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Instruction MANUAL

Model No. _____ Serial No. _____

SERIES 70 FUNCTION GENERATOR

MODELS F74/F77

INTERSTATE ELECTRONICS CORPORATION
A Subsidiary Of A-T-O Inc.
Department 7000 707 EAST VERMONT AVENUE, ANAHEIM, CALIFORNIA 92803 • (714) 772-2811
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Interstate Electronics Corporation warrants its function generators against defects in material and workmanship for a period of one year from date of shipment. We will repair or replace defective products during the warranty period provided that such defect developed under normal and proper use and that transportation costs are paid by the purchaser. We are not liable for consequential damages nor is any other warranty expressed or implied.

RECEIVING AND INSPECTION

Immediately upon receipt of the instrument, inspect the exterior of the shipping container for physical damage and notify carrier if such damage is visible. After carefully removing all packing materials, inspect the instrument to ensure that it is free of mars and blemishes.

CLAIM FOR DAMAGED SHIPMENT

If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy of the report should be sent to IEC. After receiving this report, IEC will advise you of the disposition of the instrument and arrange for its repair or replacement.

POWER

This instrument operates from a-c power only, either 115 or 230 vac, 50 to 400 Hz. A slide switch at the rear of the equipment readily selects the desired power line voltage.

CAUTION

Operation at the wrong power line voltage switch setting may damage the instrument.

PERFORMANCE TESTS

Electrical performance tests should be concluded as soon as possible. See paragraph 4-2, Section 4.

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Section 1
SPECIFICATIONS AND INSTALLATION

1-1. INTRODUCTION

This manual provides operation, maintenance, and performance testing instructions for the IEC Series 70 Function Generator. A detailed functional description of the instrument is included to provide the operator and maintenance personnel with a thorough understanding of the function generator operating capabilities and characteristics. Detailed calibration procedures are provided so that the equipment may be maintained in optimum performance condition.

1-2. DESCRIPTION

The IEC Series 70 Function Generator is a state-of-the-art signal source designed for great versatility, maximum ease of operation, and long operational life.

The case enclosing the equipment provides exceptional physical ruggedness and utility, together with effective electrostatic shielding. The latter is important for the radio-frequency operating ranges of the instrument. Attention has been given to ground isolation applications, and a grounding switch is provided at the rear of each instrument.

The serial number and other identification data are located at the rear of the instrument. The rear panel also serves as the primary heat-sink for the power supply and output amplifier.

1-3. PERFORMANCE CHARACTERISTICS

Following are the performance characteristics of the models F74 and F77 function generators. These data reflect the most accurate information available at the time of publication of this manual and may be subject to change as a result of information derived from long-term performance reports. Instrument owners will be advised of any such changes should they occur.

WAVEFORMS

Main Output (Selectable):

- Sine, square, triangle, standard pulse, sweep sawtooth (or ramp and hold), and dc level.
- Symmetry (duty cycle) of sine, square and triangle waveforms may be adjusted over a range of 5% to 95% to produce pulses or ramps whose duty cycle remains constant as frequency is varied.
- Start/stop phase of triggered and gated waveforms may be varied to create sine squared (haversine) and haver-triangles.
- Waveforms may be inverted, attenuated, or offset using front panel controls.

Fixed Amplitude Outputs:

- Sync: rectangular or square waveform, unipolar positive, 0-3V, open circuit (TTL compatible), 50-ohm source impedance.

- Sweep Ramp: linear ramp waveform, unipolar positive, 3V open circuit, 600-ohm source impedance.

- Frequency Analog: DC voltage proportional to generator frequency. 0 to +3V open circuit, 600-ohm source impedance. Static linearity of conversion ±0.25% to 100 kHz.

- Sweep Sync (F77 only): rectangular waveform unipolar positive, 3V open circuit (TTL compatible), 50-ohm source impedance.

FREQUENCY

Range: Sine, square, triangle and pulse waveforms 0.00002 Hz to 20 MHz (uncalibrated below 0.001 Hz); nonsymmetrical sine, square and triangle waveforms to 1 MHz. Ten decade ranges, up to 1000:1 continuous vernier adjustment within any X2 dial range, 500:1 on any X1 dial range. Independent, free-running, sweep-ramp generator provides sweep times from 1000 seconds to 10 μs (exclusive of retrace) in seven decade ranges with 100:1 continuous vernier adjustment within any range.

Dial Accuracy (With dial scale switch at SYMMETRICAL X1 or X2):

0.00002 Hz to 20 Hz: 2% of full scale ±1% of setting

20 Hz to 200 kHz: 1% of full scale ±1% of setting

200 kHz to 2 MHz: 2% of full scale ±1% of setting

2 MHz to 20 MHz: 3% of full scale ±2% of setting

Time Symmetry (with dial scale switch in X1 or X2): >99%, to 20 Hz; >99.5%, 20 Hz to 100 kHz; >98%, 100 kHz to 2 MHz

AMPLITUDE

Output Levels - Main Amplifier: Maximum output of sine, triangle, square and pulse waveforms is 30V p-p (bipolar) into open circuit or high-impedance loads (e.g., MOS), 15V p-p into 50-ohm load. Source impedance is 50 ohms. Minimum output is 1.5 mV p-p. Sweep waveforms exited through main amplifier are unipolar. Combined signal plus offset must lie in region between ±15V open circuit or ±7.5V into 50-ohm load. Short-circuit-proof. 200 milliamps maximum current output on any waveform.

Attenuator: Precision attenuator provides three 20-dB (10:1 in voltage) steps plus continuously variable 0-20 dB vernier; permits 80-dB output adjustment to 1.5 mV p-p minimum.

WAVEFORM CHARACTERISTICS

Frequency Response (Sine, triangle, square wave and pulse): Better than 0.1 dB to 100 kHz; 0.25 dB, 100 kHz to 2 MHz; 2dB, 2 MHz to 20 MHz.

Square wave and Pulse (50-ohm termination): Standard pulse width adjustable

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over range of 30 nanoseconds to 10 milliseconds, independent of repetition rate. Rise and fall times < 15 nanoseconds; < 5% total aberrations.

Amplitude Differential: < 5% p-p variation between symmetrical triangle, sine, pulse and square waveforms to 2 MHz.

Sine Distortion: < 0.5% to 100 kHz; < 1% 100 kHz to 1 MHz; all harmonics greater than 26 dB down from 1 MHz to 20 MHz.

Triangle Linearity: > 99% to 100 kHz; > 95% 100 kHz to 2 MHz.

Offset: Selection of zero offset, positive or negative fixed offset (half amplitude unipolar waveform peaks tangent to 0 volts), or variable offset (±15V range into open circuit). NOTE: signal plus offset must not exceed ±15V level. Offset is independent of continuously variable level setting, but not of step attenuator.

Stability: Amplitude, frequency and offset (after 30-min warmup) better than 0.05% for 10 minutes; 0.25% for 24 hours.

VCF

External dc or ac voltage control of output frequency; 0 to +5V maximum varies frequency upward 1000:1 from minimum dial setting. VCF bandwidth is 100 kHz, limited to 0.3V/μsec input slew rate; input impedance is 7.5K ohms. Linearity is within 0.2% on all ranges except X1M.

AMPLIFIER EXTERNAL INPUT (rear panel, F77 Model only)

External signals and/or offset may be introduced to the main output amplifier (inverting) via rear panel AMPL IN BNC connector when waveform switch is at dc position. Input impedance is 50 ohms; amplifier internal gain is approximately 6. Offset, inverter and attenuator controls fully active for these inputs.

TRIG-SYNC

An external waveform of 1V p-p lying between ±5V will activate an internal squaring circuit. This circuit initiates triggered or gated waveforms or may be used to synchronize the internal (continuous mode) generator to fundamental frequency (or harmonics) of the external signal frequency. Input impedance is 10K ohms shunted by 50 pF. Both trigger level and trigger slope controls provided for maximum versatility.

MODES

Continuous: Generator produces a continuous wavetrain. May be synchronized to an external periodic waveform applied to TRIG-SYNC IN when the input frequency is within -0+1% of the internal set frequency.

Triggered: Manual or external trigger pulse initiates one complete waveform cycle. (See TRIG-SYNC specifications for input characteristics). Cycle start-stop point is continuously variable $\pm 90^{o}$ using PHASE control. Start-stop aberrations are less than 5% up to 1 MHz; usable to 5 MHz.

Gated: Manual or external trigger signal starts wavetrain which continues until trigger is removed. (See TRIG-SYNC specifications for input characteristics). The last cycle of the wavetrain is always completed before the generator stops. Start-stop aberrations less than 5% up to 1 MHz; usable to 5 MHz. Cycle start-stop point is continuously variable $\pm 90^{\circ}$ using PHASE control.

Sweep: Sweeps the main generator frequency between limits established by main dial cursor and concentric sweep limit cursor. Sweep limit accuracy better than 5% of full scale. Switch selectable sweep up or sweep down. Maximum swept frequency change is 1000:1 with dial scale switch at X2 and 500:1 with dial scale at X1. Internal main generator slew-rate limitations (typically 0.3V/μsec) decreases maximum peak-to-peak frequency change to approximately 6 major dial divisions in a 10-μsec (linear) sweep time. Linear sweep is provided in both F74 and F77 Models. Log sweep (F77 Model only) provides logarithmically shaped "ramp" for full three-decade frequency range. Selectable constant amplitude, linear sweep ramp, or frequency analog outputs are provided for driving display x-axis. A rectangular waveform sweep sync output (F77 Model only) is available for pen lift function on chart recorders.

- Continuous - Sweeps the main generator repetitively at the rate established by the sweep generator controls. Retrace is not blanked.
- Trigger Sweep - Main generator starts from set baseline when triggered and produces a swept frequency output for one complete sweep cycle; returns to set baseline.
- Sweep and Hold - Main generator operates at start cursor frequency until triggered, then sweeps to other preset cursor frequency and holds until manually reset. Can be used to measure swept frequency excursions.
- Burst - Integral number of main generator waveform cycles (as established by setting trigger level control) are repetitively triggered by sweep generator at a rate established by sweep time controls.

ISOLATION

Rear panel slide switch isolates all BNC connectors and circuit grounds from case and power line ground. (Nominal .01 μF capacitance exists between circuit ground and power ground).

POWER

Switch selects 90-110V; 104-126V; 180-220V; or 208-252V ac; 50-400 Hz; 50W maximum.

OPERATING TEMPERATURE

0° to 50°C

DIMENSIONS

Benchtop models: 11-1/4" wide x 15" deep x 6" high (29 x 38 x 15.5 cm)

Rack models: Fit in 5-1/4" rack space; 12-3/4" (32.5 cm) behind panel, 2-1/4" (6 cm) in front of panel.

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WEIGHT

16.5 lb (7.5 kg) net; 20 lb (9 kg) shipping

NOTE: Except where indicated, performance characteristics apply for ambient temperature of 25°C ±5°, 10V p-p output terminated in 50-ohm resistive load; 0V dc offset; frequency dial set between .1 full scale and full scale; all external inputs removed; inverting switch off; and dial scale switch set at symmetrical. For other temperatures between 0°and 50°C, derate performance characteristics by a factor of 2.

1-4. RECEIVING AND INSPECTION

Immediately upon receipt of the instrument, inspect the exterior of the shipping container for physical damage and notify the carrier if damage is apparent. After carefully removing all packing materials, inspect the instrument for dents and scratches.

Check instrument to confirm that electrical performance meets or exceeds the specifications. Section 4 contains a suggested receiving performance test procedure. (Table 4-2).

To remove the function generator from its case, remove the two No. 6-32 retaining screws mounted in the bottom of the case at the rear of the unit and slide the electronics forward.

1-5. INSTALLATION

This instrument may be used on the workbench or may be rigidly mounted in an RETMA rack structure by means of an optional rack-mounting kit. The instrument includes a handle that facilitates carrying and a bottom-mounted tilt mechanism for optimum panel viewing angle. The tilt mechanism, handle, and feet must be removed for rack mounting.

The function generator is an all solid-state instrument; it therefore requires no special cooling facilities when operated within the specified temperature limits. Care must be taken, however, to ensure that a 2-inch minimum clearance is provided at the rear of the instrument for proper convection cooling of the heatsink.

1-6. POWER REQUIREMENTS

The function generator operates from ac power only, 50 to 400 Hz. A slide switch is provided at the rear of the equipment for selecting the desired power line voltage. Fuses for the instrument are contained in a separate envelope. Case must be taken to ensure that the proper fuse for the line voltage selected is used.

CAUTION

Operation at the wrong power line voltage switch setting may damage the instrument.

IEC function generators are supplied with a slide switch for selection of normal or low line voltage operation. A chart which indicates the proper switch setting is imprinted on the back of the instrument.

A three-conductor cord is supplied with the equipment to permit referencing the chassis and case to power system ground. This safety feature is recommended by the National Electrical Manufacturers Association (NEMA). The offset pin on the power cord connector is

the ground wire. The generator circuitry (including the input and output BNC's) may be isolated from the case ground by operating the signal ground switch on the back panel of the instrument.

1-7. REPACKAGING

If it becomes necessary to pack the instrument for shipment, the following procedure is recommended:

(1) Attach an identification tag which includes the owner's name, address, and telephone number, together with a brief explanation of the reason the equipment is being returned and the date by which its repair is required.

(2) Wrap the equipment in heavy paper or plastic before placing it in an inner container.

(3) Use a liberal amount of soft packing material around all sides of the instrument inside the inner container.

(4) Enclose the inner container in a rugged carton or wooden box with suitable packing material to prevent movement in any direction, and seal the outer container with heavy tape or metal bands.

(5) Mark the outside of the shipping container with the shipping address and "DELICATE INSTRUMENT" labels.

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Section 2
OPERATING INSTRUCTIONS

2-1. INTRODUCTION

Panel controls and graphics for the Series 70 Function Generators have been designed to facilitate efficient use of the instruments. IEC function generators, however, are sophisticated instruments with great versatility. If the user is to realize the full potential of the equipment, it is advisable that he familiarize himself thoroughly with the panel controls. The operating controls, connectors, and indicators of the F74 and F77 Model generators are shown in Figure 2-1 and described in detail in the following paragraph.

2-2. OPERATING CONTROLS

a. MODE Selector (with concentric PULSE WIDTH control).

The MODE Selector is a seven-position switch which permits the user to establish any of the following operating modes:

- Continuous - This mode provides for a conventional continuous output waveform, fully controllable via the frequency dial, FREQUENCY MULTIPLIER, WAVEFORM Selector, OUTPUT level adjust, etc.

- Triggered - A single cycle of the selected main generator waveform (not SWEEP RAMP waveform) will occur in response to a voltage level change at the TRIG-SYNC IN connector or in response to momentary actuation of the MANUAL TRIGGER OR GATE toggle switch.

- Gated - An integral number of cycles of the selected main generator waveform will occur in response to a voltage level change at the TRIG-SYNC IN connector or in response to momentary actuation of the MANUAL TRIGGER OR GATE toggle switch. The actual number of cycles gated out will be dependent upon the duration of the gate pulse with relation to dial frequency.

- Continuous Sweep - This mode causes a main generator swept frequency between limits established by the frequency dial and its associated SWEEP LIMIT control. The swept frequency pattern occurs repetitively, at a rate established by the SWEEP TIME controls.

- Trigger Sweep - A single sweep ramp and corresponding main generator frequency sweep are caused to occur in response to a voltage level change at the TRIG-SYNC IN connector or in response to momentary actuation of the MANUAL TRIGGER OR GATE switch. The output waveform returns to a dc baseline level (set by the PHASE control) at the completion of the sweep.

- Sweep and Hold - A single sweep ramp is caused to occur in response to a voltage level change at the TRIG-SYNC IN connector or in response to momentary actuation of the MANUAL TRIGGER OR GATE toggle switch. The output frequency (and sweep ramp waveform) will remain at whatever value is attained at the completion of the sweep time. Reset to initial condition must be done manually, via the SWEEP RESET toggle switch.

- Burst - Similar to the gate mode, except that the gate time is internally derived from the repetitive sweep ramp. Burst duration is adjustable by means of the TRIGGER LEVEL control. Burst repetition rate is nominally the inverse of sweep time.

b. PULSE WIDTH Selector

The PULSE WIDTH selector is a three-position switch that is employed in conjunction with the WAVEFORM selector and its concentric WIDTH vernier (note the orange-colored labeling on the instrument panel to indicate this). When the pulse waveform is selected, the resultant pulse time duration is determined by the PULSE WIDTH selector and its related width vernier. As in any pulse generator, care must be taken to insure that the selected pulse width is less than the period between pulses.

c. FREQUENCY MULTIPLIER Selector (with concentric VAR SYM/SYMMETRICAL selector).

The FREQUENCY MULTIPLIER Selector is a ten-position switch which establishes the tuning range of the frequency dial. In conjunction with the VAR SYM/SYMMETRICAL selector, full-scale dial calibration between .001 Hz and 20 MHz can be chosen.

d. VAR SYM/SYMMETRICAL Selector

The VAR SYM/SYMMETRICAL selector provides symmetrical or nonsymmetrical (VAR SYM) waveform generation.

The two switch positions associated with SYMMETRICAL determine which of the two sets of dial calibration markings are to be used. (X1 or X2) NOTE: Below 10% of full scale, the accuracy of the X1, X2 relationship progressively degrades. When the frequency dial is against the low-frequency stop, the X1, X2 selector has no effect on output frequency.

In VAR SYM (X0.1) position, the symmetry of sine, square, and triangular waveforms are adjustable over a range of 5% to 95%, using the WIDTH-VAR SYM vernier control.

e. Frequency Dial (with concentric SWEEP LIMIT control).

The frequency dial provides continuous tuning over the frequency range selected by the FREQUENCY MULTIPLIER. For X2, the frequency is tunable in excess of 1000:1 with respect to full scale, reduced to 500:1 for X1, and further reduced to approximately 100:1 for VAR SYM, X0.1.

The SWEEP LIMIT control is used to establish the upper frequency limit of a swept frequency waveform. In operation, the main frequency dial is set to the lowest frequency of the sweep; then the SWEEP

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FREQUENCY MULTIPLIER

Rotary switch. Selects one after frequency ranges.

VAR SYM — SYMMETRICAL

A 3-position rotary switch. In position 1 the waveforms are nonsymmetrical and occur at approximately 1/10 of the frequency indicated on the FREQUENCY MULTIPLIER. In position 2, the frequency indicated by the outer Frequency Dial calibrations is produced. In position 3, generator frequency is doubled and the inner Frequency Dial calibrations are used.

SWEEP LIMIT Control

Adjustable cursor. Used to set upper frequency limit of sweep wavetrains.

FREQUENCY Vernier

Planetary drive control. Provides a 6:1 vernier on the Frequency Dial.

Frequency Dial

Larger knob and dial are directly coupled to the frequency control potentiometer, which sets generator frequency over a 1000:1 range.

Power Switch

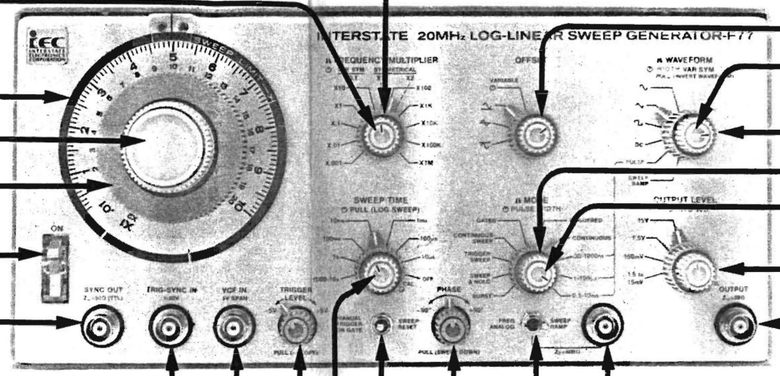
Rocker switch. Applies line power to instrument. Switch is illuminated in the ON position.

SYNC OUT Connector

Provides unipolar positive square or rectangular pulse of 2.4 volts amplitude. Source impedance is 50 ohms.

TRIG-SYNC IN Connector

External signal of 1 volt peak-to-peak (or greater) provides generator operation in TRIGGERED, GATED, TRIGGER SWEEP and SWEEP and HOLD modes. In CONTINUOUS mode the external signal may be used to synchronize generator frequency so long as generator is tuned to within 1% of external signal frequency.



VCF IN Connector

An external signal applied to this part causes the generator frequency to shift proportionally to amplitude of applied signal.

TRIGGER LEVEL & SLOPE

Provides proper generator operation from an external waveform of 1 volt p-p (or greater) offset as much as ±5 volts. Either positive or negative slope of the external waveform may be selected for trigger generation.

SWEEP TIME

An 8-position rotary switch. Provides 7 ranges of sweep time variation. Eighth position disables sweep circuitry.

Vernier control allows 100:1 variation of time on any range selected.

A linear sweep ramp is normally generated. Pulling sweep vernier knob outward results in logarithmic sweep ramp (F77 Model only).

FREQ ANALOG/SWEEP RAMP

1. Provides a voltage analog of the main generator frequency.
2. Provides a unipolar positive linear sweep ramp which is also available when not in a sweep mode.

The output waveform may be used to control one axis of a visual display device.

PHASE/SWEEP DOWN

Establishes the phase angle at which a discontinuous waveform starts or stops. When knob is pulled outward, causes sweep to start at higher frequency and finish at lower frequency.

MANUAL TRIGGER/SWEEP RESET

Provides a manually generated trigger signal for local operation in TRIGGERED, GATED, TRIGGER SWEEP and SWEEP and HOLD modes.

The control also functions to reset sweep waveform when operating in SWEEP and HOLD modes.

OFFSET

A 4-position rotary switch. Selects half amplitude unipolar positive or negative waveforms, no offset, and variable offset at full amplitude. An inner knob allows dc offset adjustment.

WAVEFORM

Selects waveform to be amplified by output amplifier. DC position allows adjustment of OFFSET controls and also connects output amplifier to a rear panel BNC connector for use in amplifying and offsetting an external waveform.

WIDTH/SYMMETRY/INVERT

A dual-purpose vernier control. Adjusts shape of unsymmetrical waveforms and adjusts pulse width of PULSE waveform. When knob is pulled outward, output waveform is inverted (does not affect DC offset setting).

MODE Switch

Selects 1 of 7 modes of waveform generation.

