INSTRUCTION MANUAL

MODELS 605, 606
PROGRAMMABLE
WAVEFORM GENERATORS

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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

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

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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INTRODUCTION

SECTION 2

2.1.0 INTRODUCTION

The Exact models 605 and 606 programmable waveform generators were designed to fulfill the need for accurate waveform generation, controlled by an external system or controller such as a digital computer. These generators can be completely controlled for amplitude Frequency, Function, Triggering, Offset, and Start phase by an external source. The external programming source can be a contact closure such as a rotary switch or a relay. It can be a signal from TTL or DTL logic systems or it can be any other electrical signal within the operating range of the program inputs. The external programming source can be electrically isolated from the generator's circuit common. The Model 605 has provisions for locally controlling all functions, frequencies and amplitudes as well as external or Remote mode.

The program inputs are on the rear panel in a single 50-pin receptacle. All other generator inputs and outputs "sync, VCF, etc" are also available on the rear of this 3 1/2" high regular rack width package. The part number for the mating plug to the 50-pin receptacle is Amphenol 57-30500.

This manual is an attempt to provide complete information on the specifications, operational procedures, circuit description, calibration, parts list, schematics, etc. of the Exact models 605 and 606. The information in this manual remains the property of Exact Electronics, Inc. and shall not be used or copied without the express permission of same. Patent Pending.

SECTION 3

SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

3.1.0 SPECIFICATIONS

DYNAMIC FREQUENCY RANGE

The instrument will operate over a frequency range from .001Hz to 1 MHz with front panel controls. It will also operate up to 1.6 MHz with 60% overrange of the 1248 BCD programming when programmed externally.
Decade frequency ranges are:

1	-	10 milliHz	100	-	1000 Hz
10	-	100 milliHz	1	-	10 KHz
100	-	1000 milliHz	10	-	100 KHz
1	-	10 milliHz	100	-	1000 KHz
10	-	100 milliHz			

Front panel vernier frequency control covers the range of 1 least significant bit (605 only).

FREQUENCY ACCURACY

± 1% of setting + 1 digit between 0.01 Hz and 100 KHz
± 2% of setting + 1 digit between 0.001 Hz and 0.01 Hz.
± 2% of setting + 1 digit between 100 KHz and 1 MHz.

FREQUENCY STABILITY

0.04% of setting for 10 minutes, 0.2% for 24 hours.

VCF (Voltage Controlled Frequency)

External frequency control with D. C. or A. C. (usable to 1 MHz). Positive input increases and negative input decreases frequency from programmed value. Nominal input 5V for 1600:1 into 5K input impedance.

WAVEFORMS

Basic Function selection produces Sine, Triangle, Square, Ramp, Pulse and Sine-Squared waveforms.

Run, Gate, Trigger - Any of the basic waveforms can be progduced continuously by selecting the Run Mode. Selecting Gate of Trigger Mode will cause the generator to lockout at zero degrees starting phase for the Sine, Triangle, and Ramp waveforms, and at the peak values for pulse or square. Sine-Squared locks out at - 90°. All waveforms can be inverted 180°.

Application of an external or manual Gate/Trigger command when in the Triggered Mode will produce 1 complete cycle of the selected waveform. In the Gate Mode the generator will continue to produce the output waveforms until the command is removed.

Gate/Trigger signal requirements are TTL - DTL compatible. Requires approximately 1.2 volts into a 10K ohm input impedance.

D. C. OFFSET

Programmed waveform is decreased to half its peak to peak amplitude and offset so that one peak is maintained at zero volts.

EXTERNAL D. C. OFFSET

Rear panel input that accepts D. C. or A. C. signals to be summed with the selected waveform. Normal 1:1 inverting relationship on the 1 - 10V P-P range is attenuated by selecting lower voltage ranges.

TRIANGLE MONITOR OUTPUT

Fixed Triangle or Ramp waveform of 10V P-P-open circuit with 600Ω output impedance.

SYNC OUT

Square Waveform of approximately 4V P-P with an output impedance of 100Ω. Square transitions are coincident with the Triangle, Ramp, and Sine peaks or the Square and Pulse transitions.

OUTPUT VOLTAGE

1 millivolt to 10 volts P-P into 50Ω load in four ranges with 3 digit setability.

1	-	10	millivolts peak to peak into 50Ω
10	-	100	millivolts "
100	-	1000	millivolts "
1	-	10	volts "

With D. C. Offset

0.5	-	5	mv peak into 50Ω
5	-	50	mv "
50	-	500	mv "
0.5	-	5	v "

External programming with the 1248 BCD code provides overranging of 60% to produce a maximum of 16V peak to peak. (Slewing rate limits prevent over-ranging frequency and voltage at the same time, 100 KHz and above).

PHASE LOCK INPUT

A signal of 5V P-P applied to this input will synchronize the instrument when the frequencies are within approximately 1%.

PROGRAMMING

The programming inputs are compatible with TTL, DTL contact closure and etc. Current sink is less than 1 ma. Programming time is less than 0.5 milliseconds.

There are 38 programming inputs plus program common which is isolated from instrument common.

INPUTS:

Frequency Decade	4	inputs	BCD
Frequency Control	12	inputs	BCD 3 digits
Voltage Control	12	inputs	BCD 3 digits
Voltage Range	2	inputs	Binary
Polarity (waveform)	1	input	Binary
D.C. Offset (fixed)	1	input	Binary
Mode Run, Gate, Trigger	2	inputs	Binary
Function (waveform)	4	inputs	Binary

SIZE

3 1/2" high x 17" wide (19" in rackmount) x 13 1/2" deep.
Rackmounting adapters supplied.

Power input requirements are 117 or 200 volts A.C.± 10% 50 - 400 Hz, other voltages availagle. 100, 200, 234 specify.

All instrument specifications apply after a 30 minute warmup time at 25°C± 5°C ambient temperature. To maintain specifications unit must be operated between 10% and 100% of maximum amplitude and frequency ranges.

3.2.0 VERIFICATION OF SPECIFICATIONS

The following is a list of test equipment required to validate the specifications of the Models 605 and 606 Programmable Waveform Generators. Test equipment of the accuracy equal to or better than the following list is acceptable for specification validation.

Oscilloscope, D.C. to 50 MHz (Tektronix Model 544)
Plug-In Differential Comparator 10 millivolts per centimeter sensitivity (Tektronix Type W)
Counter/Timer .1μ sec time base, DANA 8010B
DVM .01% Accuracy DANA 4300
Harmonic Distortion Analyzer less than .1% residual distortion (Hewlett Packard Model 333)
Spectrum Analyzer 10KHz to 100MHz (Nelson Ross plug-in for Type 544)

To proceed with verification of specifications, program the generator as follows: 800Hz on the 100 to 999Hz range, free running Normal phase sine wave of 8.00V P-P with no offset and the delta frequency control to CAL, Model 605 only. The Model 605 can be locally programmed for the same conditions.

3.2.1 FREQUENCY STABILITY

Connect the output of the generator to the frequency counter and observe that the frequency remains within .04% for ten minutes or ± .5μ sec time interval.

3.2.2 FREQUENCY ACCURACY

Frequency should be 800Hz within 1% + 1 digit or 809Hz to 791Hz.
Reprogram for 400Hz , frequency should be within 1% + 1 digit or 405Hz to 395Hz
Reprogram for 200Hz, frequency should be within 1% + 1 digit or 203Hz to 197Hz
Reprogram for 100Hz, frequency should be within 1% + 1 digit or 102Hz to 98Hz
Reprogram for 880Hz, frequency should be within 1% + 1 digit or 889.8Hz to 870.2Hz
Reprogram for 840Hz, frequency should be within 1% + 1 digit or 849.4Hz to 830.6Hz
Reprogram for 820Hz, frequency should be within 1% + 1 digit or 829.2Hz to 810.8Hz
Reprogram for 810Hz, frequency should be within 1% + 1 digit or 819.1Hz to 800.9Hz
Reprogram for 808Hz, frequency should be within 1% + 1 digit or 817.1Hz to 798.9Hz
Reprogram for 804Hz, frequency should be within 1% + 1 digit or 813Hz to 795Hz
Reprogram for 802Hz, frequency should be within 1% + 1 digit or 811Hz to 793Hz
Reprogram for 801Hz, frequency should be within 1% + 1 digit or 810Hz to 792Hz

Reprogram frequency for 800Hz, set Decade Multiplier to the bottom range, that is the 1 to 9.99mHz range. Verify the frequency as 8mHz ±2% + 1 digit or from 8.17mHz to 7.83mHz. Program up one range and verify the frequency as 80mHz ±1% + 1 digit or 80.9Hz to 79.1Hz. Program up one range and verify that the frequency is 800mHz ±1% + 1 digit or 809mHz to 791mHz. Program up one range and verify that the frequency is 8Hz ±1% + 1 digit or 8.09Hz to 7.91Hz. Program up one range and verify that the frequency is 80Hz ±1% + 1 digit or 80.9Hz to 79.1Hz. Program up one range and verify that the frequency is 800Hz ±1% + 1 digit or 809Hz to 791Hz. Program up one range and verify that the frequency is 8KHz ±1% + 1 digit or 8.09KHz to 7.91KHz. Program up one range and verify that the frequency is 80KHz ±1% + 1 digit or 80.9KHz to 7.91KHz. Program up one range and verify that the frequency is 800KHz ±2% + 1 digit or 817KHz to 783KHz.

3.2.3 AMPLITUDE ACCURACY (Note: Output must be properly terminated in 50.0Ω)

Reprogram generator for frequency of 800Hz and using comparison oscilloscope, check the amplitude accuracy at 8.00V P-P into 50.0Ω to be within ±1% + 1 digit or 8.09V to 7.91V. Reprogram output voltage for 4.00V and check that amplitude is within 1% ± 1 digit or 4.05V to 3.95V. Reprogram output voltage for 2.00V P-P and check to see that amplitude is within 1% ± 1 digit or 2.03V to 1.97V. Reprogram for 1.00V P-P output and check to see that amplitude is within 1% + 1 digit or 1.02V to .98V. Reprogram for output voltage of 8.80V P-P and check to see that amplitude is within 1% + 1 digit or 8.898V to 8.702V. Reprogram for 8.4V and check to see that output is within 1% + 1 digit or 8.494V to 8.306V. Reprogram for 8.20V P-P and check to see that amplitude is within 1% + 1 digit or 8.292V to 8.108V. Reprogram for 8.10V P-P and see that output amplitude is within 1% + 1 digit or 8.191V to 8.109V. Reprogram output voltage for 8.01V P-P and check to see that amplitude is within 1% + 1 digit or 8.10V to 7.92V. Reprogram output amplitude for 8.02V P-P and see that amplitude is within 1% + 1 digit or 811V to 793V. Reprogram for 8.04V P-P and see that amplitude is within 1% + 1 digit or 811V to 793V. Reprogram for 8.08V P-P and check to see that amplitude is within 1% + 1 digit or 8.171V to 7.989V. Return program to 8.00V P-P and program generator for frequency of 999KHz and check to see that amplitude is within 5% or 8.40V to 7.60V.

