Maintenance and Service Manual

Models 8550/8551

50 MHz Single Channel Modulated Function / Pulse Generators

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Tabor Electronics Ltd.

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REVISION: H

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PROPRIETARY NOTICE

FOR YOUR SAFETY

Before undertaking any troubleshooting, maintenance or exploratory procedure, read carefully the **WARNINGS** and **CAUTION** notices.

This equipment contains voltage hazardous to human life and safety, and is capable of inflicting personal injury.

If this instrument is to be powered from the AC line (mains) through an autotransformer, ensure the common connector is connected to the neutral (earth pole) of the power supply.

Before operating the unit, ensure the conductor (green wire) is connected to the ground (earth) conductor of the power outlet. Do not use a two-conductor extension cord or a three-prong/two-prong adapter. This will defeat the protective feature of the third conductor in the power cord.

Maintenance and calibration procedures sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures and heed warnings to avoid “live” circuits points.

Before operation this instrument:

1. Ensure the instrument is configured to operate on the voltage at the power source. See Installation Section.

2. Ensure the proper fuse is in place for the power source to operate.

3. Ensure all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If the instrument:

- fails to operate satisfactorily
- shows visible damage
- has been stored under unfavorable conditions
- has sustained stress

Do not operate until performance is checked by qualified personnel.

DECLARATION OF CONFORMITY

We: Tabor Electronics Ltd.
9 Hatasia Street, Tel Hanan
ISRAEL 20302

declare, that the 50 MHz Pulse/Function Generators

Model 8550 and Model 8551

meet the intent of Directive 89/336/EEC for Electromagnetic Compatibility and complies with the requirements of the Low Voltage Directive 73/23/EEC. Compliance was demonstrated to the following
specifications as listed in the official Journal of the European Communities:

Safety:
EN 61010-1
IEC 1010-1 (1990) + Amendment 1 (1992)

EMC:
EN 50081-1 Emissions:
EN 55022 - Radiated, Class B
EN 55022 - Conducted, Class B
EN 50082-1 Immunity:
IEC 801-2 (1991) - Electrostatic Discharge
IEC 801-3 / ENV50140 (1993) - RF Radiated
IEC 801-4 (1991) - Fast Transients

Model 8550 and Model 8551 were tested in typical configuration.

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1-1. INTRODUCTION

This manual provides operation and maintenance information for both Model 8550 - Function Generator and Model 8551 - Pulse/Function Generator. Chapter 1 provides general description of the instruments. Chapters 2 and 3 contain installation and operation instructions. IEEE-488.2 (GPIB) programming is explained in Chapter 4. Maintenance and performance checks are provided in Chapter 5. Theory of operation is described in Chapter 6. Chapter 7 outlines calibration and troubleshooting procedure. Chapter 8 contain tables of replaceable parts and recommended spare parts. Chapter 9 contains schematic and component location diagrams.

NOTE

This manual is common to both Model 8550 and Model 8551. It describes all features and functions for both models. Therefore, some features which are described in this manual may not be available in your instrument. Features that are unique to the Model 8551 are described separately.

1-2. DESCRIPTION

Model 8550 is an extremely high-performance programmable function generator. It provides a variety of signal waveforms, to be used as test stimuli for different electronic devices. Microprocessor based, Model 8550 is easy to set up for manual use. It is also simple to program in GPIB system environment.

The instrument is built in an all-round metal case for improved RFI and EMI shielding. It is housed in a size to fit half-rack enclosures. Regardless of its small size, Model 8550 offers many features and functions, such as enhanced accuracy, eight different linear and logarithmic sweep modes, automatic phase lock loop, pulse and ramp waveforms with transition time control (Model 8551 only), counted burst, internal trigger generator, full implementation of the new IEEE-488.2 standard, and more. But, most of all, Model 8550 guarantees high quality waveforms through- out the specified frequency range, amplitude span, and operating temperature.

Model 8550 generates waveforms within a frequency range from 10mHz to 50MHz and an amplitude span from 10mV to 32Vp-p. Such broad coverage warrants a variety of complex applications. Rapid, repeatable testing every time is assured by a non-volatile memory. Up to 30 front panel set-ups can be stored and recalled for later use; ensuring exact duplication of previous tests. Its performance, programmability and economy make it equally at home in every laboratory.

For improved output accuracy, Model 8550 employs a built-in counter. This counter is incorporated in an internal loop which constantly monitors the output frequency. Even the slightest deviation from the programmed frequency is detected and corrected by the microprocessor circuit.

Model 8550 features self-calibration and self-diagnostic functions that can be operated anytime from the front panel or GPIB command. The self-calibration function compares the output signal parameters to built-in internal references and stores correcting factors in special tables. If calibration routine fails or can not be completed due to electrical faults, the generator produces a failure list that can be evaluated either from the front panel or through GPIB status reporting command.

Besides its normal continuous mode, Model 8550 offers a variety of interrupted and controlled modes. Output waveform may be gated, triggered, or may generate a counted burst of output waveforms. A built-in trigger generator, having a programmable period, can replace an external trigger stimulant.

The MANUAL trigger is just an additional convenience for front panel operation. The generator may also be placed in a number of externally controlled modes, such as VCO, FM, AM, and pulse width modulation
(PWM - Model 8551 only).

Model 8550 may be used as an independent sweep generator with its output swept over an exceptionally wide range of 10 decades. The instrument offers a choice of eight sweep modes, both linear and logarithmic to cover a large number of applications. A MARKER output provides an oscilloscope Z-axis modulation to intensify segments of sweep trace.

Alternately, Model 8550 may also be used as a stand-alone phase lock generator. The instrument locks automatically to an external signal and equates its output frequency and phase to that provided by the external reference. The operator may then generate a phase offset between the reference signal and the generator's output. Phase offset is adjusted within a range of ±18550°.

Model 8550 provides an output level from 20mV to 32Vp-p into open circuit or 10mV to 16Vp-p into 50Ω. DC offset plus amplitude are independently variable within two window levels: ±16V and ±1.6V (into open circuit). This special characteristics warrants production of extremely small signals at an elevated DC environment.

Model 8551 is a pulse/function generator and is also described in this manual. This instrument is identical in its basic functions to the Model 8550. In addition, this instrument offers Pulse and Ramp waveforms. Pulse width and ramp width are adjustable within a range of 10.0ns to 999ms.

Model 8551 provides control over the transition times for the leading and trailing edges; each can be adjusted independently within a common range. Pulse complement and inverted ramp functions are also available. This manual identifies those features and specifications that only apply to Model 8551.

1-3. INSTRUMENT & MANUAL IDENTIFICATION

The serial number of the instrument is located on the rear panel of the instrument. The two most significant digits identify instrument modifications. If this prefix differs from that listed on the title page of this manual, there are differences between this manual and your instrument.

Technical corrections to this manual (if any) are listed in the back of this manual on an enclosed MANUAL CHANGES sheet.

1-4. OPTIONS

Model 8550 offers a rack mounting option; designated as OPT 001. Opt 001 is field installable or may be ordered with new instruments from the factory.

1-5. SAFETY CONSIDERATIONS

Model 8550 has been manufactured according to international safety standards. The instrument meets EN 61010-1 and UL 1244 standards for safety of commercial electronic measuring and test equipment for instruments with an exposed metal chassis that is directly connected to earth via the power supply cable. Before the instrument is switched on, make sure that protective earth terminal is connected to a protective earth via the power cord. Do not remove instrument covers when operating or when power cord is connected to mains.

Any adjustment, maintenance and repair of the opened instrument under voltage should be avoided as much as possible, but when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

1-6. ACCESSORIES SUPPLIED

Model 8550 is supplied with ac power cord and with an instruction manual. Extra manual is available on request.

1-7. SPECIFICATIONS

Instrument specifications are listed in Tables 1-1. These specifications are the performance standards or limits against which the instrument is tested.

NOTE

All specifications in the following table apply under the following conditions: main signal output terminated into 50Ω, within ±5°C and 24 hours of last internal calibration, and after 30 minutes of warm-up time within a temperature range of 0 to 50°C.

Table 1-1. Model 8550/8551 Specifications

WAVEFORMS:	Sine, Triangle, Square, Positive Pulse, Negative Pulse, Ramp (Model 8551), DC (Model 8550)
FREQUENCY CHARACTERISTICS	
Range:	10.00mHz to 50.00MHz.
Resolution:	4 digits
Accuracy:	
Continuous Mode:	±4% of reading, from 10mHz to 999.9mHz;
	±0.1%, from 1.000Hz to 50.00MHz;
VCO, and Interrupted Modes:	±4% of reading, to 50.00MHz.
Jitter:	<0.1% ±50ps.
WAVEFORM CHARACTERISTICS	
Sine Wave	
Total Harmonic Distortion:	<1%, from 10.00mHz to 100.0KHz.
Harmonic signals below the carrier level:	
	>40dB, 100KHz - 2.000MHz;
	>21dB, 2.000MHz - 50.00MHz.
Flatness:	±1%, 10.00mHz to 999.9KHz;
	±2%, 1.000MHz to 9.999MHz;
	±20%, 10.00MHz to 50.00MHz.
Triangle	
Linearity (10% to 90% of amplitude):	
	<1%, 10.00mHz to 5.000MHz;
	<3%, 5.000MHz to 20.00MHz;
	<8%, 20.00MHz to 50.00MHz;
Flatness:	±3%, 10.00mHz to 999.9KHz;
	±5%, 1.000MHz to 9.999MHz;
	±25%, 10.00MHz to 50.00MHz.
Square Wave, Pulse:	
Rise/Fall time:	<8ns, 10% to 90% of amplitude (6 ns typical).
Aberration:	<5%.
SYNC Pulse:	
Output Level:	0 to 1V, into 50Ω; 0 to 2V, open circuit.
Rise/Fall time:	<4ns, into 50Ω.
Aberrations:	<5%.
OUTPUT CHARACTERISTICS	
Output Stand-by:	Output Normal or Disabled.
Impedance:	50Ω, ±1%.
Output Level:	20.0mV to 32.0Vp-p, into open circuit;
	10.0mV to 16.0Vp-p, into 50Ω.
Resolution:	3 digits.
Accuracy (1 KHz):	±5% of reading, from 10.0mV to 16.0V.

Level Windows:	±800mV, for amplitude from 10.0mV to 99.9mV; ±8V, for amplitude from 100mV to 16.0V.
Output Protection:	Protected against continuous short to case ground.
Offset	
Resolution:	3 digits
Range:	Offset and amplitude are independently adjustable within level windows of ±800mV and ±8.00V.
Within ±800mV	0 to ±795mV;
Within ±8V	0 to ±7.95V□
Accuracy:	±(1% of setting + 1% of amplitude + 2mV), within ±800mV; ±(1% of setting + 1% of amplitude + 20mV), within ±8V.

DC CHARACTERISTICS (Model 8550 only)

Range:	Variable from -16.0V to +16.0V, into open circuit; -8.00V to +8.00V, into 50Ω.
Resolution:	3 digits with exponent.
Accuracy:	±(1% of reading + 100□V)

TRIGGERING CHARACTERISTICS

Trigger Input:	Via TRIG/REF BNC terminal.
Impedance:	10KΩ, ±5%.
Sensitivity:	500mVp-p.
Max Input Voltage:	±20V
Min Pulse width:	20ns.
Slope:	Positive going leading edge
Source:	Manual (front panel push button), internal, or external stimulant.
Modes	
Normal:	Continuous waveform is generated.
Triggered:	Each input cycle generates a single output cycle.
Internal Trigger:	An internal timer repeatedly generates a single output cycle
Gated:	External signal enables generator. First output cycle synchronous with the active slope of the triggering signal. Last cycle of output waveform always completed.
Burst:	Preset number of cycles (1-4000) stimulated by an internal, external, or manual trigger.
Internal Burst:	An internal timer repeatedly generates a burst of counted output cycles
Trigger Frequency:	
External:	To 50MHz.
Internal:	From 20µs to 999s;
Manual:	Simulates an external trigger signal.
Start Phase:	
Offset:	Adjustable, from -90° to +90°, to 500.0KHz; proportionally reduced from 500.1KHz to 50.00MHz..
Accuracy:	±4°, to 500.0KHz
Trigger Level:	variable, -10.0V to +10.0V.

LOGARITHMIC SWEEP CHARACTERISTICS

Modes:	Auto, Triggered, Gated and Burst. Output frequency repeatedly changes from start sweep to stop sweep settings. Available sweep directions are: up, down, up-down and down-up.
Width:	10 decades maximum.
Rate per Decade:	Continuously adjustable from 10mS to 999S, NOMINAL, per decade.
Steps per decade:	Depends on sweep time and range. Automatically adjusted for maximum steps per sweep time. Maximum steps are 200; minimum steps are 50.
Sweep Output:	1V/decade, below 5 decades; .5V/decade, above 5 decades.
Marker Output:	+5V with no marker; drops to 0V, NOMINAL, when marker frequency is reached and remains at this level until end of sweep.
Stop Sweep Resolution:	Same as Frequency resolution.

LINEAR SWEEP CHARACTERISTICS

Modes:	Same as in logarithmic sweep.
Width:	3 decades maximum.
Time:	Continuously adjustable from 10mS to 999S, NOMINAL.
Sweep Out:	0 to 5V, ±5%.
Sweep Steps:	Depends on sweep time and range. Automatically adjusted by the instrument to get the maximum steps per sweep time. Maximum steps are 1000; minimum steps are 2.
Marker Output:	Same as in logarithmic sweep. Stop Sweep
Resolution:	Same as Frequency resolution.

CONTROL CHARACTERISTICS

Modes:	VCO, AM, FM (Model 8550), PWM (Model 8551)
Input:	Via front panel CONTROL INPUT BNC connector.
Impedance:	10KΩ ±5%.
Max Input Voltage:	±10V.

VOLTAGE CONTROLLED OSCILLATOR (VCO)/FM CHARACTERISTICS

VCO Sensitivity:	0V to □4.7V, ±20% produces 1/1000 frequency change from main frequency when main frequency is set to 9999 counts.
FM Sensitivity:	0V to 0.5V ±70mV, modulates to 1% deviation from center frequency. Modulation Bandwidth: DC to 50KHz.

AM CHARACTERISTICS

Modulation Input:	DC coupled.
Modulation Bandwidth:	DC to 1MHz.
Modulation Range:	0 to 200%; reduced to 70% at 1MHz.
Sensitivity:	0V to 5Vp-p produces 100% modulations; 0V to 10Vp-p produces suppressed carrier amplitude modulation (SCAM).

Envelop Distortion:	<1% for modulation depth <90%, carrier frequency <1.00MHz, and modulation frequency <50KHz; <3% for modulation depth <50%, carrier frequency <50.00MHz, and modulation frequency <50KHz

PHASE LOCK CHARACTERISTICS

Reference Input:	Via TRIG/REF BNC terminal.
Impedance:	10KΩ, ±5%.
Sensitivity:	500mVp-p.
Max Input Voltage:	±20V (dc+peak ac)
Min Pulse width:	10ns.
Operation:	Output locks automatically to the frequency and phase of an external signal.
Locking Range:	10Hz to over 60MHz.
Phase Offset	
Range:	Continuously adjustable from -180° to +180°, 10Hz to 19.99MHz.
Resolution:	1°
Accuracy:	±(3° +3% of reading), 10Hz to 100KHz.

PWM CHARACTERISTICS

Sensitivity:	0 to 5V, ±20% produces >10% pulse width change from pulse width setting.
Band Width:	DC to 70KHz.

PULSE/RAMP CHARACTERISTICS (Model 8551 only)

Pulse Modes:	Symmetrical Pulse, Positive Pulse, Negative Pulse and Complement.
Pulse Period	
Range:	20.00ns to 99.99s.
Resolution:	4 digits.
Accuracy and Jitter:	Same as for frequency.
Pulse Width	
Range:	10.0ns to 999ms
Setting Accuracy:	±(5%+2ns), 10.0ns to 99.9ns; ±(4%+2ns), 100ns to 999ms.
Duty Cycle Range:	1% to 80%, up to 99% using complement mode.
Resolution:	3 digits.
Ramp Modes:	Positive or Negative going ramps. Ramp Period
Range:	7.000µs to 99.99s.
Resolution:	4 digits
Ramp Width	
Range:	5.00µs to 999ms.
Setting Accuracy:	3%, 5.00µs to 999ms.
Resolution:	3 digits.
Duty Cycle Range:	1% to 80%.

LEAD/TRAIL TIME CONTROL (Model 8551 only)

Range:	8ns to 99.9ms (10% to 90% of amplitude), in 6 overlapping ranges. Leading and trailing edges may be independently programmed within a common range.
In-Range Span:	125:1.
Resolution:	3 digits of programmed value when both transitions are in the first 10:1 portion of their transition time range, decreasing to 2 digits at 100:1.
Accuracy:	±(7% + 2ns), to 99ns; ±(6% + 2ns), above 99ns.
Linearity:	3% for transitions >100ns.

GPIB INTERFACE (IEEE-488.2)

Interface Functions:	Complies with IEEE488.2, including queries and common commands. Programmable controls: All front panel controls except POWER switch.
Subsets:	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP2, DC1, DT1, C0.
Program Message Format:	Program Message Header, Program Data (floating point and/or suffix program data), Program Message Terminator. Characters lower or upper case.
Response Message Format:	Variable length response format consisting of Response Header, Response Data (NR1, NR2, or NR3 format), and Response Message Terminator.
Common Commands and Queries:	*CAL?, *CLS, *ESE, *ESE?, *ESR, *IDN?, *OPC, *OPC?, *RCL, *RST, *SAV, *SRE, *SRE?, *STB, *TRG, *TST?, *WAI.
Status Reporting:	*ESR?, *STB?, and RQS - read by Serial Poll.
String Termination:	Selectable NL, END (EOI) or combination of both.
Address Selection:	Front panel programming. Address stored in a non-volatile memory.

GENERAL

Display:	4 digits, 7 segment LED's 0.5" high.
Power:	115/230Vac (Optional 100V available), 50 to 400Hz, 100VA max.
Stored Set-ups:	Stores 30 complete sets of front panel set-ups.
Dimensions:	3.5" x 8.3" x 15.4" (H x W x L).
Rack Mount Dimensions:	3.5" x 19" (H x W).
Weight:	Approximately 12Lbs.
Operating Temperature:	0° to 50° C.
Specified Accuracy:	Within ±5° C and 24 hours of last internal calibration.
Storage Temperature:	-40° C to +70° C.
Humidity range:	80% R.H.
Safety Designed to:	MIL-T-28800D, EN61010, IEC1010-1, UL-1224.
EMC:	EN50081-1, EN55022, EN50082-1, IEC85501-2, IEC85501-3, IEC85501-4.
Vibration:	Operates at a vibration level of 0.013 in. from 5 to 55Hz (2g at 55Hz)
Shock:	Non-operating, 40g 9ms half-sine pulse.

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2-1. INTRODUCTION

This Chapter contains information and instructions necessary for the installation and shipping of the Model 8550 and Model 8551. Details are provided for initial inspection, voltage selection, primary power frequency, power connection, grounding safety requirements, installation information, and re-packing instructions for storage or shipment.

2-2. UNPACKING AND INITIAL INSPECTION

Unpacking and handling of the counter requires only the normal precautions and procedures applicable to the handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to ascertain that the shipment is complete.

2-3. PERFORMANCE CHECKS

The instrument was carefully inspected for mechanical and electrical performance before shipment from the factory. It should be free of physical defects and in perfect electrical order upon receipt. Check the instrument for damage in transit and perform the electrical procedures outlined in Chapter 5. If there is indication of damage or deficiency, see the warranty in this manual and notify your local Tabor field engineering representative or the factory.

CAUTION

It is recommended that the operator be fully familiar with the specifications and all Chapters of this manual. Failure to do so may compromise the warranty and the accuracy which Tabor has engineered into your instrument.

2-4. LINE VOLTAGE AND FUSES

The Model 8550 accepts a primary input voltage from one of the following sources: a. 103.5 to 126.5 Vac (115 Vac, NOMINAL) b. 207 to 253 Vac (230 Vac, NOMINAL) Tabor ships the Model 8550 set for the line voltage and with the proper fuse for the destination country. Figure 2-1 illustrates the location of the line voltage switch and fuse holeder.

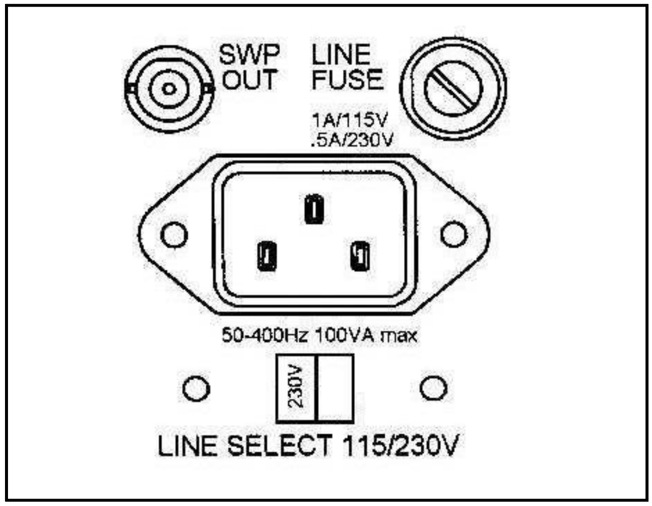


Figure 2-1. Line Voltage and Fuse Holder.

The instrument operates over the power mains frequency range of 50 to 400Hz. Always verify that the operating power mains voltage is the same as that specified on the rear panel voltage selector switch.

CAUTION

Failure to switch the instrument to match the operating line voltage will damage the instrument and may void the warranty.

The Model 8550 should be operated from a power source with its neutral at or near ground (earth potential). The instrument is not intended for operation from two phases of a multi- phase ac system or across the legs of a single-phase, three-wire ac power system. Crest factor (ratio of peak voltage to rms) should be typically within the range of 1.3 to 1.6 at 10% of the nominal rms mains voltage.

To change the line voltage, disconnect the power cord from the Model 8550, slide the Line Select switch (Figure 2-1) to the desired line voltage. Also be sure to change the fuse; see the following procedure.

To change the fuse, perform the following steps:

1. Disconnect the power cord from the instrument. Remove the fuse from the fuse holder.

2. Compare the ampere rating on the fuse to the ampere ratings given in Table 2-1. If the fuse is blown, replace it by sliding the new fuse back into the fuse holder. If the fuse is not blown and has the right rating, keep it. If the fuse has the wrong rating, replace the new fuse into the fuse holder.

3. Connect the ac line cord to the power connector at the rear of the unit and the power source.

AC Voltage	Selection	Fuse
103.5 to 126.5	115	1 amp, slo-blo
207.0 to 253.0	230	0.5 amp, slo-blo

Table 2-1. Line Voltage and Fuse Selection.

2-5. GROUNDING REQUIREMENTS

To insure the safety of operating personnel, the U.S. O.S.H.A. (Occupational Safety and Health) requirement and good engineering practice mandate that the instrument panel and enclosure be "earth" grounded. All of Tabor instruments are provided with an Underwriters Laboratories (U.L. and V.D.E) listed three-conductor power cable, which when plugged into an appropriate power receptacle, grounds the instrument. The long offset pin on the male end of the power cable carries the ground wire to the long pin of the Euro connector (DIN standard) receptacle on the rear panel of the instrument.

To preserve the safety protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to an "earth" ground.

CAUTION

To avoid operator shock hazard do not exceed the power mains voltage frequency rating which limits the leakage current between case and power mains. Never expose the instrument to rain, excessive moisture, or condensation.

2-6. INSTALLATION AND MOUNTING

The instrument is fully solid state and dissipates only a small amount of power. No special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 40° C, when the relative humidity exceeds 8550% or condensation appears anywhere on the instrument. Avoid operating the instrument close to strong magnetic fields which may be found near high power equipment such as motors, pumps, solenoids, or high power cables. Use care when rack mounting to locate the instrument away from sources of excessive heat or magnetic fields. Always leave 4 cm
(1.5 inches) of ventilation space on all sides of the instrument.

2-7. BENCH OPERATION

The Model 8550/8551 is shipped with plastic feet, tilt stand in place and ready for use as a bench or portable instrument. See outline drawing Figure 2-1 for dimensions.

2-8. RACK MOUNTING

The instrument may be rack mounted in a standard 19 inch rack. The instrument may be rack mounted in Rack Mount Kit option 001.

2-9. PORTABLE USE

The instrument may be used in applications requiring portability. A tilt stand consisting of two retractable legs is provided with each unit.

2-10. SHORT TERM STORAGE

If the instrument is to be stored for a short period of time (less than three months), place cardboard over the panel and cover the instrument with suitable protective covering such as a plastic bag or strong craft paper. Place power cable and other accessories with the instrument. Store the covered voltmeter in a clean dry area that is not subject to extreme temperature variations or conditions which may cause moisture to condense on the instrument.

2-11. LONG TERM STORAGE OR RE-PACKAGING FOR SHIPMENT

If the instrument is to be stored for a long period or shipped, proceed as directed below. If you have any questions contact your local Tabor field engineering representative or the Tabor Service Department at the factory.

If the original Tabor supplied packaging is to be used proceed as follows:

1. If the original wrappings, packing material, and container have been saved, re-pack the instrument and accessories originally shipped to you. If the original container is not available, one may be purchased through the Tabor Service Department at the factory.

2. Be sure the carton is well sealed with strong tape or metal straps.

3. Mark the carton with the model number and serial number with indelible marking. If it is to be shipped, show sending address and return address on two sides of the box; cover all previous shipping labels.

If the original container is not available, proceed as follows:

1. Before packing the unit, place all accessories into a plastic bag and seal the bag.

2. For extended storage or long distance shipping only, use U.S. government packing method II C and tape a two-unit bag of desiccant (per MIL-D-3464) on the rear cover.

3. Place a 13 cm (5 inch) by 30 cm (12 inch) piece of sturdy cardboard over the front panel for protection.

4. Place the counter into a plastic bag and seal the bag.

5. Wrap the bagged instrument and accessories in one inch thick flexible cellular plastic film cushioning material (per PPP-C-795) and place in a barrier bag (per MIL-B-131). Extract the air from bag and heat seal.

6. Place bagged instrument and accessories into an oversized card-board box (per PPP-B-636 type CF, class WR, variety SW, grade V3C). Fill additional spaces with rubberized hair or cellular plastic cushioning material. Close box in accordance with container specifications. Seal with sturdy water resistant tape or metal straps.

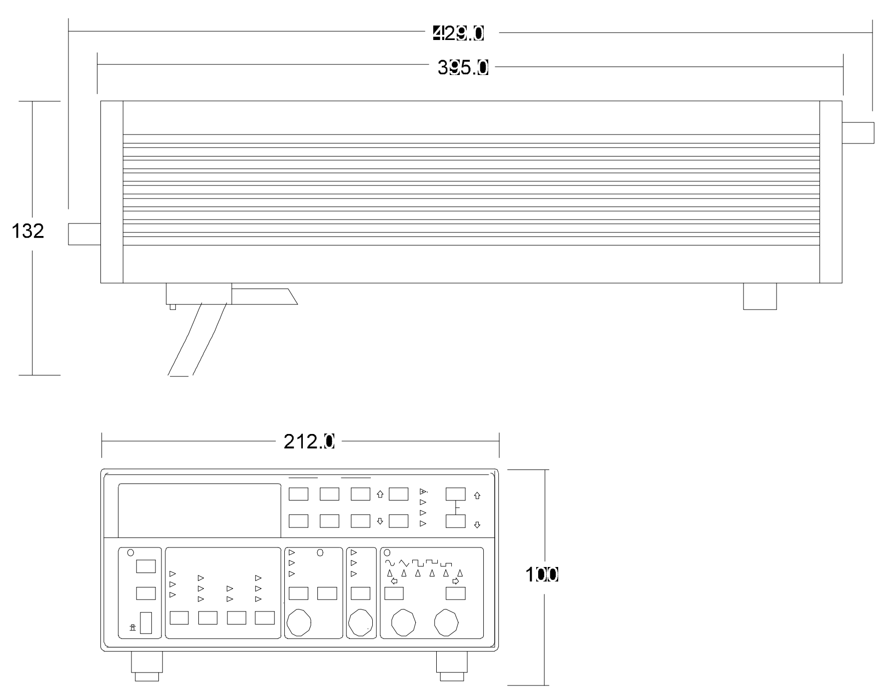


Figure 2-2. Model 8550/8551 - Outline Dimensions.