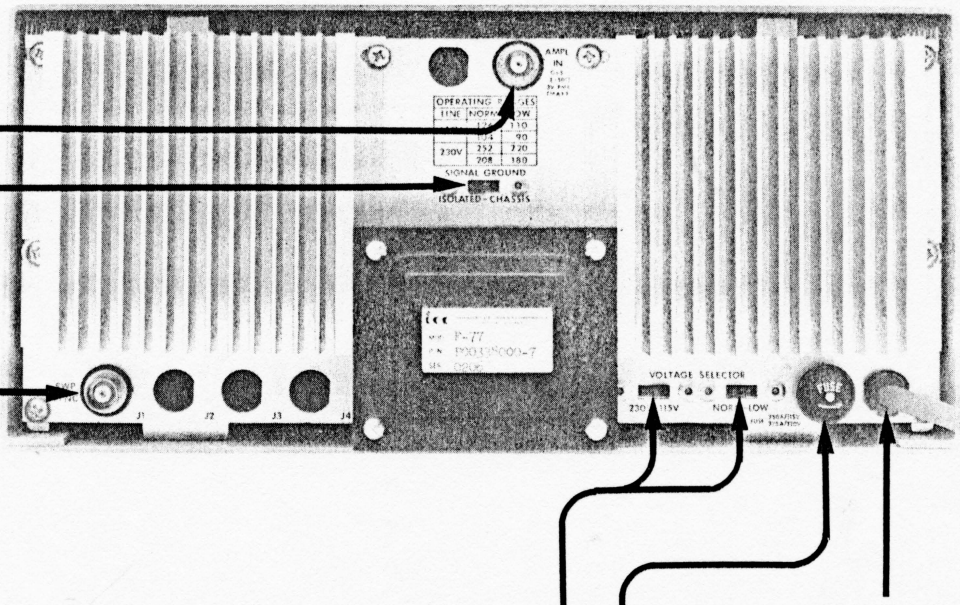
PULSE WIDTH Switch

A 3-position switch which provides three ranges of pulse width selection when PULSE waveform is selected.

OUTPUT LEVEL

The combination of a 20-dB vernier and a 4-position attenuator switch at 20 dB per step varies the output level between 1.5 mV and 15 volts peak-to-peak into 50 ohms (30 volts peak-to-peak open circuit).

Figure 2-1. Controls and Indicators



SWEEP SYNC (F77 only)

Connector provides rectangular waveform synchronized with sweep ramp.

SIGNAL GROUND Switch

Isolates generator ground connectors from case and power ground.

AMPLIFIER IN (F77 only)

Connector provides access to output amplifier in generator for amplification of external signals.

Power Cord

Three-conductor cable permanently attached to instrument. Instrument case is connected to ground wire in power cable.

Fuse

Power fuse holder. Three-fourth amp Slo Blo for 115V ac; 3/4-amp Slo Blo for 230V ac.

Power Selector Switches

Selects 115- or 230-volt operation. Use normal position for nominal line, low position for low line voltages.

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LIMIT movable cursor directly indicates the highest frequency of the sweep.

f. OFFSET Selector (with concentric variable offset control).

The OFFSET selector is used to select either the normal bipolar output signal (zero offset), fixed offset of either polarity (unipolar signal with waveform peaks tangent to 0 volts dc), or adjustable offset. For fixed offset, the output p-p amplitude is automatically reduced to ≈50% as compared to the no offset condition. NOTE: Since the SWEEP RAMP waveform is inherently a zero-based waveform, fixed offset is not useful in this instance. The VARIABLE offset control can be used to set any value of offset between zero and ±15 volts open circuit (output level attenuator at 15-volt range). For other attenuator settings, both signal and offset are reduced in the same proportion. Signal amplitude limits, with offset, are necessarily reduced due to the possibility of peak clipping of the output waveform.

g. WAVEFORM Selector (with concentric WIDTH-VAR SYM vernier control and pull to INVERT WAVEFORM switch).

The WAVEFORM selector permits a choice from six possible waveforms. The DC position removes all signal, except that the VARIABLE offset control remains effective. When the PULSE waveform is being used, the established pulse width must be fully consistent with dial frequency (considering a worst-case duty cycle limitation of 75%).

WIDTH-VAR SYM control acts as a vernier for pulse width whenever the PULSE waveform is selected. When the FREQUENCY MULTIIPLIER is at the VAR SYM, X0.1 position, the WIDTH-VAR SYM control is used to adjust time symmetry of the sine, triangle, or rectangular waveforms.

Pulling the WIDTH-VAR SYM control will at all times invert the waveform phase or polarity (using SYNC OUT as a phase reference).

h. OUTPUT LEVEL Selector (with concentric vernier).

The OUTPUT LEVEL selector is a four-position attenuator switch. Total attenuation is -60 dB in -20 dB increments (10:1 voltage ratio) exclusive of an additional 20 dB from the OUTPUT LEVEL vernier. The OUTPUT LEVEL vernier is calibrated for maximum output when rotated fully clockwise. For full counterclockwise rotation, output signal level is reduced by more than 20 dB.

i. SWEEP TIME Selector (with concentric vernier and (F77 Model only) PULL FOR LOG SWEEP switch)

The SWEEP TIME selector is an eight-position switch which establishes the 100:1 adjustment range of its associated vernier. Total range of sweep time is from 10 microseconds to 1000 seconds. The sweep generator can be active at all times (even in modes where the sweep generator is not actually required), and a 0 to +3 volt output from 600 ohms may be obtained at the FREQ ANALOG/SWEEP RAMP monitoring connector. There is an OFF position for the SWEEP TIME selector which should be utilized whenever sweep waveforms are not needed. Sweep flyback time for the fastest sweep time range is approximately 6 microseconds. For other ranges, it is approximately 10% of the minimum sweep time for that range.

The SWEEP TIME VERNIER provides 100:1 adjustment of sweep time within any given range.

The PULL for LOG SWEEP (on F77 Model only) replaces the linear sweep ramp with a logarithmic ramp; sweep time per octave remains constant. The lower frequency portions of the swept frequency waveform are then appreciably more visible than they are for a linear sweep. Selection of log sweep will not affect (1) the internal use of linear sweep in the BURST mode and (2) the waveform at the SWEEP RAMP monitor connector, which will remain linear. The latter is necessary where, for example, an X-Y recorder is used to plot response curves on log-frequency chart paper. It is also important to note that the calibration of the main frequency dial and the SWEEP LIMIT control is not affected by use of log sweep.

j. PHASE (with PULL for SWEEP DOWN Switch).

The PHASE control is used in the TRIGGERED, GATED or TRIGGER SWEEP modes. For square or pulse waveforms, the baseline remains fixed, but the time delay between the trigger or gate signal and the initial output transition becomes the adjustable variable. The PHASE control has no effect on DC, or SWEEP RAMP waveforms.

The PULL (SWEEP DOWN) control is used where it is necessary to initiate the sweep at the highest frequency, as opposed to the usual convention of beginning the sweep at low frequency.

k. TRIGGER LEVEL Control (with PULL for - SLOPE Switch).

The TRIGGER LEVEL adjustment establishes the threshold level of an external voltage applied at the TRIG-SYNC input connector. The threshold is adjustable to occur anywhere in the region between +5 and -5 volts.

Under unusual conditions, where fast rise/fall time pulses are utilized as an input, the TRIGGER LEVEL control can be adjusted not only for the usual level sensitivity, but also for an effect best described as "edge triggering". In other words, a type of dv/dt sensitivity can be obtained which will cause the input pulse to be effectively differentiated. Should this occur, the output of the Schmitt trigger will consist of narrow spikes whose width is unrelated to the true width of the actual input pulse. When in "trigger" modes, the effect will be that triggering can occur on the wrong edge of the input pulse. In the gate mode, the effect will be one of an incorrect gate time. In either case, additional care in adjustment of the control should be used to reject this "edge triggered" condition.

When the PULL (SLOPE) switch is pushed all the way in, the instrument will respond to a positive-going trigger input. The switch is simply pulled out for response to a negative-going trigger.

1. FREQ ANALOG/SWEEP RAMP Selector (with associated monitor connector).

When FREQ ANALOG is selected, there is a nominal zero to +3 volt output from the monitor BNC connector. Zero volts represents minimum frequency, with linear response to maximum frequency (3 volts). This analog voltage represents the summation of three possible frequency-determining inputs: dial, sweep, and VCF input.

The selection of SWEEP RAMP causes the monitor output to be a 0 to +3 volt linear sweep waveform in accordance with the setting

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of the sweep generator. Note that, even for non-sweeping modes of the main generator, the sweep ramp can be available as a completely independent output. There is, however, an OFF position on the SWEEP TIME selector for disabling the sweep generator at times when it is not actually being used.

m. TRIG-SYNC IN and VCF IN Input Connectors.

TRIG-SYNC IN will accept an input level between 1V p-p and 50V p-p. The level may be ac, dc, or pulsed. A threshold level, at which a Schmitt trigger circuit changes state, is adjustable between the limits of ±5 volts by the TRIGGER LEVEL control (refer also to paragraph k). Input impedance is 10K ohms shunted by about 50 pF. For inputs having frequency components above a few MHz, it is recommended that a source impedance of 50 ohms be employed. The derived trigger signal is used in conjunction with the TRIGGERED, GATED, TRIGGER SWEEP, and SWEEP & HOLD modes. When operating in CONTINUOUS mode, the function generator frequency will be "pulled" to match the repetition rate of the external periodic signal and will synchronize the internally generated frequency if the instrument dial settings are within 1% of the external frequency. This synchronizing action is useful for harmonics and subharmonics out to about the 10th order. NOTE: Be certain to remove the external trigger signal when it is not in use, because it will introduce phase jitter when not synchronized.

VCF IN (Voltage-Controller Frequency) requires a nominal 0 to +5 voltage swing to control the main generator frequency between .001 full scale and full scale. Input impedance is 7.5K ohms. Any signal present at the input is summed with dial and sweep commands.

VCF input voltage span is 5 volts for changing frequency over full dial range. Input is added to dial voltage; thus input is 0 to +5 volts for dial at low stop and 0 to -5 volts at high stop. Set dial at desired midfrequency for use with bipolar VCF inputs.

VCF Input Sensitivity (Hz/Volt Nominal) vs. Range and Dial Scale

	DIAL SCALE		
Mult. Range	Var Sym X.1	Sym X1	Sym X2
X1M	0.2×10^{6}	2×10^{6}	4×10^{6}
X100K	20×10^{3}	0.2×10^{6}	0.4×10^{6}
X10K	2×10^{3}	20×10^{3}	40×10^{3}
.	.	.	.
.	.	.	.
.	.	.	.
X0.001	0.2×10^{-3}	2×10^{-3}	4×10^{-3}

- Frequency-Change Slew Rates Considerations - VCF bandwidth is nominally 100 kHz, but slew rate limits may force a decrease in peak-to-peak frequency swing as modulation rates approach 100 kHz. Typical input slew rate limit is 0.3V/μsec, which relates to six minor dial divisions per microsecond.

- Phase-lock Loop Applications - Phase-lock loop parameters are directly affected by the VCO gain constant (K_O) and intrinsic stability of the VCO. The 1000:1 continuous tuning range of the Series 70 generators provides the designer some latitude in selecting K_O

because the same frequency can usually be selected on any of three ranges (see above table). Minimum VCO noise jitter will be realized at the high end of the dial. Loop bandwidth (B) should not be less than 0.1 percent of the operating frequency as a rule.

n. OUTPUT, SYNC OUT, and SWEEP SYNC Output Connectors.

The OUTPUT connector delivers the main generator signal from a 50-ohm source impedance. The maximum p-p voltage levels into a 50 ohm load are as indicated on the OUTPUT LEVEL selector; into a high-impedance load, levels are twice the indicated values. This output is short-circuitproof.

SYNC OUT is a rectangular wave, TTL compatible level (0 to +3V into a standard TTL load). Source impedance is 50 ohms. The SYNC OUT signal is derived from the main loop square waveform when the WAVEFORM Selector switch is set at ∿, ⩘, ⎍ or PULSE. If DC or SWEEP RAMP waveforms are selected, the SYNC OUT signal is derived from an external signal connected to the TRIG-SYNC IN BNC. A phasing diagram for main loop waveform vs. SYNC is shown in Figure 2-2.

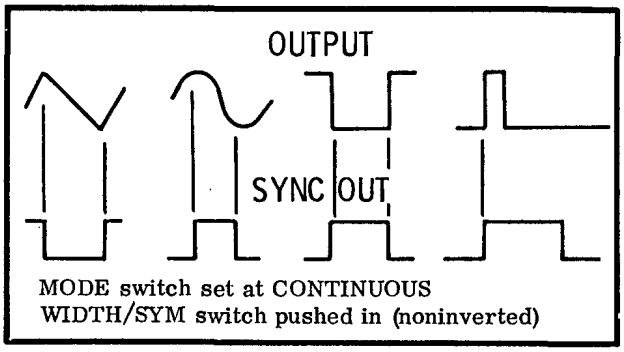

Figure 2-2. OUTPUT/SYNC OUT PHASE RELATIONSHIPS

In the triggered pulse mode only, the sync transition is coincident with the externally supplied trigger signal (or with actuation of the MANUAL TRIGGER OR GATE toggle switch).

The SWEEP SYNC connector (on the rear panel of F77 Models only) outputs a TTL compatible level during sweep time. The level is normally near ground, goes high (≈+3V) when the sweep ramp starts, and returns to ground during sweep retrace. The source impedance is 50 ohms. In the Model F74, sweep sync can be obtained from the SWEEP RAMP monitor connector.

o. AMPL IN connector (rear panel, F77 Model only).

An external signal may be amplified by the main generator output amplifier by connecting the external signal to the AMPL IN connector and selecting DC on the WAVEFORM switch. The PULL (INVERT WAVEFORM) and OFFSET switches will remain fully active. Amplifier input impedance is 50 ohms; thus, injecting a signal from a high-impedance source may result in a net signal attenuation, since the amplifier gain is only X6. To use this amplifier as a 50-ohm line driver for digital signals, the desired TTL or ECL signal must be connected to the TRIG-SYNC IN connector and jumpered between the front panel SYNC OUT and the rear panel AMPL IN connectors.

p. VOLTAGE Selector (Rear Panel)

Four distinct ranges of ac input voltage may be employed to power this instrument. One rear-panel selector switch is for nominal 115 or 230-volt operation. The second switch is used in the NORMAL position if line

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voltages are nominal ±10%. A LOW position permits operation at 100V or 200V ±10%.

CAUTION

Long-term operation in the LOW position when the VOLTAGE SELECTOR should be in NORMAL will result in excessive heat buildup within the instrument and eventually blow the fuse.

CAUTION

Operation from a 230-volt line with the selector switch in the 115-volt position will damage this instrument. Be sure to check the rating of the installed fuse before applying power. For 90-126 volts, use a 3/4-amp Slo Blo fuse; 180-252 volts, use a 3/8-amp Slo Blo fuse.

NOTES

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Section 3
CIRCUIT DESCRIPTION

3-1. INTRODUCTION

The simplified block diagram (Figure 3-1) indicates the major functional circuit groupings of the instrument. A detailed circuit schematic is included at the back of this manual. Each basic circuit group has been given an alphanumeric designation according to function. The two circuitboards are designated A1 and A2. Components of the system are coded with numbers that relate them to the respective circuitboards. For example, A1-Q301 refers to transistor Q1 located in the 3XX, or logic circuit group, on circuitboard A1. The series designations are indicated in parentheses in the following paragraph descriptions. Front panel controls are assigned a basic one- or two-digit designator, with no prefix. For example, R4 is the potentiometer connected to the main frequency dial.

3-2. POWER SUPPLY (Code A1-9XX)

a. Unregulated DC and Rectifiers

Five unregulated dc voltages, nominally +32, -32, +20, -20, and +8 volts, are provided as inputs to conventional series-regulator circuits. Center-tapped transformer windings and 5 sets of full-wave rectifiers, plus filter capacitors, are used. The regulated dc voltages developed from these raw supplies are +25, +15, +5, -25, and -15 volts. Regulated -5 volts is derived from the regulated -15 volt bus.

b. Regulator Circuits

Of the six regulated dc voltages, four are interconnected for proportional tracking (+15, -15, +25, and -25 volts). The +15 volt circuit is the master and is adjustable by R934. Dual operational amplifiers IC901 and IC902 contain the four high-gain regulating amplifiers. Q909, Q910, Q911 and Q912 provide for current limiting as protection against accidental overload or short circuit.

The +5 and -5 volt regulated voltages are nonadjustable and nontracking. The regulator for +5 volts is a single integrated circuit package (IC903) in which protective thermal shutdown is an inherent feature. The -5 volts, due to a relatively noncritical low-current usage, is derived from -15 volts by means of a simple two-transistor circuit (Q913 and Q914).

3-3. MAIN LOOP (Triangle Generator, Code A1-1XX)

The main-loop circuits control the linear charge and discharge of selectable timing capacitors C201 through C208. Controllable currents, in accordance with frequency-dial setting, VCF input voltage, operating mode, etc, are caused to alternately charge and discharge the timing capacitor between fixed amplitude limits. The result is always a triangular-shaped waveform of constant

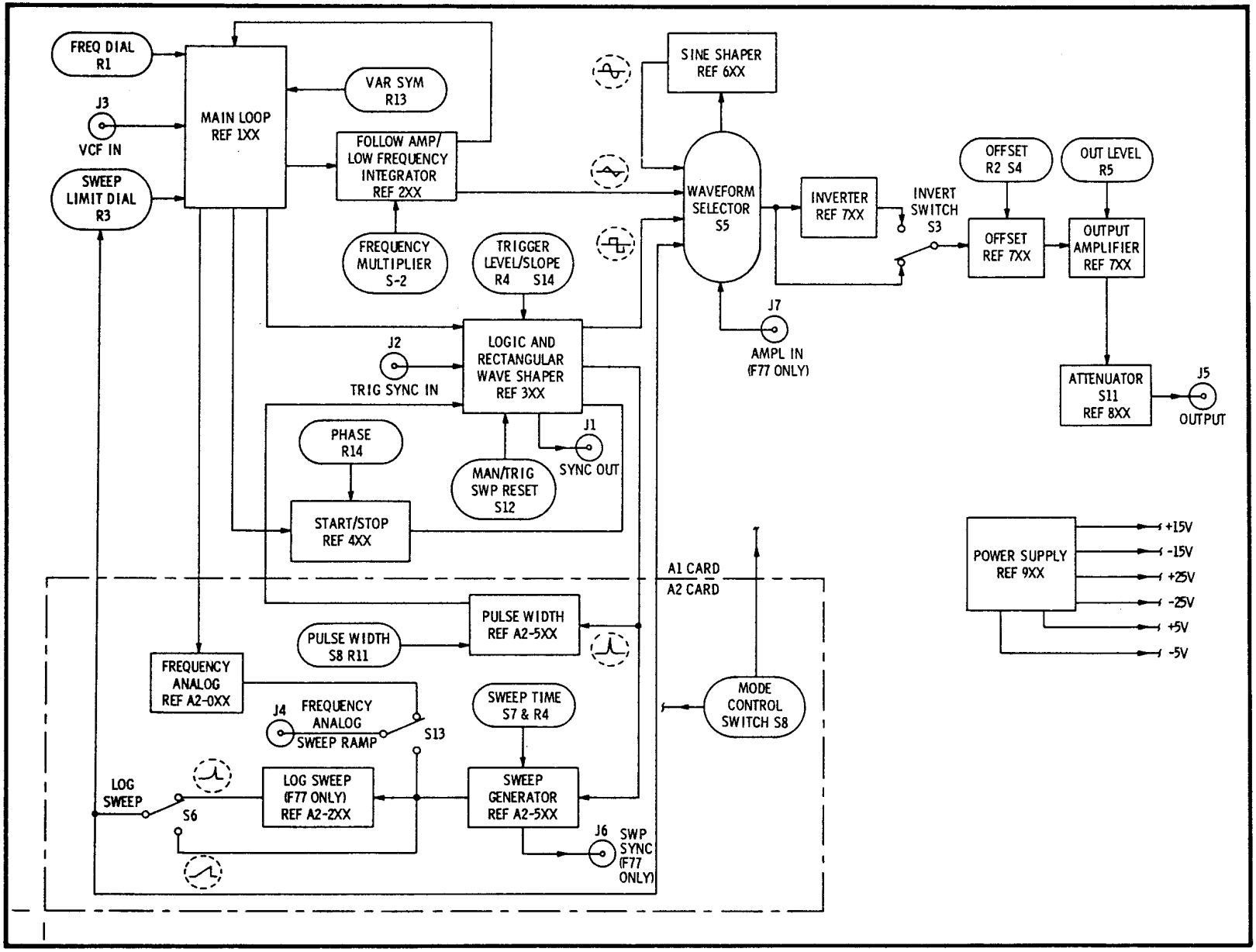

Figure 3-1. 20MHz Sweep Function Generator (F74/F77 Models) — Simplified Block Diagram

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amplitude. The amplitude is established at 5V p-p by hysteresis switch IC103. Frequency is a function of the selectable timing capacitor value and of the controllable charge and discharge currents.

a. Current Control

The front panel frequency-dial control, R1, is one of several inputs to operational amplifier IC101. Other inputs to IC101 are from the the VCF input, J3, and from the SWEEP LIMIT control, R3. Following IC101 are two parallel voltage-to-current converters, which utilize the dual operational amplifiers of IC102, plus Q104 and Q119. The output from Q119 becomes the discharge current for the selectable timing capacitor. The charging current is derived from the current output of Q103 via current mirror IC104.

Quad current switches Q106, Q107, Q120, and Q121, controlled in accordance with peak amplitudes of the timing capacitor, direct the flow of charge and discharge currents, with the result being the desired triangular voltage waveform.

b. Voltage Level Sensor

The triangular voltage waveform at the timing capacitor, following necessary buffering by the follow amplifier (paragraph 3.4), is used as an input to the voltage-level sensor, IC103. Controls R154, R185 and C117 permit the adjustment of triangle p-p amplitude, dc offset, and high-frequency amplitude flatness, respectively.

There are two digital outputs from the voltage-level sensor. One output, from pins 6 and 11 of IC103, directly controls the operation of the quad current switch, which reverses the polarity of current flow to the timing capacitor. This same output, buffered via Q110, is transmitted to the instrument logic section (Code A1-3XX). It is used to derive sync output as well as provide for the generation of a rectangular waveform.

Transistor Q114 is used to couple a portion of a necessary high-frequency amplitude compensation signal between the follow amplifier and the voltage-level sensor input via network C216, R223, and C217. Q114 also serves to couple a sync pulse from Q102 when frequency is to be synchronized to an external source.

3-4. FOLLOW AMPLIFIER/LOW FREQUENCY INTEGRATOR (Code A1-2XX)

a. Follow Amplifier

The follow amplifier is a three-stage, unity-voltage-gain, wideband power amplifier, configured with FET input Q204 and with low-impedance (50-ohm) output stages Q208 and Q210. Its functions are (1) to provide a minimal loading of the timing capacitor and (2) to deliver a low-distortion triangle wave to low-impedance instrument circuits. The amplitude-determining signal to the voltage-level sensor is taken just ahead of the final output at IC202. This avoids the extra propagation delay of the output driver, which is important to performance on the highest frequency ranges.

b. Low-Frequency Integrator

The low-frequency ranges of the instrument (X10 and below) utilize a conventional operational amplifier integrator (1/2 of IC201), with a 5-microfarad feedback capacitor, C210. The small currents (1μa full scale on the X.001 range) are determined by range selection, using scaling resistors R231 through R237.