3.2.4 SINE FREQUENCY RESPONSE

Program generator for 9.99KHz sine wave of 8.00V P-P, measure amplitude accurately and record. Program generator for 99.9KHz sine wave and verify that amplitude is within .1db (1.14% or 90mv) of reading obtained at 9.99KHz. Program generator for frequency of 999KHz and measure amplitude to verify that it is within .5db (5.6% or 448mv) of the value obtained at 9.99KHz.

3.2.5 AMPLITUDE STABILITY

Program generator for frequency of 800Hz and an output amplitude of 8.00V P-P, measure amplitude and record and then again at ten minutes and check to see that amplitude is within .05% (4mv) of reading obtained previously.

3.2.6 SINE WAVE DISTORTION

Program generator for a sine wave output of 9.99V P-P at a frequency of 9.99KHz. Connect distortion analyzer to the main output jack and measure sine distortion of less than .5%. Reprogram generator for frequency of 99.9KHz and measure sine distortion of less than .5%. Reprogram generator for frequency of 999KHz. Connect Spectrum Analyzer to Main Output jack and measure harmonic content. Observe no harmonics less than 30db down.

3.2.7 SQUARE WAVEFORM

Program generator for 999KHz square wave positive or negative of 9.99V P-P. Connect main output through 50Ω coaxial cable terminated into 50Ω to the oscilloscope. Observe

3.2.7 (Continued)

rise time and fall time of square is less than 100ns between 10% to 90% points. Observe overshoot and ringing is less than 5% of P-P amplitude (.50V ringing or overshoot).

3.2.8 TRIANGLE LINEARITY (Refer figure 3.2.8)

Connect the Main Output to a differential plug-in with 50Ω coaxial cable terminated in 50Ω. Adjust oscilloscope to obtain one-half cycle triangle across horizontal grid on oscilloscope CRT. Set differential plug-in sensitivity to 20mv per centimeter. Adjust comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below.

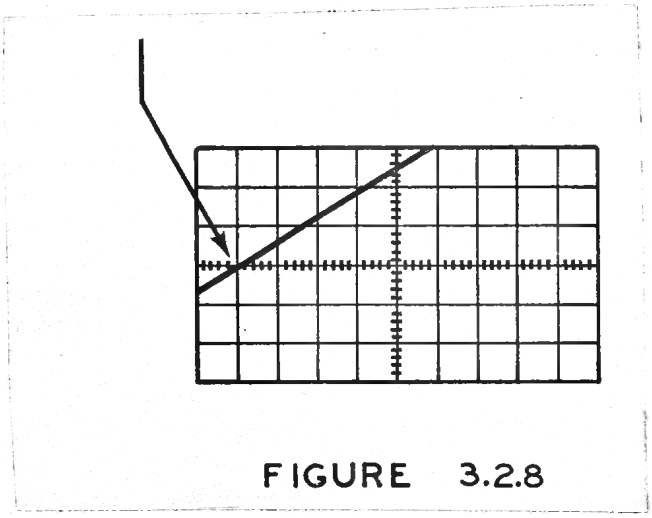


FIGURE 3.2.8

Record reference voltage using DVM accurate to 1mv. Adjust comparison voltage until slope of triangle intersects next major horizontal grid mark. Record accurately the new reference voltage. Repeat to obtain as many points as desired. Calculate linearity and observe linearity is 99% or better to 100KHz, 95% or better to 1.09MHz. Beware of oscilloscope inadequacies above 100KHz.

SECTION 4

OPERATING INSTRUCTIONS

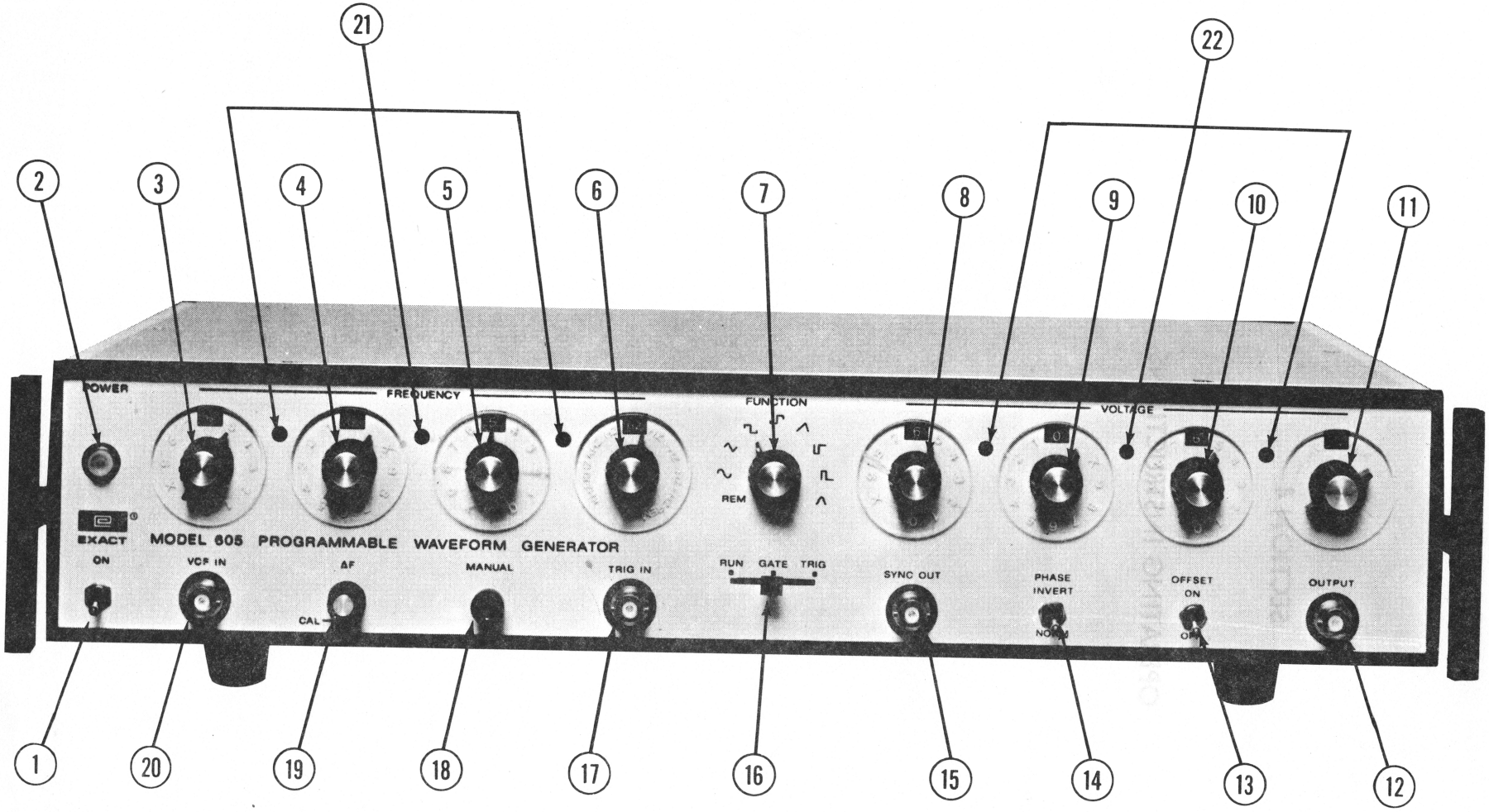


FIGURE 4.1.1
FRONT PANEL MODEL 605

4.1.0 FRONT PANEL FAMILIARITY (Figure 4.1.1)

1. Power On/Off switch - turns on input power to instrument.
2. Pilot Lamp - indicates input power On.
3. Frequency Multiplier - hundreds digit.
4. Frequency Multiplier - tens digit.
5. Frequency Multiplier - units digit.
6. Frequency Decade range selector - allows operation over nine decade frequency range.
7. Function selector - selects waveform to appear at the output connectors.
8. Voltage Multiplier - hundreds digit.
9. Voltage Multiplier - tens digit.
10. Voltage Multiplier - units digit.
11. Voltage Decade range selector - allows operation over four decade voltage range.
12. Output connector - allows 50Ω output impedance for generated waveform.
13. Offset control - decreases program waveform to 1/2 programmed amplitude and offsets same to a level equal to its peak amplitude so that one peak is maintained at 0 volts.
14. Phase control - provides for 180 degree phase inversion of output waveform.
15. Sync output connector - provides square waveform for synchronizing other equipment to the generator.
16. Trigger mode control - selects free running, gated, or triggered operation.
17. Trigger input connector - accepts gating or trigger signals.
18. Manual Trigger control - allows manual gating or triggering of generator.
19. Delta Frequency control - allows vernier adjustment of frequency.
20. VCF input connector - accepts analog voltage for control of generated frequency.
21. Automatic decimal point indicators - operated by the Frequency Decade range control.
22. Automatic decimal point indicators - operated by the Voltage Decade range control.

