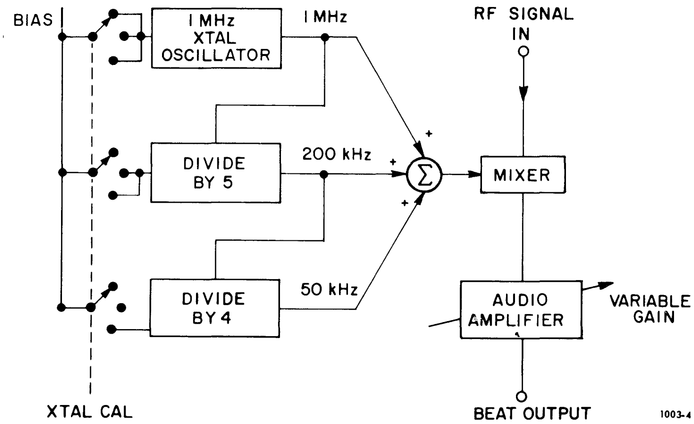


Figure 4-10. Elementary diagram of crystal calibrator.

Two pairs of diodes and buffer stages amplify and clip the signal to obtain a nearly square wave, rich in harmonics.

The divide-by-five circuit is an injection-locked-oscillator type with a natural frequency near 200 kHz, triggered by the 1-MHz drive signal. A by-product of this switching-type circuit is a square-wave output at Q726, which is partly differentiated on the way to the mixer.

A very similar circuit is used also in a divide-by-four mode to obtain a locked 50-kHz output. Q752 and Q751 make up the pair.

All three outputs are combined and added to the externally applied rf signal at the mixer, CR776. A filter, C776/R779/C777, eliminates most of the rf and high-order products, so that only low-frequency beat tones reach the amplifier input stage, Q776/Q777. Two more RC-coupled stages with localized feedback complete the amplifier, which can be controlled over at least 30 dB through a variable bias control, R719.

The rf signal enters through an attached coaxial line (via PL715) that plugs into the F-MONITOR box (J104).

Service and Maintenance—Section 5

5.1 GR FIELD SERVICE.

The two-year warranty attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by the use of the following service instructions, please write or phone our Service Department (see back page), giving full information of the trouble and of steps taken to remedy it. Describe the instrument by: type number (front panel) or preferably model number (paragraph 1.2.1), serial and ID numbers (rear panel).

Before returning an instrument to General Radio Company for service, please contact our Service Department or nearest district office, requesting a "Returned Material Tag." Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

Packaging must be adequate to protect the instrument, i.e., equivalent to the original. The instrument must be completely assembled, in cabinet, with end frames and all screws in place, before shipment.

5.2 MINIMUM PERFORMANCE STANDARDS.

5.2.1 GENERAL.

The equipment, methods, and criteria are given for verifying the specified performance of the 1003. Pertinent adjustments are described in paragraph 5.5. If performance is grossly inadequate or cannot be corrected by these adjustments, refer to the trouble analysis in paragraph 5.6. Table 5-2 lists the equipment needed for all the measurements in Section 5. Figure 5-1 shows the various interconnections used in performance evaluation.

5.2.2 STANDARD SETTINGS.

Standard positions for front-panel controls are shown in Table 5-1 . Set these up for all procedures in Section 5 except when otherwise specified.

Table 5-1

STANDARD SETTINGS FOR 1003 EVALUATION

Control	*Setting*
POWER	On
FREQ CAL	Standardized (para 3.4.2)
MONITOR SELECTOR	OFF
MODULATION LEVEL meter	50%
FINE FREQUENCY	Logging No. 4025 (1.6 MHz)
CARRIER LEVEL	Maximum
FREQUENCY RANGE	1.2 to 2.5 MHz (N = 16)
OUTPUT RANGE	0 dBm
ΔF/F CONTROL	0 PPM
MODULATION SELECTOR	INT 1 kHz
AUTO POS—SWEEP	TUNE OR SET LIMITS

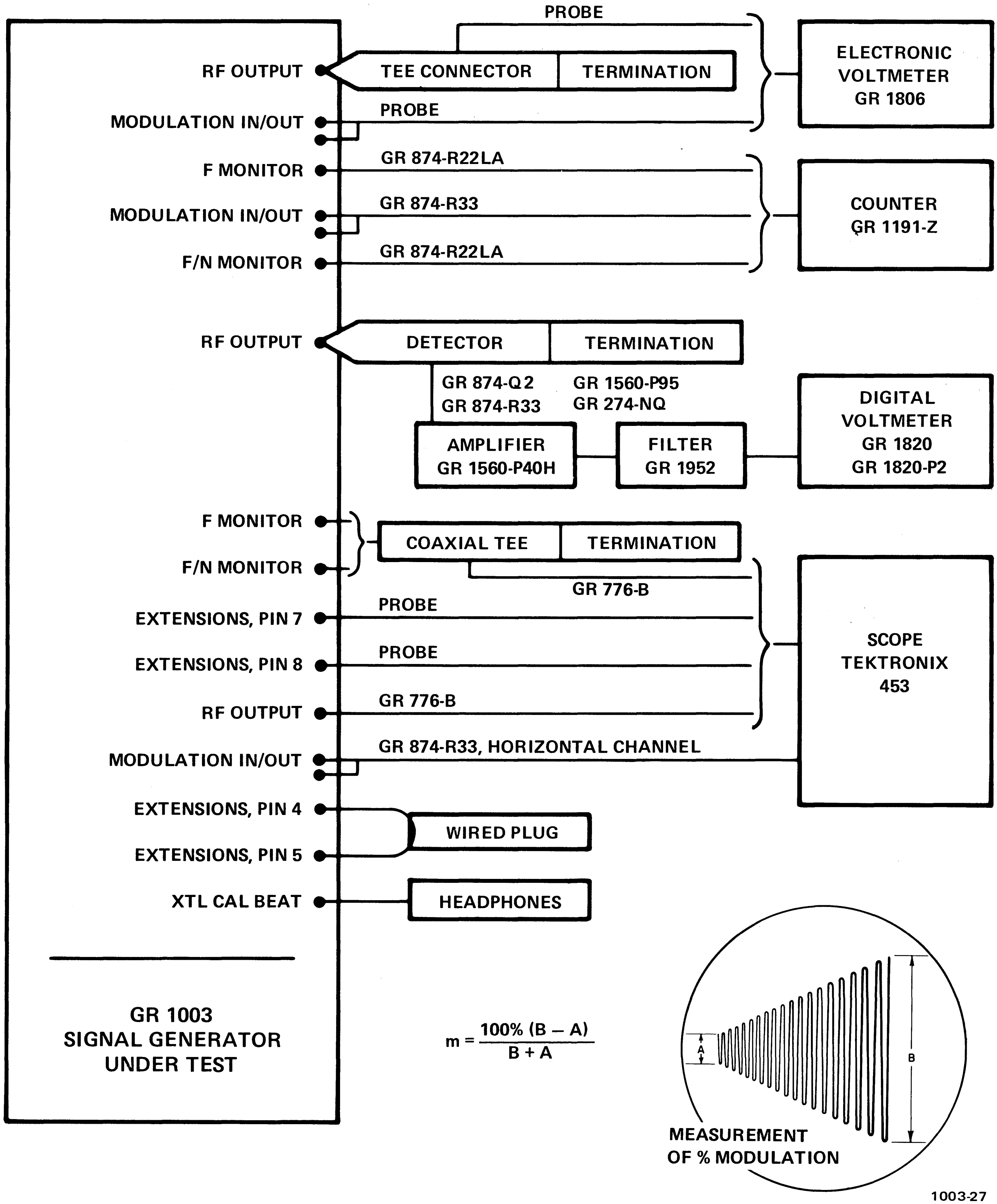


Figure 5-1. Universal setup for performance evaluation.

Table 5-2
TEST EQUIPMENT

Item	*Requirements*	*Recommended type*☆
Electronic voltmeter	1.5 V full scale, dc and 20 Hz -100 MHz.	GR 1806
Digital voltmeter	1 - 50 V dc ±0.1%	GR 1820 and 1820-P2
	6 - 100 dB re 100 μV ac, 20 Hz - 20 kHz	
Ohmmeter	0.2 Ω - 1 MΩ.	(GR 1806)
Tee connector	VSWR < 1.1 to 80 MHz, for voltmeter	GR 1806-P1
Oscilloscope□	Sensitivity: 20 mV/cm, dc –50 MHz.	Tektronix 453
Probe□	10X, for scope.	Tektronix P6010
Counter	60 Hz-80 MHz. Gate: 1 μs-10s.	GR 1191-Z (100 MHz)
Low-pass filter	Set to 15 kHz	GR 1952
Amplifier	Gain:20 dB, 20 Hz-20 kHz Noise:2.5 μV	GR 1560-P40H
Variable line transformer	Range:0-140 V ac Meters: 0-150 V ac, 0-150 W.	GR W5MT3W Variac® Adjustable Autotransformer
Microammeter□	0-200 μA.	Honeywell MM3
Headphones□	General purpose 1-2 kΩ; phone plug	Telex
Detector	50 Ω coaxial, non-terminating	GR 874-VQL
Tee	50 Ω, coaxial	GR 874-TL
Termination	50 Ω coaxial	GR 874-W50BL
Patch cord	GR874 to GR874	GR 874-R22LA†
Patch cord (2 req'd)	GR874 to BNC plug.	GR 776-B
Patch cord	GR874 to banana plugs.	GR 874-R33
Patch cord (2req'd)	Banana plugs to banana plugs	GR 274-NQ
Patch cord	Banana plugs to phone plug.	GR 1560-P95
Adaptor	GR874 to binding posts.	GR 874-Q2
12-wire extension cable, plug to socket.□	Special, make 18 in. long; connect corresponding pins of these connectors:	Cinch P-312-CCT† Cinch S-312-CCT
10-wire extension cable, plug to socket.□	Special, make 18 in. long; connect corresponding pins of these connectors:	Method MD-610-S Method 91-6010-1500-00
Wired plug□	Special, jump pins 4-5.	Cinch P-312-CCT†
Wired plug□	Special, jump 1-2, jump 3-4.	Cinch P-312-CCT†
Spanner wrench□	Special, for attenuator ring nut.	Figure 5-11
Clamp, with screws□	Special, PA shaft, tracking evaluation.	Figure 5-12

☆or equivalent. □not available from GR. †supplied with 1003.

NOTE

Allow at least 30 minutes for warmup, preferably with standard settings, before performance evaluation.

5.2.3 RF POWER.

a. Set the MODULATION SELECTOR to CW HIGH; OUTPUT RANGE to +20 dBm; CARRIER LEVEL meter to −6 dBm.

b. Plug the voltmeter tee connector with the 50-ohm termination into the RF OUTPUT connector, and the probe of the electronic voltmeter into the tee.

c. Verify that the CARRIER LEVEL meter agrees with the voltmeter within ±10%.

NOTE

If the CARRIER LEVEL meter is labeled VOLTS OPEN CIRCUIT it must read a factor of 2 higher; refer to paragraph 3.5.

d. Verify that the CARRIER LEVEL control provides at least 10 dB of output range, i.e., the ratio 300/95 mV.

e. Set the CARRIER LEVEL control to the full-scale meter reading.

f. Verify that the rf output level is maintained on each of 10 bands, while rotating the FREQUENCY RANGE switch.

g. Set the MODULATION SELECTOR to CW NORM, OUTPUT RANGE to +10 dBm, and CARRIER LEVEL control to maximum.

h. Verify that the CARRIER LEVEL meter reads 0.5 V across 50 Ω (or 1.0 V open circuit) ±10%.

i. Disconnect external components from the RF OUTPUT connector. Return controls to standard settings.

5.2.4 FREQUENCY.

a. Verify that the COARSE FREQUENCY control is operative; refer to paragraph 3.3.2.

b. Set the MODULATION SELECTOR to CW NORM, the MONITOR SELECTOR to F ON.

c. Connect the F MONITOR output to the "dc −100 MHz" input of the 1191-Z counter; adjust its input attenuator and trigger level.

d. Tune the 1003 until the cursor indicates 1.600 MHz.

e. Verify that the counter reads within the range: 1.596-1.604 MHz.

f. Check that the frequency changes by 2:1 steps, as summarized in Table 5-3, by rotation of the FREQUENCY RANGE control.

g. Retune to the bottom of the 5th band (N=16), to cursor indication 1.080 MHz.

h. Verify that the counter reads within the range 1.0773-1.0827 MHz.

i. Check the 2:1 changes as in step f.

j. Retune to the top of the 5th band (N=16), to cursor indication 2.500 MHz.

k. Verify that the counter reads within the range 2.4938-2.5062 MHz.

l. Check the 2:1 changes as in step f.

m. Retune to the center of the 5th band, (N=16), to 1.6 MHz.

n. Observe the counter readouts for settings of the △F/F control to +500 and −500 ppm.

o. Verify that the difference between those two readings is within the range 1.44-1.76 kHz (i.e., that the total span of the △F/F control is calibrated within ±10%).

p. Disconnect external equipment and return controls to standard settings.

5.2.5 MONITOR OUTPUTS.

a. Set the MODULATION SELECTOR to CW HIGH, CARRIER LEVEL meter to −10 dBm, the MONITOR selector to F ON.

b. Plug the coaxial tee and 50-ohm termination into the F MONITOR connector and patch the scope to the 3rd terminal of the tee.

c. Verify that the signal is at least 0.5 V pk-pk. Repeat at all 10 positions of the FREQUENCY RANGE control.

d. Retune to the bottom of the frequency scale and repeat step c.

e. Retune to the top of the frequency scale and repeat step c at 9 frequencies. (The check at the 10th frequency, 80 MHz, may also be made only by specially calibrating the "50-MHz" scope.)

f. Transfer the coaxial tee from the F MONITOR to the F/N MONITOR connector; switch the MONITOR selector to F/N ON.

g. Verify that the signal is at least 75 mV pk-pk (a squared waveform) for all frequencies in any one band, while tuning with the COARSE FREQUCNCY control.

h. Check that the signal is at least 75 mV pk-pk at mid-band, and repeat at all 10 positions of the FREQUENCY RANGE switch.

i. Disconnect external components from the monitor connector and return all controls to standard settings.

5.2.6 AMPLITUDE MODULATION.

a. Connect the electronic voltmeter to the front-panel modulation in/out terminals.

Table 5-3

FREQUENCY STEPS OF 2:1

N	*Megahertz* Low	Mid	High
1	.0675	0.1	.1562
2	.135	0.2	.3125
4	.27	0.4	.625
8	.54	0.8	1.25
16	1.08	1.6	2.5
32	2.16	3.2	5.
64	4.32	6.4	10.
128	8.64	12.8	20.
256	17.28	25.6	40.
512	34.56	51.2	80.

b. Verify that the signal level is at least 2 V rms (open circuit) with MODULATION SELECTOR in either INT 1 kHz, or INT 400 Hz position.

c. Connect the counter to the modulation terminals, replacing the voltmeter.

d. Verify that the frequency is within the ranges 995-1005 Hz and 398-402 Hz, respectively, for the 2 positions of step b. Disconnect the counter.

e. Connect the scope vertical channel to the RF OUTPUT connector, horizontal channel to the modulation terminals; switch the MODULATION SELECTOR to INT 1 kHz.

f. Set the MODULATION LEVEL control to read 50% on the MODULATION LEVEL meter. Measure A and B on the scope display as shown in Figure 5-1.

g. Verify that the modulation percentage m is in the range 45-55%, where m = 100% (B−A)/(B+A).

h. Reset the CARRIER LEVEL from maximum to −13 dBm on the meter scale. Measure A and B again.

i. Verify that the modulation percentage m is in the range 45-55%, as before.

j. Reset the MODULATION LEVEL control fully clockwise.

k. Verify that the modulation percentage m is at least 95%.

l. Check that the CARRIER LEVEL indication drops off scale when the MODULATION SELECTOR is turned to EXT DC.

m Disconnect patch cords and return controls to standard settings.

5.2.7 AUTO-CONTROL AND SWEEP.

NOTE

This paragraph applies only to models 1003-9702, -9705, and -9704. When referred to Section 3, find -9705 operation in paragraphs 3.3.6 and 3.3.7; -9704 in 3.3.8.

a. Check that the LIMITS can be set, and panel lamps are functioning, by the procedures of Section 3. Check similarly that the automatic-tuning function performs correctly, using the AUTO POS push button.

b. Set F1 exactly to logging number 4025. (Center the F1 control in the small range allowed by the limit lights.) Logging number 4025 obtains when the cursor points to 40 on the logging scale and 2 on the vernier dial is aligned with 5 on the window above the FINE FREQUENCY control.

c. Tune, with COARSE FREQUENCY control, to a logging number above 6000. Tune, with F1 and AUTO POS push buttons, to F1. Call the final logging number C.

d. Similarly tune to a logging number below 2000; auto-tune to F1; call the corresponding end point D.

e. Verify that C and D are each between 4015 and 4035. (Therefore, the hysteresis is less than 20 vernier divisions, or ±0.1%.)

f. Set LIMIT F2 to logging number 4425.

g. Check that SWEEP operation is normal, referring to Section 3.

h. Check for the presence of the analog output (400 mV pk-pk sawtooth waveform) at the EXTENSIONS socket, pins 7-2, using a scope.

NOTE

Steps i-m apply to models 1003-9702 and -9705 only.

i. Connect scope probe to SO101, EXTENSIONS, pin 8 (return to ground or pin 2). Switch SWEEP VOLTAGE to WIDEBAND.

j. Check that amplitude is about 260 mV pk-pk and that the dc level changes several volts with the CENTERING control.

k. Switch to NARROWBAND; set the dc component to zero (refer to paragraph 3.3.7).

m. Verify that amplitude is 4.0 V pk-pk ±5%.

n. Disconnect external instruments and return all controls to standard settings.

5.2.8 CRYSTAL CALIBRATOR.

NOTE

This paragraph applies only to models 1003-9703, -9704, and -9705.

a. Turn the MODULATION SELECTOR to CW HIGH. Turn the MONITOR selector to XTL CAL 1 MHz. Plug headphones into XTL CAL BEAT jack.

b. Listen for audio beat while tuning toward 2.0 MHz. Refer to paragraph 3.4.3. Set FINE FREQUENCY a few vernier divisions from zero-beat.

c. Verify that the frequency of the beat tone remains unchanged when the MONITOR SELECTOR is switched to 200 kHz or to 50 kHz.

d. Change FREQUENCY RANGE to the top band, N=512. Turn the MONITOR selector to 1 MHz.

e. Install the wired plug (jumping pins 4-5) in EXTENSIONS socket SO101. Connect the F/N MONITOR output to the counter; adjust its input attenuator and trigger level. Set the counting gate to 10 s.

f. Tune the 1003 to 64 MHz exactly, using the crystal calibrator.

g. Verify that the counter reads in the range 124,997.5–125,002.5 Hz.

h. Disconnect external equipment and return controls to standard settings.

5.2.9 RESIDUAL A−M NOISE.

a. Set OUTPUT RANGE to +20 dBm.

b. Terminate the 874-VQL detector with a 50-ohm termination and connect the opposite port to RF OUTPUT connector. Clamp a dc-return resistor (1 kΩ, 1/4 W) in 874-Q2 adaptor and use it in the connection between "meter" terminal of detector and universal filter. Set filter to 15 kHz, low pass, zero attenuation, and connect its output to 1820-P2 voltmeter. Set its function switch to LOG.

c. Note the voltmeter reading (about 71.5 dB re 100 μV, reduced by losses in detector and filter).

NOTE

This measurement is the detected signal level at 50% modulation, corresponding to a sideband level 12 dB below carrier.

d. Switch the MODULATION SELECTOR to CW NORM. Insert the 20 dB preamplifier ahead of filter.

e. Verify that the voltmeter reads at least 48 dB below the reading of step c. This is equivalent to a-m noise level at least 80 dB below carrier.

5.3 DISASSEMBLY AND REASSEMBLY.

5.3.1 GENERAL (Figures 5-2 through 5-10).

Cabinet.

To remove the cabinet, first disconnect all cables from rear panel. If instrument is rack-mounted, remove it from cabinet leaving the latter in place; refer to paragraph 2.2.

NOTE

RF leakage is higher from instrument operated without cabinet. Leakage specifications require complete assembly.

If the signal generator is bench-mounted:

a. Remove the 4 screws with resilient cup washers from front panel; access is through holes in main handles.

b. Tip instrument, face down, to rest on its handles.

c. Remove the 2 screws centered near sides of rear wall of cabinet.

d. Lift cabinet off, using end frames as handles. Hand grips are provided in the chassis for carrying instrument (right-side up).

WARNING

Ac-line voltage is exposed if instrument is powered outside of cabinet. Permit this only when necessary for service; never while moving, disassembling, or installing.

The most dangerous shock hazards are located at the exposed terminals of these parts:

1. POWER switch S103 (Figure 1-1).
2. Ac-line connector PL501 (Figures 1-2, 5-4).
3. Terminals AT105, AT106; motor-drive asm. (Figure 5-3).

In addition, on models 1003-9701, -9703, and -9704 only, the following points are hazardous.

4. Terminals AT103 through AT108, motor-drive assembly.
5. Several parts of auto-control panel and amplifier (Figure 5-9).
6. Limit switches S106, S107 (Figure 5-2).
7. COARSE FREQUENCY switch S852 (Figure 5-9) or equivalent.
8. Any part of bulky capacitor C105 (Figure 5-3).

NOTE

C105 exists only on models 1003-9704 and 1003-9701 issued before ID No. B817.

Shield Covers.

Oscillator and power-amplifier shield covers can be removed from the instrument and the crystal-calibrator shield cover from that separate subassembly. Loosen the set of screws near the base of cover, simultaneously; i.e., drive each screw 1 or 2 turns in sequence around cover and repeat until assembly comes free. Do not loosen double lock nuts on each screw.

To reassemble, reverse the procedure; *keep every screw turned up in harmony with the set.* Seat the cover firmly in its tapered groove to ensure a leakproof joint.

Etched Circuits.

Specific instructions for disassembly of the most complex subassemblies for access to their components appear in paragraphs 5.3.2 through 5.3.11. If an etched-circuit board must be replaced, refer to Section 6, near the corresponding schematic diagram. The part number of each complete board, with parts soldered in place and checked for performance, appears with the drawing of the board, near the corresponding schematic diagram. Boards can be repaired by replacement of faulty parts.

Individual Parts.

Removal of a part from an etched board requires care; the board will be damaged by heating much above the melting point of solder or pulling a part still attached by a trace of solder.

Knobs and Dials – Removal.

CAUTION

Do not pull on the dial to remove a dial/knob assembly. Always remove the knob first. Do not use a screwdriver or other instrument to pry off the knob if it is tight, since this may damage the dial. Do not lose the spring clip in the knob when it is removed.

To remove the knob and dial (if any) from a front-panel control, either to replace one that has been damaged or to replace the associated control, proceed as follows:

a. Grasp the knob firmly with dry fingers close to the panel and pull the knob straight away from the panel.

b. Observe the position of the setscrew in the bushing when the control is fully ccw.

c. Release the setscrew with an Allen wrench; pull the bushing off the shaft.

d. Observe the position of the dial for a known position of the shaft.

e. Release the setscrews in the central hub of the dial using an Allen wrench; pull the dial off the shaft.

NOTE

> To separate the bushing from the knob, if for any reason they should be combined off of the shaft, drive a machine tap a turn or two into the bushing to provide sufficient grip for easy separation. If the retention spring in the knob falls out, reinstall it in the interior notch with the small slit in the inner diameter of the wall.

Knobs and Dials – Installation

Replace the dial (if any) before the knob:

a. Slip dial hub over shaft and rotate to correct position as observed in disassembly.

b. Keep dial away from panel by at least the thickness of a filing card.

c. Tighten setscrews in hub.

d. Slip bushing on shaft and rotate to correct position as observed in disassembly of knob.

e. Keep bushing away from dial or panel by at least the thickness of a filing card. Pull it out farther if necessary to prevent tip of shaft from protruding.

f. Tighten the setscrew in the bushing.

g. Place knob on bushing with retention spring opposite setscrew.

h. Push knob on until it bottoms and pull it slightly, to check that the retention spring is seated in groove in bushing.

5.3.2 POWER SUPPLY (Figures 5-3, 5-4).

The power supply can be removed as follows, for its service or for access to other subassemblies. It can be operated remotely with 12-wire extension cable (Table 5-1).

a. Remove left-side panel of instrument by removing 3 screws *behind* front panel, 1 from deck, 3 from rear panel, and 4 from power supply.

b. Remove 2 screws holding power supply to rear panel.

c. Ease plug PL111 from socket SO501.

d. Lift subassembly out.

e. Etched-circuit boards may be lifted part-way out for service after removal of screws.

f. Remove boards if necessary by unsoldering wires, making sure of their identity for proper replacement.

5.3.3 POWER-AMPLIFIER ASSEMBLY (Figure 5-3, 5-5, 5-6).

Removal of power amplifier assembly (PA) is not recommended since access to most components is possible after removal of shield cover and right side panel. To attain access to the I-board (intermediate amplifier) & D-board (divider) proceed as follows:

a. Set range selector to the lowest frequency range (67-156 kHz).

b. Remove C-board (control amplifier) by gently sliding off connector SO361, then removing the 4 screws (Figure 5-6).

c. Remove the I-board in a similar manner taking care not to apply lateral force to the associated switch wafer. Note switch orientation for use in reassembly.

d. Remove the shield & associated hardware.

e. Remove the D-board as in step c.

NOTE

> When reassembling I-board or D-board, be sure switch orientation is correct as noted in steps c and e. Allow each board to find its own best position for smooth operation of the switch before tightening associated hardware.

f. Any of the 10 tank-circuit etched boards may be removed from the turret by first rotating turret for best access, then removing 2 screws located on the sides of board near contacts.

When reassembling the turret, make certain each board is firmly seated in the proper groove; install & tighten the 2 screws. If a frequency-determining component has been replaced, retune the affected tank circuit in accordance with paragraph 5.5.9.

5.3.4 OSCILLATOR ASSEMBLY. (Figures 5-7, 5-8).

CAUTION

> Do not remove oscillator assembly; do not remove or repair the oscillator board. Recalibration requires the use of special jigs and procedures beyond the scope of this manual. Refer to paragraph 5.5.4.

Partial disassembly procedure is as follows:

a. Remove cabinet and oscillator shield cover (paragraph 5.3.1).

b. Remove electronic tuning board, after unsoldering 6 wires and removing 2 screws. Observe details of coupling to shaft of R642, for reassembly.

c. Remove buffer-amplifier board, after unsoldering 3 wires and removing 2 screws.

5.3.5 MONITOR CIRCUITS (Figures 1-2, 5-3).

These small, shielded subassemblies, directly in front of their output connectors on the rear panel, J103 and J105, contain no active parts. If necessary, gain access as follows:

a. Remove the appropriate shield cover (at F MONITOR, switch linkage and bracket too) held by 2 small nuts.

b. Disconnect PL102 or PL103 from PA. Use a 3/8-in. open-end wrench. Avoid bending semirigid coaxial cable unnecessarily. At F/N Monitor unsolder wire at C101 (Figure 5-2).

c. Remove 4 screws surrounding output connector at rear panel. Remove subassembly.

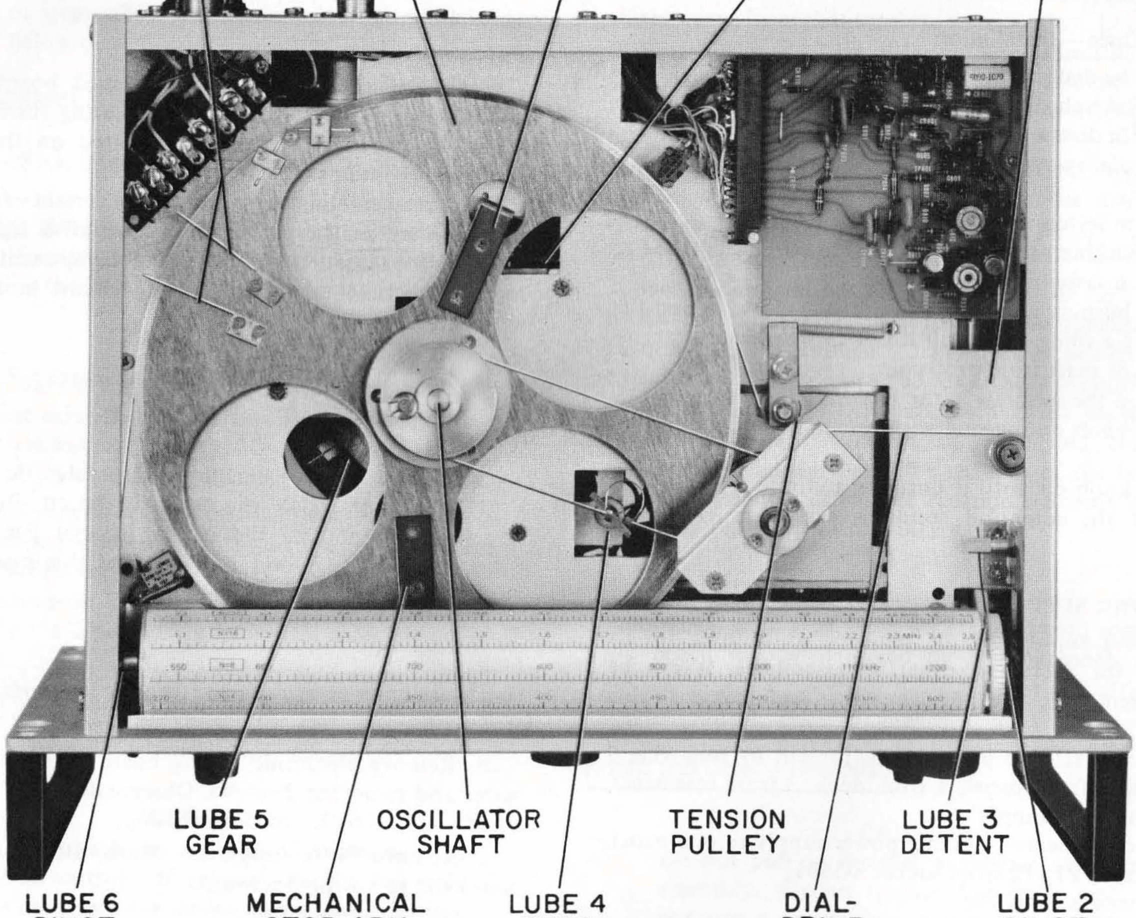


Figure 5-2A. Interior top view of the model 1003-9705 Standard-Signal Generator.

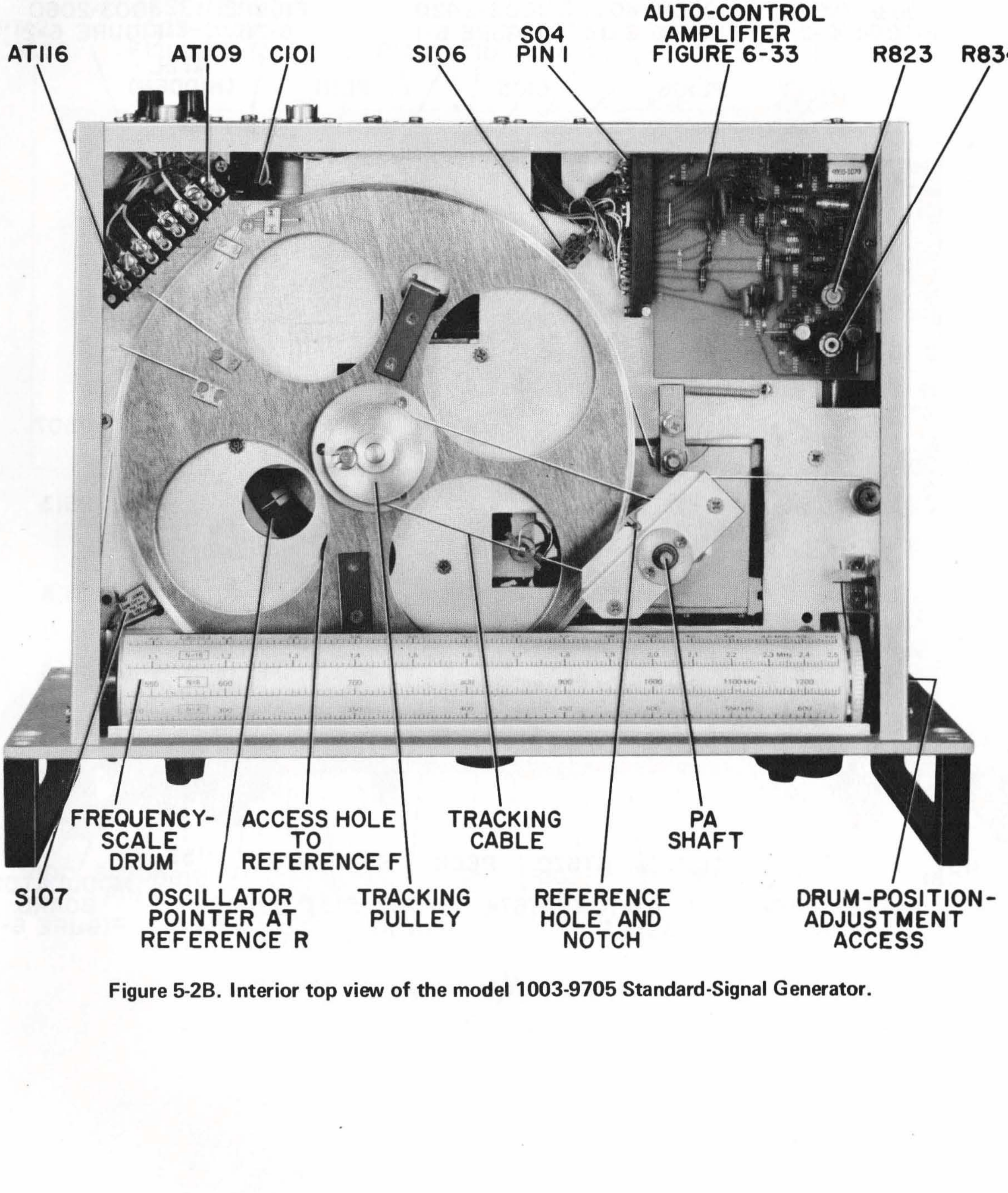


Figure 5-2B. Interior top view of the model 1003-9705 Standard-Signal Generator.

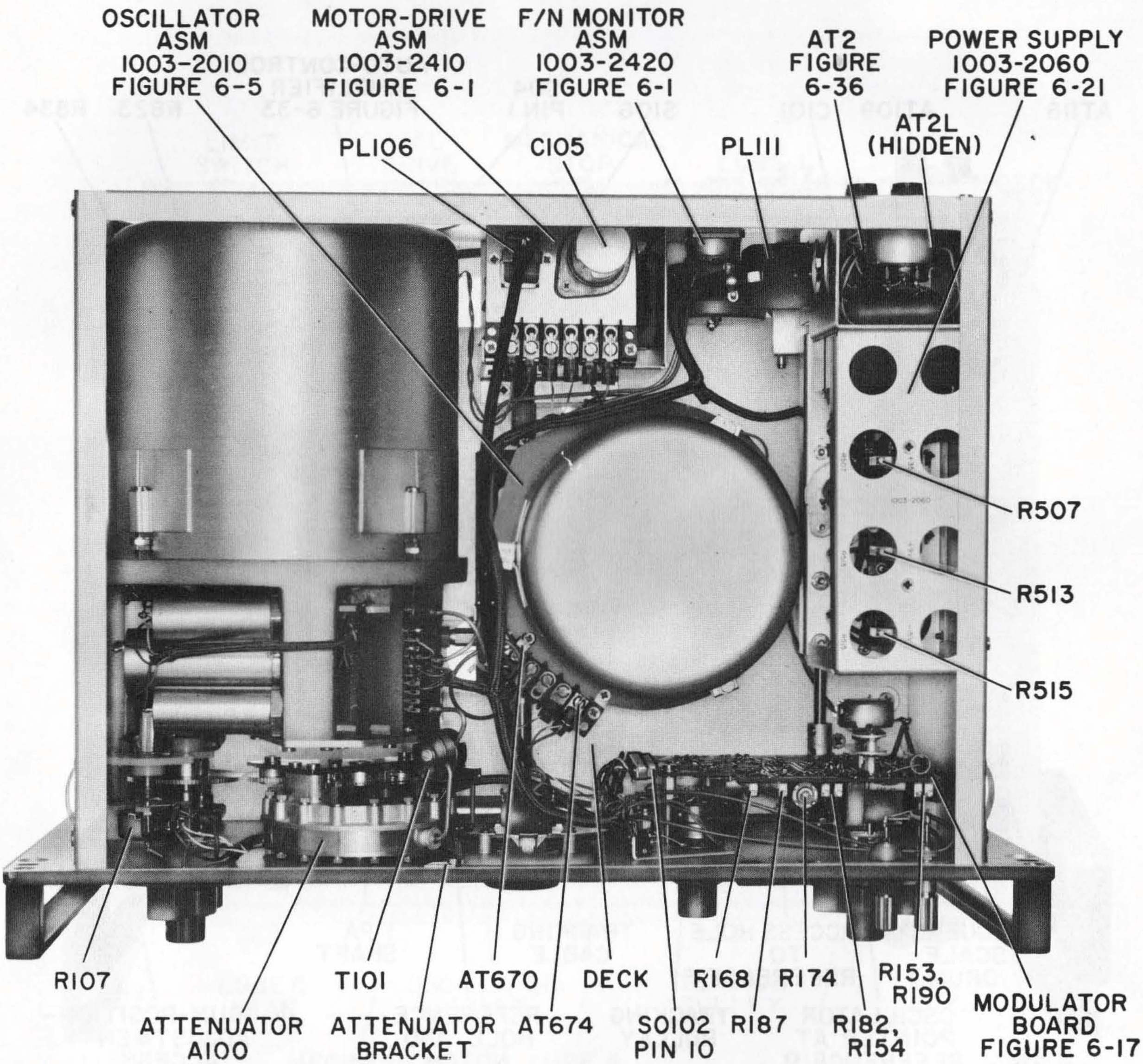


Figure 5-3A. Interior bottom view of model 1003-9701.

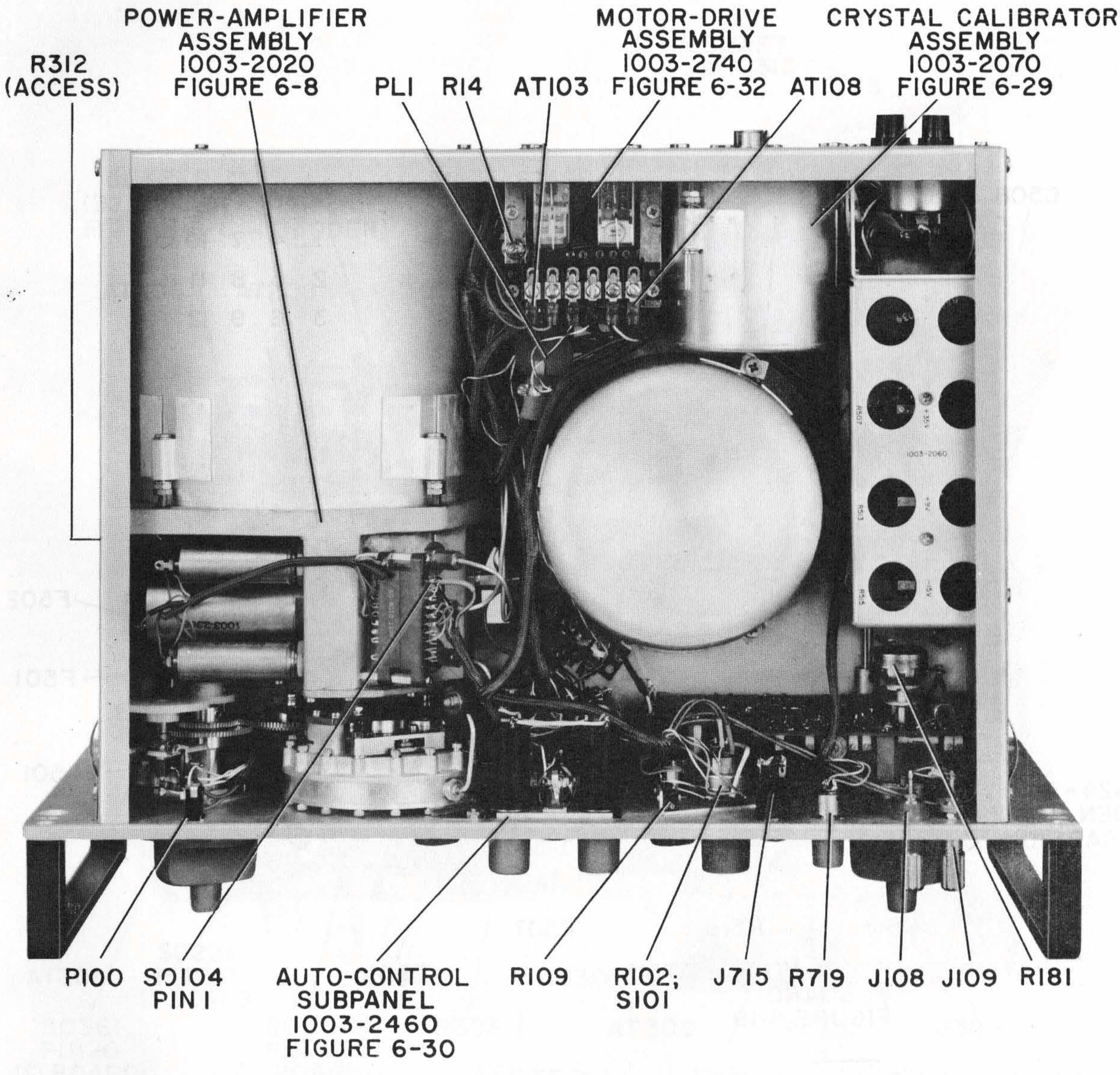


Figure 5-3B. Interior bottom view of model 1003-9705.