7. Mark container “DELICATE INSTRUMENT”, “FRAGILE”, etc. Mark instrument model and serial number and date of packaging. Affix shipping labels as required or mark according to MIL-STD-129.

NOTE

If the instrument is to be shipped to Tabor for calibration or re- pair, attach a tag to the instrument identifying the owner. Note the problem, the symptoms, and service or repair desired. Record the model and serial number of the instrument. Show the work authorization order as well as the date and method of shipment. ALWAYS OBTAIN A RETURN AUTHORIZATION NUMBER FROM THE FACTORY BEFORE SHIPPING THE INSTRUMENT TO Tabor.

2-12. SAFETY

Be fully acquainted and knowledgeable with all aspects of this instruction manual before using the instrument to assure operator safety and protection against personnel shock hazard.

3-1. INTRODUCTION

This Chapter provides maintenance, service information, and performance tests for the models 8550 and 8551. Fuse replacement procedure, line voltage selection and disassembly procedure are also included.

WARNING

The procedures described in this section are for use only by qualified service personnel. Do not perform these procedures unless qualified to do so. Many of the steps covered in this Chapter may expose the individual to potentially lethal voltages that could result in personal injury or death, if normal safety precautions are not observed.

3-2. LINE VOLTAGE SELECTION

The Model 8550 may be operated from either 115 Vac or 230 Vac nominal 50 - 60 Hz power sources. A special transformer may be installed for 100 Vac and 200 Vac ranges. The instrument was shipped from the factory set for an operating voltage of 230 Vac. To change the line voltage, proceed as follows:

WARNING

Disconnect the Model 8550 from the power cord and all other sources before changing the line voltage set- ting.

1. Using a flat-blade screwdriver, place the line voltage selection switch in the desired position. The selected voltage is marked on the selection switch.

2. Install a power line fuse consistent with the operating voltage. See paragraph 5.3

CAUTION

The correct fuse type must be used to maintain proper instrument protection.

3-3. FUSE REPLACEMENT

The Model 8550 has a line fuse to protect the instrument from excessive current. This fuse may be replaced by using the procedure described in the following:

WARNING

Disconnect the instrument from the power line and from other equipment before replacing the fuse.

1. Place the end of a flat-blade screwdriver into the slot in the LINE FUSE holder on the rear panel. Push in and rotate the fuse carrier the holder and its internal spring will push the fuse and the carrier out of the holder.

2. Remove the fuse and replace it with the proper type using Table 3-1 as a guide.

CAUTION

Do not use a fuse with a rating higher than specified or instrument damage may occur. If the instrument persistently blows fuses, a problem may exist within the instrument. If so, the problem must be rectified before continuing operation.

3-4. DISASSEMBLY INSTRUCTIONS

If it is necessary to troubleshoot the instrument or replace a component, use the following disassembly procedure to remove the top cover:

1. Remove the two screws that secure the top cover to the rear panel.

POWER LINE	RATING	FUSE TYPE
90 - 125V	0.5A, 250V	5x20mm/slo-blo
195 - 250V	1.0A, 250V	5x20mm/slo-blo

Table 3-1. Line Fuse Selection

1. Remove the two screws that secure the top cover to the rear panel.

2. Grasp the top cover at the rear and carefully lift it off the instrument. When the tabs at the front of the cover clear the front panel, the cover may be pulled completely clear.

3. When replacing the top cover, reverse the above procedure; be sure to install the tabs at the front panel before completely installing the cover.

3-5. SPECIAL HANDLING OF STATIC SENSITIVE DEVICES

MOS devices are designed to operate at a very high impedance levels for low power consumption. As a result, any normal static charge that builds up on your person or clothing may be sufficient to destroy these devices if they are not handled properly. When handling such devices, use precautions which are described in the following to avoid damaging them.

1. The MOS ICs should be transported and handled only in containers specially designed to prevent static build-up. Typically, these parts will be received in static-protected containers of plastic or foam. Keep these devices in their original containers until ready for installation.

2. Remove the devices from the protective containers only at a properly grounded work station. Also ground yourself with a suitable wrist strap.

3. Remove the devices only by the body; do not touch the pins.

4. Any printed circuit board into which the device is to be inserted must also be grounded to the bench or table.

5. Use only anti-static type solder sucker.

6. Use only grounded soldering irons.

7. Once the device is installed on the PC board, the device is normally adequately protected, and normal handling resume.

3-6. CLEANING

Model 8550 should be cleaned as often as operating condition require. Thoroughly clean the inside and the outside of the instrument. Remove dust from inaccessible areas with low pressure compressed air or vacuum cleaner. Use alcohol applied with a cleaning brush to remove accumulation of dirt or grease from connector contacts and component terminals.

Clean the exterior of the instrument and the front panel with a mild detergent mixed with water, applying the solution with a soft, lint-free cloth

3-7. REPAIR AND REPLACEMENT

Repair and replacement of electrical and mechanical parts must be accomplished with great care and caution. Printed circuit boards can become warped, cracked or burnt from excessive heat or mechanical stress. The following repair techniques are suggested to avoid inadvertent destruction or degradation of parts and assemblies.

Use ordinary 60/40 solder and 35 to 40 watt pencil type soldering iron on the circuit board. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the circuit from the base material. Keep the soldering iron in contact with the PC board for a minimum time to avoid damage to the components or printed conductors.

To desolder components use a commercial “solder sipper”, or better, solder removing SOLDER - WICK, size 3. Always replace a component with its exact duplicate as specified in the parts list.

3-8. PERFORMANCE CHECKS

The following performance checks verify proper operation of the instrument, and should normally be used:

1. As part of incoming inspection of instrument specifications;
2. As part of troubleshooting procedure;
3. After any repair or adjustment, before returning instrument to regular service.

3-8-1. Environmental Conditions

Tests should be performed under laboratory conditions having an ambient temperature of 25° ±5°C and a relative humidity of less than 8550%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure. Always perform a self-calibration sequence before commencing with the performance checks. The self-calibration, if executed without any failure, ensures proper operation of the generator. If self- calibration failure was encountered, the instrument first needs to be serviced, and the source of failure removed. Instructions how to self-calibrate the generator is given in paragraph 3-10.

3-8-2. Warm-Up Period

Most equipment is subject to at least a small amount of drift when it is first turned on. To ensure accuracy, turn on the power to the Model 8550 and allow it to warm-up for at least 30 minutes before beginning the performance tests procedure.

3-8-3. Front Panel Settings

To avoid confusion as to front panel settings, it is required that front panel set-up be reset to factory default values at the beginning of each of the performance tests. To reset front panel to factory default values depress **[2nd]** and then **[DCL]** push-buttons.

3-8-4. Recommended Test Equipment Recommended test equipment for troubleshooting, calibration and performance checking is listed in table 3-2. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

3-9. PERFORMANCE CHECKS PROCEDURE

3-9-1. Frequency Accuracy - Gated Mode

Accuracy specifications: ±4% of full scale up to 50.00MHz.
Equipment: Counter

1. Set 8550 as follows:

CONTROL	POSITION
Trigger Mode	Gated
Trigger Level	-10 V
Output	Squarewave

2. Set counter to frequency measurement.

3. Connect 8550 output to counter input. Set 8550 frequency and verify counter frequency reading as follows:

8550 SETTING	COUNTER READING
5.000 Hz	4.80 Hz - 5.20 Hz
50.00 Hz	48.0 Hz - 52.0 Hz
500.0 Hz	480.0 Hz - 520.0 Hz
5.000 KHz	4.80 KHz - 5.20 KHz
50.00 KHz	48.00 KHz - 52.0 KHz
500.0 KHz	480.0 KHz - 520.0 KHz
5.000 MHz	4.80 MHz - 5.20 MHz
10.00 MHz	9.60 MHz - 10.40 MHz
30.00 MHz	28.80 MHz - 31.20 MHz
50.00 MHz	48.0 MHz - 52.0 MHz

If model 8551 is tested, modify front panel FREQ setting to PER, and proceed with the next two tests.

8551 SETTING	COUNTER READING
999.9 ms	970.0 ms - 1.030 s
99.99 ms	97.00 ms - 103.0 ms

3-9-2. Frequency Accuracy - Continuous Mode

Accuracy specifications: ±3% of full scale up to 999.9 mHz; ±0.2% of full scale from 1.000 Hz to 50.00 MHz (full scale reading is 5000 counts).

Table 3-2. Required Test Equipment.

Instrument	Recommended	Specifications	Use (*) Model
Counter	HP5334B	100MHz Universal	P,A,T
DMM	HP3478A	0.1V - 100Vac rms, DC	P,A,T
Pulse/Function Generator	Tabor 8551	1mHz - 20MHz	P
Synthesizer	Marconi 2019	80KHz - 1040MHz	P,A
DC power supply	Tabor 341A	0V - 30V 0.1%	P,A
Oscilloscope	Tek 2465B	400MHz band width	P,A,T
Distortion analyzer	K-H 6900	100Hz - 1MHz	P,A
Spectrum analyzer	HP 3588A	10KHz - 350MHz	P
Feedthrough Termination	Tek 011-0129-00	50Ω, 2W, 0.1%	P,A
20dB feedthrough Attenuator	Tek 011-0086-00	50Ω, 2W, 2%	P
AM detector	Tabor D152	50Ω, 0.2 - 1000MHz	P

(*) P= Performance Test, A= Adjustments, T= Troubleshooting

Equipment: Counter

1. Set 8550 as follows:

CONTROL	POSITION
Output	Squarewave

2. Set counter to frequency measurement.

3. Connect 8550 output to counter input. Set 8550 frequency and verify counter frequency reading as follows:

8550 SETTING	COUNTER READING
9.999 Hz	9.997 Hz - 10.03 Hz
99.99 Hz	99.97 Hz - 100.3 Hz
999.9 Hz	999.7 Hz - 1.003 KHz
9.999 KHz	9.997 KHz - 10.03 KHz
99.99 KHz	99.97 KHz - 100.3 KHz
999.9 KHz	999.7 KHz - 1.003 MHz
9.999 MHz	9.997 MHz - 10.03 MHz
10.00 MHz	9.998 MHz - 10.02 MHz
50.00 MHz	49.90 MHz - 50.10 MHz

3-9-3. Amplitude Accuracy

Accuracy specifications (1KHz): ±5% of reading from 10 mV to 16.0 V.

Equipment: DMM, 50Ω feedthrough termination.

1. Set 8550 as follows:

CONTROL	POSITION
Display Modify	AMPL

2. Set DMM to ACV measurements (RMS).

3. Connect 8550 output to DMM input. Terminate the output with a 50Ω feedthrough termination. Set amplitude and output waveform and verify DMM reading as follows:

8550 SETTING	DMM READING
Sinewave 16.0 V	5.373 V - 5.936 V
Triangle 16.0 V	4.392 V - 4.854 V
Square 16.0 V	7.600 V - 8.400 V
Sinewave 9.99 V	3.354 V - 3.708 V
Sinewave 3.00 V	1.076 V - 1.116 V
Sinewave 999mV	335.5mV - 370.8mV
Sinewave 99.9mV	33.55mV - 37.08mV

If model 8551 is tested, modify front panel settings as follows and proceed with the next two tests.

CONTROL	POSITION
Operating Mode	Pulse
Output Waveform	Square
Period	1600 µs
Pulse Width	800 µs
Transitions	Linear, 10 ns

8551 SETTING	DMM READING
Square 16.0 V	7.750 V - 8.250 V
Ramp 16.0 V	2.45 V - 2.70 V

3-9-4. DC Characteristics

Accuracy specifications: ±(1% of setting + 1% of amplitude + 2 mV), within ±8 V; ±(1% of setting + 1% of amplitude + 0.2 mV), within ±800 mV

Equipment: DMM, 50Ω feedthrough termination.

1. Set 8550 as follows:

CONTROL	POSITION
Amplitude	100 mV

2. Set DMM to DCV measurements.

3. Connect 8550 output to DMM input. Terminate the output with a 50Ω feedthrough termination. Set 8550 offset and verify DMM reading as follows:

OFFSET SETTING	DMM READING
±7.50 V	±7.404 V to ±7.596 V
±5.00 V	±4.929 V to ±5.071 V
±3.00 V	±2.949 V to ±3.051 V
±1.00 V	±0.969 V to ±1.031 V

4. Change 8550 amplitude setting to 10.0 mV. Set offset and verify DMM reading as follows:

OFFSET SETTING	DMM READING
±100mV	±98.7mV to ±101.3mV

3-9-5. Squarewave Characteristics

Specified transition time: 6 ns (10% to 90% of amplitude).

Specified aberration: <5% of amplitude.

Equipment: Oscilloscope, 20dB attenuator.

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	1.000 MHz
Amplitude	10.0 V
Output	Squarewave

2. Connect 8550 output to the oscilloscope input. Use the 20 dB attenuator and set oscilloscope input impedance to 50Ω.

3. Set oscilloscope and verify that the rise and fall times are less than 6 ns. Verify that overshoot and undershoot are less than 5% of amplitude.

3-9-6. Sine Characteristics

Specified total harmonic distortion: <1% from 10.00mHz to 100 KHz.
Specified harmonic signals: >40 dB below the carrier level from 100 KHz to 2.000 MHz; >21 dB below the carrier level from 2.000 MHz to 50 MHz.
Equipment: Distortion Analyzer, Spectrum Analyzer, 50Ω feedthrough termination, 20dB attenuator.

1. Connect 8550 output to distortion analyzer input.
2. Set distortion analyzer to % distortion measurements, set 8550 frequency setting, and verify distortion reading as follows:

8550 SETTING	DISTORTION READING
10.00 Hz	<1%
100.0 Hz	<1%
1.000 KHz	<1%
10.00 KHz	<1%
100.0 KHz	<1%
1.000 MHz	<1%

3. Tune spectrum analyzer for minimum display amplitude, and adjust gain so that fundamental corresponds to 0 dB.
4. Change 8550 amplitude setting to 1.0 V.
5. Connect 8550 output to spectrum analyzer input through a 20dB feedthrough attenuator.
6. Set 8550 frequency setting and verify harmonic distortions levels as follows:

8550 SETTING	HARMONICS LEVEL
2.000 MHz	>40 dB
50.00 MHz	>21 dB

3-9-7. Sine Flatness

Level Flatness: ±2% to 9.999 MHz; - 20% to 50.00 MHz.
Equipment: Oscilloscope.

1. Set 8550 as follows:

CONTROL	POSITION
Amplitude	1.20 V

2. Connect 8550 OUTPUT to the oscilloscope, set oscilloscope input impedance to 50Ω, and set oscilloscope to display the sinewave within exactly 6 vertical divisions.
3. Change 8550 Frequency setting to 9.999 MHz. Verify that peak to peak of the displayed sinewave is greater than 5.8 divisions.
4. Change 8550 Frequency setting to 50.00 MHz. Verify that peak to peak of the displayed sinewave is greater than 4.8 divisions.

3-9-8. External Trig, Gate, Burst Characteristics

Specifications: Triggered - Each positive going transition at the front panel TRIG IN connector stimulates the 8550 to generate one complete output waveform. **Gated -** External signal at the TRIG IN connector enables the 8550 output. Last cycle of output waveform always completed. **Burst -** Each positive going transition at the front panel TRIG IN connector stimulates the 8550 to generate a burst of preselected number of cycles.
Equipment: Pulse/function generator, oscilloscope.

3-9-8-1. External Trigger

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	1.000 MHz
Trigger Mode	TRIG'D

2. Set external pulse/function generator period to 10µs and 4 V positive pulse and connect its output to the 8550 TRIG IN BNC connector. Set oscilloscope and verify on the oscilloscope that 8550 outputs a triggered signal. Leave external pulse generator connected to the 8550 for the next test.

3-9-8-2. External Gate

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	1.000 MHz
Trigger Mode	GATED

2. Set oscilloscope and verify on the oscilloscope that 8550 outputs a gated signal. Leave external pulse generator connected to the 8550 for the next test.

3-9-8-3. External Burst

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	1.000 MHz
Trigger Mode	BURST

2. Set oscilloscope and verify on the oscilloscope that 8550 outputs a burst of two complete output waveforms. Remove external pulse generator connection from the 8550 for the next test.

3-9-9. Internal Trigger, Burst Characteristics
Specifications: Triggered - An internal timer repeatedly generates a single output waveform. Burst - An internal timer repeatedly generates a burst of pre- selected number of cycles.
Equipment: Oscilloscope.

3-9-9-1. Internal Trigger

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	10.00 KHz
Trigger Mode	TRIG'D
Int. Trig. Per.	1 ms

2. Set 8550 to Internal Trigger mode by depressing **[2nd]** and **[INT TRG]** push-buttons in sequence.
3. Set oscilloscope and verify on the oscilloscope that 8550 outputs repetitive triggered waveform.

3-9-9-2. Internal Burst

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	10.00 KHz
Trigger Mode	Burst
Int. Trig. Per.	1 ms

2. Set 8550 to Internal Burst mode by depressing
[2nd] and **[INT TRG]** push-buttons in sequence.
3. Set oscilloscope and verify on the oscilloscope that 8550 outputs repetitive bursts of two complete output waveforms.

3-9-10. Manual Trig, Gate, Burst Characteristics
Specifications: [MANUAL] push-button simulates external stimulant.
Equipment: Oscilloscope, universal counter/timer.

3-9-10-1. Manual Trigger

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	10.00 Hz
Trigger Mode	TRIG'D

2. Connect 8550 output to the oscilloscope input. Set oscilloscope time base to 1 ms.
3. Depress a few times the **[MANUAL]** push-button and verify that you get a single sinewave waveform on the oscilloscope every time that the **[MANUAL]** push-button is depressed. Leave 8550 output connected to the oscilloscope for the next test.

3-9-10-2. Manual Gate

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	10.00 KHz
Trigger Mode	GATED

2. Depress a few times the **[MANUAL]** push-button and verify that you get a gated sinewave waveform on the oscilloscope every time that the **[MANUAL]** push-button is depressed. Remove 8550 output from the oscilloscope for the next test.

3-9-10-3. Manual Burst

1. Set 8550 as follows:

CONTROL	POSITION
Frequency	10.00 MHz
Trigger Mode	BURST
Burst	4000

2. Connect 8550 output to the universal counter/timer input. Set counter to Totaling measurement mode. Reset counter.
3. Depress the **[MANUAL]** push-button once and verify that counter reading is exactly 4000 counts.

3-9-11. Trigger Start-Phase Offset Accuracy
Specifications: -90° to +90° ±4°, to 500 KHz.
Equipment: Oscilloscope.

1. Set 8550 as follows:

CONTROL	POSITION
Amplitude	1.2 V
Trigger Mode	TRIG'D
I. TRIG	ON
Int. Trig. Per.	5.00 ms

2. Connect 8550 output to the oscilloscope input, and set oscilloscope input impedance to 50Ω.
3. Set vertical sensitivity on the oscilloscope to 0.2V per division. Set oscilloscope time base and observe that the 8550 output is displayed within exactly 6 vertical divisions.

4. Change 8550 Start-Trigger Phase Offset to -90° and observe that the base-line is shifted to the bottom of the sinewave; creating an haversine wave- form. Observe that the base line is at the -3 division line ±1 small grid lines.

5. Change 8550 Start-Trigger Phase Offset to +90° and observe that the base-line is shifted to the top of the sinewave; creating an inverted haversine wave- form. Observe that the base line is at the +3 division line ±1 small grid lines.

3-9-12. Phase Lock Loop Characteristics

Accuracy specifications: ±3%,±3° of reading from 10Hz to 100.0 KHz.

Equipment: Counter, pulse/function generator, synthesizer, 50Ω feedthrough termination, 50Ω "T" BNC connector, regular "T" BNC connector.

1. Set 8550 as follows:

CONTROL	POSITION
Operation Mode	PLL
Output Waveform	Squarewave
Display Modify	P. Offset

2. Connect test set-up as described in Figure 3-1.

3. Set external pulse/function generator period to 100ms, and duty cycle to 50%.

4. Set counter to Phase A to B function, trigger level A and B to 1.00 V, slope A and slope B to negative.

5. Set 8550 PLL phase offset and verify the following accuracy requirements:

8550 SETTING	COUNTER PHASE READING
45°	40.7° - 49.3°
90°	84.3° - 95.7°
150°	145.2° - 154.8°
-45°	310.7° - 319.3°
-90°	264.3° - 275.7°
-150°	205.2° - 214.8°

6. Change 8550 PLL Phase Offset setting to 0°, and trigger level setting to 0.0 V.

7. Change counter function setting to Ratio A/B, Trigger level A and B settings to 0.00 V, and Input Impedance A and B to 50Ω.

8. Connect test set-up as described in Figure 3-2.

9. Set synthesizer frequency, and verify counter reading as follows:

2019 SETTING	COUNTER RATIO READING
10.00000 MHz	1.0000000
20.00000 MHz	1.0000000
30.00000 MHz	1.0000000
40.00000 MHz	1.0000000
50.00000 MHz	1.0000000
60.00000 MHz	1.0000000

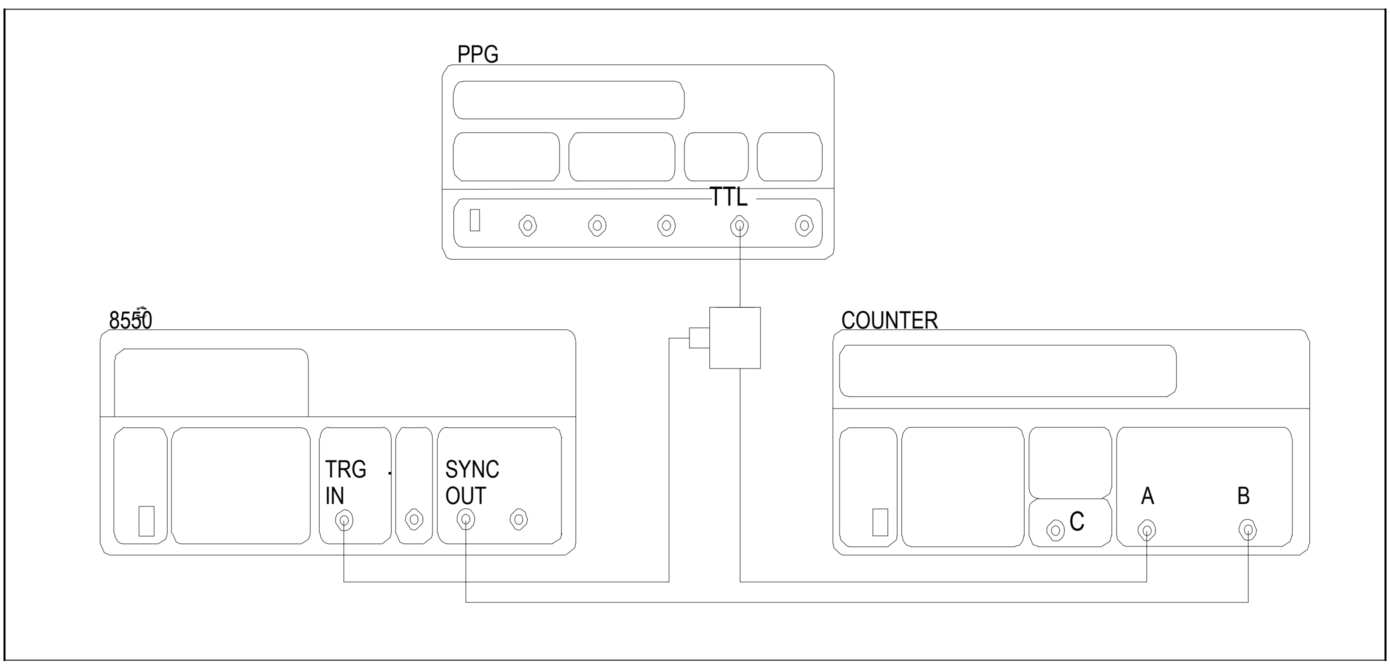
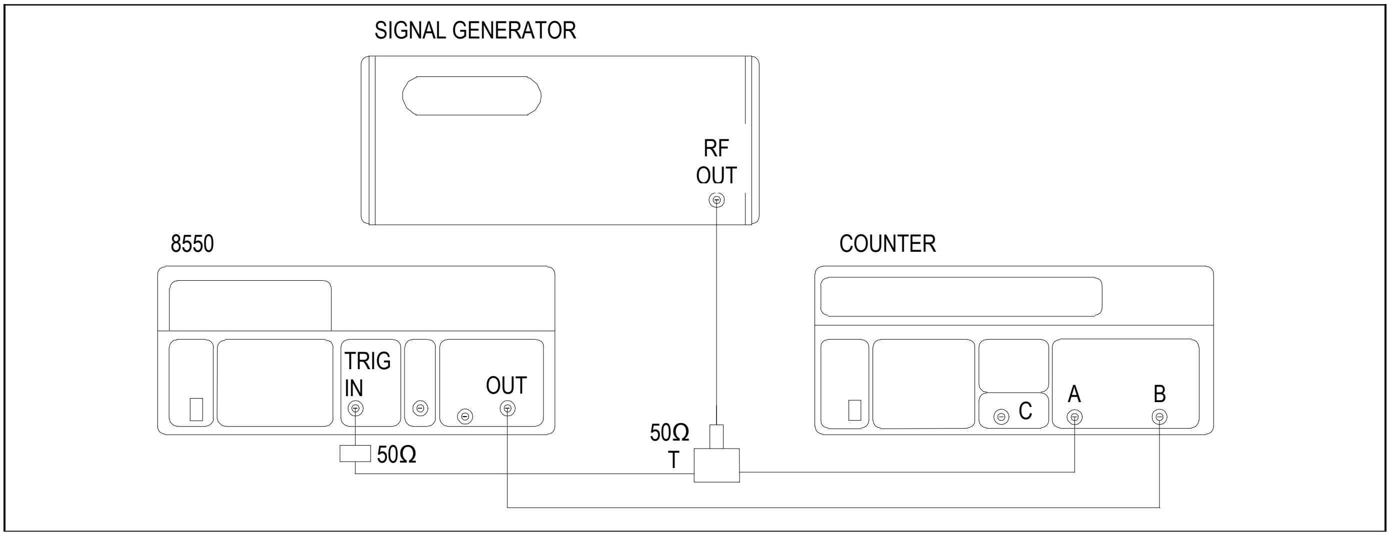


Figure 3-1. PLL Phase Offset Accuracy Check.

Figure 3-2. Phase Lock Loop Operation Check.