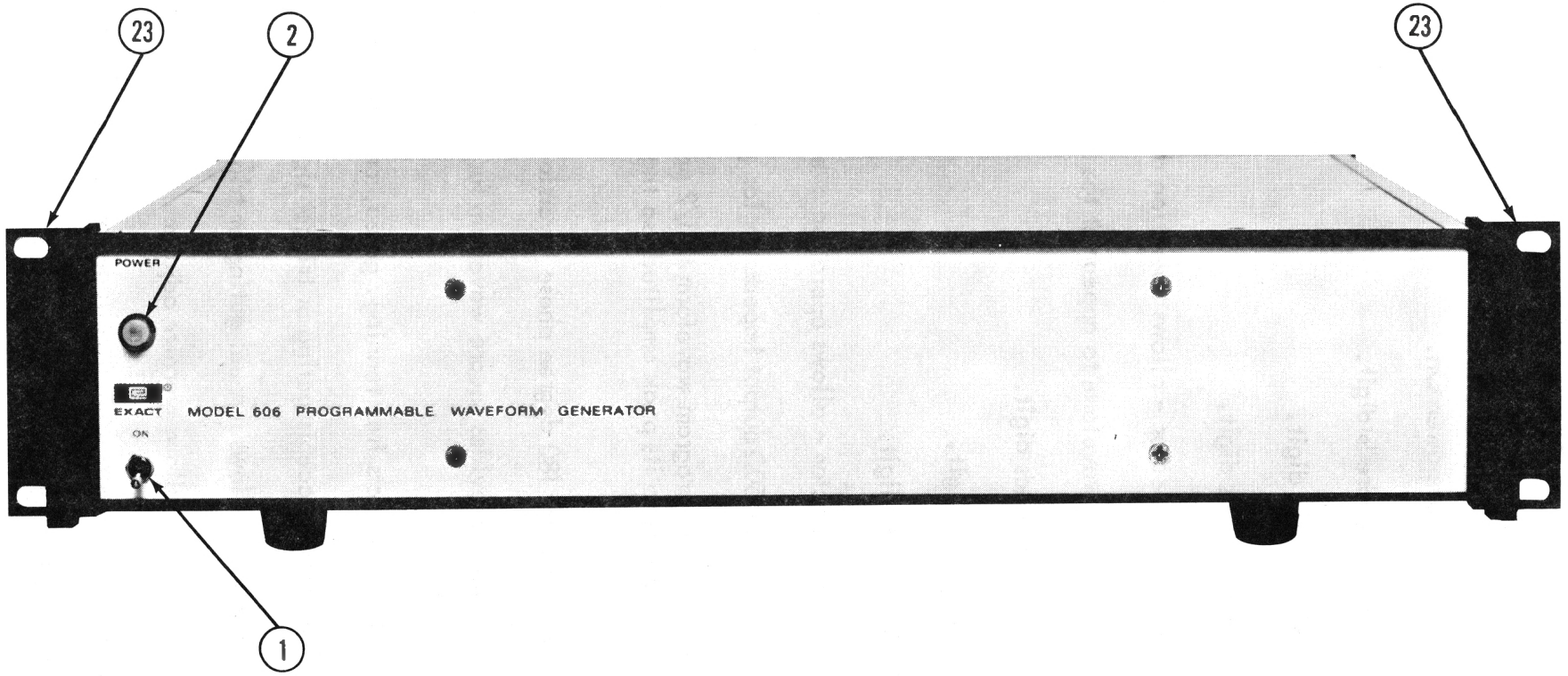


FIGURE 4.1.2
FRONT PANEL MODEL 606

4.1.2 FRONT PANEL FAMILIARITY (Figure 4.1.2)

1. Power On/Off switch - turns on input power to instrument.
2. Pilot Lamp - indicates input power On.
3. Rack mounting - standard equipment.

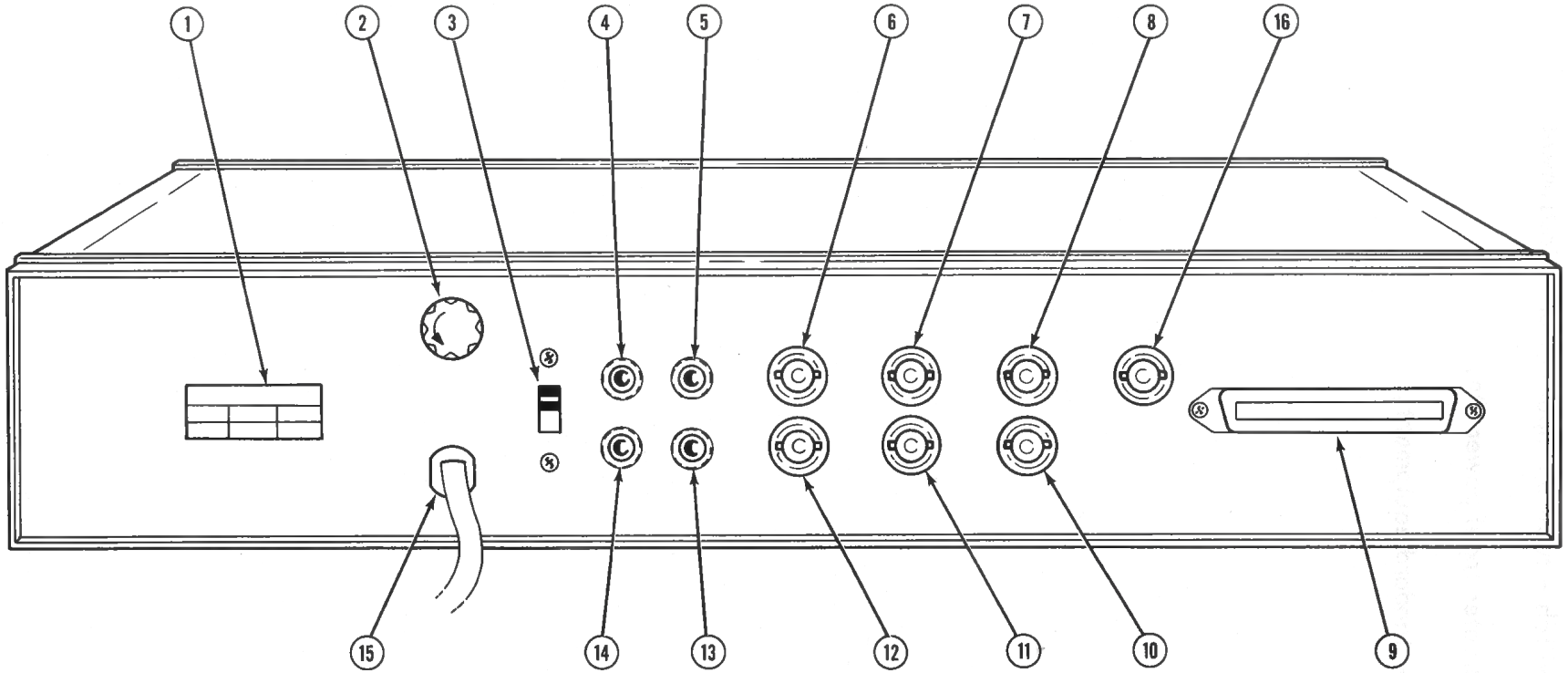


FIGURE 4.2.1
REAR PANEL MODEL 605-606

4.2.0 REAR PANEL FAMILIARITY (Refer figure 4.2.1)

1. Fuse data chart - shows requirements for operation at 115 or 220 volts.
2. Fuse holder - allows easy replacement in the event of fuse failure.
3. Line voltage selector - allows instrument operation from 110 or 220 volts AC.
4. Circuit Common connection - allows floating Circuit Common operation of instrument.
5. Programming Common connection - allows floating operation of the Programming circuitry.
6. Output connector - main output of generator.
7. DC Offset input connector - accepts external analog signal for programming D.C. offset.
8. Sync output connector - provides signal for synchronizing other equipment such as oscilloscopes, etc.
9. Programming input connector - accepts program inputs for remote control of the generator.
10. Trigger input connector - accepts input signals for gating or triggering of generator.
11. VCF input connector - accepts wideband AC or DC input for analog programming of generator frequency.
12. Triangle Monitor connector - provides constant monitor of triangle or ramp waveform generated in the instrument.
13. Chassis ground connection - provides for grounding of program common.
14. Chassis ground connection - provides for grounding of circuit common.
15. Line cord - accepts input power of the instrument.
16. Phase lock - accepts input synchronizing signal.

4.3.0 PROGRAMMING REQUIREMENTS

The circuitry at the programming inputs consists of a single transistor with a diode switching bridge on the base input.

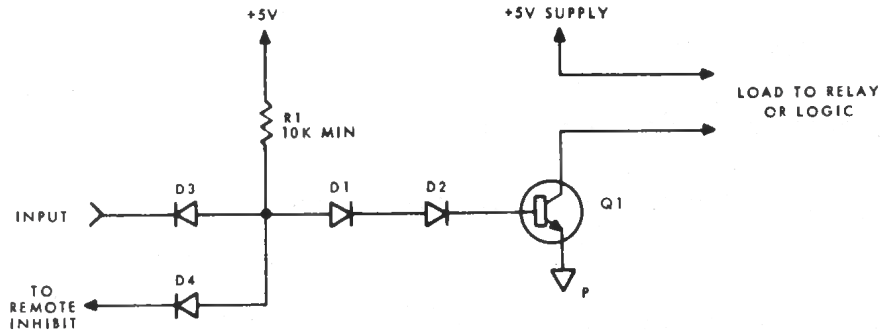


FIGURE 4.3.1

The transistor Q1 is used as a saturated switch for operation of reed relays and also as direct input for the TTL logic in the instrument. Resistor R1 provides the necessary base current for transistor Q1 through diodes D1 and D2. As either the input or the remote/inhibit bus is held low (programming ground or up to -50V), the current supplied from R1 is shunted out through the input diode D3 and D4. Without base current for Q1, collector current does not flow, and the relay or logic system is not energized. As the input is held positive (above 1.4V nominal), current from R1 begins to flow through D1 and D2 turning on Q1's collector current and activating its relay or logic circuitry. Some of the possible combinations of circuitry that can be used to operate the inputs are contact closure, DTL, TTL, direct voltage application and etc. One requirement of programming sources is that it must be capable of holding the low level state while sinking the 1 milliamp (nominal) of current being supplied by R1 (refer figure as previous). Maximum value of resistance to hold the input to a low stage should be 1.6KΩ.