The second half of IC201 serves as a current-to-voltage converter, interfacing the quad current switch at relatively high current level (16 ma full scale) to the voltage source of the operational amplifier integrator.

3-5. START/STOP (Code A1-4XX)

The start/stop section provides digital and analog control for those modes of operation where a dc baseline must be part of the output waveform. IC402 accepts start and stop commands from the logic section (Code A1-3XX), and also provides for synchronizing those commands with the state of the main-loop voltage-level sensor. In this way, incomplete or fractional cycles are never permitted. Whenever the output of IC402 (TP401) is high ($\approx$ +3V), the main loop will run. Whenever TP401 goes low, the differential amplifier of IC401 becomes active, sinking current from the main loop via CR408. In the active condition, IC401 is in essence a regulating amplifier, with its loop closed around the timing capacitor (and, at low frequencies, around the low-frequency integrator). The nature of this regulator action is to cause a specific dc voltage to be established across the timing capacitor, which then appears as a waveform baseline at the final instrument output. For sine and triangular waveforms, this baseline is adjustable by means of front-panel PHASE control, R14.

3-6. SINE SHAPER (Code A1-6XX)

Sine waves are produced by shaping the triangle waveform with a nonlinear diode-resistor network. Matched sets of hot-carrier diodes, CR601 through CR605 and CR607 through CR611, in conjunction with resistor networks R609, R614, and R616, load the triangle and thereby inscribe a sine wave into the original triangle waveform. IC601 is the basis for a buffer amplifier, which reconstitutes the peak-to-peak amplitude of the sine wave to the same amplitude as the incoming triangle (5V p-p from 50 ohms). Potentiometer R635 adjusts the gain of the buffer amplifier.

3-7. LOGIC/RECTANGULAR WAVE SHAPER (Code A1-4XX)

This section handles the bulk of digital-type operations within the instrument, including steering of control signals for mode selection.

a. Logic

Shaping and steering of SYNC IN, J2, is done via Q301 and IC301. Q301 and part of IC301 are configured as a Schmitt trigger for squaring the edge of any input waveshape. IC302 provides switch debouncing for momentary panel switch S12. IC303 and IC304 steer selected signals, depending on mode and waveform, between the A1 and A2 board to the SYNC OUT driver, Q305, and to the rectangular wave shaper, Q306-Q309.

b. Rectangular Wave Shaper

The conversion from TTL logic level to a bipolar, standardized, high-quality rectangular waveform is accomplished by shaper/amplifier Q306-Q309. The peak levels of the output at TP303 are established by adjustments of R326 and R336. The output from TP303 is active only for rectangular or pulse waveform selection.

3-8. INVERTER/OFFSET/OUTPUT AMPLIFIER (Code A1-7XX)

The selected waveform from panel waveform control S5 is passed sequentially through inverter and offset circuits, as selected via

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S3 and S4, then to output-level control R5 and to the output amplifier. Finally, a 50-ohm switchable attenuator (Code 8XX) completes the signal flow to the OUTPUT BNC connector, J5.

a. Inverter Amplifier

A fast, unity-gain inverting amplifier is built around IC702. The amplifier is active in all modes and for all waveforms. Pull-to-invert switch S3 simply selects either the input or output, sending the resultant signal on to the offset and output amplifier circuits.

b. Offset

Resistor networks, switchable by S4, introduce a desired degree of offset and attenuation into the selected waveform. Potentiometers R702 and R707 serve to adjust the peak of fixed offset waveforms to zero volts.

c. Output Amplifier

The output amplifier, due to the need for quite fast circuits at relatively high voltage swings, is largely comprised of discrete transistors. However, a single, integrated circuit, IC701, does provide for low-drift, low-distortion characteristics from dc through 200 kHz. At frequencies above 200 kHz, there is an automatic crossover to stages which are better equipped to handle high-frequency waveforms, specifically Q709 through Q712. The result is effectively a two-channel amplifier where the summation of channels is at the bases of Q709 through Q712. Pre-driver stages Q705 and Q713 operate into resistive load R763 and R764, followed by complementary emitter-follower drivers Q708 and Q715. Field-effect transistor switches Q701, Q702 and Q703 program feedback paths in accordance with the waveform selected, thereby optimizing rise/fall time for rectangular and pulse waveforms and maximizing waveform fidelity for sine and triangular waveforms.

3-9. SWEEP GENERATOR (Code A2-0XX)

The sweep-generator waveform is derived from an operational integrator and buffer amplifier, each built around half of IC001. Control of the sweep time (and of sweep retrace) is effected by resistance-capacitance-diode networks which are switchable via SWEEP TIME selector S7, in conjunction with vernier potentiometer R4. The basic sweep waveform, as generated at IC001, is a 0 to +3 volt ramp. Voltage comparator IC003 establishes the ramp starting and finishing levels. Transistors Q003 and Q004 are drivers which establish integrator current during retrace.

The OFF position of SWEEP TIME, as well as the TRIGGER SWEEP and SWEEP & HOLD modes of instrument operation, require that the sweep integrator be stalled at the zero-volt level for at least a part of its cycle. This is accomplished by turning transistor Q002 on, which is then essentially a short across the integrator feedback capacitor.

Both SWEEP & HOLD and TRIGGER SWEEP modes require that the ramp start from zero volts and hold at the +3 volt level until commanded to reset. In the case of SWEEP AND HOLD, the reset can only be done by activating SWEEP RESET switch S12 located in logic section A1-3XX). For triggered sweep the reset is automatic for each manual or remote trigger command. The logic for this sequence is provided for by IC005. Transistor switch Q007 transfers between the integrator ramp and a static +3 volt holding level. Trimmer R064 precisely adjusts the +3 volt holding level.

Scaling and buffer amplifiers IC002 provide "sweep up" and "sweep down" capability plus a frequency analog output signal. Logic control for the various sweep generator modes, and, in addition, a driver for sweep sync output transistor Q010, is provided by IC004. IC006, a 10-μsec, one-shot multivibrator, permits stabilization of the analog sweep level at zero volts prior to release of the main generator for a TRIGGERED SWEEP cycle.

3-10. LOG SWEEP CONVERTER (Code A2-2XX)

The conversion from a linear sweep ramp to a logarithmic waveform is accomplished by IC201, IC202, and IC203. The base-to-emitter characteristic of a reference transistor in IC201 is used as the conversion element. For optimum precision, IC201 is temperature-regulated through control of on-chip heating. Half of IC202 is used as a regulating amplifier for temperature control of IC201, and the other half is used as an input scaling amplifier to interface with the logarithmic transistor. Output amplifier IC203 converts the logarithmic current to a 0 to +3 volt sweep level.

3-11. PULSE WIDTH GENERATOR (Code A2-5XX)

The pulse-width generator is a variable timing circuit with a range of control from $<$30 nsec to $>$10 msec. The circuit is triggered from, and its output is returned to, the logic section of the main generator (A1 card). A controllable current, via Q501, charges a selectable timing capacitance at node TP501. When the timing capacitance charges to a 2.2-volt level, Q503 operates and causes the timing capacitor to reset to its quiescent state, awaiting a subsequent retrigger. The output, at TP502, is TTL-compatible.

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Section 4
CALIBRATION AND PERFORMANCE

4-1. INTRODUCTION

This section contains procedures used for receiving inspection and for completely calibrating all elements of the instrument. Table 4-1 is a list of recommended test equipment required to perform the calibration procedures. Table 4-2 is a suggested simple Receiving Inspection Test which effectively checks all functions, controls, and connectors for proper operation. Complete procedures for calibrating the instrument are given in Tables 4-3 and 4-4.

4-2 TEST POINTS AND ADJUSTMENTS

The locations of test points and adjustments are shown in Figures 4-1 (A1 adjustments), 4-2 (A1 Test Points), and 4-3 (A2 Adjustments and Test Points).

TABLE 4-1. TEST EQUIPMENT REQUIRED FOR CALIBRATION

Test Equipment	Suggested Model
Digital Voltmeter	John Fluke 8300A
Counter	HP 5326A
Oscilloscope	Tektronix 454 or 475
Function Generator	IEC F31-F37 or IEC F51-F55
Distortion Analyzer	HP 331A

TABLE 4-2. RECEIVING INSPECTION TEST

Procedure	Setup	Step
1	Set VOLTAGE SELECTOR switches on rear panel for proper line voltage. NOTE: Make certain that the proper fuse is installed for the voltage selected.	
2	Turn power switch on. Switch will illuminate.	
3	Attach oscilloscope and cable with 50-ohm termination to OUTPUT connector. Set instrument controls as follows: Frequency dial: 10 (1X scale) FREQUENCY MULTIPLIER switch: X10 Symmetry switch (concentric with FREQUENCY MULTIPLIER switch): X1 OFFSET switch: ⏦ WAVEFORM switch: ∿ SWEEP TIME switch: 100 μs Sweep vernier (concentric with SWEEP TIME switch): CAL MODE switch: CONTINUOUS OUTPUT LEVEL switch: 15V Output vernier (concentric with OUTPUT LEVEL switch): CAL	15V p-p sine wave should appear on oscilloscope.
4	Set FREQUENCY MULTIPLIER switch at X100.	15V p-p sine wave should appear on oscilloscope.
5	Turn symmetry switch to X2 position.	Frequency doubling should occur.

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Table 4-2. Receiving Inspection Test (Continued)

Procedure	Setup	Step
6	Turn symmetry switch to X0. 1 position.	Vary symmetry vernier (concentric with WAVEFORM switch); waveform symmetry should change.
7	Turn symmetry switch to X1 position.	Turn WAVEFORM switch successively to ⩘, ⊓, and SWEEP RAMP positions; proper waveforms should be displayed on oscilloscope. Pull INVERT switch (concentric with WAVEFORM switch); sweep ramp waveform inversion should occur.
8	With WAVEFORM switch at SWEEP RAMP position (F77 Model ONLY).	Operate PULL (LOG SWEEP) switch (concentric with SWEEP TIME switch); logarithmic waveform should appear.
9	Turn WAVEFORM switch to PULSE position.	(a) Vary pulse symmetry vernier (concentric with WAVEFORM switch); 15V p-p pulse of varying width should appear. (b) Rotate PULSE WIDTH switch (concentric with MODE switch); step changes in pulse width should occur.
10	Turn WAVEFORM switch to DC position; turn OFFSET switch to VARIABLE position.	Rotate OFFSET vernier; baseline should shift from -7. 5V to +7. 5V.
11	Turn WAVEFORM switch to ∿ position; turn OFFSET switch to ⊼ position.	7. 5V p-p sine wave unipolar negative should appear.
12	Turn OFFSET switch to ⊻ position.	7. 5V p-p sine wave unipolar position should appear.
13	Turn OFFSET switch to ⊽ position.	Rotate OUTPUT LEVEL switch to 1. 5V, 150mV, and 15mV. Appropriate 10:1 variations in amplitude should appear.

Table 4-2. Receiving Inspection Test (Continued)

Procedure	Setup	Step
14	Turn OUTPUT LEVEL switch to 15V position.	Remove oscilloscope cable from OUTPUT and connect to SYNC OUT connector; >1V p-p rectangular waveform should appear.
15	Remove 50-ohm termination from scope cable and attach cable to FREQ ANALOG/SWEEP RAMP monitor. Place toggle switch in FREQ ANALOG position.	DC baseline should vary from 0V to +3V as frequency dial is rotated from CW to CCW stops.
16	Place FREQ ANALOG/SWEEP RAMP switch in SWEEP RAMP position.	Approximately 3V p-p sweep ramp waveform should appear.
17	Remove scope cable from SWEEP RAMP connector and attach to SWP SYNC connector (on rear panel F77 Model only).	Approximately 3V p-p rectangular waveform should appear.
18	Reinstall 50-ohm termination on oscilloscope cable; attach scope cable to OUTPUT connector. Connect separate cable between Sweep Ramp monitor and VCF IN connectors.	
	Set frequency dial at 1 (X1 scale); turn SWEEP TIME switch to 1s position.	Scope should display frequency modulation.
19	Disconnect cable from VCF IN connector and attach to TRIG-SYNC IN connector. Turn Frequency Multiplier to X100K range.	Rotate TRIGGER LEVEL control to achieve repetitive single-cycle waveform. Vary PHASE control and check that baseline between cycles can be varied from negative to positive waveform peaks.
	Turn MODE switch to TRIGGERED position; turn SWEEP TIME switch to 100μs position.	

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Table 4-2. Receiving Inspection Test (Continued)

Procedure	Setup	Step
20	Turn MODE switch to GATED position.	Set control for maximum length. Pull slope switch outward (-SLOPE). Observe absence of wavetrain. Rotate TRIGGER LEVEL control and observe appearance of wavetrain.
21	Disconnect cable from TRIG-SYNC IN and FREQ ANALOG/SWEEP RAMP connectors. Turn MODE switch to CONTINUOUS SWEEP position; turn SWEEP TIME switch to 1s position; set frequency dial at 1 (X1 scale).	Check that swept waveform frequency variation is controlled by SWEEP LIMIT cursor position.
22	Turn MODE switch to TRIGGER SWEEP; set SWEEP LIMIT cursor at 10.	Swept frequency burst should occur when MANUAL TRIGGER switch is operated.
23	Turn MODE switch to SWEEP & HOLD position.	(a) Frequency should shift from low to high when MANUAL TRIGGER switch is operated. Operate SWEEP RESET switch; frequency should return to low frequency. (b) Operate PULL (SWEEP DOWN) switch (on PHASE control) and repeat step (a). Frequency should shift from high to low.
24	Turn MODE switch to BURST position.	Burst of constant frequency cycles should occur, with burst length controlled by manipulation of TRIGGER LEVEL control.
25	Turn WAVEFORM switch to DC position; connect separate cable between SWEEP RAMP monitor and AMPL IN (located on rear panel) connectors (F77 Model only).	Sweep ramp waveform of ≈ 0.25 p-p should appear.

TABLE 4-3. CALIBRATION PROCEDURE — A1 Boards, 70 Series

Initial Control Settings (Standard)		
Control	Switch Function/Position	Setting
FREQUENCY MULTIPLIER Selector	Outer Switch (Ⓞ)	X100
	Inner Switch (⊙)	X1
Frequency Dial	X1 Scale	8.00
OFFSET Selector	Outer Switch (Ⓞ)	∿
WAVEFORM Selector	Outer Switch (Ⓞ)	⋀
	Inner Switch (Noninverted) (⊙)	Pushed in
	WIDTH/VAR SYM (Inner Sw)	Fully CW
SWEEP TIME Selector	Outer Switch (Ⓞ)	OFF
	Vernier (Inner Sw) (⊙)	CAL
	Linear Sweep (⊙)	Inner Switch pushed in (F77 Model only)
MODE Selector	Outer Switch (Ⓞ)	CONTINUOUS
	PULSE WIDTH (Inner Sw) (⊙)	1-100 μs
OUTPUT LEVEL Selector	Outer Switch (Ⓞ)	15V
	Vernier (Inner Sw) (⊙)	CAL
FREQ ANALOG/SWEEP RAMP Switch		SWEEP RAMP

CAUTION NO EXTERNAL INPUTS SHOULD BE CONNECTED UNLESS SPECIFICALLY CALLED FOR IN PROCEDURE.

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
1.0	POWER SUPPLY (A1, 9XX)	ON	DVM (DC)	a. Connect DVM to +15 TP. b. Adjust R934 for +15±0.04v.
2.0	TRIANGLE GENERATION (A1, 1XX & 2XX)			

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Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
2. a.	Level Adjustment	Std	DVM (DC)	(1) Connect TP203 to gnd w/clip lead. (2) Connect DVM to TP205. (3) Turn WAVEFORM switch to DC. (4) Adjust R216 (Chg. DC) to -3.5 ±0.1V. (5) Remove clip lead from TP203.
b.	Amplitude Adjustment	Std	DVM (DC) DVM (AC) (Average reading calibrated for RMS sine wave)	(1) Connect DVM (DC) to TP205. (2) Connect DVM (AC) to TP104 (IC 202 Pin 6). (3) Turn WAVEFORM switch to ∿. (4) Alternately adjust R154 (Δ AC) & R185 (Δ DC), until final result is (a) DMV (AC) = 1.388±0.01V (b) DMV (DC) = 0.000±0.01V.
c.	Switch Symmetry	Std	DVM (DC)	(1) Connect DVM (DC) between TP103 & TP102 (use floating DVM terminals with respect to gnd). (2) Adjust R142 (Sw. Sym) to 0 ±0.02V.
d.	Triangle Symmetry	Std	Counter (time interval)	(1) Connect both inputs of counter to SYNC OUT BNC. (2) Arrange start & stop inputs to counter so that adjustment of R121 (HI SYM) has no effect on counter (≈625 μs). (3) Record measured time interval to within 1μs.

Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Pro-cedure	Calibration	Control Setting	Test Equipment (Mode)	Step
2.d. (Cont.)				(4) Reverse start & stop inputs to counter. (5) Adjust R121 (HI SYM) within ±2 μs of value recorded in step c above.
e.	Low-End Triangle Symmetry	Std, except FREQUENCY MULTIPLIER set at X10K	Scope (DC) Counter (Freq) DVM (D)	(1) Connect scope to TP205. (2) Connect DVM (DC) to frequency dial potentiometer wiper (R4). (3) Connect counter to SYNC OUT BNC. (4) Set frequency dial at its low-frequency stop. Observe DVM (DC) reading of +125 ±25 mV. If necessary, readjust mechanical position of potentiometer body. (5) Set main frequency dial for a DVM reading of 200 ±10mV. (6) Adjust R104 (lo fine) to approximately midrange. (7) Alternately adjust R106 (lo coarse) and R125 (low sym) for symmetrical triangle (scope accuracy at TP205), at frequency between 200 & 400 Hz. (8) Alternately adjust R104 (lo fine) and R125 (low sym) for symmetrical triangle (scope accuracy at TP205), at frequency of 300 ±25 Hz. (9) Set frequency dial at CW stop and observe a measured frequency of <180 Hz.

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Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
3.	OUTPUT AMPLIFIER (A1, 7XX)	Std	DVM (AC) (Average reading calibrated for RMS sine wave) Scope (AC)	
a.	Gain			(1) Connect 50-ohm, 2W, ±0.25% load to OUTPUT BNC. (2) Connect DVM across load. (3) Adjust R754 (HF#1) and R757 (HF#2) to approximately midrotation. (4) Adjust R725 (~/Δ) for reaching of 4.16 ±0.02 VRMS (15V p-p). (5) Connect scope to TP704; turn OUTPUT LEVEL control for approximately half amplitude. (6) Observing amplitude of signal present at TP704, adjust R754 (HF#1) so that its amplitude is reduced by nominally one half. (7) Adjust R757 (HF#2) for an optimum null of the signal at TP704. (8) Turn OUTPUT LEVEL control (inner shaft) to CAL position. (9) Recheck adjustment of steps (4) through (8) above.
3.b.	Offset	Std	DVM (DC) DVM (AC)	(1) Connect DVM (AC) to OUTPUT BNC, using 50-ohm termination.

Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Pro-cedure	Calibration	Control Setting	Test Equipment (Mode)	Step
3.b. Cont.				(2) Adjust OUTPUT LEVEL control for 3.6 ±0.1Vac. (3) Connect DVM (DC) to the output load. (4) Adjust R724 (DC) for 0±0.01Vdc.
c.	Baseline Adjustment			(1) Connect scope to OUTPUT BNC with 50-ohm termination. (2) Adjust output level for approximately 8V p-p. (3) Turn OFFSET switch to ⏦. (4) Using 1 V/cm scope calibration, adjust R707 (Pos Offset) for zero-volt baseline. (5) Turn OFFSET switch to ⏦. (6) Using 1 V/cm scope calibration, adjust R702 (Neg. Offset) for zero-volt baseline. (7) Recheck Procedures 3b(1) through 3c(6).
4.	SQUAREWAVE (A1, 3XX)	Std	Scope (DC) DVM (DC)	
a.	Driver Adjustment			(1) Connect scope (DC) to TP205 and calibrate scope gain for p-p display of precisely full scale. (2) Turn WAVEFORM switch to ⎍. (3) Connect scope and DVM (DC) to TP303.

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Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

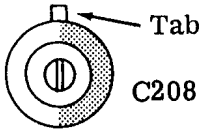
Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
4.a. Cont.				(4) Alternately adjust R326 (⎍ pos) ± R336 (⎍ neg) for scope display of full scale and DVM (DC) = 0. ± 0.02V.
b.	Output Adjustment (Gain Balance)	Std, except set WAVEFORM switch at ⎍ and FREQUENCY MULTIPLIER at X10K	Scope (DC)	(1) Adjust OUTPUT LEVEL control to ≈ 2/3 max (10v p-p). (2) Connect scope to OUTPUT BNC with 50-ohm termination. (3) Adjust R731 (⎍ wave) for optimum squareness of the corners of the waveform.
5.	FREQUENCY (A1, 2XX)			
a.	10-MHz Calibration	Std, except set FREQUENCY MULTIPLIER at X1M	Counter (Freq) scope (DC)	(1) Connect count to SYNC OUT BNC. (2) Adjust C208 to midrange.  (3) Connect scope to OUTPUT BNC, using a 50-ohm wideband termination; adjust OUTPUT LEVEL control (inner switch) to approximately 2/3 max. (4) Manually tune from low to high frequency, and adjust C117 for most uniform response throughout range. (5) With frequency dial at 10 (X1 calibration), adjust C208 for 10 ± 0.1 MHz.

Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Pro-cedure	Calibration	Control Setting	Test Equipment (Mode)	Step
5. a. Cont.				(6) If there is any noticeable dc offset to 10 MHz waveform, adjust R142 (Sw. Sym) for minimum offset. (7) Recheck steps (4), (5), and (6).
b.	20-MHz Calibration	Std, except set FREQUENCY MULTIPLIER at X1Nm X2F	Counter (Freq)	(1) Connect counter to SYNC OUT BNC. (2) Set frequency dial at 20 (3) Adjust C122 for 20 ±0. 2 MHz. (4) Repeat Procedure 5. a, steps (4) through (6) and 5. b, steps (1) through (3).
c.	1 kHz to 100 kHz CALIBRATION	Std	Counter (Freq)	(1) Connect counter to SYNC OUT BNC. (2) Adjust R267 (1kHz) to 800 ±4 Hz. (3) Turn FREQUENCY MULTIPLIER switch to X1K (4) Adjust R268 (10kHz) to 8. 00 ± 0. 04 kHz (5) Turn FREQUENCY MULTIPLIER switch to X10K. (6) Adjust R269 (100kHz) to 80. 0 ±0. 4 kHz.
d.	1-MHz Calibration	Std, except set FREQUENCY MULTIPLIER at X100K	Counter (Freq)	(1) Connect counter to SYNC OUT BNC. (2) Adjust C205 to 800 ±10 kHz.