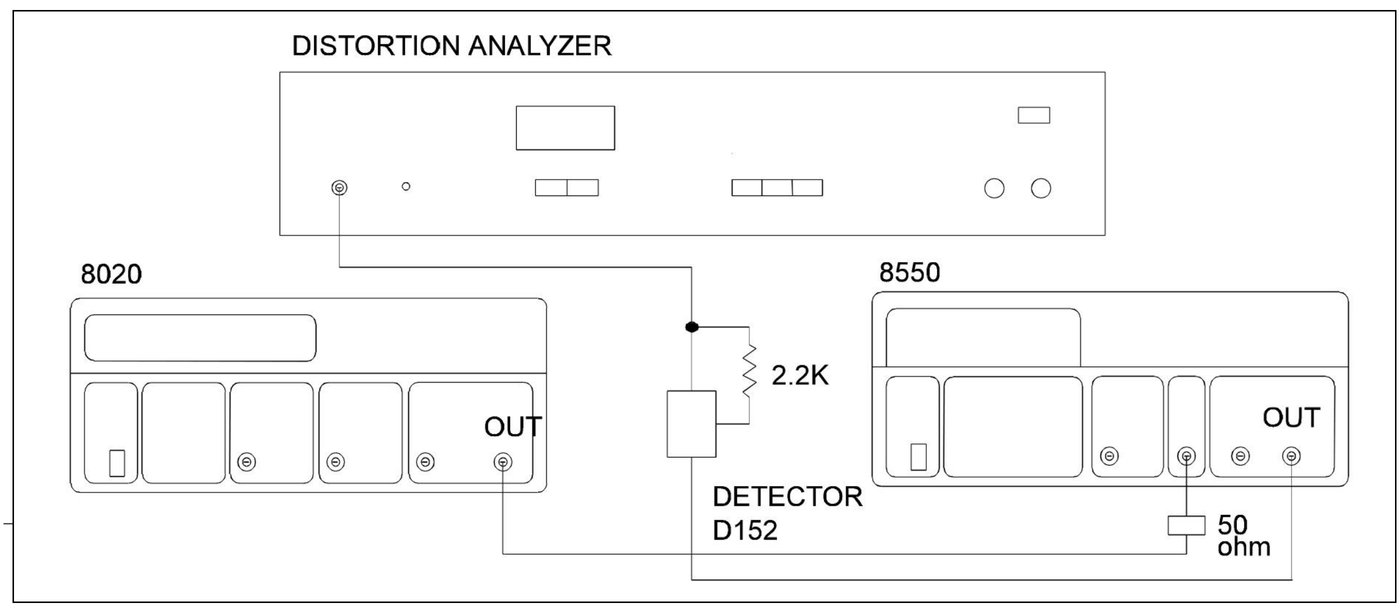


3-9-13. Amplitude Modulation Characteristics
Specifications: Envelop Distortion - <1% with carrier frequency <1.000 MHz; <3% with carrier frequency to 50.00 MHz.
Equipment: Pulse/function generator, distortion analyzer, AM detector .

1. Set 8550 as follows:

CONTROL	POSITION
MOD Mode	AM
Frequency	1 MHz
Amplitude	4 V

Figure 3-3. Amplitude Modulation Operation Check



2. Connect test set-up as described in Figure 3-3.
3. Set external function generator frequency setting to 10.0 KHz, amplitude setting to 2.5 V, and offset setting to 1.25 V.
4. Verify that reading on the distortion analyzer is less than 1%.
5. Verify that reading on the distortion analyzer is less than 3% from 10.00 MHz to 50.00 MHz.

3-9-14. FM and VCO Characteristics

Specifications: VCO - 0 to -4.7 V, ±20% produces 1/1000 change from main frequency.

Equipment: Counter, DMM, dc power supply.

1. Set 8550 as follows:

CONTROL	POSITION
MOD Mode	FM
Frequency	999.9 KHz

2. Connect 8550 output to counter input and note frequency reading on the counter.

3. Connect dc power supply output to 8550 MOD input. Connect DMM leads to power supply output.

4. Vary power supply output voltage until the counter displays a frequency reading of 1.020 MHz. Verify that DMM reading is +1 V ±100 mV.

5. Change power supply leads polarity and vary power supply output voltage until the counter displays a frequency reading of 980.0 KHz. Verify that DMM reading is -1 V ±100 mV.

6. Change 8550 MOD Mode setting to VCO.

7. Vary power supply output voltage until the counter displays a frequency reading of approximately 1 KHz. Verify that DMM reading is -4.7 V ±500 mV.

3-9-15. Sweep Characteristics (model 8550)

Specifications: Logarithmic - 10 decades, Linear - 3 decades, Automatic up, down, up-down, and down-up directions. Gated, Triggered, and counted sweep
Equipment: Oscilloscope

1. Set 8550 as follows:

CONTROL	POSITION
Operating Mode	Linear Sweep
Sweep Direction	Down
Start Frequency	9.999 MHz Stop
Frequency	1.000 MHz
Marker frequency	5.000 MHz

2. Connect 8550 output connector to oscilloscope input. Set oscilloscope so that sweep may be observed. Note that 8550 sweeps down.

3. Modify 8550 sweep Time setting and observe that sweep time changes accordingly. Reset sweep time to 1 second.

4. Change sweep direction setting to UP and observe that 8550 sweeps up. Change sweep direction to up-down and watch the result.

5. Connect the rear panel Sweep Out BNC connector to oscilloscope and observe that DC level changes from 0 to 5V in approximately one second for a full sweep cycle.

6. Connect the rear panel Marker Out connector to the oscilloscope and observe that output changes from 0V to -5V when marker frequency is reached.

7. Change Operating Mode setting to Logarithmic Sweep and repeat the above tests.

8. Change 8550 Trigger Mode to Triggered. Observe that 8550 output sweeps once for every time that the [MANUAL] push-button is depressed.

9. Change 8550 Trigger Mode to Gated. Observe that 8550 output sweeps continuously as long as the [MAN- UAL] push-button is depressed.

10. Change 8550 Trigger Mode to Burst. Observe that 8550 output sweeps twice for every time that the [MANUAL] push-button is depressed. Change burst setting and observe that the number of sweeps corresponds to the number of selected burst count.

3-9-16. Pulse Width Accuracy (model 8551)
Accuracy Specifications: ±(6% + 2ns) from 10 ns to 99.9 ns; ±(5% +2ns) from 100 ns to 999 ms.
Equipment: Counter, Oscilloscope.

1. Set 8551 as follows:

CONTROL	POSITION
Operating Mode	Pulse
Output	Squarewave

2. Set counter to pulse width measurement and counter input impedance to 50Ω. Connect 8550 output to counter input.

3. Set 8551 Pulse Width and Period and verify counter reading as follows:

PERIOD SETTING	WIDTH SETTING	COUNTER READING
277.7 ns	50.0 ns	45.0 ns - 55.0 ns
277.7 ns	99.9 ns	92.0 ns - 108 ns
277.7 ns	100 ns	93.0 ns - 107 ns
1.500 µs	500 ns	473 ns - 527 ns
15.00 µs	5.00 µs	4.75 µs - 5.25 µs
150.0 µs	50.0 µs	47.5 µs - 52.5 µs
1.500 ms	500 µs	475 µs - 525 µs
15.00 ms	5.00 ms	4.75 ms - 5.25 ms
150.0 ms	50.0 ms	47.5 ms - 52.5 ms
1.500 s	500 ms	475 ms - 525 ms

4. Disconnect 8551 output from counter input and connect to oscilloscope input. Set oscilloscope input impedance to 50Ω.

5. Set 8551 Period to 100.0 ns and Pulse Width to 10.0 ns.

6. Verify that oscilloscope reading is between 8 ns to 12 ns.

3-9-17. Rise/Fall Time Accuracy (model 8551)
Accuracy Specifications: ±(5% + 2 ns) from 8 ns to 99.9 ms, ±(4% + 2 ns), above 99 ns.
Equipment: Counter, Oscilloscope, 50Ω feedthrough termination.

1. Set 8551 as follows:

CONTROL	POSITION
Operating Mode	Pulse
Output	Squarewave
Amplitude	4.00 V
Transitions	Linear

2. Set counter to Rise/Fall Time measurement. Connect 8551 output to counter input through the 50Ω feedthrough termination.

3. Set 8551 Period, Pulse Width, and Lead/Trail Transition times and verify counter reading as given in Table 3-3.

4. Disconnect 8551 output from the counter and connect to oscilloscope input. Set oscilloscope input impedance to 50Ω.

5. Change 8551 Period setting to 100.0 ns, Pulse width setting to 50.0 ns, and Lead and Trail setting to 10.0 ns.

6. Verify that oscilloscope reading is between 7.5 ns to 12.5 ns.

3-9-18. PWM Characteristics (model 8551)
Specifications: 0 to 5 V ±20% produces >10% pulse width change, from DC to 700 KHz.
Equipment: Counter, DMM, dc power supply.

1. Set 8551 as follows:

CONTROL	POSITION
MOD Mode	PWM
Operating Mode	Pulse
Period	1.500 ms
Pulse Width	500 µs
Output	Squarewave

2. Connect 8551 output to counter input. Set counter and note pulse width reading on the counter.

3. Connect dc power supply output to the 8551 MOD input. Connect DMM leads in parallel to power supply output.

4. Vary power supply output voltage until the counter displays a pulse width reading variance of 10%. Verify that DMM reading is between 4 V to 6 Vdc.

PERIOD SETTING	WIDTH SETTING	LEAD/TRAIL SETTING	COUNTER READING
1.000 µs	500 ns	99 ns	90.0 ns - 109.0 ns
2.000 µs	1.00 µs	500 ns	468 ns - 532 ns
20.00 µs	10.0 µs	5.00 µs	4.70 µs - 5.30 µs
200.0 µs	100 µs	50.0 µs	47.0 µs - 53.0 µs
2.000 ms	1.00 ms	500 µs	470 µs - 530 µs
20.00 ms	10.0 ms	5.00 ms	4.70 ms - 5.32 ms
200.0 ms	100 ms	50.0 ms	47.0 ms - 53.2 ms

Table 3-3. Rise/Fall Time Accuracy Tests

4-1. INTRODUCTION

This Chapter contains an overall functional description of the 8550 series function generators as well as detailed circuit analysis of the various Chapters of the instruments. Information pertaining to the pulse width, the amplitude modulation and the standard IEEE interface are also included.

Information is arranged to provide a description of individual functional circuit blocks. As an aid to understanding, the descriptions are keyed to a block diagram and to Detailed schematics and component layout drawings which are located at the end of this instructions manual.

4-2. OVERALL FUNCTIONAL DESCRIPTION

The Model 8550/8551 is fully programmable function generator having various standard output functions. All parameters are adjustable through front panel touch switches or through IEEE programming. The high performance of the Model 8550/8551 is accomplished by utilizing a very fast, discrete analog circuits. Microprocessor and digital circuits control the per- formance of the analog circuits and permit direct interfacing to the front panel keyboard and display and to the GPIB. Figure 4-1 is a block diagram of the most important Chapters of the Model 8550/8551. Refer to this block diagram throughout the following general description.

The heart of the function generator is its VCO, where two identical currents with opposite polarities are created. These two currents are switched in, on and off, charging and consequently discharging a capacitor. This cycle generates a continuous ascending and descending voltage ramps. The repetition rate depends on the applied capacitor and the sup- plied current. The output of the VCO also generates a rectangular waveform.

The same ramp is used for driving the triangle and buffer. The triangle waveform is also utilized in generating the sinewave output by using a sine shaper. The three basic waveforms are then amplified or attenuated through the output amplifier and fed to the output connector. The output amplifier circuit is capable of driving its output waveforms into a 50Ω load.

The analog signals are controlled by D to A converters. The D to A converters receive their controlling information through serial to parallel converters; directed by the microprocessor components.

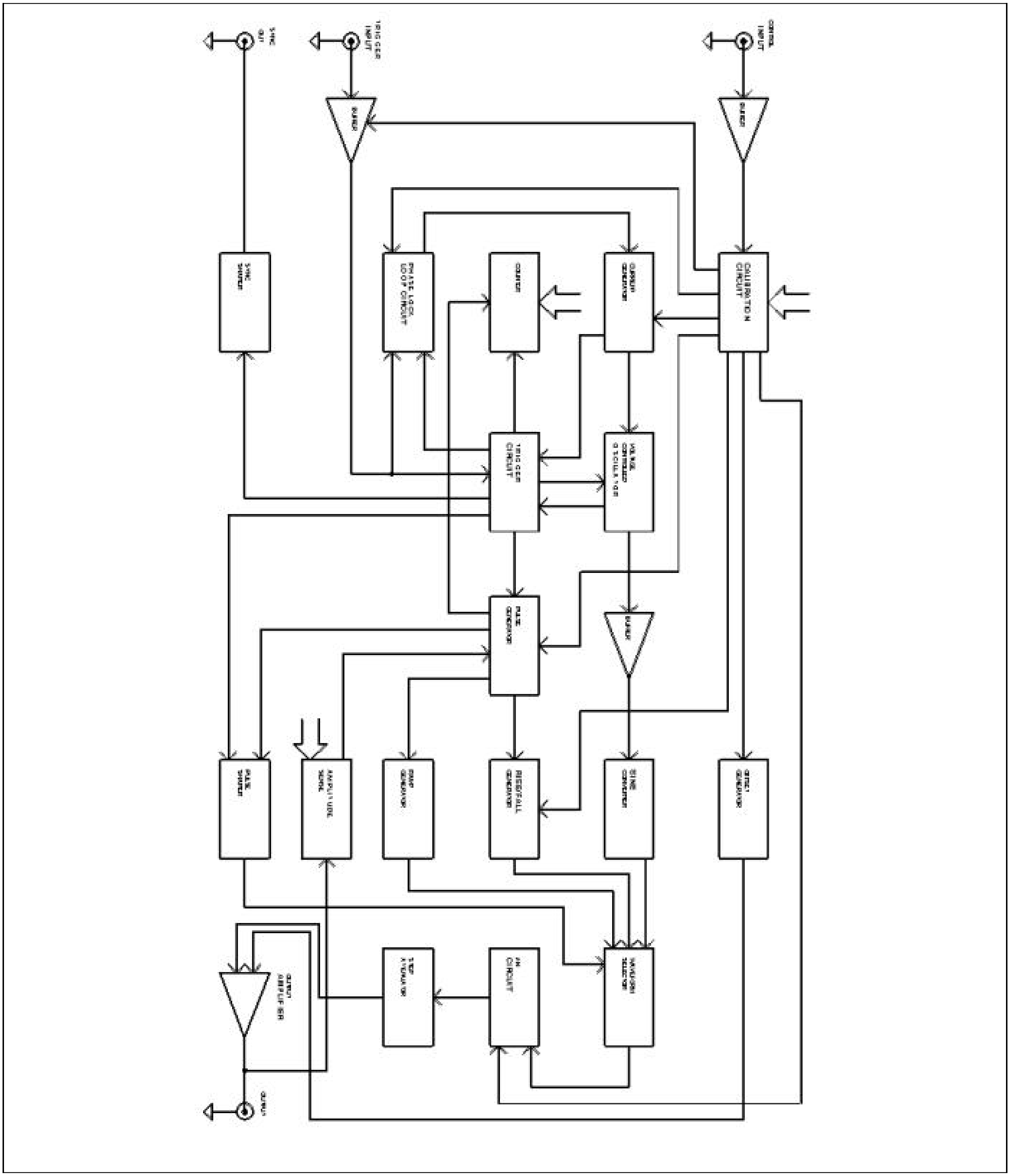
Model 8550/8551 is mechanically constructed on a number of plug-in boards. Each board contains different electronic circuits; making it easy for troubleshooting and servicing. Model 8550/8551 has four plug-in boards: CPU board, VCO board, Calibration board, Output Amplifier board, and Main board. Model
8551 has one additional pulse width and rise/fall time control board. The power supplies to the various Chapters of the generator is built on the main board assembly together with the connections for the plug-in boards. The various circuits on each board are described in the following.

4-3. C.P.U. BOARD

Model 8550/8551 operation is supervised by an internal microprocessor (CPU). The CPU controls parameter selection process, front panel switching, the displayed read-out and IEEE operation. All of these tasks are performed under software supervision. This Chapter briefly describes the operation of the various Chapters of the microprocessor and its associated digital circuitry. For more complete circuit details refer to the schematics at the end of this manual.

Circuit operation centers around the microprocessor unit (CPU) U5. The CPU is an 8-bit microprocessor capable of directly addressing up to 64K bytes of program memory (ROM) and up to another 2K bytes of data memory (RAM). The microprocessor works with a 12 MHz clock which is divided by U6 to provide clocks for the various Chapters of the instrument. Software for the CPU is contained in one EPROM U8 containing 64K bytes of memory

Figure 4-1. Model 8550/8551 - Simplified Block Diagram



space. Temporary storage is provided by RAM U9 which can store up to 2K bytes of information.

4-3-1. Display and Keyboard Interface

Interfacing between the CPU, the keyboard and the display is performed by the Keyboard/Display interface U2. The information for the seven segment LEDs is sent through buffer U1 and limiting resistors RN1. U1 multiplex the digits and LED and drive the high current transistors Q1 through Q8 which, in turn, drive the anodes of the appropriate LED. The sense lines S0, S1 and S2 determine which of the front panel push-button were depressed.

4-3-2. Counter Circuit

The counter circuit is employed in the Model 8550/8551 for the purpose of controlling the accuracy of the frequency at the output connector. The counter circuit is composed of U10, U11, U13, and U14. The counter circuit counts the number of pulses from the VCO during a pre-determined gate time interval. The CPU then computes the relation between these pulses to the reference clock. The result is compared to the required accuracy. If deviation is sensed, the CPU sends correcting data to the current generator circuit.

4-3-3. IEEE-488 Interface Bus (GPIB)

The instrument has a built in IEEE-488 interface bus that permits remote control through a system controller. The IEEE interface is made of U15, (General Purpose Interface Adapter), U16 and U17 interface bus drivers. On the CPU side of the GPIB, data transmission is handled much like any other bus transaction. The output of the U15 is standard GPIB format and is buffered by the two GPIB drivers U16 and U17. The bus drivers are necessary for enhancing the drive capability of the interface. Up to 15 devices may be connected in parallel.

4-4. V.C.O. BOARD

The following paragraphs contain descriptions of the various circuit that are available on the VCO board. The circuits that are discussed here are: the voltage controlled oscillator and the clamp circuit, the current generator circuit, the timing capacitors and the capacitance multiplier circuit, the sine shaper circuit, the trigger circuit, the SYNC out circuit, and the auxiliary circuits. Complete and detailed schematics of this board are located at the end of this manual.

4-4-1. Voltage Controlled Oscillator

The VCO is comprised of a comparator - U13, FET buffer - Q12, current switches - Q13, Q14, Q19, and Q20, and timing (range) capacitors - C21 through C24 and C36, and their associated components. The timing capacitors are charged by a positive constant current source which is made of Q18 and U18; creating a positive going linear voltage ramp which is applied to the positive input of U13.

When this ramp meets the +1.2 V reference voltage level which is applied to the negative input of the comparator, the current switch which is made of Q19 and Q20 reverses the polarity of the current which is applied to the timing capacitor; discharging the timing capacitor and creating a negative going linear voltage ramp.

At this time, the reference voltage at the negative input of the comparator is switched to -1.2 V by the current switch which is made of Q13 and Q14. When the negative going ramp meets the -1.2 V reference voltage level, the current switch reverses the polarity again. This sequence is automatically repeated; creating a triangular waveform.

The above triangular waveform is buffered by an impedance converter - Q12 ant its associated components and applied to the rest of the circuits through K1. This buffer isolates the timing capacitors from the level comparator and provides sufficient current drive for the level detector. The triangular waveform may be clamped at any voltage level between +1.2 V and -1.2 V for the purpose of generating start phase offsets. This is done by applying a programmable level at the cathode of CR10 diode. This programmable level is generated by circuits located on the calibration board and is applied through Q28, CR13, U29a, Q33, and Q23 through Q25. When the timing capacitor is clamped, the current source which is made of Q27, R114, and R121 injects positive current into CR13 - equal in magnitude to the current injected into CR10.

4-4-2. Current Generator

The current generator generates the necessary currents for the VCO and the trigger circuits. The current magnitude determines the oscillation frequency within a selected range. The frequency reference circuit which is located on the calibration board produces a voltage level which is applied to the VCO through J2 pin 13. This voltage is proportional to the frequency. This voltage is then converted to alternating positive and negative currents by U15a, Q22, U18, Q18, U17, and Q21.

The calibration board also produces a voltage level which determines the amplitude of the triangular waveform in the VCO circuit. This voltage is applied to the VCO board through J2 pin 15. On lower frequencies, the amplitude of the triangular waveform is ±1.2 V. On higher frequencies, this level is reduced proportionally to compensate for delays in the VCO components.

4-4-3. Range Capacitors and Multiplier

The frequency at the main output is being generated by charging range capacitors with alternating currents from the current generator. The range capacitors C36, and C21 through C24 are used for the 100 Hz to 50 MHz ranges. They are connected to the VCO circuit through the relay K2. They are switched in and out of the circuit by the transistors Q8 through Q11.

The capacitor multiplier is used for the 10 mHz to 99.99 Hz ranges. The function of this circuit is to generate an equivalent large capacitance. The larger values of capacitors are required to generate lower frequencies. The capacitor multiplier is formed by U1 ,U2, U3, and their associated components. The multiplier ratio is selected by changing the ranging resistors in the negative feedback path of U1.

4-4-4. Sine Shaper

The sine shaper consists of a series of differential stages which are formed by limiting amplifier arrays U9, U11 and U12. The differential stages are connected in parallel and receive the drive signal from the triangle buffer output - U10. This circuit takes advantage of the non-linear characteristics of the transistors and by biasing them to different dc levels, the output of the common collector is shaped to a sinewave. The sinewave is then routed through R51 to an amplifier, amplified, and re-biased, to oscillate around 0 V, with a differential amplifier which is formed by Q2 through Q7 and their associated components. Q1 is an electronic switch which removes the supplied current from the sine amplifier when it is not being used.

4-4-5. Trigger and Burst Circuit

The trigger circuit is active when one of the trigger modes is selected. It provides 4 different trigger modes for the Model 8550/8551: continuous mode, triggered mode, gated mode, and counted burst mode. Refer to the schematic diagrams at the end of this manual throughout the following description. Detailed description of the various trigger modes is provided in the following paragraphs. The trigger command is applied to the trigger circuit from the calibration board through J2 pin 12 to the gates in U23b, U23c, and U23d. These gates shape and differentiate this signal and apply it to the reset input of U16a, and U16b.

Continuous Mode. In this mode, U16a is always set to its reset position. Its output control the emitter coupled transistors Q24 and Q25 through diodes CR11 and CR12. The current from R104 flows through Q24; producing a positive voltage on the collector of Q24 which is then applied through the emitter follower - Q23 to the cathode of the clamping diode CR10. CR10 is then negative-biased and does not interfere with the VCO oscillations.

Triggered Mode. In this mode, the reset input to U16a is released. The “D” input is kept at logic level “1" by Q26. A positive transition from the comparator U13, at the clock input to U16a, sets U16a output to logic level ”1" causing Q24 to turn off and forward biasing CR10 through the emitter follower Q23; clamping the triangle waveform to a certain voltage level. A positive going transition of the triggering signal is differentiated by U23, R118, and C46 and applied to the reset input of U16a; changing its state and reverse biasing diode CR10. then, the positive going charging current which was flowing through CR10 is diverted to the timing capacitor; allowing the VCO to oscillate until the next positive transition at the output of U13. This new transition sets U16a back to logic level “1" and clamps the VCO to a non-oscillating status.

Gated Mode. Gated mode operation is very much similar to the triggered mode operation except that a stable gating level is applied to the reset input of U16a. As long as the reset level is set to logic level “1", the VCO oscillates. When the reset level is set to logic level ”0", The VCO stops its oscillation after the last waveform is completed.

Burst Mode. In this mode, the differentiated triggering signal is applied to reset input of both U16a and U16b. Q26 no longer keeps the “D” input of U16a at a logic level “1". U16a output is at logic level ”1" and the VCO does not oscillate.

A trigger signal resets U16a and U16b enables the VCO, however, because the “D” input of U16a is now set to logic level “0", the pulses from the VCO cannot set U16a to logic level ”1" and cannot interrupt the VCO oscillation. The VCO pulses are then routed through the gate U21c to the burst counter which is made of U19, U20, and U22 and to the gates U21a and U21b. In parallel, the VCO pulses are applied to the clock input of U16b. When the burst counter reaches its maximum possible count (FFF) the next VCO positive going transition sets the “Q” output of U16b to logic level “1"; creating conditions for U16a to be set to logic level ”1" and to stop the VCO oscillation.

4-4-6. SYNC Output Circuit

The SYNC output generates a fixed voltage level signal, having a sharp and defined transitions, which are synchronous with the positive transitions at the main output connector. The signal from the VCO circuit is routed to the SYNC amplifier circuit via a selector U27a, U27b, and U27c. In continuous mode, the SYNC signal is taken from the VCO circuit; in gated and triggered modes the signal is shaped and taken from the trigger input signal; in burst mode the SYNC signal is taken from the burst circuit, with duration equal to the burst length. The SYNC signal is then coupled through U27d to the SYNC amplifier which is made of Q29 through Q32 and their associated components.

4-4-7. Auxiliary Circuits

The information for the various gates and digital controls is received from the CPU board in a form of serial data. The serial data is then converted to parallel data and is latched for constant control of the various circuits. U4 and U6 are used for TTL serial to parallel conversion; U24 and U25 are used for ECL serial to parallel conversion. TTL signals are converted to ECL by U26a, U26b, and U26d. U7 is a high power buffer which drives the various relays throughout the board. The timing capacitors are switched in and out by U5.

4-5. CALIBRATION BOARD

The following paragraphs contain descriptions of the various circuit that are available on the Calibration board. The circuits that are discussed here are: the reference circuit, the D/A control circuit, the Trigger input circuit, the phase lock circuit, and the counter conditioning circuit. Complete and detailed schematics of this board are located at the end of this manual.

4-5-1. Reference Circuit

The reference circuit provides accurate and controlled voltage references for adjusting and calibrating the various parameters of the instrument. The reference voltages are applied to the reference inputs of the various digital to analog converters. The octal DAC - U1, operational amplifiers U3, and U4 provide correcting voltages for the digital to analog converters. Operational amplifiers - U5 and U2 combine these correcting voltages with the +5 V and the -5 V references. External controls are applied to U5 through U8 and the analog multiplexer switch U7.

The output of U5b controls the reference input to the frequency D/A converter; the output of U5c controls the reference input to the amplitude D/A converter; the output of U5d controls the reference input to the pulse width D/A converter; the output of U2a controls the PLL phase-offset; and the output of U2b controls the trigger start phase offset.

4-5-2. D/A Parameter Control Circuit

The following describes the control circuits for the various parameters that are available for modification through front panel programming.

The offset parameter is controlled by a digital to analog converter U24, operational amplifiers U23 and U29, analog switch U25a, and their associated components. The digital to analog converter receives its digital commands from serial to parallel converters U27 and U28.

The frequency parameter is controlled by two digital to analog converters U6 and U14, operational amplifiers U9, U10, and U13, by transistor Q2, and their associated components. The current through the collector of Q2 controls the current generator in the VCO board.

Below 1 MHz, the amplitude of the triangle which is generated in the VCO circuit is controlled by an operational amplifier U22 and resistors R38 and R39. The triangle is set to operate within +1.2 V and -1.2 V amplitude limits. In higher output frequencies, above the range of 1 MHz, due to internal circuit delays, this triangle amplitude presents tendencies to increase. Within the output frequency range of 1 MHz to 10 MHz, a digital to analog converter U16 compensates this effect by injecting correcting current at the input to U22 through an analog switch U25b and R42. Within the range of 10 MHz to 50 MHz, the correcting current is generated by the digital to analog converter U16, and applied through an analog switch U25c, R43, and thermistor T1.

The Calibration board also contains some circuits pertaining to the sweep outputs. The sweep output voltage is generated by the digital to analog converter U19, operational amplifier U18a and their associated components. The marker output signal is generated by an operational amplifier U18b.

4-5-3. Trigger Input Circuit

The trigger input circuit receives external stimulating signal, shapes it, and adjusts the internal threshold amplitude to the required level. The external signal is received through the TRIG IN BNC connector and is routed through R40 to the comparator U26 and its associated components. CR1 and CR2 are used as protection against overloading the comparator input. The threshold level is generated by a digital to analog converter U1, operational amplifier U4b and their associated components.

4-5-4. Phase Locking Circuit

Model 8550/8551 is capable of locking on an external signal and automatically adjust itself to the frequency and the phase of the external signal. The various parts of the locking circuit are described in the following.

U37a, U37b, and U37c is a signal selector which selects the signal to be applied to the phase detector input. The square wave signal from the VCO is applied to the second input of the phase detector through U38a. The phase detector is comprised of a "D" flip-flops U33a and U33b, gate U37d and their associated components. The phase lock loop also include a "pump charge" generator which is made of current switches Q5 through Q8, current generators made of Q9 and Q10, and their associated components. The loop amplifier is made of operational amplifier U32. The phase locking filtering capacitor- resistor networks are selected by a multiple analog switch U30 which connects the required feedback network to the loop amplifier. The phase locking detector is comprised of a window comparator U31a, U31b, R87, R88, R89, and level shifter made of CR3 and R66.