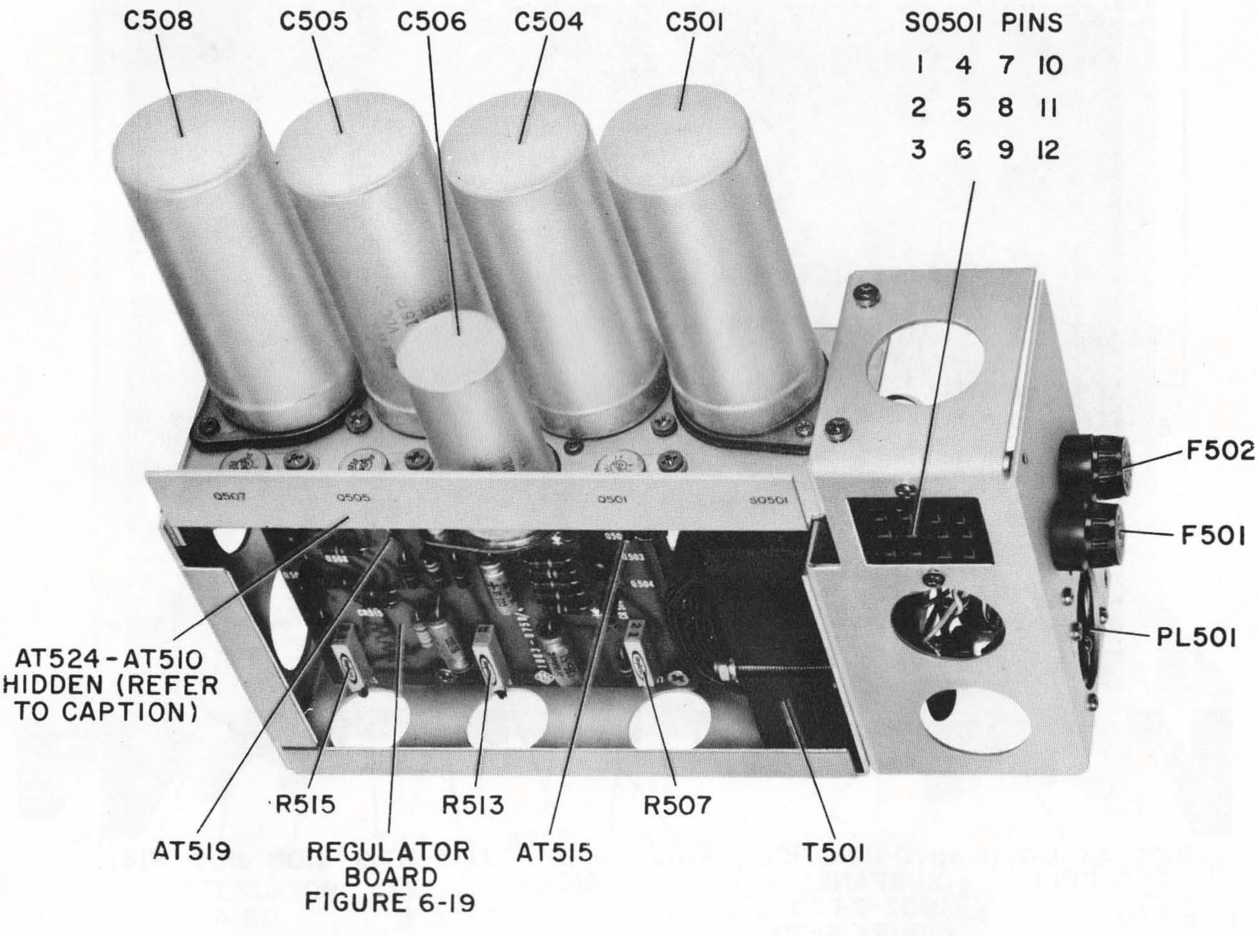


Figure 5-4. Power supply. The sequence of anchor terminals along the top of the etched board is: AT524, -513, -514, -520, -517, -519, -512, -511, -518, -509, -507, -508, -510, -515, left to right.

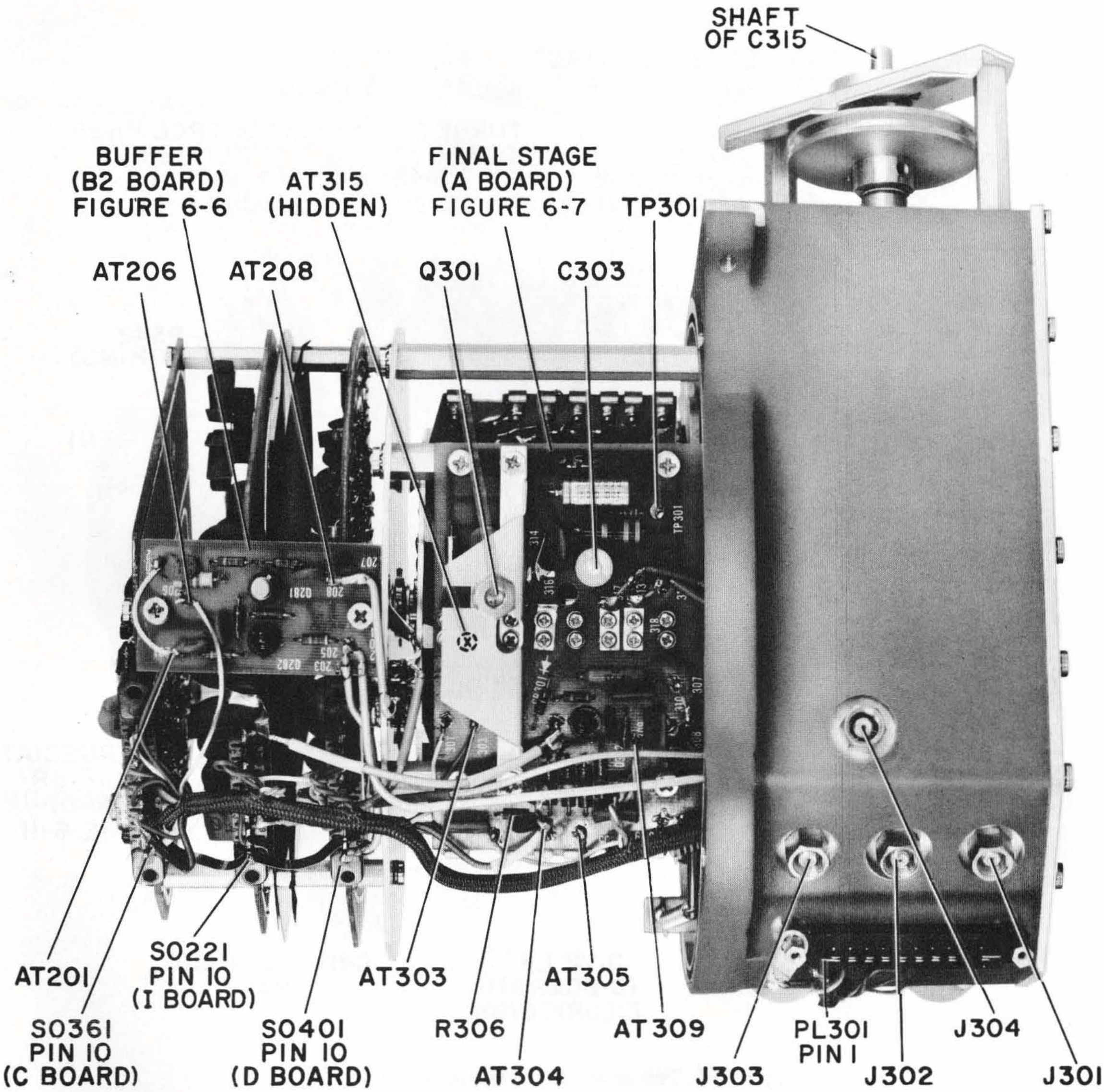


Figure 5-5. Power amplifier, left side view.

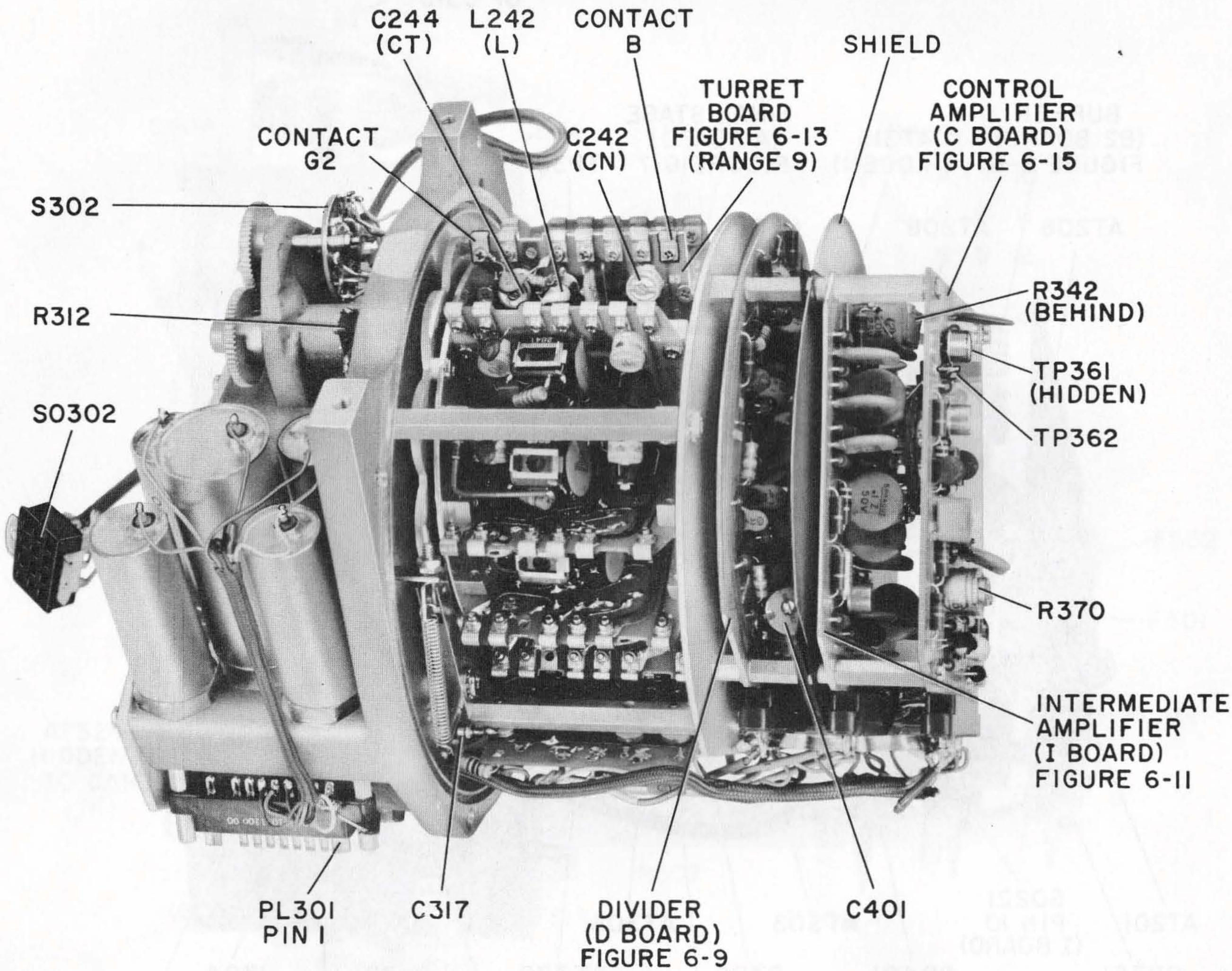


Figure 5-6. Power amplifier, bottom view.

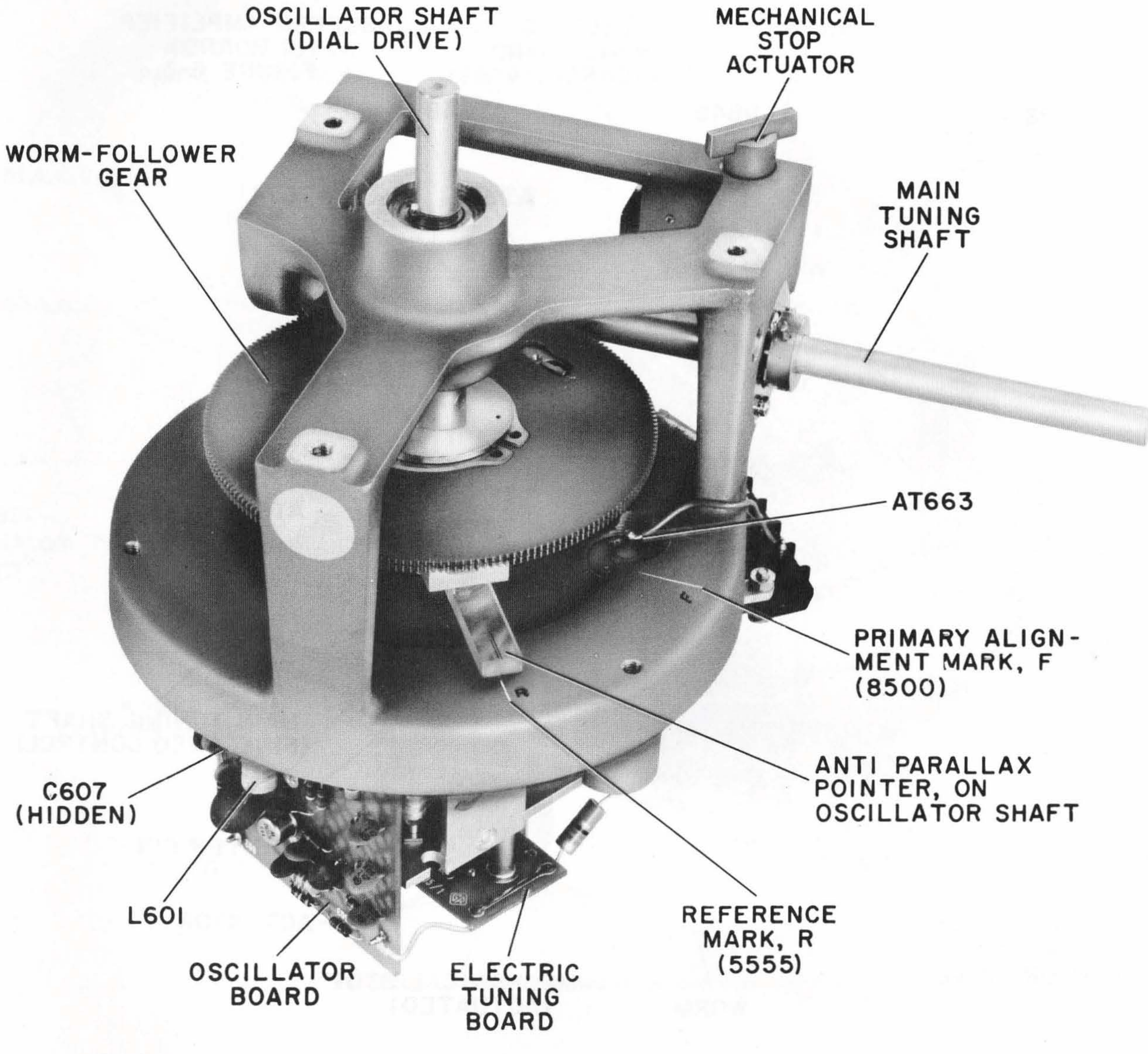


Figure 5-7. Oscillator assembly, top view.

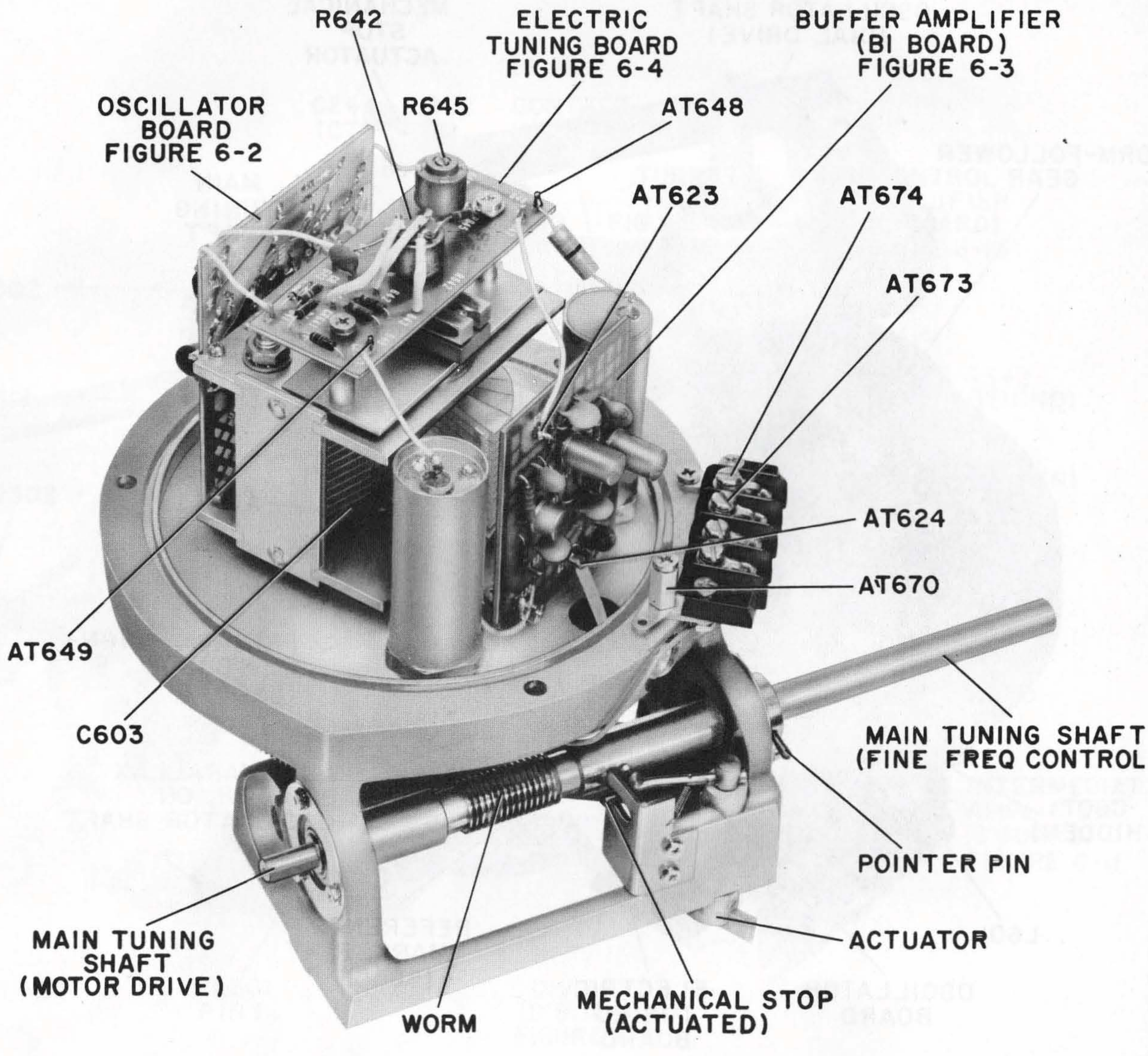


Figure 5-8. Oscillator assembly, bottom view.

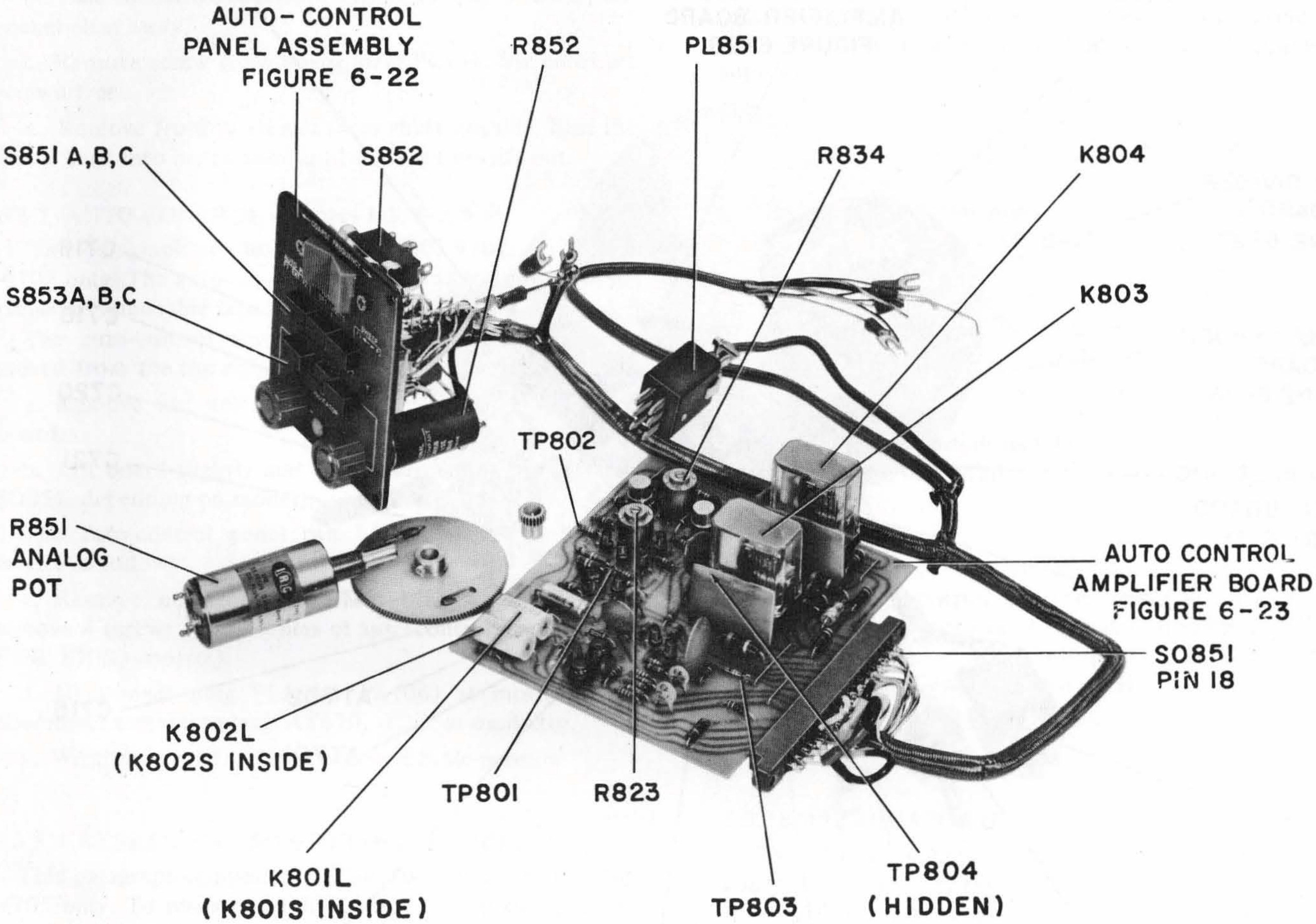


Figure 5-9. Auto-control-system components used in model 1003-9704.

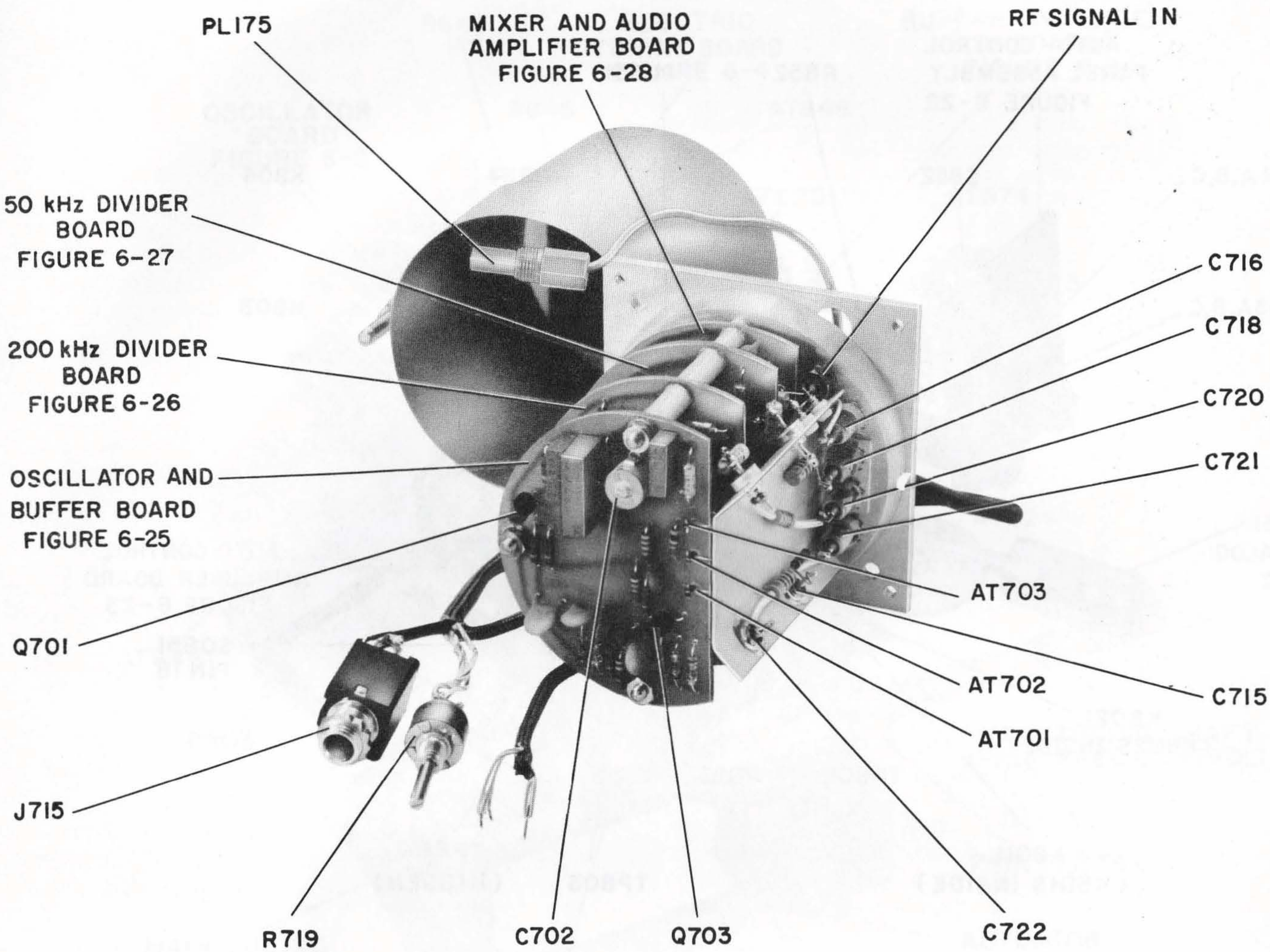


Figure 5-10. Crystal calibrator.

5.3.6 MODULATOR BOARD (Figure 5-3).

This board is accessible with cabinet off. Modulator can be operated remotely with 10-wire extension cable (Table 5-1)after removal as follows:

a. Remove MODULATION LEVEL and MODULATION SELECTOR knobs and dial. Refer to paragraph 5.3.1.

b. Ease socket SO102 from PL151 (end of board); push socket clear away.

c. Remove screw from board, near PL151. Use an offset screwdriver.

d. Remove front-panel nut from shaft bushing. Ease the board back into instrument until shaft is free; lift out.

5.3.7 AUTO-CONTROL (Figures 1-1, 5-2, 5-9).

This paragraph applies to models 1003-9702, -9704, and -9705 only. The auto-control amplifier and the auto-control panel are removable separately.

The auto-control amplifier circuit board is easily removed from the top right rear of the instrument as follows:

a. Remove nut and washer in center of right edge of board.

b. Lift board slightly and ease out of connector (SO4 or SO851, depending on model).

The auto-control panel can be partly withdrawn for service as follows:

c. Remove nut from attenuator bracket (Figure 5-3); remove 4 screws from corners of auto-control panel (below FINE FREQ control).

d. Disconnect plug PL1 (or PL106) at motor drive; disconnect screw terminals AT670, -1, -2, at oscillator.

e. Withdraw panel as far as attached cable permits.

5.3.8 CRYSTAL CALIBRATOR (Figure 5-10).

This paragraph applies to models 1003-9703, -9704, and -9705 only. To remove and disassemble the crystal calibrator, proceed as follows:

a. Remove left side panel and power supply, as in paragraph 5.3.2.

b. Remove shield can from oscillator assembly for better access. *Do not bump oscillator parts.*

c. Loosen plug PL175 from the small subassembly forward of the F MONITOR connector, using a 5/16-in. open-end wrench.

CAUTION

Do not disconnect PL175 yet. Avoid unnecessary bending of semirigid cable.

NOTE

Because older instruments have loose spacers associated with these screws, remove them with instrument standing on rear panel with the left quarter extending over the edge of work table.

d. Remove 4 screws, at corners of square base, from rear panel.

e. Gently ease the semirigid cable from f-monitor subassembly and withdraw crystal calibrator from instrument.

f. Remove the shield cover (paragraph 5.3.1), for access to test points.

g. Remove etched boards, if necessary, by unsoldering connections and unscrewing hardware at 3 points of support.

5.3.9 DIAL-DRIVE MECHANISM (Figure 5-2).

The cursor for the main dial, frequency and logging scales, is attached to a cable that is driven by the large dial-drive wheel or pulley. Disassembly is not recommended.

The proper route for this cable is around the wheel, around 2 small idlers at front corners of deck, around the idler at right end of deck, and with a reverse bend around the tension pulley to right of center of deck. Both ends are clamped to the wheel.

The proper relationships between dial indication and oscillator shaft position are tabulated in paragraph 5.5.4.

NOTE

Some early instruments (before ID No. B741) have a ribbon instead of the cable. If the ribbon dial-drive malfunctions, return the instrument to the closest General Radio service facility for replacement with a new cable.

5.3.10 ATTENUATOR (Figures 1-1, 5-3).

The step attenuator A100 (behind J107, RF OUTPUT connector) is not to be repaired in the field. It can be removed for replacement with a pretested exchange attenuator as follows:

a. Remove FINE FREQUENCY and FREQUENCY RANGE knobs; refer to paragraph 5.3.1. Turn instrument upside down.

b. Set MONITOR selector to OFF position. Note orientation of arm on shaft extension at f-monitor subassembly. (In OFF position of selector, shaft arm should be next to spring-loaded arm.) Loosen coupling on MONITOR selector shaft extension.

c. Remove SO104 from PL301 on the power amplifier (See figure 5-3).

d. Remove the semirigid cable between attenuator and J301 of the power amplifier, being careful not to flex the cable unnecessarily, nor to damage ferrite cup cores of T101 through which it passes. Use a 3/8-in. open-end wrench (See Figure 5-3).

e. Remove the slotted ring nut that surrounds RF OUTPUT connector. Use a special tool, see Figure 5-11, to minimize the risk of damage and, later, to facilitate reassembly.

f. Remove the 6-32 nut holding the attenuator bracket. The attenuator is now loose but held captive between the PA and panel.

g. Loosen 10 screws holding front panel to chassis; these are 3 (No. 10-32) in a row beside each handle and 4 (No. 6-32) in a row parallel to the main dial. Back the screws nearest bottom of instrument at least 1/4 in. out, the others less, as required; tip the panel 1/4 in.

h. Ease the attenuator back and out of the instrument.

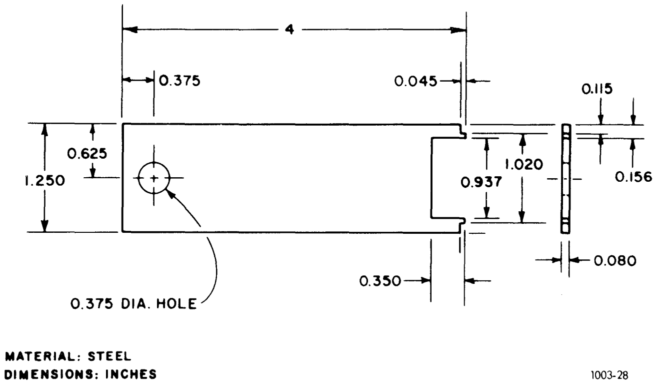


Figure 5-11. Spanner wrench for attenuator nut.

NOTE

It is very important, in reassembly, to have clean, metal-to-metal contact between attenuator and panel; *tighten the ring nut securely* to reestablish the original high-conductance rf gound connection. Similarly, good, tight connections are required at both semirigid-cable connectors.

5.3.11 MOTOR DRIVE (Figure 5-3).

There are two types of motor-drive assembly: part no. 1003-2410 for instrument models 1003-9701, -9703, and -9704 -- part no. 1003-2740 for models 1003-9702 and -9705. (See Figures 5-3A and B.) The two types are not interchangeable; the former uses a line-voltage ac motor, the latter a variable-speed dc motor. If removal is required for servicing, proceed as follows:

a. Observe the color coding of 6 wires connected to barrier strip AT103-AT108; disconnect them. Remove plug PL1 or PL106 (depending on model).

b. If there is a crystal calibrator, remove it and the power supply, as in paragraph 5.3.8.

c. Rotate the FINE FREQUENCY control until the slot in the coupling to the motor-drive assembly is vertical.

Table 5-4
LUBRICATION

Part	*Location and Access*	*Figures*	*Lubricant*
Worm-follower gear	On oscillator shaft, access: "lube 5" hole (tune to low freq.) or from left (power supply removed).	5-2; 5-8	Master Lubricants Inc. Lubriko H101
Spur gear	† At analog pot R851, above oscillator; access through deck hole, "lube 1".	5-2; 5-9	Master Lubricants Inc. Lubriko H101
Stop actuator	Top front corner of oscillator; access through deck hole, "lube 4".	5-2; 5-7	Lehigh Chemical Co. Anderol L-401-D
Detent mechanism	Frequency scale positioner; access at front right corner, "lube 3".	1-1; 5-2	Master Lubricants Inc. Lubriko H101
Pivots (2)	Frequency-scale drum, 1 drop each; access at front corners, "lube 2, lube 6".	1-1; 5-2	Lehigh Chemical Co. Anderol L-401-D
Bearings (2)	*Motor MO101, motor drive unit.	5-3	Premium motor oil, SAE 20 or 30
Stud	*Shaft of fiber idler gear, motor drive.	—	Light hydraulic oil, Tellus 27DTE
Gear teeth	*Motor drive unit.	—	Adhesive grease, Mobilplex EP1

†Models 1003-9702, -9704, and -9705 only.
*Models 1003-9701, -9703, and -9704 only.

d. Remove 5 screws (2 in deck, 3 in rear panel). Lift the subassembly out.

e. In reassembling, start all screws, slide motor drive left or right to assure that shaft alignment is satisfactory, then tighten screws.

5.4 LUBRICATION.

Several mechanical parts require periodic lubrication to avoid unnecessary wear. Lubricate the signal generator annually in normal service, twice a year in continuous service (8 hours per day); follow Table 5-4.

5.5 ADJUSTMENTS.

5.5.1 GENERAL.

This section is a guide to minor adjustments which may be required to bring an instrument within the minimum performance standards of paragraph 5.2, following repair or other disturbance. In the event of a more severe malfunction, refer to section 5.6 for trouble-shooting assistance.

5.5.2 POWER SUPPLY.

WARNING

Ac line voltage is exposed when the instrument is operated out of its cabinet. Use care to minimize shock hazard. See paragraph 5.3.1 for a list of danger points.

a. Remove cabinet and apply power. *Allow instrument to warm up for at least 15 minutes before proceeding.*

b. Check the following voltages at SO104 (power amplifier; see Figure 5-3) to ground. The tolerances require use of a digital voltmeter. Adjust the appropriate control as necessary:

SO104 pin 6: +35 ±0.3 V, adjust R507.
SO104 pin 4: −15 ±0.05 V, adjust R515.
SO104 pin 5: +8.8 ±0.05 V, adjust R513.

5.5.3 RF POWER.

If the CARRIER LEVEL meter does not agree with the external voltmeter within ±10% (refer to Paragraph 5.2.3 c) and remains constant when either the frequency setting or FREQUENCY RANGE is varied, proceed as follows:

a. Check mechanical zero of meter (power off).

b. Set CARRIER LEVEL fully clockwise.

c. Set MODULATION SELECTOR to CW HIGH and adjust R168 for exactly 3.0 volts into 50 ohms on the 1806-A voltmeter. R168 is located on the modulator board and is accessible from the bottom of the instrument (Figure 5-3).

d. Set MODULATION SELECTOR to CW NORM and adjust R182 for exactly 1.50 volts into 50 ohms on the 1806-A voltmeter. (See Figure 5-3).

e. Adjust R312 as necessary for a CARRIER-LEVEL meter indication of 1.50 volts (3.0 volts if meter legend is VOLTS OPEN CIRCUIT). R312 is located on the power-amplifier assembly and is accessible through a hole in the right side panel (Figure 5-3).

f. If the CARRIER-LEVEL-meter indication varies with change of frequency setting or FREQUENCY RANGE, refer to paragraph 5.6 for trouble analysis.

NOTE

R342, R370, & C401 in the power amplifier are factory adjustments and should not be changed. Tuning adjustments in and near the PA turret assembly interact with mechanical adjustments. To assure proper tracking between the oscillator and power-amplifier stages, refer to paragraph 5.5.9.

5.5.4 FREQUENCY.

The frequency calibration depends directly on the main dial-drive mechanism, as well as the frequency-determining components in the oscillator. Table 5-5 summarizes the checkpoints used in this paragraph.

a. Check that the dial-drive mechanism operates smoothly and shows no signs of fraying or breakage. Refer to paragraph 5.3.9.

b. Set FREQUENCY RANGE switch to 40-80 MHz band and tune to logging number 8500. Check that the main tuning shaft is aligned such that the pointer pin (Figure 5-8) points horizontally toward the yellow-painted screw head, and that the antiparallax pointer on the oscillator assembly is lined up with reference mark F (Figures 5-2, 5-7). Verify that RF output frequency is between 79.800 and 80.200 MHz.

c. If the vernier dial is not at zero when the pointer pin is aligned in step b, reset it as follows: Remove the four no. 6-32 screws holding the auto-control panel, if any. Carefully withdraw this assembly as far as its leads will allow. This should allow access to the setscrews on the vernier dial. Loosen them and reset the dial properly.

d. If the cursor does not indicate exactly 85 on the logging scale at this checkpoint, standardize the FREQ CAL adjustment as described in paragraph 3.4.2.

e. If the cursor does not indicate exactly 80 MHz at this checkpoint, turn the drum-position-adjusting screw through access hole in right side panel (Figure 5-2).

f. Tune to logging number 5555. Verify that the output frequency is between 59.414 and 59.712 MHz. At this checkpoint, the antiparallax pointer should be opposite reference mark R on oscillator casting.

g. Tune to logging number 0000. Verify that the output frequency is between 34.108 and 34.278 MHz. At this checkpoint, the pointer pin should once again be opposite the yellow screw head. A total accumulated error of 1/5 turn (20 divisions) is acceptable on the vernier dial, between 00 and 85 on the main logging scale. An error in excess of 20 divisions indicates that the dial-drive cable probably requires replacement.

Table 5-5

NORMAL FREQUENCIES AND MECHANICAL CHECKPOINTS

Explanation	*Primary*	*Intermediate*	*Lowest*
Oscillator, reference position of antiparallax pointer. (Figures 5-2, 5-7)	F	R	none
Pointer pin on main tuning shaft points horizontally to yellow screw head (Figure 5-8).	Yes	No	Yes
Frequency, MHz.	80.000	59.563	34.193
Turns of FINE FREQUENCY control or main tuning shaft, ccw.	reference	29.45	85.000
Logging number.	8500	5555	0000
Power amplifier, reference position of pulley (Figure 5-2). Hole in pulley to be centered in U-notch in bracket (or line on pulley centered in V-notch).	F	R	none

h. If the frequency is out of tolerance at any of these 3 checkpoints, return the instrument to General Radio Company for recalibration.

i. If the △F/F control is out of tolerance, measure the voltage from the cw terminal of the △F/F pot R102 (bus wire connection to trimpot R109) to ground. Set this to exactly −8.80 volts with trimpot R109. Recheck as in paragraph 5.2.4.

5.5.5 MONITOR OUTPUTS.

There are no adjustments located in monitor subassemblies. If minimum performance standards are not satisfied, refter to section 5.6 for trouble analysis.

5.5.6 AMPLITUDE-MODULATION ADJUSTMENTS.

Frequency.