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Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
5.e. Cont.	Low-Frequency Calibration	Std	DVM (DC) Counter (Period)	(1) Connect counter to SYNC OUT BNC. (2) Connect DVM to TP204. (3) Adjust R207 (Low Freq. Sym #1) to 0 ±1 mV. (4) Connect DVM to TP202. (5) Adjust R210 (Low Freq. Sym #2 to 0 ±1 mV. (6) Turn FREQUENCY MULTIPLIER switch to X10. (7) Adjust R266 (Low Freq) to 12.50 ±0.03 ms.
f.	VAR SYM Calibration	Std, except set FREQUENCY MULTIPLIER at X1K, and inner switch at X0.1	Counter (Freq)	(1) Connect counter to SYNC OUT BNC. (2) Adjust WIDTH/VAR SYM (inner switch) vernier control to approximately midpoint. (3) Adjust R160 (Var Sym) to 800 ±8 Hz.
6.	INVERTER (A1, 7XX)	Std	DVM (DC) DVM (AC) (Average reading, calibrated for RMS sine wave)	(1) Connect DVM (AC) to OUTPUT BNC. Terminate with 50 ohms. (2) Connect DVM (DC) to TP701. (3) Pull INVERT WAVEFORM control out. (4) Alternately adjust R780 (invert AC) & R779 (invert DC) until final result is (1) DVM (AC) = 4.16 ±0.02V (2) DVM (DC) = 0 ±0.01V.

Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
7	HIGH-FREQUENCY TIME SYMMETRY	Std, except FREQUENCY MULTIPLIER set at X1M, X2F and WAVEFORM outer switch set at ⊓ (squarewave)	Scope (DC)	(1) Connect scope to OUTPUT BNC, using a 50-ohm wideband termination. (2) Set frequency dial at 18. (3) Check squarewave time symmetry to scope accuracy. If necessary, select a new value for R328.
8	FIXED OFFSET (A1, 7XX) Frequency Compensation	Std, except FREQUENCY MULTIPLIER set at X100K, and WAVE FORM switch at ⊓	Scope (DC)	(1) Connect scope to OUTPUT BNC, using a 50-ohm wideband termination. (2) Turn OFFSET switch to ∿. (3) Using 1V/cm scope calibration, observe first 100ns of negative-going edge. Adjust C701 for < .30V overshoot. (4) Turn OFFSET switch to ∿. (5) Using 1V/cm scope calibration, observe first 100ns of positive-going edge. Adjust C702 for < .30V overshoot.
9	SINE SHAPER (A1, 6XX)			

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Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
9.a.	Distortion Adjustment	Std, except WAVEFORM switch set at ∿	Harmonic Analyzer (% Distortion)	(1) Connect analyzer to OUTPUT BNC. Terminate with 50-ohm ±0.25% load. (2) Adjust amplitude level vernier to approximately 2/3 of maximum rotation. (3) Adjust analyzer to measure total harmonic distortion in percent. (4) Alternately adjust the following pairs for minimum distortion (<0.40%): (a) R602 (DA#1) & R625 (DA#2) (b) R610 (DA#3) μ R617 (DA#4) (c) R606 (DA#5) & R619 (DA#6).
b.	Sine Amplitude	Std, except WAVEFORM switch set at ∿	DVM (AC) DVM (DC)	(1) Connect 50-ohm, 2W, ±0.25% load to OUTPUT BNC. (2) Connect DVM (AC) across load. (3) Adjust R635 (Sine AC) to 5.30 ±0.02V. (4) Adjust OUTPUT LEVEL control for 4.6 ±0.1V ac. (5) Change over to DVM (DC). (6) Adjust R632 (Sine DC) to 0 ±0.01V.
10	X1, X2 RATIO CHECK	Std, except FREQUENCY MULTIPLIER set at X2.	Counter (Freq)	(1) Connect counter (freq.) to SYNC OUT BNC. (2) Adjust frequency dial for reading of 1600 ±1 Hz.

Table 4-3. Calibration Procedure — A1 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
10 Cont.				(3) Turn FREQUENCY MULTIPLIER switch to X1. (4) Counter should read 800 ±3 Hz.
11	VARIABLE SYMMETRY CHECK	Std, except FREQUENCY MULTIPLIER set at X0. 1	Scope (DC)	(1) Connect scope (DC) to SYNC OUT BNC. (2) Adjust the VAR SYM vernier fully CCW. Observe positive-going pulse with duty cycle ≤5%. (3) Adjust the VAR SYM vernier fully CW. Observe a negative-going pulse, with a duty cycle ≤ 5%.

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TABLE 4-4. CALIBRATION PROCEDURE — A2 Boards, 70 Series

Initial Control Settings (Standard)		
Control	Switch Function/Position	Setting
FREQUENCY MULTIPLIER		
Selector	Outer Switch (⏻)	X100
	Inner Switch (⊙)	X1
Frequency Dial	X1 Scale	8.00
OFFSET Selector	Outer Switch (⏻)	∿
WAVEFORM Selector	Outer Switch (⏻)	∿
	Inner Switch (⊙)	Pushed in
	WIDTH/VAR SYM (Inner Sw)	Fully CCW
SWEEP TIME Selector	Outer Switch (⏻)	1ms
	Vernier (Inner Sw) (⊙)	Midrotation
	Linear Sweep (F77 Model) Vernier(⊙)	Pushed in
MODE SELECTOR	Outer Switch (⏻)	TRIGGER SWEEP
	PULSE WIDTH (Inner Sw) (⊙)	0.1-10 ms
OUTPUT LEVEL SELECTOR	Outer Switch (⏻)	15V
	Vernier (Inner Sw) (⊙)	CAL
FREQ ANALOG/SWEEP RAMP Switch		SWEEP RAMP
PHASE Control	SWEEP UP (Control pushed in)	Midrotation

CAUTION DO NOT CONNECT EXTERNAL INPUTS UNLESS SPECIFICALLY CALLED FOR IN PROCEDURE.

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
1.	SWEEP GENERATOR (A2, 0XX)	A2 std	DVM (DC)	
a.	Hold Zero Adjustment			(1) Connect DVM (DC) to TP003. (2) Activate momentary SWEEP RESET toggle on front panel. (3) Adjust R015 (Hold Zero) to 0 ± 1mV.

Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

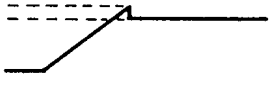
Pro-cedure	Calibration	Control Setting	Test Equipment (Mode)	Step
1. b.	Baseline Adjustment	A2 std, except set MODE switch at CONTINUOUS SWEEP and SWEEP TIME switch to 10ms	Scope (DC)	(1) Connect scope (DC) to TP003. (2) Using a scope calibration of 200 mV/CM, observe the negative peak of the sweep ramp waveform and adjust R023 (Baseline Zero) to 0 ± 20 mV.
c.	Hold Level Adjustment	A2 std, except turn MODE switch to SWEEP & HOLD	DVM DC	(1) Connect DVM (DC) to TP003. (2) Activate momentary MANUAL TRIGGER OR GATE toggle on front panel. (3) Adjust R064 (Hold) to 3.00 ± 0.01V.
d.	Amplitude Adjustment	A2 Std	Scope (DC) Function generator	(1) Connect scope (DC) to TP003. (2) Adjust external function generator to ≈5V p-p square wave at 200 Hz. (3) Connect external function generator to TRIG-SYNC IN BNC. (4) Adjust TRIGGER LEVEL control & scope sweep for a repetitive ramp up and hold waveform display. (5) Adjust R031 (Amplitude) such that the peak level of the ramp matches the holding level to within scope accuracy. 

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Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
1.e.	Sweep Down Offset Adj.	A2 std, except turn MODE switch to SWEEP & HOLD and PHASE control pulled out for sweep down	DVM (DC)	(1) Connect DVM (DC) to TP004. (2) Activate momentary MANUAL TRIGGER OR GATE toggle on front panel. (3) Adjust R062 (Down Offset) to 0 ± 1mV.
f.	Sweep Rate Calibration	A2 std, except turn SWEEP TIME vernier full CW to CAL and MODE switch to CONTINUOUS sweep	Counter (time interval) Scope (DC)	(1) Connect time-interval counter to IC004- pin #8 (or, for F77 Model only, to SWP, SYNC BNC, J6, on rear panel). (2) Adjust counter to start on + slope and to stop on - slope (3) Adjust R003 (Hi Freq) to 1000 ± 10 μs. (4) Turn SWEEP TIME switch to 10 μs. (5) Connect scope (DC) to TP003. (6) Observing negative peak of sweep waveform, adjust R082 (Comp) to 0 ± 20 mV at neg. peak. (7) Verify sweep time (positive ramp) of nominally 10 μs. NOTE: Counter will read low due to propagation delays. (8) Turn SWEEP TIME vernier to full CCW position. (9) Observing the time-interval counter, adjust R081 (100:1) to 1100 ± 10 μs.

Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
1.f. Cont.				(10) Verify maximum sweep times for all ranges; if any are outside specification limits, readjust R081 as necessary SWEEP TIME setting: (a) 100μs counter should read >10.3 ms (b) 1ms - counter should read > 103 ms (c) 10ms - counter should read > 1030 ms (d) 100ms - counter should read > 10.3 sec (e) 1s - counter should read > 103 sec (f) 10s - counter should read > 1030 sec
2. a.	LOG CIRCUIT (F77 Model only) (A2, 2XX) Log Diode Temp Adj.	A2 std	DVM (DC)	(1) Connect DVM (DC) to TP203. (2) For an ambient temperature of 77°F (± 5°F) at test bench, adjust R210 (Temp) for -6.0 ±0.2V. For other ambients, determine proper level as follows: Δ v≈0.7V per 10 F less negative (more positive potential for increasing ambient temperature.) NOTE: Allow enough time for circuit to stabilize after adjustment.

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Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
2.b.	Offset Adj.	A2 std	DVM (DC)	(1) Connect short jumper between TP201 and ground (TPG). (2) Connect DVM (DC) to TP204 Press SWEEP RESET. (3) Adjust R223 (Offset) to -3 mV ± 0.1 mV. (4) Remove jumper from TP201.
c.	Null Adj.	A2 std	DVM (DC)	(1) Connect short jumper between TP202 and (TPG). (2) Connect DVM (DC) to TP204. (3) Adjust R201 (Null) to 0 ± 0.1 mV. (4) Remove jumper from TP202.
d.	Log Scaling	A2 std, except turn MODE switch to SWEEP & HOLD		(1) Connect DVM (DC) to TP204. (2) Activate momentary MANUAL TRIGGER OR GATE toggle on front panel. (3) Adjust R204 (Scale) to 3.00 ± 0.01 v. (4) Return to step 2.c. and repeat procedure to this point (one time only). (5) Remove DVM and connect scope (DC) to TP204. (6) Place MODE selector at CONTINUOUS SWEEP. (7) Place SWEEP TIME selector at 10 ms, and vernier at CAL.

Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
2.d. Cont.				(8) Observing the positive peak of the log sweep waveform, adjust R031 (Amplitude) for a peak level of +3.00V (to within scope accuracy at 0.5 V/cm).
3.	SWEEP LIMIT CIRCUITS (A1, 1XX)	A2 std	Scope (AC) DVM (DC)	
a.	Limit Adj.	A2 std, except turn MODE switch to CONTINUOUS and FREQUENCY MULTIPLIER to X1K (outer switch) and X2 (inner switch)	Counter (Freq) Scope (AC)	(1) Connect counter to SYNC OUT. (2) Adjust front panel frequency dial to 20 (X2 calibration). Record measured frequency to 4 significant digits. (3) Turn MODE switch to SWEEP & HOLD. (4) Activate momentary MANUAL TRIGGER toggle on front panel. (5) Set front panel frequency dial to CW stop (minimum frequency). Adjust SWEEP LIMIT cursor to 20 on dial. (6) Adjust A1-R163 (Sweep Limit Cal) for the same counter reading (±0.05 KHz) as previously recorded in step 1. (7) Turn MODE switch to CONTINUOUS SWEEP. (8) Adjust front panel SWEEP LIMIT control to zero sweep width (fully CCW).

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Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

Pro-cedure	Calibration	Control Setting	Test Equipment (Mode)	Step
3.a. Cont.				(9) Connect scope to A1-TP101. (10) Adjust A1-R164 (Sweep Null) for the best scope null. (11) Place MODE switch at SWEEP & HOLD and repeat steps (4) through (10) above (one time only).
4.	FREQUENCY ANALOG AMPLIFIER (A1, 0XX) Offset Adjustment	A2 std	DVM (DC)	(1) Connect DVM (DC) to FREQ ANALOG/SWEEP RAMP connector on front panel. (2) Place selector toggle to FREQ ANALOG position. (3) Adjust frequency dial to low frequency stop (fully CW). (4) Adjust R084 (analog) to 0 ± 5 mV.
5.	PULSE WIDTH (A2, 5XX)	A2 std, except turn WAVE-FORM switch to PULSE and SWEEP TIME switch to OFF	Scope (AC)	
5.a.	Bias Adjustment	A2 Std, except turn MODE switch to CONTINUOUS		(1) Connect scope (AC) to TP504. (2) Adjust R502 (Min.) to ≈ 50% rotation. (3) Adjust R510 (Bias) so that a nominal 0.7V p-p pulse, ≈ 100 μs wide, is observed.

Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

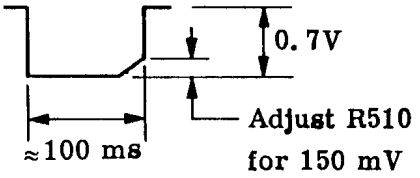
Procedure	Calibration	Control Setting	Test Equipment (Mode)	Step
5.a. Cont.				(4) Optimize the adjustment of R510 in accordance with waveform shown below. 
5.b.	Width Cal.	A2 std, except turn WAVEFORM switch to PULSE and SWEEP TIME switch to OFF	Scope (DC)	(1) Connect scope (DC) to OUTPUT BNC, using a 50-ohm wideband termination. (2) Verify that the WIDTH vernier at WAVEFORM switch is fully CCW. (3) Adjust R502 (Min) for width (at 1/2-amplitude point) of 85 ± 5 μs. (4) Turn FREQUENCY MULTIPLIER switch to X1. (5) Adjust WIDTH vernier fully CW. (6) Adjust R508 (Max) for width at 1/2 amplitude of 12.5 ±0.5 ms. (7) Turn PULSE WIDTH switch to 1-100μs. (8) Turn FREQUENCY MULTIPLIER switch to X100. (9) Observe a pulse width at 1/2 amplitude) > 111 μs Adjust R508 (Max) for 118 ± 7 μs. (10) Turn FREQUENCY MULTIPLIER switch to X10K.

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Table 4-4. Calibration Procedure — A2 Boards, 70 Series (Continued)

Pro-cedure	Calibration	Control Setting	Test Equipment (Mode)	Step
5.b. Cont.				(11) Adjust WIDTH vernier fully CCW. (12) Observe a pulse width (at 1/2 amplitude) < 0.95 μs. Adjust R502 (Min.) for 0.90 ± 0.05 μs only if required. (13) Turn PULSE WIDTH switch to 30-1000ns. (14) ADJUST WIDTH vernier fully CW. (15) Adjust C508 for width at 1/2 amplitude of 1.4 ± 0.1 μs.
6.	HOLD FREQUENCY ADJUST	Std, except Freq Dial at X1K, X2, & MODE at CONTINUOUS	Counter (Freq)	(1) Connect counter (Freq) to SYNC OUT BNC. (2) Place frequency dial at its low-frequency stop. (3) Place SWEEP LIMIT dial at 20 (X2 scale). (4) Adjust frequency dial for a measured frequency of 40 ± 2 Hz. (5) Turn MODE switch to SWEEP & HOLD. (6) Activate momentary SWEEP RESET toggle. (7) Adjust A2-R015 (Hold Zero) for 40 ± 2 Hz. (8) Pull PHASE control out for SWEEP DOWN. (9) Activate momentary MANUAL TRIGGER OR GATE toggle switch. (10) Adjust A2-R062 (Down Offset).

NOTES

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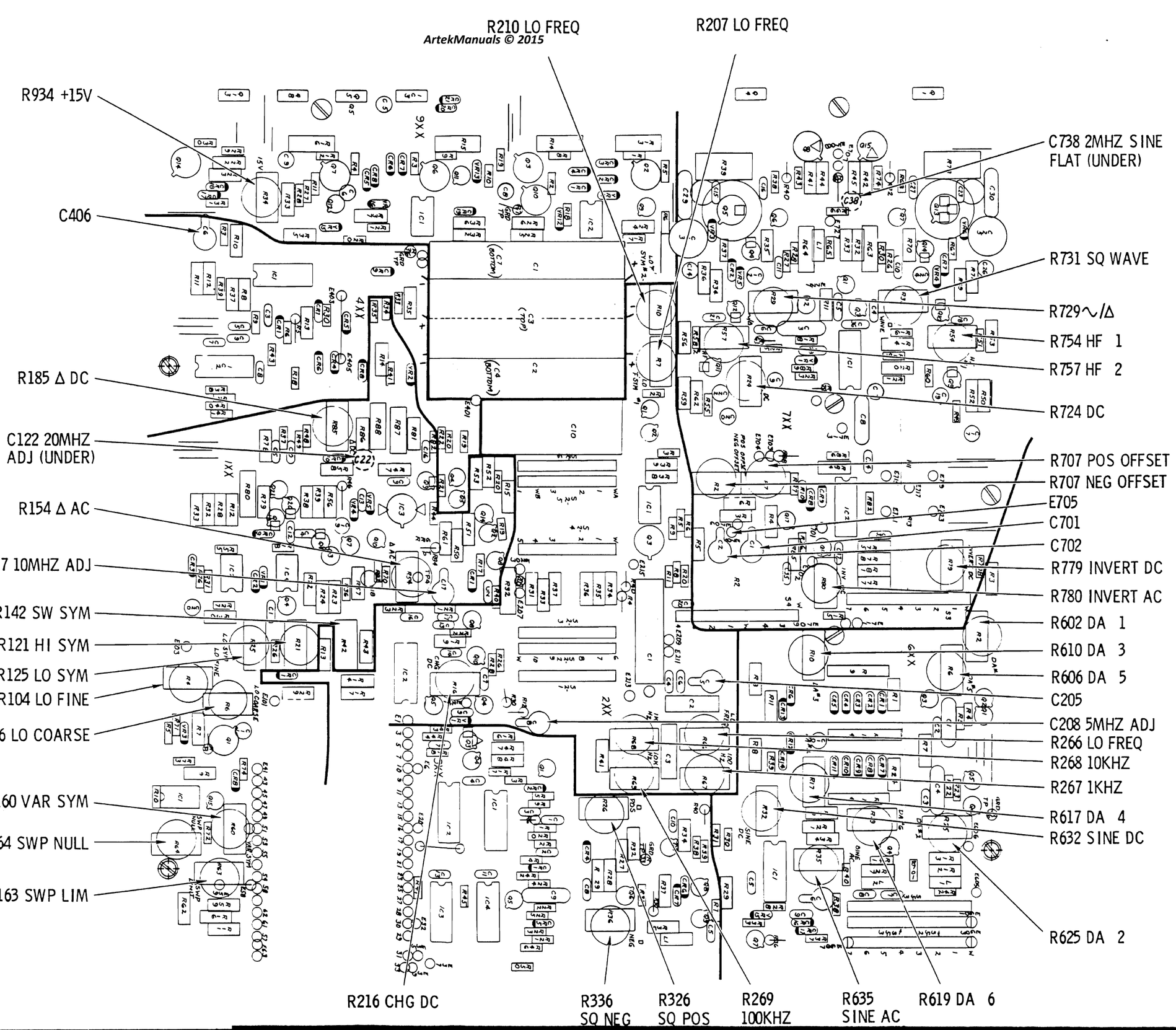

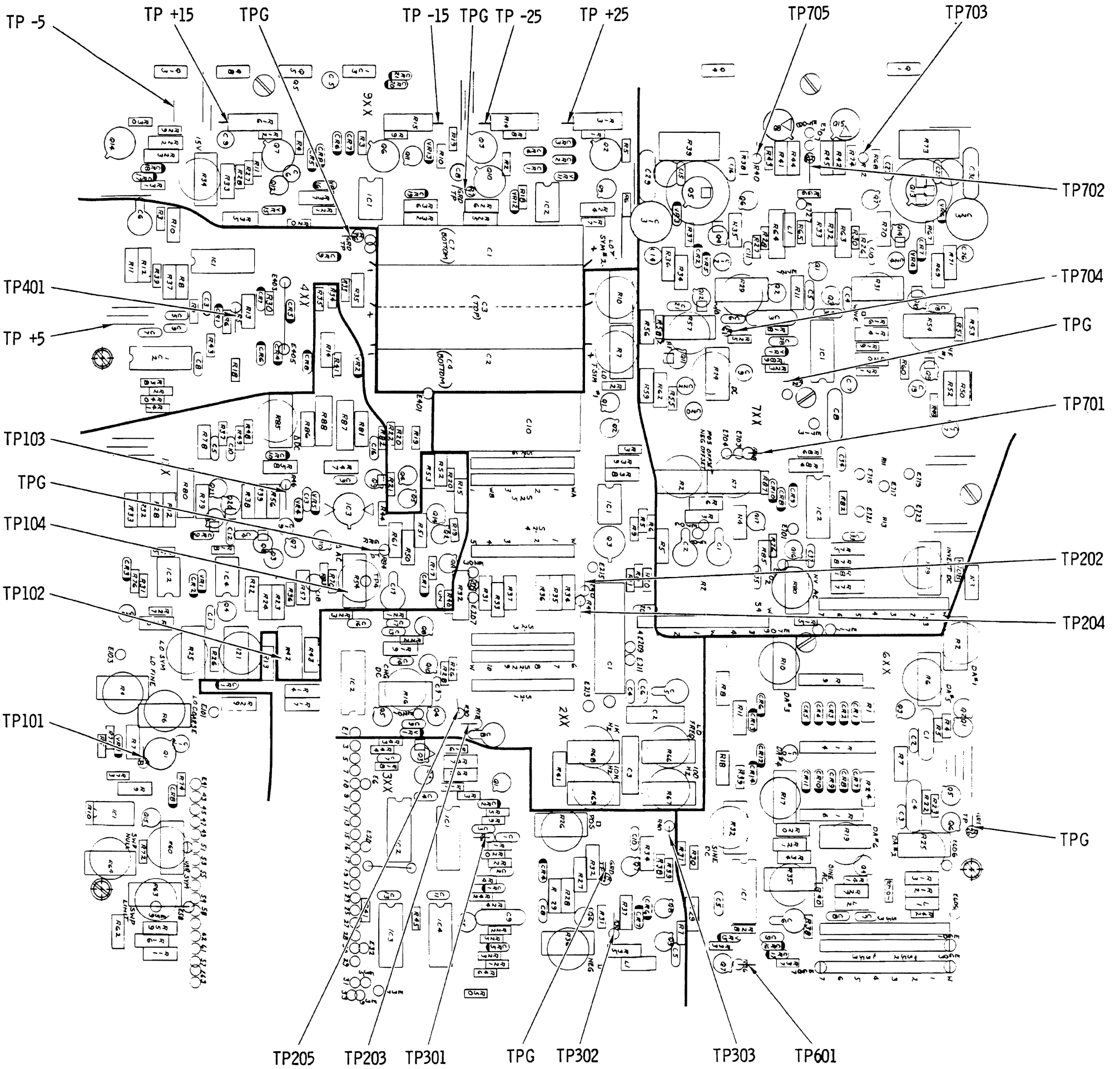

Figure 4-2. Test Point Location Diagram (F44/F77 Models, A-1 Card)