4-5-5. Counter Conditioning Circuit

Model 8550/8551 employs a built-in counter which is used in a number of applications such as frequency accuracy control, automatic calibration, measure frequency of an external signal, and more. The counter circuit itself is located on the CPU board assembly, however, signal conditioning and routing to the counter from the different parts of the instrument is controlled by circuits on the calibration board. The various parts of the conditioning circuits are described in the following.

The counter input may receive its signal from a number of sources: from the trigger input, from the VCO, from the phase sensing circuit U38c and U34a, and from the pulse width board (Model 8551 only). The signal for the counter input is selected by a selector which is made of gates U39a, U39b, U39c, and U39d. Frequencies up to 1 MHz are routed directly to the counter input. U40 divides signals above 1 MHz by 10 to reduce maximum frequency that may reach the counter input to 5 MHz. The signals for the counter circuit are converted from ECL to TTL by a comparator U35.

4-6. OUTPUT AMPLIFIER BOARD

The following paragraphs contain descriptions of the various circuit that are available on the Output Amplifier board. The circuits that are discussed here are: the pulse shaper circuit, the waveform selector circuit, the amplitude modulator circuit, the step attenuator, the power amplifier, the offset and amplitude sensing circuit, and the rise time sensing circuit. Complete and detailed schematics of this board are located at the end of this manual.

4-4-1. Pulse Shaper Circuit

The purpose of the pulse shaper is to convert the signal from the level detector to pulses having very fast rise and fall times and with precise amplitude. The pulse shaper is located on the output amplifier assembly board.

The squarewave for the pulse shaper may come either from the VCO board or from the pulse width board (Model 8551 only). The signal is routed to the output amplifier board through the connector J2 pin
2. The squarewave signal is conditioned by the line receiver U6 and routed to the pulse shaper input. The pulse shaper consists of emitter coupled transistors Q2, Q3, Q4, and Q5 positive and negative current generators U5b, Q6, R11, U5a, Q7, R10, and level shifter made of diodes CR1 through CR4. When the generator is set to operate in squarewave function, the output of the pulse shaper, alternates between the positive current source and the negative current source.

4-4-2. Waveform Selector Circuit

Model 8550/8551 is capable of generating different wave- forms at the output connector, such as, sine and triangular waveforms. The waveform selector circuit selects the necessary waveform to be applied to the output amplifier circuit. This circuit is comprised of a quad DMOS switch U1. Its output is controlled by comparators U3a, U3b, U3c, and U3d. The output of the waveform selector circuit is connected to the amplitude modulator circuit.

4-4-3. Amplitude Modulation Circuit

The amplitude modulation circuit serves two purposes. The first task is control the amplitude at the output connector, the second is to modulate the carrier signal which is generated by the Model 8550/8551 with an external modulating signal.

The amplitude modulator is made of an analog multiplier circuit U2, differential amplifier U9, and their associated components. One input of U2 receives the waveform from the waveform selector circuit, the second input receives either a dc level for amplitude control or an external signal for amplitude modulation. The amplitude level is controlled by a digital to analog converter U10, operational amplifier U7 and their associated components.

4-4-4. Step Attenuator Circuit

The signal from the amplitude modulator is attenuated with the step attenuator circuit before it is routed to the output amplifier Chapter and then with a post attenuator before the signal is applied to the output connector. The step attenuator circuit is made of three sets of “phi” shaped resistors R50 through R58. The resistors are switched in and out of the attenuator with relays K1, K2, and K3. The post attenuator is a 20dB attenuator which is connected between output of the power amplifier and the output connector. This post attenuator is made of K5, R120, R121, and R125.

4-4-5. Power Amplifier Circuit

Refer to the schematics at the end of this manual throughout the following description. The output amplifier is a wideband current feedback type amplifier. The signal from the step attenuators is fed to the power amplifier through the emitter of transistors Q11 and Q12 which are connected in a cascadable fashion with Q10 and Q13 respectively. Q15 and Q16 are emitter followers that drive the gain stage made of Q17 and Q18. Q19 and Q20 buffer the amplified signal for the final class B amplifier stage which is made of power transistors Q21 through Q24.

Note that the power transistors are mounted on special heat sinks mounted on a bracket which is connected to the side support to remove the heat stress from these transistors. Q25 with R95 and R96 set the quiescent current for the power transistors.

The current feedback is extracted from the output through R104, R105, R78, and R79 and is fed to the input transistors Q11 and Q12. The input bias current of the power amplifier is compensated by an operational amplifier U14, a buffer made of Q8 and Q9, and their associated components.

The operational amplifier U15 and resistors R68, R69, R91, R92, R97, R98, R104, and R105 closes this feedback around the power amplifier and compensate for its offsets and dc gain errors. R91 trimmer resistor adjusts the low frequency gain to be equal with the high frequency gain.

4-4-6. Offset and Amplitude Sensing Circuit

Offsets and amplitudes within the power amplifier are monitored by special circuits which are capable of measuring and adjusting both parameters to be within the required specifications. The information from the sensing circuits is sent to the CPU board; it is stored in special correction tables, and is automatically applied to the output digital to analog converters for full accuracy operation. The power amplifier offset if sensed by the comparator U16b and is transferred to the CPU through CR12. The amplitude is sensed by U16a. This comparator circuit compares the peak amplitude against a precise dc reference of -2.5 V. The result is converted to TTL and sent to the CPU board to be used in amplitude calibration tables.

4-4-7. Rise Time Sensing Circuit (Model 8551)

Similar to the offset and amplitude sensing circuit, the rise/fall times are measured by a special circuit and converted to correcting information to be used by the CPU circuit. The rise/fall time sensing circuit is made of a dual comparator U17 and its associated components. It converts the rise time to an equivalent pulse width to be measured by the counter. The results are then compared by the CPU circuit to reference values, and translated to correcting factors which are later being used for accuracy correction.

4-7. MAIN BOARD

The main board assembly contains the power supply, calibration references, reference digital to analog circuits, connectors for the plug-in boards and the interconnections between the various boards which are used on Models 8550 and Model 8551. The various parts that are laid on the main board are described in the following. Complete and detailed schematics of this board are located at the end of this manual.

4-7-1. Power Supply Circuit

Refer to the power supply schematic at the end of this manual for the following discussions. The power supply consists of a main power transformer, three bridge rectifiers, four integrated regulators, +5 V, and -5.2 V linear power supply. The LINE fuse and the Line Selector are accessible at the rear panel. The LINE VOLTAGE SELECT switch select 115V or 230V operation.

CR7 is used as a full-wave rectifier to provide a sufficient DC voltage for the -24 V and +24 V regulators U9 and U10 respectively. CR6 is used as a full-wave rectifier to provide a sufficient DC voltage for the +15 V and -15 V regulators U6 and U7 respectively. The +5 V linear power supply is made of power transistor Q9, control amplifier U8b, Q4, R25, R28, and overload protection Q5 and R26. The -5.2 V linear supply is made of power transistor Q8, control amplifier U8a, Q6, R26, R29, and overload protection Q7 and R27.

4-7-2. Reference Distribution Circuit

The reference distribution circuit is responsible for distributing the □2.5 V and the □5 V reference voltages throughout the instrument. The +5 V reference is made of U2, and it is being distributed by the quad operational amplifier U1 and its associated components.

4-7-3. Reference DACs Circuit

The reference digital to analog converters generate reference voltages for correcting and compensating accuracy errors on the power amplifier and on the pulse width boards. The digital to analog converter U4, operational amplifier U5 and their associated components generate an offset correcting voltage for the power amplifier circuit. The digital to analog converter U12, operational amplifier U13 and their associated components generate an offset correcting voltage for the rise/fall time circuit. The D/A converters receive their digital commands from serial to parallel converters U3 and U11.

4-8. PULSE GENERATOR CIRCUIT (Model 8551)

The pulse generator board has the necessary circuits for generating pulses and ramps with variable pulse width and variable rise and fall times. The pulse generator board is only installed on Model 8551. The following paragraphs contain descriptions of the various circuit that are available on the pulse generator board. The circuits that are discussed here are: the monostable multivibrator circuit, the pulse width cur- rent generator circuit, the ramp generator circuit, the transition times generator circuit, the transition times current generator circuit, and the auxiliary circuits. Complete and detailed schematics of this board are located at the end of this manual.

4-8-1. Monostable Multivibrator Circuit

The Monostable Multivibrator generates a pulse with a certain width every time that a trigger input signal is received. This circuit is made of “D” flip-flop U18a, U18b, timing capacitors, ramp buffer Q28, comparator U20, and their associated components. In the stable state, the output of U18b (pin 15) is set at about -0.8 V - equal to the voltage level on the selected timing capacitor. This voltage is applied through an impedance converter and buffer Q28 to the inverting input of U20. The non-inverting input of U20 is kept at a lower voltage level by a dc control circuit. The resulting voltage level at the output of the comparator output (pin 5) is “0" ECL level (-1.8 V). The timing capacitor discharging current flows from Q36 through the output of U18b pin 15.

The triggering signal for the multivibrator is received from the VCO board through J2 pin 12 and is routed to the clock input of U18a. U18a together with the delay circuit which is made of R70 and C23 generate narrow positive going pulses every time that a positive transition from the VCO signal is received. This pulse triggers U18b and diverts the discharging current from Q36 to the timing capacitor. The discharging current causes the voltage on the timing capacitor to drop linearly until the voltage level at the inverting input to the comparator equals the dc level at its non-inverting input. At this time, the output of the comparator changes its state to “1" ECL level (-0.8 V) and sets U18b forcing a charge current on the timing capacitor from the output of U18b. The comparator output then returns to its previous stable state of ”0" ECL level, and waits for the next triggering signal.

4-8-2. Pulse Width Current Generator Circuit

The current generator is controlled by a digital to analog converter U24 which receives its controlling signals from the CPU board and by an operational amplifier U23. The reference input to the digital to analog converter is supplied form the calibration board. The voltage which is generated by the D/A converter is converted to current by an operational amplifiers U22a and U22b, transistors Q36 and Q38, and their associated components. The amplitude of the ramp, which is generated by the monostable circuit, at the non-inverting input of the comparator U20 is controlled by an operational amplifier U27b and resistors R99 and R103. Transistors Q35, Q37, and Q39, operational amplifier U27a, and their associated components, compensate for temperature variations, and control the discharging current which generate the ramp.

4-8-3. Ramp Generator Circuit

The ramp generator circuit generates the ramp wave-form which is then made available at the 8551 output connector. The negative going ramp waveform is derived from the monostable circuit by discharging a timing capacitor. This ramp is buffered by Q28 and routed to the ramp amplifier input U21. An offset correcting voltage is summed to the same input through R68 and additional compensating voltage through R84. The positive going ramp at the output of U21 is inverted by an operational amplifier U19 and resistors R64 and R65. The selection of positive or negative going ramp to the output amplifier board is made by a relay K2.

4-8-4. Transition Times Generator Circuit

The transition times generator control the rise and fall times of the generated pulses at the 8551 output connector. In general, the variable rise and fall times are generated by charging and discharging a selected timing capacitor with a known level of current; generating a positive and negative going linear voltage ramps. The currents for the transition times generator will be discussed in paragraph 4-8-5.

Emitter coupled current switches Q22, Q24, Q23, and Q25 alternately switch the required current to a selected timing capacitor C1, C2, C3, C9, and C10. This generates a positive and consequently negative voltage ramps on the capacitors. The positive going ramp is limited to +1.5 V by a circuit made of U1b, Q2, and their associated components. The negative going ramp is limited to -1.5 V by a circuit made of U1a, Q1, and their associated components. The ±1.5 voltage limits are referenced to the -5 V reference voltage on the main board.

The generated squarewave with its linear transition times is buffered by a dual FET circuit Q8 and buffer U5, and then routed to the appropriate input on the output amplifier board.

4-8-5. Transition Times Current Generator

As discussed above, the transition times current generator circuit generates the required current to charge the timing capacitors for the transition time ramps. The current generator is controlled by a digital to analog converters U8 and U11 which receives their controlling signals from the CPU board. The reference input to the digital to analog converters is supplied form operational amplifiers U2a and U2b and are referenced to the -5 V reference voltage on the main board. The voltage which is generated by the D/A converters is converted to positive and negative currents by quad operational amplifiers U6 and U7, transistors Q14 through Q21, and their associated components

4-8-6. Auxiliary Circuits

The information for the various gates and digital controls on the pulse generator board is received from the CPU board in a form of serial data. The serial data is then converted to parallel data by a train of serial to parallel converters U28, U26, U12, U13, U14, U9, and U4 and is latched for constant control of the various circuits. The timing capacitors for the pulse width ranges are switched in and out by switching transistors Q29 through Q34. The timing capacitors for the transition times ranges are switched in and out by switching transistors Q3, and Q5 through Q7. These switching transistors are driven by quad operational amplifiers U3, U15, and U17. The gate selector made of U16c and U16d is responsible for selecting a waveform for the output amplifier Chapter. Selection can be made from rectangular squarewave or variable pulse width square- wave. The gate selector U16a and U16b is responsible for routing the correct signal to the counter circuit. Selection for the counter is made between the variable pulse width signal which is being generated on this board and between the rise/fall time sensing circuit which is generated on the output board. The gate U10 selects from normal and inverted signals to be applied to the switching transistors in the transition times generator circuit.

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5-1. INTRODUCTION

This Chapter contains information necessary to adjust and troubleshoot the 80 function generator and the 81 pulse/function generator.

WARNING

The procedures described in this section are for use only by qualified service personnel. Do not perform these procedures unless qualified to do so. Many of the steps covered in this Chapter may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.

5-2. ADJUSTMENTS

5-2-1. Environmental Conditions

Adjustments should be performed under laboratory conditions having an ambient temperature of 24°, ± 5°C and a relative humidity of less than 70%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure. Between adjustments, Always leave top cover on the unit to keep internal temperature as stable as possible.

5-2-2. Warm-Up Period

Most equipment is subject to at least a small amount of drift when it is first turned on. To ensure long-term calibration accuracy, turn on the power to the Model 80/81 and allow it to warm-up for at least 30 minutes before beginning the adjustment procedure.

5-2-3. Recommended Test Equipment

Recommended test equipment for calibration is listed in Table 5-2. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

5-2-4. Adjustment Procedures

All adjustments are performed with the POWER switch ON. The top cover should be removed to allow access to test points and adjustments. Always perform a self-calibration sequence before starting the adjustment procedure. The self-calibration, if executed without any failure, ensures proper operation of the generator. If self-calibration failure was en- countered, refer first to the troubleshooting instructions in this Chapter to verify and rectify the source of this failure. Instructions how to self-calibrate the function generator is given in paragraph 3-10.

WARNING

Take special care to prevent contact with live circuits or power line area which could cause electrical shock

Instrument	Recommended Model	Minimum Specifications
Counter	HP5334B	100MHz, universal counter
DMM	HP3478AA	0.1V - 500Vac rms, DC, 0.05%
Function generator	Fluke model 90	Sine, square, 2mHz - 20MHz, 20Vp-
p Synthesizer	Marconi 2019	80KHz - 1040MHz, 1ppm
Oscilloscope	Tektronix 2465B	400MHz analog bandwidth
Distortion Analyzer	K-H 6900	10Hz - 1MHz, 0.01% resolution
20dB Attenuator	Tektronix 011-0086-00	50Ω, 2W, 2%

Table 5-1. Recommended Test Equipment

resulting in serious injury or death. Use an isolated tool when making adjustments.

When necessary, refer to the component layouts in Chapter 9 for determining adjustment points. Follow the procedure in the sequence indicated because some of the adjustments are interrelated and dependent on the proceeding steps.

Verify that the generator is functioning according to the performance checks. Make sure that all results are within, or close to, the range of the required specifications, otherwise refer to the troubleshooting procedures given later in this Chapter.

Perform the following adjustment procedure. If an adjustment can not be made to obtain a specific result, refer to the troubleshooting procedures.

NOTE

If not otherwise specified, before every adjustment set Model 80/81 controls to factory defaults by depressing **[2nd]** and **[DCL]** in sequence. Always connect the output BNC connector through a 50Ω feedthrough termination.

5-3. ADJUSTMENT PROCEDURE

5-3-1. Distortion Adjustment

Equipment: Distortion analyzer

1. Connect 80/81 output to distortion analyzer input as shown in Figure 5-1.

2. Adjust V.C.O. board trimmers R22 and R101 repeatedly, until the distortion reading on the analyzer is adjusted to minimum, but not more than 0.8%.

3. Change 80/81 setting to 9.999 KHz. Repeat step 2 for best distortion reading. Note that each one of these resistors contribute a small amount to the distortion correction. It is up to the service technician to find the most effective sequence to perform this step. Repeat steps 2 and 3 until distortion reading is equal and minimal in both frequencies.

5-3-2. Sine Level Adjustment

Equipment: DMM

1. Connect 80/81 output to DMM input as shown in Figure 5-2. Set DMM to DCV measurements and 200 mV range.

2. Adjust V.C.O. board trimmer R21 until DMM reading on is 0 V ±5 mV.

5-3-3. Squarewave Response Adjustment

Equipment: DMM, Oscilloscope (2465B), 20 dB feedthrough attenuator

1. Change 80/81 Frequency setting to 1.000 MHz, amplitude setting to 10.0 V, and output waveform to squarewave.

2. Connect 80/81 output through the 20dB attenuator to the oscilloscope input as shown in Figure 5-3. Set oscilloscope input impedance to 50Ω.

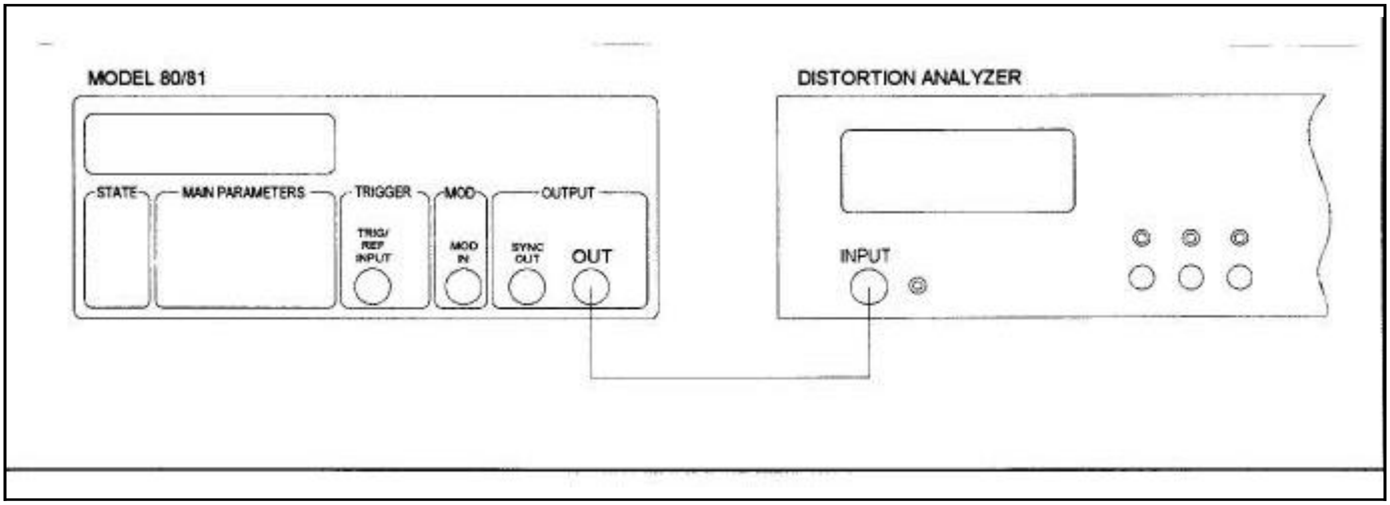
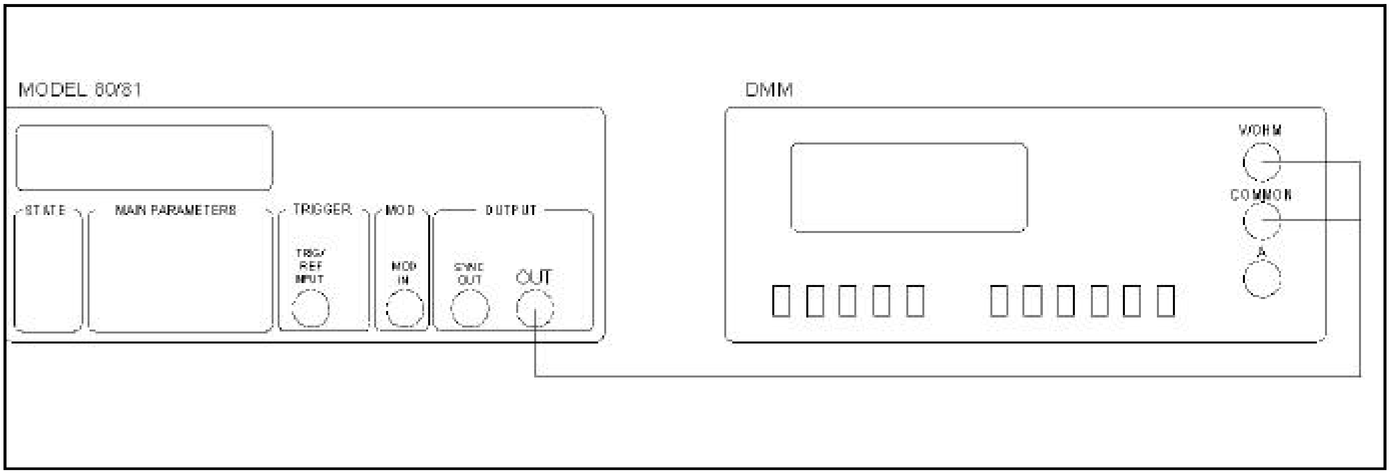


Figure 5-1. Connection - Distortion Adjustment.

Figure 5-2. Connection - Sine Level Adjustment.



3. Set oscilloscope vertical gain and time base, and adjust output board trimmer R84 for best pulse response.
4. Change 80/81 amplitude setting to 1.00 V. Set oscilloscope vertical gain and adjust output board trimmer R95 for best pulse response.
5. Repeat steps 4 and 5 until best pulse response is obtained in both adjustments.
6. Set DMM function to DCV and range to 2 V. Connect DMM leads across R93 and verify that DMM reading is less than 1.5 V, otherwise readjust R95.
7. Change 80/81 frequency setting to 10.00 KHz, amplitude setting to 10.0 V, and output waveform to squarewave.
8. Set oscilloscope vertical gain and time base, and adjust R91 for best pulse flatness.
9. Change 80/81 frequency setting to 1.000 KHz and readjust R91 for best flatness in this range.
10. Repeat steps 8 and 9 until best result is obtained in both steps.
11. Change Model 80/81 frequency setting to 50.00 MHz.
12. Set oscilloscope vertical gain and time base, and select R13 for best horizontal pulse symmetry.

5-3-4. Pulse Width Adjustment (Model 81)

Equipment: Oscilloscope

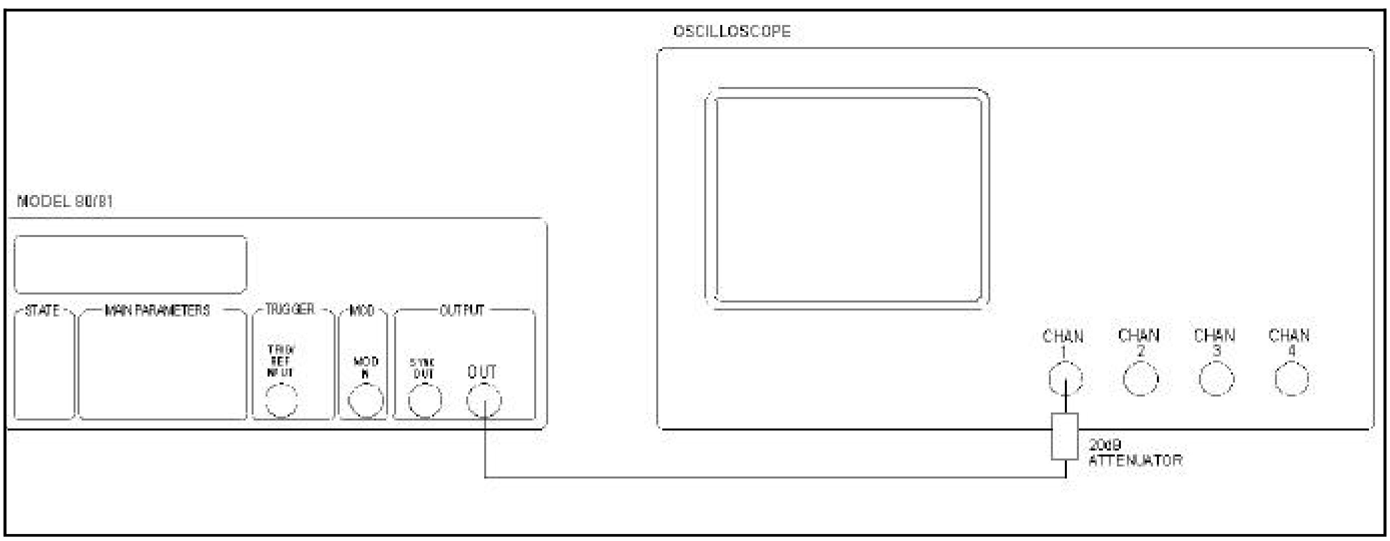
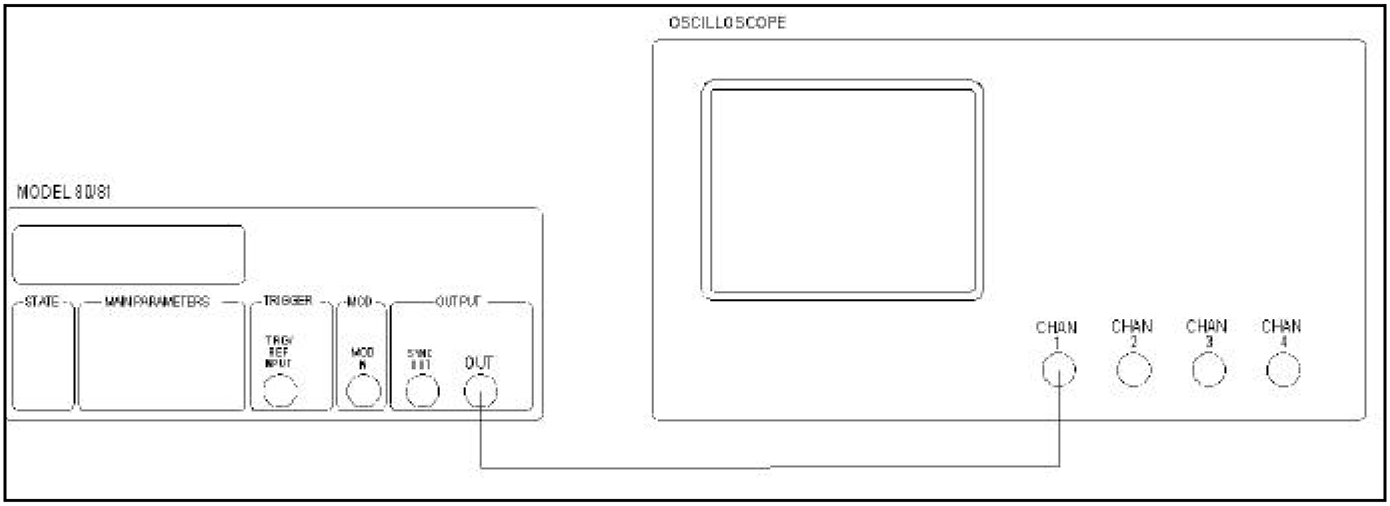


Figure 5-3. Connection - Squarewave Response Adjustment.

Figure 5-4. Connection - Pulsewidth/Ramp Adjustment.



1. Change 81 operating mode setting to pulse mode, period to 100.0 ns, pulse width to 10.0 ns, and output waveform to squarewave.

2. Connect 81 output to oscilloscope input as shown in Figure 5-4. Set oscilloscope input impedance setting to 50Ω.

3. Set oscilloscope vertical gain and time base, and adjust trimmer R100 on the pulse generator board to get a 10.0 ns ±1 ns reading on the oscilloscope.