If the internal 400 Hz or 1 kHz modulation frequencies are out of tolerance, adjust R154 or R153 respectively (See Figure 5-3).

Modulation Amplitude.

If MODULATION meter calibration is in error proceed as follows:

a. Recheck meter mechanical zero (power off).

b. Set MODULATION LEVEL control for 50% modulation as indicated by scope display (B/A = 3/1; see figure 5-1). To get this display, connect RF OUTPUT to vertical channel of scope, MODULATION OUT to horizontal channel. Adjust R174 on modulation board for a meter indication of 50%.

c. Turn MODULATION LEVEL control fully clockwise. Adjust R190 on the modulator board for a meter reading of 100%.

Modulation Equalization.

If modulation (as indicated by scope) does not stay within the limits 44 to 55% as the CARRIER LEVEL control is reduced from max. to −13 dBm, proceed as follows.

a. Set CARRIER LEVEL control for an indication of 1.5 volts (3 volts open circuit) on the panel meter. Adjust MODULATION LEVEL control for 50% modulation as indicated by scope (B/A = 3/1; see figure 5-1).

b. Reduce CARRIER LEVEL CONTROL to -13 dBm as indicated by panel meter. Adjust R187 on modulator board as necessary to restore 50% modulation as indicated by scope. Repeat steps a and b until no further adjustment is required.

c. Because of slight interaction with R168 and R182, repeat pertinent checks in paragraphs 5.5.3 and 5.5.6.

5.5.7 AUTO-CONTROL AND SWEEP.

Auto-control.

If the signal generator fails to tune automatically to a limit F1 (or F2) within the tolerances of paragraph 5.2.7, adjust as follows:

a. If C and D differ by more than 10 (1/10 turn) and C is larger, the system is undershooting. Adjust R834 *slightly* clockwise. It is on auto-control amplifier board, Figure 5-2. Recheck as in paragraph 5.2.7.

b. If C and D differ by more than 10 (1/10 turn) and D is larger, the system is overshooting and susceptible to hunting. Adjust R834 *slightly* ccw; receck as in paragraph 5.2.7.

c. If C and D differ by less than 10, but their average differs from the nominal setting by more than 5, balance control R823 needs resetting as follows:

d. Depress push button F1.

e. Connect a temporary jumper wire between pins 2 and 3 of SO4, Figure 5-2 (or the equivalent, SO851, of model 1003-9704).

f. Adjust R823 for correct limit indication (lights off, model 1003-9705, or LIMIT INDICATOR on, model 1003-9704). Remove the jumper wire. Repeat steps a, and b, if necessary.

Narrow-band Sweep Output.

This adjustment pertains to models 1003-9702 and -9705 only.

a. Switch to NARROW BAND and set the dc component of the sweep output to zero, as in paragraph 3.3.7.

b. Adjust R14 as necessary for a sweep output of 4 volts pk-pk ±5%, indicated on a scope (SO101 pin 8 to ground). R14 is on motor-drive assembly (Figure 5-3).

5.5.8 CRYSTAL CALIBRATOR.

If the crystal-calibrator frequencies are out of tolerance or lock, it will be necessary to remove the crystal-calibrator assembly and to make operating adjustments with its shield cover removed. Final checks should be performed with the shield cover in place.

Crystal Frequency, 1 MHz.

a. Install a wired plug (jumping pins 4-5) in EXTENSIONS socket SO101. Connect the F/N MONITOR output to a precision counter.

NOTE

Basic accuracy of 1 MHz crystal is ±20 ppm; therefore precision of counter time base should be within ±2 ppm.

b. Turn the MODULATION SELECTOR to CW HIGH and the MONITOR selector to XTL CAL 1 MHz. Plug headphones into the XTL CAL BEAT jack.

c. Tune the signal generator to 64 MHz, exactly. Because N = 512, the counter must indicate 125,000 ±0.2 Hz. Use the △F/F control for final setting, with the counter switched to a counting gate of 10 seconds.

d. Adjust C702 as necessary to achieve a low-frequency beat in the headphones. A tone of 100 Hz corresponds to an error of less than 2 ppm (because beat is generated between main oscillator at 64 MHz and the 64th harmonic of crystal oscillator).

Divider, 200 kHz.

a. Turn the MONITOR selector to XTL CAL 200 kHz.

b. Adjust L726 on the 200-kHz-divider board as necessary to bring the divider to the middle of its lock range.

Divider, 50 kHz.

a. Turn the MONITOR selector to XTL CAL 50 kHz.

b. Adjust L751 on 50-kHz-divider board as necessary to bring this divider to the middle of its lock range.

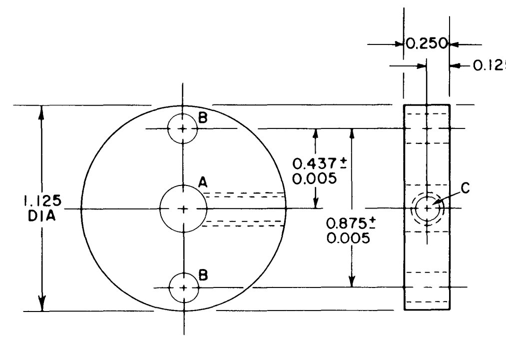
c. Install shield cover and recheck.

5.5.9 TRACKING.

Adjustments of the tracking mechanism and reactive trimmers tune the PA final stage to resonance with the oscillator at all settings of FREQUENCY RANGE and FINE FREQUENCY controls. Before proceeding with this paragraph, make certain that the oscillator and divider circuits are operating properly and fabricate a special clamp, shown in Figure 5-12.

CAUTION

Tracking should not be considered a routine type of adjustment. It should be undertaken only after careful consideration by qualified technical personnel. *Never loosen setscrews holding pulley on PA shaft.*



MATERIAL: ALUMINUM
DIMENSIONS: INCHES
HOLES: A - 0.253 ± 0.001 DIA (1)
B - 0.161 ± 0.003 DIA (2)
C - NO. 10-32 TAP (1)

ASSEMBLE WITH 2 SCREWS, NO. 6-32, 1/2 INCH, WITH LOCK WASHERS, B HOLES.
1 SCREW, NO. 10-32, 5/8 INCH, WITH KNURLED HEAD, C HOLE.

1003-29

Figure 5-12. Clamp with screws for P A tracking evaluation.

Determination of Tracking Error.

Tracking error is measured as follows:

a. Remove PA shield cover; set FINE FREQUENCY to logging number 1000, exactly Set OUTPUT RANGE to 0 dBm.

b. Lock the PA shaft with the clamp (Figure 5-12) as follows:

(1) Remove the two no. 6-32 screws holding the bearing-retainer collar on the PA shaft (Figure 5-2). Do not remove collar.

(2) Install the special clamp over the PA Shaft and fasten using ½-in. 6-32 screws and lockwashers.

(3) Tighten the thumb screw in clamp to lock shaft. Check that logging number is still 1000, exactly.

c. Loosen setscrews of the tracking pulley on the oscillator shaft (Figure 5-2.) Do not disturb dial-drive wheel.

d. Connect an electronic voltmeter from TP361 (C-board, Figure 5-6) to ground (Approx 1 V_{dc}).

e. While monitoring the CARRIER LEVEL meter and electronic voltmeter rotate the FINE FREQUENCY control through a range where the CARRIER LEVEL meter indication remains constant but TP361 voltage passes through a minimum at resonance. Note the logging number at the resonance point.

NOTE

• If the resonant point is not apparent, the following alternate method may be used:

Turn off power to 1003, apply +1.0 to 1.5 V_{dc} to TP361 (negative lead to ground) from a low-impedance power supply or battery to deactivate leveling circuitry. Resonance will now be indicated by a peak in CARRIER-LEVEL meter reading as the oscillator is tuned past.

f. Determine the tracking error (difference between logging number at resonance and original setting of 1000) for each position of the FREQUENCY RANGÈ switch. Each error should be less than 200, i.e., 2 turns of FINE FREQUENCY control.

g. Reset the FINE FREQUENCY control to logging number 1000 exactly and retighten setscrews on tracking pulley on oscillator shaft. Release the clamp locking the oscillator shaft.

h. Tune the signal generator to logging number 7500, exactly.

i. Repeat steps b through g. Again the error should be less than 200 vernier divisions at each checkpoint.

Correction of Tracking Error.

If the tracking is out of tolerance on all ranges and all in the same direction, recheck mechanical alignment, steps a, b, c. Otherwise skip to step d.

a. Set FINE FREQUENCY control to logging number 8500, exactly. Check that the anti-parallax pointer on oscillator assembly points exactly to the F line on oscillator casting (Figures 5-2, 5-7) and that the reference hole F on PA-shaft pulley is aligned with the notch in PA-shaft support.

b. If these two references are not lined up simultaneously, align the antiparallax pointer to the F mark on the oscillator casting. Loosen the setscrews on the tracking pulley on the oscillator shaft. Rotate pulleys slightly until F mark on PA-shaft pulley is correctly lined up with notch in PA shaft support. Retighten those setscrews.

c. If after the foregoing adjustments, the logging dial is no longer at 8500 exactly, proceed with mechanical adjustments of paragraph 5.5.4.

d. If any tracking error at logging number 1000 exceeds 200, refer to Table 4-2 to determine appropriate coil, L, to be adjusted on the tank-circuit board for the frequency range in question. It may be necessary to rotate the FREQUENCY RANGE switch to allow access to that coil. Adjust L, 1/4 turn at a time, until the tracking error is less than 50 (0.5%) at logging number 1000.

e. Measure the tracking errors at logging number 7500. If any exceed 200, refer to Table 4-2 to identify the appropriate trimmer, C –– excluding the neutralizing trimmers. Adjust C, 1/4 turn at a time until the tracking error is less than 50 at logging number 7500.

f. Because some interaction occurs between L and C adjustments in any tank circuit, repeat steps d and e until no further adjustment is required.

5.5.10 TUNING STOPS (Figure 5-2).

CAUTION

Never disable mechanical stops. If one should become inoperative, be certain to stop tuning before the end of main dial is reached or severe damage may occur.

There are 2 types of stops in the main tuning mechanism of the 1003, mechanical & electrical. These should be checked and if necessary adjusted as follows:

a. Tune to top of dial and verify that the mechanical stop is reached between logging numbers 8500 and 8600. Otherwise, back off about 2 turns of the FINE FREQUENCY control, slightly loosen the screws holding the mechanical-stop arm, adjust, tighten, and recheck.

b. Verify that the limit switch S107 is actuated (audible click as FINE FREQUENCY control is rotated from 2 turns below full scale) between logging numbers 8360 & 8400. Adjust the limit-switch arm (as in step a). Recheck.

c. In similiar manner, at bottom of dial, check that the mechanical stop is reached between 000 and −100 (i.e., 1 turn below zero) and that the limit switch S106 is actuated between logging numbers 100 and 140.

5.6 TROUBLE ANALYSIS.

5.6.1 GENERAL.

Analysis of trouble in a damaged or faulty 1003 signal generator should be based on suggested procedures and normal operating data from the accompanying text. A thorough understanding of the operating procedures (Section 3) and principles of operation (Section 4) is also essential to good servicing.

Access to several parts of the signal generator is enhanced by removal of the power supply. Use the 12-wire extension cable between PL111 and SO501 if it is also necessary to apply power.

Normal voltages (tabulated in the following paragraphs) are typical only if all controls are at standard settings, unless otherwise specified. Refer to paragraph 5.2.2. Table 5-6 gives normal voltages at the most accessible terminals.

5.6.2 POWER SUPPLY (Figure 6-21)

Blown Fuse.

CAUTION

Never bypass the fuses. Replacements must be the specified types.

a. Gradually increase line voltage from zero, using Metered Variac. If fault is present, power will exceed the normal 20 W before line reaches 115 V. Stop at 25 W; turn power off.

b. Isolate power supply by removal from instrument. Use a wired dummy plug to connect pins 1 and 2 and also pins 3 and 4 of socket SO501.

c. Repeat step a. Normal no-load power is 2.5 W. Stop at 3 W. If fault is in power supply, continue analysis with power off, using ohmmeter.

d. If fault is not in power supply, check other line-voltage circuits, using the list of shock hazards (in paragraph 5.3.1) as a guide. The first check should be a visual inspection for signs of burning.

Table 5-6

NORMAL VOLTAGES, MOST-ACCESSIBLE POINTS

Terminal	V_{dc}	V_{ac}	*Note*
Front Panel (Figure 1-1)			
J108 MOD IN/OUT	0	1.9	1 kHz
J107 RF OUTPUT	0	0.38	1.6 MHz
Rear Panel (Figure 1-2)			
SO101-1 or -2	0	0	Gnd = pin 2
-3 or -4	+35. V	0	
-5 or -6	0	0	
-7	–4.	0	Notes 1, 2
-8	0-settable		Notes 3, 4, 5
-9 or -11	0	0	
-10	–8	0	Note 1
-12	0	1.9	1 kHz
Deck (Figure 5-2)			
AT109, or -111	0±	0	Gnd = AT116
AT110	–15.0	0	Regulated
AT112	+8.8	0	Regulated
AT113	+35.	0	
AT114	+35.0	0	Regulated
AT115 or -116	0±	0	

Notes:

1. Models 1003-9702, -9704, -9705 only.
2. Varies linearly with tuning dial.
3. Models 1003-9702 and -9705 only.
4. On WIDEBAND, set CENTERING as required.
5. On NARROWBAND, turn FINE FREQ as req'd, <5 turns.

Normal Voltages.

a. Verify that line voltage is normal and that the power transformer is properly connected by checking that 115 V ac appears between AT105 and AT106 at the motor-drive assembly (Figure 5-3).

b. Check the full-load output voltages of power supply, at left rear corner of deck (Figure 5-2). Ground is AT116.

AT terminal strip:	AT114	AT112	AT110
Normal-load voltages:	+35.0 V	+8.8 V	–15.0 V

c. If any of those voltages is more than 0.5 V in error, remove power supply (Figure 5-4). Use a wired dummy plug in socket SO501 to connect pins 1 and 2 and also pins 3 and 4. Check the no-load voltages as follows:

At SO501:	Pin 7	Pin 8	Pin 9
Or on regulator board:	AT517	AT518	AT520
No-load voltages:	+35.0 V	+8.8 V	–15.0 V

d. If any terminal voltage is more than 0.5 V in error, continue analysis by measuring internal voltages with the help of Table 5-7.

NOTE

The 3 regulators are interdependent. The 9-V one depends on the 15-V; both depend on the 35-V.

DC Circuit Overload.

Analysis of the dc-power distribution may be helpful in isolation of a fault to one of the major subassemblies.

a. Using the Metered Variac, as in the "blown fuse" procedure, measure line power at normal line voltage. If total power is much different from normal (20 W ±5 W for models with auto-control system) proceed as follows. Otherwise skip to step c.

Table 5-7

POWER SUPPLY, NORMAL VOLTAGES

Transistor	*Test points*	*No load*	*Full load*
Power transformer			
–––––	AT5-AT6	10.7 V ac	10.4 V ac
–––––	AT7-AT8	17.0	16.4
–––––	AT9-AT10	34.1	32.8
–––––	SO501, 11-12	6.5	6.3
+35 V Regulator			
(Q501, e)	AT501	–10.3 V dc	–7.5 V dc
(Q501, b)	AT509	–9.8	–6.8
–––––	AT517	35.0	35.0
Q503	emitter	28.8	29.1
	base	28.2	28.4
	collector	18.6	21.5
Q504	emitter	8.6	8.6
	base	8.0	8.0
	collector	–9.6	–6.6
+9 V Regulator			
(Q505, c)	AT503	13.6 V dc	12.2 V dc
b)	AT 512	9.5	9.6
e)	AT518	8.8	8.8
Q506	base	0.6	0.6
–15 V Regulator			
(Q507, c)	AT505	7.3 V dc	5.1 V dc
b)	AT513	0.6	0.6
–––––	AT520	–15.0	–15.0
Q508	base	–8.6	–8.6
Q509	emitter	–9.2	–9.2
	base	–8.6	–8.6
	collector	–0.3	–0.3
Q510	base	–0.06	+0.05

b. Disconnect one subassembly as outlined in Table 5-8, measure power and note the increment. Reconnect, then proceed to next subassembly.

c. If total power is about normal switch off power, disconnect PL111 from SO501, and make an ohmmeter check as follows.

d. Measure resistances at pins 7, 8, and 9 of PL111, with respect to pin 6 and compare with values given in Table 5-9.

e. If resistance of any line is particularly low (the tabulated limit is 80% of normal), disconnect one portion of the total load in the sequence given. The appropriate terminals are given in Table 5-8. Measure the 3 resistances again and compare with table 5-9. Do not reconnect loads; they should be all disconnected at the final step.

f. Repeat step e until measured resistance is normal. The last subassembly that was disconnected is faulty.

g. If all 4 steps of disconnection fail to remove a condition of very low (zero) resistance, the dc wiring is faulty.

5.6.3 POWER-AMPLIFIER ASSEMBLY (Figure 6-8).

Normal Voltages at Accessible Terminals.

Table 5-10 gives the normal operating voltages at key points accessible after removal of shield cover.

Abnormally High Current, Final Stage.

Current up to 10 times normal value may be drawn by Q301, overloading the power supply (and affecting all 3 regulators). Such a condition can usually be traced to a failure in the level-control loop, which includes rf circuits, monitor diode CR301, and the control amplifier. If there is evidence of excessive power consumption by the power amplifier, use the following analysis:

a. Connect a 0–200–μA meter between TP301 (+) and ground (Figure 5-5). Turn power on briefly; meter reading is normally 20–35 μA (1/1000 of Q301 emitter current). If this current is high, proceed with next step. Otherwise, the following analysis may not apply.

b. Switch FREQUENCY RANGE temporarily to band 10 (40-80 MHz). Repeat step a. If current is still abnormally high, proceed to next step. If current is normal on band 10, fault is probably in divider (D) or intermediate amplifier (I). (If it is normal on band 10, high on all other bands, fault is more likely in I.)

c. With power off, apply + 1.0 to 1.5 V dc to TP361 (Figure 5-6), negative to ground (corner of C-board). Use a low-impedance power supply or flashlight cell.

CAUTION

Check that Q301 emitter is not shorted to ground before applying power, or the resulting collector-current pulse could be disastrous.

d. Repeat step a. If current is still high, fault is in output amplifier (A); if normal, turn power on for further analysis.

e. Read CARRIER LEVEL meter M101. If there is no response, skip to step g. If meter responds (indication should vary with tuning) there is detection of rf signal by monitor diode. The reason for high current of step a, brought down by steps c and d, is then one of two probabilities separable by next step.

f. Measure voltage at SO361, pin 7 (C-board connector, Figure 5-5) using scope. Normal signal is + 2.2 V dc with 0.78 V ac ripple at 1 kHz. If this signal is abnormal, analyze modulator and CARRIER LEVEL circuits. Otherwise fault is probably in control amplifier, C.

g. Measure rf voltage at TP302 (Figure 5-5) with MODULATION SELECTOR temporarily at EXT AC, using scope or electronic voltmeter. Normal level is 3 V rms at 1.6 MHz; if low or zero, proceed to next step. If this voltage is normal, the reason for lack of response at step e is a damaged monitor diode, CR301, or faulty meter circuit.

h. Measure rf voltage at AT315 (Figure 5-5), normally 0.5 V rms, 1.6 MHz. If this voltage is low, proceed to next step. If voltage is close to normal, the reason for a weak signal at TP302 is a fault in Q301, resonant tank circuit, or tracking mechanism.

NOTE

Each tank includes current-limiting resistance of 33 Ω in the collector circuit (simplified in Figure 6-8).

Table 5-8

TROUBLE ANALYSIS BY LINE-POWER INCREMENTS

Subassembly	*Terminals*	*Power Increment*
Auto-control system	AT110, -112, -114	2.5 W
Power amplifier	SO104	5.
Oscillator	AT674	1.5
Modulator	SO102	2.5

Table 5-9

TROUBLE ANALYSIS BY DC-LINE RESISTANCES (PL111)

Condition	*Pin 7 Ohmmeter + Normal*	*(Limit)*	*Pin 8 Ohmmeter + Normal*	*(Limit)*	*Pin 9 Ohmmeter − Normal*	*(Limit)*
All loads connected	5900 Ω	(4700)	65 Ω	(52)	900 Ω	(720)
Auto-control system disconnected	7200	(5800)	66	(53)	950	(760)
PA also disconnected (1)	7200	(5800)	4500	(3600)	1550	(1250)
(2)	7200	(5800)	15 k	(12 k)	1550	(1250)
Oscillator also disconnected (1)	7200	(5800)	4500	(3600)	11 k	(8.8 k)
(2)	7200	(5800)	15 k	(12 k)	11 k	(8.8 k)
Modulator also disconnected (1)	Open	-----	4500	(3600)	open	-----
(2)	Open	-----	15 k	(12 k)	open	-----

Note (1) Models 1003-9703, -9704, -9705.
(2) Models 1003-9701, -9702.

i. Measure voltage at SO401, pin 10 (Figure 5-5), normally 1.4 V rms, 51.2 MHz. If this voltage is low, analyze the oscillator assembly, with its buffer (B1).

j. If the voltage at SO401-10 is close to normal but the level at AT315 is low, look for fault in divider-intermediate-amplifier chain. (This possibility was the object of step b, where it was assumed that only one of two alternate signal paths would be faulty.) If these symptoms persist even on the 40-80 MHz range, suspect a fault also in buffer amplifier (B2).

Abnormally Low Current, Final Stage.

a. Connect a 0–200–μA meter between TP301 (+) and ground as described in step a of preceding analysis. If the current is less than 20 μA, check the following possibilities:

b. Transistor Q301 cut off by negative bias on base.

c. Open collector circuit (through contacts C and B of turret, pins 1 and 6 of SO361).

d. Transistor Q301 damaged.

NOTE

Each tank includes current-limiting resistance of 33 Ω in the collector circuit (simplified in Figure 6-8).

Normal Voltages at Internal Points.

Table 5-11 gives the normal operating voltages at key points on the C, I, and D boards. Access to I and D boards requires removal of preceding board. Final stage Q301 operates only if C board is connected.

I-board data are valid whether C is connected or not, except as noted in the table.

D-board data are valid with both C and I disconnected. D-board measurements must be made with a very low-capacitance probe; use a physically small 10-kΩ resistor in series with a scope probe.

NOTE

With controls at standard settings, the first 5 divider stages are operating, the 6th (R449, CR412, Q407) is disabled by S401, and the following 3 stages hold either high or low states at random (Table 5-11). The divider data can be applied to measurements in another FREQUENCY RANGE band: the "disabled stage" moves up the table (decreasing transistor nos.) as the output frequency increases, and vice versa. Refer to Figure 6-10.

Table 5-10

POWER-AMPLIFIER ASSEMBLY
NORMAL VOLTAGES ACCESSIBLE WITHOUT DISASSEMBLY

Terminal	*V dc*	*V ac*	*Note*
Input socket			**Figures 5-3, 6-1**
SO104-2	+ 0.05 V		Pin 1 is ground
3	+ 2.15	0.78 V	1 kHz
4	−15.0		
5	+ 8.8		
6	+35.		
Control amplifier (C-board)			**Figures 5-5, 6-16**
SO361-1	+33.8 V		Pin 9 is ground
3	+ 1.	85 mV	1 kHz
7	+ 2.2	0.78 V	1 kHz
10	+ 2.2	0.91	1 kHz
TP361	+ 1.0		Figure 5-6
TP362	+ 2.2		
Intermediate amplifier (I)			**Figure 6-12**
SO221-1	+ 3.6 V		Pin 10 is ground
2	−10.		
4	+ 0.2	55 mV	1.6 MHz
5	+ 8.5		
6	+ 2.1	0.78 V	1 kHz
8	+ 0.9	0.55	1.6 MHz
(8	0.13	0.66	C-board disconnected)
9	−10.		
9	−13.2		CW HIGH
Divider (D-board) connector			**Figure 6-10**
SO401-4	0	55 mV	1.6 MHz
6	+ 9.3 V	0.35 V pk-pk	Note 1
10	0	1.4 V	51.2 MHz
Buffer (B2-board)			**Figure 6-8**, Note 2
AT201	−12.5 V		
AT208	+ 1.1	0.8 V	51.2 MHz
Q281 emitter	−0.65	1.	51.2 MHz
base	− 0.63		
Q282 emitter	− 0.7	1.8	51.2 MHz
base	− 0.17	1.2	51.2 MHz
collector	+ 6.5		
Output stage (A-board)			**Figure 6-8**
TP301	+ 0.83 V	(20-35 μA)	Note 3
TP302	0	4.5 V	1.6 MHz
	0	3.0	Note 4
AT306	+ 0.27		Note 5
307	0	1.6	Note 4
310	0	1.2	Note 4
314	+ 0.83		
315	+ 0.9	0.5	1.6 MHz
316	+32.5		
Q302 emitter	− 0.7	1.55	1.6 MHz
base	0		
collector	+ 6.2		

Notes:

1. Set MONITOR selector to F/N ON; measure with scope; f=100 kHz.
2. Set FREQ RANGE to 40-80 MHz for the buffer measurements.
3. Use microammeter as in paragraph 5.6.3, a.
4. Set MOD SELECTOR to EXT AC; observe f=1.6 MHz.
5. Normally only +0.07 V in early version in which R306 was 18 kΩ.

Table 5-11

POWER-AMPLIFIER ASSEMBLY, NORMAL VOLTAGES IN CIRCUIT BOARDS

Transistor or test point	*Emitter V dc,*	*Emitter V ac*	*Base V dc,*	*Base V ac*	*Collector V dc,*	*Collector V ac*	*AC-component frequency*
Control Amplifier (C)							
Q361	+ 1.6 V		---		+17.4 V		
Q362	+ 1.6		---		+18.5		
Q363	+19.1		---		---		
Q364	+ 1.6		---		+33		
Q365	---		+33.5 V		+34.5		
Intermediate Amplifier (I)							
Q321	– 0.78 V		– 0.025 V,	0.05 V	+ 6.6 V		1.6 MHz
Q322	– 0.8		– 0.06,	0.15	+ 6.5	0.03 V	1.6
Q323	– 7.0		– 6.5,	0.03	+ 1.15,	0.7 *	1.6
					+ 1.0,	0.8 △	
Q324	+ 1.4		+ 2.0,	0.01	+ 8.2		1.0 kHz
Q325	–13.7		–13.,	< .001	---		1.0
Divider (D) (Note 1)							
Q401	– 0.37 V,	0.31 V	+ 0.25 V,	0.25 V	+ 5.3 V		51.2 MHz
Junction R407, R409	+ 0.48						
Q402	– 0.44,	0.30	+ 0.24,	0.23	+ 4.8		25.6
Junction R415, R417	+ 0.46						
Q403	– 0.49,	0.27	+ 0.23,	0.23	+ 4.8		12.8
Junction R423, R425	+ 0.48						
Q404	– 0.50,	0.26	+ 0.24,	0.23	+ 4.8		6.4
Junction R431, R433	+ 0.48						
Q405	– 0.50,	0.23	+ 0.24,	0.22	+ 4.8		3.2
Junction R441, R443	+ 0.46						
Q406	– 0.37,	0.19	+ 0.23,	0.21	+ 4.8		1.6
Junction R449, R451	0						
Q407	– 0.60,	0	0,	0	+ 4.8		
Junction R457, R459	+ 0.46						
Q408	– 0.16/ –0.58		+ 0.43/ +0.02		+ 4.8	Alternate states, at random	
Junction R466, R468	+ 0.46						
Q409	– 0.16/ –0.58		+ 0.44/ +0.02		+ 4.8	Alternate states, at random	
Junction R474, R476	+ 0.45						
Junction CR418, CR419	+ 0.03/ +0.43					Alternate states, at random	
Q410	0		– 2.8		+ 8.2		
Junction L416, CR420	– 0.05						
Divider, MONITOR SELECTOR set to F/N ON (Note 2)							
Junction R449, R451	+ 0.46 V						
Q407	– 0.37,	0.19 V	+ 0.23 V,	0.20 V	+ 4.8		800 kHz
Junction R457, R459	+ 0.46						
Q408	– 0.36,	0.19	+ 0.23,	0.19	+ 4.8		400
Junction R466, R468	+ 0.46						
Q409'	– 0.37	0.19	+ 0.23,	0.19	+ 4.8		200
Junction R474, R476	+ 0.46						
Junction CR418, CR419	+ 0.23,	0.19					100
Q410	+ 2.9,	0.19	+ 3.5		+ 8.2		100
Junction L416, CR420	+ 8.0						
SO401, pin 6	+ 9.3	0.16					100
SO401, pin 10	0	1.4					51.2 MHz

Note 1: Measure with C- and I- boards disconnected; use a very low-C probe.

Note 2: Data for preceding stages (Q401-Q406) unchanged.

* C-board connected

△ C-board disconnected.

Table 5-12

OSCILLATOR ASSEMBLY, NORMAL VOLTAGES

Transistor or test point	*Emitter*	*Base*	*Collector*
Cable terminals (Figure 5-3)			
AT671	– 4.V (Notes 1, 2)		
AT672	– 8. (Note 1)		
AT673	+ 8.8/–8.8 (Note 3)		
Points on circuit boards (Figure 5-8)			
AT602	–10 V (Approx.)		
AT621	1.4 ac at 51 MHz		
AT624	1.4 ac at 51 MHz		
AT648	–14.6		
Q601	–10.2 V	–11.2 V	0 V
51-MHz component			10
Q602	– 6.7	– 6.0	
51-MHz component:		1.8	
Q621	– 5.2	– 4.8	– 1.3
51-MHz component:			1.7
Q622	– 6.4	– 5.8	0
51-MHz component:	0.45		2.75

Note 1: This circuit used on models 1003-9702, -9704, -9705, only.
Note 2: Voltage varies linearly with tuning dial.
Note 3: Δ F/F dial set temporarily to +500/–500 ppm.

5.6.4 OSCILLATOR ASSEMBLY (Figure 6-5).

Normal Voltages.

Refer to Table 5-12 for normal voltages in the oscillator assembly. Data apply with power amplifier disconnected (at SO104).

Deficient Output Level.

If the rf signal is weak or missing at SO401-10, disconnect power amplifier at SO104 and determine whether the oscillator is faulty or the signal is lost in one of the buffer stages. Check dc voltages. Repair if necessary, except Q601 or the reactive components of that stage. Replacement parts must be exactly like the originals.

CAUTION

Handle all parts with care especially near Q601 and C603. Position each replacement part like the original. Do not adjust C607, R645, or L601.

Adjustment of the frequency-determining circuit requires procedures and special jigs that are beyond the scope of this manual. Please return the instrument to General Radio Company for such service.

Frequency Error.

If the frequency is out of tolerance, proceed as follows:

a. Verify that the fault is in the oscillator, not the divider chain.

b. Check that the dial and the oscillator shaft are properly related, paragraph 5.5.4.

c. Check that the rotor of tuning capacitor C603 moves freely, without backlash.

d. Make sure that all setscrews in the assembly are tight.

e. Check that all voltages are normal (Table 5-12), and if necessary make repairs, except to the oscillator stage.

f. Verify that the ΔF/F function is normal, paragraph 5.2.4.

g. If, finally, the oscillator frequency is in error, please return the instrument to General Radio Company for service.

NOTE

Removal of the shield cover reduces the oscillator frequency about 0.3%; make final evaluation with cover on.

5.6.5 MONITOR CIRCUITS (Figure 6-1).

F Monitor.

a. Check for proper operation of switch S104, linked by a long shaft to the MONITOR SELECTOR control. In the OFF position, the actuator of S104 should be adjacent to, but not put in tension by, the spring-loaded arm of S104.

b. Check the rf circuit with an ohmmeter, particularly the connections and switching. In the F ON position, there should be continuity between AT310 (A-board of the PA) and J103 (the F MONITOR jack).

c. Check the operation of Q302, on the A board; refer to paragraph 4.3.3.

F/N Monitor.

a. Check for proper operation of MONITOR SELECTOR S102. In the F/N ON position, normal voltages are:
at AT111 (left rear, Figure 5-1). . . . . +35 V dc,
at AT115 . . . . +11.

b. If those voltages are not normal, check the bias circuit through R105 (located under barrier strip at AT111-115) and C101 (Figure 5-2) to SO401-6 at the D board (Figure 5-5).

c. Check the rf connections. There should be continuity between SO401-6 (D-board, PA) and C101 (visible below deck, Figure 5-2).

d. Check the operation of Q410, on the D board; refer to paragraph 4.3.3.

5.6.6 MODULATOR (Figures 6-1, 6-18)

The several functions are relatively easy to separate for analysis: audio oscillation, dc-reference-level setting, buffering, meter driving, and switching. To gain access, remove the modulator board and make connections via the 10-wire extension cable. Normal voltages are given in Table 5-13.

5.6.7 AUTO-CONTROL CIRCUITS.
(Figures 6-1, 6-22, 6-24, 6-30, 6-32, 6-34).

Motor Drive.

Check for proper COARSE FREQUENCY tuning (paragraph 3.3.2). If necessary, analyze the wiring, switching, relays, and the motor itself.

NOTE

The following applies to models 1003-9702, -9704, and -9705 only.

Auto-Position.

Check for proper AUTO POSITIONING (Section 3). If necessary, analyze the auto-control amplifier, first making sure that the input voltages are correct (analog at TP801 and limit F1 or F2 at TP802). Refer to paragraph 4.3.8 or 4.3.9 as applicable. Access is shown in Figure 5-2.

Table 5-13

MODULATOR, NORMAL VOLTAGES

Terminal or Transistor	*Voltage* *Emitter*	*Base*	*Collector*
Front Panel			
J108 MOD IN/OUT	1.9 V ac at 1 kHz.		
Rear Panel			
SO101 EXTENSIONS, pin 12	1.9 V ac at 1 kHz.		
Modulator Board			
SO102-1	+ 2.6 V with 0.78 V ac at 1 kHz		
2	+ 2.0 V		
10	+ 2.6		
Q151	+13.5	+14. V	+26.5 V
Q152	+27.	---	+21.
Q153	+ 2.0	---	+23.
Q154	+34.	+33.3	---

Table 5-14

CRYSTAL CALIBRATOR, SWITCHING VOLTAGES

*Position**	*Terminals of S102*		
	110F	*111F*	*112F*
OFF or F/N ON	0	0	0
1 MHz	+9 V	0	0
200 kHz	+9	+9 V	0
50 kHz	+9	+9	+9 V

*MONITOR–XTL CAL selector, S102.

Sweeping.

Check for proper SWEEP operation. If necessary analyze the Schmitt and flip-flop circuits on the auto-control amplifier board.(Figure 5-2).

Sweep Outputs.

Check for the presence of the analog output (paragraph 5.2.7, h.). If instrument is model 1003-9702 or -9705, check for sweep outputs at EXTENSIONS socket SO101-8 (paragraph 4.3.8). If necessary, analyze the associated circuits including microswitch S5 and gear-driven potentiometer R11, which are on a hinged bracket behind the SWEEP VOLTAGE NARROW BAND – WIDE BAND control.

5.6.8 CRYSTAL CALIBRATOR (Figure 6-29).

NOTE

This paragraph applies to models 1003-9703, -9704, and 9705 only.

a. Verify that the F MONITOR functions normally. If not, repair that first.

b. Remove left side panel and power supply (as in paragraph 5.3.2). Check for proper action of switch S102, directly behind MONITOR SELECTOR–XTL CAL control. Refer to Table 5-14.

c. Remove the crystal-calibrator assembly, as in paragraph 5.3.8. Check again for proper bias-voltage switching, at the feedthrough-capacitor terminals.

d. If necessary, analyze trouble in the individual circuits.

Parts Lists and Diagrams—Section 6

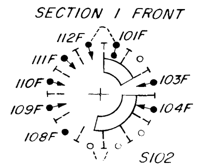
INDEX OF DIAGRAMS

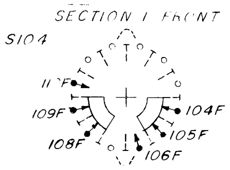
NOTE

Parts lists and etched-board drawings appear before associated schematic diagrams or exterior views.

ELECTRICAL PARTS LIST

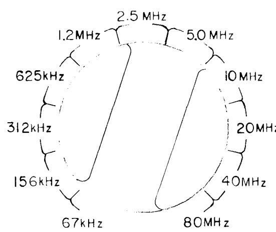
Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C101	Ceramic, 1000 pF +100-0% 500 V (GMV)	4400-2200	01121	FA5C-102W	
C102	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C103	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80183	CC16, 0.01 μF +80-20%	5910-974-5697
C104	Plastic, 3 μF ±20% 200 V	4875-5309	56289	4875-5309	
C106	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C107	Ceramic, 10 pF ±10% 500 V	4404-0108	72982	831, 10 pF ±10%	
RESISTORS					
R102	Composition, 1 kΩ ±10%	6045-3000	01121	JT, 1 kΩ ±10%	
R103	Composition, 10 Ω ±10% 1/4 W	6099-0109	75042	RC09GF100J	
R104	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R105	Composition, 1.2 kΩ ±5% 1 W	6110-2125	01121	RC32GF122J	5905-279-2553
R106	Composition, 11 Ω ±5% 1/2 W	6100-0115	01121	RC20GF110J	5905-279-3524
R107	Potentiometer, composition 5 kΩ ±10%	6000-0500	24655	6000-0500	
R108	Composition, 12 K ±5% 1/2 W	6100-3125	01121	RC20GF123J	5905-279-3502
R109	Potentiometer, wire wound 500 Ω	6059-1509			
R110	Composition, 22 Ω ±5% 1/4 W	6099-0225	75042	BTS, 22 Ω ±5%	5905-279-5459
R111	Composition, 51 Ω ±5% 1/4 W	6099-0515	75042	BTS, 51 Ω ±5%	
R112	Composition, 100K ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
MISCELLANEOUS					
A100	Attenuator Assembly, OUTPUT RANGE	0825-4040	24655	0825-4040	
FL101	FILTER, electrical	5280-3020	56289	103C15A4	
FL102	FILTER, electrical	5280-3020	56289	103C15A4	
J103	JACK Part of	1003-2820			
J104	JACK	4260-1288	02600	5116058350	
J105	JACK	0874-4503			
J107	JACK Part of	0825-4040			
J108 J109	JACK	0938-3000	24655	0938-3000	
L101	INDUCTOR, 5600 μH ±10%	4300-5900	99800	3500, 5600 μH ±10%	
L102	INDUCTOR, 5600 μH ±10%	4300-5900	99800	3500, 5600 μH ±10%	
L103	INDUCTOR, 39 μH ±10%	4300-3000	99800	2150-38, 39 μH ±10%	
M101	METER	5730-1403	40931	140003-0106	
M102	METER	5730-1404	40931	140002-0112	
MO101	MOTOR	5760-1010	05624	HZKE 12247-1	
P100	PILOT LIGHT	5600-0300	24454	#328	6240-155-7857
PL102	PLUG	1003-2840	24655	1003-2840	
PL103	PLUG	1003-2842	24655	1003-2842	
PL104	PLUG Part of	1003-2851			
PL106	PLUG	4220-4900	71785	261-31-06-030	
PL107	PLUG	1003-2860	24655	1003-2860	
PL108	PLUG	1003-2860	24655	1003-2860	
PL111	PLUG	4220-5100	24655	4220-5100	5935-237-6662
SO101	SOCKET, multiple connector	4230-3700	71785	S-312-AB	
SO102	SOCKET, multiple connector	4230-2710	95354	91-6010-1201-00	
SO103	SOCKET, multiple connector	4230-3500	71785	S-306-AB	
SO104	SOCKET, multiple connector	4230-2710	95354	91-6010-1201-00	
S101	SWITCH Part of R102				
S102	SWITCH, rotary wafer	7890-4810	76854	259703-H1	
S103	SWITCH, toggle	7910-1300	04009	83053-SA	5930-909-3510
S104	SWITCH, rotary wafer	7890-7010	76854	261434-F	
S105	SWITCH, toggle	7910-1655	88140	8136K 20C 1851	
S106	SWITCH, pushbutton, single	7870-1513	81751	MAC-100	
S107	SWITCH, pushbutton, single	7870-1513	81751	MAC-100	
T101	TRANSFORMER Part of 1003-2851				
	Motor Drive Assembly	1003-2410	24655	1003-2410	
	F/N Monitor Assembly	1003-2420	24655	1003-2420	





Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ○ KNOB CONTROL
	8. ⊘ SCREWDRIVER CONTROL
	9. AT ANCHOR TERMINAL
4. RESISTORS 1/2 WATT.	10. TP TEST POINT



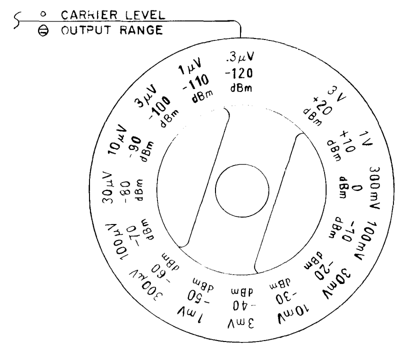


Figure 6-1 Over-all →

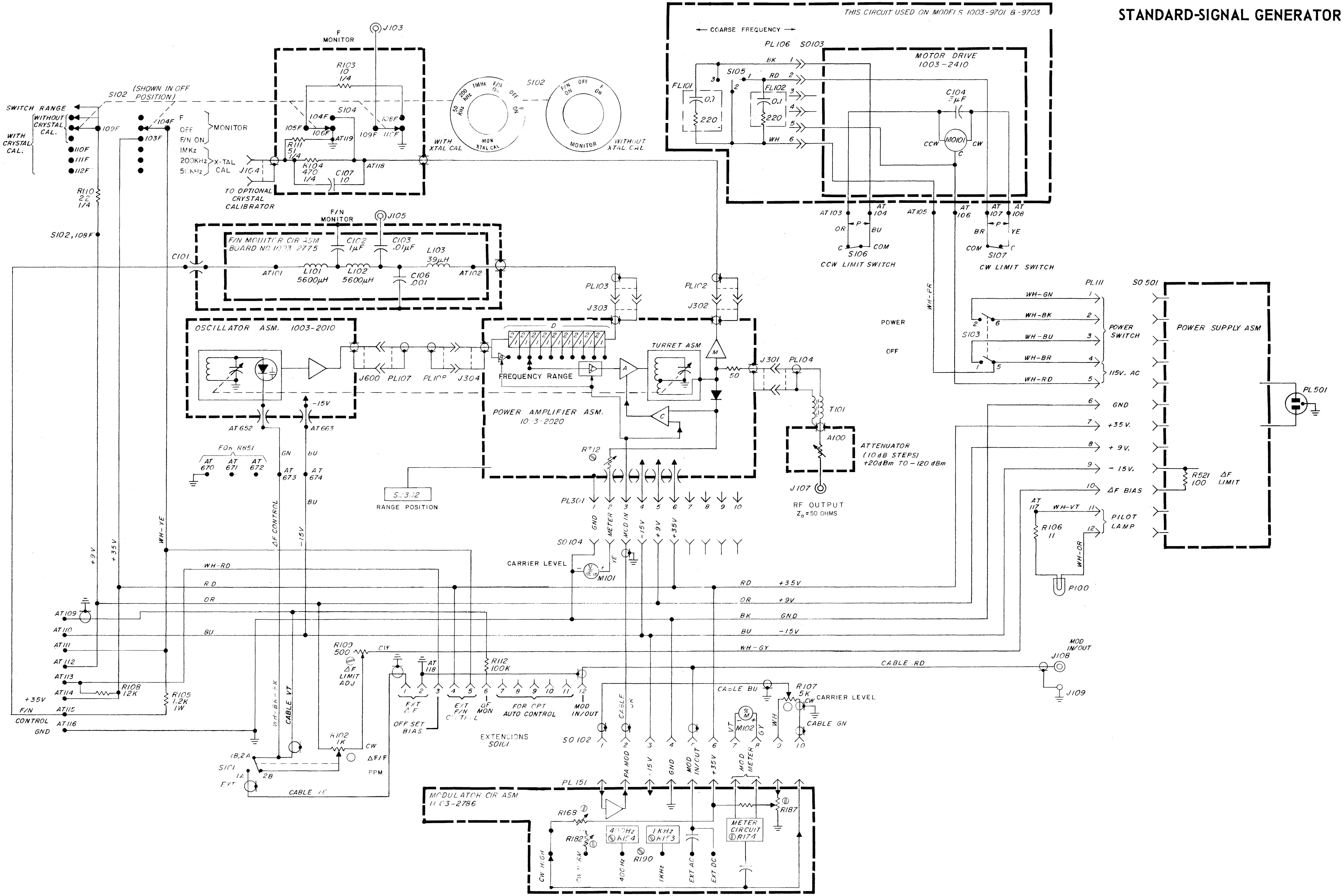


Figure 6-1. Over-all schematic diagram for the basic 1003 Standard-Signal Generator (model 1003-9701).