CONTROL SETTINGS USED
FOR WAVEFORM PHOTOGRAPHS
Freq Dial @ 8.0
FREQ MULT @ X 100
SYM @ X 1
OFFSET @ ∿
WAVEFORM @ ∿
INVERT @ NonInvert (in)
Vernier @ CW Stop
SWEEP TIME @ OFF
Vernier @ CAL
LOG/LIN @ Lin (in)
MODE @ Continuous
PULSE WIDTH @ 1-100 nsec
OUTPUT LEVEL @ 15 V
Vernier @ CAL
FREQ ANALOG Switch @
FREQ ANALOG
External Inputs: None
Scope: Trigger @ Ext
(from SYNC OUT)
Slope @ - Slope

A2-TP001
H: 0.2 ms/cm
V: 5 V/cm
SWEEP TIME @ 1 ms
Scope @ Internal Trigger
A2-TP003
H: 0.2 ms/cm
V: 1 V/cm
SWEEP TIME @ 1 ms
Scope @ Internal Trigger
A2-TP204
H: 0.2 ms/cm
V: 1 V/cm
SWEEP TIME @ 1 ms
Scope @ Internal Trigger
LOG-LIN Sw. @ LOG
A2-TP501
H: 0.2 ms/cm
V: 1 V/cm
WAVEFORM @ PULSE
A2-TP502
H: 0.2 ms/cm
V: 2 V/cm
WAVEFORM @ PULSE
A2-TP503
H: 0.2 ms/cm
V: 2 V/cm
WAVEFORM @ PULSE
A1-TP103
H: 0.2 ms/cm
V: 1 V/cm
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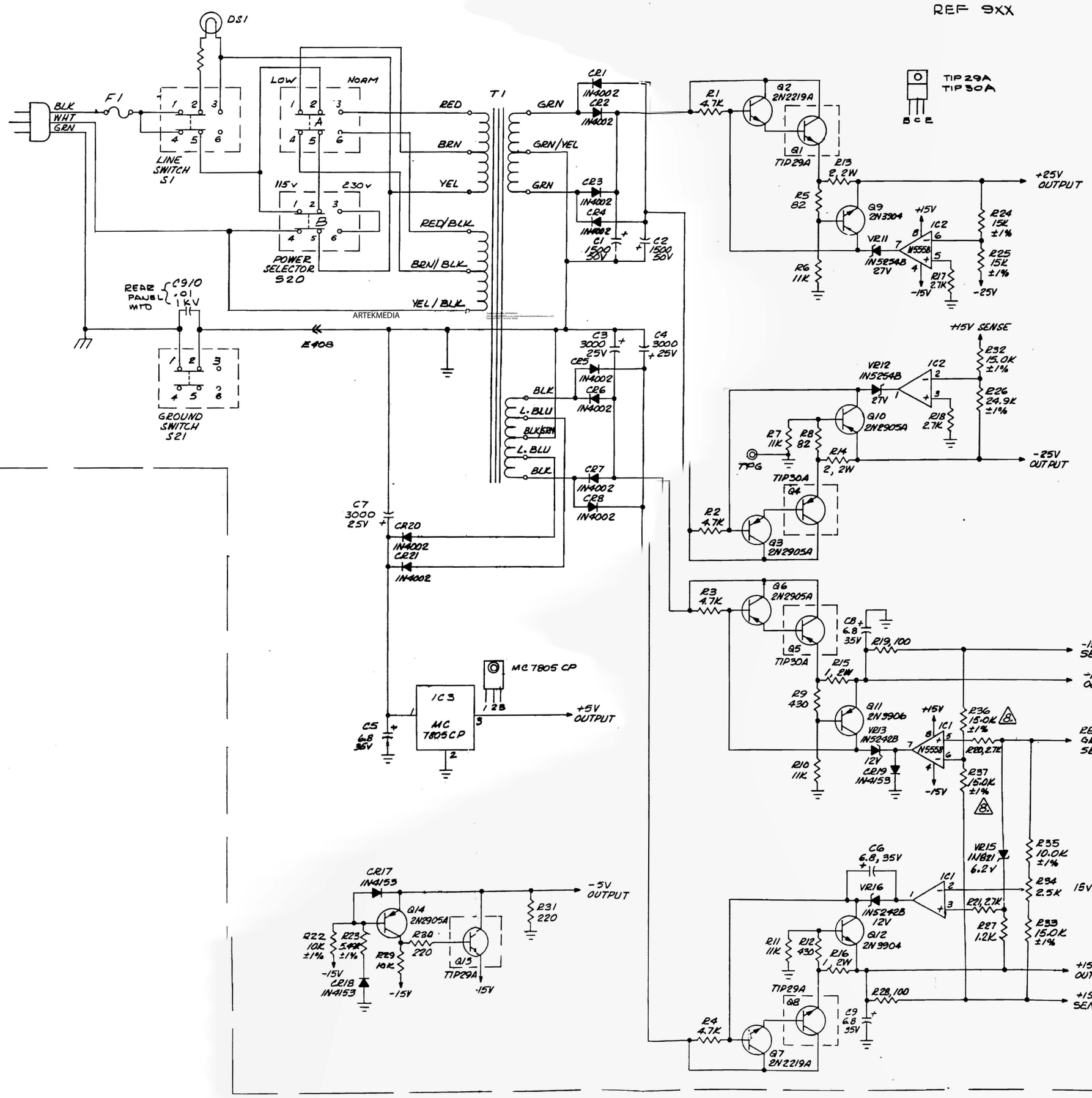
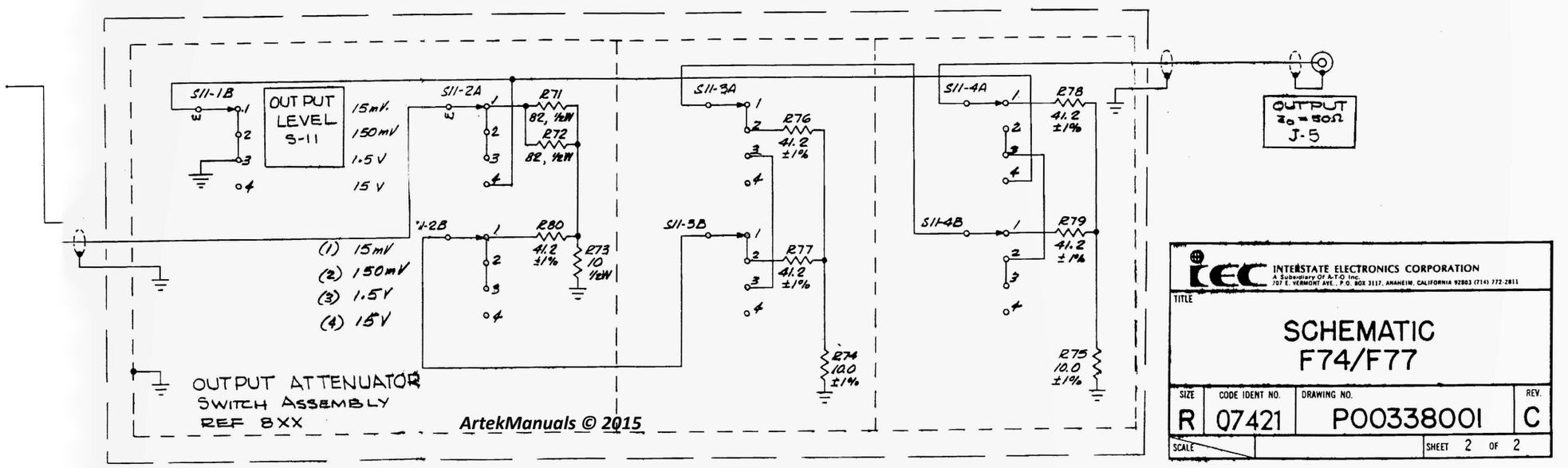
A1-TP202
H: 2 ms/cm
V: 2 V/cm
FREQ MULT @ X 10
A1-TP203
H: 0.2 ms/cm
V: 2 V/cm
A1-TP204
H: 2 ms/cm
V: 2 V/cm
FREQ MULT @ X 10
A1-TP205
H: 0.2 ms/cm
V: 2 V/cm
H: 0.5 ms/cm
V: 2 V/cm
MODE @ TRIGGERED
External signal of 1.5 p-p @ 500 Hz connected to TRIG-SYNC IN
A1-TP301
H: 0.5 ms/cm
V: 2 V/cm
MODE @ TRIGGERED
External signal of 1.5 p-p @ 500 Hz connected to TRIG-SYNC IN
A1-TP303
H: 0.2 ms/cm
V: 2 V/cm
WAVEFORM @ ⊓
A1-TP601
H: 0.2 ms/cm
V: 2 V/cm
WAVEFORM @ ∿
A1-TP701
H: 0.2ms/cm
V: 2v/cm
A1-TP702
H: 0.2 ms/cm
V: 10 V/cm

PULSE WIDTH REF 5XX A2 Bd
LOGIC REF 3XX
SWEEP CKT REF 0XX A2 PC Bd.
START/STOP 4XX
VOLTAGE LEVEL SENSOR REF 1XX
FOLLOW AMPL REF 2XX
INVERTER REF 7XX
OUTPUT AMPL REF 7XX
SINE SHAPER REF 6XX
FREQ CONTROL REF 1XX
CURRENT SOURCE SWITCH REF 1XX
L.F. INTEGRATOR REF 2XX
FREQ MULTIPLIER S-2
LOG CKT REF 2XX A2 Bd F77 ONLY
1. △ DENOTES 1/2 BEADS
□ DENOTES FULL BEADS
2. ALL CAPACITORS IN µF UNLESS NOTED
3. ALL RESISTORS 1/4W 5% UNLESS NOTED
4. CR601, CR605, CR607, CR611 ARE MATCHED PER P00347304
5. C201, C202, C203, AND C204 ARE MATCHED PER P00347753
6. R112, R128, R132 ARE RATIO MATCHED PER P00347619
7. ALL VOLTAGES INDICATED ARE FOR NOMINAL CONDITIONS AND MAY VARY FROM UNIT TO UNIT
8. R936 AND R937 ARE MATCHED PER P00347617
IEC INTERSTATE ELECTRONICS CORPORATION
SCHEMATIC F74/F77
R 07421 P00338001 C

POWER SUPPLY
REF 9XX





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707 E. VERMONT AVE., P.O. BOX 3117, ANAHEIM, CALIFORNIA 92803 (714) 772-2811

TITLE
SCHEMATIC
F74/F77

SIZE	CODE IDENT NO.	DRAWING NO.	REV.
R	07421	P0033800I	C

SCALE | SHEET 2 OF 2

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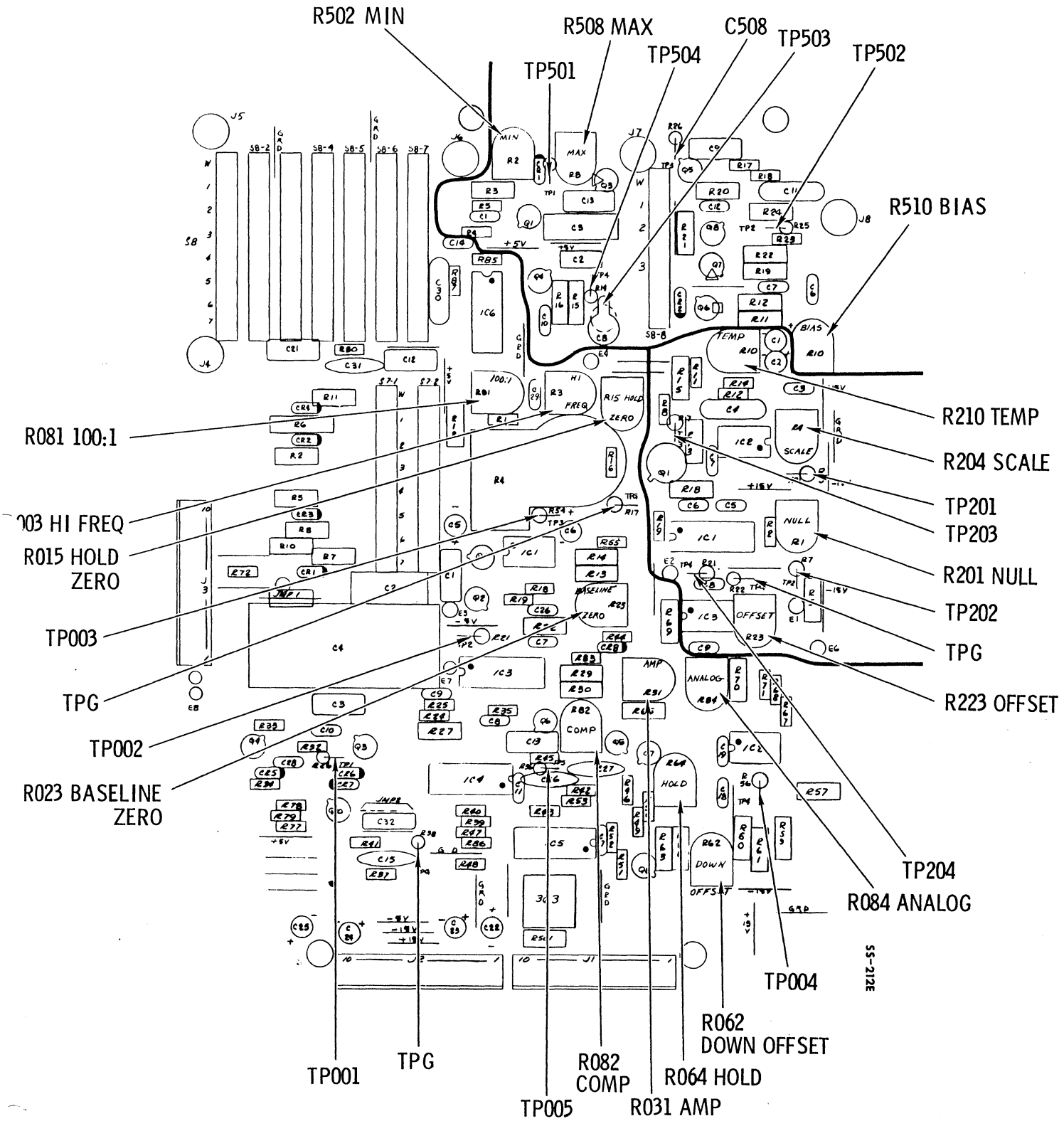

Figure 4-3. Testpoint Location Diagram (Solder Side)

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Section 5
MAINTENANCE

5-1. INTRODUCTION

This section is intended to aid service personnel in tracing signal flow and in locating components. The schematic diagram, included at the back of the manual, shows waveforms at various critical test points under indicated control settings.

The small printed-circuit card (A2) may be swung away from the instrument to provide access to components. The instrument remains fully operational in this condition.

To swing the A2 card outward, perform the following steps:

(1) Disconnect power cord from power source.

(2) Remove both knobs from SWEEP TIME switch shaft and from MODE switch shaft.

(3) Remove two board mounting screws.

(4) Loosen three hinge slide retainer screws.

(5) Slide board toward rear of instrument to clear SWEEP TIME and MODE switch shafts.

(6) Rotate board outward to 90° position (See figure 5-1).

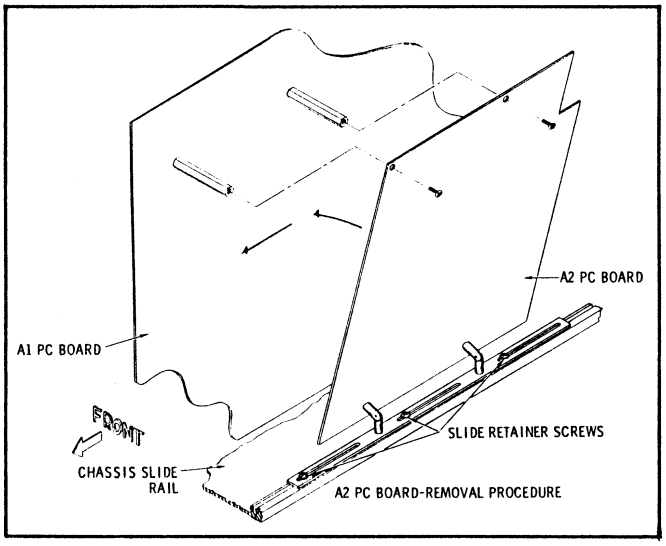

Figure 5-1. A2 Board (Series 70 Models) — Disassembly Diagram

Figures 5-2, 5-3, and 5-4 are wiring diagrams for the attenuator, sweep time and waveform switches. Figures 5-5 and 5-6 depict the location of parts mounted on the front and rear panels.

5-2. TIMING DIAGRAMS

The following timing diagrams show the sequence of logic used to produce discontinuous wavetrains.

a. Triggered and Gated Modes (See figure 5-7)

The trigger signal used to start and stop main loop triangle generation appears at pin 6

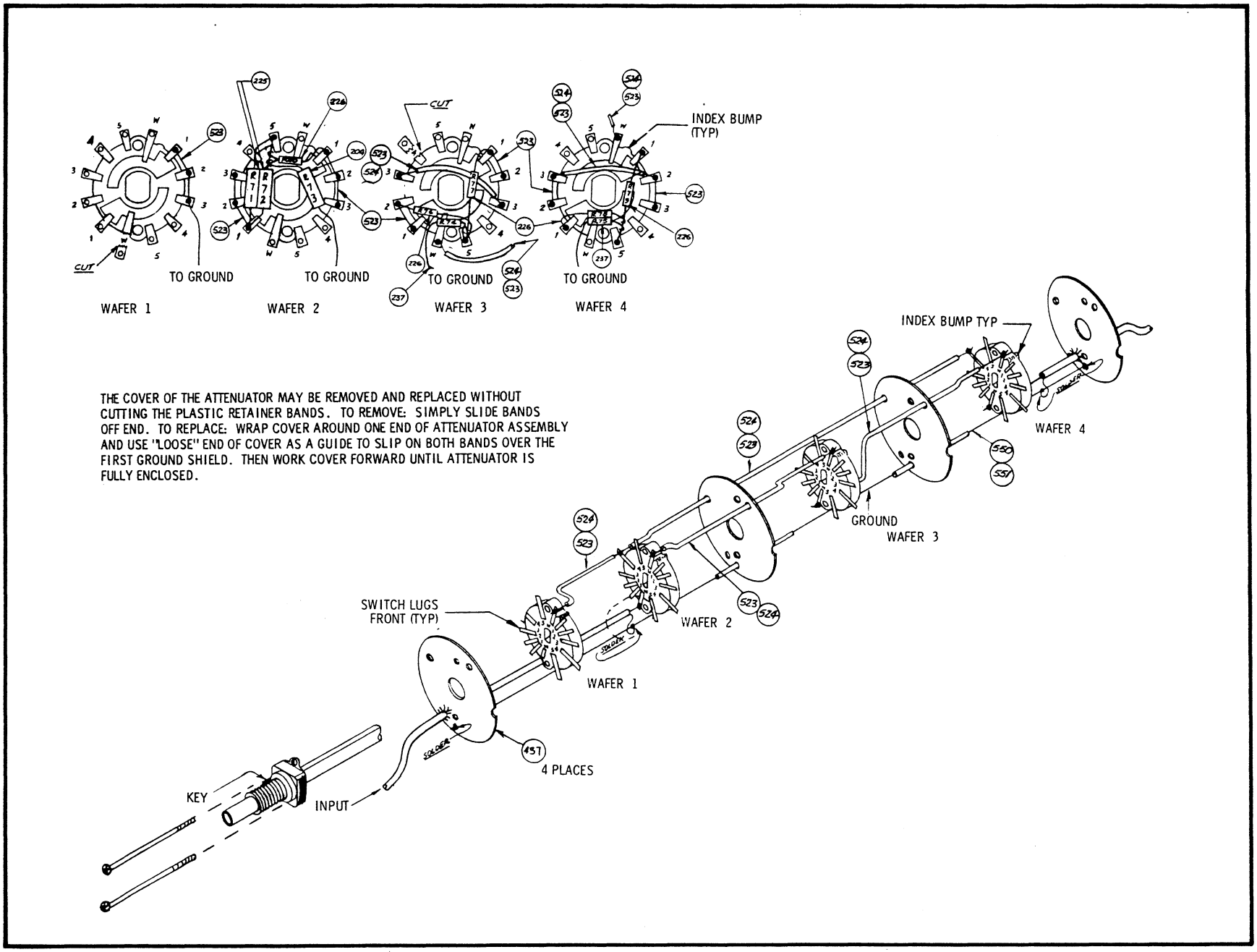

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Figure 5-2. Attenuator Switch Assembly

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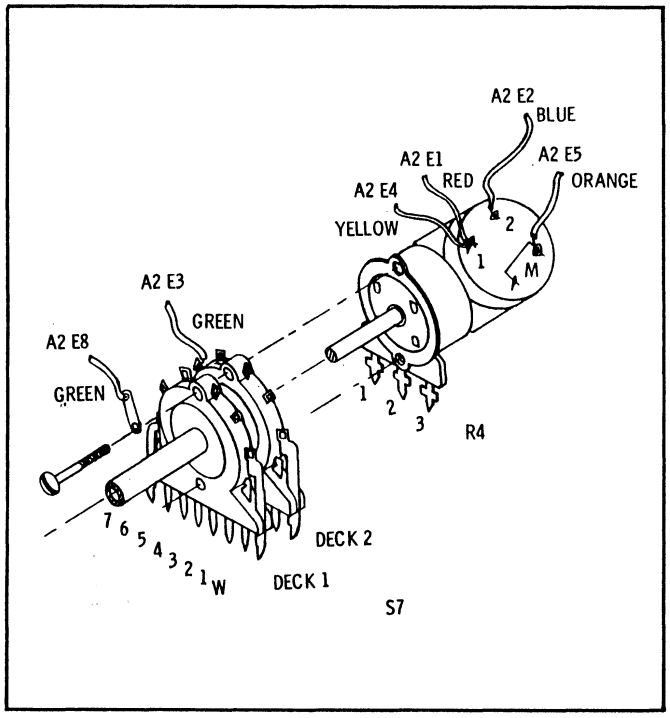

Figure 5-3. Sweep Time Switch (F44/F77 Models)

of A1-IC301. Whenever this signal is high (logic level of +3 volts), waveform generation is inhibited. A low-state (0 volts) initiates or allows operation. A1-IC402 pin 1 receives this signal directly in the GATED mode and through a differentiating capacitor when in the TRIGGERED mode.