An almost limitless list of combinations exists with the inputs' capability of handling ±50V DC and the switch point being at +1.2V nominal, in reference to the programming common. Some combinations are shown below:

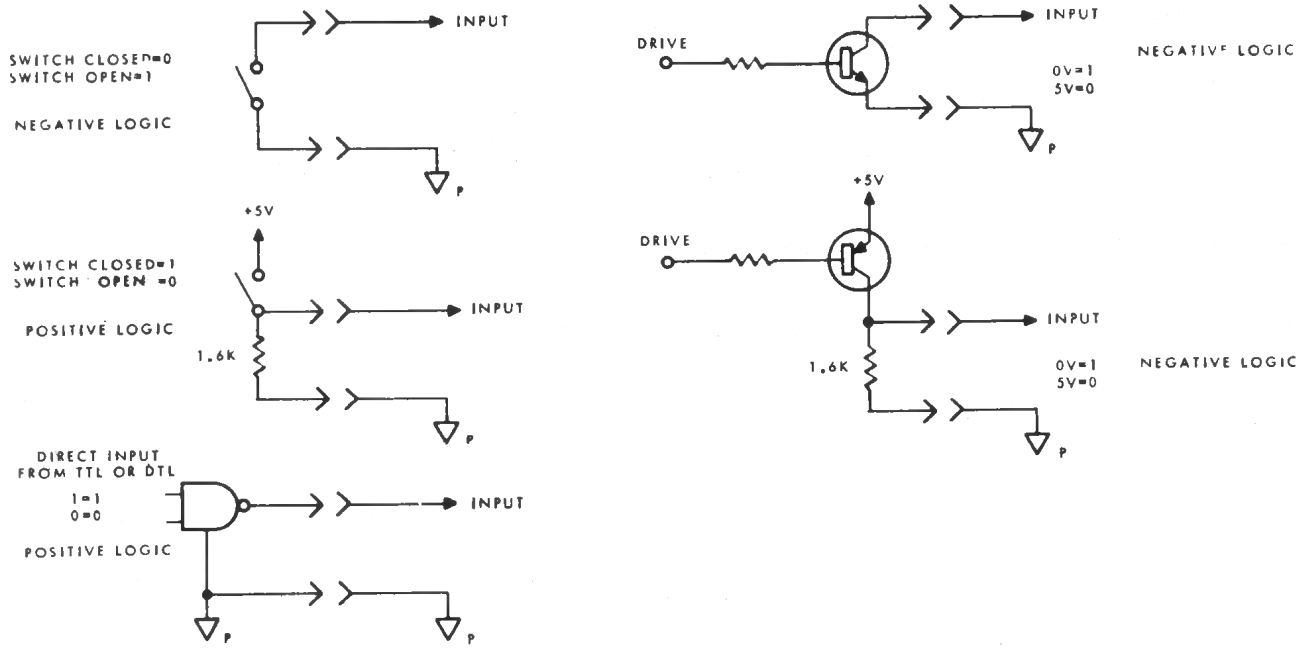


FIGURE 4.3.2

4.4.0 PROGRAMMING TABLES

The Models 605 and 606 have thirty-eight active inputs for programming output waveforms. With a logical "0" being defined as +.4V or less and logical "1" being defined as +2.4V or more, a truth table can be shown for generator control in response to logical "0's" and "1's". In the Model 605, the inputs and controls are grouped into three groups so that any one of the three groups can be controlled remotely or locally. Any group can be operated in either control mode without affecting the others. The three groups are as follows: frequency, function (includes trigger mode, invert and offset), and voltage. Of the three groups, "frequency" has a total of sixteen external inputs. "Function" has eight inputs and "voltage" has fourteen inputs.

4.4.1 Of the sixteen inputs listed under "Frequency", four are used to control the decade range and twelve are used to control the multiplier.

The decoding for the decade range is as follows:

Decimal Eq.	Pin Number for Programming Input Connector 43	42	41	40	Frequency Range
0	0	0	0	0	1 - 10 mHz
1	0	0	0	1	10 - 100 mHz
2	0	0	1	0	100 - 1000 mHz
3	0	0	1	1	1 - 10 Hz
4	0	1	0	0	10 - 100 Hz
5	0	1	0	1	100 - 1000 Hz
6	0	1	1	0	1 - 10 KHz
7	0	1	1	1	10 - 100 KHz
8	1	0	0	0	100 - 1000 KHz
Binary Weight	8	4	2	1	

Binary weight and decimal equivalents apply to standard 1-2-4-8 BCD or straight binary only.

4.4.1 (Continued)

The decoding for the multiplier is as follows:

Decimal Eq.	Pin Number Program Input Connector 28	29	30	31		32	33	34	35		36	37	38	39
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	1	10	0	0	0	1	1	0	0	0	1
200	0	0	1	0	20	0	0	1	0	2	0	0	1	0
300	0	0	1	1	30	0	0	1	1	3	0	0	1	1
400	0	1	0	0	40	0	1	0	0	4	0	1	0	0
500	0	1	0	1	50	0	1	0	1	5	0	1	0	1
600	0	1	1	0	60	0	1	1	0	6	0	1	1	0
700	0	1	1	1	70	0	1	1	1	7	0	1	1	1
800	1	0	0	0	80	1	0	0	0	8	1	0	0	0
900	1	0	0	1	90	1	0	0	1	9	1	0	0	1
X00	1	0	1	0	X0	1	0	1	0	X	1	0	1	0
Binary Weight	8	4	2	1		8	4	2	1		8	4	2	1

Binary weight and decimal equivalent apply to standard 1248 BCD codes only.

4.4.2 The eight inputs used to program functions can be broken down into several groups, some of which have only a single function as compared to others which are used in a sequence. The groups are trigger mode control (two inputs), polarity inversion (one input), fixed offset (one input), and waveform (four inputs).

4.4.2 (Continued)

The decoding table for the trigger mode control is as follows:

Decimal Eq.	Pin Number of Program Input Connector 27	26	
0	0	0	Inhibit External Triggering (Avail. as Option)
1	0	1	Trigger
2	1	0	Gate
3	1	1	Run
Binary Weight	2	1	

The decoding for the polarity inversion input is as follows:

Decimal Eq.	Pin Number of Program Input Connector 5	
0	0	Normal Output Polarity
1	1	Inverted Output
Binary Weight	1	

The decoding for the fixed offset input is as follows:

Decimal Eq.	Pin Number of Program Input Connector 3	
0	0	Fixed Offset
1	1	Normal Waveform
Binary Weight	1	

4.4.2 (Continued)

Decoding for the waveform inputs is as follows:

Decimal Eq.	Pin Number of Program Input Connector 4	44	1	2	
8	1	0	0	0	Sine
9	1	0	0	1	Triangle
10	1	0	1	0	Normal Square
11	1	0	1	1	INV Square
14	1	1	1	0	INV Pulse
15	1	1	1	1	Normal Pulse
0	0	0	0	0	90 Degree Sine
5	0	1	0	1	Ramp
Binary Weight	8	4	2	1	

4.4.2 (Continued)

The decoding table for the "voltage" multiplier is as follows:

Decimal Eq.	Pin Number Program Input Connector 6	7	8	9		10	11	12	13		14	15	16	17
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	1	10	0	0	0	1	1	0	0	0	1
200	0	0	1	0	20	0	0	1	0	2	0	0	1	0
300	0	0	1	1	30	0	0	1	1	3	0	0	1	1
400	0	1	0	0	40	0	1	0	0	4	0	1	0	0
500	0	1	0	1	50	0	1	0	1	5	0	1	0	1
600	0	1	1	0	60	0	1	1	0	6	0	1	1	0
700	0	1	1	1	70	0	1	1	1	7	0	1	1	1
800	1	0	0	0	80	1	0	0	0	8	1	0	0	0
900	1	0	0	1	90	1	0	0	1	9	1	0	0	1
X00	1	0	1	0	X0	1	0	1	0	X	1	0	1	0
Binary Weight	8	4	2	1		8	4	2	1		8	4	2	1

Binary weight and decimal equivalent apply to standard 1248 BCD codes only.

The decoding for the "Voltage Decade" is as follows

Decimal Eq.	Pin Number of Prog. Input 19	18	
0	0	0	1-10mv
1	0	1	10-100mv
2	1	0	100-1000mv
3	1	1	1-10V
Binary Weight	2	1	

4.4.3 Pin #50 of the program input connector is the common return for all programming input connections. Pin #25 of the program input connector is a supply of +5V suitable for supplying logical "1's" to inputs held low with resistors.

4.4.4 Representative program might be as follows: generate a free running 925Hz inverted triangle (no offset) at 678mv P-P.

Frequency Group

	Pin Number Program Input Connector															
	28	29	30	31	32	33	34	35	36	37	38	39	43	42	41	40
Binary Weight	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
Necessary Input	1	0	0	1	0	0	1	0	0	1	0	1	0	1	1	0
Actual Output		9				2				5			X 100 to 1000Hz Range = 925Hz			

Function Group

	Pin Number of Program Input Connector							
	27	26	5	3	4	44	1	2
Binary Weight	2	1	1	1	8	4	2	1
Necessary Input	1	1	1	1	1	0	0	1
	Run		Inv.	No Offset		Triangle		

Voltage Group

	Pin Number of Input Connector															
	18	19	6	7	8	9	10	11	12	13	14	15	16	17		
Binary Weight	2	1	8	4	2	1	8	4	2	1	8	4	2	1		
Necessary Input	1	0	0	1	1	0	0	1	1	1	1	0	0	0		
Actual Output	100-1000mv Range		X	6			7				8 = 678mv					

In the Model 605, it is necessary to set the frequency decade control, the function selector, and voltage to the Remote position for complete remote programming as is the foregoing.

4.4.5 LOCAL OPERATION, MODEL 605

In order to generate the free-running 925Hz inverted triangle with no offset at 678mv P-P (as in the previous example), it is necessary to preset the control knobs as follows: With the power switch on, preset the frequency multiplier to the digits 925 as indicated in the program and rotate the decade selector until the automatic decimal point indicates that you have selected 925Hz. Select Triangle on the function selector and also set the phase switch to the Inverted position. Preset the trigger mode selector to Run for free-running waveform. Next it is necessary to select the digits 6, 7 and 8 on the voltage multiplier and then rotate the voltage decade selector until the automatic decimal indicator indicates that you have selected 678mv. Monitoring the output connector at this point and time should verify that indeed you have generated the required waveform as set forth in the program.