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C602	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C603	Ceramic, 120 pF	1003-2200	24655	1003-2200	
C604	Ceramic, 4.7 pF ±5% 500 V (N30)	4411-9475	80131	CC60, 4.7 pF (N30)	
C605	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	
C606	Ceramic, 27 pF ±5% 500 V (NPO)	4410-0105	80131		
C607	Trimmer, 0.8-8.5 pF	4910-1100	73899	VC9GW, 0.8-8.5 pF	5910-683-7157
C608	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C609	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C610	Ceramic, 47 pF ±5% 500 V	4404-0475	72982	831, 47 pF ±5%	
C611	Ceramic, 22 pF ±5% 500 V (NPO)	4410-0225	80131	CC61, 22 pF (NPO)	
C612	Ceramic, 43 pF ±5% 500 V (N750)	4417-0435	80131	CC61, 43 pF (N750)	
C613	Ceramic, 15 pF ±5% 500 V (N750)	4417-0155	80131	CC60, 15 pF ±5%	
C614	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C615	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C616	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C617	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C618	Ceramic, 15 pF (N750) ±5%	4417-0155	80131	CC60, 15 pF ±5%	
C620 thru C625	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C641	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C642	Electrolytic, 22 μF ±20% 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
C643	Ceramic, 220 pF ±10% 500 V	4404-1228	72982	831, 220 pF ±10%	
C651 thru C653	Ceramic, 1000 pF (GMV) +100-0% 500 V	4400-2200	01121	315N750, 1000 pF	
RESISTORS					
R601	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R602	Composition, 300 kΩ ±5% 1/4 W	6099-4305	75042	BTS, 300 kΩ ±5%	5905-681-8854
R603	Composition, 68 kΩ ±5% 1/4 W	6099-3685	75042	BTS, 68 kΩ ±5%	5905-681-8853
R604	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R605	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R606	Composition, 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ ±5%	
R607	Composition, 91 Ω ±5% 1/4 W	6099-0915	75042	BTS, 91 Ω ±5%	
R608	Composition, 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ ±5%	
R609	Composition, 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R610	Composition, 75 Ω ±5% 1/4 W	6099-0755	75042	BTS, 75 Ω ±5%	
R611	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275	75042	BTS, 2.7 kΩ ±5%	
R612	Composition, 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω ±5%	
R613	Composition, 22 Ω ±5% 1/4 W	6099-0225	75042	BTS, 22 Ω ±5%	5905-279-5459
R614	Composition, 10 Ω ±5% 1/4 W	6099-0105	75042	RC09GF100J	5905-809-8596
R615	Composition, 15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 15 Ω ±5%	
R621	Composition, 51 Ω ±5% 1/4 W	6099-0515	75042	BTS, 51 Ω ±5%	
R622	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R623	Composition, 680 Ω ±5% 1/2 W	6100-1685	01121	RC20GF681J	5905-195-6791
R624	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R625	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R626	Composition, 240 Ω ±5% 1/4 W	6099-1245	75042	BTS, 240 Ω ±5%	
R627	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R628	Composition, 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1.8 kΩ ±5%	5905-688-3738
R629	Composition, 15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 15 Ω ±5%	
R632	Composition, 10 Ω ±5% 1/4 W	6099-0105	75042	RC09GF100J	5905-809-8596
R633	Composition, 10 Ω ±5% 1/4 W	6099-0105	75042	RC09GF100J	5905-809-8596
R641	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%	5905-723-5251
R642	Potentiometer, composition 10 kΩ ±10%	6041-3109	01121	GA4G028S103AA	
R643	Composition, 1.6 kΩ ±5% 1/4 W	6099-2165	75042	BTS, 1.6 kΩ ±5%	
R644	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R645	Potentiometer, composition 25 kΩ ±20%	6040-0800	24655	6040-0800	5905-958-7950
R651	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R652	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
MISCELLANEOUS					
CR601	DIODE, type 1N3604	6082-1001	24446	1N3604	5960-995-2199
CR602	DIODE, type PS1, V-10	6084-1012	59875	V-10	
CR603	DIODE, type 1N3604	6082-1001	24446	1N3604	5960-995-2199
CR604	DIODE, type IN3253	6081-1001	79089	IN3253	5961-814-4251
CR641	DIODE, type 1N758A	6083-1012	07910	1N758-A	
CR642	DIODE, type 1N758A	6083-1012	07910	1N758-A	
CR643	DIODE, type 1N3604	6082-1001	24446	1N3604	5960-995-2199
FL601	FILTER, electrical	5280-3026	56289	1J127	
L601	INDUCTOR,	1003-2140	24655	1003-2140	
L602	INDUCTOR, 2.2 μH ±10%	4300-1200	99800	1537-20, 2.2 μH ±10%	
L603	INDUCTOR, 1 μH ±10%	4300-0700	99800	1537, 1 μH ±10%	
J600	JACK	1003-2150	24655	1003-2150	
T621	TRANSFORMER	5000-2403	24655	5000-2403	
T622	TRANSFORMER	5000-2403	24655	5000-2403	
Q601	TRANSISTOR, type 2N2218	8210-1161	81349	2N2218	5960-059-4464
Q602	TRANSISTOR, type 2N2369	8210-1052	93916	2N2369	5960-682-7755
Q621	TRANSISTOR, type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q622	TRANSISTOR, type 2N2218	8210-1028	81349	2N2218	5960-059-4464
	Oscillator Assembly	1003-2010	24655	1003-2010	

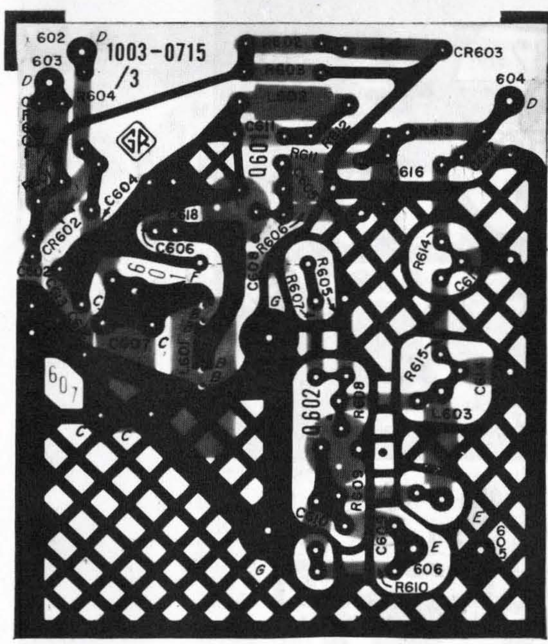


Figure 6-2. Oscillator etched-circuit board (P/N 1003-2716).

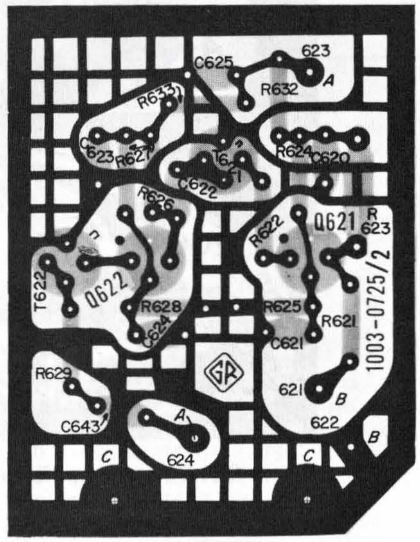


Figure 6-3. Buffer Amplifier etched-circuit board (P/N 1003-2726).

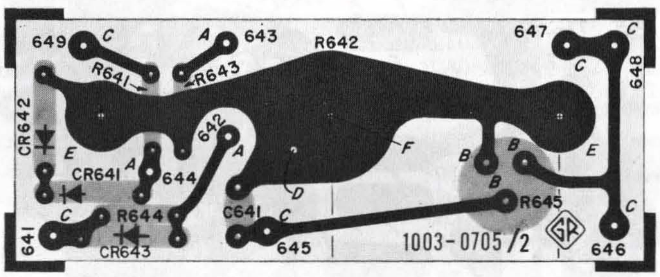


Figure 6-4. Electronic tuning etched-circuit board (P/N 1003-2706).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP = TEST POINT

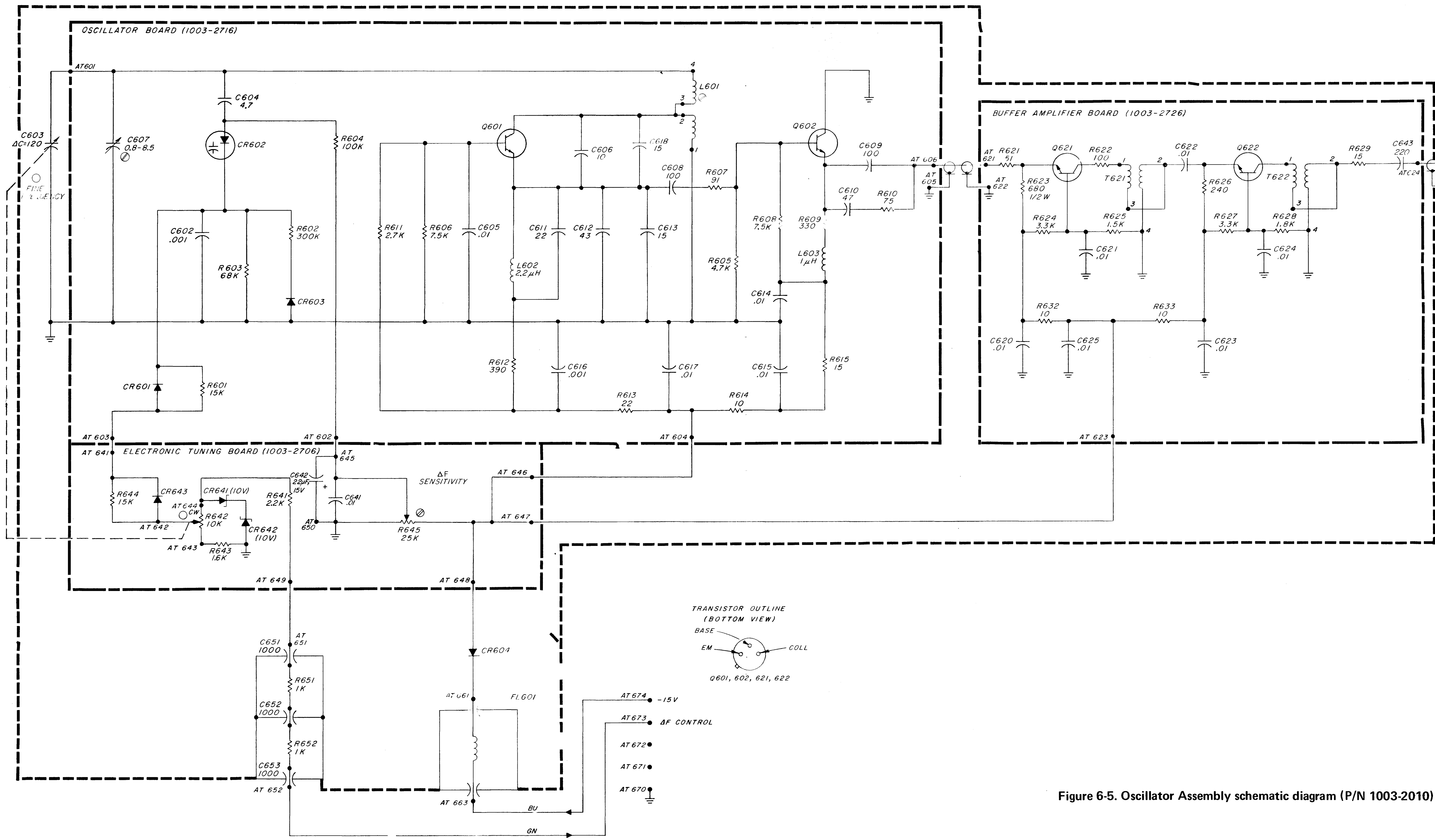


Figure 6-5. Oscillator Assembly schematic diagram (P/N 1003-2010).

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C260	Mica .00750 μF +2% 500 V	4530-1750	14655	1A5D75GE	
C261	Mica 500 pF +1% 300 V	4690-4000	00656	CM20E, 500 pF ±1%	
C262	Mica .0147 ±F ±2% 300 V	4550-2147	14655	1A3S147GE	
C263	Mica 200 pF ±2% 500 V	4690-2500	00656	CM20E, 200 pF ±2%	
C264	Mica .00750 μF ±2% 500 V	4530-1750	14655	1A5D75GE	
C265	Ceramic 1000 pF (GMV) +100-0	4400-2200	01121	FA5C, 1000 pF	
C268	Electrolytic 22 μF ±20% 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
C272	Electrolytic 22 μF ±20% 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
C274	Electrolytic 22 μF ±20% 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
C281	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C282	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C283	Ceramic, 56 pF ±5% 500 V	4404-0565	72982	831, 56 pF ±5%	
C284	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C285	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C301	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C302	Electrolytic, 1 μF ±20% 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C303	Trimmer, 5.5-18 pF 350 V	4910-2044	72982	538-002, 5.5-18 pF	
C304	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C305	Electrolytic, 180 μF ±20% 6 V	4450-5617	80183	150D, 180 μF ±20%	
C306	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C307	Ceramic, 100 pF ±10% 500 V	4400-2092	01121	FA5C-1011	
C308	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C309	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C310	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C311	Ceramic, 0.22 μF ±20% 25 V	4400-2052	80183	5C13, 0.22 μF	5910-974-5694
C312	Ceramic, 0.22 μF ±20% 25 V	4400-2052	80183	5C13, 0.22 μF	5910-974-5694
C313	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C314	Ceramic, 0.1 μF ±20% 25 V	4400-2050	80183	5C13, 0.1 μF ±20%	5910-974-5695
C315A	115 pF Part of	1003-2300			
C315B	230 pF Part of	1003-2300			
C316	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C317	Electrolytic, 6.8 μF ±20% 35 V	4450-7680	56289	180D685X003RT	
C318	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
RESISTORS					
R281	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R282	Composition, 510 Ω ±5% 1/4 W	6099-1515	75042	BTS, 510 Ω ±5%	5905-801-8272
R283	Composition, 10 Ω ±5% 1/4 W	6099-0105	75042	RC09GF100J	5905-809-8596
R284	Composition, 51 Ω ±5% 1/4 W	6099-0515	75042	BTS, 51 Ω ±5%	
R285	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R286	Composition, 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R301	Composition, 5.1 kΩ ±5% 1/4 W	6099-2515	75042	BTS, 5.1 kΩ ±5%	5905-279-4623
R302	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	5905-683-2243
R303	Composition, 33 Ω ±5% 1 W	6110-0335	01121	RC32GF330J	
R304	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R305	Composition, 220 kΩ ±5% 1/2 W	6100-4225	01121	RC20GF224J	5905-192-0667
R306	Composition, 16 kΩ ±5% 1/4 W	6099-3165	75042	BTS, 16 kΩ ±5%	
R307	Electrolytic, 49.9 Ω ±1% 1/2 W	6450-9499	75042	CEC, 49.9 Ω ±1%	
R308	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R309	Composition, 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R310	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155	01121	RC20GF152J	5905-841-7461
R311	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R312	Potentiometer, wire wound 5 kΩ ±10%	6059-2509	80294	3067P-1-502	
R313	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R314	Composition, 270 Ω ±5% 1/2 W	6100-1275	01121	RC20GF271J	5905-171-2006
R315	Composition, 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ ±5%	5905-279-4629
R316	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129

ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
MISCELLANEOUS					
CR301	DIODES, type 1N3604	6082-1026	99180	1N3604	
FL301	FILTER, electrical	5280-3025	56289	1JX96	
FL302	FILTER, electrical	5280-3026	56289	1JX127	
FL303	FILTER, electrical	5280-3025	56289	1JX96	
FL304	FILTER, electrical	5280-3025	56289	1JX96	
J301	JACK and cable asm.	1003-0251	24655	1003-0251	
J302	JACK and cable asm.	1003-0250	24655	1003-0250	
J303	JACK and cable asm.	1003-0252	24655	1003-0252	
J304	JACK and cable asm.	1003-0253	24655	1003-0253	
L261	INDUCTOR, Molded 10,000 μH ±10%	4300-6200	99800	3500-42, 10000 μH ±10%	
L262	INDUCTOR, Molded 10,000 μH ±10%	4300-6200	99800	3500-42, 10000 μH ±10%	
L271	INDUCTOR, Molded 150 μH ±10%	4300-3810	99800	3500-12, 150 μH ±10%	5950-770-3508
L272	INDUCTOR, Molded 150 μH ±10%	4300-3810	99800	3500-12, 150 μH ±10%	5950-770-3508
L281	INDUCTOR, 22 μH ±10%	4300-2600	99800	1537, 22 μH ±10%	5950-668-5867
L301	INDUCTOR, 10 μH ±10%	4300-2200	99800	1537, 10 μH ±10%	
L302	INDUCTOR, 220 μH ±10%	4300-4350	99800	3500, 10 μH ±10%	
L303	INDUCTOR, 100 μH ±10%	4300-3500		2890-42 100 μH ±10%	
L304	INDUCTOR, 22 μH ±10%	4300-2600	99800	1537, 22 μH ±10%	5950-668-5867
L305	INDUCTOR, 22 μH ±10%	4300-2600	99800	1537, 22 μH ±10%	5950-668-5867
PL301	PLUG	4220-0140	07261	60-6010-1100-00	
SO302	SOCKET	4230-3700	71785	S-312-AB	
S301	SWITCH	1003-8450	24655	1003-8450	
S302	SWITCH	7890-7000	76854	261429-F	
Q281	TRANSISTOR, type 2N2369	8210-1052	93916	2N2369	5960-682-7755
Q282	TRANSISTOR, type 2N918	8210-1066	07263	2N3563	
Q301	TRANSISTOR, type 2N3375	8210-1108	Greene-Shaw	2N3375	
Q302	TRANSISTOR, type 2N918	8210-1066	07263	2N3563	
	Power Amplifier Assembly	1003-2020	24655	1003-2020	
	Filter Assembly, low-pass (Mod)	1003-2360	24655	1003-2360 (Includes board no. 1003-2720)	
	Radiator, heat, transistor	6070-0209	24655	6070-0209	
	Tank Circuit Assembly (17.3-40)	1003-2711	24655	1003-2711	
	Tank Circuit Assembly (34.6-80)	1003-2713	24655	1003-2713	
	Cont. Amplifier Circuit Assembly	1003-2730	24655	1003-2730	
	Divider Circuit Assembly	1003-2741	24655	1003-2741	
	Buf. Amplifier Circuit Assembly	1003-2745	24655	1003-2745	
	Tank Circuit Assembly (270-625)	1003-2761	24655	1003-2761	
	Tank Circuit Assembly (540-1250)	1003-2763	24655	1003-2763	
	Tank Circuit Assembly (1.08-2.5)	1003-2765	24655	1003-2765	
	Tank Circuit Assembly (2.16-5)	1003-2767	24655	1003-2767	
	Int. Amplifier Circuit Assembly	1003-2771	24655	1003-2771	
	Tank Circuit Assembly (67-156)	1003-2781	24655	1003-2781	
	Tank Circuit Assembly (135-312)	1003-2783	24655	1003-2783	
	Tank Circuit Assembly (4.32-10)	1003-2791	24655	1003-2791	
	Tank Circuit Assembly (8.64-20)	1003-2793	24655	1003-2793	
	Power Amplifier Etched Circuit Board	1003-2701	24655	1003-2701	

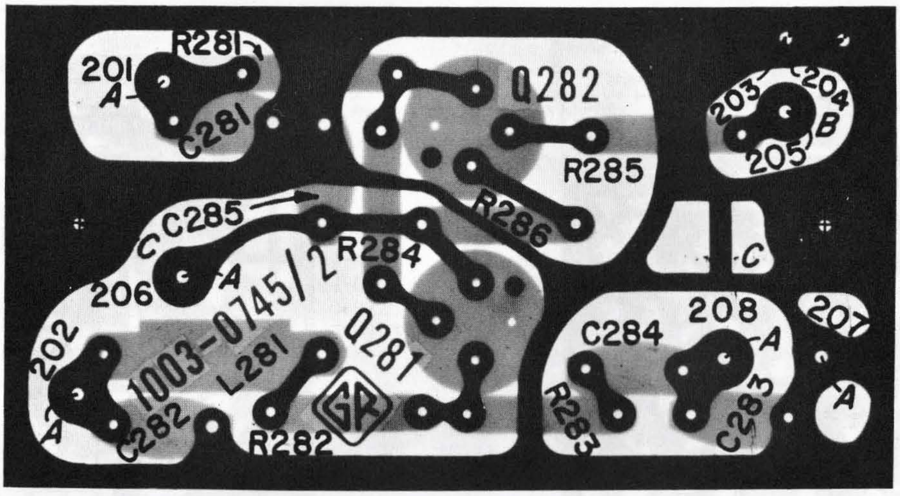


Figure 6-6. Buffer Amplifier etched-circuit board (P/N 1003-2745).

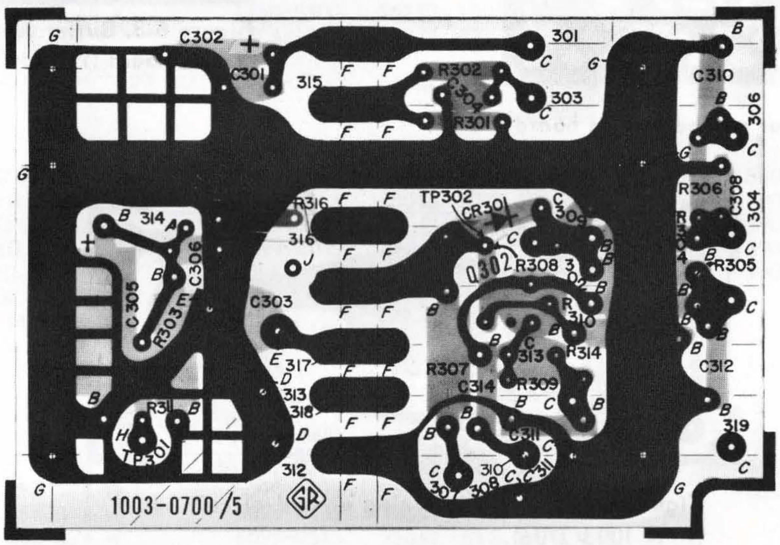
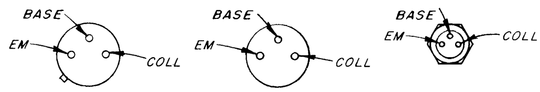


Figure 6-7. Power-Amplifier Final Stage etched-circuit board (P/N 1003-2701).

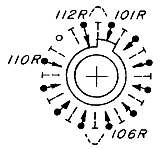
NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ◯ KNOB CONTROL
	8. ⊘ SCREWDRIVER CONTROL
	9. AT = ANCHOR TERMINAL
4. RESISTORS 1/4 WATT.	10. TP = TEST POINT

TRANSISTORS - BOTTOM VIEW



Q281 Q282, 302 Q301



S302
SECTION 1, REAR

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

Figure 6-8 Power Amp. →

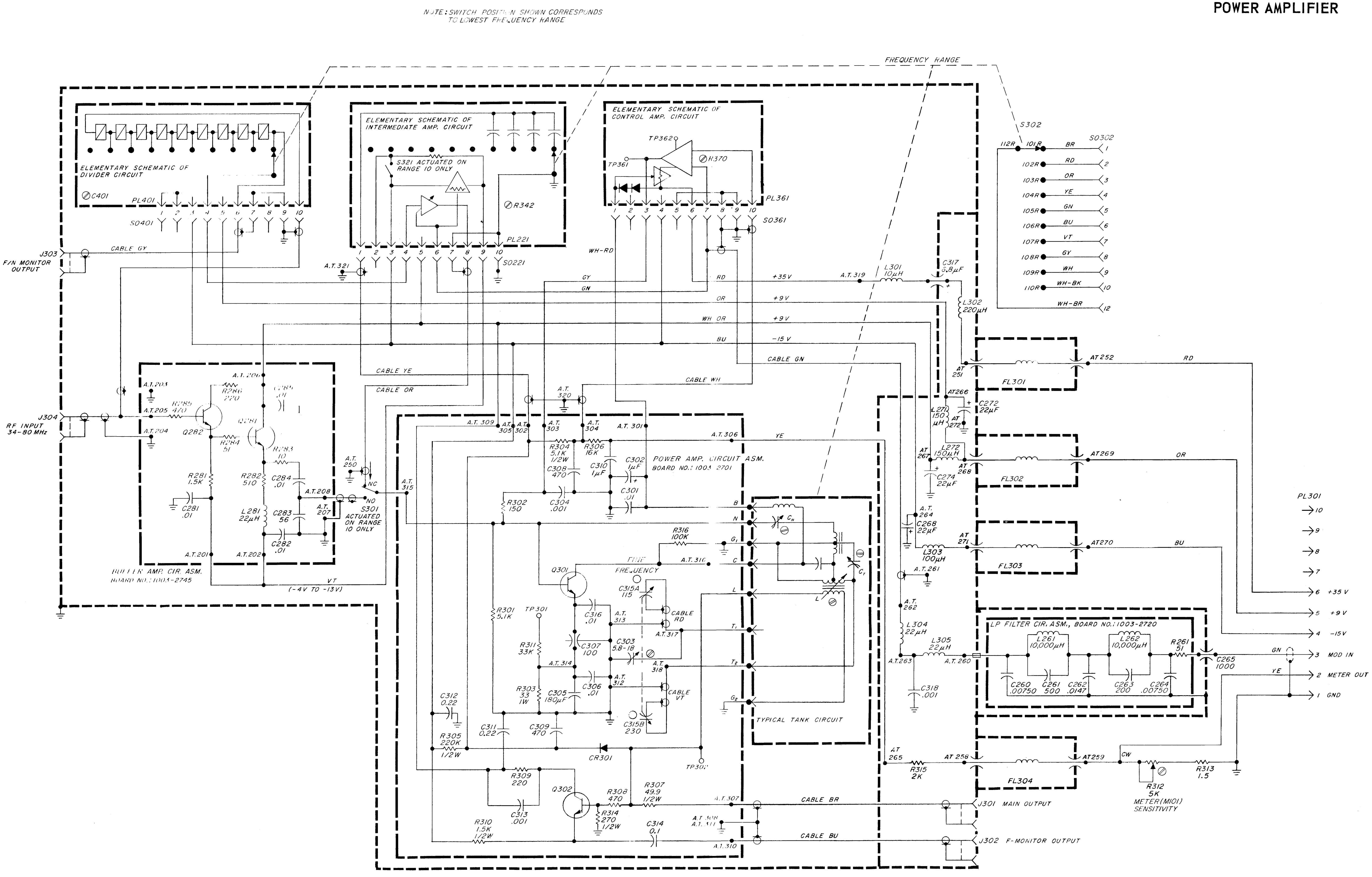


Figure 6-8. Power-Amplifier Assembly schematic diagram (P/N 1003-2020).

ELECTRICAL PARTS LIST

Ref. No	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C401	Trimmer, 9-50 pF 350 V	4910-2060	72982	3192-000	
C402	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C403	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C404	Ceramic, 75 pF ±5% 500 V	4411-0753	80131	CC62, 75 pF ±5%	
C405	Ceramic, 33 pF ±5%	4404-0335	72982	831, 33 pF ±5%	
C406	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C407	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C408	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C409	Ceramic, 68 pF ±10% 500 V	4404-0688	72982	831, 68 pF ±10%	
C410	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C411	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C412	Ceramic, 220 pF ±10% 500 V	4404-1228	72982	831, 220 pF ±10%	
C413	Ceramic, 68 pF ±10% 500 V	4404-0688	72982	831, 68 pF ±10%	
C414	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C415	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C416	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C417	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C418	Ceramic, 68 pF ±10% 500 V	4404-0688	72982	831, 68 pF ±10%	
C419	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C420	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C421	Ceramic, 680 pF ±10% 500 V	4405-1688	72982	801, 680 pF ±10%	
C422	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C423	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C424	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C425	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C426	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C427	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C428	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C429	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C430	Ceramic, 0.0022 μF ±10% 500 V	4406-2228	72982	811, 0.0022 μF ±10%	
C431	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C432	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C433	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C434	Ceramic, 0.0022 μF ±10% 500 V	4406-2228	72982	811, 0.0022 μF ±10%	
C435	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C436	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C437	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C438	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C439	Ceramic, 0.0047 μF +80-20% 500 V	4405-2479	72982	801, 0.0047 μF +80-20%	
C440	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF	
C441	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF	
C442	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
RESISTORS					
R401	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R402	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R403	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R404	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R405	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195
R406	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R407	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R408	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R409	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R410	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R411	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R412	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195
R413	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 7.5 kΩ ±5%	
R414	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R415	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R416	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R417	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R418	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R419	Composition, 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-892-0107
R420	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195
R421	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R422	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R423	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R424	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R425	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R426	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R427	Composition, 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R428	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195

ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
RESISTORS (Cont)					
R429	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R430	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R431	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R432	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R433	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R434	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R435	Composition, 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R436	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195
R437	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R438	Composition, 51 Ω ±5% 1/2 W	6100-0515	01121	RC20GF510J	5905-279-3517
R439	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R440	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R441	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R442	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R443	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R444	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R445	Composition, 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω ±5%	
R446	Composition, 7.5 kΩ ±5% 1/4 W	6100-2755	01121	RC20GF752J	5905-249-4195
R447	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R448	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R449	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R450	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R451	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R452	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R453	Composition, 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω ±5%	
R454	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195
R455	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R456	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R457	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R458	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R459	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R460	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R461	Composition, 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω ±5%	
R462	Composition, 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω ±5%	
R463	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195
R464	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R465	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R466	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R467	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R468	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R469	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R470	Composition, 750 Ω ±5% 1/4 W	6099-1755	75042	BTS, 750 Ω ±5%	
R471	Composition, 7.5 kΩ ±5% 1/2 W	6100-2755	01121	RC20GF752J	5905-249-4195
R472	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R473	Composition, 62 Ω ±5% 1/4 W	6099-0625	75042	BTS, 62 Ω ±5%	
R474	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R475	Composition, 56 Ω ±5% 1/4 W	6099-0565	75042	BTS, 56 Ω ±5%	
R476	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R477	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R478	Composition, 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R479	Composition, 750 Ω ±5% 1/4 W	6099-1755	75042	BTS, 750 Ω ±5%	
R480	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS,	5905-681-9969
R481	Composition, 56 kΩ ±5% 1/4 W	6099-3565	75042	BTS,	5905-800-0179
R482	Composition, 240 kΩ ±5% 1/4 W	6099-4245	75042	BTS, 240 kΩ ±5%	
MISCELLANEOUS					
CR401	DIODE, Type STD-694	6085-1001	24454	STD-694	
CR402 thru CR409	DIODE, Type 40572	6085-1009	93916	40572	
CR410	DIODE, Type 1N3719	6085-1005	24454	1N3719	
CR411	DIODE, Type 1N3719	6085-1005	24454	1N3719	
CR412 thru CR419	DIODE, Type 1N3718	6085-1006	24454	1N3718	
CR420	DIODE, Type 1N9598	6083-1010	72699	1N959B	
L401	INDUCTOR, 0.47 μH ±20%	4300-0400	99800	1537, 0.47 μH ±20%	
L402	INDUCTOR, 0.47 μH ±20%	4300-0400	99800	1537, 0.47 μH ±20%	
L403	INDUCTOR, 1.5 μH ±10%	4300-1000	99800	1537, 1.5 μH ±10%	
L404	INDUCTOR, 4.7 μH ±10%	4300-1600	99800	1537-28, 4.7 μH	
L405	INDUCTOR, 1.5 μH ±10%	4300-1000	99800	1537, 1.5 μH ±10%	
L406	INDUCTOR, 10 μH ±10%	4300-2200	99800	1537, 10 μH ±10%	

ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
MISCELLANEOUS (Cont)					
L407	INDUCTOR, 1.5 μH ±10%	4300-1000	99800	1537, 1.5 μH ±10%	
L408	INDUCTOR, 15 μH ±10%	4300-2400	99800	1537-40, 15 μH ±10%	5950-615-0091
L409	INDUCTOR, 2.2 μH ±10%	4300-1200	99800	1537-20, 2.2 μH ±10%	
L410	INDUCTOR, 22 μH ±10%	4300-2600	99800	1537, 22 μH ±10%	5950-668-5867
L411	INDUCTOR, 2.2 μH ±10%	4300-1200	99800	1537-20, 2.2 μH ±10%	
L412	INDUCTOR, 22 μH ±10%	4300-2600	99800	1537, 22 μH ±10%	5950-668-5867
L413	INDUCTOR, 2.2 μH ±10%	4300-1200	99800	1537-20, 2.2 μH ±10%	
L414	INDUCTOR, 150 μH ±10%	4300-3810	99800	3500-12	5950-770-3508
L415	INDUCTOR, 2.2 μH ±10%	4300-1200	99800	1537-20, 2.2 μH ±10%	
L416	INDUCTOR, 10,000 μH ±10%	4300-6200	99800	3500-42, 10,000 μH ±10%	
PL401	PLUG	Part of 1003-2741			
SO401	SOCKET	4230-2710	95354	91-6010-1201-00	
S401	SWITCH	7890-4510	76854	261427-F2	
Q401 thru Q405	TRANSISTOR, Type 2N918	8210-1066	07263	2N3563	
Q406 thru Q410	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749

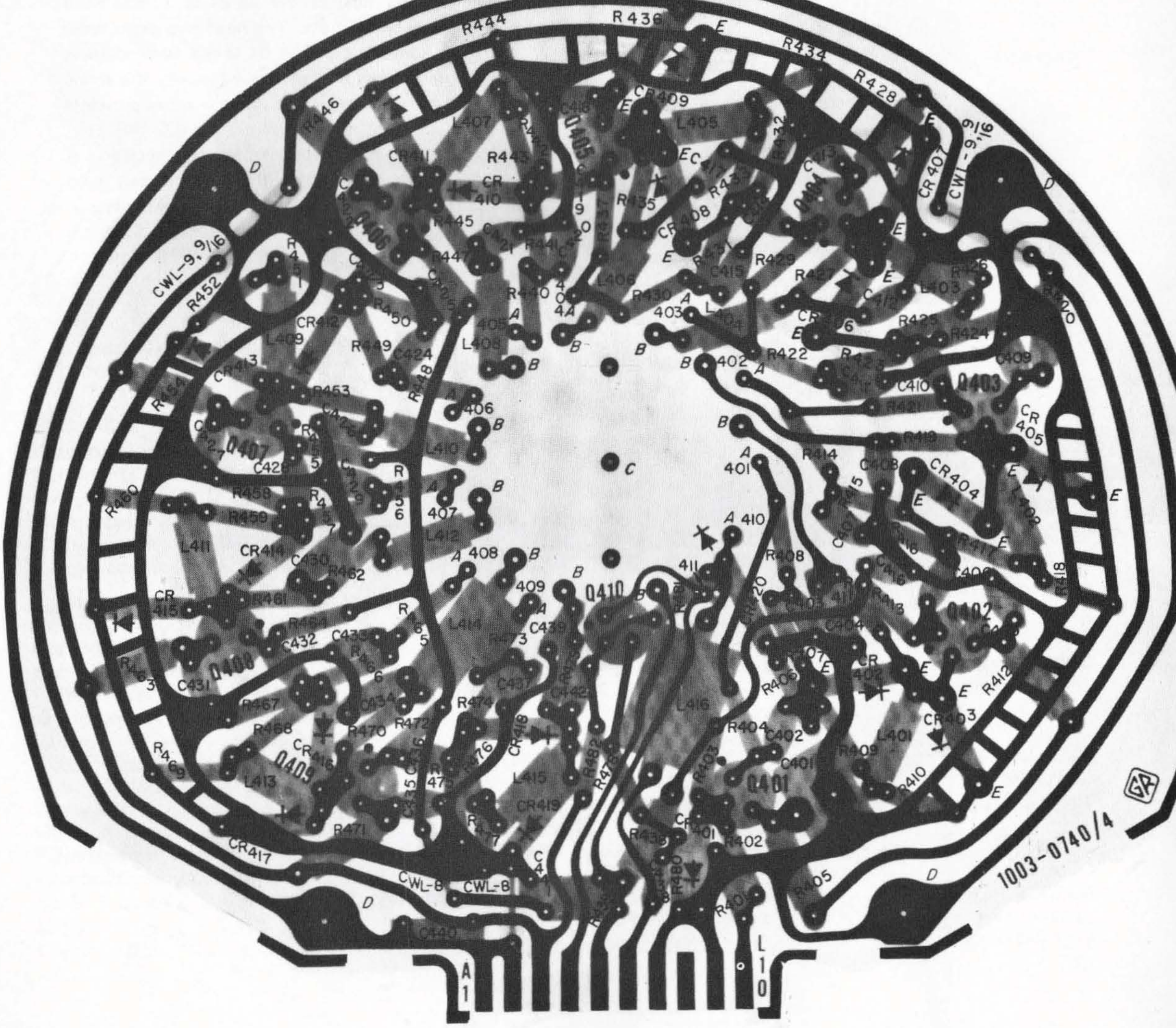
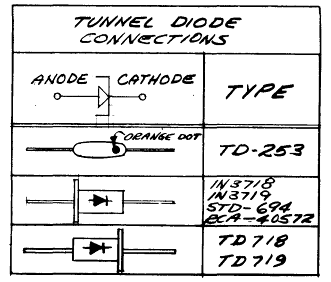


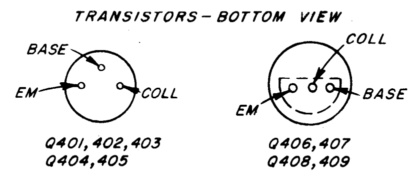
Figure 6-9. Divider etched-circuit board (P/N 1003-2741).