The output of flip-flop A1-IC402 pin 3 then goes high, as does TP401, unlocking the start-stop analog circuitry. The flip-flop is reset when the main loop squarewave appearing at A1-IC402 pin 9 makes a negative-going transition at a time when the logic signal at A1-IC402 pin 1 is high.

A1-TP401 remains high, however, until the main loop squarewave goes positive. The triangle waveform then runs to the level set by the analog clamp circuitry (PHASE Control) and stops.

b. TRIGGER SWEEP and SWEEP & HOLD Modes (See figure 5-8)

Both of these modes function by generating only one complete sweep cycle. At the peak of the sweep sawtooth waveform, an auxiliary dc voltage replaces the sweep waveform, so that the frequency control voltage sent to the SWEEP LIMIT dial remains at peak level although the actual sweep ramp has reset.

A trigger signal derived from the logic section A1-IC301 pin 6 appears at A2-IC001 pin 2, causing the output of a one-shot multivibrator (A2-IC001 pin 8) to go high for 10 microseconds. At the end of this delay period, start-stop flip-flop output A2-IC004 pin 3 is set high. This releases the analog clamp transistor, A2-Q002, and forces test points A2-TP001 and A2-TP005 high (by action of A2-CR008).

The analog waveform at A2-TP002 rises to a peak valve at which time A2-TP001 and A2-TP005 reset. This, in turn, resets the ramp voltage at A2-TP002; resets the start-stop flip-flop, A2-IC004 pin 3; and causes "hold" flip-flop A2-IC005 pin 8 to go low, replacing the analog output at A2-TP003 with a fixed voltage equal to the sweep waveform peak amplitude.

This fixed amplitude is removed by one of two actions. When in TRIGGER SWEEP mode, the fixed amplitude is removed by the arrival of the next trigger pulse from A1-IC301 pin 6. When in SWEEP & HOLD mode, the fixed amplitude is removed by the operation of SWEEP RESET switch S12.

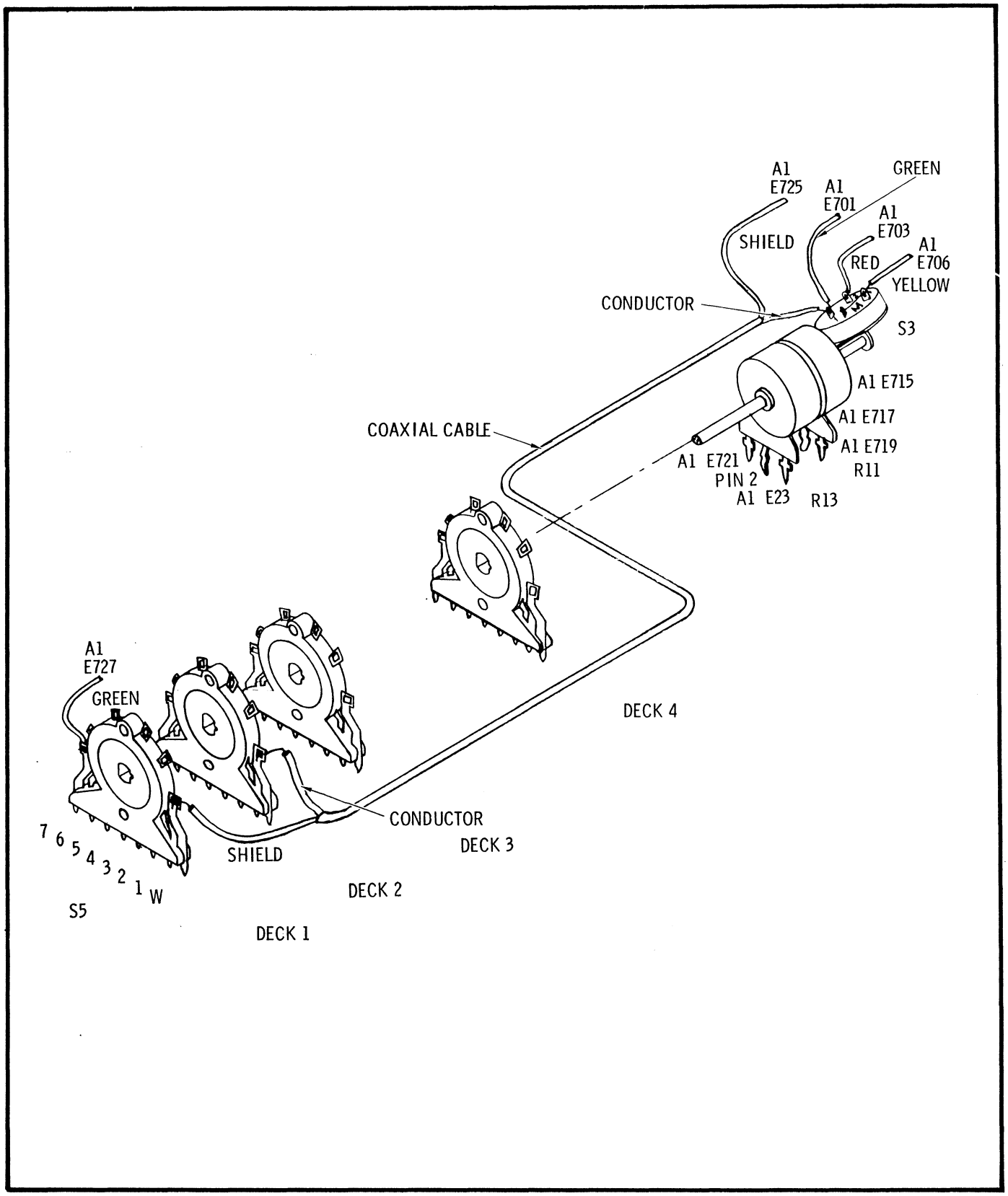

Figure 5-4. Waveform Switch (F44/F77 Models)

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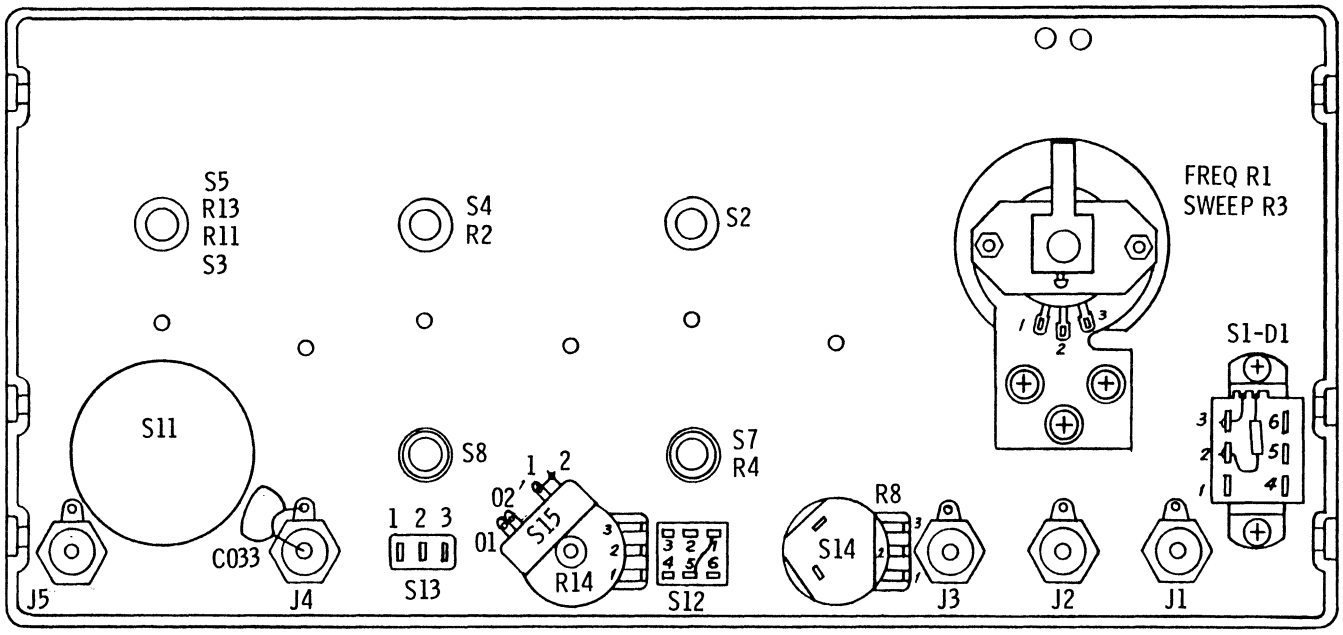

Figure 5-5. Front Panel Components (F74/F77 Models) — Location Diagram

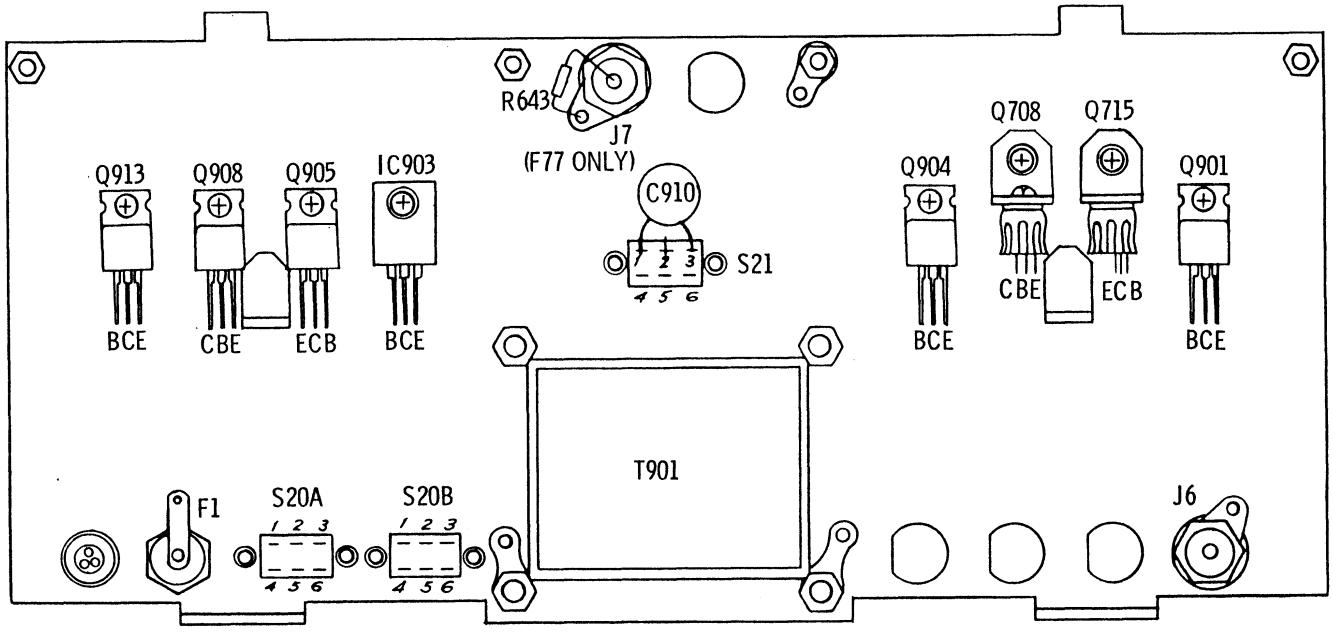

Figure 5-6. Rear Panel Components (F74/F77 Models) — Location Diagram

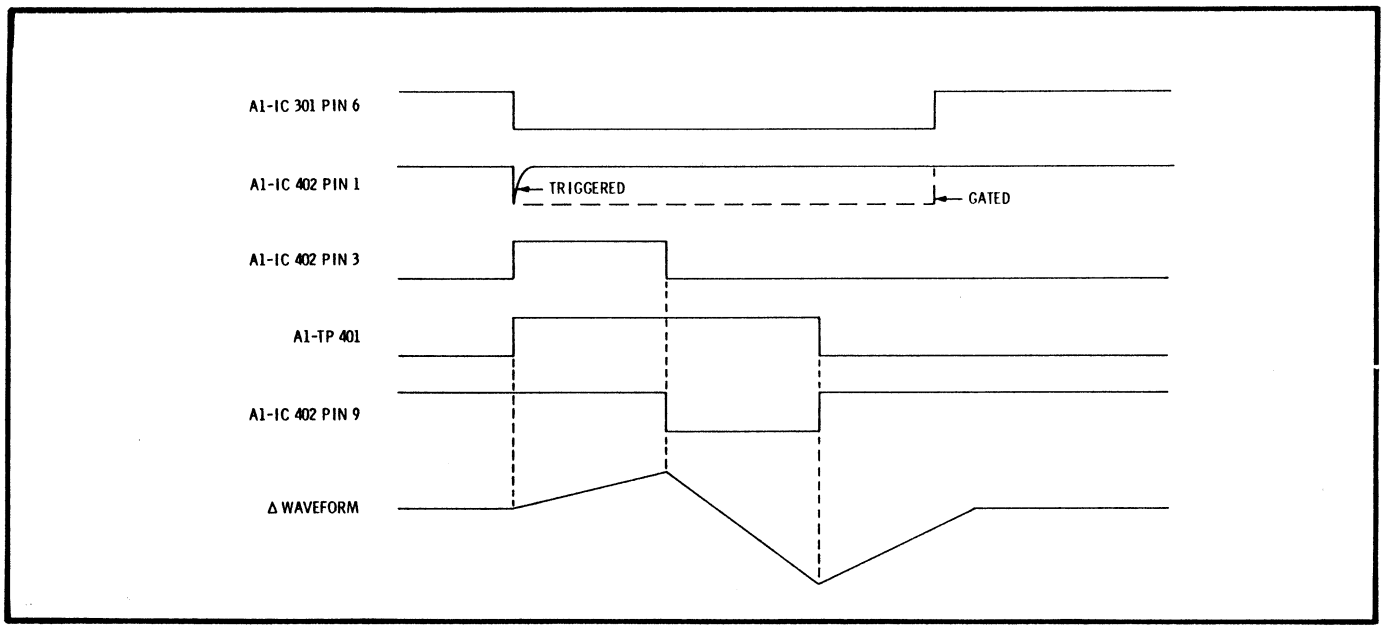

Figure 5-7. Timing Diagram — Triggered & Gated Modes

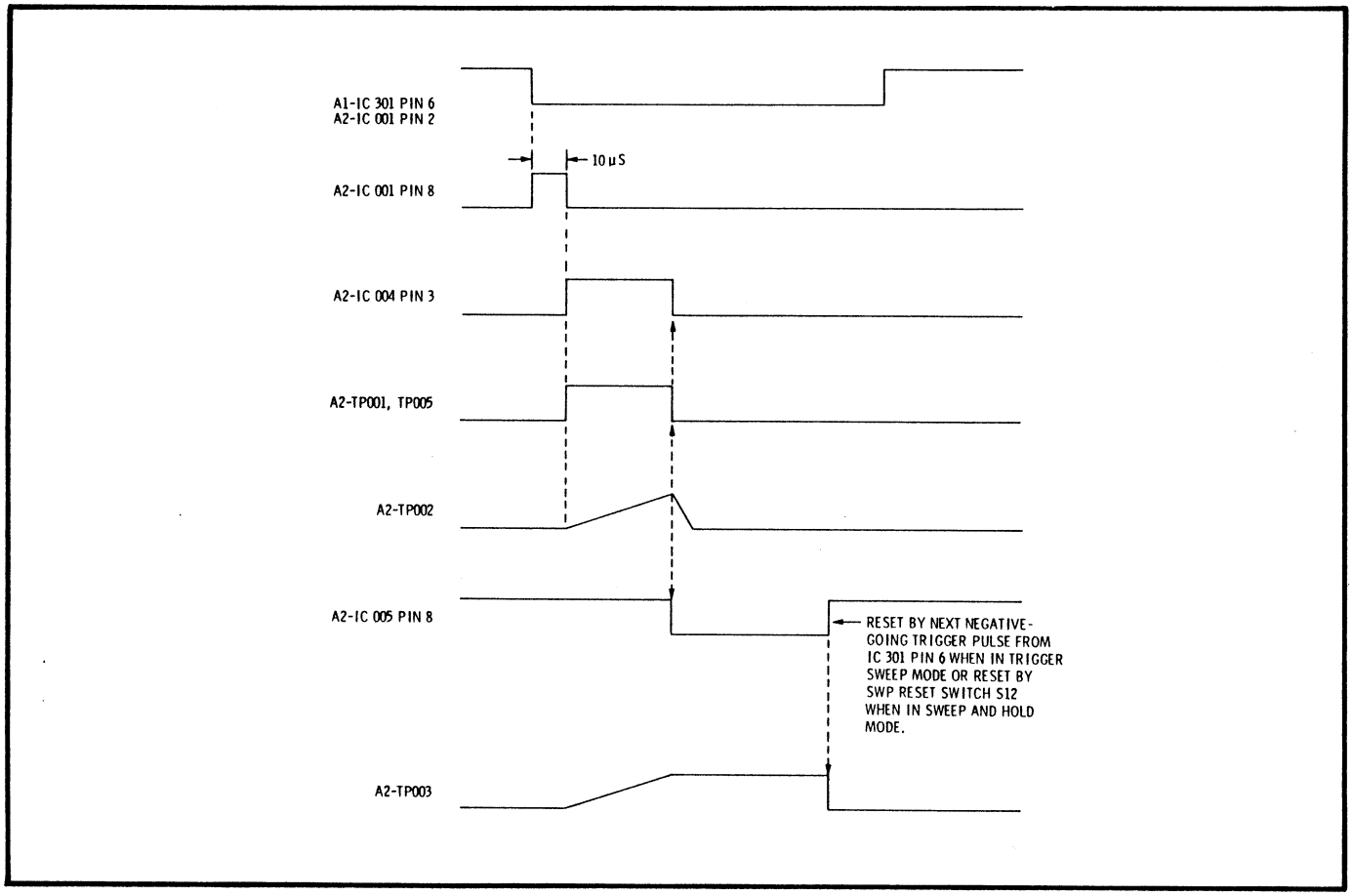

Figure 5-8. Timing Diagram — Sweep Trigger and Sweep & Hold Modes

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Section 6
PARTS LIST

6-1. INTRODUCTION

This section contains information for identifying and ordering replacement parts. Replacement parts may be ordered from Interstate Electronics Corporation. Be certain that the order or inquiry identifies the part by description and part number.

6-2. PARTS LIST

Table 6-1 is a list of all manufacturers who supply parts used in the function generator. Table 6-2 lists, by circuit reference number, all electrical and electronic parts mounted on circuit board A1. Table 6-3 lists those parts mounted on circuit board A2.

TABLE 6-1. LIST OF MANUFACTURERS

Code	Manufacturer
01295	Texas Instruments Inc., Dallas, Texas
02735	RCA Corporation, Somerville, New Jersey
04713	Motorola Semiconductor Products, Inc., Phoenix, Arizona
07263	Fairchild Camera and Instrument Corp., Mountain View, California
07421	Interstate Electronics Corp., Anaheim, California
07994	American Radionic Co., Danbury, Connecticut
17856	Siliconix, Inc., Santa Clara
18324	Signetics Corp., Sunnyvale, California
22753	UID Electronics, Hollywood, Florida
27264	Molex Products Co., Lisle, Illinois
28480	Hewlett-Packard Co., Palo Alto, California
49956	Raytheon Co., Lexington, Massachusetts
56289	Sprague Electric Co., North Adams, Massachusetts
71450	CTS Corp., Elkhart, Indiana
71590	Centralab, Milwaukee, Wisconsin
73445	Amperex Elec. Corp., Hicksville, New York
75042	IRC Inc., Philadelphia, Pennsylvania
75915	Littelfuse Inc., Des Plaines, Illinois
76493	J. W. Miller Co., Los Angeles, California
80294	Bourns, Inc., Riverside, California

Table 6-1. List of Manufacturers (Continued)

Code	Manufacturers
80740	Beckman Instruments, Fullerton, California
84171	Arco Electronics Inc., Great Neck, New York
91213	Johanson Mfg. Corp., Boonton, New Jersey
91637	Dale Electronics, Columbus, Nebraska

TABLE 6-2. PARTS LIST, A1 BOARD

Ref Design	Value	Description	Mfg Code	Part Number
C101	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C102	30 PF	C:Mica 500V 5%	84171	CM05ED300J
C103	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C104	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C105	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C110	20 PF	C:Mica 500V 5%	84171	DM5-200J
C111	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C112	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C113	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C116	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C117	3-30 PF	C:Var	91213	9303
C119	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C120	47 MF	C:Tant El 6V 10%	56289	196D476X9006KA1
C121	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C122	3-30 PF	C:Var	91213	9303
C201	0.82 MF	C:M-Set of 4	07421	P00347753
C202	0.082 MF	C:M-Set of 4	07421	P00347753
C203	0.0082 MF	C:M-Set of 4	07421	P00347753
C204	680 PF	C:Mica 500V 5%	84171	CM05ED681J
C205	3-30 PF	C:Var	91213	9303
C206	FS	C:Mica 500V 5%		
C207	FS	C:Mica 500V 5%		
C208	2-20 PF	C:Var	91213	9302
C209	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C210	5.0 MF	C:M-Set of 4	07421	P00347753
C213	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C214	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C215	22 PF	C:Mica 500V 5%	84171	DM5-220J
C216	10 PF	C:Mica 500V 5%	84171	DM5-100J

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
C217	120 PF	C:Mica 500V 5%	84171	CM05ED121J
C220	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C221	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C301	15PF	C:Mica 500V 10%	84171	DM5-150J
C303	2PF	C:Mica 500V 10%	84171	DM5-020J
C304	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C305	62 P	C:Mica 500V 5%	84171	CM05ED620J
C307	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C308	100 PF	C:Mica 500V 5%	84171	CM05ED101J
C309	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C310	100 PF	C:Mica 500V 5%	84171	CM05ED101J
C311	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C313	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C401	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C402	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C403	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C405	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C406	3-30 PF	C:Var	91213	9303
C407	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C408	68 PF	C:Mica 500V 5%	84171	CM05ED680J
C409	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C601	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C602	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C603	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C604	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C605	15 PF	C:Mica 500V 10%	84171	DM5-150J
C607	100 PF	C:Mica 500V 5%	84171	CM05ED101J
C608	120 PF	C:Mica 500V 5%	84171	CM05ED121J
C609	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C610	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C611	68 PF	C:Mica 500V 5%	84171	CM05ED680J
C701	3-30 PF	C:Var	91213	9303
C702	3-30 PF	C:Var	91213	9303
C703	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C704	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C705	510 PF	C:Mica 500V 5%	84171	CM05ED511J
C706	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C707	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
C708	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C709	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C710	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C711	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C712	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C713	100 MF	C:Elect 50V -10+100%	90201	MTV100DE50
C714	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C715	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C716	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C717	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C719	22 MF	C:Tant El 10V 10%	56289	196D226X9010KA1
C720	22 MF	C:Tant El 10V 10%	56289	196D226X9010KA1
C722	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C723	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C724	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C725	100 MF	C:Elect 50V -10+100%	90201	MTV100DE50
C726	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C727	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C728	270 PF	C:Mica 500V 5%	84171	CM05ED271J
C729	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C730	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C733	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C734	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C735	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C736	68 PF	C:Mica 500V 5%	84171	CM05ED680J
C737	FS	C:Mica 500V 5%		
C738	3-30 PF	C:Var	91213	9303
C901	1500 MF	C:Elect 50V-10+75%	56289	TVA1318
C902	1500 MF	C:Elect 50V-10+75%	56289	TVA1318
C903	3000 MF	C:Elect 25V-10+75%	56289	TVA1214
C904	3000 MF	C:Elect 25V-10+75%	56289	TVA1214
C905	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C906	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C907	3000 MF	C:Elect 25V-10+75%	56289	TVA1214
C908	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C909	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C910	0.01 MF	C:Ceramic 100V 20%	56289	5GAS10