5-3-5. Ramp Base-Line Adjustment (Model 81)

Equipment: Oscilloscope

1. Leave Model 81 connected to the oscilloscope as was shown in Figure 5-4. Change Model 81 output setting to ramp.

2. Change oscilloscope input setting to DC coupling and 50Ω input impedance. Change oscilloscope vertical gain setting to be 100 mV/div. Adjust trace vertical position so that it appears exactly at the center line.

3. Connect 81 output to the oscilloscope. Adjust R66 on the pulse generator board until the base line is calibrated on the center line.

5-3-6. Reference Oscillator Adjustment

Equipment: Synthesizer

1. Change 80/81 trigger level setting to 0.0 V.

2. Set synthesizer frequency to one of the following frequencies: 1 MHz, 5 MHz, or 10 MHz.

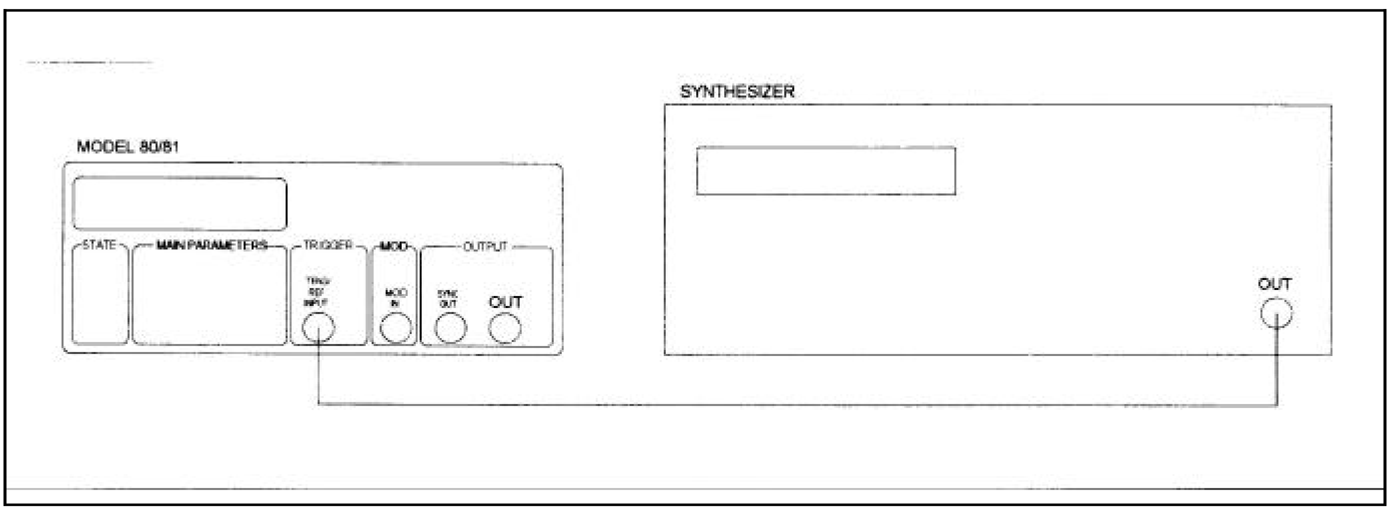


Figure 5-5. Connection - Reference Oscillator Adjustment.

Connect synthesizer output to 80/81 TRIG IN BNC connector.

4. Perform a self-calibration procedure as described in paragraph 3-10. Note that a leading + appears in front of the rotating bar; indicating that Model 80/81 accepted the external frequency reference as its new standard.

5-4. TROUBLESHOOTING

The troubleshooting instructions contained in this Chapter are intended for qualified personnel having a basic understanding of analog, and digital circuitry. The individual should also be experienced at using typical test equipment as well as ordinary troubleshooting procedures. The information presented here has been written to assist in isolating a defective circuit, or circuit Chapter; isolation of the specified component is left to the technician.

5-4-1. Recommended Test Equipment

The success or failure in troubleshooting a complex piece of equipment, like the Model 80/81, depends not only on the skills of the technician, but also relies heavily on accurate, reliable test equipment. Table 5-2 lists the recommended test equipment for a complete troubleshooting and adjustment of the Model 80/81. However, it is also possible to troubleshoot Model 80/81 with the minimum equipment which is listed in Table 5-1. Other equipment such as logic analyzer, and in-circuit emulator etc., could also be helpful in difficult situation.

5-4-2. Power-up tests

Upon power-up the Model 80/81 performs a set of tests which is described in paragraph 3-4. If the instrument locks up due to ROM or RAM fail, there is a little point in attempting to troubleshoot elsewhere unless the microcontroller circuit is operating properly.

5-5. TROUBLESHOOTING USING THE SELF-DIAGNOSTICS FUNCTION

An advanced feature of the Model 80/81 is its self-diagnostics capability. This feature helps in reducing troubleshooting time of faulty circuits to mini- mum. The self-diagnostics feature is a derivative of the self-calibration function. If, for whatever reason, the instrument can not calibrate itself to some built-in calibration limits, it automatically generates a failure list. This list can later be examined using front panel programming sequence. Calibration failures also pro- duce error bits in the special calibration failure registers which are accessible through GPIB commands and queries.

Front panel calibration and self-diagnostics aspects are discussed in paragraphs 3-10 and 3-11. GPIB aspects of calibration failure status registers are discussed in paragraph 4-14-3. The self-calibration sequence may be initiated at any time. It is, however, recommended that such sequence be initiated under certain conditions which are listed in paragraph 3-10.

Troubleshooting procedure should also be initiated whenever the generator fails to perform either completely or partially. It is also required to troubleshoot Model 80/81 whenever the instrument fails to fully comply with its published specifications. In such cases, it is first recommended that self-calibration procedure be initiated. If this procedure has been completed without encountering an error, and if prob- lem still remains, it is then necessary to remove the top and bottom covers and troubleshoot the generator using some other means. Note that the information given in the following do not intend to replace full scale troubleshooting, but merely to direct the service engineer to the area were the source of the trouble is located.

The self-diagnostics failure list is automatically generated after a self-calibration procedure. To initiate the self-calibration procedure depress the two front panel [AUTOCAL] push-buttons simultaneously, and observe that the generator displays the following message:

CAL?

The “?” (question mark) appears blinking; indicating that the instrument has not yet commenced with its calibration routine. Depress the [EXE] push-button and observe that the blinking question mark is re- placed by a rotating LED bar. The bar rotates as long as the self-calibration program is in process.

If a calibration failure was detected, the generator displays the following message:

FAIL d

Where **d** represents a blinking digit in the range of 1 through 9. A function LED indicator, in the front panel MAIN PARAMETERS block, blinks simultaneously; indicating the source of the calibration failure. For example, **FREQ** indicator that blinks with a display reading of **FAIL 2** indicates that some circuits that generate the second frequency range failed to perform properly.

One may examine the full list of calibration failures immediately after a self-calibration program was executed, or at any later time provided, however, that the *CLS common command was not used before the list have been evaluated. To examine the full list of calibration failures immediately after a self- calibration program was executed depress the [FAIL LIST □] or the [FAIL LIST □] push-buttons. The following paragraphs describe each failure and give some ideas how to locate the source of the failure.

Whenever necessary, refer to the detailed schematic diagrams given in Chapter 9. The theory of operation Chapter in this manual may also assist in understanding how the circuits should operate.

5-5-1. Frequency Calibration Failures

Failures in the frequency generation circuits are indicated by a blinking **FREQ** indicator with an associated displayed readout. In general, frequency failures may generate as a result of faults in the V.C.O., current generator, and the counter circuits. The following is a list of possible frequency calibration failures. Possible solutions to remove the source of these errors are suggested.

FAIL 1 - Check the capacitor multiplier circuit. Check K2, K3, and their driving circuit on the V.C.O. board.
FAIL 2 - Check capacitor multiplier circuit. Check K2, K3, and their driving circuit on the V.C.O. board.
FAIL 3 - Check C21, Q8, K2, K3, and their driving circuit on the V.C.O. board.
FAIL 4 - Check C22, Q9, K2, K3, and their driving circuit on the V.C.O. board.
FAIL 5 - Check C23, Q10, K2, K3, and their driving circuit on the V.C.O. board.
FAIL 6 - Check C24, Q11, K2, K3, and their driving circuit on the V.C.O. board.
FAIL 7 - Check C36 on the V.C.O. board. Check U16, U25 and their associated components on the calibration board.
FAIL 8 - Check C36, K3 and its drive on the V.C.O. board. Check U40, U16, U25, and their associated components on the calibration board.
FAIL 9 - Check U9 and its associated components on the calibration board.

5-5-2. Amplitude Calibration Failures

Failures in the amplitude generation circuits are indicated by a blinking **AMPL** indicator with an associated displayed readout. In general, amplitude failures may generate as a result of faults in the V.C.O., calibration, pulse width, and output amplifier boards. The following is a list of possible amplitude calibration failures. Possible solutions to remove the source of these errors are suggested. If **FAIL 1** through **FAIL 5** were detected refer first to the theory of operation Chapter and verify proper operation of the following circuits: waveform Selector, amplitude modulator, step attenuator, output amplifier, and amplitude sensing circuits. For other failures proceed with the following list.

FAIL 1 - Check the sine generator and the sine amplifier circuits, check relay K1 and buffer U10 on the V.C.O. board.
FAIL 2 - Check relay K1 and buffer U10 on the V.C.O. board.
FAIL 3 - Check ECL signal on U23 pin 2 on the V.C.O. board.
Check ECL signal on U16 pin 2 on the V.C.O. board.
Check the pulse shaper circuit on the output amplifier board.
FAIL 4 - Check the pulse generator circuit on the pulse generator board.
Check the rise/fall time generator on the pulse generator board.
Check the output amplifier circuit on the output amplifier board.
FAIL 5 - Check U19, U21 and their associated components on the pulse generator board.

5-5-3. Offset Calibration Failures

Failures in the offset generation circuits are indicated by a blinking **OFST** indicator with an associated displayed readout. In general, offset failures may generate as a result of faults in the calibration, output amplifier, and main boards. The following is a list of possible offset calibration failures. Possible solutions to remove the source of these errors are suggested.

FAIL 1 - Check the offset compensation circuit U11, U12, U13, and their associated components on the main board.
Check the preamplifier circuit U9, resistor R38, and their associated components on the output amplifier board.
FAIL 2 - Check the offset generator circuit U23, U24, U29, and their associated components on the output amplifier board.

Check U8, Q14, R73, R82, and R83 on the output amplifier board.

5-5-4. Phase Lock Offset Calibration Failures

Failures in the phase locking circuits are indicated by a blinking P.OFST indicator with an associated displayed readout. In general, phase lock offset failures may generate as a result of faults in the calibration, and the CPU boards. The following is a list of possible phase lock offset calibration failures. Possible solutions to remove the source of these errors are suggested.

FAIL 1 - Check the signal selector circuit to the phase lock detector Uxx and its associating components on the calibration board.
Check the PLL detector Uxx on the calibration board
Check the trigger input circuit on the calibration board
Check the PLL filter U30, U32, and their associated components on the calibration board

FAIL 2 - Check the U3d, U4c, U2a, U38c, U34a, and their associated components on the calibration board.
Check the counter circuit on the C.P.U. board.

FAIL 3 - Check the components as in FAIL 2.

5-5-5. Trigger Phase Offset Calibration Failures

Failures in the trigger phase offset circuits are indicated by a blinking TRIG PHASE indicator with an associated displayed readout. In general, trigger phase offset failures may generate as a result of faults in the calibration, and the V.C.O. boards. The following is a list of possible trigger phase offset calibration failures. Possible solutions to remove the source of these errors are suggested.

FAIL 1 - Check the trigger input circuit U26 and its associated components. Also check the trigger phase offset control U2b, U3a, U3d, Q1, and their associated components on the calibration board. Check the trigger logic circuit U23, U16, U21 and their associated components on the V.C.O. board

FAIL 2 - Check the trigger phase offset control circuit U2b, U3a, U3d, Q1, and their associated components. on the calibration board.

5-5-6. Counted Burst Calibration Failures

Failures in the counted burst circuit is indicated by a blinking TRIG BUR indicator with an associated displayed readout. In general, counted burst failures may generate as a result of faults in the V.C.O. board. The following is a list of possible counted burst calibration failures. Possible solutions to remove the source of these errors are suggested.

FAIL 1 - Check the counted burst circuit U19, U20, U21, U22, and their associated components on the V.C.O. board

5-5-7. Pulse Width Calibration Failures (Model 81)

Failures in the pulse width circuit is indicated by a blinking WID indicator with an associated displayed readout. In general, pulse width failures may generate as a result of faults in the pulse generator board. The following is a list of possible pulse width calibration failures. Possible solutions to remove the source of these errors are suggested. If **FAIL 1** through **FAIL 8** were detected refer first to the theory of operation Chapter and verify proper operation of the following circuits on the pulse generator board: monostable multivibrator, pulse width current generator, and auxiliary circuit.

Also verify proper operation of the pulse width reference control on the calibration board, and the counter circuit on the C.P.U. board. For other failures proceed with the following list. All of the following tests are performed on the pulse width board.

FAIL 1 - Check C22, R78, K3, U25, R87, R88 and their associated components.
FAIL 2 - Check U25, K3, and their associated components.
FAIL 3 - Check K3, check C33, Q32 and their driving circuit.
FAIL 4 - Check C34, Q29 and their driving circuit.
FAIL 5 - Check C35, Q33 and their driving circuit.
FAIL 6 - Check C32, Q31 and their driving circuit.
FAIL 7 - Check C37, Q30 and their driving circuit.
FAIL 8 - Check C36, Q34 and their driving circuit.

5-5-8. Rise/Fall Time Calibration Failures (Model 81)

Failures in the rise/fall time circuit is indicated by a blinking LEAD or TRAIL indicator with an associated displayed readout. In general, rise/fall time failures may generate as a result of faults in the pulse generator or in the main boards. The following is a list of possible rise/fall time calibration failures. Possible solutions to remove the source of these errors are suggested. If **FAIL 1** through **FAIL 6** were detected refer first to the theory of operation Chapter and verify proper operation of the following circuits on the pulse generator board: rise/fall time current generator, rise/fall time generator, and rise/fall time output buffer on the pulse width board.

Also verify proper operation of the rise/fall time reference control on the main board. For other failures proceed with the following list. All of the following tests are performed on the pulse width board.

FAIL 1 - Check C10, K1, and their associated components.
FAIL 2 - Check C9, K1, Q7, and their associated components.
FAIL 3 - Check C4.
FAIL 4 - Check C3, Q6 and their driving circuit.
FAIL 5 - Check C2, Q3 and their driving circuit.
FAIL 6 - Check C1, Q5 and their driving circuit.

5-6. GENRAL TROUBLESHOOTING HINTS

The following troubleshooting procedures should be performed whenever the self-diagnostic routine is insufficient to identify the source of the fault. In some instances, for example, it will be impossible to execute a self-calibration routine because the generator either does not power up at all, the display is fully or partially blank, or front panel controls can not be modified because software-hardware related problem has locked the unit.

In such cases, it is recommended to first verify proper operation of the power supply circuit, the C.P.U. circuit, front panel display, and keyboard operation.

WARNING

The following procedures described in this Chapter are for use only by qualified service personnel. Do not perform these procedures unless qualified to do so. The steps covered in the troubleshooting procedure may expose the individual to potentially lethal voltages that could result in personal injury or death, if normal safety precautions are not observed.

For in-circuit troubleshooting procedure, it is required to remove the top and bottom covers. With the above warning in mind, carfully remove the covers, and proceed with the following checks.

5-6-1. Power Supply Checks

It is highly suggested that the first step in troubleshooting the Model 80/81, as well as any similar equipment, would be to check the power supply. If the various supply voltages within the instrument are not within the required limits, troubleshooting the remaining circuits can be very difficult. Table 5-2 shows several checks that can be made to the power supplies within the generator. In addition to the normal voltage checks, it is also a good idea to check the various supplies with an oscilloscope to make sure that no noise or ringing is present.

In case of a “dead short” between one of the supplies to the common ground, it would be best to disconnect the entire supply Chapter from the remaining of the circuitry, and then determine whether the problem is in the power supply or in the remaining circuits. Model 80/81 is equipped with such quick- disconnect points, which are located on the bottom side of the main PC board. To access these points, it is necessary to remove the bottom cover, and then to remove the solder layer from these points.

While troubleshooting the power supply Chapter, bear in mind that the +15 V supply also provides the reference voltage to the +5 V. Therefore, it would

Test Point	Description	Test Result
+24 V	+24 V supply	+23 V to +25 V
-24 V	-24 V supply	-23 V to -25 V
+15 V	+15 V supply	+14.4 V to +15.6 V
-15 V	-15 V supply	-14.4 V to -15.6 V
+5 V	+5 V supply	+4.8 V to +5.2 V
-5.2 V	-5.2 V supply	-5 V to -5.4 V

Table 5-2. Power Supply Checks.

be impossible to troubleshoot the +5 V supply if the +15 V supply is defective. Similarly, the +5 V supply is used as a reference voltage to the -5.2 V supply.

5-6-2. Digital Circuitry and Display Checks

The most important Chapter, to be verified after the power supply checks, is the digital Chapter with its various clocks. Problems with the digital circuitry could cause erratic operation or erroneous display readings. Problems in the clock generator for the C.P.U. and the digital circuit may cause a complete malfunction of the entire Chapter. The C.P.U. would not even start generating the control lines. This makes it impossible to troubleshoot the remaining of the circuits.

Check the various components, associated with the digital circuitry, clocks, and the IEEE-488 interface, using the information given in Table 5-3.

Test Point	Description	Test Result
U12 pin 13	CPU clock	10 MHz, TTL level signal
U6 pin 9	GPIB interface clock	5 MHz, TTL level signal
U6 pin 6	Display interface clock	1.25 MHz, TTL level signal
U6 pin 15	CPU timer clock	4.88 KHz, TTL level signal
U6 pin 1	Beeper clock	2.44 KHz, TTL level signal
U5 pin 30	ALE line	160ns, TTL level, positive going signal
U5 pin 29	PSEN line	265ns, TTL level, negative going signal
U5 pin 17	RD line	500ns, TTL level, negative going signal
U5 pin 16	WR line	500ns, TTL level, negative going signal
U14 pin 3	Accuracy control signal	1KHz, 50% duty cycle TTL level signal *
U14 pin 2	Control counter gate	Period=300ms, width=250ms, TTL signal *
U11 pin 1	10 MHz counter reference	10MHz, TTL level signal *
U11 pin 2	Counter synchronized gate	Period=300ms, width=50ms, TTL signal *
U4 pin 2	Strobe line	500ns, TTL, positive going signal §
U4 pin 12	Strobe line	500ns, TTL, positive going signal §
U4 pin 15	Strobe line	500ns, TTL, positive going signal §
U4 pin 4	Serial clock	500ns bursts, TTL, pos. going signal §
U5 pin 10	Serial data	TTL level bursts, positive going signal §
U2 pin 4	Keyboard interrupt	30ms, TTL, positive going signal †

* Test results after selecting DCL.
§ Continuously depress one of the [x1 ↑] or [x1 ↓] vernier push-buttons.
† Depress and release once for each test.

Table 5-3. Digital Circuitry and Display Checks.

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Parts List — Chapter 6

6-1 GENERAL

This Chapter contains information for ordering replacement parts. the replacement parts are available from Tabor Instruments.

6-2 ORDERING INFORMATION

When ordering replacement parts, always include the following information:

a) Instrument Model number.
b) Instrument Serial number.
c) Tabor part number. d) Part description.
e) Circuit designation (where applicable).
f) Vendor code number

6-3 VENDORS

A list of vendors, their address and their CAGE codes are given in Table 6-1.

6-4 PARTS DESCRIPTION

Table 6-2 lists parts that are used in Model 8551. Unless otherwise noted, resistance is given in □, ±5%, and capacitance is given in F, ±20%. Parts description in Table 6-2 overrides values shown on the schematic and the assembly drawings, in places where part description does not match.

Table 6-1. Model 8550/8551 - List of Vendors

Vendor	Address	CAGE Code
Amphenol Products	4300 Commerce Court, Lisle Illinois 60532	1CD05
Amphenol Canada	44 Metropolitan Road, Scaborough Ont M1R 2T9 Canada	03554
Analog Devices	One Technology Way, Norwood MA 06062	24355
AVX	Senaca Avenue, Olean NewYork 14760	96095
Belden Wire, Inc.	2200 U.S. highway, 27 South Richmond Indiana 47374	70903
Bourns Inc.	1200 Columbia Avenue Bldg. C, Riveside CA 92507	80294
Comlinear Corporation	4800 Wheaton Drive, Fort Collins Collorado 80525	62839
Corcom Inc.	1600 Winchester Road, Libertyville Illinois	05245
Cornell-Dubilier	150 Avenue L, Newark New Jersey 07101	14655
CTS Knights Division	400 Reidmann Avenue, Sandwich Illinois 60548	75378
Dale Electronics	2064 12th Avenue, Columbus Nebraska 68601	91637
E.F. Johnson Company	299 Johnson Avenue, Waseca Minnesota 56093	74970
General Instruments	600 West John Street, Hicksville New York 11802	14936
Hamlin	Lake/Grove Streets, Lake Mills Wisconsin 53551	12617
Harris Semiconductors	1301 Woody Burke Road, Melbourne Florida 32902	36472
HP (7 seg)	3000 Hanover Street, Palo Alto California 94304	50434
HP (Schottkey diodes)	3000 Hanover Street, Palo Alto California 94304	34649
Intel Corporation	3065 Bowers Avenue, Santa Clara California 95051	34649
International Resistor Co.	Greenway Road, Boone North Carolina 28607	74902
ITT Components	Holzhauser Strasse 62-32, D-1000 Berlin 72 Germany	
Kemet Elctronics Corp.	2835 Kemet Way, Simpson Ville South Carolina 29681	31433
Littlefuse	800 Northwest HWY, Des Plannes Illinois 60016	75915
LSI Computer Systems	1235 Walt Whitman Road, Melville New York 11747	55261

Table 6-1. Model 8551 - List of Vendors (continued)

Vendor	Address	CAGE Code
Maxim	120 San Gabriel Drive, Sunnyvale California 94086	1ES66
Molex	2222 Wellington Court, Lisle Illinois 60532	27264
Motorola	5006East McDowell Road, Phoenix Arizona 85008	04713
National Semiconductors	2900 Semiconductor Drive, Santa Clara California 95051	27D14
North American Philips Corp.	7158 Merchant Avenue, El Paso Texas 79915	59821
Projects Unlimited	3860 Wyse Road Dayton, Ohio 45414	04597
Seiko Instruments	2990 W. Lomita Blvd.	
SGS	1000 East Bell Road, Phoenix Arizona 85022	66958
SGS-Thompson Micro Elctr.	1310 Electronics Drive, Carrollton Texas 75006	5D590
Shurter AG	Werkhofstasse 8 CH-6002, Luzern Switzerland	61935
Signetics	811 East Argus Avenue, Sunnyvale California 94088	18324
Siliconix	2201 Laurelwood Road, Santa Clara California 95054	17856
Sprague Electronics	61 Split Brook Road STE 305, Nashua NH 3060	56289
Switchcraft Inc.	5555 N. Ellstone Avenue, Chicago IL 60630	82389
Takamisawa	16-7, Kamium-3 Chome, Setagaya-ku Tokyo 154, Japan	55101
Texas Instruments	13500N. Central Expressway, Dallas TX 75265	01295
TRW	14520 Aviation Blvd., Lawndale CA 90260	01281
Tabor	9045 Balboa Avenue, San Diego CA	23338

Table 6-2. Model 8550/8551 - Parts List

Model 8551, List of Assemblies

Main Board Assembly	6100-61850	23338
C.P.U. Board Assembly	6100-62000	23338
Current Generator Board Assembly	6100-62100	23338
V.C.O. Board Assembly	6100-62200	23338
Pulse Generator Board Assembly	6100-62500	23338
Output Amplifier Board Assembly	6100-62300	23338
Front Panel Board Assembly	6100-61910	23338
Rear Panel Assembly	6100-62800	23338
Case Assembly	6100-62700	23338

Current Generator Board Assembly ***6100-62100*** ***23338***

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
1	C8	CAP CER 3.3P	1500-03R30
1	C38	CAP CER 15P	1500-01500
1	C20	CAP CER 470P	1500-04710
1	C27	CAP CER 220P	1500-02210
3	C16,C24,C39	CAP CER 10n	1500-01030
1	C40	CAP CER 47NF	1500-04730
7	C10,C11,C15,C22,C23,C30,C31	CAP CER 0.1m 2.5m"m	1500-0104A
2	C19,C25	CAP CER 0.1m	1500-01040
2	C14,C18	CAP TANT 1.0m	1540-01050
12	C1,C2,C3,C4,C5,C6,C7 C13,C17,C26, C36,C37	CAP TANT 10UF25V	1540-0106B

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
1	C12	CAP ELEC 100mF 10V	1532-0107P
4	C32,C33,C34,C35	CAP ELEC 100mF 25V	1533-01070
2	CR1, CR2	DIODE HOT CARRIER 5082-2810	0300-10200
1	CR3	DIODE ZENER 1N751A 5.1 V	0300-20010
1	CR4	DIODE 1N4151	0300-00400
3	J1,J2,J3	CON FEMALE 2X8	3000-30520
1	J4	CON RF MALE 131-3701-261	3000-16000
1	L1	FERRITE BEAD 4312.020	4200-00000
1	Q1	TSTR J-309	0400-02510
1	Q2	TSTR 2N5210	0400-01910
4	Q3,Q4,Q9,Q10	TSTR PN3904	0400-01200
4	Q5,Q6,Q7,Q8	TSTR 3646	0400-00200
2	R61,R76	RES COMP 33 5% 1/4W	0100-03300
2	R65,R102	RES COMP 82 5% 1/4W	0100-08200
1	R48	RES COMP 100 5% 1/4W	0100-01010
2	R64,R101	RES COMP 130 5% 1/4W	0100-01310
1	R74	RES COMP 200 5% 1/4W	0100-02010
1	R82	RES COMP 330 5% 1/4W	0100-03310
4	R59,R60,R75,R77	RES COMP 470 5% 1/4W	0100-04710
1	R9	RES COMP 510 5% 1/4W	0100-05110
5	R50,R51,R83,R100,R109	RES COMP 560 5% 1/4W	0100-05610
9	R79,R91,R92,R93,R94, R95,R78,R97,R98	RES COM 560 1/8W 5%	0102-05610
4	R11, R49, R66,R111	RES COMP 1K 5% 1/4W	0100-01020
1	R86	RES COMP 1.2K 5% 1/4W	0100-01220
1	R10	RES COMP 1.5K 5% 1/4W	0100-01520
6	R52,R62,R68,R85, R105,R108	RES COMP 1.8K 5% 1/4W	0100-01820
6	R56,R63,R67,R84, R104,R107	RES COMP 2.7K 5% 1/4W	0100-02720
1	R99	RES COMP 3.9K 5% 1/4W	0100-03920
1	R72	RES COMP 4.7K 5% 1/4W	0100-04720
3	R69,R70,R71	RES COMP 6.8K 5% 1/4W	0100-06820
1	R88	RES COMP 7.5K 1/8W 5%	0102-07520
2	R87,R89	RES COMP 6-2K 1/8W 5%	0102-08220
1	R90	RES COMP 10K 1/8W 5%	0102-01030
7	R29,R30,R33,R47,R96,R103,R110	RES COMP 10K 5% 1/4W	0100-01030
1	R31	RES COMP 100K 5% 1/4W	0100-01040
1	R32	RES COMP 1M 5% 1/4W	0100-01050
1	R36	RES MF 9.76 1% 1/4W	0104-9R760
2	R57,R58	RES MF 499 1% 1/4W	0104-49900
1	R17	RES MF 825 1% 1/4W	0104-82500
1	R53	RES MF 1K 1% 1/4W	0104-10010
1	R14	RES MF 2K 1% 1/4W	0104-20010
3	R4,R7,R8	RES MF 3.32K 1% 1/4W	0104-33210
1	R41	RES MF 3.92K 1% 1/4W	0104-39210
2	R3,R13	RES MF 4.02K 1% 1/4W	0104-40210
2	R73,R81	RES MF 4.99K 1% 1/4W	0104-49910
1	R55	RES MF 5.62K 1% 1/4W	0104-56210
1	R43	RES MF6-25K 1% 1/4W	0104-82510