SECTION 5

CIRCUIT DESCRIPTION

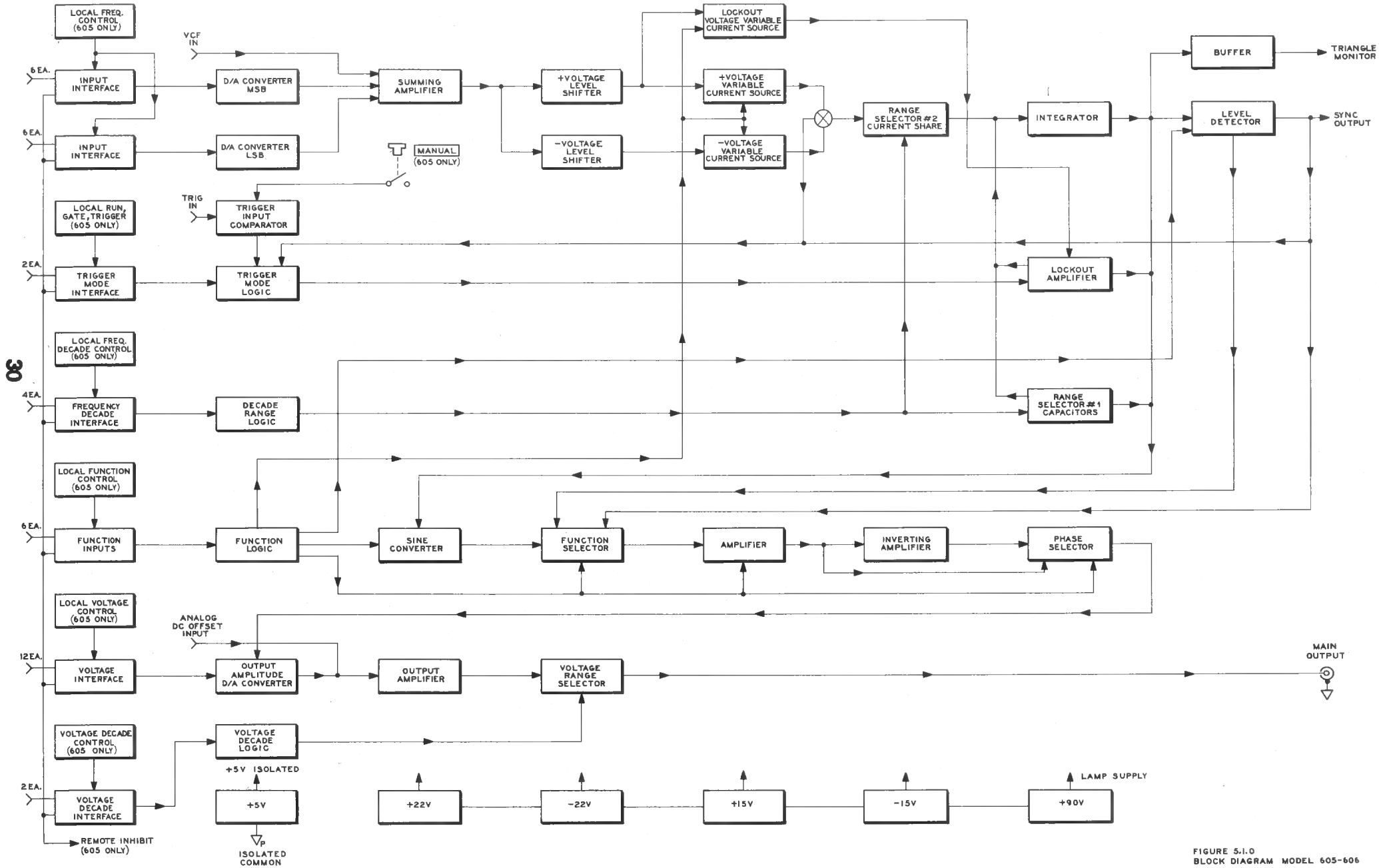


FIGURE 5.1.0
BLOCK DIAGRAM MODEL 605-606
11-18-70

5.1.0 BLOCK DIAGRAM (Refer Figure 5.1.0)

The basic generator loop utilized in this generator is an operational integrator and a bi-stable level detector. The bi-stable level detector switches integrator input currents at predetermined points on the integrator output. The loop generates a constant amplitude triangle whose frequency is proportional to the integrator input current and integrator feedback capacitance. Decade values of frequency are selected by decade selection of feedback capacitance and for the lower ranges decade selection of current sharing network on the input of the integrator. Variable frequency adjustment is accomplished by having voltage variable current sources feeding into the current switch at the input of the integrator. These voltage variable current sources are in actuality operational current sources driven by two operational voltage level shifters which are driven by the single summing amplifier. The summing amplifier is used to provide an external analog programming of frequency (VCF) or it is used to sum the outputs of the two amplifiers used to provide the digital analog conversion. The digital to analog conversion is done in two sections so that each section can be operated at a higher current level and therefore neither one has to operate at extremely low current levels. D to A conversion is done through a series of relay closures providing different resistance value for each weighting of an input. The relay activation is provided by the interface circuitry which is a saturated transistor switch operated by an external input signal.

The basic generator loop (the integrator and level detector) by nature provides a triangular waveform and a square waveform that can be processed and used as output signals to provide two waveforms. The triangular wave can be processed through the sine converter and provide a sinusoidal waveform. All three of these waveforms then are supplied to the function selector which is controlled by the function logic circuitry. The function logic circuitry decodes the input of the six function inputs such that each waveform can be provided for a given input condition at the function inputs. The output of the function selector is applied to the amplifier which provides a constant output amplitude and at the same time provides for the offset half amplitude function. The output of this amplifier is fed to the phase selector and also the inverting amplifier. The output of the inverting amplifier is fed to the phase selector. Phase selector is controlled by the function logic so that either output phase from the main generator loop can be provided to the output amplifier. The output of the phase selector is fed to the output amplitude D to A converter. The output D to A converter is a series of relays and different values of input resistors for the output amplifier. These relays are activated by the output amplitude interface circuitry which is the input circuitry for the external programming. The output amplifier accepts the signals from the output D to A converter and converts them to output voltage for the voltage range selector. The output amplifier provides the power necessary for driving a 50Ω output impedance. Voltage range selector is a series of 20db attenuator pads. These attenuator pads are controlled by the voltage decade logic circuitry. The voltage decade logic circuitry decodes the inputs from the voltage decade interface for selection of the correct voltage range. The interface circuitry provides conditioning for the external programming input signals.

There are six power supplies in the Models 605 and 606; one of the power supplies being a +5V supply that is completely isolated from the other power supplies. The +5V supplies

5.1.0 (Continued)

all the logic circuitry and interface circuitry associated with the external programming. The +22 and -22 supplies are used to provide voltage for the current sources and the output amplifier. The +15 and -15 are re-regulated from the +22V and -22V. They are used to provide operating voltages for other circuitry in the generator loop. +90V supply is used to power the pilot lamps and the automatic decimal point lamps in the instruments.

5.2.0 POWER SUPPLY (Refer Figure 8.2.1)

The power line voltage is fed to the instrument through Plug P100 to the protective fuse F100. The line switch S100 supplies line voltage to the operating voltage selector S101. S101 applies the voltage to the transformer in either a series or parallel arrangement depending on the line voltage available. The transformer T100 is used to step down the voltages to lower values for application to the rectifier filter combinations in the instrument. Diodes D100 and D105 in combination with capacitors C101 provide an unregulated voltage of approximately 9.8V to supply the integrated circuit regulator Q100. Q100 is a complete power supply inside an integrated circuit package. It contains its own reference, voltage supply, and error amplifier. Q105 is an external series pass transistor used to enhance the current carrying capabilities of Q100. R105 is a current sensing resistor used to supply current limiting voltages to the integrated circuit Q100. Resistive divider R100, R101 and R102 is used to provide the necessary feedback voltage to the error amplifier inside Q100. R101 provides for a small adjustment in the value of the output voltage. Diode D105 prevents any external application of negative voltage to any of the circuitry on the +5V programming power supply lines.

With all of the TTL logic and logic interface circuitry, etc. connected to the +5V power supply, an overvoltage would be somewhat catastrophic; therefore, a completely passive "Crowbar" circuit has been installed. Any overvoltage on the +5V power supply line in excess of 10% will cause Q115, a silicon control rectifier, to conduct and remain conducting until the overvoltage has been corrected. The power switch must be turned off and then on again to restore operation. SCR Q115 receives its gate current drive from transistor Q110. Transistor Q110 is operated as a saturated switch. It gets its base drive from tunnel diode D110. Tunnel diode D110 is biased near its peak point current by resistor R111 and adjustment R112. Resistor R110 is used to increase the amount of voltage drop across the base emitter junction so that it is adequate to turn on Q110. The programming supply +5V and its common are isolated from instrument common and also from line ground or chassis ground. If needed, these connections can be made through rear panel jacks J102 and J103. Rear panel jacks J101 and J100 also provide connection of circuit common which is also isolated to chassis ground.

Full wave diode bridge D120 along with filter capacitors C120 and C140 provides approximately ±30V for the regulators that regulate to +22 and -22V. Integrated circuit Q120 is a power supply unit that contains its own reference error amplifier and etc. Transistor Q125 is used to enhance the current carrying capability of the integrated circuit. Resistor R125 provides the current sensing so that the integrated circuit can be used to provide current limiting. Feedback voltage for the error amplifier in the

5.2.0 (Continued)

integrated circuit is developed across voltage divider R126, R127 and R128. Adjustment R127 is used to provide a small amount of voltage adjustment for the +22V supply. Diode D125 provides protection against accidental applications of negative voltages to the +22V power supply line. The +22V supply is used as a reference for the discreet component regulator that generates the -22V. Divider R156, R157 and R158 applies this reference to the differential amplifier made up of transistors Q150 and Q155. The base of transistor Q150 is held at 0V by resistor R150. The output of the differential pair (which appears at the collector of Q150) is applied to the base of transistor Q140 through resistor R151. Capacitor C141 and resistor R142 are phase compensating networks for the regulator. The output of transistor Q140 is applied to resistor R145 which in turn is connected to the base of the series pass transistor Q145. The emitter of Q145 supplies the necessary output current through current sensing resistor R145 to the power supply output. Transistor Q160 is used to provide a feedback signal to the differential amplifier Q155 through diode D160. This turns power supply voltage off in the event of a current limit signal which is developed across R145. Feedback necessary for power supply operation is through resistor R158 which maintains the reference to Q155 at 0V when both the power supplies are equal and opposite. Adjustment R157 provides for small amount of adjustment in the output voltage of the -22V supply. Diode D160 prevents damage in the event of application of positive voltage to the -22V power supply line. To provide a very stable 15V supply, the +22V from regulator Q120 is applied to integrated circuit Q130 and is re-regulated. Q130 is a complete power supply in one integrated circuit; that is, it has its own reference, error amplifier, etc. Transistor Q135 is used to enhance the current carrying capabilities of the integrated circuit. Resistor R135 is a current sensing resistor used to provide current limit operation of the integrated circuit. Feedback necessary for closed loop operation is through resistive divider made up of R136, R137 and R138. Adjustment R137 is used to provide a small amount of variation in the value of the supply voltage obtained at +15V supply output. Diode D135 is used to prevent damage in the event of application of negative voltage to the +15V power supply line. Operational amplifier Q165 is used as an inverting amplifier with a gain of 1 to provide a negative 15V power supply that tracks very accurately the positive 15V power supply. Diode D165 is used to shift the level of the operational amplifier to a higher voltage for operation of the Darlington circuit made up of transistors Q170, Q175. The output of the series pass transistor Q175 is applied to the -15V line through current sensing resistor R175. Transistor Q180 is used to provide a feedback signal when current limit is reached. This feedback signal is applied to the input of the operational amplifier and reduces its output in the event of a current limit. Feedback necessary for closed loop operation is through R167, adjustment R166, and R165 to the +15V supply. Adjustment R166 is used to provide the small range of adjustment in the output voltage of the -15V supply. Diode D175 is used to prevent damage in the event of an application of the positive voltage to the -15V line. Diode D10, D11, D12 and D13, in conjunction with capacitor C10, are used to provide a supply of positive 90V DC. This supply is used to operate the instrument power on lamp and the automatic decimal point indicating lamps on the front panel of the Model 605.