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
CR101		Diode:Sil		1N4153
CR102		Diode:Sil		1N4153
CR103		Diode:Sil		1N4153
CR108		Diode:Sil		1N4153
CR109		Diode:Sil		1N4153
CR110		Diode:Sil		1N4153
CR201		Diode:Sil		1N4153
CR301		Diode:Sil		1N4153
CR302		Diode:Sil		1N4153
CR304		Diode:Sil		1N4153
CR305		Diode:Sil		1N4153
CR306		Diode:Sil		1N4153
CR307		Diode:Sil		1N4153
CR308		Diode:Sil		1N4153
CR404		Diode:Sil		1N4153
CR405		Diode:Sil		1N4153
CR406		Diode:Sil		1N4153
CR408		Diode:Sil		1N4153
CR409		Diode:Sil		1N4153
CR601		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR602		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR603		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR604		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR605		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR606		Diode:Sil Hot Carrier	07263	FH1100
CR607		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR608		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR609		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR610		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR611		Diode:Sil Hot Carrier	07421	P00347304/FH1100
CR612		Diode:Sil Hct Carrier	07263	FH1100
CR613		Diode:Sil		1N4153
CR614		Diode:Sil		1N4153
CR616		Diode:Sil		1N4153
CR617		Diode:Sil		1N4153
CR702		Diode:Sil		1N4153
CR707		Diode:Sil		1N4153

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
CR708		Diode:Sil		1N4153
CR709		Diode:Sil		1N4153
CR710		Diode:Sil		1N4153
CR711		Diode:Sil		1N4153
CR901		Diode:Sil		1N4002
CR902		Diode:Sil		1N4002
CR903		Diode:Sil		1N4002
CR904		Diode:Sil		1N4002
CR905		Diode:Sil		1N4002
CR906		Diode:Sil		1N4002
CR907		Diode:Sil		1N4002
CR908		Diode:Sil		1N4002
CR917		Diode:Sil		1N4153
CR918		Diode:Sil		1N4153
CR919		Diode:Sil		1N4153
CR920		Diode:Sil		1N4002
CR921		Diode:Sil		1N4002
IC101		Int Ckt:8 Pin Dip	01295	SN72741P
IC102		Int Ckt:8 Pin Dip	07421	N5558V
IC103		Int Ckt:12 Pin T05	02735	CA3049T
IC104		Int Ckt:8 Pin Dip	01295	SN72741P
IC201		Int Ckt:8 Pin Dip	49956	RC4558DN
IC202		Int Ckt:14 Pin Dip	07421	P00347408
IC301		Int Ckt:14 Pin Dip	01295	SN7486N
IC302		Int Ckt:14 Pin Dip	01295	SN7400N
IC303		Int Ckt:14 Pin Dip	01295	SN7451N
IC304		Int Ckt:14 Pin Dip	01295	SN7400N
IC401		Int Ckt:14 Pin Dip	07421	P00347408
IC402		Int Ckt:14 Pin Dip	01295	SN74S00N
IC601		Int Ckt:14 Pin Dip	02735	CA3086
IC701		Int Ckt:14 Pin Dip	02735	CA3086
IC702		Int Ckt:14 Pin Dip	02735	CA3086
IC901		Int Ckt:8 Pin Dip	18324	N5558V
IC902		Int Ckt:8 Pin Dip	18324	N5558V
IC903		Int Ckt:5V Reg	04713	MC7805CP
L301	0.22 UH	Choke:	76493	9310-02
L602	1.2 UH	Choke:	76493	9310-14

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
L701	FS	Choke:		
Q101		Tstr:Sil PNP		2N2905A
Q102		Tstr:Sil PNP		2N4258
Q103		Tstr:Sil PNP	04713	MP56523
Q104		Tstr:Sil NPN		2N3904
Q106		Tstr:Sil PNP	07263	2N5771
Q107		Tstr:Sil PNP	07263	2N5771
Q108		Tstr:N Ch Fet	07421	P00347206
Q109		Tstr:Sil NPN		2N3904
Q110		Tstr:Sil NPN		2N3904
Q114		Tstr:Sil PNP		2N3906
Q115		Tstr:Sil NPN		2N3904
Q119		Tstr:Sil NPN		2N3904
Q120		Tstr:Sil NPN	07263	2N5769
Q121		Tstr:Sil NPN	07263	2N5769
Q201		Tstr:Sil NPN		2N3904
Q202		Tstr:Sil PNP		2N3906
Q203		Tstr:Dual N J Fet	07421	P00347201
Q204		Tstr:N Ch Fet	17856	E212
Q205		Tstr:Sil NPN	07263	2N5769
Q208		Tstr:Sil NPN	07263	2N5769
Q210		Tstr:Sil PNP	07263	2N5771
Q301		Tstr:Sil PNP		2N3906
Q303		Tstr:Sil PNP	07263	2N4258
Q304		Tstr:Sil PNP	07263	2N4258
Q305		Tstr:Sil NPN		2N3904
Q206		Tstr:Sil PNP	07263	2N4258
Q307		Tstr:Sil PNP	07263	2N4258
Q308		Tstr:Sil NPN	07263	2N5769
Q309		Tstr:Sil PNP	07263	2N4258
Q404		Tstr:Sil NPN	07263	2N5769
Q405		Tstr:Sil NPN	07263	2N5769
Q601		Tstr:Sil NPN		2N3904
Q602		Tstr:Sil PNP		2N3906
Q603		Tstr:Sil NPN	07263	2N5769
Q604		Tstr:Sil PNP	07263	2N5771
Q605		Tstr:Sil PNP		2N3906

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
Q606		Tstr:Sil NPN		2N3904
Q607		Tstr:Sil PNP	07263	2N5771
Q701		Tstr:N Ch J Fet	07421	P00347203
Q702		Tstr:N Ch J Fet	07421	P00347202
Q703		Tstr:N Ch J Fet	07421	P00347202
Q704		Tstr:Sil PNP	07421	P00347103
Q705		Tstr:Sil PNP		2N2905A
Q706		Tstr:Sil NPN	07263	2N5769
Q707		Tstr:Sil NPN	07263	2N5769
Q708		Tstr:Sil NPN	07263	2N5109
Q709		Tstr:M-P Q709/Q711	07421	P00347099
Q710		Tstr:Sil PNP	07263	2N5771
Q711		Tstr:M-P Q709/Q711	07421	P00347099
Q712		Tstr:Sil NPN	07263	2N5769
Q713		Tstr:Sil NPN		2N2219A
Q714		Tstr:Sil NPN		2N2369A
Q715		Tstr:Sil PNP	07263	2N5160
Q716		Tstr:Sil PNP		2N3906
Q717		Tstr:Sil PNP	07263	2N5771
Q901		Tstr:Sil NPN	01295	TIP29A
Q902		Tstr:Sil NPN		2N2219A
Q903		Tstr:Sil PNP		2N2905A
Q904		Tstr:Sil PNP	01295	TIP30A
Q905		Tstr:Sil PNP	01295	TIP30A
Q906		Tstr:Sil PNP		2N2905A
Q907		Tstr:Sil NPN		2N2219A
Q908		Tstr:Sil NPN	01295	TIP29A
Q909		Tstr:Sil NPN		2N3904
Q910		Tstr:Sil PNP		2N2905A
Q911		Tstr:Sil PNP		2N3906
Q912		Tstr:Sil NPN		2N3904
Q913		Tstr:Sil NPN	01295	TIP29A
Q914		Tstr:Sil PNP		2N2905A
R002	10K	Pot:P/O S4		
R003	5K	Pot:P/O S5 Log Taper		
R011		Pot:Pulse Width/Sym	07421	P00347691
R104	25K	R:Var 1/4W 30%	71590	TSV-25K

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R105	2.4M	R:Carbon 1/4W 5%		RC07GF245J
R106	5K	R:Var 1/4W 30%	71590	TSV-5K
R107	42.2K	R:Met Film 1/2W 1%		RN60D-4222F
R108	9.09K	R:Met Film 1/2W 1%		RN60D-9091F
R109	18.2K	R:Met Film 1/2W 1%		RN60D-1822F
R110	5.6K	R:Met Glaze 1/4W 5%	75042	RG1/4-562J
R111	7.50K	R:Met Film 1/2W 1%		RN60D-7501F
R112	464	R:Met Film 1/2W 1%		RN60D-4640F
R114	158	R:Met Film 1/2W 1%	07421	P0034619 M-Set 3
R117	390	R:Met Glaze 1/4W 5%	75042	RG1/4-391J
R118	82K	R:Met Glaze 1/4W 5%	75042	RG1/4-823J
R119	27K	R:Met Glaze 1/4W 5%	75042	RG1/4-273J
R120	390	R:Met Glaze 1/4W 5%	75042	RG1/4-391J
R121	100	R:Var 1/4W 30% 1	71590	TSV-100
R122	187	R:Met Film 1/2W 1%		RN60D-1870F
R123	357	R:Met Film 1/2W 1%		RN60D-3570F
R124	357	R:Met Film 1/2W 1%		RN60D-3570F
R125	25K	R:Var 1/4W 30%	71590	TSV-25K
R126	1.2M	R:Carbon 1/4W 5%		RC07GF125J
R127	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R128	316	R:Met Film 1/2W 1%		P00347619 See R114
R129	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R130	3.83K	R:Met Film 1/2W 1%		RN60D-3831F
R131	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R132	316	R:Met Film 1/2W 1%		P00347619 See R114
R133	464	R:Met Film 1/2W 1%		RN60D-4640F
R134	FS	R:Met Glaze 1/4W 5%		
R135	FS	R:Met Glaze 1/4W 5%		
R136	1.3M	R:Carbon 1/4W 5%		RC07GF135J
R137	2.0M	R:Carbon 1/4W 5%		RC07GF205J
R138	499	R:Met Film 1/2W 1%		RN60D-4990F
R139	1.15K	R:Met Film 1/2W 1%		RN60D-1151F
R140	51	R:Met Glaze 1/4W 5%	75042	RG1/4-510J
R141	2.4K	R:Met Glaze 1/4W 5%	75042	RG1/4-242J
R142	500	R:Var 1/4W 30%	71590	TSV-500
R143	787	R:Met Film 1/2W 1%		RN60D-7870F
R144	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R146	2.49K	R:Met Film 1/2W 1%		RN60D-2491F
R147	261	R:Met Film 1/2 W 1%		RN60D-2610F
R148	150K	R:Met Glaze 1/4W 5%	75042	RG1/4-154J
R149	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R150	357	R:Met Film 1/2W 1%		RN60D-3570F
R151	7.50K	R:Met Film 1/2W 1%		RN60D-7501F
R152	6.65K	R:Met Film 1/2W 1%		RN60D-6651F
R153	3.32K	R:Met Film 1/2W 1%		RN60D-3321F
R154	500	R:Var Cermet	80740	91V-501
R155	330K	R:Met Glaze 1/4W 5%	75042	RG1/4-334J
R156	215	R:Met Film 1/2W 1%		RN60D-2150F
R157	287	R:Met Film 1/2W 1%		RN60D-2870F
R158	309	R:Met Film 1/2W 1%		RN60D-3090F
R159	2.00K	R:Met Film 1/2W 1%		RN60D-2001F
R160	500	R:Var Cermet	80740	91V-501
R161	665	R:Met Film 1/2W 1%		RN60D-6650F
R162	4.99K	R:Met Film 1/2W 1%		RN60D-4991F
R163	2.5K	R:Var 1/4W 30%	71590	TSV-2.5K
R164	500	R:Var 1/4W 30%	71590	TSV-500
R170	47	R:Met Glaze 1/4W 5%	75042	RG1/4-470J
R171	FS	R:Met Glaze 1/4W 5%		
R172	15K	R:Met Glaze 1/4W 5%	75042	RG1/4-153J
R173	5.6K	R:Met Glaze 1/4W 5%	75042	RG1/4-562J
R174	3K	R:Met Glaze 1/4W 5%	75042	RG1/4-302J
R176	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R178	806	R:Met Film 1/2W 1%		RN60D-8060F
R179	3.01K	R:Met Film 1/2W 1%		RN60D-3011F
R180	1.00K	R:Met Film 1W 1%		RN65E-1001F
R181	1.2K	R:Carbon 1/2W 5%		RC20GF122J
R182	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R183	1.2K	R:Met Glaze 1/4W 5%	75042	RG1/4-122J
R184	215	R:Met Film 1/2W 1%		RN60D-2150F
F185	25K	R:Var 1/4W 30%	71590	TSV-25K
R186	20.0K	R:Met Film 1/2W 1%		RN60D-2002F
R187	576	R:Met Film 1W 1%		RN65E-5760F
R188	1.05K	R:Met Film 1W 1%		RN65E-1051F
R202	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R203	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R204	383	R:Met Film 1/2W 1%		RN60D-3830F
R205	680K	R:Met Glaze 1/4W 5%	75042	RG1/4-684J
R206	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R207	25K	R:Var 1/4W 30%	71590	TSV-25K
R208	10K	R:Met Glaze 1/4W 5%	75042	RG1/4-103J
R209	2M	R:Carbon 1/4W 5%		RC07GF205J
F210	25K	R:Var 1/4W 30%	71590	TSV-25K
R211	150	R:Met Glaze 1/4W 5%	75042	RG1/4-151J
R212	51	R:Met Glaze 1/4W 5%	75042	RG1/4-510J
R213	4.99K	R:Met Film 1/2W 1%		RN60D-4991F
R214	4.99K	R:Met Film 1/2W 1%		RN60D-4991F
R216	500	R:Var 1/4W 30%	71590	TSV-500
R217	475	R:Met Film 1/2W 1%		RN60D-4750F
R219	715	R:Met Film 1/2W 1%		RN60D-7150F
R220	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R223	3.6K	R:Met Glaze 1/4W 5%	75042	RG1/4-362J
R224	160	R:Met Glaze 1/4W 5%	75042	RG1/4-161J
R226	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R227	33K	R:Met Glaze 1/4W 5%	75042	RG1/4-333J
R228	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R230	35.7	R:Met Film 1/2W 1%		RN60D-35R7F
R231	19.6K	R:Met Film 1/2W 1%		RN60D-1962F
R232	1.50M	R:Met Film 1/2W 1%	91637	DC1/4-1504F
R233	66.5K	R:Met Film 1/2W 1%		RN60D-6652F
R234	665K	R:Met Film 1/2W 1%		RN60D-6653F
R235	66.5K	R:Met Film 1/2W 1%		RN60D-6652F
R236	6.65K	R:Met Film 1/2W 1%		RN60D-6651F
R237	665	R:Met Film 1/2W 1%		RN60D-6650F
R238	33.2K	R:Met Film 1/2W 1%		RN60D-3322F
R239	33.2K	R:Met Film 1/2W 1%		RN60D-3322F
R240	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R241	1.50K	R:Met Film 1/2W 1%		RN60D-1501F
R266	5K	R:Var 1/4W 30%	71590	TSV-5K
R267	5K	R:Var 1/4W 30%	71590	TSV-5K
R268	5K	R:Var 1/4W 30%	71590	TSV-5K
R269	5K	R:Var 1/4W 30%	71590	TSV-5K

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R301	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R302	10K	R:Met Glaze 1/4W 5%	75042	RG1/4-103J
R304	8.2K	R:Met Glaze 1/4W 5%	75042	RG1/4-822J
R305	560	R:Met Glaze 1/4W 5%	75042	RG1/4-561J
R306	82K	R:Met Glaze 1/4W 5%	75042	RG1/4-823J
R307	30	R:Met Glaze 1/4W 5%	75042	RG1/4-300J
R309	560	R:Met Glaze 1/4W 5%	75042	RG1/4-561J
R316	560	R:Met Glaze 1/4W 5%	75042	RG1/4-561J
R317	5.6K	R:Met Glaze 1/4W 5%	75042	RG1/4-562J
R318	300	R:Met Glaze 1/4W 5%	75042	RG1/4-301J
R320	510	R:Met Glaze 1/4W 5%	75042	RG1/4-511J
R321	300	R:Met Glaze 1/4W 5%	75042	RG1/4-301J
R322	47	R:Met Glaze 1/4W 5%	75042	RG1/4-470J
R323	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R324	30	R:Met Glaze 1/4W 5%	75042	RG1/4-300J
R325	1.8K	R:Met Glaze 1/4W 5%	75042	RG1/4-182J
R326	100	R:Var 1/4W 30%	71590	TSV-100
R327	324	R:Met Film 1/2W 1%		RN60D-3240F
R329	357	R:Met Film 1/2W 1%		RN60D-3570F
R330	301	R:Met Film 1/2W 1%		RN60D-3010F
R332	2.00K	R:Met Film 1/2W 1%		RN60D-2001F
R333	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R334	3.01K	R:Met Film 1/2W 1%		RN60D-3011F
R335	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R336	500	R:Var 1/4W 30%	71590	TSV-500
R337	3.01K	R:Met Film 1/2W 1%		RN60D-3011F
R338	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R339	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R340	36	R:Met Glaze 1/4W 5%	75042	RG1/4-360J
R341	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R342	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R343	200	R:Met Glaze 1/4W 5%	75042	RG1/4-201J
R344	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R345	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R346	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R347	FS	R:Met Film 1/2W 1%		
R348	499	R:Met Film 1/2W 1%		RN60D-4990F

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R350	62	R:Met Glaze 1/4W 5%	75042	RG1/4-620J
R402	200	R:Met Glaze 1/4W 5%	75042	RG1/4-201J
R403	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R404	510	R:Met Glaze 1/4W 5%	75042	RG1/4-511J
R405	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R407	3.16K	R:Met Film 1/2W 1%		RN60D-3161F
R408	715	R:Met Film 1/2W 1%		RN60D-7150F
R409	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R410	499	R:Met Film 1/2W 1%		RN60D-4990F
R411	5.76K	R:Met Film 1/2W 1%		RN60D-5761F
R412	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R413	715	R:Met Film 1/2W 1%		RN60D-7150F
R418	680	R:Met Glaze 1/4W 5%	75042	RG1/4-681J
R419	3K	R:Met Glaze 1/4W 5%	75042	RG1/4-302J
R420	1.5K	R:Met Glaze 1/4W 5%	75042	RG1/4-152J
R421	330	R:Met Glaze 1/4W 5%	75042	RG1/4-331J
R422	3K	R:Met Glaze 1/4W 5%	75042	RG1/4-302J
R430	3K	R:Met Glaze 1/4W 5%	75042	RG1/4-302J
R433	18K	R:Met Glaze 1/4W 5%	75042	RG1/4-183J
R435	4.99K	R:Met Film 1/2W 1%		RN60D-4991F
R436	2.00K	R:Met Film 1/2W 1%		RN60D-2001F
R437	FS	R:Met Film 1/2W 1%		
R438	300	R:Met Glaze 1/4W 5%	75042	RG1/4-301J
R439	FS	R:Met Glaze 1/4W 5%		
R440	510	R:Met Glaze 1/4W 5%	75042	RG1/4-511J
R441	430	R:Met Glaze 1/4W 5%	75042	RG1/4-431J
R443	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R601	15.0K	R:Met Film 1/2W 1%		RN60D-1502F
R602	1K	R:Var 1/4W 30%	71590	TSV-1K
R603	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R604	22K	R:Met Glaze 1/4W 5%	75042	RG1/4-223J
R605	43	R:Met Glaze 1/4W 5%	75042	RG1/4-430J
R606	100	R:Var 1/4W 30%	71590	TSV-100
R607	1.10K	R:Met Film 1/2W 1%		RN60D-1101F
R608	FS	R:Met Film 1/2W 1%		
R609		R:Net	07421	P00347406
R610	50	R:Var Cermet	80740	91V-500

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R611	680	R:Carbon 1/2W 5%		RC20GF681J
R612	430	R:Carbon 1W 5%		RC32GF431J
R613	49.9	R:Met Film 1/2W 1%		RN60D-49R9F
R614		R:Net	07421	P00347407
R616		R:Net	07421	P00347406
R617	50	R:Var Cermet	80740	91V-500
R618	680	R:Carbon 1/2W 5%		RC20GF681J
R619	100	R:Var 1/4W 30%	71590	TSV-100
R620	1.10K	R:Met Film 1/2W 1%		RN60D-1101F
R621	FS	R:Met Film 1/2W 1%		
R622	43	R:Met Glaze 1/4W 5%	75042	RG1/4-430J
R623	22K	R:Met Glaze 1/4W 5%	75042	RG1/4-223J
R624	15.0K	F:Met Film 1/2W 1%		RN60D-1502F
R625	1K	R:Var 1/4W 30%	71590	TSV-1K
R626	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R627	301	R:Met Film 1/2W 1%		RN60D-3010F
R628	910	R:Met Glaze 1/4W 5%	75042	RG1/4-911J
R629	715	R:Met Film 1/2W 1%		RN60D-7150F
R630	390	R:Met Glaze 1/4W 5%	75042	RG1/4-391J
R631	47K	R:Met Glaze 1/4W 5%	75042	RG1/4-473J
R632	25K	R:Var 1/4W 30%	71590	TSV-25K
R633	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R634	715	R:Met Film 1/2W 1%		RN60D-7150F
R635	250	R:Var 1/4W 30%	71590	TSV-250
R636	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R637	47	R:Met Glaze 1/4W 5%	75042	RG1/4-470J
R638	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R639	10K	R:Met Glaze 1/4W 5%	75042	RG1/4-103J
R640	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R641	FS	R:Met Glaze 1/4W 5%	75042	
R642	56	R:Met Glaze 1/4W 5%	75042	RG1/4-560J
R643	560	R:Met Glaze 1/4W 5%	75042	RG1/4-561J
R701	330	R:Met Glaze 1/4W 5%	75042	RG1/4-331J
R702	500	R:Var 1/4W 30%	71590	TSV-500
R703	2.05K	R:Met Film 1/2W 1%		RN60D-2051F
R704	365	R:Met Film 1/2W 1%		RN60D-3650F
R705	365	R:Met Film 1/2W 1%		RN60D-3650F