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
1	R54	RES MF 9.09K 1% 1/4W	0104-90910
18	R6,R12, R15,R16,R22,R24,R25 R26,R27,R28,R35,R37, R38,R39,R40,R44,R45,R46	RES MF 10K 1% 1/4W	0104-10020
1	R106	RES MF 12.5K 1% 1/4W	0104-12520
1	R5	RES MF 20K 1% 1/4W	0104-20020
2	R1,R42	RES MF 40.2K 1% 1/4W	0104-40220
1	R80	RES MF 47.5K 1% 1/4W	0104-47520
4	R2,R18,R19,R21	RES MF 49.9K 1% 1/4W	0104-49920
2	R23,R34	RES MF 100K 1% 1/4W	0104-10030
1	R20	RES MF 332K 1% 1/4W	0104-33230
1	RN1	RES NET 10K/9	0111-1103B
2	RN2,RN3	RES NET 10K/8	0110-01030
2	RN4,RN5	RES NET 1.8K/8	0110-01820
1	RN6	RES NET CSC09A-01-272G 2.7K/9	0111-1272B
1	T1	RES 1K 5%	0114-01400
1	U1	AD7228	0500-60200
3	U2,U9,U18	DUAL OP AMP LM1458N	0500-56500
2	U3,U4	QUAD OP AMPL LM324N	0500-53210
1	U5	AMPL TL084CP	0500-56750
1	U6	MAX 543	0560-00850
2	U7,U30	ANALOG SWITCH DG211	0500-90900
6	U10,U29,U13,U17,U22,U23	OP AMP OP07CP	0500-56330
8	U11,U12,U15,U20,U21, U27,U28,U36	8 BIT SHIFT REGISTER CD4094B	0540-01100
4	U14,U16,U19,U24	D/A 10 BIT CONVERTER AD7533	0560-00700
1	U25	DG411	0500-91000
1	U26	MAX9691E	0500-60940
1	U31	COMPARATOR LM393N	0500-53700
2	U8,U32	BIMOS OP AMP CA3140E	0500-57200
1	U33	ECL FLIP-FLOP MC10H131P	0500-45300
1	U35	MAX913CPA	0500-60960
1	U37	ECL NOR MC10H102P	0500-45000
2	U34,U39	10102P	0500-40900
1	U38	ECL XOR/XNOR MC10107P	0500-40950
1	U40	ECL DIVIDER MC10138P	0500-40930

Front Panel Board Assembly ***6100-61910*** ***23338***

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
1	C1	CAP ELEC 100µ 16V 2222.036	1532-01070
2	C2,C3	CAP CER 0.1µ SR155C104ZAA	1500-01040
4	DS1-DS4 7	SIGMENT LED HDSP 5601	1200-11000
1	DS5	7 SEG LED HDSP 7801	1200-11100
2	DS6	±1 LED HDSP 7807	1200-11200
6	DS7,DS15,DS25,DS29,DS32,DS35	MINI 3MM LED RED HLMP1301	1000-00300
29	DS6-14,DS16-24,DS26-DS28,DS30-31,DS33-34,DS36-S41	LED GRN MV 54124-A	1000-00900
1	J1	FLAT CABLE 20 PIN 9L28020	6800-50600

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
10	Q1-Q10	TSTR PNP 2N4403	0400-01800
10	R1-R10	RES COMP 220 5% 1/4W	0100-02210
2	R11-R12	RES COMP 10 5% 1/4W	0100-01000
21	S1-S21	KEY SWITCH M320.03 E1-1	2000-61600
1	U1	IC 74LS42	0510-05300
1	U2	IC 74LS138	0510-02700

Main Board Assembly ***6100-61850*** ***23338***

QTY	REFERENCE	Description and Commercial P/N	P/N TABOR
2	C1,C2,C10,C11	CAP ELEC 100UF/25V	1533-01070
2	C3,C4	CAP ELEC 3300UF/35V	1534-03380
2	C5,C6	CAP ELEC 1000UF/50V	1535-01080
2	C7,C8	CAP ELEC 10.000m 16V 2222.037	1532-01090
1	C9	CAP ELEC 1000m 25V 2222.037	1533-01080
1	C13	CAP TANT 10UF/25V 5m"m	1540-01060
1	C14	CAP CER 1n SR155C102MAA	1500-01020
3	CR1,CR2,CR3	DIODE 1N4151	0300-00400
2	CR4,CR5*	DIODE 1N5908	0300-90400
1	CR6	DIODE BRIDGE W005	0300-50100
2	CR8,CR5	DIODE BRIDGE KBU-6A	0300-50200
5	Q1,Q2,Q3,Q4,Q7	TSTR PN3904	0400-01200
2	Q5,Q6	TSTR PN3906	0400-01340
1	Q8	TSTR MJE3055A	0400-40400
1	Q9	TSTR MJE2955A	0400-40300
2	R26*,R27	RES COMP 0.27 5% 2W	0103-0R270
2	R6,R8	COMP 2.7 5% 1/4W	0100-02R70
3	R3,R25,R26	RES COMP 100 5% 1/4W	0100-01010
4	R23,R24,R28,R29	RES COMP 1K 5% 1/4W	0100-01020
1	R4	COMP 1.5K 5% 1/4W	0100-01520
2	R1,R15	RES COMP 1.8K 5% 1/4W	0100-01820
1	R2	COMP 2.2K 5% 1/4W	0100-02220
1	R5	COMP 27K 5% 1/4W	0100-02730
1	R20	RES MF 4.64K 1% 1/4W	0104-46410
3	R9,R14,R22	RES MF 4.99K 1% 1/4W	0105-49910
1	R19	RES MF 6-66K 1% 1/4W	0104-86610
5	R11,R12,R17,R21,R30	RES MF 10K 1% 1/4W	0104-10020
2	R10,R13	RES MF 10K .1% 1/4W	0105-10020
4	R16,R18,R31,R32	RES MF 20K 1% 1/4W	0104-20020
1	BEEP1	AT-02	0900-01900
1	U1	QUAD OP AMP LM324	0500-53210
1	U2	VOLTAGE REFERENCE REF02CP	0530-00100
2	U3,U11	8 BIT SHIFT REGISTER CD4094B	0540-01100
2	U4,U12	D/A 10 BIT CONVERTER MX7533JN	0560-00700
3	U5,U8,U13	DUAL OP AMP LM1458N	0500-56500
1	U6	VOLTAGE REGULATOR MC7815CP	0500-52100
1	U7	VOLTAGE REGULATOR MC7915CP	0500-52500
1	U9	VOLTAGE REGULATOR MC7924CP	0500-52700
1	U10	VOLTAGE REGULATOR MC7824CP	0500-52600
2	RN1, RN2	4.7MOHM	0100-04750

Table 6-2. Model 8551 - Parts List (continued)

Output Amplifier Board Assembly		***6100-6230***	***23338***
QTY	**REFERENCE**	**Description and Commercial P/N**	**TABOR P/N**
4	C1,C2,C3,C4	CAP ELECTR 100m 25V	1533-01070
4	C13,C17,C31,C35	CAP CER 1n	1500-01020
1	C32	0.1UF	1500-0104A
12	C11,C15,C16,C18, C24,C25, C34,C43,C51, C59,C62,C63	CAP TANT 10m	1540-0106B
1	C14	CAP CER 10n	1500-01030
16	C22,C23,C28,C30, C36,C38,C39,C40 C46,C47,C48,C49,C52,C53,C54,C56	CAP CER 0.1m	1500-01040
1	C29	CAP CER 1.5n	1500-01520
1	C33	CAP MICA 56P	1510-05600
2	C37,C42	CAP CER 33p	1500-03300
1	C41	CAP CER 470P	1500-04710
1	C45	CAP CER 3.3P	1500-03R30
2	C44,C50	CAP ELECTR 220m 50V	1535-02270
1	C64	CAP CER 27PF	1500-02700
1	C65	CAP CER 1.5P	1500-01R50
1	C66	CAP 10P	1500-01000
1	C8	CAP TAN 10MF 35V	1540-0106A
2	CR1,CR4	1N747A 3.6V	0300-20110
2	R40,R41	1N747A 3.6V	0300-20110
2	CR2,CR3	1N753A 6.2V	0300-20200
5	CR6,CR7,CR8,CR10,CR11	DIODE 1N4151	0300-00400
2	CR12,CR13	DIODE ZENER 1N751A 5.1V	0300-20010
2	CR14,CR15	DIODE 1N752A 5.6V	0300-20100
2	CR16,CR17	DIODE ZENER 1N746A 3.3V	0300-20000
2	J1,J2	CON FEMALE 2X8	3000-30520
2	J3,J4	CON RF MALE	3000-16000
5	K1,K2,K3,K4,K5	RELAY RY-05W	0900-00700
9	L9-L18	BEAD Ferrite	4200-00000
3	Q1,Q7,Q8	TSTR PN3904	0400-01200
1	C55	1P	1510-01R00
2	Q6,Q9	TSTR PN3906	0400-01340
6	Q4,Q5,Q10,Q11,Q15,Q25	TSTR MPS3646	0400-00200
5	Q2,Q3,Q12,Q13,Q16	TSTR MPS3640	0400-00100
4	Q18,Q19,Q21,Q23	TSTR 2N3866A	0400-01610
2	Q17,Q20	TSTR 2N5160A	0400-00800
1	Q14	TSTR J-109	0400-02500
2	Q22,Q24	2N2905A	0400-01500
1	R13	RES COMP 2.43K 1% 1/4W	0104-24310
2	R94,R99	RES COMP 4.7 5% 1/4W	0100-04R70
2	R101,R108	RES COMP 10 5% 1W	0101-0100A
1	R77	RES COMP 22 5% 1/4W	0100-02200
1	R82	RES COMP 82 5% 1/4W	0100-08200
6	R19,R21,R89,R113,R114,R116	RES COMP 100 5% 1/4W	0100-01010
1	R18	RES COMP 130 5% 1/4W	0100-01310
1	R68	RES COMP 270 5% 1/4W	0100-02710

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
1	R37	RES COMP 390 5% 1/4W	0100-03910
2	R5,R39	RES COMP 510 5% 1/4W	0100-05110
1	R15	RES COMP 560 5% 1/4W	0100-05610
4	R12,R75,R109,R110	RES COMP 1K 5% 1/4W	0100-01020
1	R14	RES COMP 2.2K 5% 1/4W	0100-02220
6	R8,R9,R25,R26,R111,R112	RES COMP 3.3K 5% 1/4W	0100-03320
1	R6	RES COMP 4.7K 5% 1/4W	0100-04720
6	R59,R60,R61,R70,R71,R72	RES COMP 10K 5% 1/4W	0100-01030
1	R74	RES COMP 100K 5% 1/4W	0100-01040
4	R102,R103,R106,R107	RES MF 10 1% 1/4W	0104-10R00
3	R29,R30,R51	RES MF 24.3 1% 1/4W	0104-24R30
2	R85,R90	RES MF 33.2 1/4W 1%	0104-33R20
2	R1,R42	RES MF 49.9 1% 1/4W	0104-49R90
3	R56,R58,R125	RES MF 61.9 1% 1/4W	0104-61R90
1	R120	RES MF 61.9 1% 1W	0104-61R9B
3	R27,R28,R54	RES MF 71.5 % 1/4W	0104-71R50
2	R93,R100	RES MF 71.5 1/2W 1%	0104-71R5A
2	R53,R55	RES MF 95.3 1/4W 1%	0104-95R30
2	R62,R65	RES MF 100 1% 1/4W	0104-10000
2	R117,R118	RES MF 100 1% 2W	0104-1000C
2	R122,R123	RES MF 100 .1% 1/4W	0105-10000
2	R76,R80	RES MF 121 1/4W 1%	0104-12100
2	R50,R52	RES MF 215 1% 1/4W	0104-21500
1	R121	RES MF 249 1% 1/2W	0104-2490A
1	R57	RES MF 249 .1% 1/4W	0105-24900
3	R10,R11,R96	RES MF 442 1% 1/4W	0104-44200
2	R31,R32	RES MF 499 .1% 1/4W	0105-49900
2	R35,R36	RES MF 750 1% 1/4W	0104-75100
2	R2,R7	RES MF 825 1% 1/4W	0104-82500
9	R63,R64,R66,R67,R78,R79,R104,R105, R119	RES MF 1K 1% 1/4W	0104-10010
1	R92	RES MF 1.15K 1/4W 1%	0104-11510
1	R73	RES MF 1.33K .1% 1/4W	0105-13310
2	R86,R87	RES MF 1.5K 1/2W 1%	0104-1501A
2	R3,R20	RES MF 2K 1% 1/4W	0104-20010
2	R22,R24	RES MF 2.49K 1% 1/4W	0104-24910
1	R88	RES MF 6.34K 1% 1/2W	0104-6341A
4	R23,R69,R97,R98	RES MF 10K 1% 1/4W	0104-10020
1	R38	RES MF 20K 1% 1/4W	0104-20020
2	R82,R83	RES MF 24K .1% 1/4W	0105-24020
2	R84,R91	RES VAR 200 3386W-1-201	0203-0201A
2	R95	RES VAR 2K 3386W	0203-0202A
1	RN1	RES NET MSP-05-01-33G 33K/5	0110-0333B
1	U1	ANALOG SWITCH SD5000N	0500-57110
1	U2	DAC AD834	0500-60100
1	U3	QUAD COMP LM339N	0500-50400
3	U4,U11,U13	8 BIT SHIFT REGISTER 4094	0540-01100
1	U5	DUAL OP AMP LM1458N	0500-56500
1	U6	TRIPLE LINE REC 10216P	0500-41100

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
1	U7	SINGLE OP AMP TL081	0500-56700
1	U9	HIGH FREQ OP AMP CLC404AJP	0560-00300
1	U10	D/A 10 BIT CONVERTER 7533JN	0560-00700
1	U12	BUFFER ULN2004	0500-11600
3	U8,U14,U15	SUPER GAIN OP AMP OP07CP	0500-56330
1	U16	OP AMP LM393N	0500-53700
1	U17	ANALOG SWITCH NE521N	0500-54500

Pulse Generator Board Assembly ***6100-62500*** ***23338***

QTY	REFERENCE	Description and Commercial P/N	P/N TABOR
1	C34	CAP POLY 0.01m 100V	1522-01030
1	C3	CAP POLY 47n 100V	1522-04730
1	C2	CAP POLY 470n 50V	1522-04740
1	C1	CAP POLY 4.7m 100V	1522-04750
1	C4	CAP POLY 4.7n 100V	1522-04720
1	C35	CAP POLY 0.1m 100V	1522-01040
1	C32	CAP POLY 1m 100V	1522-0105A
5	C5,C6,C7,C8,C36	CAP ELEC 100m 25V	1533-01070
1	C22	82P	1500-08200
1	C10	CAP CER 22P	1500-02200
1	C23	CAP CER 33P	1500-03300
1	C9	CAP CER 470PF	1500-04710
5	C17,C18,C30,C39,C44	CAP CER 1n	1500-01020
2	C11,C31	CAP CER 0.1m	1500-0104A
9	C14,C15 C19,C20,C24,C25,C26 C40,C41	CAP CHIP 0.1m	1560-01040
7	C12 C13 C16 C21, C37,C38,C42	CAP TANT 10m	1540-0106B
1	C27	CAP CER 10n	1500-01030
1	C33	1N	1500-0102A
1	C28	15PF	1500-01500
3	CR1,CR2,CR7	DIODE ZENER 1N746A 3.3V	0300-20000
2	CR4,CR6	DIODE ZENER 1N747A 3.6V -	0300-20110
2	CR3,CR5	DIODE ZENER 1N753A 6.2V-	0300-20200
2	J1,J2	CON 2X8	3000-30520
2	K1,K3	RELAY DIP 1A 5V	0900-01100
1	K2	RELAY DIP 1C 5V	0900-01000
21	Q2,Q3,Q4,Q5,Q6,Q7,Q13,Q15 Q16, Q19,Q20,Q26,Q27,Q29 Q30,Q31,Q32,Q33,Q34,Q36,Q37	TSTR PN3904	0400-01200
6	Q1,Q14,Q17,Q18, Q21,Q38	TSTR PN3906	0400-01340
4	Q9,Q10,Q22,Q24	TSTR MPS3640	0400-00100
2	Q11,Q12	TSTR BFY-90	0400-00710
3	Q23,Q25,Q35	PN3646	0400-00200
2	Q28,Q39	TSTR J-309 -	0400-02510
1	Q8	TSTR 2N5912	0400-40200
2	R30,R32	RES COMP 22 5% 1/4W	0100-02200
1	R78	RES COMP 22 5% 1/8W	0102-02200
3	R21,R81,R94	RES COMP 33 5% 1/4W	0100-03300

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
2	R48,R49	RES COMP 47 5% 1/4W	0100-04700
1	R77	RES COMP 82 5% 1/4W	0100-08200
2	R23,R97	RES COMP 100 5% 1/4W	0100-01010
1	R79	RES COMP 270 5% 1/4W	0100-02710
1	R74	RES COMP 130 5% 1/4W	0100-01310
1	R60	RES COMP 300 5% 1/4W	0100-03010
5	R27,R52,R53,R59,R63	RES COMP 510 5% 1/4W	0100-05110
4	R57,R61,R82,R93	RES COMP 562 1% 1/4W	0104-56200
4	R3,R4,R73,R86	RES COMP 1K 5% 1/4W	0100-01020
4	R6,R31,R33,R55	RES COMP 2.2K 5% 1/4W	0100-02220
2	R54,R69	RES COMP 2.7K 5% 1/4W	0100-02720
2	R56,R58	RES COMP 3.3K 5% 1/4W	0100-03320
1	R26	RES COMP 4.7K 5% 1/4W	0100-04720
6	R1,R2,R19,R62,R95,R97	RES COMP 10K 5% 1/4W	0100-01030
1	R92	RES COMP 1M 5% 1/4W	0100-01050
2	R71,R85	RES MF 10 1% 1/4W	0104-10R00
2	R72,R80	RES MF 33.2 1% 1/4W	0104-33R20
4	R22,R24,R28,R29	RES MF 49.9 1% 1/4W	0104-49R90
1	R25	RES MF 61.9 1% 1/4W	0104-61R90
4	R34,R36,R67,R70	RES MF 100 1% 1/4W	0104-10000
2	R38,R40	RES MF 200 1% 1/4W	0104-20000
1	R83	RES MF 402 1% 1/4W	0104-40200
6	R35,R37,R39,R41, R42,R44	RES MF 499 1% 1/4W	0104-49900
2	R50,R51	RES MF 619 1% 1/4W	0104-61900
1	R12	RES MF 1K 1% 1/4W	0104-10010
4	R43,R45,R87,R88	RES MF 1.1K 1% 1/4W	0104-11010
1	R89	RES MF 1.24K 1% 1/4W	0104-12410
2	R46,R47	RES MF 1.5K 1/4W 1%	0104-15010
5	R64,R65,R75,R84,R96	RES MF 4.99K 1% 1/4W	0104-49910
6	R5,R7,R98,R104,R90,R91	RES MF 10K 1% 1/4W	0104-10020
1	R76	20K 1% 1/4W	0104-20020
1	R9	RES MF 23.2K 1% 1/4W	0104-23220
1	R8	RES MF 33.2K 1% 1/4W	0104-33220
1	R13	RES MF 100K 1% 1/4W	0104-10030
1	R101	RES MF 249K 1% 1/4W	0104-24930
1	R103	RES MF 301K 1% 1/4W	0104-30130
2	R14,R68	RES MF 332K 1% 1/4W	0104-33230
2	R99,R102	RES MF 2M 1% 1/4W	0104-20040
1	R66	RES VAR 20K 3386W-1-203	0203-0203A
1	R100	RES VAR 250K 3386W-1-254	0203-0254A
2	R10,R11	10K 0.1% 1/4W	0105-10020
1	RN1	RES NET MSP-08A-03-182G 1.8K/8	0110-01820
1	RN2	RES NET MSP-05-01-272G 2.7K/5	0110-0272B
5	R15,R16,R17,R18,R20	2.2K 1/8W 5%	0102-02220
2	U1,U22	DUAL OP AMP LM1458N	0500-56500
1	U2	OP AMP OP200GP	0500-56350
7	U4,U9,U12,U13,U14, U26,U28	8 BIT SHIFT REGISTER CD4094B	0540-01100
1	U5	HA3-5033-5	0500-56340
2	U6,U7	OP AMP OP400GP	0500-56370

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	TABOR P/N
3	U8,U11,U24	AD7533JN	0560-00700
2	U10,U16	ECL NOR MC10H102P	0500-40900
3	U3,U15,U17	QUAD OP AMP LM324N	0500-53210
1	U18	ECL FLIP-FLOP MC10H131P	0500-45300
2	U19,U21	OP AMP TL081CP	0500-56700
1	U20	COMPARATOR MAX9691	0500-60940
1	U23	OP07CPZ	0500-56330
1	U25	ANALOG SWITCH DG411CJ	0500-91000
1	U27	DUAL OP AMP TL082CP	0500-56600
1	L1	BEAD	4200-00000

CPU Board Assembly ***6100-6200*** ***23338***

QTY	REFERENCE	Description and Commercial P/N	TABOR /PN
13	C1,C2,C4,C5,C6,C7,C8,C9,C10 C11,C12,C13,C14	CAP CER 0.1m SR155C104ZAA	1500-01040
1	C3	CAP TANT 3.3m T350A335M025AS	1540-01550
1	C15	CAP ELECTR 470m 25V 2222.037	1533-04770
2	J1,J2	CON FEMALE 2X8 90152-2216	3000-30520
1	J3,J4	CON MALE 2X10 90131-0770	3000-30280
1	Q1	TSTR PN3904	0400-01200
1	Q2	TSTR 2N4401	0400-01810
1	R1	RES COMP 3.3K 5% 1/4W	0100-03320
3	R2,R3,R4	RES COMP 1K 5% 1/4W	0100-01020
2	R5,R6	RES COMP 510 5% 1/4W	0100-05110
1	RN1	RES NET MDP-16-03-150G 15/16	0109-01500
1	U1	BUFFER ULN2004N	0500-11600
1	U2	KEYBOARD/DISPLY P8279	0500-20700
1	U3	IC 74LS138	0510-02700
1	U4	HEX INVERTER 74HC4049	0520-07300
1	U5	CONTROLLER P8031	0500-21420
1	U6	COUNTER/DIVIDER 74HC4040	0520-07000
1	U7	LOW POWER SCHOTTKEY 74LS373	0510-03650
1	U8	EPROM 27C512	0500-21250
1	U9	RAM MK48ZO2B-200PSI	0500-11160
1	U10	32BIT BINARY COUNTER LS7062	0550-00300
1	U12	IC 74LS02	0510-00110
1	U13	IC 74LS00	0510-00100
1	U14	IC 74F74	0500-12600
1	U15	NAT7210PBD	0500-21310
1	U16	GPIB BUFFER DS75161N	0500-21520
1	U17	GPIB BUFFER DS75160N	0500-21510
1	Y1	CRYSTAL 10MHz CY-12A	0800-30000

Table 6-2. Model 8551 - Parts List (continued)

VCO Board Assembly ***6100-6220*** ***23338***

QTY	REFERENCE	Description and Commercial P/N	P/N TABOR
1	C46	CAP CER 27P	1500-02700
1	C36	CAP CER 33P	1500-03300
1	C16	CAP CER 100P	1500-01010
2	C30,C39	CAP CER 1n	1500-01020
4	C27,C47,C48,C49	CAP CER 10n	1500-01030
1	C15	CAP CER 0.1m	1500-0104A
1	C23	CAP POLY 4.7n 100V	1522-04720
1	C22	CAP POLY 47n 100V	1522-04730
1	C21	CAP POLY 0.47m 50V	1522-04740
1	C50	CAP MYL 1m 100V	1522-0105A
1	C24	CAP MICA 470P	1510-04710
6	C1,C2,C3,C4,C5,C6	CAP ELEC 100m 25V	1533-01070
6	C7,C10,C26,C34,C35,C51	CAP TANT 10m	1540-0106B
1	C11	1PF	1500-01R00
3	CR1,CR3,CR5	DIODE 1N4151	0300-00400
2	CR8,CR9	DIODE ZENER 1N749A -	0300-20900
2	CR11,CR12	DIODE 1N753A 6.2V	0300-20200
1	CR2	DIODE ZENER 1N759A 12V	0300-20500
1	CR4	DIODE ZENER 1N756A 6-2V	0300-20700
2	CR6,CR7	DIODE ZENER 1N746A	0300-20000
2	CR10,CR13	DIODE HOT CARRIER 5082-2835	0300-10300
2	J1,J2	CON FEMALE 2X8	3000-30520
2	J3,J4	CON RF MALE 131-1701-201	3000-16000
1	K1	RELAY RY-05WK-R10	0900-00700
1	K2	RELAY DIP 1A 5V	0900-01100
1	K3	RELAY DIP 2A 5V	0900-01200
4	L1-L4	BEAD Ferrite CERAMAG24 57-1355	4200-00000
1	Q1	TSTR J-109	0400-02500
1	Q12	TSTR J-309	0400-02510
7	Q8,Q9,Q10,Q11,Q16,Q21,Q27	TSTR PN3904	0400-01200
2	Q19,Q20	TSTR MRF904	0400-40600
4	Q15,Q17,Q18,Q33	TSTR PN3906	0400-01340
8	Q4,Q6,Q7,Q23,Q24,Q25, Q31,Q32	TSTR MPS3640	0400-00100
9	Q2,Q3,Q5,Q28,Q13,Q14.Q26,Q29,Q30	TSTR MPS3646	0400-00200
1	Q22	TSTR PN5087	0400-01900
2	R43,R44	RES COMP 10 5% 1/8W	0102-01000
4	R36,R86,R88,R89	RES COMP 22 5% 1/8W	0102-02200
13	R29,R30,R31,R32,R35,R38,R40, R53 R57,R66,R68,R75,R84	RES COMP 33 5% 1/8W	0102-03300
2	R46,R72	RES COMP 33 5% 1/4W	0100-03300
1	R27	RES COMP 39 5% 1/8W	0102-03900
1	R132	RES COMP 47 5% 1/4W	0100-04700
1	R28	RES COMP 51 5% 1/8W	0102-05100
1	R137	RES COMP 82 5% 1/4W	0100-08200
7	R52,R73,R74,R87,R93, R94,R118	RES COMP 100 5% 1/8W	0102-01010
6	R85,R102,R105,R120, R133,R134	RES COMP 100 5% 1/4W	0100-01010