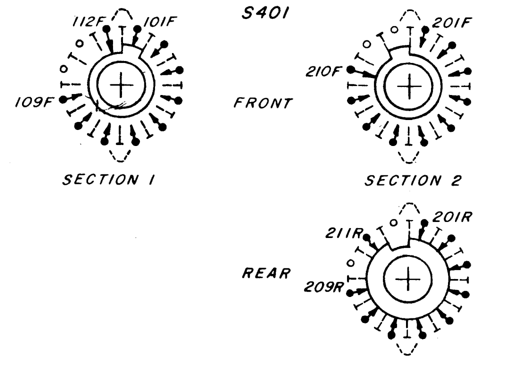
NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ○ KNOB CONTROL
	8. ⊘ SCREWDRIVER CONTROL
	9. AT - ANCHOR TERMINAL
4. RESISTORS 1/4 WATT.	10. TP - TEST POINT

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.







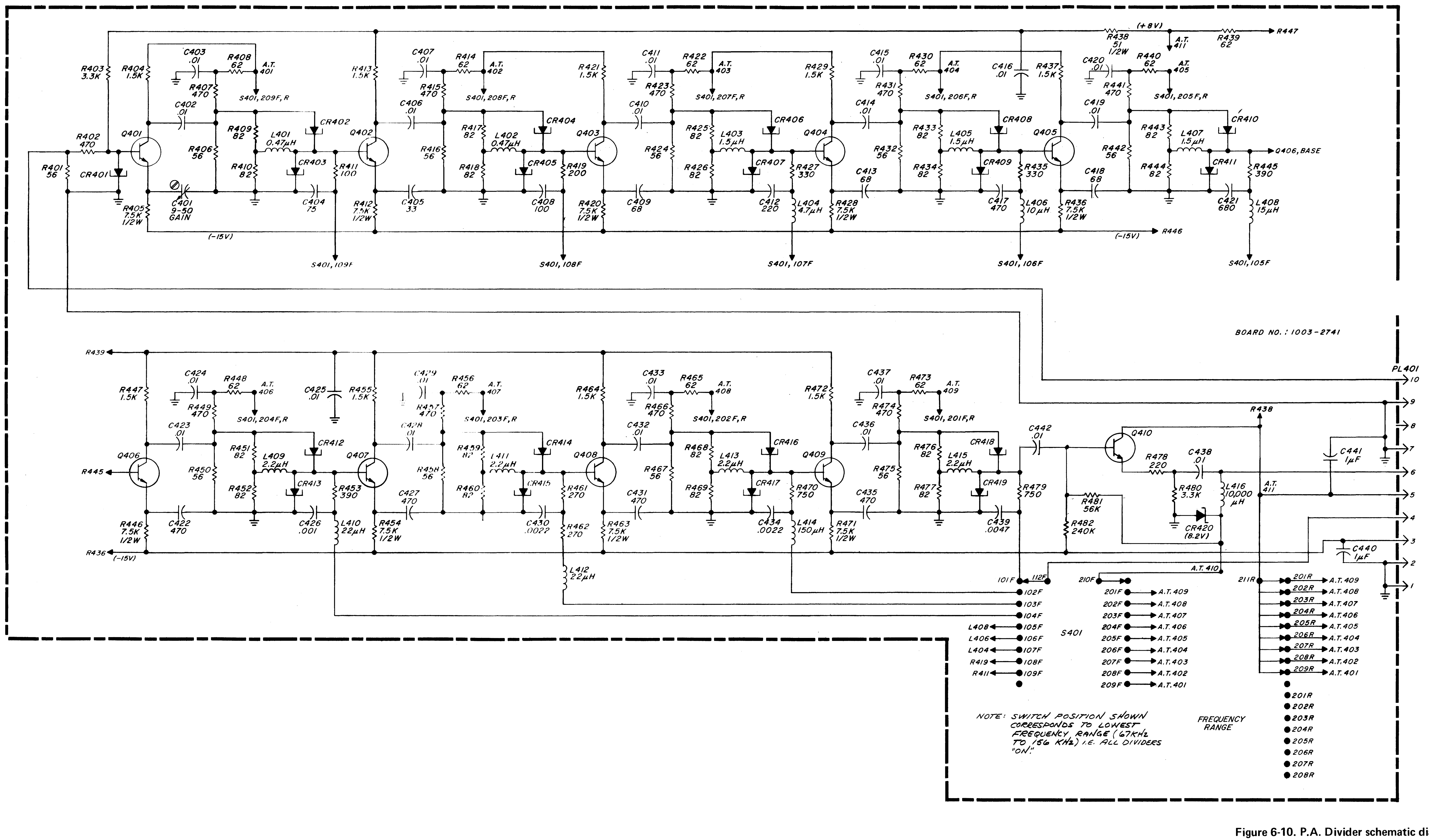


Figure 6-10. P.A. Divider schematic diagram.

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C321	Ceramic, 0.01 μF +80-20% 500 V	4406-3109	72982	811, 00X5U103X	5910-977-7579
C322	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C323	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C324	Ceramic, 62 pF ±10% 500 V	4404-0628	72982	831, 62 pF ±10%	
C325	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C326	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C327	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C328	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C329	Electrolytic, 15 μF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C330	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C331	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C332	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C333	Electrolytic, 3.3 μF ±20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
C334	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C335	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C336	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C337	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C338	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-811-4788
C339	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C340	Ceramic, 0.0068 μF ±10% 500 V	4409-2688	72982	CC65, 0.0068 μF ±10%	
C341	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C342	Ceramic, 330 pF ±10% 500 V	4404-1338	72982	831, 330 pF ±10%	5910-974-5702
C343	Ceramic, 150 pF ±10% 500 V	4404-1158	72982	831, 150 pF ±10%	
C344	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C345	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C346	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C347	Plastic, 0.01 μF ±10% 100 V	4860-7750	84411	663UW, 0.01 μF ±10%	
C348	Ceramic, 0.0047 μF ±10% 500 V	4407-2478	72982	PORM ±10%, 0.0047 μF	5910-931-0529
C349	Ceramic, 0.0022 μF ±10% 500 V	4406-2228	72982	811, 0.0022 μF ±10%	
C350	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C351	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C352	Electrolytic, 22 μF ±20% 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
RESISTORS					
R321	Composition, 300 Ω ±5% 1/2 W	6100-1305	01121	RC20GF301J	5905-279-5481
R322	Composition, 22 Ω ±5% 1/2 W	6100-0225	01121	RC20GF220J	5905-279-3519
R323	Composition, 430 Ω ±5% 1/2 W	6100-1435	01121	RC20GF431J	5905-279-3512
R324	Composition, 47 Ω ±5% 1/2 W	6100-0475	01121	RC20GF470J	5905-252-4018
R325	Composition, 82 Ω ±5% 1/2 W	6100-0825	01121	RC20GF820J	5905-279-1894
R326	Composition, 2.2 kΩ ±5% 1/2 W	6100-2225	01121	RC20GF222J	5905-279-1876
R327	Composition, 750 Ω ±5% 1/2 W	6100-1755	01121	RC20GF751J	5905-195-9481
R328	Composition, 22 Ω ±5% 1/2 W	6100-0225	01121	RC20GF220J	5905-279-3519
R329	Composition, 300 Ω ±5% 1/2 W	6100-1305	01121	RC20GF301J	5905-279-5481
R330	Composition, 33 Ω ±5% 1/2 W	6100-0335	01121	RC20GF330J	5905-192-4490
R331	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155	01121	RC20GF152J	5905-841-7461
R332	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R333	Composition, 620 Ω ±5% 1/2 W	6100-1625	01121	RC20GF621J	5905-279-1761
R334	Composition, 220 Ω ±5% 1/2 W	6100-1225	01121	RC20GF221J	5905-279-3513
R335	Composition, 33 Ω ±5% 1/2 W	6100-0335	01121	RC20GF330J	5905-192-4490
R336	Composition, 220 Ω ±5% 1 W	6110-1225	01121	RC20GF221J	5905-279-3513
R337	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R338	Composition, 56 Ω ±5% 1/2 W	6100-0305	01121	RC20GF300J	5905-279-3518
R339	Composition, 10 kΩ ±5% 1/2 W	6100-3105	01121	RC20GF103J	5905-185-8510
R340	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R341	Composition, 360 Ω ±5% 1/2 W	6100-1365	01121	RC20GF361J	5905-279-1889
R342	Potentiometer, composition 50 kΩ ±20%	6040-0900	24655	6040-0900	
R343	Composition, 10 kΩ ±5% 1/2 W	6100-3105	01121	RC20GF103J	5905-185-8510
R344	Composition, 10 Ω ±5% 1/2 W	6100-0105	01121	RC20GF100J	5905-190-8883
R345	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155	01121	RC20GF152J	5905-841-7461
R346	Composition, 1 kΩ ±5% 1/2 W	6100-0915	01121	RC20GF910J	5905-279-3516
R347	Composition, 560 Ω ±5% 1/2 W	6100-1565	01121	RC20GF561J	5905-195-6800
MISCELLANEOUS					
CR321	DIODE, Type 1N965B	6083-1015	07910	1N965B	5960-877-6192
L321	INDUCTOR, 1.5 μH ±10%	4300-1000	99800	1537, 1.5 μH ±10%	
S321	SWITCH	7890-4500	76854	261428-F2	
Q321	TRANSISTOR, Type 2N918	8210-1066	07263	2N3563	
Q322	TRANSISTOR, Type 2N918	8210-1066	07263	2N3563	
Q323	TRANSISTOR, Type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q324	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q325	TRANSISTOR, Type 2N697	8210-1040	82219	2N697	5961-752-0150

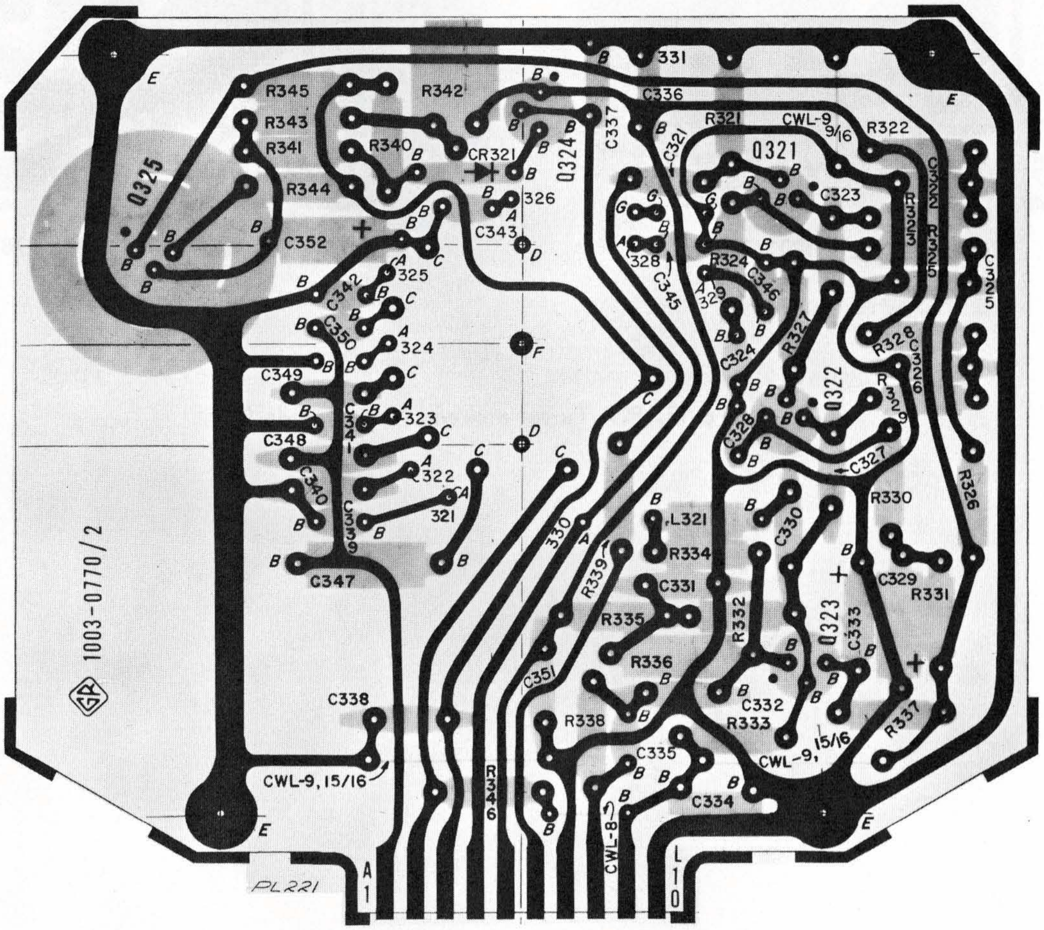


Figure 6-11. P.A. Intermediate Amplifier etched-circuit board (P/N 1003-2771).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

Figure 6-12 Inter Amp. →

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

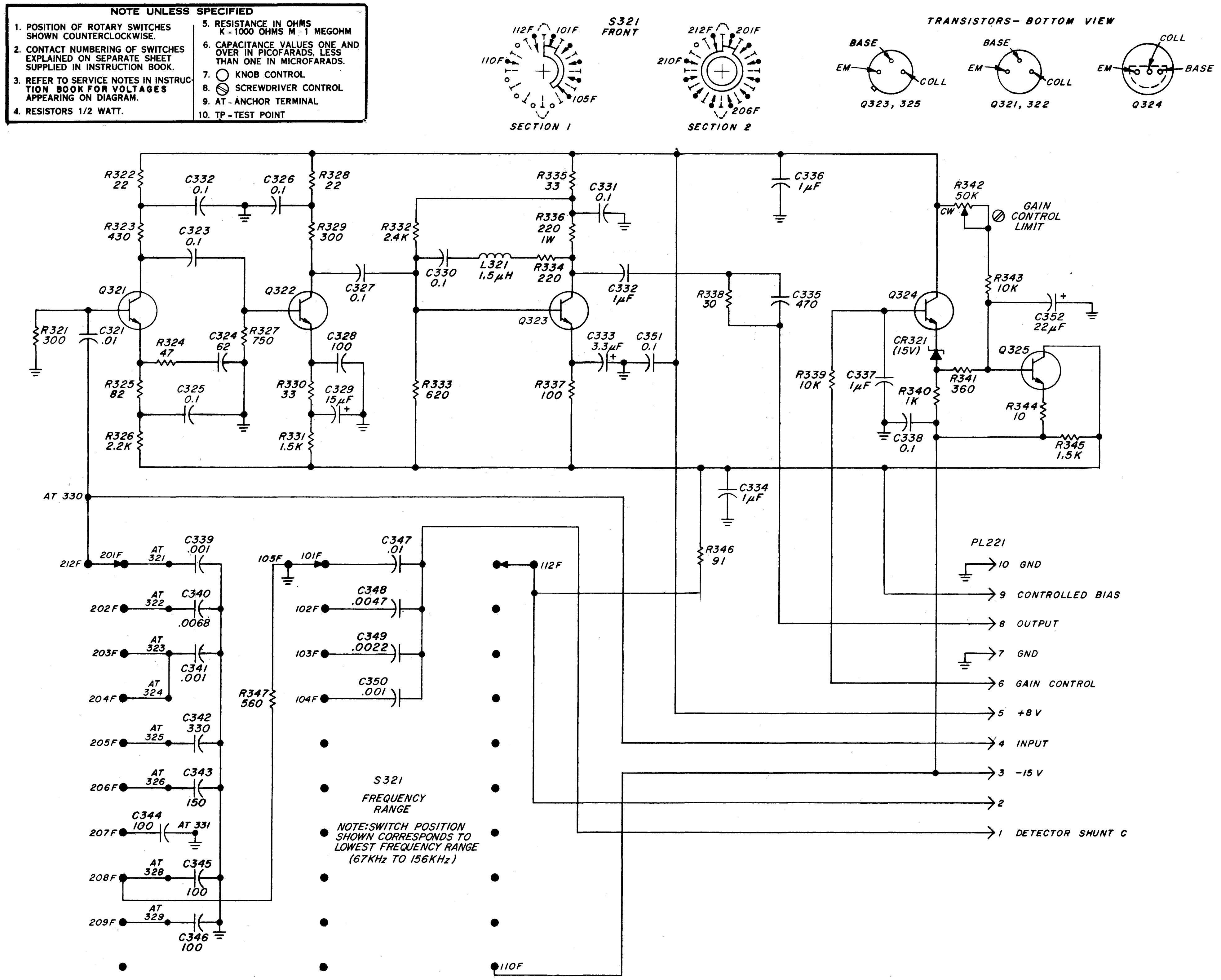
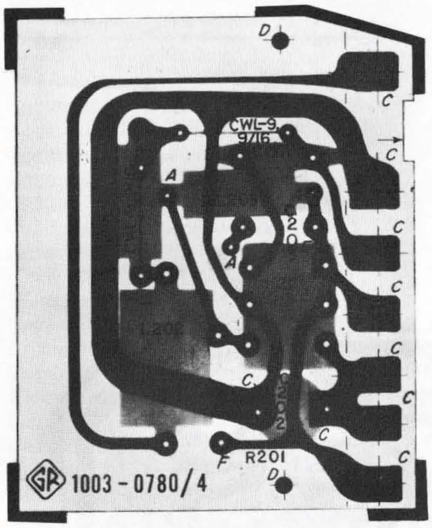


Figure 6-12. P.A. Intermediate Amplifier schematic diagram.

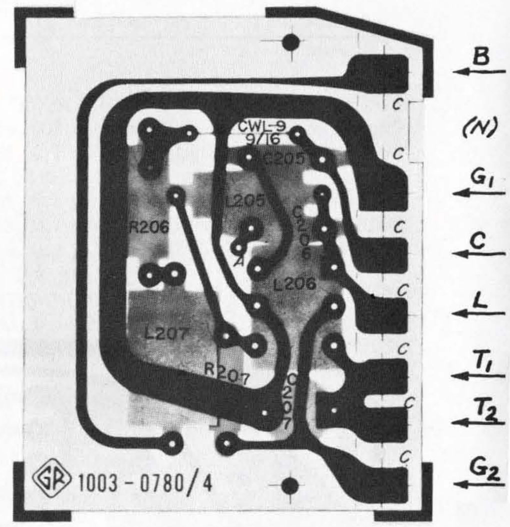
ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C201	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C202	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C203	Plastic, 0.015 pF ±10% 100 V	4860-7655	84411	663UW, 0.015 pF ±10%	
C205	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C206	Ceramic, 0.0068 μF ±10% 500 V	4409-2688	72982	3841	
C207	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF) N300	
C208	Ceramic, 27 pF ±5% 500 V	4404-0275	72982	831, 27 pF ±5%	
C211	Ceramic, 0.0033 μF ±10% 500 V	4406-2338	72982	811, 0.0033 μF ±10%	5910-836-5740
C212	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 1 μF +80-20%	5910-974-5699
C213	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C214	Ceramic, 62 pF ±5% 500 V	4417-0625	80131	CC63, 62 pF ±5%	
C216	Ceramic, 0.0022 μF ±5% 500 V	4406-2225	72982	811, 0.0022 μF ±5%	5910-899-0668
C217	Ceramic, 0.05 μF +80-20% 50 V	4403-3500	01121	40-503W	5910-883-7321
C218	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C221	Ceramic, 0.001 μF ±5% 500 V	4405-2105	72982	801, 0.001 μF ±5%	
C222	Ceramic, 0.05 μF +80-20% 50 V	4403-3500	01121	40-503W	5910-883-7321
C223	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C226	Ceramic, 470 pF ±5% 500 V	4406-1475	72982	811, 470 pF ±5%	
C227	Ceramic, 0.05 μF +80-20% 50 V	4403-3500	01121	40-503W	5910-883-7321
C228	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C231	Trimmer, 2-8 pF 350 V	4910-2045	72982	538-002, (2-8 pF)	
C232	Ceramic, 0.5 μF +80-20% 50 V	4403-3500	01121	40-503W	5910-883-7321
C233	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C234	Ceramic, 470 pF ±5% 500 V	4404-1475	72982	831, 470 pF ±5%	
C236	Trimmer, 2-8 pF 350 V	4910-2045	72982	538-002 (2-8 pF)	
C237	Ceramic, 0.02 μF +80-20% 50 V	4402-3200	01121	36-2036	5910-974-5698
C238	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C239	Ceramic, 220 pF ±5% 500 V	4404-1225	72982	831, 220 pF ±5%	
C241	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C242	Trimmer, 2-8 pF 350 V	4910-2045	72982	538-002 (2-8 pF)	
C243	Ceramic, 0.01 μF +80-20% 500 V	4406-3109	72982	811, 000X5U103X	5910-977-7579
C244	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C245	Ceramic, 10 pF (N30) ±5% 500 V	4411-0105	80131	CC61, 10 pF (N30)	
C246	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C247	Trimmer, 2-8 pF 350 V	4910-2045	72982	538-002 (2-8 pF)	
C248	Ceramic, 0.01 μF +80-20% 500 V	4406-3109	72982	811, 000X5U103X	5910-977-7579
INDUCTORS					
L201	Miscellaneous	5000-2847	24655	5000-2847	
L202	Choke, molded 5600 μH ±10%	4300-5900	99800	3500, 5600 μH ±10%	
L203	Choke, molded 22 μH ±10%	4300-6600	99800	2890, 22 μH ±10%	
L205	Choke, molded 22 μH ±10%	4300-6600	99800	2890, 22 μH ±10%	
L206	Miscellaneous	5000-2846	24655	5000-2846	
L207	Choke, molded 2200 μH ±10%	4300-6370	99800	3500, 2200 μH ±10%	5950-088-9939
L211	Choke, molded 10 μH ±10%	4300-6500	99800	2150, 10 μH ±10%	
L212	Miscellaneous	5000-2845	24655	5000-2845	
L213	Choke, molded 1200 μH ±10%	4300-5100	99800	3500, 1200 μH ±10%	
L216	Choke, molded 4.7 μH ±10%	4300-6400	99800	1840, 4.7 μH ±10%	
L217	Miscellaneous	5000-2844	24655	5000-2844	
L218	Choke, molded 560 μH ±10%	4300-4900	99800	3500, 560 μH ±10%	
L221	Choke, molded 2.2 μH ±10%	4300-7501	99800	2.2 μH ±10%	
L222	Miscellaneous	5000-2843	24655	5000-2843	
L223	Choke, molded 270 μH ±10%	4300-4375	99800	3500, 270 μH ±10%	
L226	Choke, molded 1.2 μH ±10%	4300-0900	99800	1537, 1.2 μH ±10%	
L227	Miscellaneous	5000-2840	24655	5000-2840	
L228	Choke, molded 150 μH ±10%	4300-3810	99800	3500-12	5950-770-3508
L231	Miscellaneous	5000-2848	24655	5000-2848	
L232	Choke, molded 150 μH ±10%	4300-3810	99800	3500-12, 150 μH ±10%	5950-770-3508
L233	Miscellaneous	5000-2842	24655	5000-0405	
L234	Choke, molded 0.47 μH ±10%	4300-0405	99800	1537, 0.47 μH ±10%	
L236	Miscellaneous	5000-2849	24655	5000-2849	
L237	Choke, molded 47 μH ±10%	4300-3100	99800	2150, 47 μH ±10%	
L238	Miscellaneous	5000-2841	24655	5000-2841	
L239	Choke, molded 0.22 μH ±10%	4300-0205	99800	1537, 0.22 μH ±10%	
L241	Choke, molded 4.7 μH ±10%	4300-1600	99800	1537-28, 4.7 μH ±10%	
L242		1003-2520	24655	1003-2520	
L243	Miscellaneous	5000-2407	24655	5000-2407	
L246	Choke, molded 2.2 μH ±10%	4300-1200	99800	1537-20, 2.2 μH ±10%	
L247		1003-2530	24655	1003-2530	
L248	Miscellaneous	5000-2406	24655	5000-2406	

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
RESISTORS					
R201	Composition, 120 Ω ±5% 1/2 W	6100-1125	01121	RC20GF121J	5905-252-5434
R205	Composition, 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R206	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC32GF330J	
R207	Composition, 150 Ω ±5% 1/2 W	6100-1155	01121	RC20GF151J	5905-299-1541
R211	Composition, 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R212	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC32GF330J	
R213	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	
R216	Composition, 22 Ω ±5% 1/4 W	6099-0225	75042	BTS, 22 Ω ±5%	5905-279-5459
R217	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC20GF330J	
R218	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R221	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC32GF330J	
R222	Composition, 22 Ω ±5% 1/4 W	6099-0225	75042	BTS, 22 Ω ±5%	5905-279-5459
R223	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R226	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC32GF330J	
R227	Composition, 22 Ω ±5% 1/4 W	6099-0225	75042	BTS, 22 Ω ±5%	5905-279-5459
R228	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R231	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC32GF330J	
R232	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R236	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC32GF330J	
R241	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC20GF330J	
R246	Composition, 33 Ω ±10% 1 W	6110-0339	01121	RC32GF330J	
R261	Composition, 51 Ω ±5% 1/4 W	6099-0515	75042	BTS, 51 Ω ±5%	
MISCELLANEOUS					
FL241	FILTER	1003-2250	24655	1003-2250	
FL246	FILTER	1003-2251	24655	1003-2251	
PL221	PLUG	Part of 1003-2771			
SO221	SOCKET	4230-2710	95354	91-6010-1201-00	

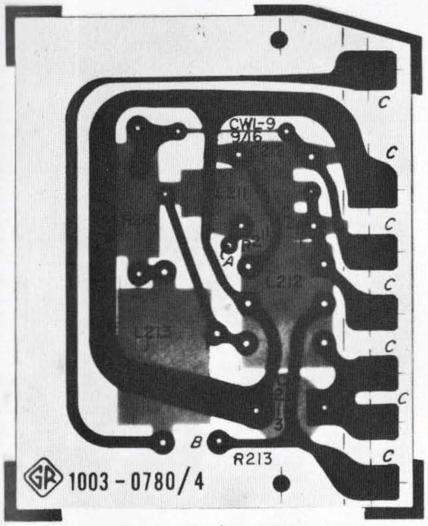


Range 1 – P/N 1003-2781

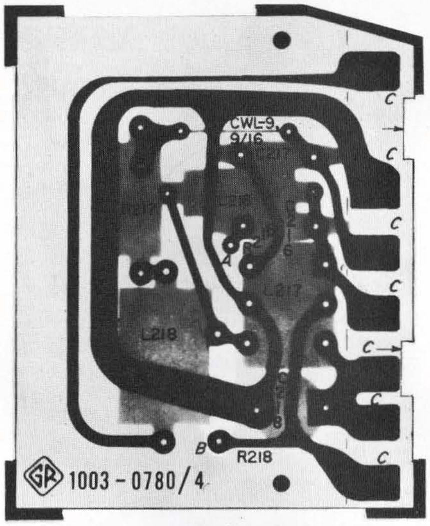


Range 2 – P/N 1003-2783

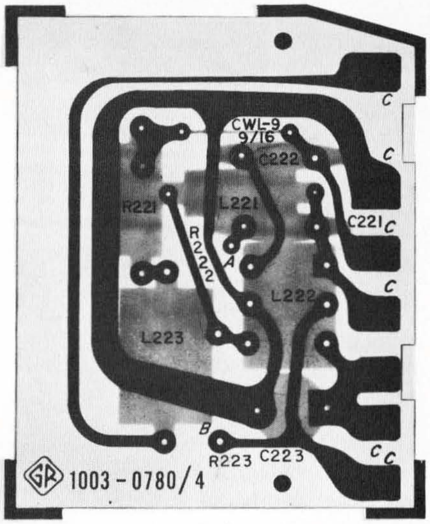
Figure 6-13. P.A. Turret etched-circuit boards (10).



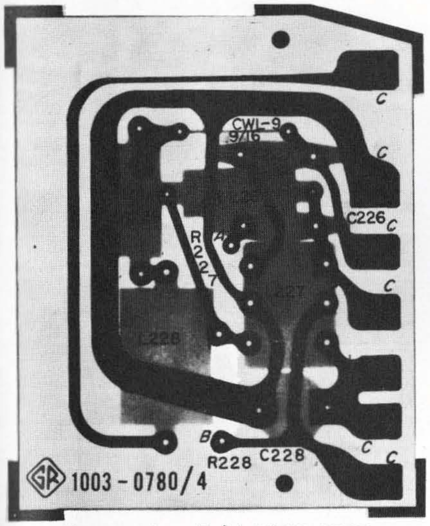
Range 3 – P/N 1003-2761



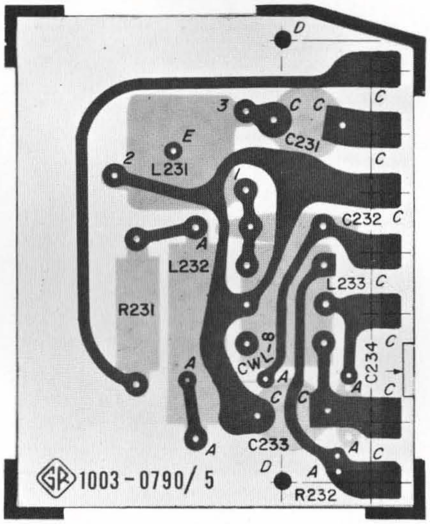
Range 4 – P/N 1003-2763



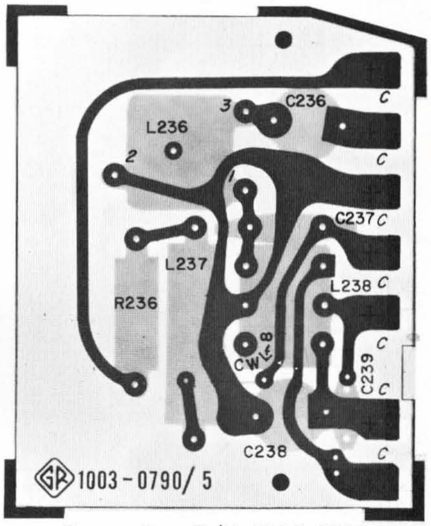
Range 5 – P/N 1003-2765



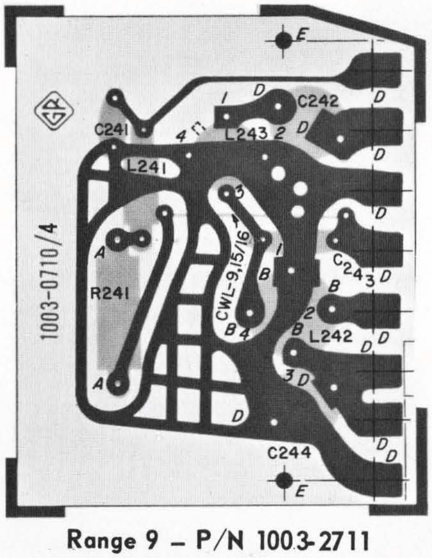
Range 6 – P/N 1003-2767



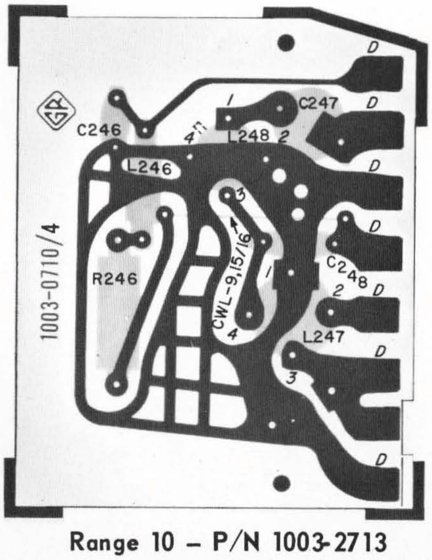
Range 7 – P/N 1003-2791



Range 8 – P/N 1003-2793



Range 9 – P/N 1003-2711



Range 10 – P/N 1003-2713

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ○ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

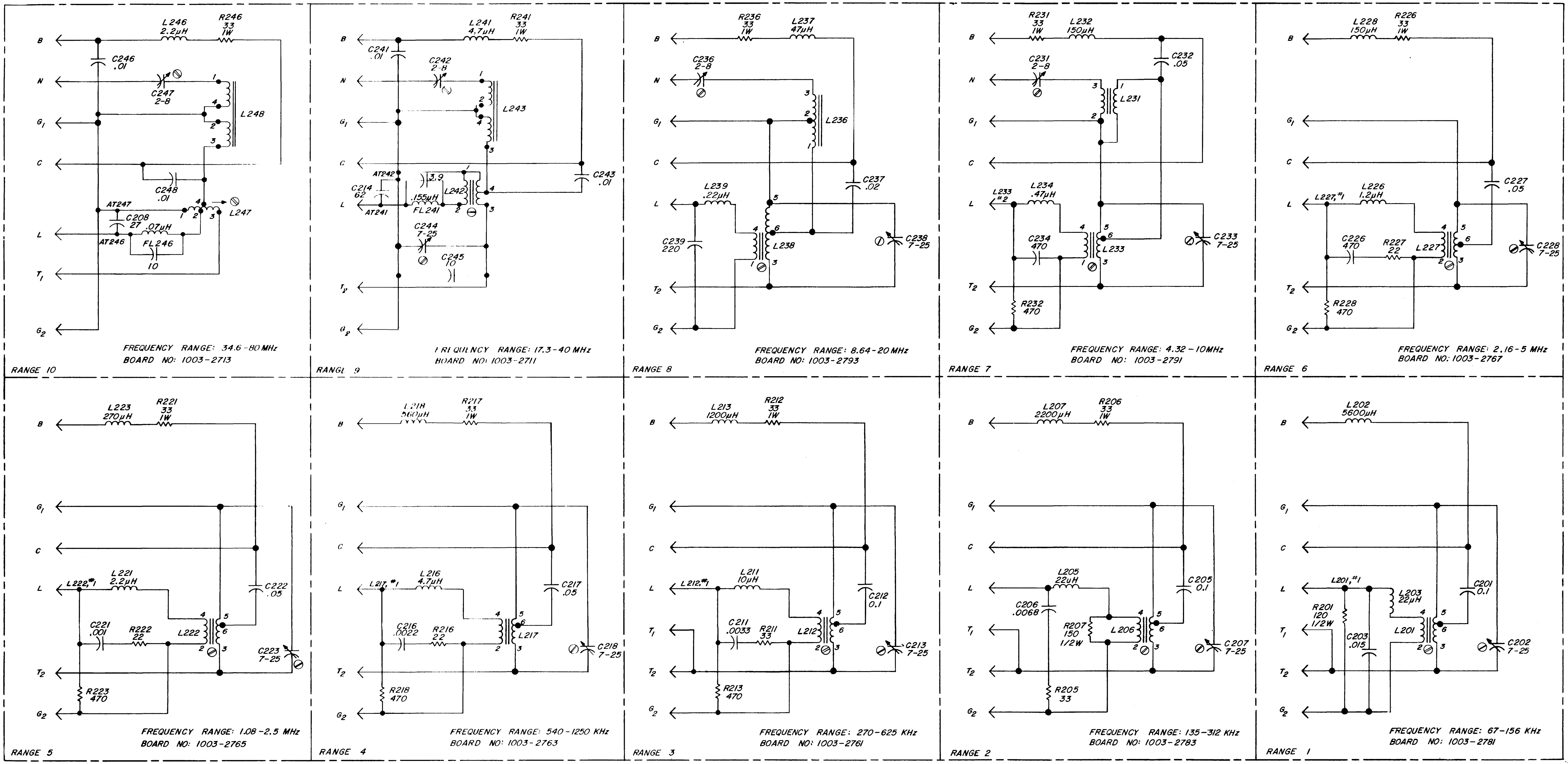


Figure 6-14. P.A. Turret Assembly schematic diagrams.