5.3.0 GENERATOR LOOP CIRCUITRY (Refer Figure 8.2.2)

The integrator portion of the generator loop circuitry can best be described as an operational amplifier utilizing capacitors as feedback network, therefore can be termed an operational integrator. This operational amplifier has two signal paths, one covering the range DC to 100KHz and the other covering the range 100KHz and above. Transistor Q340 being a matched dual field effect transistor comprises the input circuitry for the low frequency path in the amplifier. This circuit is a differential amplifier whose outputs are applied to another differential amplifier made up of Q355, Q360. The voltage developed across voltage dividers R347 thru R351 and including R344 is used to offset the differential voltage between the two gate connections of the dual transistor Q340. The output of this second differential pair (the collector of transistor Q340) is applied to the base of one of the transistors used in the differential mixer (transistors Q365 and Q370). The input for the high frequency channel is transistor Q350. The signal from Q350 is applied to the other input of the differential mixer (the base of Q370). One polarity of output from the differential mixer (the collector of Q365) is applied to the base of Q375 through phase compensating network C365 and R366. Transistor Q375 inverts this signal and it becomes the same polarity as the opposite output of the differential mixer. These two signals are then connected together through bias diodes D375 and D370 and including resistor R370 to the output emitter followers transistors Q380 and Q385. The emitter followers Q380 and Q385 provide a very low value of output impedance for the operational amplifier. Diodes D371 and D376 provide short circuit protection for the output devices in this amplifier.

The feedback capacitors necessary to form the operational integrator from the operational amplifier is a matched set of capacitors C435A through C435E. For the higher ranges, a small variable capacitor with a parallel fixed capacitor (C436 and C437) is used. The input current for the integrator is applied to the current sharing networks. The current sharing networks are only used for the three lower ranges of the instrument. For all other ranges, a "short to summing junction relay" is turned on and the current is applied directly to the input of the operational integrator. Diodes D319A and B are a matched pair. Diodes D320A and B are also a matched pair. These four diodes are used to short the output of the integrator to the input and to lock out the Integrator-Level detector loop and stop operation of both. Diodes D315 and D316 are used to sink the current from the lock-out current source when it is not desired to lock out the integrator level detector loop. Differential pair Q315 and Q320 are used to control these diodes when the signal from the integrated circuit Q310 is present. Integrated circuit Q310 is wired as a flip-flop so that the generator can only be locked out after the level detector has changed states and the integrator is approaching zero volts. Either signal at the input to the integrated circuit Q310 (pins 1 and 2) can override the reset signal and provide for continuous running as when relay K302 is actuated or when gated through pin 1. Any command through the trigger input comparator is coupled through capacitor C303 and provides a short pulse to set the flip-flop and one cycle will be generated. When K301 is actuated and the input comparator is turned on, the generator continues to run as the flip-flop is held in that state. The flip-flop is allowed to reset after this gate signal is removed. The trigger comparator is an integrated circuit comparator with positive feedback applied

5.3.0 (Continued)

through R303 to R302. Diodes D301 and D300 protect the input of the integrated circuit comparator from large voltage swings possible at the input jack of the instrument. S304 provides a manual actuation of the input comparator so that an external voltage is not always needed to trigger or gate this generator. Diodes D302 and D303 provide the necessary operating voltages for the integrated circuit. Transistor Q305 provides the necessary 5V for operation of the Q310, the integrated circuit.

The level detector is a high-speed current mode switch whose input is differential pair Q395A and Q395B. This differential pair drives differential pair Q415 and Q430. The collectors of Q415 and Q430 are clamped by diodes. The collector output signals are also buffered by complimentary emitter followers Q405, Q410 for the collector of Q415, Q420 and Q425 for the collector of Q430. With the base of Q395B held at ground or zero volts, the switch point at the base of Q395A then becomes zero volts. The output of the integrator is fed through resistor R387 and high frequency peaking capacitors 385 and 386 to the base of the input transistor Q395A. Also connected to the input of the level detector is the switching bridge composed of diodes D390A, D390B, D391 and D392. The square signal present at the output of the complimentary emitter followers Q405 and Q410 then is applied to this switching bridge which selects either a positive or negative current to be fed to the input of the level detector. This forms the positive feedback necessary for bi-stable operation of the detector. The square wave signal that is applied to this switching bridge is also applied to the switching bridge at the input of the integrator that selects either positive or negative input current for the integrator. To analyze the operation of this detector one must assume that the output of the complimentary emitter follower Q405 and Q410 was at a positive state which selects a positive current for the level detector reference, and also a positive current for the integrator input. With this input, the output of the integrator is integrating in a negative direction. As the current through R387 (the input resistor to the level detector) reaches the same value as the current being supplied by R391 and R390 to the base of the input transistor Q395A, zero volts is reached and the level detector switches states to the other state which selects a negative input current for the integrator and a negative current through the switching bridge for the input of the level detector. In order that both polarities of the square wave are available for processing in the output amplifiers, the complimentary buffers Q420 and Q425 are provided. This buffer also provides a square wave for a synchronizing output signal.

5.4.0 D TO A CONVERTOR AND CURRENT SOURCES (Refer Figure 8.2.3)

In order to provide input current for the integrator and to provide voltage control of frequency, voltage variable current sources have been utilized. Diodes D281, D282, D283 and D280 form a switching bridge that allow the currents to be switched from negative to positive at the integrator input. The negative current source is applied to the integrator input at all times and the positive current source (which is of a value of 2 x the negative current source) can be switched on and the resultant current flow to the integrator input is equal and opposite to the value of the negative current

5.4.0 (Continued)

source. Operational amplifier Q275, transistor Q280 and transistor Q295 form an operational current source whose output is the collector of Q295 and the Drain of Q280. As the input voltage to the positive input of the operational amplifier is varied, the voltage across resistor R276 is varied. The current in the source of Q280 and the emitter of Q295 changes, varying the output of the current source. When K280 ramp reset relay is energized, resistor R280 is in the circuit and the current value of the current source is increased to approximately two times the normal value. This provides for a faster reset producing the 85 to 15 ramp-reset ratio. In order to provide level shifting and proper phase inversion for the correct polarity of drive signal, operational current source Q265 and Q270 has been provided. This current source shifts the level of the 0 to 4V available out of the summing amplifier to a +15 to +11V suitable for driving the Positive Current Source. In the same manner, operational current source Q245 (in conjunction with Field Effect Transistor Q250) provides a level shift to drive the negative current source. It takes the 0 to 4V available out of the summing amplifier and converts it from -15 to -11V suitable for input of the negative current source. The negative current source is an operational current source made up of integrated circuit Q255 and Field Effect Transistor Q260. Resistor R256 and adjustment R257 provide the operating current for transistor Q260 which is the output current of the current source. In the Triangle mode of operation, relay K260 is energized and resistor R260 and adjustment R261 are connected, increasing the value of current to maintain a symmetrical relationship for the triangle of 50% to 50%. Also being driven from the level shifted voltage generated by operational current source Q265 and transistor Q270 is the Lock-out current source which is comprised of integrated circuit Q285 and transistor Q290. This current source is used to supply a current to the lock-out diodes that is equal and opposite to the integrator input, thereby sinking all integrator input current and causing it to remain in a lock-out condition. In the Triangle mode of operation, relay K290 is energized and the value of the current output is controlled by parallel combination of resistor R293 (and its adjustment R292) and resistor R290 (and its adjustment R291).

Operational amplifier Q230 has been utilized as a summing amplifier to accept either signal from the D to A convertors or an external VCF input signal to drive the level shifting current sources. Relays K240, K241, K242 and K243 are used to provide a vernier adjustment for each decade range involving a different integrating capacitor. These relays switch in a very fine adjustment of the gain of the summing amplifier for each decade range. Balance adjustment R230 and its divider R231 through R233 is used to provide a balance for the offset voltage inherent in the integrated circuit operational amplifier. Frequency vernier adjustment R214 is also an input through summing resistor R213.

In order that no portion of the D to A convertor would have to operate at very low current level, it has been broken down into two sections with output weightings one decade apart. Operational amplifier Q205 has the highest weighting which is summed into the summing amplifier through R212. Operating at 1/10th the weighting is operational amplifier Q215 which is fed to the summing amplifier through resistor

5.4.0 (Continued)

R222. As each of the D to A convertor relays K185 and K203 is closed or opened, the output of the summing amplifier can be varied over its entire range with three digit resolution. Resistor R209 and adjustment R210 is used to provide frequency calibration. Resistor R219 and its adjustment R220 is also used to provide calibration at the low frequency end of the multiplier.