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	P/N TABOR
1	R138	RES COMP 130 5% 1/4W	0100-01310
1	R136	RES COMP 220 5% 1/4W	0100-02210
9	R14,R15,R56,R60,R61, R65,R67,R108,R109	RES COMP 270 5% 1/8W	0102-02710
1	R104	RES COMP 300 5% 1/4W	0100-03010
1	R82	RES COMP 510 1/4W 5%	0100-05110
1	R112	RES COMP 510 1/8W 5%	0102-05110
12	R110,R111,R113,R116, R117, R122,R123,R124,R126,R128,R129,R130	RES COMP 560 1/8W 5%	0102-05610
4	R47,R48,R49,R50	RES COMP 1K 5% 1/4W	0100-01020
1	R83	RES COMP 1.5K 5% 1/4W	0100-01520
2	R106,R107	RES COMP 1.8K 1/8W 5%	0102-01820
1	R140	RES COMP 1.8K 5% 1/4W	0100-01820
1	R114	RES COMP 2K 5% 1/4W	0100-02020
2	R103,R119	RES COMP 2.2K 5% 1/4W	0100-02220
1	R148	RES COMP 2.7K 5% 1/4W	0100-02720
2	R9,R10	RES COMP 3.3K 5% 1/4W	0100-03320
2	R143,R149	RES COMP 10K 5% 1/4W	0100-01030
2	R11,R13	RES COMP 33K 5% 1/4W	0100-03330
3	R23 R24 R135	RES MF 49.9 1% 1/4W	0104-49R90
1	R51	RES MF 61.9 1% 1/8W	0102-61R9A
1	R76	RES MF 100 1% 1/4W	0104-10000
2	R54 R55	RES MF 115 1% 1/8W	0102-1150A
2	R58 R59	RES MF 127 1%1 1/8W	0102-1270A
2	R62 R63	RES MF 140 1% 1/8W	0102-1400A
2	R70 R71	RES MF 154 1% 1/8W	0102-1540A
1	R77	RES MF 200 1% 1/4W	0104-20000
1	R12	RES MF 249 1% 1/4W	0104-24900
2	R98,R100	RES MF 249 0.1% 1/4W	0105-24900
2	R64 R69	RES MF 261 1% 1/8W	0102-2610A
4	R41 R42 R115 R127	RES MF 330 5% 1/8W	0102-03310
1	R131	RES MF 365 1% 1/4W	0104-36500
1	R121	RES MF 464 1% 1/4W	0104-46400
2	R17 R33	RES MF 499 1% 1/8W	0102-4990A
1	R37	RES MF 619 1% 1/8W	0102-6190A
2	R90 R91	RES MF 820 5% 1/8W	0102-08210
1	R18	RES MF 825 1% 1/8W	0102-8250A
2	R5 R16	RES MF 1K 1% 1/4W	0104-10010
1	R45	RES 1K 1% 1/8W	0102-01020
3	R96,R97,R99	RES MF 1K 0.1% 1/4W	0105-10010
1	R8	RES MF 1.1K 1% 1/4W	0104-11010
1	R19	RES MF 1.13K 1% 1/8W	0102-1131A
2	R20,R34	RES MF 1.87K 1% 1/8W	0102-1871A
1	R95	RES MF 2 K .1% 1/4W	0105-20010
1	R80	RES MF 2.49K 1% 1/4W	0104-24910
4	R26,R78,R79,R142	RES MF 4.99K 1% 1/4W	0104-49910
1	R7	RES MF 6.04K 1% 1/4W	0104-60410
1	R39	RES MF 7.32K 1% 1/8W	0102-7321A

1	R25	RES MF 9.09K 1% 1/4W	0104-90910

Table 6-2. Model 8551 - Parts List (continued)

QTY	REFERENCE	Description and Commercial P/N	P/N TABOR
2	R2,R3	RES MF 10K 1% 1/4W	0104-10020
1	R150	RES MF 20K 1% 1/4W	0104-20020
1	R1	RES MF 51.1K 1% 1/4W	0104-51120
1	R4	RES MF 100K 1% 1/4W	0104-10030
1	R6	RES MF 1M 1% 1/4W	0104-10040
1	R101	RES VAR 20K 3386W-1-203	0203-0203A
1	R21	RES VAR 2K 3386W-1-202	0203-0202A
1	R22	RES VAR 1K3386W	0203-0102A
1	R81	RES 499 1% 1/4W	0104-49900
1	R139	RES 1K 5% 1/8W	0102-1001A
1	R141	RES 86.6K 1% 1/4W	0104-86620
1	RN1	5X1K CSC06A-01-102J	0110-1102B
1	U1	OP AMP TL081CP	0500-56700
1	U28	ANALOG SWITCH DG411DJ	0500-91000
1	U2	MAX312	0500-91040
4	U8,U3,U17,U18	OP AMP OP07CP	0500-56330
4	U4,U6,U24,U25	8 BIT SHIFT REGISTER CD4094BCN	0540-01100
1	U5	QUAD OP AMP LM324N	0500-53210
1	U7	BUFFER ULN2004N	0500-11600
3	U9,U11,U12	TRANS ARRAY CA3127E	0500-60000
1	U10	HA3-5033-5	0500-56340
1	U13	MAX9691EPA	0500-60940
1	U29	DUAL OP AMP TL082CP	0500-56600
2	U14,U15	OP AMP OP 200GP	0500-56350
1	U16	ECL FLIP-FLOP MC10H131P	0500-45300
3	U19,U20,U22	ECL MC10HO16P	0500-45600
1	U21	ECL OR/NOR GATE MC10H105P	0500-45100
2	U23,U27	ECL NOR MC10102P	0500-40900
1	U26	QUAD COMP LM339N	0500-50400
1	U13 (SOLDER SIDE)	MAX4200ESA	0500-5620S

Rear Panel Assembly ***6100-6280*** ***23338***

QTY	REFERENCE	Description and Commercial P/N	P/N TABOR
1	T1	MAINS TRANSFORMER	2500-05000
1	J1	MAINS RECEPT & FILTER 3EEA1	3000-20500
1	J4	CON GPIB 57FE-2 0240-20ND35	3000-40300
1	S2	SW LINE SELECT EPS1SL1	2000-10220
1	F1	FUSE 1A/250V S/B 5x20 216-001	100-15600
1	FA1	FAN 12VDC ST-60X12A	1700-00100

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Schematic Drawings Chapter 7