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C361	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C362	Plastic, 0.051 μF ±5% 100 V	4860-7873	84411	663UW, 0.051 μF ±5%	5910-899-0660
C363	Electrolytic, 6.8 μF ±20% 50 V	4450-5000	56289	150D685X0035B2	5910-814-5869
C364	Ceramic, 1 μF ±20%	4400-2070	80183	5C13, 1 μF ±20%	
C365	Ceramic, 0.0015 μF ±10% 100 V	4700-0691	14655	22A, 0.0015 μF ±10%	
C366	Plastic, 0.051 μF ±5% 100 V	4860-7873	84411	663UW, 0.051 μF ±5%	5910-899-0660
C367	Ceramic, 0.0047 μF ±10% 500 V	4407-2478	72982	PORM 10%, 0.0047 μF	5910-931-0529
C368	Plastic, 0.051 μF ±5% 100 V	4860-7873	84411	663UW, 0.051 μF ±5%	5910-899-0660
C369	Electrolytic, 15 μF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C370	Ceramic, 0.001 μF ±10% 500 V	4405-2108	72982	801, 0.001 μF ±10%	
C371	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C372	Electrolytic, 50 μF +100-10% 3 V	4450-5590	80183	D15953	5910-226-4120
C373	Electrolytic, 15 μF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
RESISTORS					
R361	Composition, 18 kΩ ±5% 1/2 W	6100-3185	01121	RC20GF183J	5905-279-3500
R362	Composition, 1.2 kΩ ±5% 1/2 W	6100-2125	01121	RC20GF122J	5905-190-8880
R363	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R364	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R365	Composition, 200 Ω ±5% 1/2 W	6100-1205	01121	RC20GF201J	5905-279-2674
R366	Composition, 10 kΩ ±5% 1/2 W	6100-3105	01121	RC20GF103J	5905-185-8510
R367	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R368	Composition, 18 kΩ ±5% 1/2 W	6100-3185	01121	RC20GF183J	5905-279-3500
R369	Composition, 200 Ω ±5% 1/2 W	6100-1205	01121	RC20GF201J	5905-279-2674
R370	Potentiometer, composition 250 Ω ±20%	6040-0200	24655	6040-0200	
R371	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R372	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R373	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R374	Composition, 6.8 kΩ ±5% 1/2 W	6100-2685	01121	RC20GF682J	5905-279-3503
R375	Composition, 620 Ω ±5% 1/2 W	6100-1625	01121	RC20GF621J	5905-279-1761
R376	Composition, 270 Ω ±5% 1/2 W	6100-1275	01121	RC20GF271J	5905-171-2006
R377	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R378	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395	01121	RC20GF392J	5905-279-3505
R379	Composition, 1.2 kΩ ±5% 1/2 W	6100-2125	01121	RC20GF122J	5905-190-8880
R380	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R381	Composition, 2.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
R382	Composition, 220 Ω ±5% 1/2 W	6100-1225	01121	RC20GF221J	5905-279-3513
R383	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
MISCELLANEOUS					
CR361	DIODE, Type 1N759A	6083-1014	07910	1N759A	5961-846-9157
CR362	DIODE, Type 1N753A	6083-1006	07910	1N753A	5961-752-6121
CR363	DIODE, Type 1N748A	6083-1002	07910	1N748A	5960-800-3973
CR364	DIODE, Type 1N3253	6081-1001	79089	1N3253	5960-814-4251
CR365	DIODE, Type 1N3253	6081-1001	79089	1N3253	5960-814-4251
PL361	PLUG	Part of 1003-2730			
SO361	SOCKET	4230-2710	95354	91-6010-1201-00	
Q361	TRANSISTOR, Type 2N2346	8210-1138	93916	2N3416	
Q362	TRANSISTOR, Type 2N2346	8210-1138	93916	2N3416	
Q363	TRANSISTOR, Type 2N1131	8210-1025	96214	2N1131	5960-788-8644
Q364	TRANSISTOR, Type 2N697	8210-1040	82219	2N697	5961-752-0150
Q365	TRANSISTOR, Type 2N3906	8210-1112	93916	2N3906	

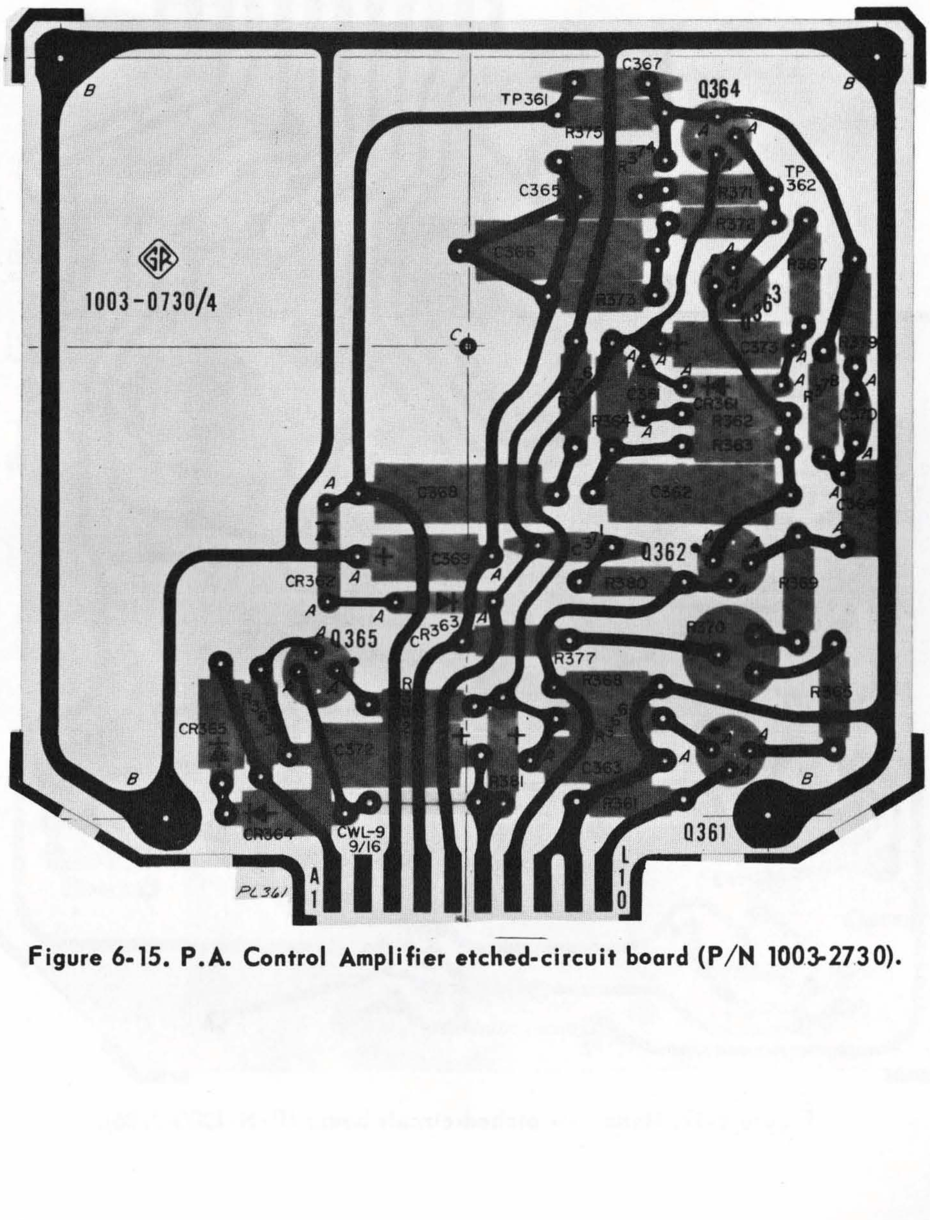


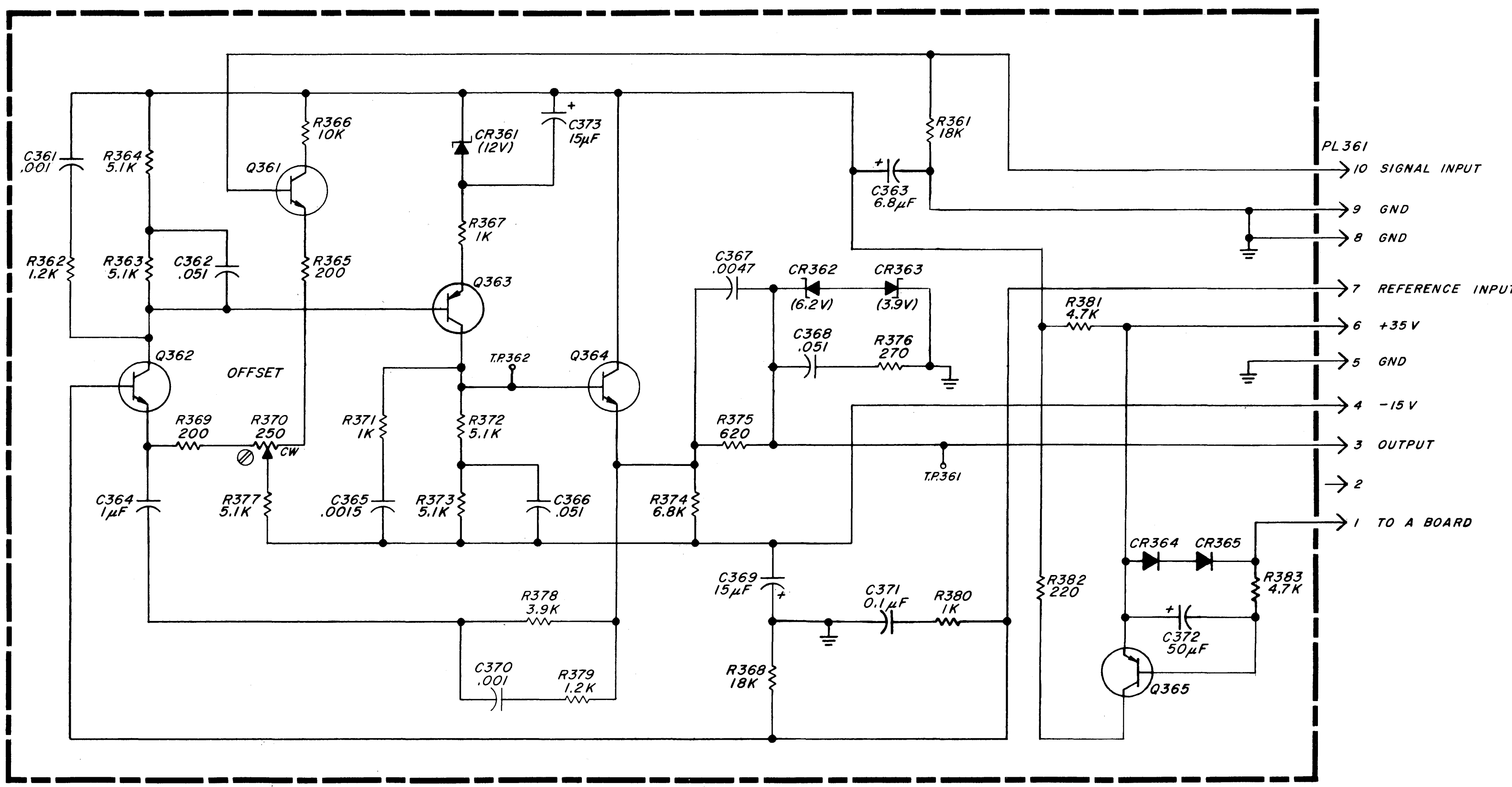
Figure 6-15. P.A. Control Amplifier etched-circuit board (P/N 1003-2730).

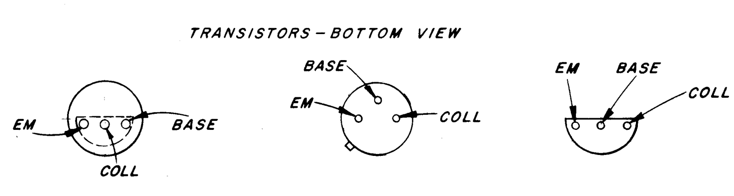
NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

Figure 6-16 Control Amp. →

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT





BOARD NO.: 1003-2730

Figure 6-16. P.A. Control Amplifier schematic diagram.

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITOR					
C151	Mica, 0.02 µF ±1% 100 V	4560-0400	14655	1AD3S2FF	5910-931-4151
C152	Mica, 0.02 µF ±1% 100 V	4560-0400	14655	1AD3S2FF	5910-931-4151
C153	Plastic,0.0301µF ±1% 100 V	4860-7842	84411	663UW, 0.030 µF	
C154	Plastic, 0.0301 µF ±1% 100 V	4860-7842	84411	663UW, 0.0301 µF	
C155	Electrolytic, 40 µF +100-10% 6 V	4450-3600	37942	20-40707S4	5910-952-0467
C156	Electrolytic, 10 µF +100-10% 25 V	4450-3800	56289	30D106G025BB4M1	5910-952-8658
C157	Electrolytic, 10 µF +100-10% 25 V	4450-3800	56289	30D106G025BB4M1	5910-952-8658
C158	Electroltyic, 5 µF +100-10% 50 V	4450-3900	37942	204059S9C10X3	5910-926-2454
C159	Electrolytic, 25 µF +100-10% 50 V	4450-3000	80183	D33883	5910-799-9285
C160	Electrolytic, 25 µF +100-10% 50 V	4450-3000	80183	D33883	5910-799-9285
C161	Electrolytic, 25 µF +100-10% 50 V	4450-3000	80183	D33883	5910-799-9285
C162	Electrolytic, 5 µF +100-10% 50 V	4450-3900	37942	2040595S9C10X3	5910-926-2454
C163	Electrolytic, 50 µF +100-10% 3 V	4450-5590	37942	TT, 50 µF 3 V	
C164	Ceramic, 33 pF ±10% 500 V	4400-4100	72982	C1-1-N750, 33 pF	
RESISTORS					
R151	Film, 16.9 kΩ ±1% 1/8 W	6250-2169	75042	CEA, 16.9 kΩ ±1%	5905-806-8487
R152	Film, 16.9 kΩ ±1% 1/8 W	6250-2169	75042	CEA, 16.9 kΩ ±1%	5905-806-8487
R153	Potentiometer, wire wound 1 kΩ ±10%	6051-2109	02660	2600-PC, 1 kΩ ±10%	
R154	Potentiometer, wire wound 5 kΩ ±10%	6051-2509	02660	2600-PC, 5 kΩ ±10%	
R155	Composition, 560 Ω ±5% 1/2 W	6100-1565	01121	RC20GF561J	5905-195-6800
R156	Film, 10 kΩ ±1% 1/8 W	6250-2100	75042	CEA, 10 kΩ ±1%	5905-883-4847
R157	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335	01121	RC20GF332J	
R158	Film, 7.5 kΩ ±1% 1/8 W	6250-1750	75042	CEA, 7.5 kΩ ±1%	5905-660-4129
R159	Composition, 30 kΩ ±25%	6740-1402	02606	GB43V1	
R160	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R161	Film, 10 kΩ ±1% 1/8 W	6250-2100	75042	CEA, 10 kΩ ±1%	5905-883-4847
R162	Composition, 2.7 kΩ ±5% 1/2 W	6100-2275	01121	RC20GF272J	5905-279-1880
R163	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R164	Composition, 200 Ω ±10%	6740-1600	02606	KB22J1	
R165	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R166	Composition, 750 Ω ±5% 1/2 W	6100-1755	01121	RC20GF751J	5905-195-9481
R167	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R168	Potentiometer, wire wound 20 kΩ ±10%	6051-3209	02660	2600-PC, 20 kΩ ±10%	
R169	Composition, 15 kΩ ±5% 1/2 W	6100-3155	01121	RC20GF153J	5905-279-2616
R170	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
R171	Composition, 750 Ω ±5% 1/2 W	6100-1755	01121	RC20GF751J	5905-195-9481
R172	Composition, 270 Ω ±5% 1/2 W	6100-1275	01121	RC20GF271J	5905-171-2006
R173	Composition, 8.2 kΩ ±5% 1/2 W	6100-2825	01121	RC20GF822J	5905-299-1971
R174	Potentiometer, composition 25 kΩ ±20%	6040-0800	24655	6040-0800	5905-958-7950
R175	Composition, 39 kΩ ±5% 1/2 W	6100-3395	01121	RC20GF393J	5905-279-3497
R176	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R177	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395	01121	RC20GF392J	5905-279-3505
R178	Composition, 620 Ω ±5% 1/2 W	6100-1625	01121	RC20GF621J	5905-279-1761
R179	Composition, 56 kΩ ±5% 1/2 W	6100-3565	01121	RC20GF563J	5905-171-1986
R180	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R181	Potentiometer, composition 2.5 kΩ ±10%	6010-0700	24655	6010-0700	5905-910-5671
R182	Potentiometer, wire wound 2 kΩ ±10%	6051-2209	07999	2600P, 2 kΩ ±10%	
R183	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155	01121	RC20GF152J	5905-841-7461
R184	Composition, 91 Ω ±5% 1/2 W	6100-0915	01121	RC20GF910J	5905-279-3516
R185	Composition, 200 Ω ±5% 1/2 W	6100-1205	01121	RC20GF201J	5905-279-2674
R186	Composition, 39 kΩ ±5% 1/2 W	6100-3395	01121	RC20GF393J	5905-279-3497
R187	Potentiometer, wire wound 500 Ω ±10%	6051-1509	02660	2600PC, 500 Ω ±10%	
R188	Composition, 390 Ω ±5% 1/2 W	6100-1395	01121	RC20GF391J	5905-279-1890
R189	Composition, 200 Ω ±10%	6740-1600	02606	KB22J1	
R190	Potentiometer, wire wound 2 kΩ ±10%	6051-2209	07999	2600P2K ±10%	
R191	Composition, 15 kΩ ±5% 1/2 W	6100-3155	01121	RC20GF153J	5905-279-2616
R192	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155	01121	RC20GF152J	5905-841-7461
MISCELLANEOUS					
CR151	DIODE, Type 1N957B	6083-1009	07910	1N957B	
CR152	DIODE, Type 1N816	6082-1001	24446	1N3604	5960-995-2199
PL151	PLUG Part of	1003-2786			
S151	SWITCH	7890-4800	76854	261440-FD3	
	Modulation Etched Circuit Board	1003-2786	24655	1003-2786	
Q151	TRANSISTOR, Type 2N3416	8210-1138	93916	2N3416	
Q152	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q153	TRANSISTOR, Type 2N697	8210-1040	82219	2N697	5960-752-0150
Q154	TRANSISTOR, Type 2N1131	8210-1025	96214	2N1131	5960-788-8644
Q155	TRANSISTOR, Type 2N3416	8210-1138	93916	2N3416	

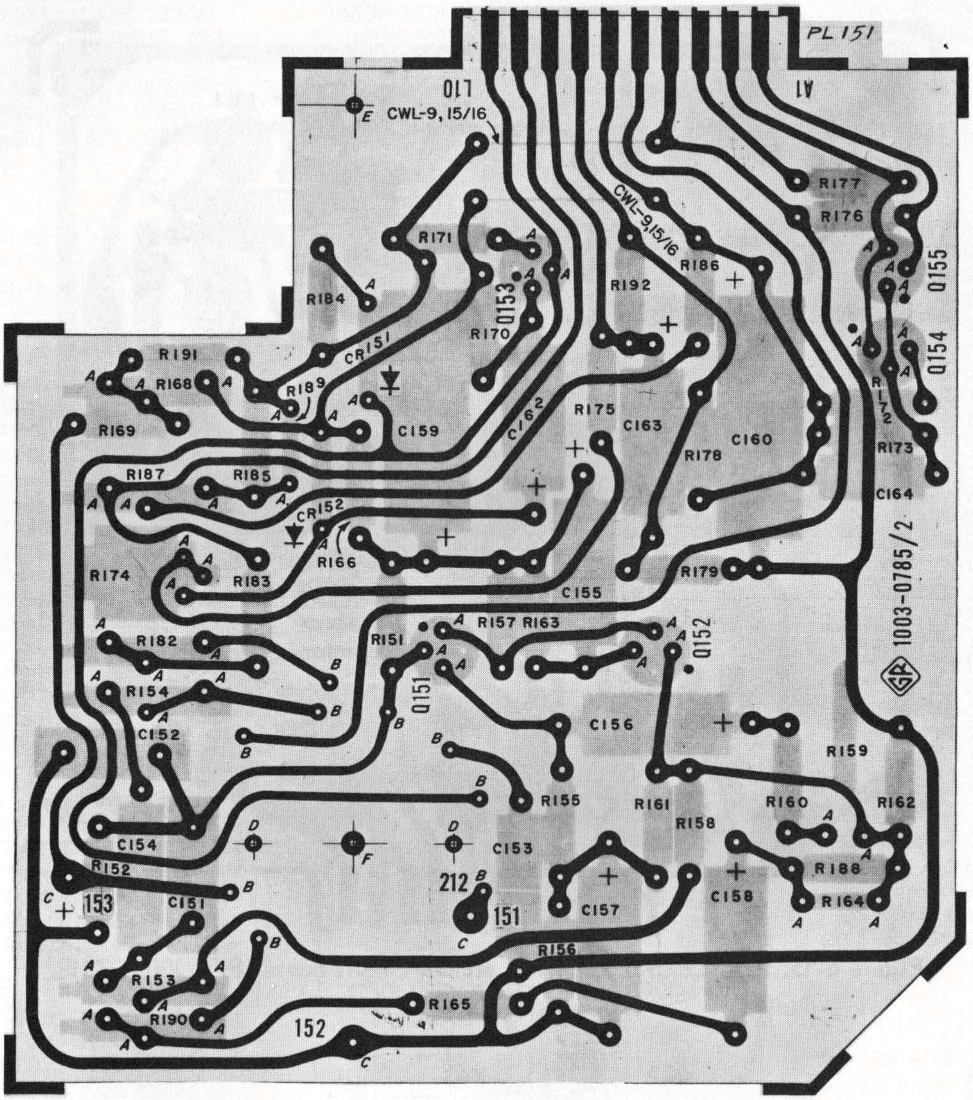
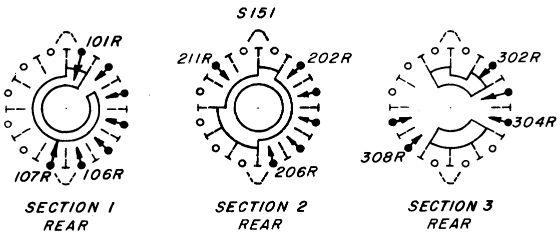


Figure 6-17. Modulator etched-circuit board (P/N 1003-2786).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.



Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

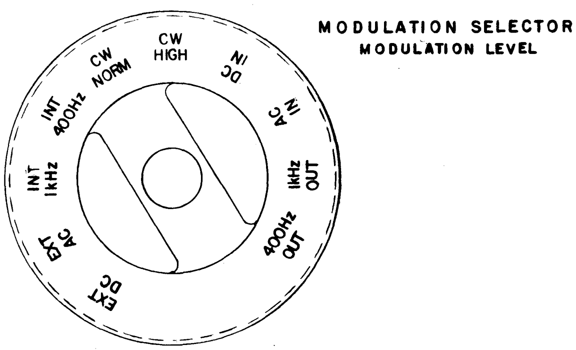
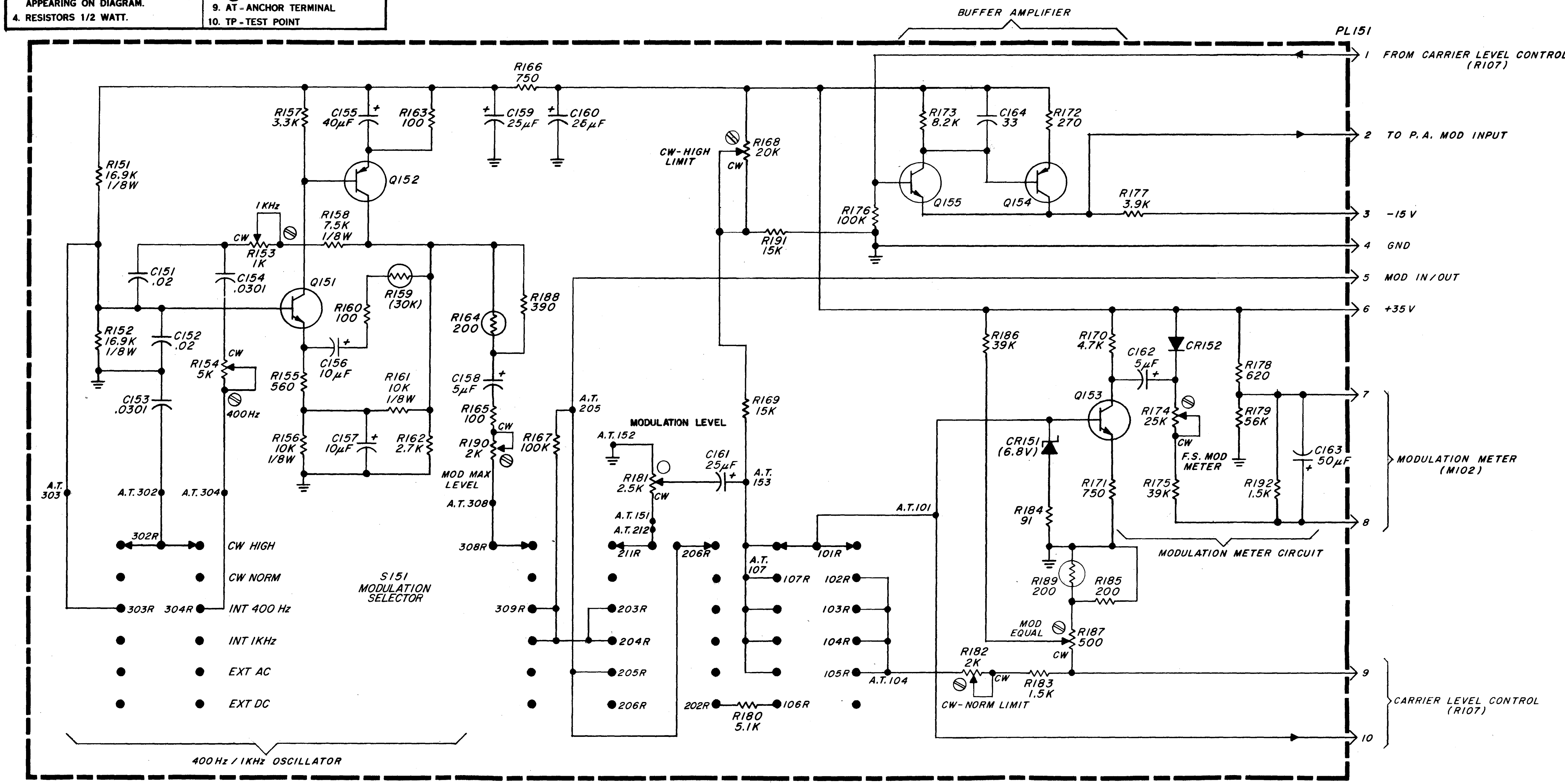


Figure 6-18 Modulator →

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K-1000 OHMS M-1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS. LESS THAN ONE IN MICROFARADS.
7. ○ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT-ANCHOR TERMINAL
10. TP-TEST POINT



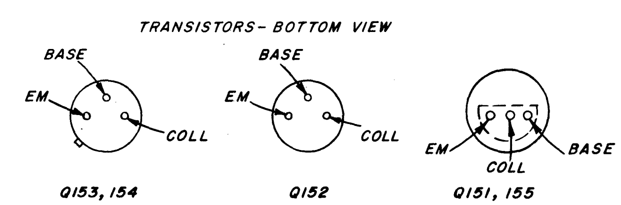


Figure 6-18. Modulator schematic diagram (P/N 1003-2786).

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C501A					
C501B	Electrolytic, 1200 μF 75 V	4450-5606	37942	FP20000022414005	
C501C					
C503	Electrolytic, 5 μF 50 V	4450-3900	37942	2040595S9C10X3	5910-448-5527
C504A					
C504B	Electrolytic 4800 μF 15 V	4450-4200	37942	20-21339-99-6	
C504C					
C505A					
C505B	Electrolytic, 4800 μF 15 V	4450-4200	37942	20-21339-99-6	
C505C					
C506A C506B	Electrolytic, 1200 μF 15 V	4450-5622	37942	COE-84, 600-600 μF, 15 V	
C507	Electrolytic, 10 μF 25 V	4450-3800	56289	30D106G025BB4M1	5910-952-8658
C508A					
C508B	Electrolytic, 3000 μF 25 V	4450-0700	90201	203828S10C10X2	5910-970-1587
C508C					
C509	Electrolytic, 10 μF 25 V	4450-3800	56289	30D106G025BB4M1	5910-952-8658
C510	Ceramic, 0.01 μF 1000 V	4406-3109	72982	811, 000X5U103X	5910-977-7579
C511	Ceramic, 0.0068 μF +80-20% 1000 V	4406-2689	72982	811, 0.0068 μF +80-20%	
C512	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
RESISTORS					
R501	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R502	Composition, 560 Ω ±5% 1/2 W	6100-1565	01121	RC20GF561J	5905-195-6800
R503	Composition, 22 kΩ ±5% 1/2 W	6100-3225	01121	RC20GF223J	5905-171-2004
R504	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R505	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625	01121	RC20GF622J	5905-279-2673
R506	Composition, 15 kΩ ±5% 1/2 W	6100-3155	01121	RC20GF153J	5905-279-2616
R507	Potentiometer, wire wound 10 kΩ ±10%	6051-3109	02660	2600-PC, 10 kΩ ±10%	
R508	Composition, 68 kΩ ±5% 1/2 W	6100-3685	01121	RC20GF683J	5905-249-3661
R510	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335	01121	RC20GF332J	
R511	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395	01121	RC20GF392J	5905-279-3505
R512	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625	01121	RC20GF622J	5905-279-2673
R513	Potentiometer, wire wound 2 kΩ ±10%	6051-2209	07999	2600P, 2 kΩ ±10%	
R514	Composition, 18 kΩ ±5% 1/2 W	6100-3185	01121	RC20GF183J	5905-279-3500
R515	Potentiometer, wire wound 10 kΩ ±10%	6051-3109	02660	2600-PC, 10 kΩ ±10%	
R516	Composition, 560 Ω ±5% 1/2 W	6100-1565	01121	RC20GF561J	5905-195-6800
R517	Composition, 5.6 kΩ ±5% 1/2 W	6100-2565	01121	RC20GF562J	5905-195-6453
R518	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R519	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R520	Composition, 5.6 kΩ ±5% 1/2 W	6100-2565	01121	RC20GF562J	5905-195-6453
R521	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
MISCELLANEOUS					
CR501 thru CR512	DIODE, Type 1N3253	6081-1001	79089	1N3253	5960-814-4251
CR513	DIODE, Type 1N971B	6083-1049	07910	1N971B	5960-865-8625
CR514	DIODE, Type 1N971B	6083-1049	07910	1N971B	5960-865-8625
CR515	DIODE, Type 1N825	6083-1060	75042	1N825	
F501	FUSE, 250 V 0.3 Amp	5330-0900	71400	MDL, 0.4 Amp.	5920-537-6654
F502	FUSE, 125 V 0.2 Amp	5330-0600	71400	MDL, 0.2 Amp	
L501	INDUCTOR, 0.33 μH ±10%	4300-0300	99800	1537, 0.33 μH ±10%	
PL501	PLUG	4240-0702	24655	4240-0702	
S501	SWITCH	7910-0831	42190	4603	
T501	TRANSFORMER, Power	0485-4034	24655	0485-4034	
Q501	TRANSISTOR, Type 2N3441	8210-1110	76684	2N3441	
Q502	TRANSISTOR, Type 2N3416	8210-1138	93916	2N3416	
Q503	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q504	TRANSISTOR, Type 2N3905	8210-1114	04713	2N3905	
Q505	TRANSISTOR, Type 40250	8210-1095	12672	40250	
Q506	TRANSISTOR, Type 2N3416	8210-1138	93916	2N3416	
Q507	TRANSISTOR, Type 40250	8210-1095	12672	40250	
Q508	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q509	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q510	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
	Power Supply Assembly	1003-2060	24655	1003-2060	
	Reg. Etched Circuit Board	1003-2750	24655	1003-2750	
	Rect. Etched Circuit Board	1003-2755	24655	1003-2755	
	Fuse Mounting Device	5650-0100	71400	HKP-H	5920-284-7144
SO501	SOCKET	4230-3700	71785	S312AB	

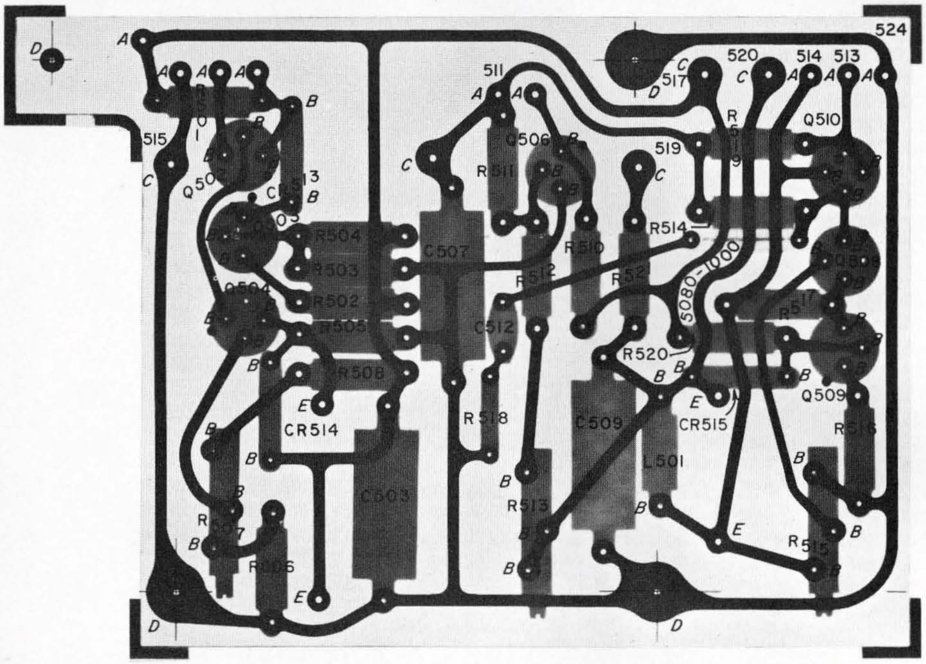


Figure 6-19. P.S. Regulator etched-circuit board (P/N 1003-2750).

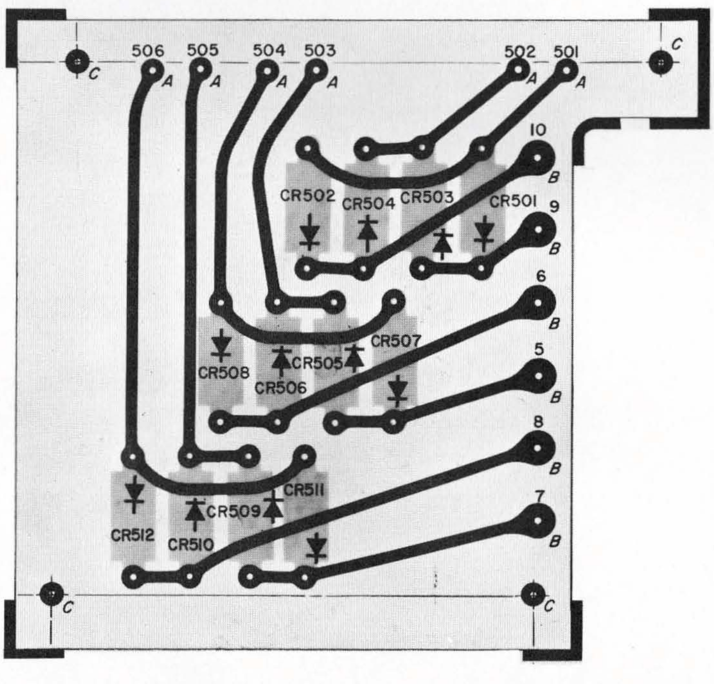


Figure 6-20. P.S. Rectifier etched-circuit board (P/N 1003-2755).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

Figure 6-21 Power Supply →

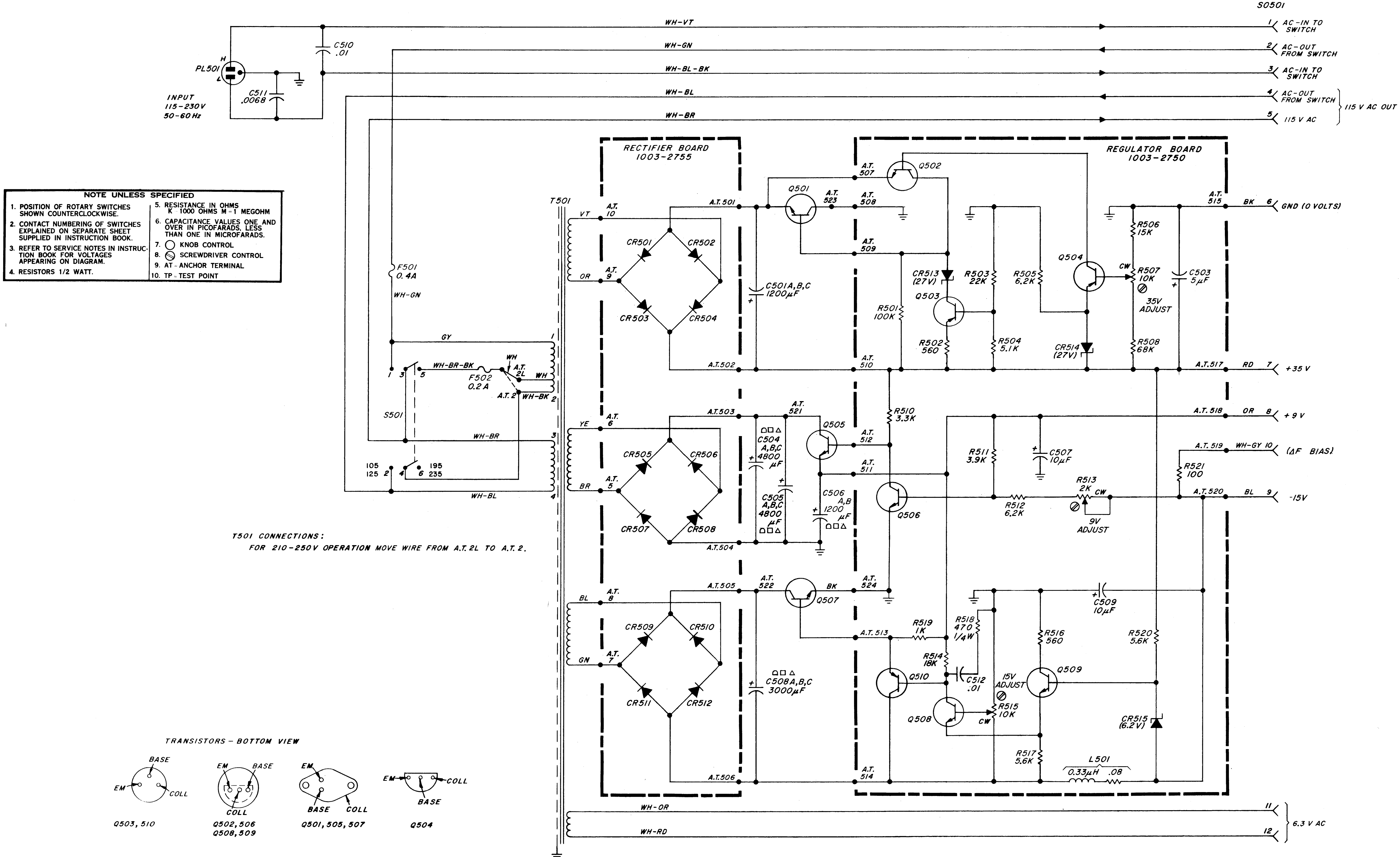


Figure 6-21. Power Supply schematic diagram (P/N 1003-2060).

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C801	Ceramic, 0.47 µF +80-20% 10 V	4435-4479	56289	41C172, 0.47 µF +80-20%	
C802	Ceramic, 0.0033 µF ±10% 500 V	4406-2338	72982	811, 0.0033 µF ±10%	5910-836-5740
C803	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C804	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C805	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C806	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C807	Electrolytic, 10 µF +100-10% 25 V	4450-3800	56289	30D106G025BB4M1	5910-952-8658
C808	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C809	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C810	Ceramic 0.1 µF +80-20% 50 V	4403-4100	80131	CC63, 0.1 µF +80-20%	5910-974-5699
C811	Ceramic, 0.1 µF +80-20% 50 V	4403-4100	80131	CC63, 0.1 µF +80-20%	5910-974-5699
C812	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
RESISTORS					
R801	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R802	Composition, 27 kΩ ±5% 1/4 W	6099-3275	75042	BTS, 27 kΩ ±5%	5905-683-3838
R803	Composition, 27 kΩ ±5% 1/4 W	6099-3275	75042	BTS, 27 kΩ ±5%	5905-683-3838
R804	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R805	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R806	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R807	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R808	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6.8 kΩ ±5%	5905-686-9997
R809	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	5905-683-2243
R810	Composition, 36 kΩ ±5% 1/4 W	6099-3365	75042	BTS, 36 kΩ ±5%	5905-683-7726
R811	Composition, 36 kΩ ±5% 1/4 W	6099-3365	75042	BTS, 36 kΩ ±5%	5905-683-7726
R812	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R813	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R814	Composition, 47 kΩ ±5% 1/4 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
R815	Composition, 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R816	Composition, 47 kΩ ±5% 1/4 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
R817	Composition, 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ ±5%	
R818	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R819	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R820	Composition, 68 kΩ ±5% 1/4 W	6099-3685	75042	BTS, 68 kΩ ±5%	5905-681-8853
R821	Composition, 68 kΩ ±5% 1/4 W	6099-3685	75042	BTS, 68 kΩ ±5%	5905-681-8853
R822	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R823	Potentiometer, composition 2.5 kΩ ±20%	6040-0500	24655	6040-0500	
R824	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 2.5 kΩ ±5%	5905-686-9995
R825	Composition, 62 kΩ ±5% 1/4 W	6099-3625	75042	BTS, 62 kΩ ±5%	
R826	Composition, 240 kΩ ±5% 1/4 W	6099-4245	75042	BTS, 240 kΩ ±5%	
R827	Composition, 75 kΩ ±5% 1/4 W	6099-3755	75042	BTS, 75 kΩ ±5%	
R828	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R829	Composition, 4.3 kΩ ±5% 1/4 W	6099-2435	75042	BTS, 4.3 kΩ ±5%	
R830	Composition, 4.3 kΩ ±5% 1/4 W	6099-2435	75042	BTS, 4.3 kΩ ±5%	
R831	Composition, 47 kΩ ±5% 1/4 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
R832	Composition, 4.3 kΩ ±5% 1/4 W	6099-2435	75042	BTS, 4.3 kΩ ±5%	
R833	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R834	Potentiometer, composition 5 kΩ ±20%	6040-0600	24655	6040-0600	5905-034-5374
R835	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R836	Composition, 150 Ω ±5% 1/2 W	6100-1155	01121	RC20GF151J	5905-299-1541
R837	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5% 1/4 W	
R838	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R839	Composition, 51 kΩ ±5% 1/2 W	6100-3515	01121	RC20GF513J	5905-279-3496
R840	Wire wound, 150 Ω ±5% 2 W	6760-1155	75042	BWH, 150 Ω ±5%	5905-838-4197
R841	Composition, 47 kΩ ±5% 1/2 W	6100-3475	01121	RC20GF473J	5905-254-9201
R842	Composition, 33 Ω ±5% 1/2 W	6100-0335	01121	RC20GF330J	5905-192-4490
R843	Composition, 33 Ω ±5% 1/2 W	6100-0335	01121	RC20GF330J	5905-192-4490
R844	Wire wound, 10 Ω ±10% 2 W	6760-0109	75042	BWH, 10 Ω ±10%	
R845	Wire wound, 10 Ω ±10% 2 W	6760-0109	75042	BWH, 10 Ω ±10%	
R851	Potentiometer, wire wound 50 kΩ ±5%	6049-0260	80294	3501S-36-503	
R852	Potentiometer, wire wound 50 kΩ ±5%	6060-4552	75042	7305	
R853	Potentiometer, wire wound 50 kΩ ±5%	6060-4552	75042	7305	
MISCELLANEOUS					
CR801	DIODE, Type 1N965B	6083-1015	07910	1N965B	5960-877-6192
CR802 thru CR806	DIODE, Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR807	DIODE, Type 1N3253	6081-1001	79089	1N3253	5960-814-4251
CR808	DIODE, Type 1N3253	6081-1001	79089	1N3253	5960-814-4251
CR809	DIODE, Type 1N752A	6083-1004	07910	1N752	

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
MISCELLANEOUS (Cont)					
CR810	DIODE, Type 1N959B	6083-1010	72699	IN959B	
CR811	DIODE, Type 1N3254	6081-1002	09213	1N3254	5960-082-7347
P851	PILOT LIGHT 1/25 W	7510-2420	03797	EG02-CCB-NE2E	
PL851	PLUG	4220-4900	71785	261-31-06-030	
FL801	FILTER	5280-3020	24655	5280-3020	
FL802	FILTER	5280-3020	24655	5280-3020	
K801A	RELAY, 3750 Ω 30 V	6090-1070	71707	KU-16245-P	
K801B	RELAY, 0.1 Ω 1 W 250 V	6090-1060	30874	765830	
K802A	RELAY, 3750 Ω 30 V	6090-1070	71707	KU-1624-P	
K802B	RELAY, 0.1 Ω 1 W 250 V	6090-1060	30874	765830	
K803	RELAY, 700 Ω 24 V	6090-1160	American Zettler, Inc.	AZ-421-70-136	
K804	RELAY, 700 Ω 24 V	6090-1160	American Zettler, Inc.	AZ-421-70-136	
SO803	SOCKET	7540-3455	American Zettler, Inc.	A ST 141-U1	
SO804	SOCKET	7540-3455	American Zettler, Inc.	A ST 141-U1	
SO851	SOCKET	4230-2699	95354	91-6018-1201-00	
S851	SWITCH	7880-2055	71590	2KCC0210021	
S852	SWITCH	7910-1655	88140	8136K 20C 1851	
S853	SWITCH	7880-2050	71590	2KCC030000022	
Q801	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q802	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q803	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q804	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q805	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q806	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q807 thru Q812	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q813	TRANSISTOR, Type 2N697	8210-1040	82219	2N697	5961-752-0150
Q814	TRANSISTOR, Type 2N697	8210-1040	82219	2N697	5961-752-0150
	Auto C. A. Circuit Assembly	1003-2736	24655	1003-2736	

NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K 1000 OHMS M - 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ◯ KNOB CONTROL
	8. ⊘ SCREWDRIVER CONTROL
	9. AT - ANCHOR TERMINAL
4. RESISTORS 2 WATT.	10. TP - TEST POINT

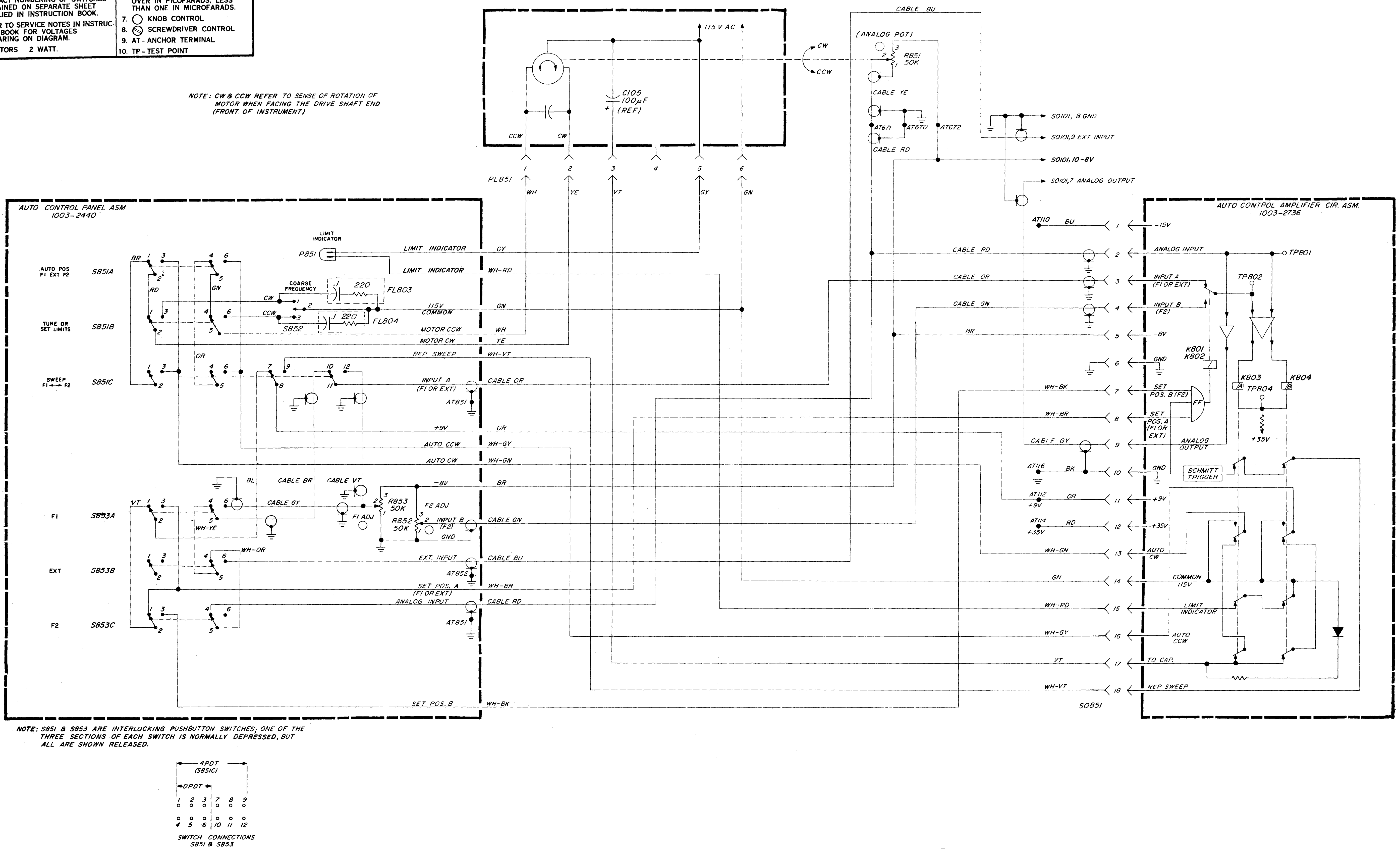


Figure 6-22. Auto-Control System schematic diagram for model 1003-9704 only.