5.5.0 DECADE FREQUENCY CONTROL CIRCUIT (Refer figure 8.2.4)

The decade frequency control circuitry consists of the logic interface connections plus suitable decoding to convert a four-input BCD signal to eight lines for controlling the relays discussed previously in the generator loop circuitry. These relays control the current-sharing networks on the input of the integrator and the feedback capacitors for the integrator. The interface circuitry for the four external inputs that control the frequency decade consist of a NPN transistor used as a saturated switch and a diode switching bridge that supplies base current to the NPN transistor. Transistors Q525 through Q540 are the four saturated switches that comprise the four input BCD decade frequency control. The two diodes in series with the base lead of the transistor, for example diodes D526 and D525, provide noise immunity by increasing the amount of voltage required to saturate the NPN transistor. The two diodes D525 and D526, along with the base emitter drop of the transistor (Q525), raise the voltage required at the junction of the bias resistor R526 and the two series base diodes D525 and D526 to a potential of approximately 2.1V. At the input, such as pin 40, any voltage greater than +1.4V begins to reverse bias the input diode (D528) and the current flowing through it becomes 0 and all the current supplied by the bias resistor (R526) begins to flow through diodes D525 and D526, turning on transistor Q525. The same control over Q525 is exhibited by input diode D527. This diode is connected to the remote inhibit bus which holds the potential at the bias resistor and the transistor input point to less than .7V which does not allow the transistors to saturate. This effectively inhibits the action of all the remote inputs; therefore, it is dubbed remote inhibit bus. In the local control mode in the Model 605 only, the remote inhibit bus is held in a low state which deactivates all the external inputs and the transistors remain in an OFF condition. This allows the voltage at the collector load of the transistors to rise to the value of the positive supply voltage, providing a "one" input for integrated circuit Q550. Integrated circuit Q550 provides an "OR" function so that remote control in the Model 605 can be accomplished. The outputs of the four gates providing the four "OR" functions are fed to integrated circuit Q555. This integrated circuit provides a decimal output for a binary coded decimal input consisting of four inputs. Lamps I550 through I552 provide an automatic decimal point indication that allows direct reading of frequency from the front panel of the Model 605. The switch controlling these lamps is ganged with the decade frequency control switch. The bottom four ranges of the generator (the 1 millihertz to 1Hz range) share the same timing capacitor (the 10μfd capacitor) and utilize the current sharing networks to control the decade frequency. Therefore, these four lower signals are grouped together and fed to integrated circuit Q560 which controls the decoding in a manner that maintains the 10μfd capacitor connection while utilizing the current sharing networks for the different inputs

5.5.0 (Continued)

involved with the bottom four ranges. Integrated circuit Q565A, B and C control the current sharing network that utilizes the 2.15K resistor. Integrated circuits Q565D and Q570A and B control the current sharing network utilizing the 24.3K resistor. Integrated circuits Q575A and Q575D actuate the 10μfd trim relay which enables the variable resistor in the VCF summing amplifier. Q575B and Q575C activate the 10μfd relay. Q575A through D also provide a switching function for the CAL NORM switch. This switch defeats the 10μfd capacitor connection and the trim relay connection and instead actuates .01μfd relay and .01μfd trim relay so that timing of the lower frequency ranges of the instrument can be done at a higher frequency. Integrated circuit Q560A output signal actuates the short to summing junction relay, that is K320, which defeats all current sharing networks and allows full input current from the current sources to be applied to the integrator. The inverse of this signal, that is the 221Ω relay, is actuated by integrated circuits Q570C and Q570D which inverts signal from Q560A. Integrated circuit Q585A and B provide phase inversion necessary to drive integrated circuits Q580B and C, Q590B and C for actuation of the 1μfd relay and the .1μfd relay. Also activated at the same time is integrated circuit Q580A, Q580D, Q590A and Q590D. These integrated circuits control the trim relays associated with the timing capacitors relays. Q585D provides a phase inversion necessary for operation of Q595B, Q595D while at the same time providing for the actuation of the .01μfd relay when the CAL NORM switch has been switched to the CAL position. The output of an integrated circuit Q595B and Q595C directly drives the .01μfd relay K440. Q595A and Q595D are parallel to drive the .01μfd trim relay. Activation of the 910pf relay is accomplished by integrated circuits Q600B and Q600C which are operated in parallel and driven from integrated circuit Q585C which inverts the signal.

5.6.0 FREQUENCY MULTIPLIER CONTROL CIRCUIT (Refer figure 8.2.5)

In order to activate the relays associated with D to A convertor used to drive the voltage variable current sources, the interface networks consisting of the saturated transistors as shown in schematic diagram are utilized. Twelve transistors are provided to activate the twelve relays in the D to A convertor. These transistors receive their base bias current from the bias resistors such as R460. Diodes D462 and D461 are used to provide noise immunity by boosting the input voltage required to saturate the transistor to approximately 2.1V. Diodes such as D190 connected across the relay coils prevent over-voltage from appearing at the collector of the transistors due to the reactive kickback in the relay. Input diodes D463 and D464 provide input capabilities for either the remote inhibit bus or the external controlling input. As the remote inhibit bus is held at a low state, the current supplied by the base current supply resistor is shunted through diodes such as D463. This does not allow the voltage at the anode of D462 to rise to 2.1V and does not allow the transistor to be activated. When the remote inhibit bus is in a positive state or in a remote condition, the external input signal, such as through diode D466, then has complete control over the transistor switch. When the remote inhibit bus is held low, such as in a local control mode, then the relay is allowed to be actuated through diodes such as D460 to the front panel controls such as S460.

5.7.0 AMPLIFIER AND INVERTING AMPLIFIER CIRCUITS (Refer figure 8.2.6)

The amplifier and inverting amplifier circuitry consists of two high-performance wide-band operational amplifiers. One is used to provide summing and gain conditioning for the sine waveform generated by diode bridge network, the triangle waveform generated from the integrator output, and the square waveforms generated from the level detector outputs. The inputs to the amplifier are selected by function selector circuitry. The output from the integrator, being a constant amplitude due to the fact that it is controlled by the level detector, can be processed directly through a simple summing network to the operational amplifier. The triangle also is fed to a series of four diode bridges which are arranged so that they provide equal break points along the triangular waveform creating a sinusoidal function of very low distortion with an output of the proper amplitude necessary for conditioning in the amplifier circuitry. As the input voltage is raised to any one of these diode gridges, the output current from that same bridge begins to raise until it reaches the maximum value of current supplied by the resistor potentiometer combination and then it becomes a constant current source. Each bridge is turned on at a successively higher level and, therefore, provides a peak value of the combination of all four bridges for an output current at the peak of the triangle. The square waves from the level detector are processed through input relays and a switching bridge which provide a constant output current level. The complimentary emitter follower buffer circuit consisting of Q1200 and Q1205 provides a continuously monitored output of the triangular wave generated at the integrator. The output of this buffer circuit is applied directly to the rear output connector through the output resistor R1208. The sine offset relay is used to provide a current equal and opposite to the offset generated at the integrator output when the generator is operated in a 90 degree sine output mode. The offset relay K700 is used to provide the fixed DC offset when the offset control is actuated. Also actuated at the same time the offset control is actuated is relay K755 which parallels the operational amplifier feedback resistor with a resistor of an equal amount, reducing the gain to one-half the original value. The output of this amplifier circuitry is applied directly to the input of the inverting amplifier which is operated at a gain of 1. Being an operational amplifier, it provides 180 degree phase inversion giving then two phases for processing in the amplitude selector. These two operational amplifiers are nearly identical with two signal paths in each amplifier. One signal path covers frequencies from DC to approximately 100KHz and the other signal path processes frequencies above 100KHz. The input circuitry for the low frequency path is a differential pair consisting of Q710, a matched pair of silicon transistors. Resistive divider made up of R715 to R719 is used to compensate for the differences in the base emitter drops of these input transistors. The output of this differential pair and their collector load resistors R711 and R712 are applied to differential pair Q715 and Q725. Single-ended output appearing at the collector of Q715 of this differential pair is applied to a differential mixer made up of Q730 and Q740. This differential mixer mixes the low frequency signal path and the high frequency signal path. The input circuitry for the high frequency signal path flows through Junction Field Effect Transistor Q720 through capacitor C740 to the other input of the differential mixer Q740. The collector signal Q730 is fed to inverter transistor Q735 so that a complimentary signal of the same phase as the output of

5.7.0 (Continued)

collector Q740 is available for processing in the complimentary emitter follower buffer consisting of Q745 and Q750. Diodes D735 and D740, along with resistor R742, provide the quiescent bias voltages necessary for operation of the complimentary buffer Q745 and Q750. Diodes D745 and D750 provide short circuit protection in the event that the output of this amplifier were accidentally short circuited. The inverting amplifier operates in the same manner as the amplifier previously described and its circuitry is identical with the exception that the feedback components and the input resistors are of different value to provide the necessary gain of one. The output of the inverting amplifier is also fed to a phase selector called the invert relay so that either phase can be fed to the amplitude selector.

5.8.0 FUNCTION CONTROL CIRCUITRY (Refer figure 8.2.7)

Function control circuitry, as shown, consists of four different inputs and their input interface circuitry and the decoding logic necessary to operate the appropriate relays in the generator circuitry. Q610, Q995, Q975 and Q980 are the saturated switches and for a description of their operation refer to Section 5.6.0. The outputs of these saturated switches are fed to the decoding circuitry directly. Integrated circuit Q615D is used to invert the signal from the saturated switch Q610. The output of Q615D is used to drive the parallel combination of the integrated circuits Q620A and Q620D. This output in turn drives the relay K291. The parallel combination of integrated circuits Q615B and Q615C directly drives relay K260. The parallel combination of integrated circuits Q620 and Q620C directly drives relay K290. The logic involved with these three relays is such that the symmetry in the generator loop circuitry can be set for a 50% to 50% ratio or an 85% to 15% ratio. For local control in Model 605, switch decks S610D and S610E control this symmetry on the ramp functions and the pulse functions so that the ratio is 85-15 and all other functions so that the ratio is 50-50. Integrated circuits Q1005A and Q1005D receive their signals from a saturated switch Q995 and from the local control switch deck S610E in the Model 605. The outputs of these integrated circuits are used to directly drive the relays in the generator loop circuitry that create the 90 degree start point in the waveform as compared to the 0 degree start point. Integrated circuits Q1005B and Q1005C are used to provide the operating potentials for relay K677 which provides the offset necessary in the sine shaping network to provide the Haversine waveform, when the generator is programmed for a start level of 90 degrees as compared to the 0 degrees start level. Integrated circuits 1015A and 1015D receive the outputs of the saturated switch Q975. Integrated circuits Q1015 and Q1015C receive the outputs from saturated switch Q980. These integrated circuits also can receive the signals from the local control switch deck S610A and S610C. The outputs of these integrated circuits are decoded in a manner so as to provide the necessary switching of the relays to connect the sine shaper to the amplifier circuitry or the positive or negative square to the amplifier circuitry or the triangle, etc. Integrated circuit 1025A is used to drive relay K695. Integrated circuit 1025B is used to drive relay K702. This relay is used to provide offset current in the amplifier circuitry so that the ramp waveform, when processed at 0 degrees start level, can be used as a bipolar signal. Relay K695 is used to apply the output of the sine shaper bridges

5.8.0 (Continued)

to the amplifier circuitry. Integrated circuit Q1030B is used to drive the relay K675 from the outputs of both Q1015C and Q1015B. Relay K675 is used to apply the triangular signal from the integrator to the input of the sine shaping bridges. Integrated circuit Q1030A is used to drive relay K705 when activated from a signal from Q1015A and Q1015C. Relay K705 provides a triangular waveform for processing in the amplifier circuit. Integrated circuit Q1025B and Q1025C are parallel combination used to operate relay K935. Relay K935 supplies the inverting square to the square switching bridge. Integrated circuit Q1020A and Q1020D are parallel combination that operates K936. Relay K936 is used to provide the positive square to the square wave switching bridge. Integrated circuits Q1020B and Q1020C drives relay K937 which is used to apply the output of the square switching bridge to the input of the amplifier circuitry.