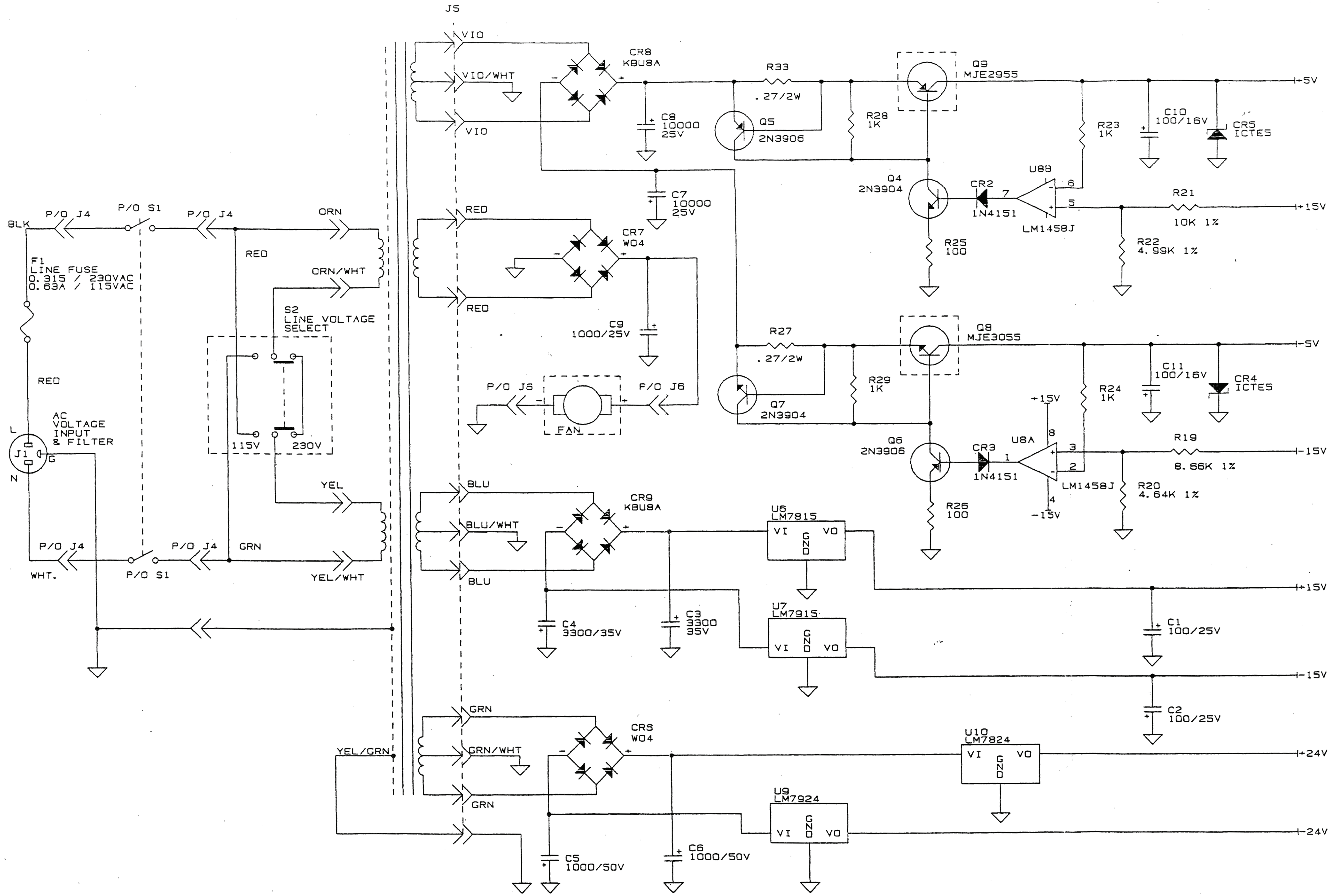

Figure 9-1. Main Board - Power Supply

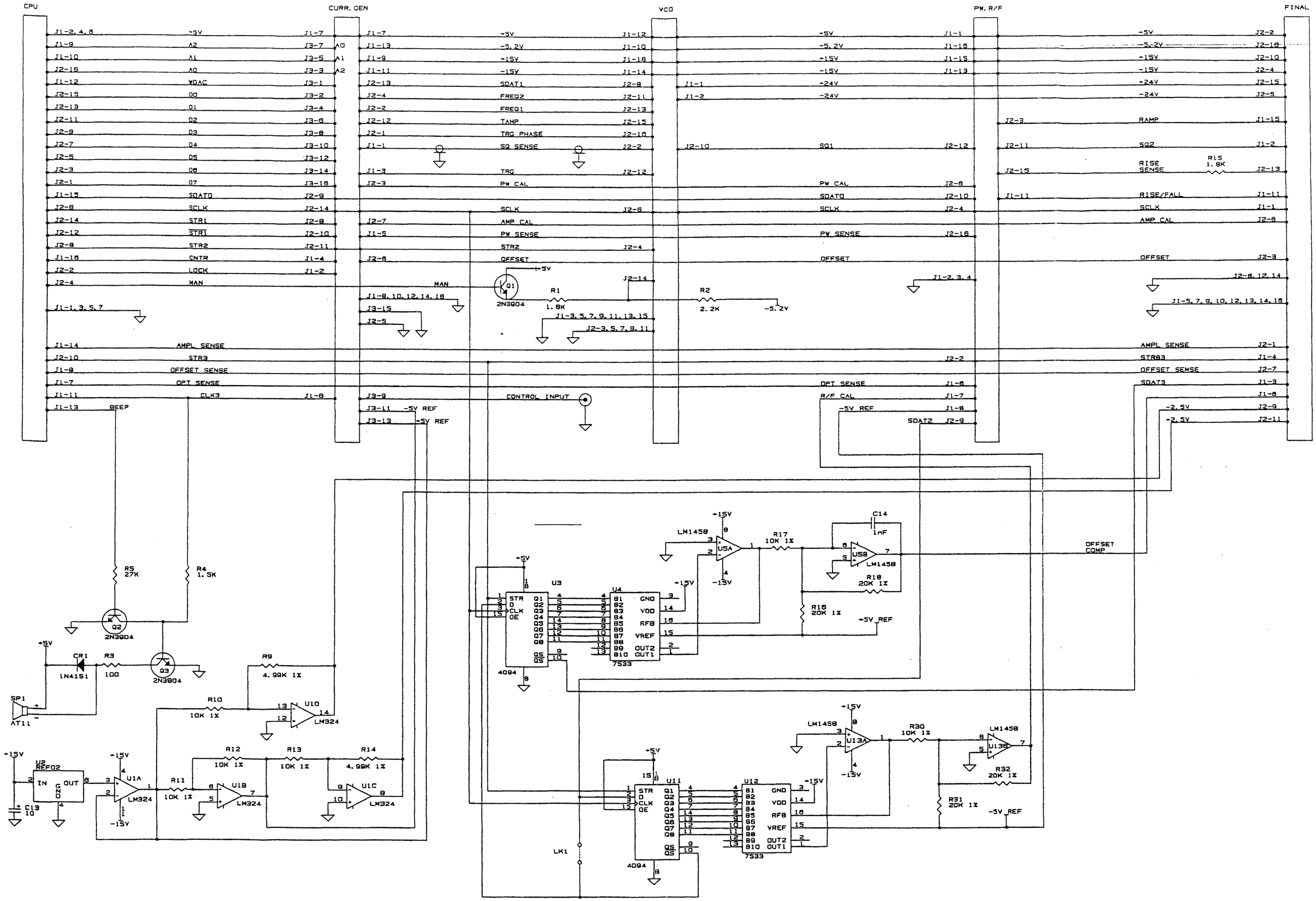

Figure 9-2. Main Board - Inter-connection Diagram

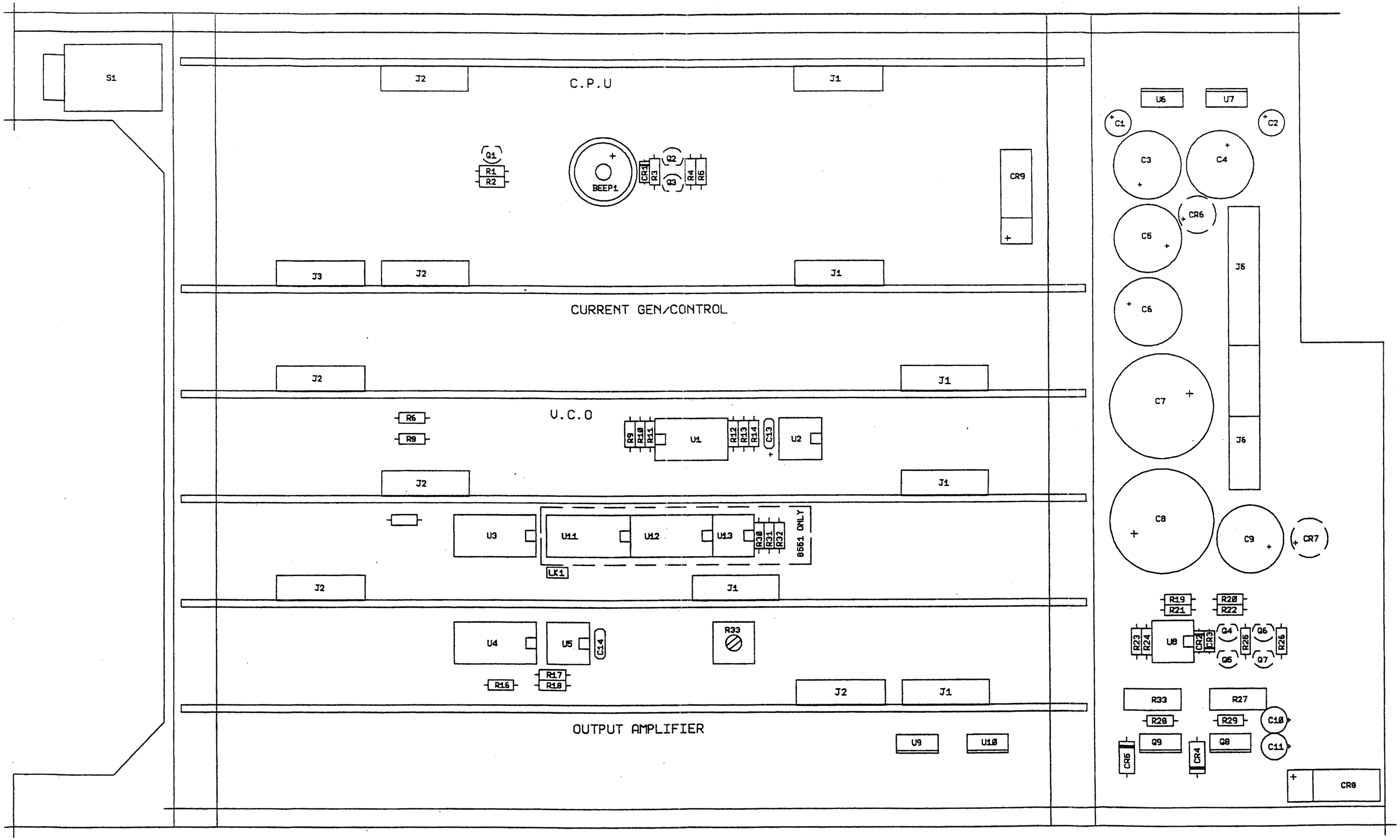

Figure 9-3. Main Board - Components Location

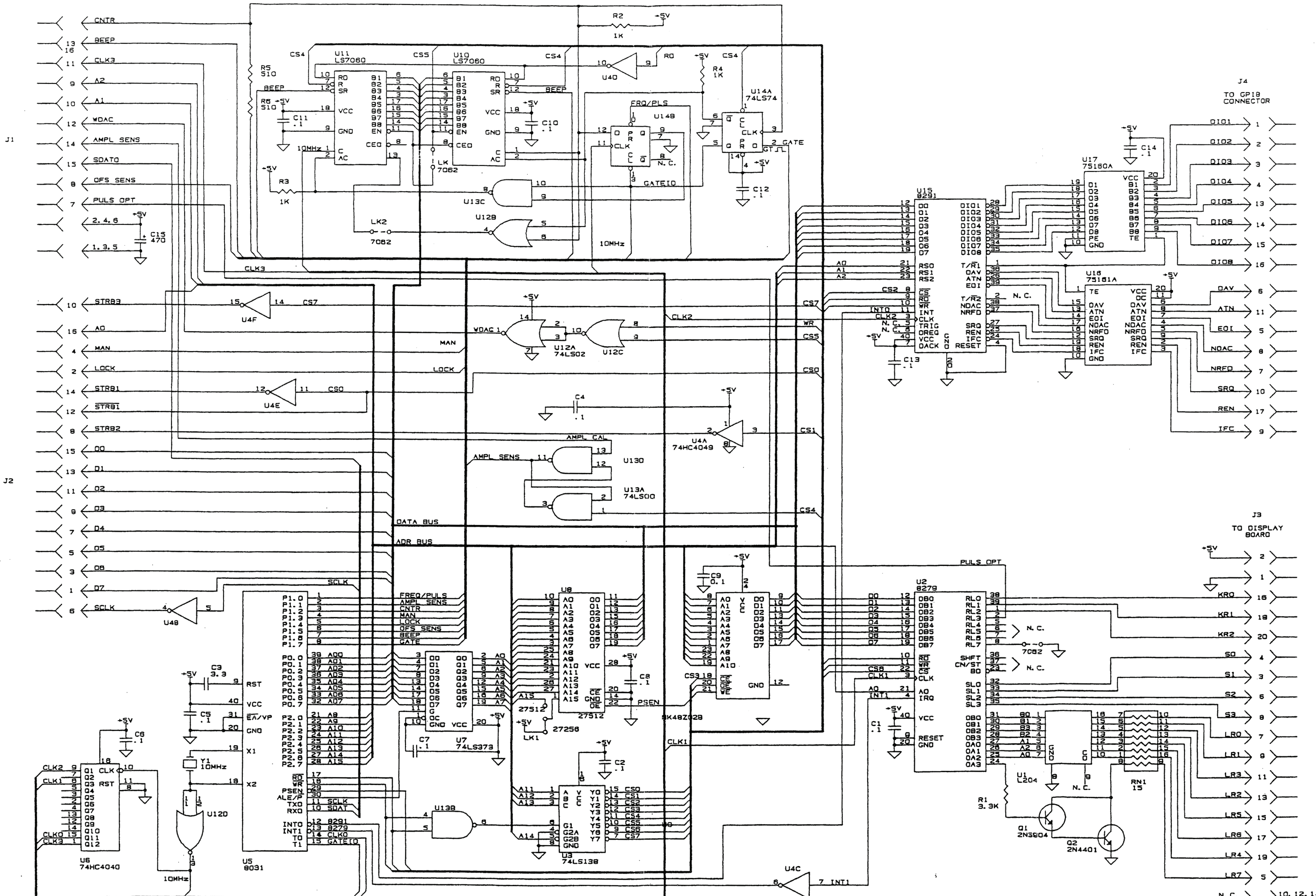

Figure 9-4. CPU Board

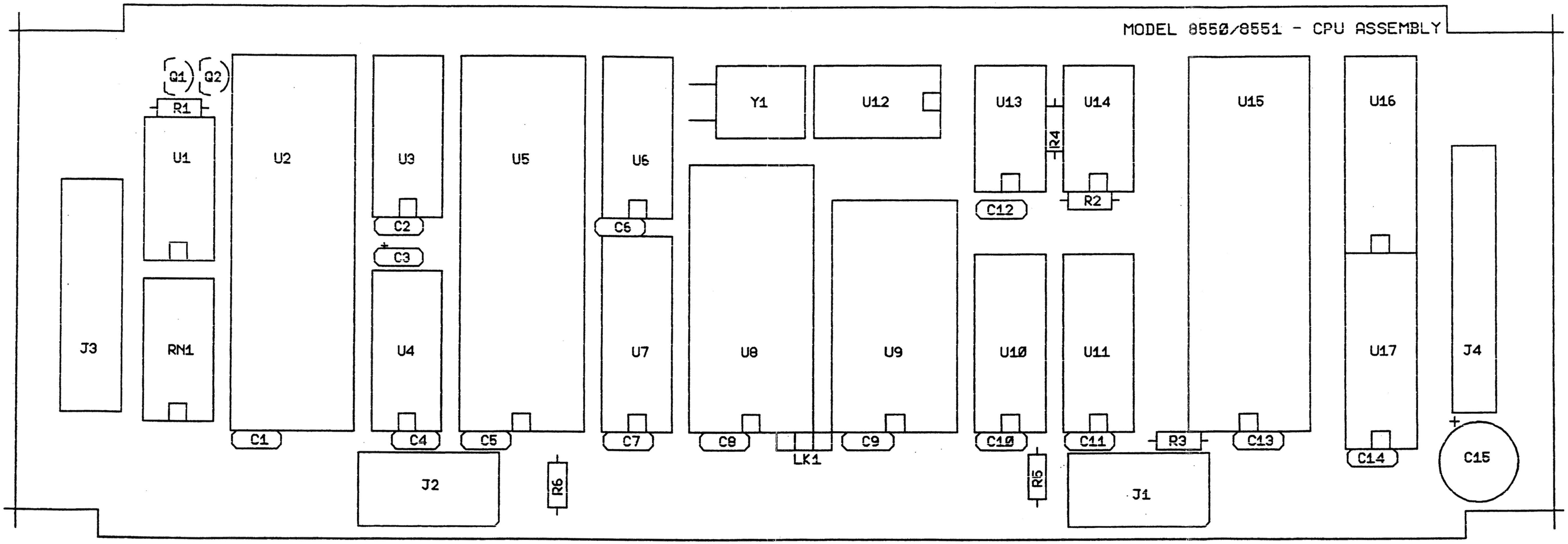

Figure 9-5. CPU Board - Components Location

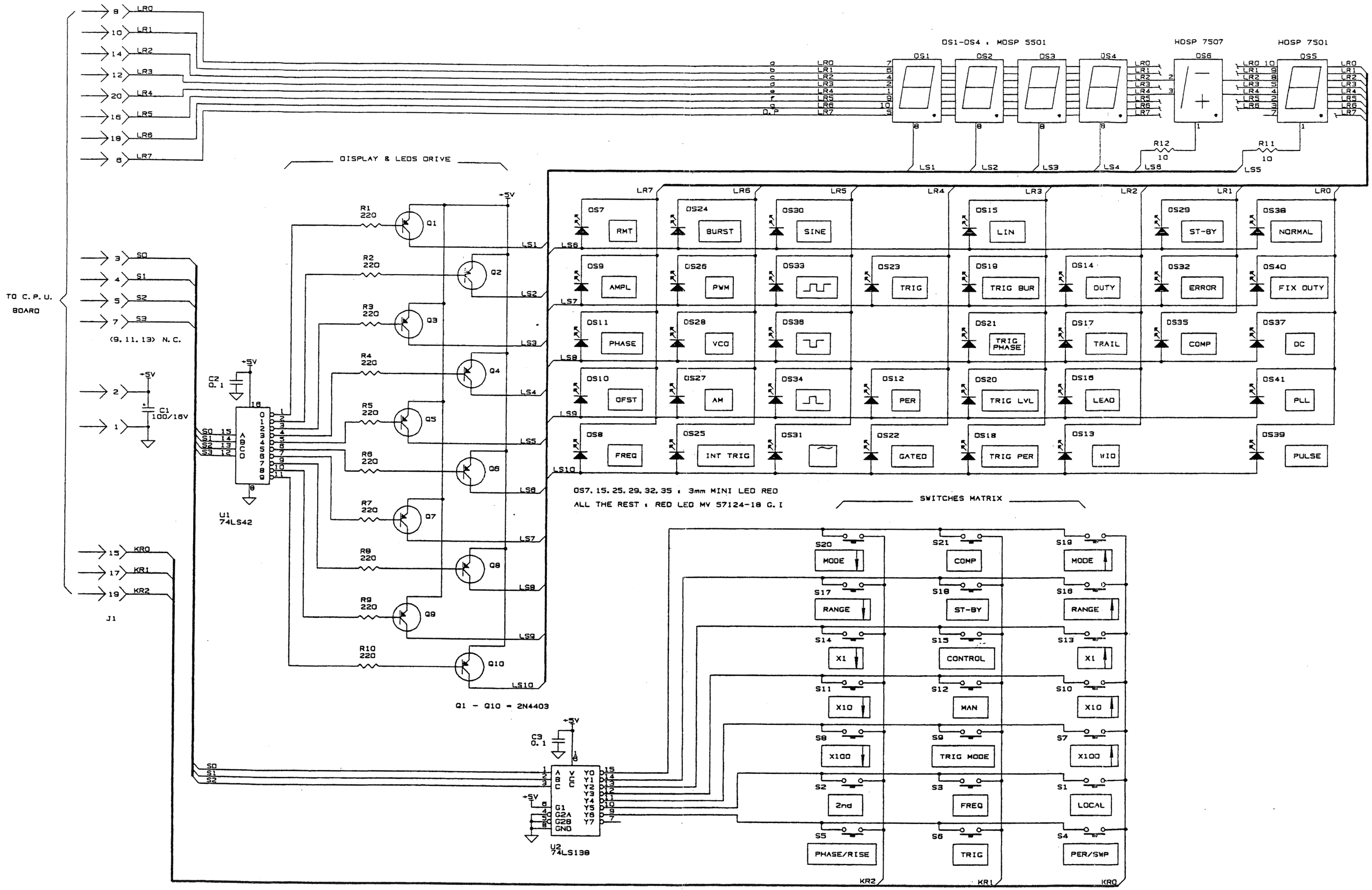

Figure 9-6. Keyboard and Display

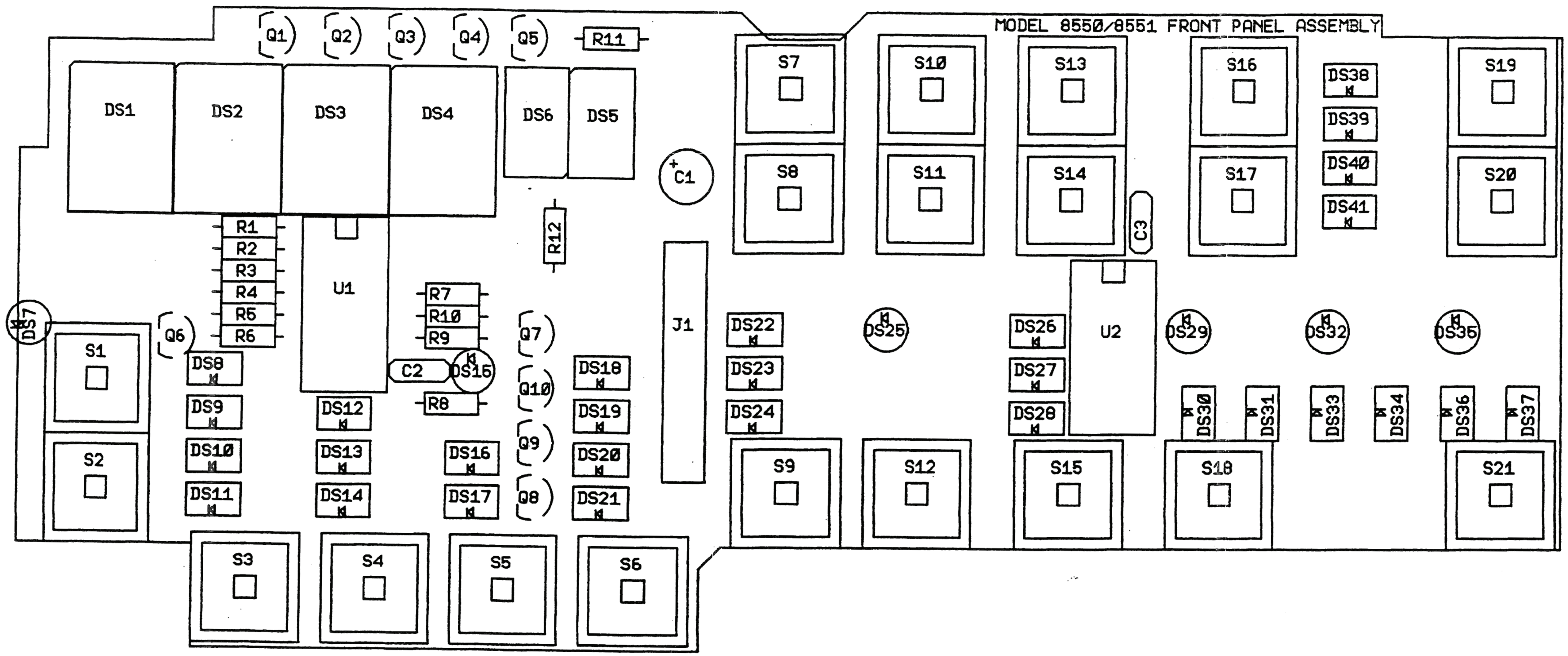

Figure 9-7. Keyboard and Display - Components Location

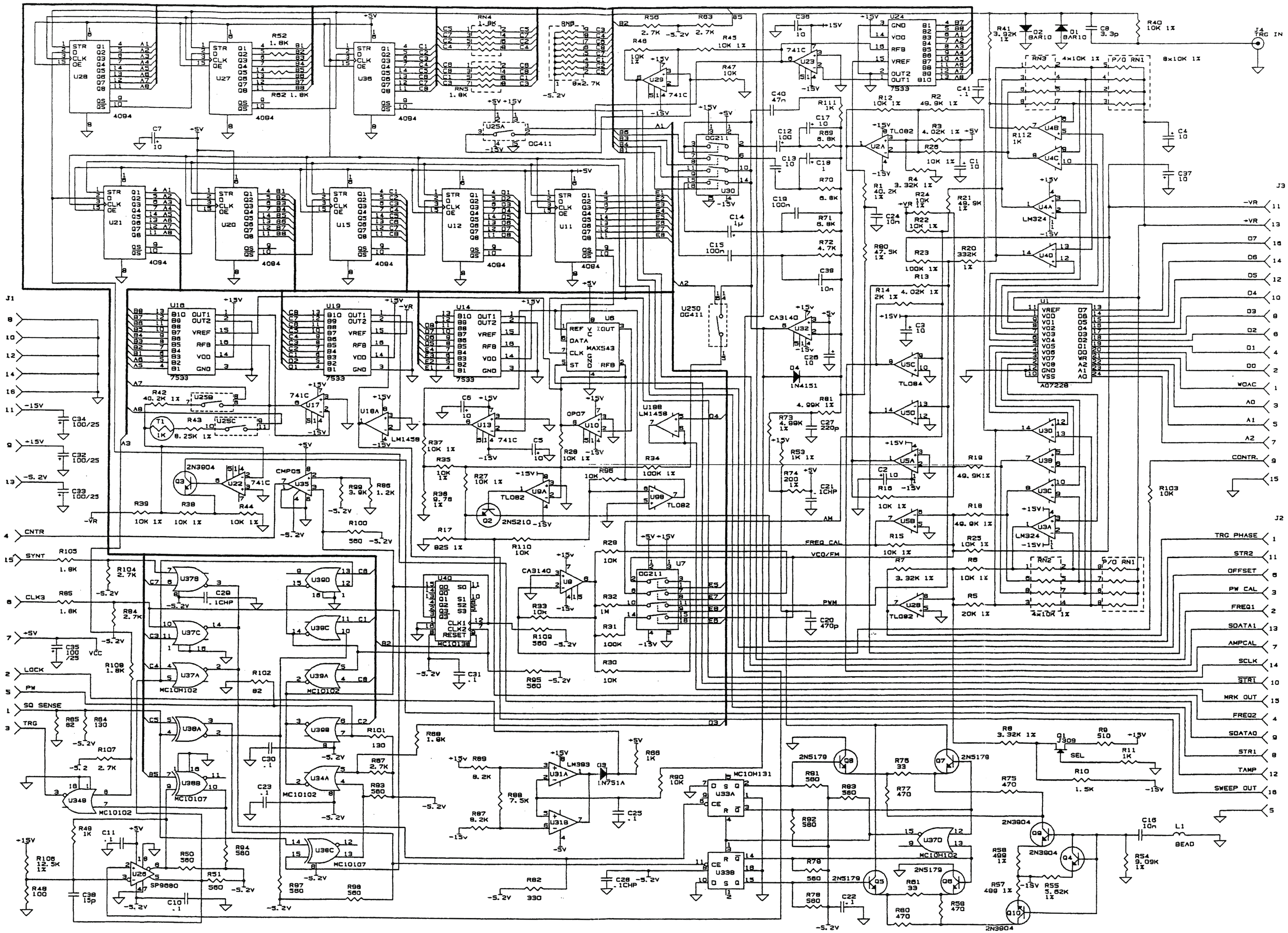

Figure 9-8. Current Generator Board

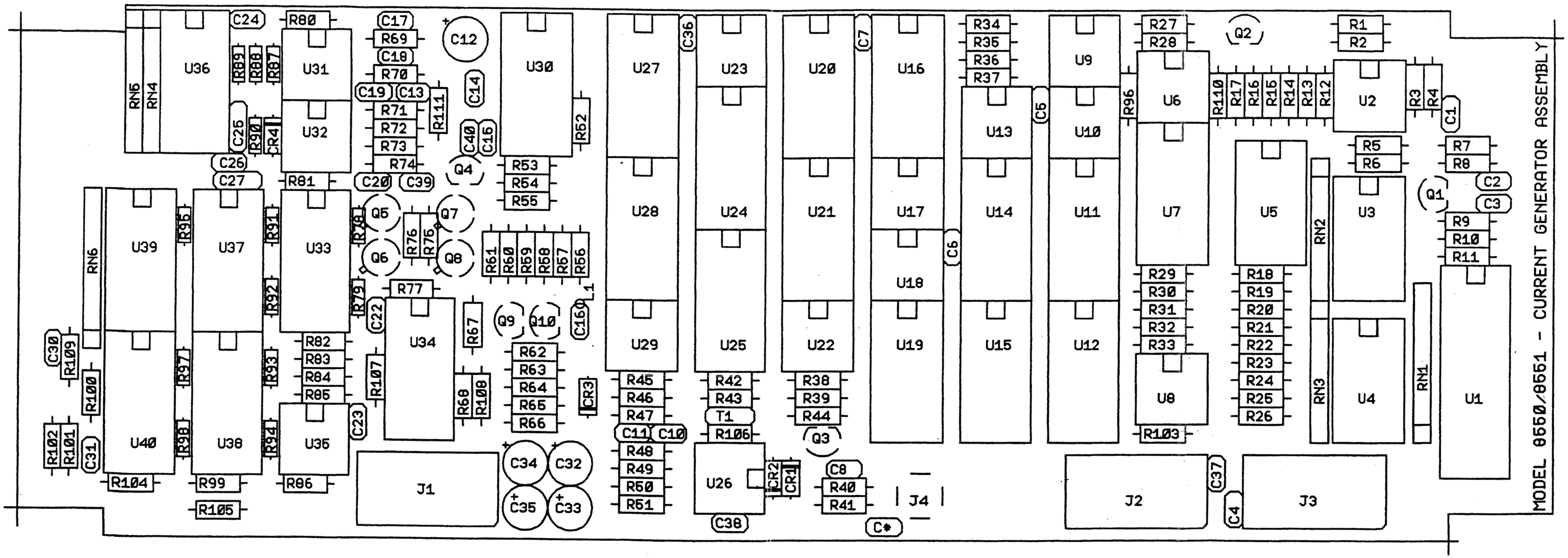

Figure 9-9. Current Generator Board - Components Location

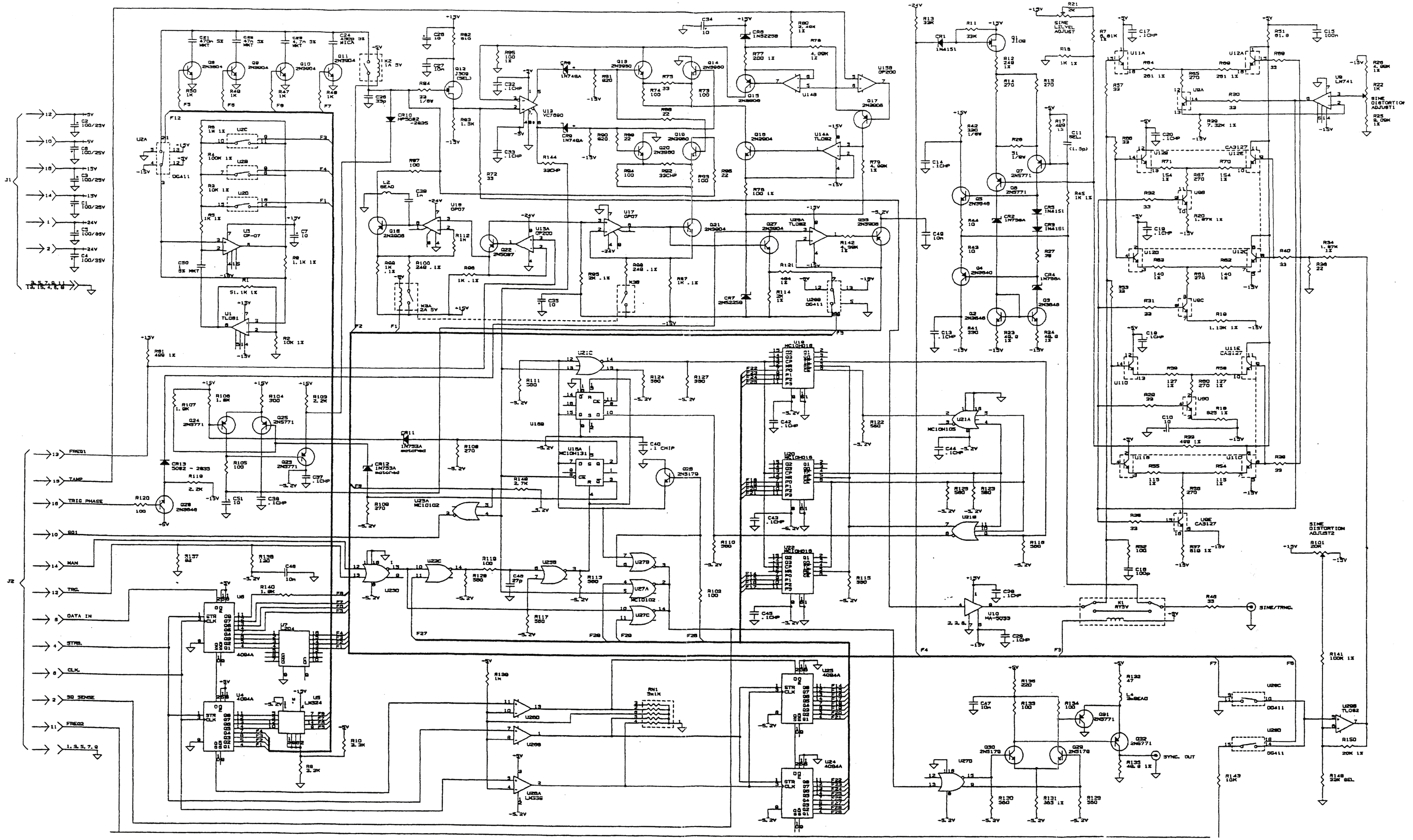

Figure 9-10. VCO Board

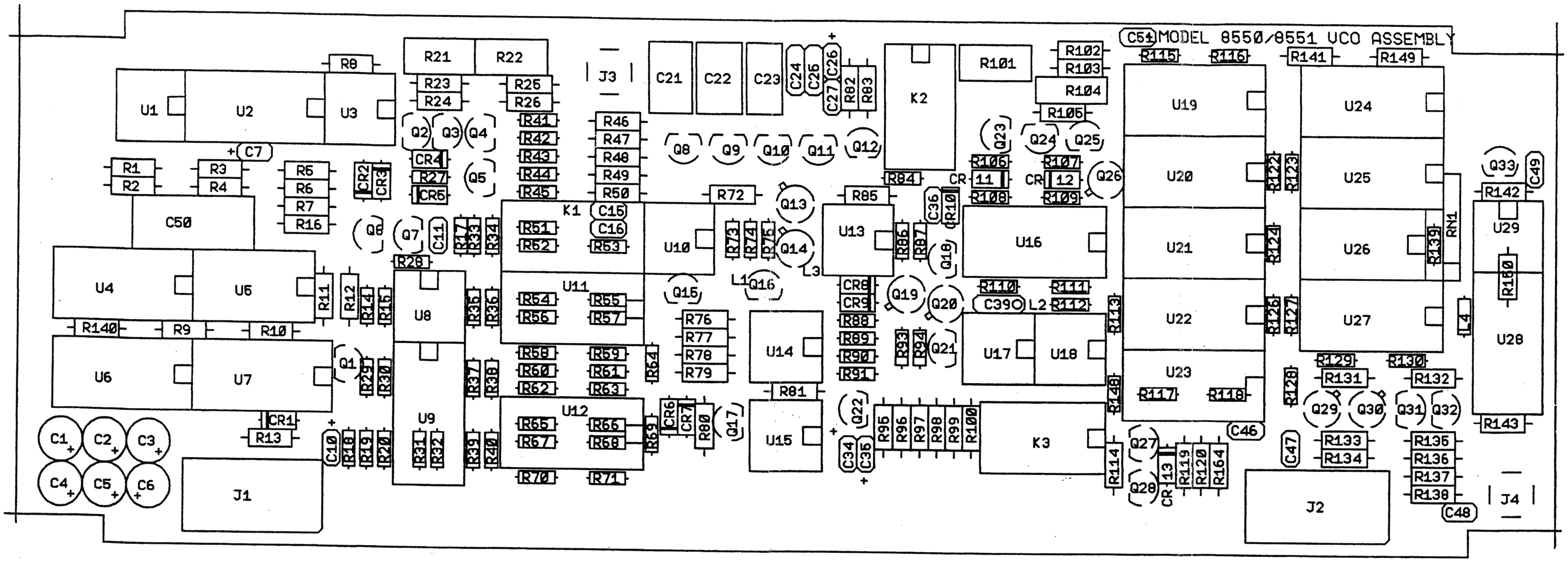

Figure 9-11. VCO Board - Components Location

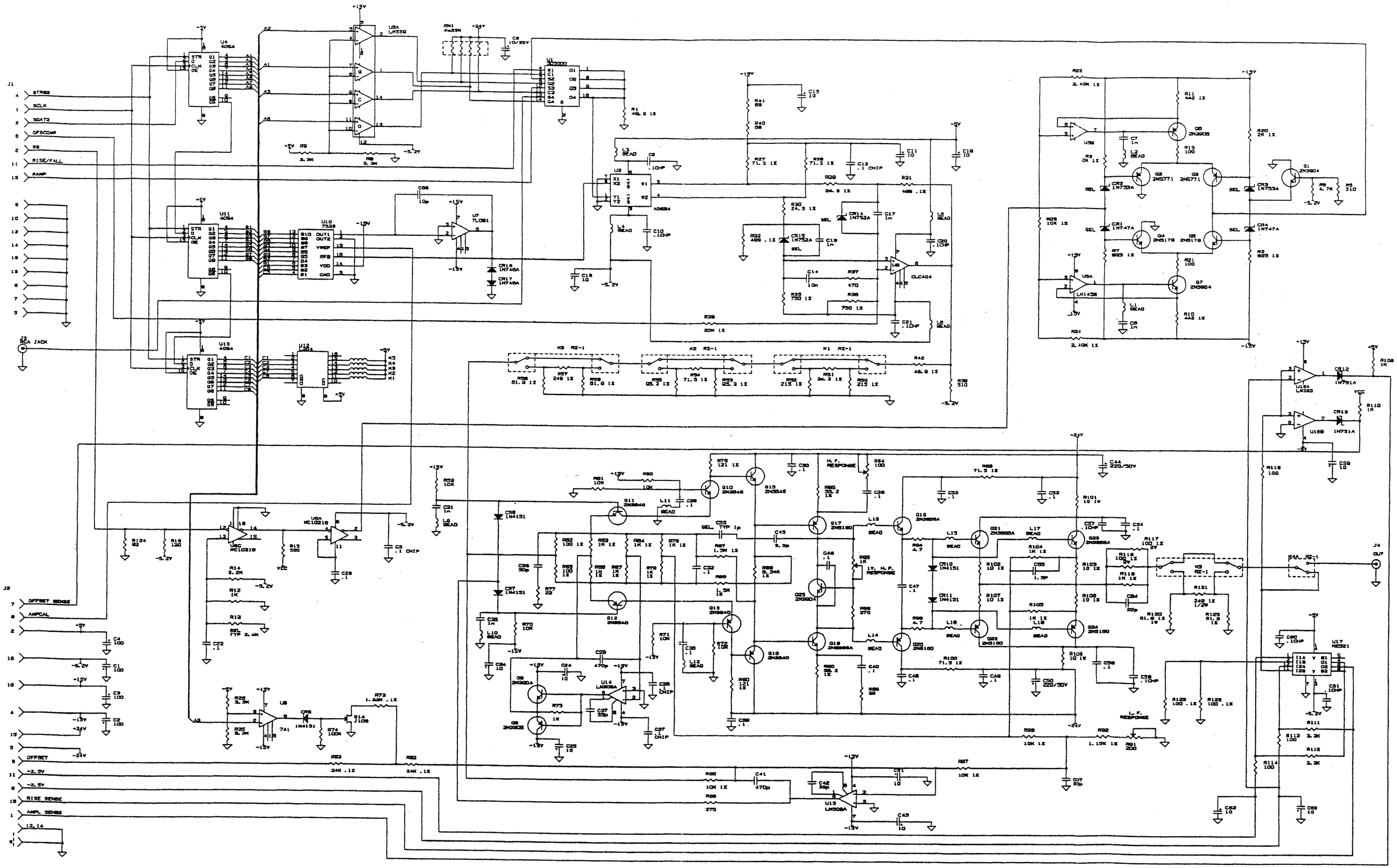

Figure 9-12. Output Amplifier Board

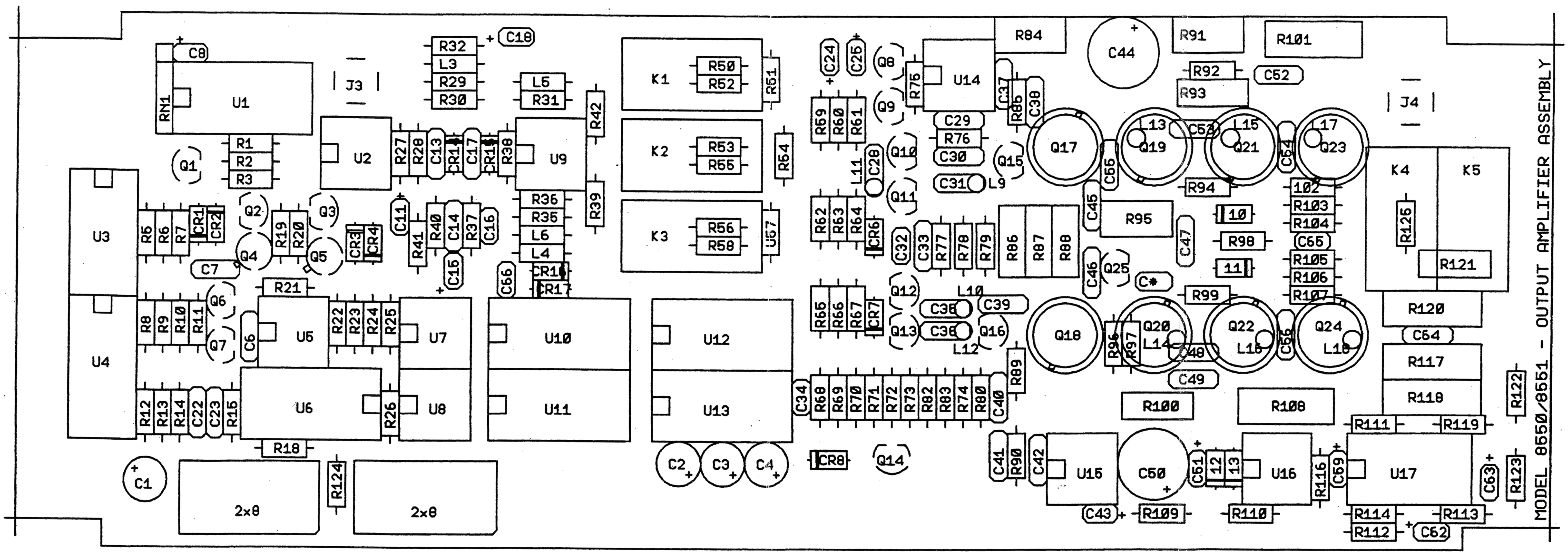

Figure 9-13. Output Amplifier Board - Components Location

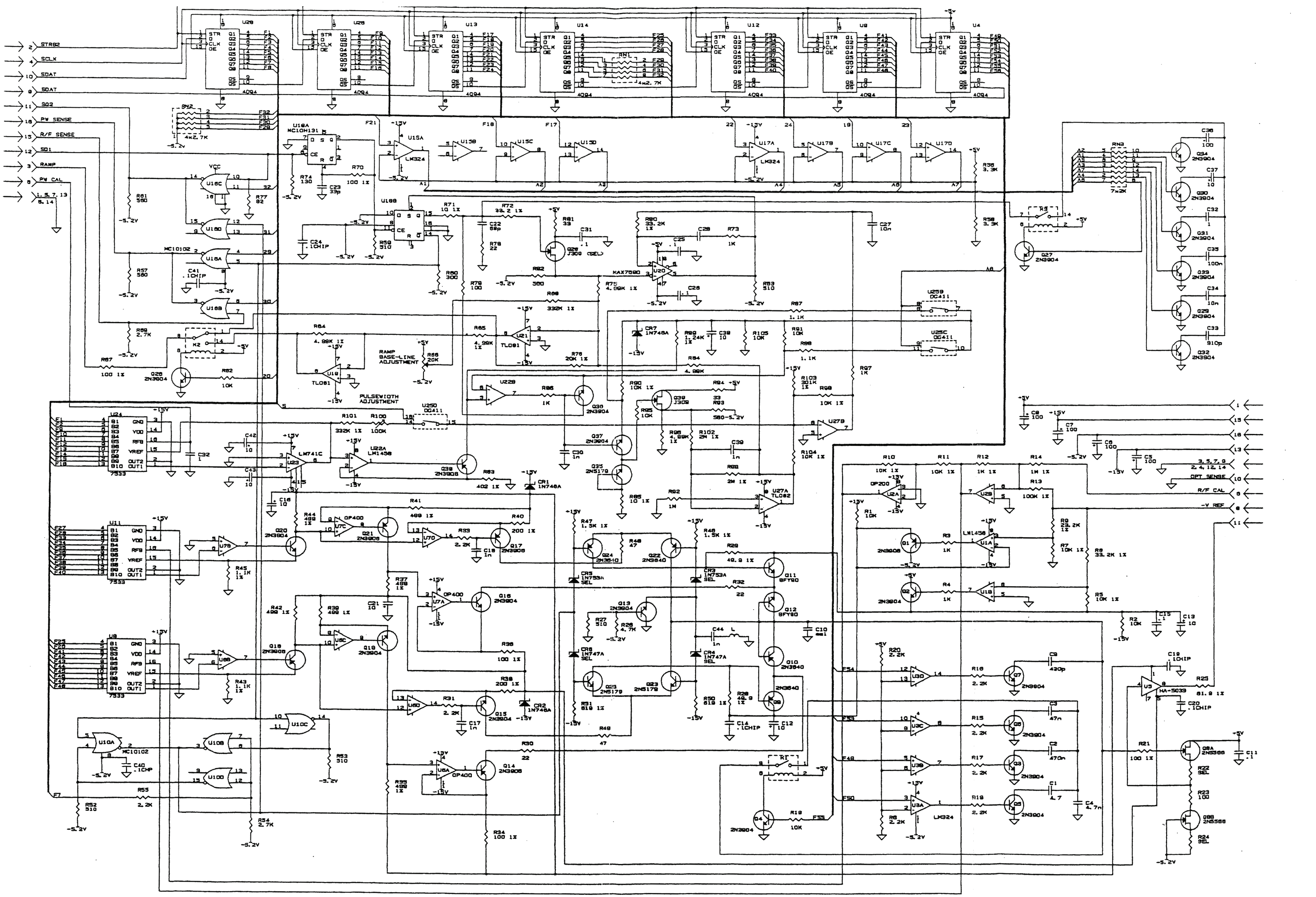

Figure 9-14. Pulse Generator Board

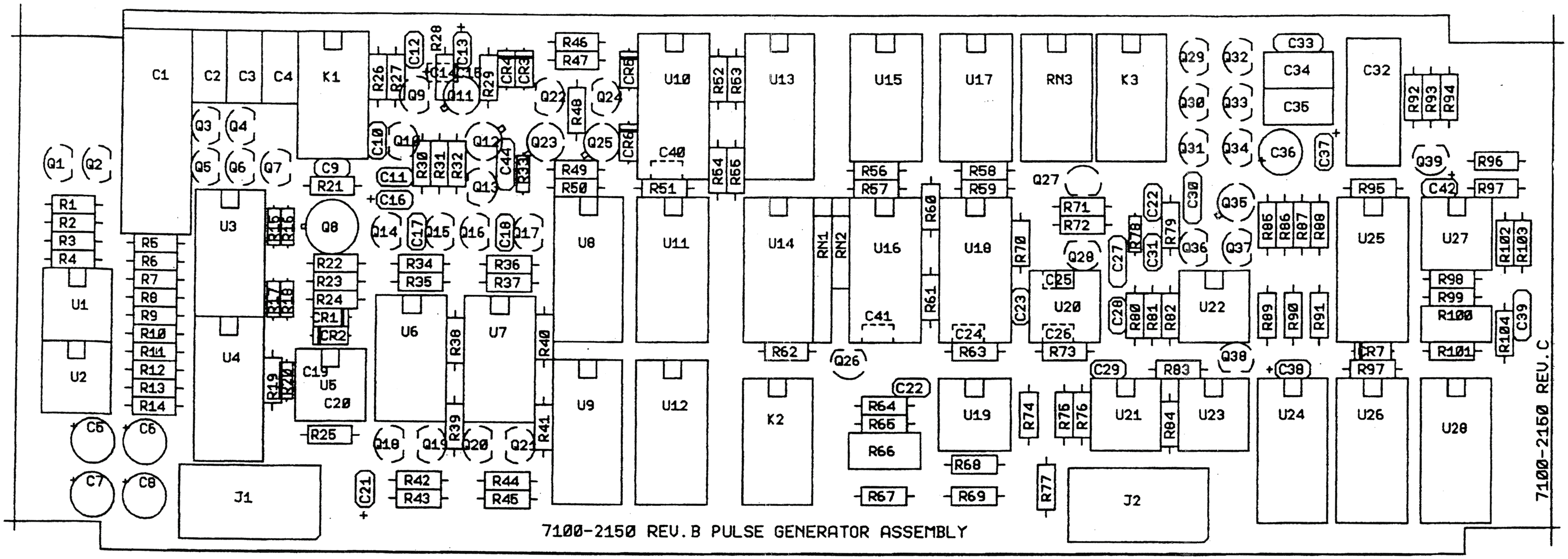

Figure 9-15. Pulse Generator Board - Components Locatic