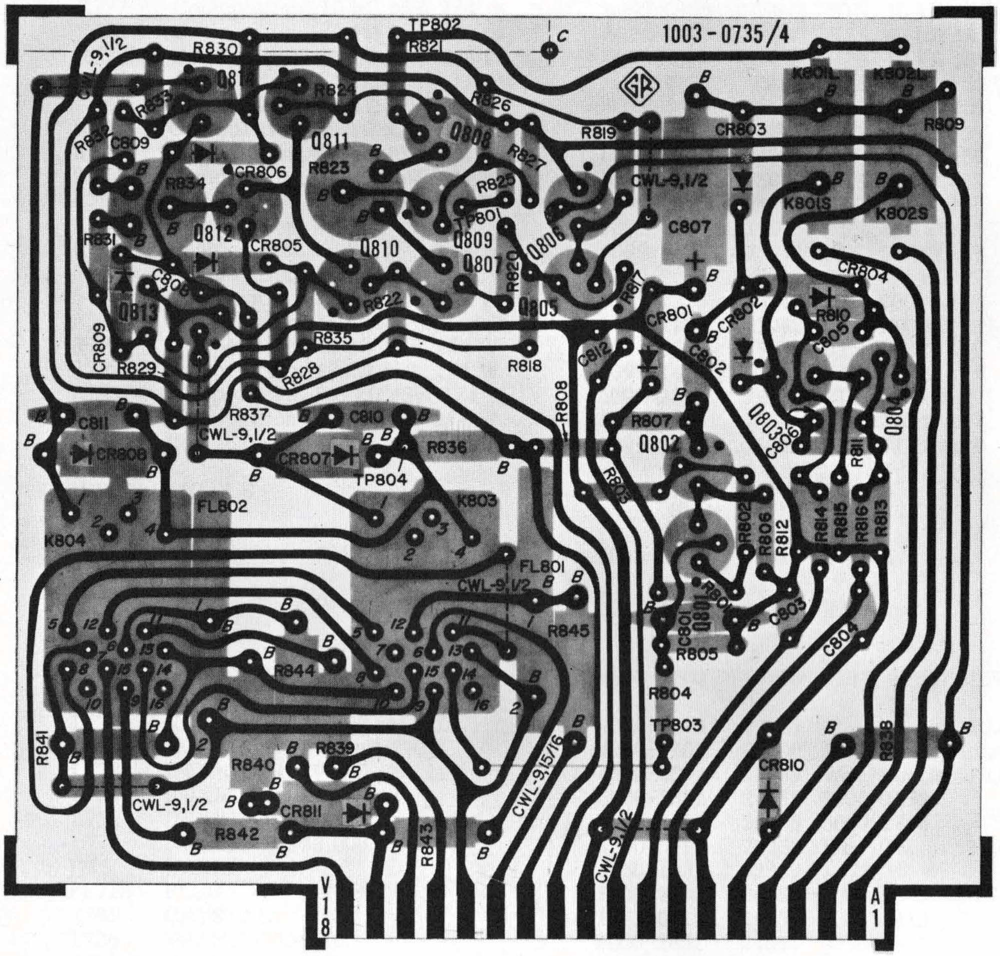
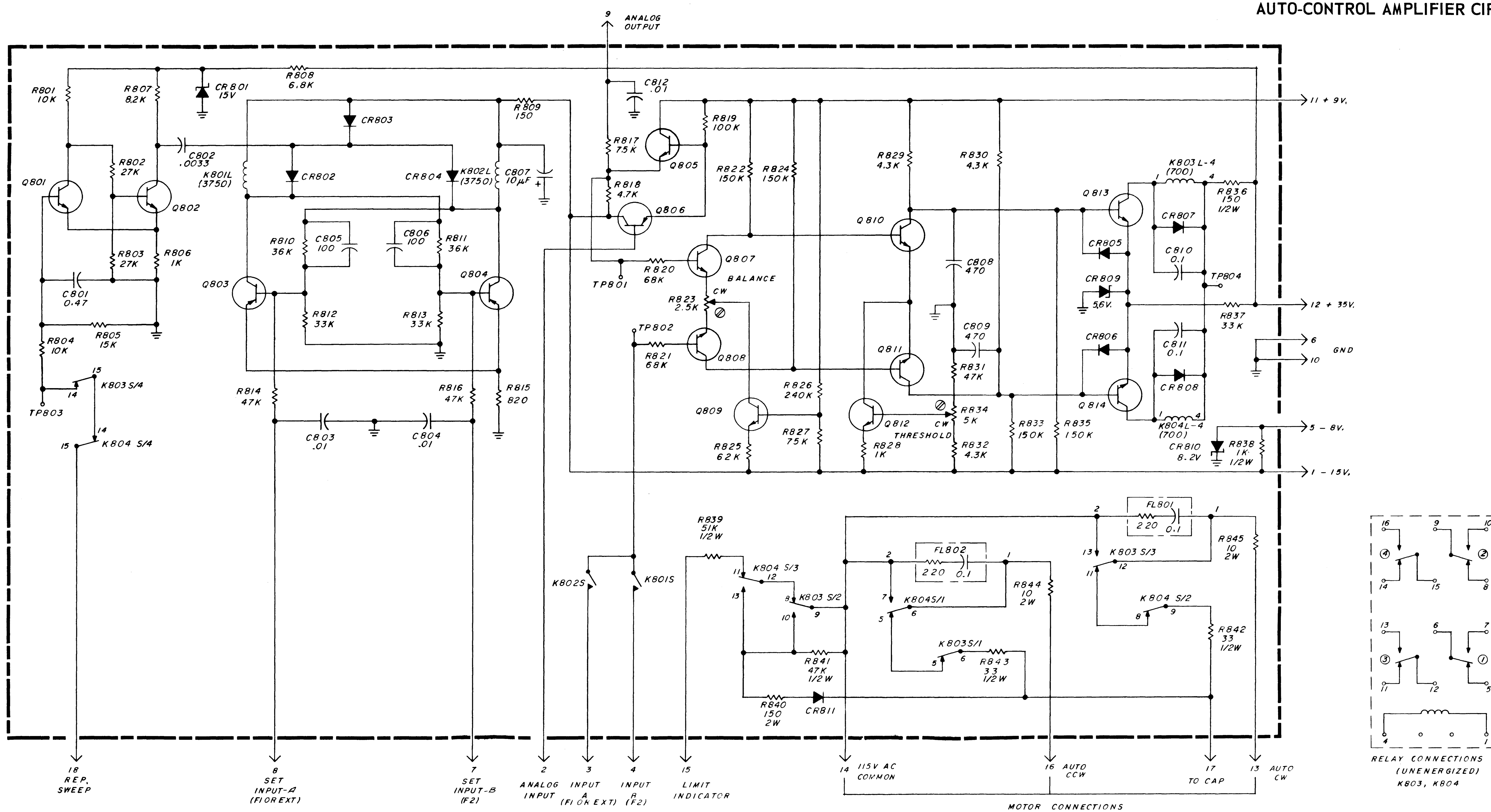


Figure 6-23. Auto-Control Amplifier etched-circuit board (P/N 1003-2736).

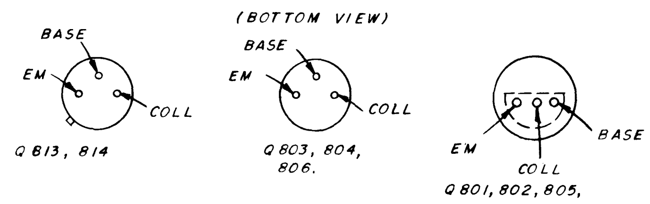
NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

Figure 6-24 A-C Amp (-9704) →



BOARD NO: 1003-2736

TRANSISTOR OUTLINES (BOTTOM VIEW)



NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ○ KNOB CONTROL 8. ⊘ SCREWDRIVER CONTROL 9. AT - ANCHOR TERMINAL
4. RESISTORS 1/4 WATT.	10. TP - TEST POINT

Figure 6-24. Auto-Control Amplifier schematic diagram, for model 1003-9704 only.

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C701	Mica, 27 pF ±5% 500 V	4700-0235	88419	CM22D, 27 pF ±5%	5910-974-5716
C702	Trimmer, 7-25 pF 350 V	4910-2043	72982	538-002 (7-25 pF)	
C703	Mica, 220 pF ±5% 500 V	4700-0519	14655	22A, 220pF ±5%	
C704	Mica, 0.0022 µF ±5% 100 V	4580-0500	14655	5A, 0.0022 µF ±5%	5910-051-6076
C705	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C706	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C707	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C708	Ceramic, 220 pF ±10% 500 V	4404-1228	72982	831, 220 pF ±10%	
C709	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C715	Ceramic, 1000 pF (GMV) +100-0% 500 V	4400-2200	01121	315N750, 1000 pF	
C716	Electrolytic, 39 µF ±20% 10 V	4450-7390	56289	180D396X0010RT	
C717	Ceramic, 100 pF (GMV) +100-0% 500 V	4400-2200	01121	315N750, 1000 pF	
C718	Electrolytic, 39 µF ±20% 10 V	4450-7390	56289	180D396X0010RT	
C719	Ceramic, 1000 pF (GMV) +100-0% 500 V	4400-2200	01121	315N750, 1000 pF	
C720	Electrolytic, 39 µF ±20% 10 V	4450-7390	56289	180D396X0010RT	
C721	Electrolytic, 39 µF ±20% 10 V	4450-7390	56289	180D396X0010RT	
C722	Ceramic, 1000 pF (GMV) +100-0% 500 V	4400-2200	01121	315N750, 1000 pF	
C723	Ceramic, 1000 pF (GMV) +100-0% 500 V	4400-1800	01121	FB2B, 0.001 µF	5910-792-3172
C724	Ceramic, 0.0047 µF ±20% 500 V	4405-2470	72982	801, 0.0047 µF ±20%	
C726	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C727	Ceramic, 0.001 µF ±10% 500 V	4405-2108	72982	801, 0.001 µF ±10%	
C728	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C729	Mica, 180 pF ±10% 500 V	4700-0500	14655	22A5T15, 180 pF ±10%	
C730	Mica, 0.00365 µF ±2% 300 V	4590-3650	14655	5A, 0.00365 µF ±2% 300 V	
C751	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C752	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C753	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C754	Mica, 680 pF ±5% 300 V	4700-0810	14655	22A, 680 pF ±5%	
C755	Mica, 0.0147 µF ±2% 300 V	4550-2147	14655	1A3S147GE	
C775	Ceramic, 15 pF (N30) ±5% 500 V	4411-0155	80131	CC61, 15 pF (N30)	
C776	Ceramic, 0.0047 µF ±20% 500 V	4405-2470	72982	801, 0.0047 µF ±20%	
C777	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C778	Ceramic, 0.1 µF +80-20% 10 V	4431-4109	80131	CC61, 0.1 µF +80-20%	
C779	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C781	Ceramic, 0.1 µF +80-20% 10 V	4431-4109	80131	CC61, 0.1 µF +80-20%	
C782	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C783	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C784	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C785	Ceramic, 0.01 µF +80-20% 50 V	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
C786	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C787	Ceramic, 0.0047 µF ±20% 500 V	4405-2470	72982	801, 0.0047 µF ±20%	
RESISTORS					
R701	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R702	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R703	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R704	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%	5905-723-5251
R705	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275	75042	BTS, 2.7 kΩ ±5%	
R706	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-577-0627
R707	Composition, 24 kΩ ±5% 1/4 W	6099-3245	75042	BTS, 24 kΩ ±5%	
R708	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275	75042	BTS, 2.7 kΩ ±5%	
R709	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	5905-683-2243
R710	Composition, 300 kΩ ±5% 1/4 W	6099-4305	75042	BTS, 300 kΩ ±5%	5905-681-8854
R711	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R715	Composition, 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	5905-279-5481
R716	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R717	Composition, 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	5905-279-5481
R718	Composition, 10 Ω ±5% 1/4 W	6099-0105	75042	RC09GF100J	5905-809-8596
R719	Potentiometer, composition 2 kΩ ±10%	6041-2208	01121	JT, 2 kΩ ±10%	
R720	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R726	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R727	Composition, 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R728	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R729	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R730	Composition, 180 Ω ±5% 1/4 W	6099-1185	75042	BTS, 180 Ω ±5%	5905-279-5476
R731	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R732	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R733	Composition, 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω ±5%	
R734	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R735	Composition, 560 Ω ±5% 1/4 W	6099-1565	75042	BTS, 560 Ω ±5%	
R751	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238

ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
RESISTORS (Cont)					
R752	Composition, 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R753	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R754	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R755	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R756	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R757	Composition, 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω ±5%	
R758	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R776	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R777	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R778	Composition, 47 kΩ ±5% 1/4 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
R779	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R780	Composition, 300 kΩ ±5% 1/4 W	6099-4305	75042	BTS, 300 kΩ ±5%	5905-681-8854
R781	Composition, 68 kΩ ±5% 1/4 W	6099-3685	75042	BTS, 68 kΩ ±5%	5905-681-8853
R782	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R783	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R784	Composition, 12 kΩ ±5% 1/4 W	6099-3125	75042	BTS, 12 kΩ ±5%	
R785	Composition, 510 Ω ±5% 1/4 W	6099-1515	75042	BTS, 510 Ω ±5%	5905-801-8272
R786	Composition, 430 kΩ ±5% 1/4 W	6099-4435	75042	BTS, 430 kΩ ±5%	
R787	Composition, 56 kΩ ±5% 1/4 W	6099-3565	75042	BTS, 56 kΩ ±5%	5905-800-0179
R788	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6.8 kΩ ±5%	5905-686-9997
R789	Composition, 200 Ω ±5% 1/4 W	6099-1225	75042	BTS, 200 Ω ±5%	5905-892-0107
R790	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R791	Composition, 18 kΩ ±5% 1/4 W	6099-3185	75042	BTS, 18 kΩ ±5%	5905-687-0000
R792	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R793	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R794	Composition, 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω ±5%	
R795	Composition, 47 kΩ ±5% 1/4 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
MISCELLANEOUS					
CR701 thru CR704	DIODE, Type IN3604	6082-1001	24446	IN3604	5960-995-2199
CR776	DIODE, Type IN994	6082-1017	24446	IN994	
L716 thru L719	INDUCTOR, 22 μH ±10%	4300-2600	99800	1537, 22 μH ±10%	5950-668-5867
L720	INDUCTOR, 10,000 μH ±10%	4300-6394	72259	Wee-Ductor, 10,000 μH ±10%	
L721	INDUCTOR, 0.47 μH ±20%	4300-0400	99800	1537, 0.47 μH ±20%	
L722	INDUCTOR, 10,000 μH ±10%	4300-6394	72259	Wee-Ductor, 10,000 μH ±10%	
L726	INDUCTOR	5000-2852	24655	5000-2852	
L751	INDUCTOR	5000-2853	24655	5000-2853	
L776	INDUCTOR, 33,000 μH ±10%	4300-6398	72259	Wee-Ductor, 33,000 μH	
J715	JACK	4260-1032	82389	L111	
PL715	PLUG	1003-2841	24655	1003-2841	
X701	CRYSTAL	1003-0410	24655	1003-0410	
T726	TRANSFORMER	5000-2851	24655	5000-2851	
Q701	TRANSISTOR, Type 2N4124	8210-1154	93916	2N4124	
Q702	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q703	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q726	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q727	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q751	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q752	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q776 thru Q779	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
	Oscillator and Buffer Circuit Assembly	1003-2703	24655	1003-2703	
	200 kHz Division Circuit Assembly	1003-2707	24655	1003-2707	
	50 kHz Division Circuit Assembly	1003-2717	24655	1003-2717	
	Mixer and Audio Assembly	1003-2722	24655	1003-2722	
	Auto Control Amplifier Board	1003-0735	24655	1003-0735	
	Crystal Calibrator Assembly	1003-2070	24655	1003-2070	

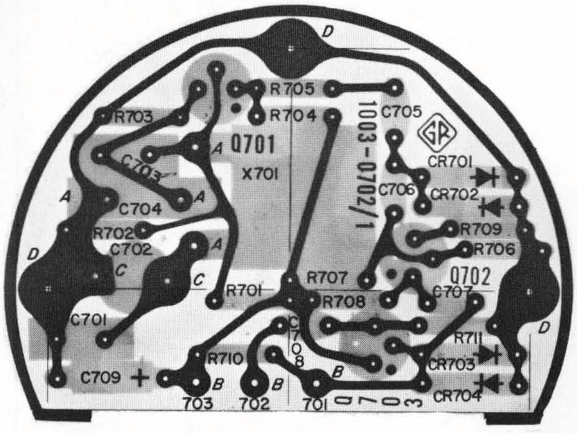


Figure 6-25. Calibrator Oscillator and Buffer Amplifier etched-circuit board (P/N 1003-2703).

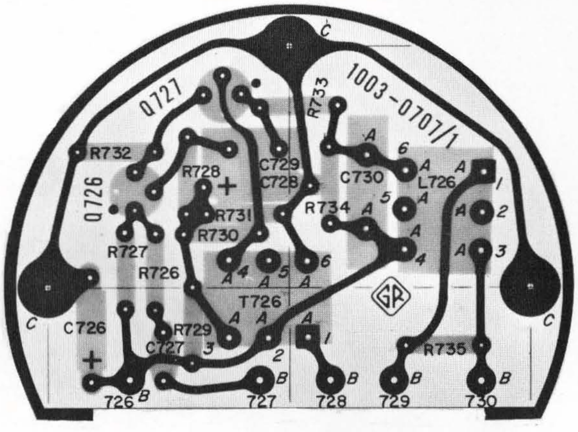


Figure 6-26. Calibrator 200 kHz Divider etched-circuit board (P/N 1003-2707).

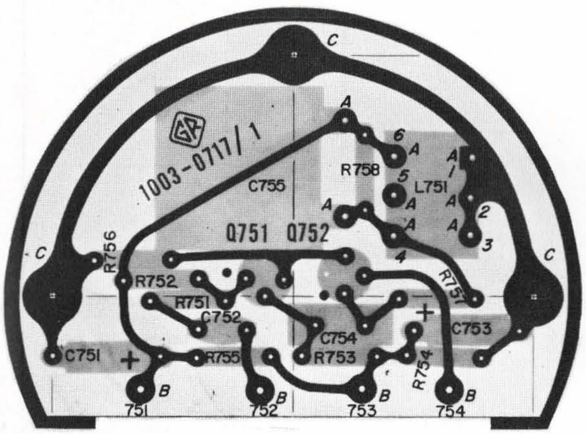


Figure 6-27. Calibrator 50 kHz Divider etched-circuit board (P/N 1003-2717).

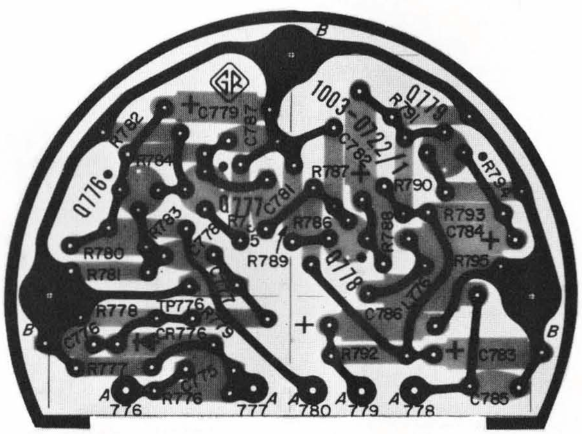


Figure 6-28. Calibrator Mixer and Audio Amplifier etched-circuit board (P/N 1003-2722).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

Figure 6-29 Crystal Cal →

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

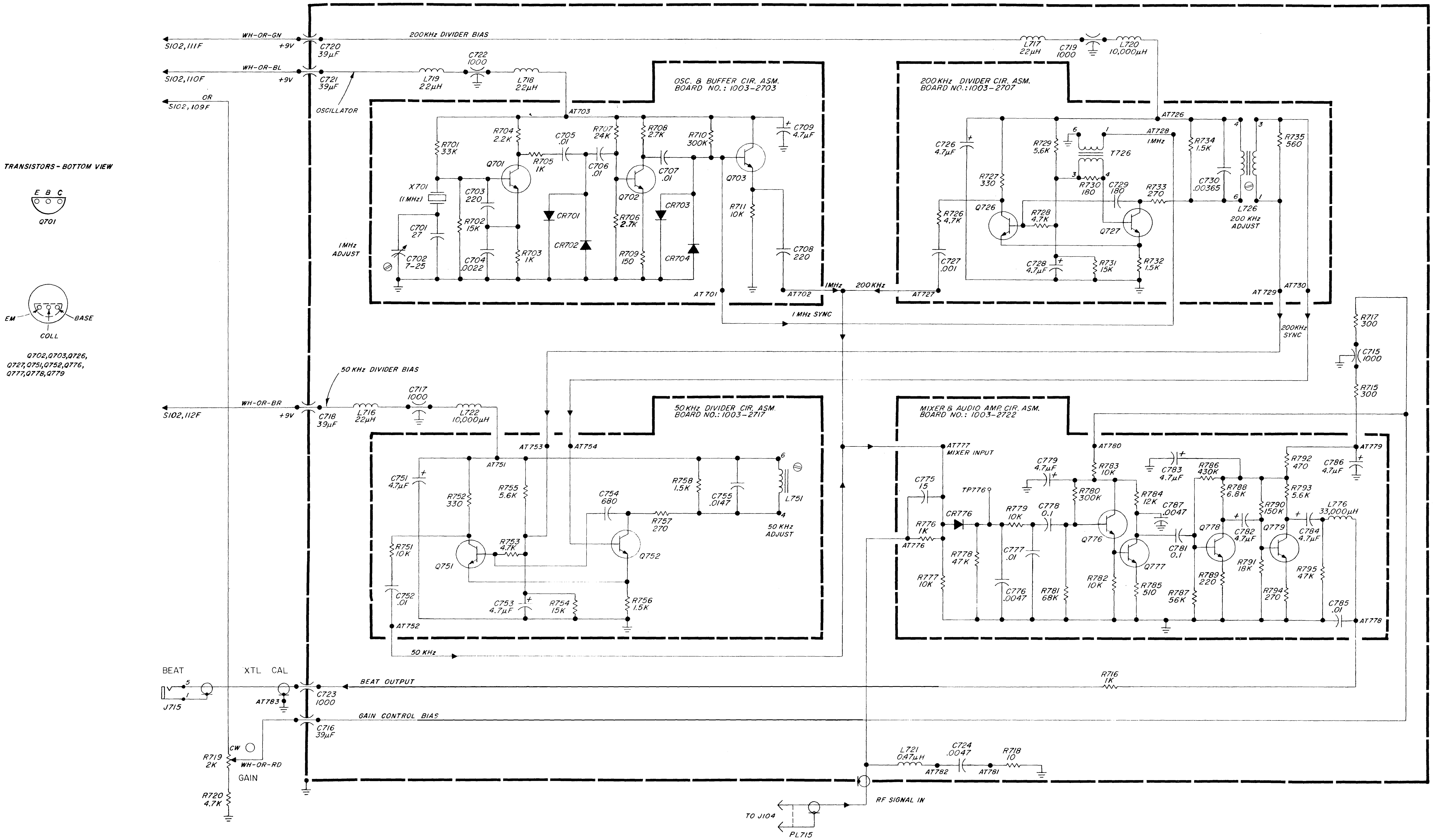


Figure 6-29. Crystal Calibrator Assembly schematic diagram (P/N 1003-3013) for models 1003-9703, -9704, and -9705.

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
RESISTORS					
R6	Pot. Comp. 10 kΩ ±10%	6041-3105	01121	GA, 10 kΩ ±10%	
R7	Pot. Wire Wound 50 kΩ ±5%	6060-0100	75042	7305	
R8	Pot. Wire Wound 50 kΩ ±5%	6060-0100	75042	7305	
R9	Relay 1.6 kΩ ±5% 1/4 W	6090-2165	24655	6090-2165	
R10	Composition 33 kΩ ±5% 1/2 W	6100-3335	01121	RC20GF333J	5905-171-1998
R11	Pot. Comp. 10 kΩ ±20%	6049-0550	80294	3438S-1-103	
R12	Pot. Comp. 50 kΩ ±10%	6000-0800	01121	JU, 50 kΩ ±10%	5905-910-5669
R15	Film 9.66 kΩ ±0.5% 1/8 W	6251-1966	75042	CEA-TO, 9.66 kΩ ±.5%	
R851	Potentiometer, wire wound 50 kΩ ±5%	6049-0260	80294	3501 S-36-503	
MISCELLANEOUS					
S1	SWITCH, push button, lighted	7870-1521	24655	7870-1521	
S2	SWITCH, push button, lighted	7870-1521	24655	7870-1521	
S3	SWITCH, push button, set of 3	7880-2055	24655	7880-2055	
S4	SWITCH, push button, set of 3	7880-2050	24655	7880-2050	
S5	SWITCH, rotary	1003-8890	24655	1003-8890	
S01	SOCKET, Multiple connection	4230-3700	71785	S-312-AB	
S04	SOCKET, Multiple connection	4230-2699	95354	91-6018-1500-00	
P1	PILOT LIGHT 28 V	5600-0307	71744	#327	
P2	PILOT LIGHT 28 V	5600-0307	71744	#327	
P3	PILOT LIGHT 10 V	5600-0301	24454	367X	
PL1	PLUG, Multiple connection	4220-5100	71785	P312CCT	5935-237-6662

NOTE UNLESS SPECIFIED

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3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ○ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

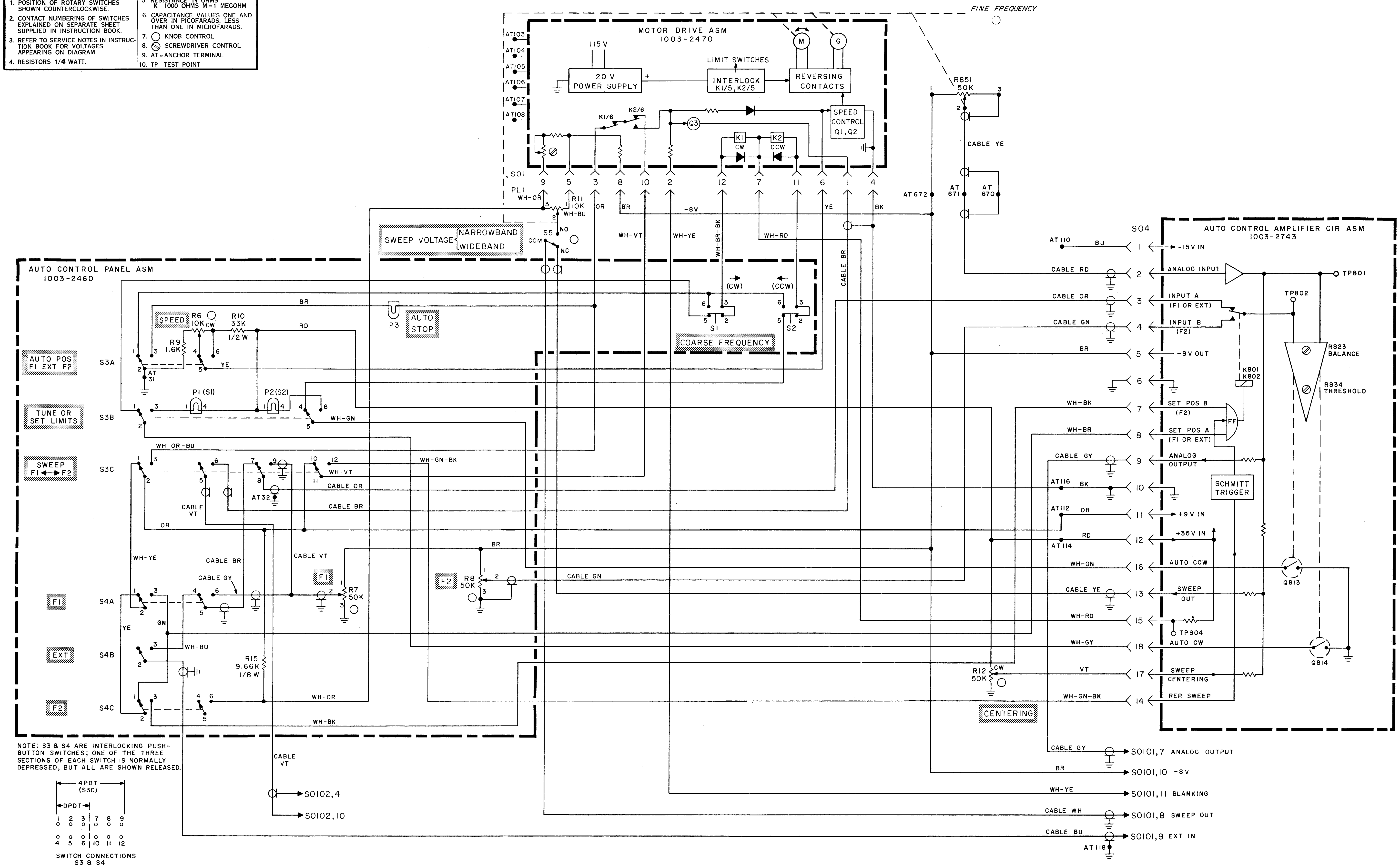

Figure 6-30. Auto-Control System schematic diagram for models 1003-9702 and -9705 only.

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITOR					
C1	Electrolytic, 600 μF +100-10% 35 V	4450-2400	37942	2021149S4C10X1	5910-822-2691
C4	Electrolytic, 6.8 μF ±20% 10 V	4450-7680	56289	180D685X0035RT	
C5	Electrolytic, 6.8 μF ±20% 10 V	4450-7680	56289	180D685X0035RT	
C6	Electrolytic, 6.8 μF ±20% 10 V	4450-7680	56289	180D685X0035RT	
C7	Electrolytic, 6.8 μF ±20% 10 V	4450-7680	56289	180D685X0035RT	
DIODES					
CR1	IN3253	6081-1001	79089	IN3253	5961-814-4251
CR2	IN3253	6081-1001	79089	IN3253	5961-814-4251
CR3	IN3253	6081-1001	79089	IN3253	5961-814-4251
CR4	IN3253	6081-1001	79089	IN3253	5961-814-4251
CR5	IN4009	6082-1012	24446	IN3253	5961-814-4251
CR6	IN3253	6081-1001	79089	IN3253	5961-814-4251
CR7	IN3253	6081-1001	79089	IN3253	5961-814-4251
K1	RELAY 430 Ω 24 V	6090-1163	24655	6090-1163	
K2	RELAY 430 Ω 24 V	6090-1163	24655	6090-1163	
M01	MOTOR-GENERATOR ASM.	5760-3071	13094	E150-MGH	
Q1	TRANSISTOR, Type 2N3414	8210-1047	24446	2N3416	5961-989-2749
Q2	TRANSISTOR, Type 2N3441	8210-1110	86684	2N3441	
Q3	TRANSISTOR, Type 2N3414	8210-1047	24446	2N3416	5961-989-2749
RESISTORS					
R1	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R2	Film, 8.66 kΩ ±0.5% 1/8 W	6251-1866	75042	CEA-TO, 8.66 kΩ ±.5%	
R3	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R4	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R5	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R13	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R14	POTENTIOMETER, Composition 100 kΩ ±10%	6041-4109	01121	GA, 100 kΩ ±10%	
S02	SOCKET, for relay K1	7540-3456	24655	7540-3456	
S03	SOCKET, for relay K2	7540-3456	24655	7540-3456	
T1	TRANSFORMER	0345-2031	24655	0345-2031	

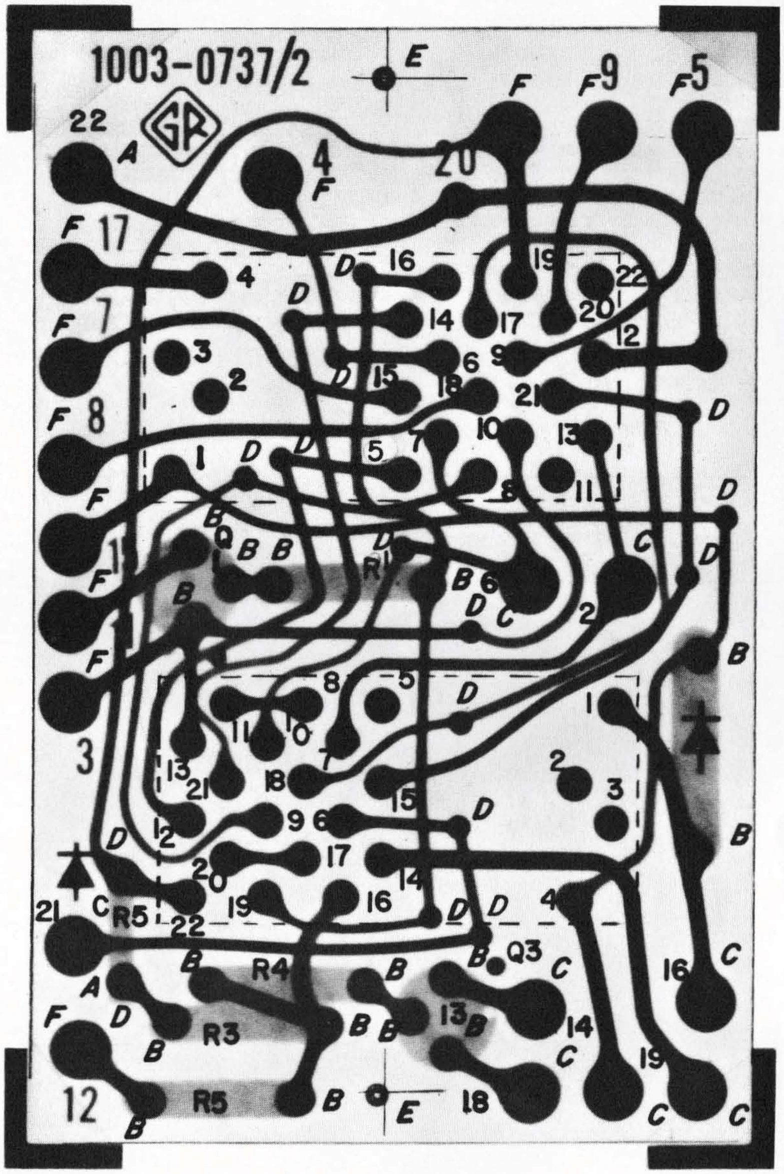

Figure 6-31. Motor Drive etched-circuit board (P/N 1003-2737). Upper socket is SO2, for relay K1; lower socket is SO3, for K2.

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

NOTE UNLESS SPECIFIED

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2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

TRANSISTOR BASE DIAGRAMS

Q1,3 Q2

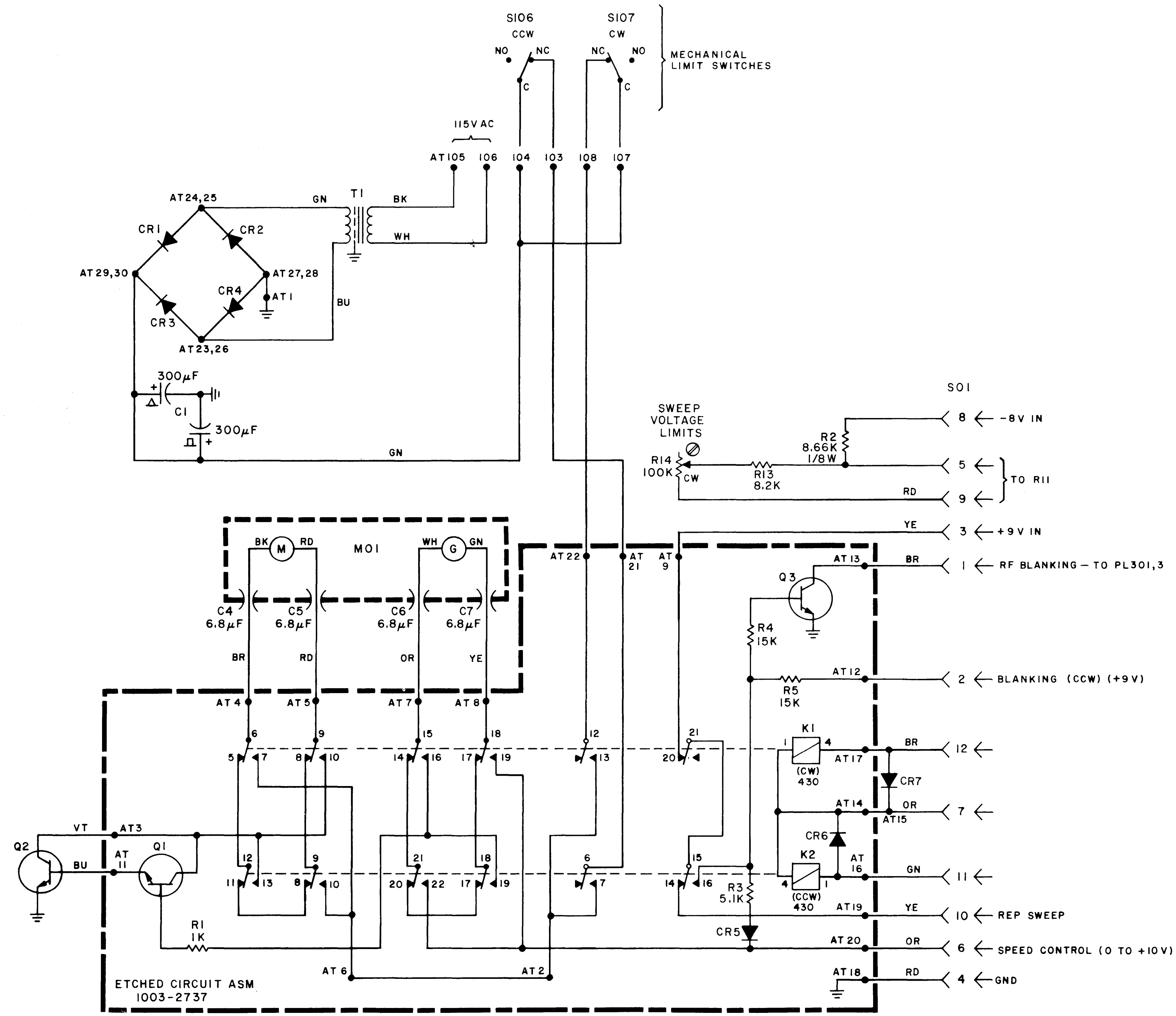


Figure 6-32. Motor-Drive Assembly schematic diagram (P/N 1003-2470) for models 1003-9702 and -9705 only.