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R706	2.05K	R:Met Film 1/2W 1%		RN60D-2051F
R707	500	R:Var 1/4W 30%	71590	TSV-500
R708	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R711	12.4K	R:Met Film 1/2W 1%		RN60D-1242F
R714	2.00K	R:Met Film 1/2W 1%		RN60D-2001F
R715	20	R:Met Glaze 1/4W 5%	75042	RG1/4-200J
R716	100K	R:Met Glaze 1/4W 5%	75042	RG1/4-104J
R718	1.5K	R:Met Glaze 1/4W 5%	75042	RG1/4-152J
R719	150K	R:Met Glaze 1/4W 5%	75042	RG1/4-154J
R720	1.33K	R:Met Film 1/2W 1%		RN60D-1331F
R721	150K	R:Met Glaze 1/4W 5%	75042	RG1/4-154J
R722	1.8K	R:Met Glaze 1/4W 5%	75042	RG1/4-182J
R723	FS	R:Carbon 1/4W 5%		
R724	25K	R:Var 1/4W 30%	71590	RSV-25K
R725	3K	R:Met Glaze 1/4W 5%	75042	RG1/4-302J
R726	100K	R:Met Glaze 1/4W 5%	75042	RG1/4-104J
R727	100K	R:Met Glaze 1/4W 5%	75042	RG1/4-104J
R728	4.3K	R:Met Glaze 1/4W 5%	75052	RG1/4-432J
R729	5K	R:Var 1/4W 30%	71590	TSV-5K
R730	4.3K	R:Met Glaze 1/4W 5%	75042	RG1/4-432J
R731	5K	R:Var 1/4W 30%	71590	TSV-5K
R732	12.1K	R:Met Film 1/2W 1%		RN60D-1212F
R733	6.65K	R:Met Film 1/2W 1%		RN60D-6651F
R734	150	R:Met Film 1/2W 1%		RN60D-1500F
R735	56.2	R:Met Film 1/2W 1%		RN60D-56R2F
R736	1.07K	R:Met Film 1/2W 1%		RN60D-1071F
R737	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R738	39	R:Met Glaze 1/4W 5%	75042	RG1/4-390J
R739	22	R:Carbon 2W 5%		RG2GF220J
R740	5.6	R:Carbon 1/4W 5%	75042	RC07GF-5R6J
R741	10.0K	R:Met Film 1/2W 1%		RN60D-1002F
R742	10.0K	R:Met Film 1/2W 1%		RN60D-1002F
R743	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R744	133	R:Met Film 1W 1%		RN65D-1330F
R745	133	R:Met Film 1W 1%		RN65D-1330F
R746	133	R:Met Film 1W 1%		RN65D-1330F
R749	12	R:Met Glaze 1/4W 5%	75042	RG1/4-120J

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R750	715	R:Met Film 1/2W 1%		RN60D-7150F
R752	715	R:Met Film 1/2W 1%		RN60D-7150F
R753	124	R:Met Film 1/2W 1%		RN60D-1240F
R754	100	R:Var 1/4W 30%	71590	TSV-100
R755	12	R:Met Glaze 1/4W 5%	75042	RG1/4-120J
R756	124	R:Met Film 1/2W 1%		RN60D-1240F
R757	100	R:Var 1/4W 30%	71590	TSV-100
R759	715	R:Met Film 1/2W 1%		RN60D-7150F
R760	200	R:Met Glaze 1/4W 5%	75042	RG1/4-201J
R761	200	R:Met Glaze 1/4W 5%	75042	RG1/4-201J
R762	715	R:Met Film 1/2W 1%		RN60D-7150F
R763	453	R:Met Film 1W 1%	07421	P00347613-4530
R764	453	R:Met Film 1W 1%	07421	P00347613-4530
R766	FS	R:Met Glaze 1/4W 5%		
R767	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R768	39	R:Met Glaze 1/4W 5%	75042	RG1/4-390J
R769	150	R:Met Film 1/2W 1%		RN60D-1500F
R770	56.2	R:Met Film 1/2W 1%		RN60D-56R2F
R771	1.07K	R:Met Film 1/2W 1%		RN60D-1071F
R772	5.6	R:Carbon 1/4W 5%	75042	RC07GF-5R6J
R773	22	R:Carbon 2W 5%		RG42GF220J
R774	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R775	FS	R:Met Film 1/2W 1%		
R776	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R777	499	R:Met Film 1/2W 1%		RN60D-4990F
R778	1.37K	R:Met Film 1/2W 1%		RN60D-1371F
R779	100	R:Var 1/4W 30%	71590	TSV-100
R780	500	R:Var 1/4W 30%	71590	TSV-500
R781	1.37K	R:Met Film 1/2W 1%		RN60D-1371F
R782	51	R:Met Glaze 1/4W 5%	75042	RG1/4-510J
R784	665	R:Met Film 1/2W 1%		RN60D-6650F
R785	1.43K	R:Met Film 1/2W 1%		RN60D-1431F
R786	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R787	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R788	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R781	47	R:Met Glaze 1/4W 5%	75042	RG1/4-470J
R901	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J

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Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R902	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R903	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R904	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R905	82	R:Met Glaze 1/4W 5%	75042	RG1/4-820J
R906	11K	R:Met Glaze 1/4W 5%	75042	RG1/4-113J
R907	11K	R:Met Glaze 1/4W 5%	75042	RG1/4-113J
R908	82	R:Met Glaze 1/4W 5%	75042	RG1/4-820J
R909	430	R:Met Glaze 1/4W 5%	75042	RG1/4-431J
R910	11K	R:Met Glaze 1/4W 5%	75042	RG1/4-113J
R911	11K	R:Met Glaze 1/4W 5%	75042	RG1/4-113J
R912	430	R:Met Glaze 1/4W 5%	75042	RG1/4-431J
R913	2	R:Wire 2W 5%	75042	BWH-2R0J
R914	2	R:Wire 2W 5%	75042	BWH-2R0J
R915	1	R:Wire 2W 5%	75042	BWH-1R0J
R916	1	R:Wire 2W 5%	75042	BWH-1R0J
R917	2.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-272J
R918	2.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-272J
R919	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R920	2.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-272J
R921	2.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-272J
R922	10.0K	R:Met Film 1/2W 1%		RN60D-1002F
R923	5.49K	R:Met Film 1/2W 1%		RN60D-5491F
R924	15.0K	R:Met Film 1/2W 1%		RN60D-1502F
R925	15.0K	R:Met Film 1/2W 1%		RN60D-1502F
R926	24.9K	R:Met Film 1/2W 1%		RN60D-2492F
R927	1.2K	R:Met Glaze 1/4W 5%	75042	RG1/4-122J
R928	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R929	10K	R:Met Glaze 1/4W 5%	75042	RG1/4-103J
R930	220	R:Met Glaze 1/4W 5%	75042	RG1/4-221J
R931	220	R:Met Glaze 1/4W 5%	75042	RG1/4-221J
R932	15.0K	R:Met Film 1/2W 1%		RN60D-1502F
R933	15.0K	R:Met Film 1/2W 1%		RN60D-1502F
R934	2.5K	R:Var 1/4W 30%	71590	TSV-2.5K
R935	10.0K	R:Met Film 1/2W 1%		RN60D-1002F
R936	15.0K	R:Met Film 1/2W 1%		RN60D-1502F
R937	15.0K	R:Met Film 1/2W 1%		RN60D-1502F
S002		SW:Mult/Sym S2	07421	P00347928

Table 6-2. Parts List, A1 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
S004		SW:Offset S4/R2	07421	P00347930
S005		SW:Waveform S5/S3	07421	P00347929
S006	FS	SW:Inv P/O S5		
VR101	6.8V	Diode:Zener		IN5235B
VR102	8.2V	Diode:Zener		IN5237B
VR103	9.1V	Diode:Zener		IN5239B
VR104	9.1V	Diode:Zener		IN5239B
VR105	5.1V	Diode:Zener		IN5231B
VR201	3.0V	Diode:Zener		IN5225B
VR615	5.1V	Diode:Zener		IN5231B
VR701	5.1V	Diode:Zener		IN5231B
VR703	3.0V	Diode:Zener		IN5225B
VR704	12V	Diode:Zener		IN4742A
VR705	12V	Diode:Zener		IN4742A
VR706	3.0V	Diode:Zener		IN5225B
VR911	27V	Diode:Zener		IN5254B
VR912	27V	Diode:Zener		IN5254B
VR913	12V	Diode:Zener		IN5242B
VR915	6.2V	Diode:Zener		IN821
VR916	12V	Diode:Zener		IN5242B

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TABLE 6-3. PARTS LIST, A2 BOARD

Ref Design	Value	Description	Mfg Code	Part Number
C001	FS	C:Mica 500V 5%		
C002	820 PF	C:Mica 500V 5%	84171	CM06CC821J
C003	0.01 MF	C:Met Poly 50V 5%		P00347752 M-P W/C4
C004	10 MF	C:Met Poly 50V 5%	07421	P00347752 M-P W/C3
C005	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C006	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C007	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C008	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C009	10 PF	C:Mica 500V 5%	84171	DM5-100J
C010	20 PF	C:Mica 500V 5%	84171	DM5-200J
C011	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C012	120 PF	C:Mica 500V 5%	84171	CM05ED121J
C013	75 PF	C:Mica 500V 5%	84171	DM5-750J
C014	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C015	0.002 MF	C:Ceramic 1000V 20%	56289	C016A102J202M
C016	0.002 MF	C:Ceramic 1000V 20%	56289	C016A102J202M
C017	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C018	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C019	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C021	120 PF	C:Mica 500V 5%	84171	CM05ED121J
C022	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C023	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C024	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C025	6.8 MF	C:Tant el 35V 10%	56289	196D685X0035KA1
C026	0.0047 MF	C:Ceramic 25V 20%	56289	C069A250C472M
C027	820 PF	C:Mica 500V 5%	84171	CM06CC-821J
C028	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C029	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C030	0.002 MF	C:Ceramic 1000V 20%	56289	C016A102J202M
C031	0.002 MF	C:Ceramic 1000V 20%	56289	C016A102J202M
C032	270 PF	C:Mica 500V 5%	84171	CM05ED271J
C033	270 PF	C:Mica 500V 5%	84171	CM05ED271J
C201	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C202	6.8 MF	C:Tant El 35V 10%	56289	196D685X0035KA1
C203	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M

Table 6-3. Parts List, A2 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
C204	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C205	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C206	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C207	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C208	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C209	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C501	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C502	0.0047 MF	C:Film 80V 10%	07421	192P4729R8
C503	0.47 MF	C:Film 80V 10%	73445	C280AH/A470K
C506	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C507	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C508	2-20 PF	C:Var	91213	9302
C509	30 PF	C:Mica 500V 5%	84171	CM05ED300J
C510	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C511	0.1 MF	C:Dip Mylar 50V 40%	07994	FM0104U
C512	0.01 MF	C:Ceramic 100V 20%	56289	C023A101F103M
C513	10 PF	C:Mica 500V 5%	84171	DM5-100J
CR001		Diode:Hot Carrier	28480	HP5082-2811
CR002		Diode:Sil		1N4153
CR003		Diode:Hot Carrier	28480	HP5082-2811
CR004		Diode:Sil	07263	FD333
CR005		Diode:Sil		1N4153
CR006		Diode:Sil		1N4448
CR007		Diode:Sil		1N4153
CR008		Diode:Sil		1N4153
CR501		Diode:Sil		1N4153
CR502		Diode:Sil		1N4153
IC001		Int Ckt:8 Pin Dip	18324	N5558V
IC002		Int Ckt:8 Pin Dip	18324	N5558V
IC003		Int Ckt:14 Pin Dip	01295	SN72710N
IC004		Int Ckt:14 Pin Dip	01295	SN7400N
IC005		Int Ckt:14 Pin Dip	01295	SN7400N
IC006		Int Ckt:14 Pin Dip	01295	SN74122N
IC201		Int Ckt:14 Pin Dip	02735	CA3086
IC202		Int Ckt:8 Pin Dip	18324	N5558V

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Table 6-3. Parts List, A2 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
IC203		Int Ckt:8 Pin Dip	01295	SN7271P
J001		Connector	27264	09-65-1101
J002		Connector	27264	09-65-1101
J003		Connector	27264	09-65-1101
J004		Jack:Phono	27264	15-24-0501
J005		Jack:Phono	27264	15-24-0501
J006		Jack:Phono	27264	15-24-0501
J007		Jack:Phono	27264	15-24-0501
J008		Jack:Phone	27264	15-24-0501
Q001		TSTR:Dual N J FET	07421	P00347201
Q002		TSTR:Sil NPN	07421	P00347000
Q003		TSTR:Sil NPN		2N3904
Q004		TSTR:Sil PNP		2N3906
Q005		TSTR:Sil NPN		2N3904
Q006		TSTR:Sil NPN		2N3904
Q007		TSTR:Sil PNP		2N3906
Q008		TSTR:Sil NPN		2N3904
Q010		TSTR:Sil NPN		2N3904
Q201		TSTR:Sil PNP		2N2905A
Q501		TSTR:Sil PNP		2N3251A
Q503		TSTR:Sil PNP	07263	2N5771
Q504		TSTR:Sil NPN		2N3904
Q505		TSTR:Sil NPN	07263	2N5769
Q506		TSTR:Sil PNP	07263	2N4258
Q507		TSTR:Sil PNP	07263	2N4258
Q508		TSTR:Sil NPN	07263	2N5769
R001	150	R:Met Glaze 1/4W 5%	75042	RG1/4-151J
R002	42.2K	R:Met Film 1/2W 1%	07421	P00347601-4222
R003	5K	R:Var 1/2W 20%	71450	U260-502
R004	5K	Pot:Swp Vern P/O S9		
R005	422K	R:Met Film 1/2W 1%		RN60D-4223F
R006	4.22M	R:Met Film 1/2W 1%	91637	DC1/4-4224F
R007	5.90K	R:Met Film 1/2W 1%		RN60D-5901F
R008	12.1K	R:Met Film 1/2W 1%		RN60D-1212F
R010	36.5K	R:Met Film 1/2W 1%		RN60D-3652F

Table 6-3. Parts List, A2 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R011	133K	R:Met Film 1/2W 1%		RN60D-1333F
R012	1.33K	R:Met Film 1/2W 1%		RN60D-1331F
R013	30.1K	R:Met Film 1/2W 1%		RN60D-3012F
R014	30.1K	R:Met Film 1/2W 1%		
R015	50K	R:Var 1/2W 20%	71450	U260-503
R016	1.8M	R:Carbon 1/4W 5%		RC07GF185J
R017	39K	R:Met Glaze 1/4W 5%	75042	RG1/4-393J
R018	47K	R:Met Glaze 1/4W 5%	75042	RG1/4-473J
R019	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R021	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R022	30.1K	R:Met Film 1/2W 1%		RN60D-3012F
R023	20K	R:Var 1/2W 20%	80294	3359P-1-203
R024	390	R:Met Glaze 1/4W 5%	75042	RG1/4-391J
R025	1.5K	R:Met Glaze 1/4W 5%	75042	RG1/4-152J
R026	2.00K	R:Met Film 1/2W 1%		RN60D-2001F
R027	1.69K	R:Met Film 1/2W 1%		RN60D-1691F
R029	1.62K	R:Met Film 1/2W 1%		RN60D-1621F
R030	2.00K	R:Met Film 1/2W 1%		RN60D-2001F
R031	1K	R:Var 1/2W 20%	71450	U260-102
R032	3.3K	R:Met Glaze 1/4W 5%	75042	RG1/4-332J
R033	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R034	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R035	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R036	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R037	270	R:Met Glaze 1/4W 5%	75042	RG1/4-271J
R038	240	R:Met Glaze 1/4W 5%	75042	RG1/4-241J
R039	270	R:Met Glaze 1/4W 5%	75042	RG1/4-271J
R040	240	R:Met Glaze 1/4W 5%	75042	RG1/4-241J
R041	47	R:Met Glaze 1/4W 55	75042	RG1/4-470J
R042	270	R:Met Glaze 1/4W 5%	75042	RG1/4-271J
R043	240	R:Met Glaze 1/4W 55	75042	RG1/4-241J
R044	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R045	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R046	36K	R:Met Glaze 1/4W 5%	75042	RG1/4-363J
R047	560	R:Met Glaze 1/4W 5%	75042	RG1/4-561J

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Table 6-3. Parts List, A2 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R048	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R049	2K	R:Met Glaze 1/4W 5%	75042	RG1/4-202J
R050	6.8K	R:Met Glaze 1/4W 5%	75042	RG1/4-682J
R051	1.5K	R:Met Glaze 1/4W 5%	75042	RG1/4-152J
R052	1K	R:Met Glaze 1/4W 5%	75042	RG1/4-102J
R053	510	R:Met Glaze 1/4W 5%	75042	RG1/4-511J
R054	200	R:Met Glaze 1/4W 5%	75042	RG1/4-201J
R055	200	R:Met Glaze 1/4W 5%	75042	RG1/4-201J
R056	499	R:Met Film 1/2W 1%		RN60D-4990F
R057	590	R:Met Film 1/2W 1%		RN60D-5900F
R059	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R060	4.75K	R:Met Film 1/2W 1%		RN60D-4751F
R061	499	R:Met Film 1/2W 1%		RN60D-4990F
R062	500	R:Var 1/2W 10%	80294	3359P-1-501
R063	4.99K	R:Met Film 1/2W 1%		RN60D-4991F
R064	1K	R:Var 1/2W 20%	71450	U260-102
R065	4.99K	R:Met Film 1/2W 1%		RN60D-4991F
R066	1.00K	R:Met Film 1/2W 1%		RN60D-1001F
R067	3.3K	R:Met Glaze 1/4W 5%	75042	RG1/4-332J
R068	10K	R:Met Glaze 1/4W 5%	75042	RG1/4-103J
R069	17.4K	R:Met Film 1/2W 1%	07421	RN60D-1742F
R070	5.62K	R:Met Film 1/2W 1%	07421	RN60D-5621F
R071	620	R:Met Glaze 1/4W 5%	75042	RG1/4-621J
R072	620	R:Met Glaze 1/4W 5%	75042	RG1/4-621J
R077	30	R:Met Glaze 1/4W 5%	75042	RG1/4-300J
R078	1.8K	R:Met Glaze 1/4W 5%	75042	RG1/4-182J
R079	47	R:Met Glaze 1/4W 5%	75042	RG1/4-470J
R080	47	R:Met Glaze 1/4W 5%	75042	RG1/4-470J
R081	100	R:Var 1/2W 20%	71450	U260-101
R082	5K	R:Var 1/2W 20%	71450	U260-502
R083	9.1K	R:Met Glaze 1/4W 5%	75042	RG1/4-912J
R084	10K	R:Var 1/2W 20%	71450	U260-103
R085	4.7K	R:Met Glaze 1/4W 5%	75042	RG1/4-472J
R086	430	R:Met Glaze 1/4W 5%	75042	RG1/4-431J
R087	36K	R:Met Glaze 1/4W 5%	75042	RG1/4-363J

Table 6-3. Parts List, A2 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R201	50K	R:Var 1/2W 20%	71450	U260-503
R202	68K	R:Met Glaze 1/4W 5%	75042	RG1/4-683J
R203	178	R:Met Film 1/2W 1%		RN60D-1780F
R204	50	R:Var 1/2W 20%	80294	3359P-1-500
R205	90.9K	R:Met Film 1/2W 1%		RN60D-9092F
R207	3.01K	R:Met Film 1/2W 1%		RN60D-3011F
R208	8.2M	R:Carbon 1/4W 5%		RC07GF825J
R210	50K	R:Var 1/2W 20%	71450	U260-503
R211	150K	R:Met Glaze 1/4W 5%	75042	RG1/4-154J
R212	10K	R:Met Glaze 1/4W 5%	75042	RG1/4-103J
R213	14.3K	R:Met Film 1/2W 1%		RN60D-1432F
R214	1M	R:Carbon 1/4W 5%		RC07GF105J
R215	499	R:Met Film 1/2W 1%		RN60D-4990F
R217	200	R:Met Glaze 1/4W 55	75042	RG1/4-201J
R218	390	R:Carbon 1/2W 55		RC20GF391J
R219	820	R:Met Glaze 1/4W 5%	75042	RG1/4-821J
R221	1.50K	R:Met Film 1/2W 1%		RN60D-1501F
R222	1.5K	R:Met Glaze 1/4W 5%	75042	RG1/4-152J
R223	10K	R:Var 1/2W 20%	71450	U260-103
R501	4.32K	R:Met Film 1/2W 1%		RN60D-4321F
R502	1K	R:Var 1/2W 20%	71450	U260-102
R503	499	R:Met Film 1/2W 1%		RN60D-4990F
R504	47K	R:Met Glaze 1/4W 5%	75042	RG1/4-473J
R505	100	R:Met Glaze 1/4W 5%	75042	RG1/4-101J
R508	50K	R:Var 1/2W 20%	71450	U260-503
R509	47K	R:Met Glaze 1/4W 5%	75042	RG1/4-473J
R510	200	R:Var 1/2W 20%	80294	3359P-1-201
R511	1.10K	R:Met Film 1/2W 1%		RN60D-1101F
R512	511	R:Met Film 1/2W 1%		RN60D-5110F
R514	560	R:Met Glaze 1/4W 5%	75042	RG1/4-561
R515	309	R:Met Film 1/2W 1%		RN60D-3090F
R516	73.2	R:Met Film 1/2W 1%		RN60D-73R2F
R517	7.5K	R:Met Glaze 1/4W 5%	75042	RG1/4-752J
R518	200	R:Met Glaze 1/4W 5%	75042	RG1/4-201J
R519	680	R:Carbon 1/2W 5%		RC20GF-681J

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Table 6-3. Parts List, A2 Board (Continued)

Ref Design	Value	Description	Mfg Code	Part Number
R520	1.47K	R:Met Film 1/2W 1%		RN60D-1471F
R521	280	R:Met Film 1/2W 1%		RN60D-2800F
R522	274	R:Met Film 1/2W 1%		RN60D-2740F
R523	1.8K	R:Met Glaze 1/4W 5%	75042	RG1/4-182J
R525	51	R:Met Glaze 1/4W 5%	75042	RG1/4-510J
R526	10	R:Met Glaze 1/4W 5%	75042	RG1/4-100J
R871	82	R:Carbon 1/2W 5%		RC20GF820J
R872	82	R:Carbon 1/2W 5%		RC20GF820J
R873	10	R:Met Glaze 1/2W 5%		RC20GF100J
R874	10.0	R:Met Film 1/4W 1%		RN55D-10R0F
R875	10.0	R:Met Film 1/4W 1%		RN55D-10R0F
R876	41.2	R:Met Film 1/4W 1%		RN55D-41R2F
R877	41.2	R:Met Film 1/4W 1%		RN55D-41R2F
R878	41.2	R:Met Film 1/4W 1%		RN55D-41R2F
R879	41.2	R:Met Film 1/4W 1%		RN55D-41R2F
R880	41.2	R:Met Film 1/4W 1%		RN55D-41R2F
S007		SW:Swp Time S7/R4	07421	R00347931-2
S008		SW:Mode/Pul W S8	07421	P00347927-1