ELECTRICAL PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C801	Ceramic, 0.47 μF +80-20% 10 V	4435-4479	56289	41C172, 0.47 μF +80-20%	
C802	Ceramic, 0.0033 μF ±10% 500 V	4406-2338	72982	811, 0.0033 μF ±10%	5910-836-5740
C803	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C804	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C805	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C806	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C807	Electrolytic, 10 μF +100-10% 25 V	4450-3800	56289	30D106G025BB4M1	5910-952-8658
C808	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C809	Ceramic, 470 pF ±10% 500 V	4404-1478	72982	831, 470 pF ±10%	
C810	Ceramic 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C811	Ceramic, 0.1 μF +80-20% 50 V	4403-4100	80131	CC63, 0.1 μF +80-20%	5910-974-5699
C812	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
C813	Ceramic, 0.01 μF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μF +80-20%	5910-974-5697
RESISTORS					
R801	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R802	Composition, 27 kΩ ±5% 1/4 W	6099-3275	75042	BTS, 27 kΩ ±5%	5905-683-3838
R803	Composition, 27 kΩ ±5% 1/4 W	6099-3275	75042	BTS, 27 kΩ ±5%	5905-683-3838
R804	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R805	Composition, 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R806	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R807	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R808	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6.8 kΩ ±5%	5905-686-9997
R809	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	5905-683-2243
R810	Composition, 36 kΩ ±5% 1/4 W	6099-3365	75042	BTS, 36 kΩ ±5%	5905-683-7726
R811	Composition, 36 kΩ ±5% 1/4 W	6099-3365	75042	BTS, 36 kΩ ±5%	5905-683-7726
R812	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R813	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R814	Composition, 47 kΩ ±5% 1/4 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
R815	Composition, 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R816	Composition, 47 kΩ ±5% 1/4 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
R817	Composition, 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ ±5%	
R818	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R819	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R820	Composition, 68 kΩ ±5% 1/4 W	6099-3685	75042	BTS, 68 kΩ ±5%	5905-681-8853
R821	Composition, 68 kΩ ±5% 1/4 W	6099-3685	75042	BTS, 68 kΩ ±5%	5905-681-8853
R822	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R823	Potentiometer, composition 2.5 kΩ ±20%	6040-0500	24655	6040-0500	
R824	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 2.5 kΩ ±5%	5905-686-9995
R825	Composition, 62 kΩ ±5% 1/4 W	6099-3625	75042	BTS, 62 kΩ ±5%	
R826	Composition, 240 kΩ ±5% 1/4 W	6099-4245	75042	BTS, 240 kΩ ±5%	
R827	Composition, 75 kΩ ±5% 1/4 W	6099-3755	75042	BTS, 75 kΩ ±5%	
R828	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R829	Composition, 3 kΩ ±5% 1/4 W	6099-2305	75042	BTS, 3 kΩ ±5%	5905-682-4097
R830	Composition, 3 kΩ ±5% 1/4 W	6099-2305	75042	BTS, 3 kΩ ±5%	5905-682-4097
R831	Composition, 27 kΩ ±5% 1/4 W	6099-3275	75042	BTS, 27 kΩ ±5%	
R832	Composition, 4.3 kΩ ±5% 1/4 W	6099-2435	75042	BTS, 4.3 kΩ ±5%	
R833	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R834	Potentiometer, composition 5 kΩ ±20%	6040-0600	24655	6040-0600	5905-034-5374
R835	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R836	Composition, 150 Ω ±5% 1/2 W	6100-1155	01121	RC20GF151J	5905-299-1541
R837	Composition, 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5% 1/4 W	
R838	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R839	Composition, 200 kΩ ±5% 1/2 W	6100-4205	01121	RC20GF204J	
R840	Composition, 51 kΩ ±5% 1/2 W	6100-3515	01121	RC20GF513J	5905-279-3496
R841	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
MISCELLANEOUS					
CR801	DIODE, Type 1N965B	6083-1015	07910	1N965B	5960-877-6192
CR802 thru CR806	DIODE, Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR807	DIODE, Type 1N3253	6081-1001	79089	1N3253	5960-814-4251
CR808	DIODE, Type 1N3253	6081-1001	79089	1N3253	5960-814-4251
CR809	DIODE, Type 1N752A	6083-1004	07910	1N752	

ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
MISCELLANEOUS (Cont)					
CR810	DIODE, Type 1N959B	6083-1010	72699	IN959B	
K801A	RELAY, 3750 Ω 30 V	6090-1070	71707	KU-16245-P	
K801B	RELAY, 0.1 Ω 1 W 250 V	6090-1060	30874	765830	
K802A	RELAY, 3750 Ω 30 V	6090-1070	71707	KU-1624-P	
K802B	RELAY, 0.1 Ω 1 W 250 V	6090-1060	30874	765830	
Q801	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q802	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q803	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q804	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q805	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q806	TRANSISTOR, Type 2N3638	8210-1096	07263	2N3638	
Q807 thru Q812	TRANSISTOR, Type 2N3416	8210-1047	24454	2N3414	5961-989-2749
Q813	TRANSISTOR, Type 2N697	8210-1040	82219	2N697	5961-752-0150
Q814	TRANSISTOR, Type 2N697	8210-1040	82219	2N697	5961-752-0150
	Auto C. A. Circuit Assembly	1003-2736	24655	1003-2736	

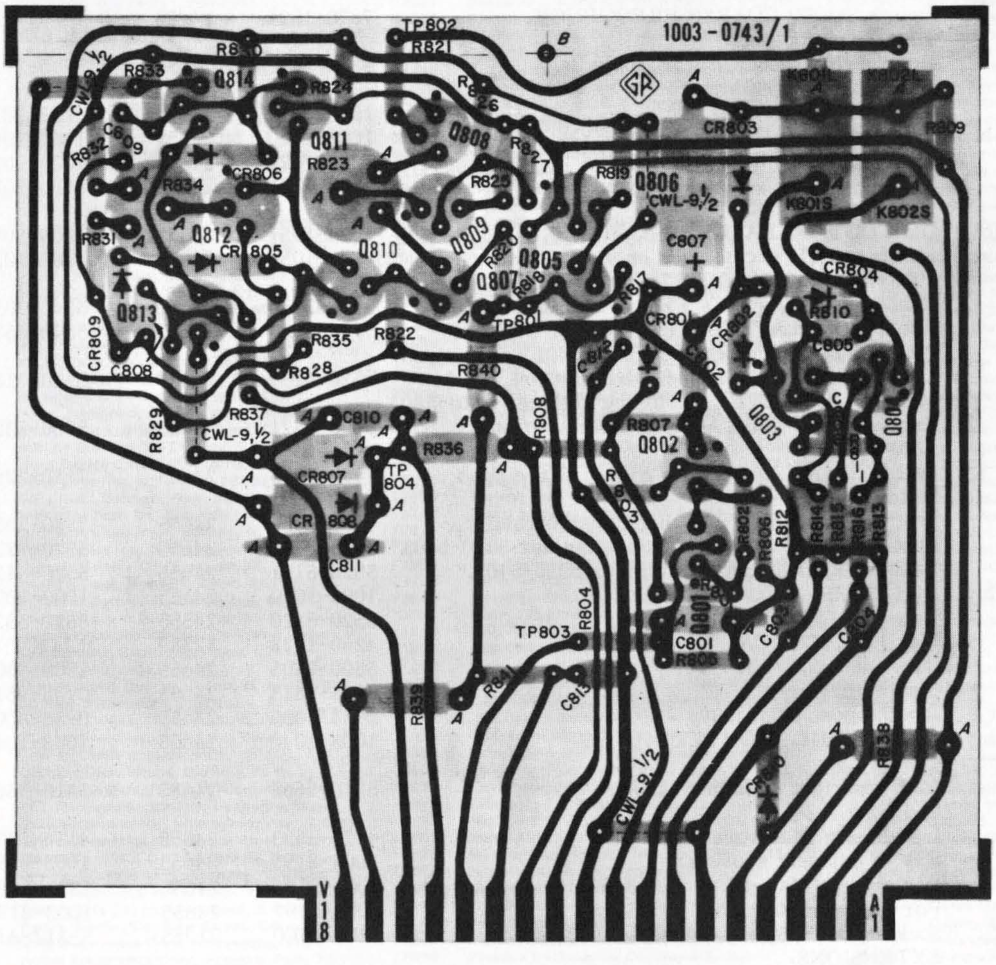
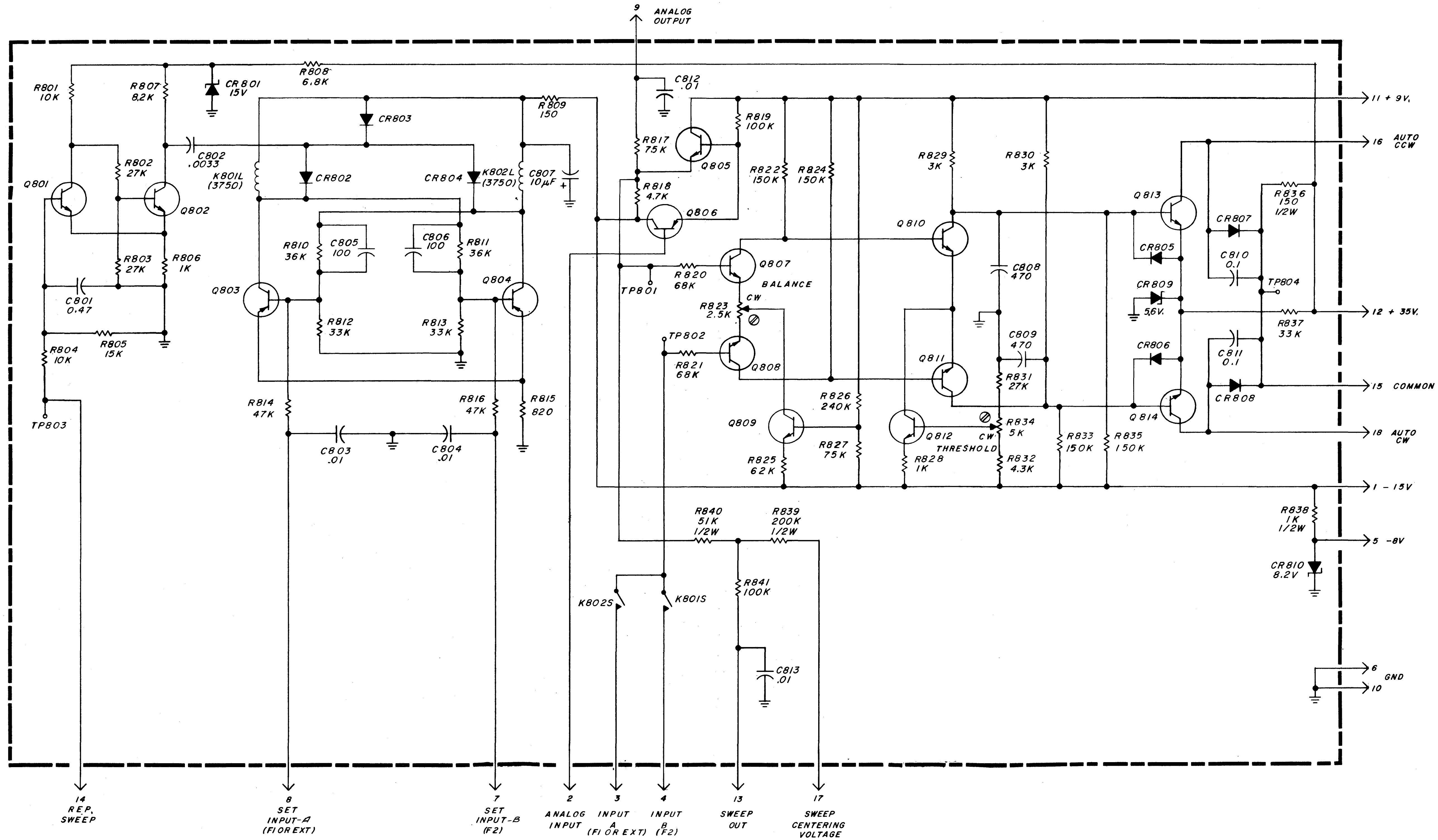
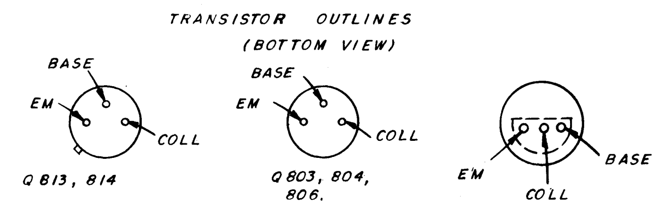


Figure 6-33. Auto-Control Amplifier etched-circuit board (P/N 1003-2743).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

Figure 6-34 A-C Amp (-9705) →





NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K-1000 OHMS M-1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

Figure 6-34. Auto-Control Amplifier schematic diagram for models 1003-9702 and -9705 only.

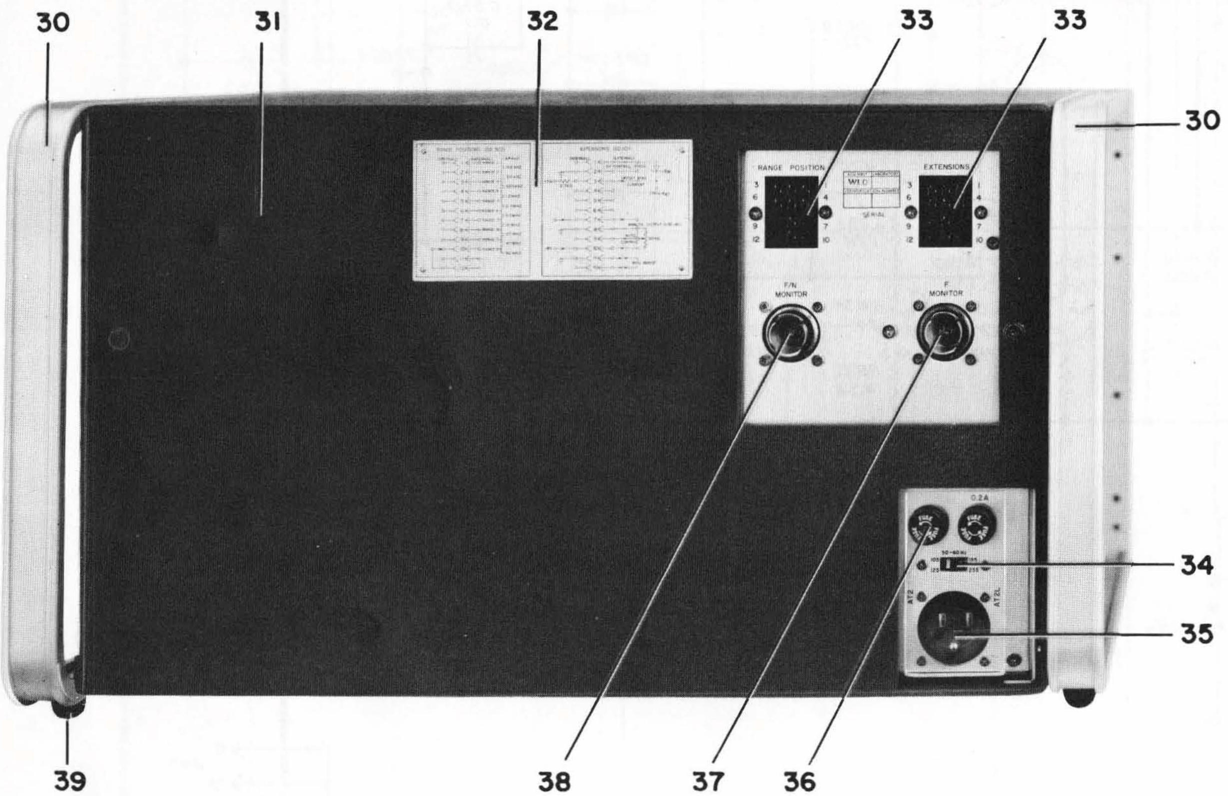


Figure 6-35. Rear view, mechanical replaceable parts identified.

MECHANICAL PARTS LIST

Quantity	Ref. No.	Name	Description	Part No.	FM Code	Mfg. Part No.	Fed. Stock No.
1	1	Dress Nut	Dress nut, 15/32-32, 7/16	5800-0800	24655	5800-0800	5310-344-3634
1	2	Switch	Toggle switch S103, POWER, OFF.	7910-1300	04009	83053-SA	5390-909-3510
1	3	Dial assembly	Dial, MONITOR and XTL CAL selector.*	1003-1085	24655	1003-1085	
1	-	Dial assembly	Dial, MONITOR selector models 1003-9701,-9702	1003-1080	24655	1003-1080	
2	4	Knob	Knob, MONITOR or CENTERING, including retainer 5220-5402	5500-5320	24655	5500-5320	
2	5	Meter cover	Meter cover, light gray, MODULATION LEVEL or CARRIER LEVEL	5720-3713	24655	5720-3713	
2	6	Switch	Switch S1; S2; COARSE FREQUENCY, single push buttons.*	7870-1521	24655	7870-1521	
1	7	Knob	Knob, FINE FREQUENCY, including retainer 5220-5401	5520-5420	24655	5520-5420	
1	8	Window	Window, vernier dial	1003-7011	24655	1003-7011	
1	-	Dial assembly	Vernier dial (FINE FREQUENCY)	1003-1060	24655	1003-1060	
1	9	Window	Window, freq. dial; logging scale	1003-7021	24655	1003-7021	
1	10	Knob	Knob, FREQUENCY RANGE, including retainer 5220-5401	5500-5521	24655	5520-5521	
1	11	Dial assembly	Dial, OUTPUT RANGE selector	1003-1051	24655	1003-1051	
1	-	Dial assembly	Similar to 11, except used only on models 1003-9701 before 1D B817 and -9704	1003-1050	24655	1003-1050	
2	12	Handle	Handle, metal	5360-2056	24655	5360-2056	
2	13	Knob	Knob, MODULATION SELECTOR or OUTPUT RANGE, including retainer 5220-5401	5500-5530	24655	5500-5530	
3	14	Knob	Knob, XTL CAL GAIN, MODULATION LEVEL, or CARRIER LEVEL, including retainer 5220-5403	5520-5130	24655	5520-5130	
1	15	Knob	Knob, SWEEP VOLTAGE, including retainer 5220-5401.*	5500-5321	24655	5500-5321	
3	16	Switch	Switch S3, AUTO-TUNE-SWEEP, Three push buttons *	7880-2055	24655	7880-2055	
3	17	Switch	Switch S4, F1-EXT-F2, three push buttons.*	7880-2050	24655	7880-2050	
2	18	Knob	Knob, LIMIT control including retainer 5220-5402*	5520-5220	24655	5520-5220	
1	19	Knob	Knob, SPEED, including retainer 5220-5403.*	5520-5121	24655	5520-5121	
1	20	Dial assembly	Dial, ΔF/F.	1003-1070	24655	1003-1070	
1	21	Knob	Knob, ΔF/F, including retainer 5220-5402	5520-5320	24655	5520-5320	
1	22	Jack	Jack J715, XTL CAL BEAT.*	4260-1032	82389	L111	
1	23	Dress nut	Dress nut, 3/8-32, 7/16.*	5800-0805	24655	5800-0805	
1	24	Insulator	Insulator, gray	0938-9813	24655	0938-9813	
2	25	Binding post	Binding post J108; J109.	0938-3000	24655	0938-3000	
1	26	Dial assembly	Dial, MODULATION SELECTOR.	1003-1040	24655	1003-1040	
1	30	End frame set	Left and right including clamps, screws, and feet.	5310-9662	24655	5310-9662	
1	31	Cabinet asm.	Instrument enclosure.	4176-2323	24655	4176-2323	
1	32	Tag	Key to adjacent sockets.*	1003-8195	24655	1003-8195	
1	-	Tag	For models 1003-9701, -9703 only	1003-8196	24655	1003-8196	
1	-	Tag	For models 1003-9702, -9705 only	1003-8197	24655	1003-8197	
2	33	Socket	Socket SO302; SO101, RANGE POSITIONS or EXTENSIONS.	4230-3700	71785	S-312-AB	
1	34	Switch	Slide switch S501, line-voltage.	7910-0831	42190	4603	
1	35	Plug	Power plug PL501	4240-0702	24655	4240-0702	
2	36	Fuse holder	Fuse-mounting device	5650-0100	71400	HKP-H	5920-284-7144
1	37	Jack assembly	Connector, F MONITOR	0874-4503	24655	0874-4503	
1	38	Jack assembly	Connector, F/N MONITOR	1003-2850	24655	1003-2820	
4	39	Foot	Resilient foot	5260-0710	24655	5260-0710	
1	-	Power cord	3-wire	4200-9622	24655	4200-9622	6150-968-0081
-	-	Patch cord	Coaxial GR874 (accessory)	0874-9683	24655	0874-9683	5995-933-6852
-	-	Plug	12-pin (accessory, for item 37)	4220-5100	24655	4220-5100	5935-237-6662

*For all models, except items:	3, 22, 23	6, 15, 19	16, 17, 18	32
are used only on models:	1003-9703, -9704, -9705	-9702, -9705	-9702, -9704, -9705	-9704

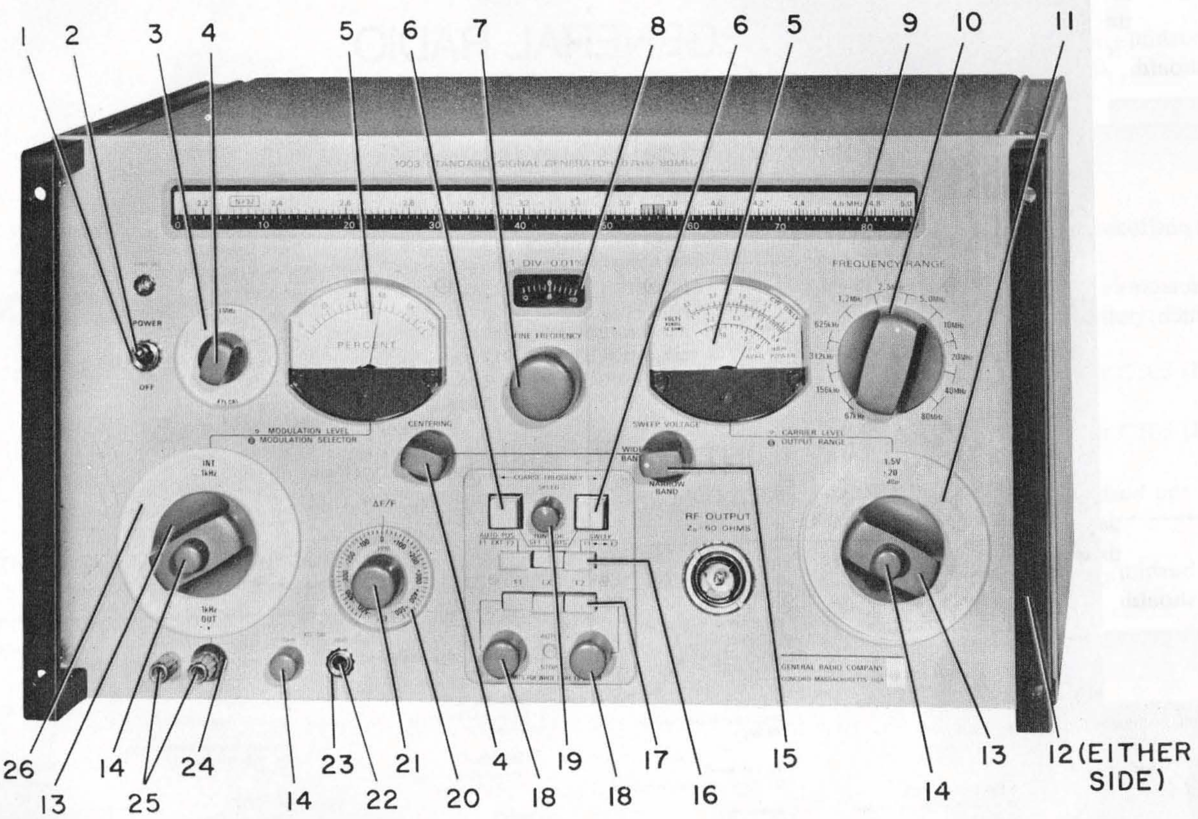


Figure 6-36. Front view, mechanical replaceable parts identified.

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer
00192	Jones Mfg. Co, Chicago, Illinois
00194	Walsco Electronics Corp, L.A., Calif.
00434	Schweber Electronics, Westburg, L.I., N.Y.
00656	Aerovox Corp, New Bedford, Mass.
01009	Alden Products Co, Brockton, Mass.
01121	Allen-Bradley, Co, Milwaukee, Wisc.
01295	Texas Instruments, Inc, Dallas, Texas
02114	Ferroxcube Corp, Saugerties, N.Y. 12477
02606	Fenwal Lab Inc, Morton Grove, Ill.
02660	Amphenol Electron Corp, Broadview, Ill.
02768	Fastex, Des Plaines, Ill. 60016
03508	G.E. Semicon Prod, Syracuse, N.Y. 13201
03636	Grayburne, Yonkers, N.Y. 10701
03888	Pyrofilm Resistor Co, Cedar Knolls, N.J.
03911	Clairex Corp, New York, N.Y. 10001
04009	Arrow-Hart & Hegeman, Hartford, Conn. 06106
04713	Motorola, Phoenix, Ariz. 85008
05170	Engr'd Electronics, Santa Ana, Calif. 92702
05624	Barber-Colman Co, Rockford, Ill. 61101
05820	Wakefield Eng, Inc, Wakefield, Mass. 01880
07126	Digitron Co, Pasadena, Calif.
07127	Eagle Signal (E.W. Bliss Co), Baraboo, Wisc.
07261	Avnet Corp, Culver City, Calif. 90230
07263	Fairchild Camera, Mountain View, Calif.
07387	Birtcher Corp, No. Los Angeles, Calif.
07595	Amer Semicond, Arlington Hts, Ill. 60004
07828	Bodine Corp, Bridgeport, Conn. 06605
07829	Bodine Electric Co, Chicago, Ill. 60618
07910	Cont Device Corp, Hawthorne, Calif.
07983	State Labs Inc, N.Y., N.Y. 10003
07999	Borg Inst., Delavan, Wisc. 53115
08730	Vemaline Prod Co, Franklin Lakes, N.J.
09213	G.E. Semiconductor, Buffalo, N.Y.
09408	Star-Tronics Inc, Georgetown, Mass. 01830
09823	Burgess Battery Co, Freeport, Ill.
09922	Burndy Corp, Norwalk, Conn. 06852
11236	C.T.S. of Berne, Inc, Berne, Ind. 46711
11599	Chandler Evans Corp, W. Hartford, Conn.
12040	National Semiconductor, Danbury, Conn.
12498	Crystalonics, Cambridge, Mass. 02140
12672	RCA, Woodbridge, N.J.
12697	Clarostat Mfg Co, Inc, Dover, N.H. 03820
12954	Dickson Electronics, Scottsdale, Ariz.
13327	Solitron Devices, Tappan, N.Y. 10983
14433	ITT Semiconductors, W.Palm Beach, Fla.
14655	Cornell-Dubilier Electric Co, Newark, N.J.
14674	Corning Glass Works, Corning, N.Y.
14936	General Instrument Corp, Hicksville, N.Y.
15238	ITT, Semiconductor Div, Lawrence, Mass.
15605	Cutlet-Hammer Inc, Milwaukee, Wisc. 53233
16037	Spruce Pine Mica Co, Spruce Pine, N.C.
17771	Singer Co, Diehl Div, Somerville, N.J.
19396	Illinois Tool Works, Pakton Div, Chicago, Ill.
19644	LRC Electronics, Horseheads, N.Y.
19701	Electra Mfg Co, Independence, Kansas 67301
21335	Fafnir Bearing Co, New Briton, Conn.
22753	UID Electronics Corp, Hollywood, Fla.
23342	Avnet Electronics Corp, Franklin Park, Ill.
24446	G.E., Schenectady, N.Y. 12305
24454	G.E., Electronics Comp, Syracuse, N.Y.
24455	G.E. (Lamp Div), Nela Park, Cleveland, Ohio
24655	General Radio Co, W. Concord, Mass. 01781
26806	American Zettlet Inc, Costa Mesa, Calif.
28520	Hayman Mfg Co, Kenilworth, N.J.
28959	Hoffman Electronics Corp, El Monte, Calif.
30874	I.B.M, Armonk, New York
32001	Jensen Mfg. Co, Chicago, Ill. 60638
33173	G.E. Comp, Owensboro, Ky. 42301
35929	Constanta Co, Mont. 19, Que.
37942	P.R. Mallory & Co Inc, Indianapolis, Ind.
38443	Marlin-Rockwell Corp, Jamestown, N.Y.
40931	Honeywell Inc, Minneapolis, Minn. 55408
42190	Muter Co, Chicago, Ill. 60638
42498	National Co, Inc, Melrose, Mass. 02176
43991	Norma-Hoffman, Stanford, Conn. 06904
49671	RCA, New York, N.Y. 10020
49956	Raytheon Mfg Co, Waltham, Mass. 02154
53021	Sangamo Electric Co, Springfield, Ill. 62705
54294	Shallcross Mfg Co, Selma, N.C.
54715	Shure Brothers, Inc, Evanston, Ill.
56289	Sprague Electric Co, N. Adams, Mass.
59730	Thomas and Betts Co, Elizabeth, N.J. 07207
59875	TRW Inc, (Accessories Div), Cleveland, Ohio
60399	Torrington Mfg Co, Torrington, Conn.
61637	Union Carbide Corp, New York, N.Y. 10017
61864	United-Carr Fastener Corp, Boston, Mass.
63060	Victoreen Instrument Co, Inc, Cleveland, O.
63743	Ward Leonard Electric Co, Mt. Vernon, N.Y.
65083	Westinghouse (Lamp Div), Bloomfield, N.J.
65092	Weston Instruments, Newark, N.J.
70485	Atlantic-India Rubber, Chicago, Ill. 60607
70563	Amperite Co, Union City, N.J. 07087
70903	Belden Mfg Co, Chicago, Ill. 60644
71126	Bronson, Homer D, Co, Beacon Falls, Conn.
71294	Canfield, H.O. Co, Clifton Forge, Va. 24422
71400	Bussman (McGraw Edison), St. Louis, Mo.
71468	ITT Cannon Elec, L.A., Calif. 90031
71590	Centralab, Inc, Milwaukee, Wisc. 53212
71666	Continental Carbon Co, Inc, New York, N.Y.
71707	Coto Coil Co Inc, Providence, R.I.
71744	Chicago Miniature Lamp Works, Chicago, Ill.
71785	Cinch Mfg Co, Chicago, Ill. 60624
71823	Darnell Corp, Ltd, Downey, Calif. 90241
72136	Electro Motive Mfg Co, Wilmington, Conn.
72259	Nytronics Inc, Berkeley Heights, N.J. 07922
72619	Dialight Co, Brooklyn, N.Y. 11237
72699	General Instr Corp, Newark, N.J. 07104
72765	Drake Mfg Co, Chicago, Ill. 60656
72825	Hugh H. Eby Inc, Philadelphia, Penn. 19144
72962	Elastic Stop Nut Corp, Union, N.J. 07083
72982	Erie Technological Products Inc, Erie, Penn.
73138	Beckman Inc, Fullerton, Calif. 92634
73445	Amperex Electronics Co, Hicksville, N.Y.
73559	Carling Electric Co, W.Hartford, Conn.
73690	Elco Resistor Co, New York, N.Y.
73899	JFD Electronics Corp, Brooklyn, N.Y.
74193	Heinemann Electric Co, Trenton, N.J.
74861	Industrial Condenser Corp, Chicago, Ill.
74970	E.F. Johnson Co, Waseca, Minn. 56093
75042	IRC Inc, Philadelphia, Penn. 19108
75382	Kulka Electric Corp, Mt. Vernon, N.Y.
75491	Lafayette Industrial Electronics, Jamica, N.Y.
75608	Linden and Co, Providence, R.I.
75915	Littelfuse, Inc, Des Plaines, Ill. 60016
76005	Lord Mfg Co, Erie, Penn. 16512
76149	Mallory Electric Corp, Detroit, Mich. 48204
76487	James Millen Mfg Co, Malden, Mass. 02148
76545	Mueller Electric Co, Cleveland, Ohio 44114
76684	National Tube Co, Pittsburg, Penn.
76854	Oak Mfg Co, Crystal Lake, Ill.
77147	Patton MacGuyer Co, Providence, R.I.
77166	Pass-Seymour, Syracuse, N.Y.
77263	Pierce Roberts Rubber Co, Trenton, N.J.
77339	Positive Lockwasher Co, Newark, N.J.
77542	Ray-O-Vac Co, Madison, Wisc.
77630	TRW, Electronic Comp, Camden, N.J. 08103
77638	General Instruments Corp, Brooklyn, N.Y.
78189	Shakeproof (Ill. Tool Works), Elgin, Ill. 60120
78277	Sigma Instruments Inc, S.Braintree, Mass.
78488	Stackpole Carbon Co, St. Marys, Penn.
78553	Tinnerman Products, Inc, Cleveland, Ohio
79089	RCA, Rec Tube & Semicond, Harrison, N.J.
79725	Wiremold Co, Hartford, Conn. 06110
79963	Zierick Mfg Co, New Rochelle, N.Y.
80030	Prestole Fastener, Toledo, Ohio
80048	Vickers Inc, St. Louis, Mo.
80131	Electronic Industries Assoc, Washington, D.C.
80183	Sprague Products Co, No. Adams, Mass.
80211	Motorola Inc, Franklin Park, Ill. 60131
80258	Standard Oil Co, Lafeyette, Ind.
80294	Bourns Inc, Riverside, Calif. 92506
80431	Air Filter Corp, Milwaukee, Wisc. 53218
80583	Hammarlund Co, Inc, New York, N.Y.
80740	Beckman Instruments, Inc, Fullerton, Calif.
81030	International Insturment, Orange, Conn.
81073	Grayhill Inc, LaGrange, Ill. 60525
81143	Isolantite Mfg Corp, Stirling, N.J. 07980
81349	Military Specifications
81350	Joint Army-Navy Specifications
81751	Columbus Electronics Corp, Yonkers, N.Y.
81831	Filtron Co, Flushing, L.I., N.Y. 11354
81840	Ledex Inc, Dayton, Ohio 45402
81860	Barry-Wright Corp, Watertown, Mass.
82219	Sylvania Elec Prod, Emporium, Penn.
82273	Indiana Pattern & Model Works, LaPort, Ind.
82389	Switchcraft Inc, Chicago, Ill. 60630
82647	Metals & Controls Inc, Attleboro, Mass.
82807	Milwaukee Resistor Co, Milwaukee, Wisc.
83033	Meissner Mfg, (Maguire Ind) Mt. Carmel, Ill.
83058	Carr Fastener Co, Cambridge, Mass.
83186	Victory Engineering, Springfield, N.J. 07081
83361	Bearing Specialty Co, San Francisco, Calif.
83587	Solar Electric Corp, Warren, Penn.
83740	Union Carbide Corp, New York, N.Y. 10017
83781	National Electronics Inc, Geneva, Ill.
84411	TRW Capacitor Div, Ogallala, Nebr.
84835	Lehigh Metal Prods, Cambridge, Mass. 02140
84971	TA Mfg Corp, Los Angeles, Calif.
86577	Precision Metal Prods, Stoneham, Mass. 02180
86684	RCA (Elect. Comp & Dev), Harrison, N.J.
86687	REC Corp, New Rochelle, N.Y. 10801
86800	Cont Electronics Corp, Brooklyn, N.Y. 11222
88140	Cutler-Hammer Inc, Lincoln, Ill.
88219	Gould Nat. Batteries Inc, Trenton, N.J.
88419	Cornell-Dubilier, Fuquay-Varina, N.C.
88627	K & G Mfg Co, New York, N.Y.
89482	Holtzer-Cabot Corp, Boston, Mass.
89665	United Transformer Co, Chicago, Ill.
90201	Mallory Capacitor Co, Indianapolis, Ind.
90750	Westinghouse Electric Corp, Boston, Mass.
90952	Hardware Products Co, Reading, Penn. 19602
91032	Continental Wire Corp, York, Penn. 17405
91146	ITT (Cannon Electric Inc), Salem, Mass.
91293	Johanson Mfg Co, Boonton, N.J. 07005
91506	Augat Inc, Attleboro, Mass. 02703
91598	Chandler Co, Wethersfield, Conn. 06109
91637	Dale Electronics Inc, Columbus, Nebr.
91662	Elco Corp, Willow Grove, Penn.
91719	General Instruments, Inc, Dallas, Texas
91929	Honeywell Inc, Freeport, Ill.
92519	Electra Insul Corp, Woodside, L.I., N.Y.
92678	E.G.&G., Boston, Mass.
93332	Sylvania Elect Prods, Inc, Woburn, Mass.
93916	Cramer Products Co, New York, N.Y. 10013
94144	Raytheon Co, Components Div, Quincy, Mass.
94154	Tung Sol Electric Inc, Newark, N.J.
95076	Garde Mfg Co, Cumberland, R.I.
95121	Quality Components Inc, St. Mary's, Penn.
95146	Alco Electronics Mfg Co, Lawrence, Mass.
95238	Continental Connector Corp, Woodside, N.Y.
95275	Vitramon, Inc, Bridgeport, Conn.
95354	Methode Mfg Co, Chicago, Ill.
95412	General Electric Co, Schenectady, N.Y.
95794	Anaconda Amer Brass Co, Torrington, Conn.
96095	Hi-Q Div. of Aerovox Corp, Orlean, N.Y.
96214	Texas Instruments Inc, Dallas, Texas 75209
96256	Thordarson-Meissner, Mt. Carmel, Ill.
96341	Microwave Associates Inc, Burlington, Mass.
96791	Amphenol Corp, Jonesville, Wisc, 53545
96906	Military Standards
98291	Sealectro Corp, Mamaroneck, N.Y. 10544
98474	Compar Inc, Burlingame, Calif.
98821	North Hills Electronics Inc, Glen Cove, N.Y.
99180	Transitron Electronics Corp, Melrose, Mass.
99313	Varian, Palo Alto, Calif. 94303
99378	Atlee Corp, Winchester, Mass. 01890
99800	Delevan Electronics Corp, E. Aurora, N.Y.

GENERAL RADIO

WEST CONCORD, MASSACHUSETTS 01781
617 369-4400

SALES AND SERVICE

ATLANTA	404 633-6183	DENVER	303 447-9225	ROCHESTER	315 394-2037
*BOSTON	617 646-0500	DETROIT	313 261-1750	PHILADELPHIA	215 646-8030
BRIDGEPORT	203 377-0165	GREENSBORO	919 288-4316	SAN DIEGO	714 232-2727
*CHICAGO	312 992-0800	HARTFORD	203 658-2496	*SAN FRANCISCO	415 948-8233
CLEVELAND	216 886-0150	HOUSTON	713 464-5112	SEATTLE	206 GL4-7545
COCOA BEACH	800 241-5122	HUNTSVILLE	800 241-5122	SYRACUSE	315 454-9323
*DALLAS	214 637-2240	INDIANAPOLIS	317 636-3907	*WASHINGTON, BALTIMORE	301 946-1600
DAYTON	513 434-6979	*LOS ANGELES	213 469-6201		
		*NEW YORK	(NY) 212 964-2722 (NJ) 201 943-3140		

INTERNATIONAL DIVISION

WEST CONCORD, MASSACHUSETTS 01781, USA

AUSTRALIA
Warburton Franki Industries Pty. Ltd.
Sydney, Melbourne, Brisbane, Adelaide

CANADA –
*General Radio Canada Limited
Toronto, Montreal, Ottawa

DEMOCRATIC REPUBLIC OF THE CONGO
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