5.9.0 FUNCTION AND TRIGGER MODE CIRCUITRY (Refer figure 8.2.8)

The function and trigger mode circuitry, as shown in the schematic diagram, consists of four separate inputs and their saturated switches and necessary decoding logic to decode these signals to drive the phase control, offset control, and trigger mode control. Transistors Q985, Q990, Q630 and Q645 are the saturated switches used to process the incoming signals from the external programming source. The outputs of these saturated switches are used directly as inputs to the integrated circuits used to decode the input signal. Integrated circuit Q1000A and Q1000D are parallel combination used to drive relay K760. They also provide the necessary input for the local control of the Model 605 of the PHASE NORMAL INVERT switch. Integrated circuit Q1000D and Q1000C are parallel combination used to drive relay K761. These two relays are used to provide either one signal from the amplifier circuit to be processed in the amplitude selector or the output of the inverting amplifier to be processed in the amplitude selector. Integrated circuit Q1010B and Q1010C is a parallel combination used to drive relay K700. Integrated circuit Q1010B and C accepts the signal from saturated switch Q990 and from the local control of the Model 605 OFFSET switch. Integrated circuit Q1010A and Q1010D are used to operate relay K755. These two relays provide for selecting the offset signal applied to the amplifier circuitry through fixed bias resistor and also for reducing the gain of the amplifier circuitry by paralleling the feedback resistor of the operational amplifier. Integrated circuit Q635B accepts the signal from saturated switch Q630 or from the TRIGGER mode switch on the front panel of Model 605. The output of this integrated circuit is fed to integrated circuit Q640A and Q640B which operates relay K302. Relay K302 is a continuous run relay on the trigger circuitry. Integrated circuits Q635C and Q635D decode the two inputs and are capable of operating the optional relay K300. This relay is used to provide an inhibit signal to inhibit any trigger from operating the generator when activated. Integrated circuit Q635A accepts the signal from saturated switch Q645 or from the local control TRIGGER mode switch S630B. The output of this integrated circuit is fed to parallel combination of Q640C and Q640D which drives relay K301. Relay K301 is used to provide for either AC or DC coupling of the trigger comparator circuit so that a gated or a triggered mode of operation is available.

5.10.0 OUTPUT AMPLIFIER CIRCUITRY (Refer figure 8.2.9)

Output amplifier circuitry, as shown in the schematic diagram, consists of a wide-band high-performance operational amplifier capable of supplying large amounts of output current. The amplitude selector, as shown, consists of a series of input resistors to this operational amplifier that can be switched on and off providing a control with twelve binary bits. Relays K820 thru K842 operate as switches that can either apply the signal from the phase selector relays directly to the input resistors or leave the circuitry open so that no signal is applied to that resistor. In order that accuracy can be obtained, resistors of the most significant values are provided with an adjustment for gain trimming. Also available as an input to this output amplifier is the analog DC offset programming signal from the rear panel connection. This input is applied to the summing junction of the operational amplifier thru resistor R844. The operational amplifier consists of two signal paths, one covering the frequencies from DC to approximately 100KHz and the other processing the signals from 100KHz and above. These two signals are mixed together in a differential mixer and applied to the output buffers and from there to the decade voltage control circuitry. Dual Junction Field Effect Transistor Q850 accepts the DC to 100KHz input signals and applies them to differential pair Q860 and Q865. The output of this differential pair is taken in a single-ended manner and fed to one input of the differential mixer Q875. The frequencies above 100KHz are applied to the differential mixer through input transistor Q870 which is a high frequency Junction Field Effect Transistor. The output of differential mixer Q875 is fed to the inverter driver Q880. This transistor inverts a signal and increases the power level to a sufficient level to drive the output buffers. The output of Q885 which is one transistor of the differential mixer pair is applied directly to the output buffers. Quiescent operating bias voltages are developed thru the diode resistor combination of D880, D885 and R887. Transistors Q890 thru Q905 form a complimentary buffer circuit with each compliment being a parallel combination of two transistors. These transistors have heat sinks to maintain safe operation at the high power levels involved with the output circuitry of the generator. The feedback resistor from the output to the summing junction is R845 which is paralleled by a compensation capacitor combination C845 and C846. The decade voltage selector consists of a series of relays used to operate 20db pads so that the signal can be attenuated in ratios of 10:1 for each decade of output voltage selection. The parallel combination of R906, R907 and R908 provides the 50Ω output impedance for the output amplifier circuitry. All attenuator sections in the decade voltage selector provide the output impedance of 50Ω also. Therefore, it is necessary that the generator circuit also be operated into 50Ω to maintain amplitude accuracy, waveform quality, etc.

5.11.0 OUTPUT AMPLIFIER CONTROL CIRCUITRY (Refer figure 8.2.10)

The output amplifier control circuitry consists of a series of saturated switches that accept the external input commands and actuate the relays involved with the amplitude selector circuitry. These saturated switches operate in the same manner as previously discussed for input signal conditioning. The extra diode as D1040, D1045, etc., provide for a local control in the Model 605. This allows the switch to directly operate the relay when the saturated switch has been inactivated by the remote inhibit bus.

5.12.0 OUTPUT ATTENUATOR CONTROL CIRCUITRY (Refer figure 8.2.11)

The output attenuator control circuitry consists of two saturated switches for accepting the external input signals. The outputs of these saturated switches are fed to decoding logic so that four different ranges can be accommodated with only two inputs from an external source. The logic circuitry also provides for operation in a local control in the Model 605. Integrated circuits Q955A and B are parallel combination that accepts the input from Q945 and applies it directly to operate relay K916. Integrated circuit Q955C inverts the signal from saturated switch Q945 and applies it directly to integrated circuit Q960A and Q960D whose output is paralleled to operate relay K910. Integrated circuit Q955D is used to invert the signal from saturated switch Q950. The output of saturated switch Q950 is applied directly to the input of integrated circuit Q965B and Q965C. This integrated circuit directly drives relay K915. Q970A and D are paralleled for operation of K921. Q970B and C are also paralleled for operation of K925. Switch deck S955D is used to operate the automatic decimal point indicating lamps I955 and I957. These lamps allow the front panel controls to be read directly in output voltage.

SECTION 6

CALIBRATION PROCEDURE

6.1.0 EQUIPMENT REQUIRED

The following test equipment or suitable equivalents of known accuracy are required for complete calibration of the Models 605 and 606 Programmable Waveform Generators.

Adjustable line voltage transformer, Superior Powerstat or equivalent
Differential or digital voltmeter capable of resolving 1mv and 15V
Oscilloscope, D.C. through at least 50MHz bandwidth
Differential plug-in capable of resolving 1mv in 15V
Frequency and time interval counter
Distortion analyzer, Hewlett Packard 333A

6.2.0 INITIAL CONTROL SETTINGS

POWER switch	ON
FREQUENCY dials	800Hz
FUNCTION	TRIANGLE
VOLTAGE	8.00V
TRIGGER mode	RUN
PHASE	NORMAL
OFFSET	OFF
DELTA FREQUENCY (Model 605 Only)	CAL

6.3.0 CALIBRATION (Refer figure 6.3.1 and 6.3.2)

After a 30-minute warm-up time, the instrument is prepared for calibration.

1. Connect DVM or Differential Voltmeter to 22V test point and adjust 22V adjust for 22.0V ±10mv.

2. Connect DVM to -22V test point and adjust -22V adjust for 22.0V ±10mv.

3. Connect DVM to +15V test point and adjust the +15V adjust for +15.0V ±2mv.

4. Connect DVM to -15V test point and adjust the -15V adjust for -15.0V ±2mv.

5. CAUTION: The following adjustment is necessary only in cases of extreme mal-adjustment and/or catastrophic failure. The crowbar adjustment requires that the logic power supply +5V be over-voltaged to 5.5V and possible damage to the integrated circuits. Extreme caution must be exercised. To adjust the crow-bar, you must adjust the +5V adjust to a voltage of maximum or not greater than 5.5V. Upon achieving this, advance crowbar adjustment until the output wave-form from the instrument ceases. This indicates that the 5V power supply is crowbarred and you may now return the 5V adjustment to midscale. Turn instru-ment power switch OFF and then return to ON again. Instrument output wave-form should be restored. It is necessary to readjust the +5V power supply upon completion of this test at any time.

6.3.0 (Continued)

6. Connect DVM to TP117 and adjust the +5V adjust for 5.0V ±10mv.

7. Using adjustable line transformer, vary line voltage between 105V and 125V AC and probe each power supply in turn, checking regulation. ±22V supplies should regulate within 20mv. ±15V supplies should regulate within 2mv. +5V supply should regulate within 10mv.

8. Connect oscilloscope with differential plug-in to integrator output TP386. Monitor comparison voltage on the differential plug-in with Digital Voltmeter so that accuracy can be maintained to within 1mv. Adjust positive peak adjust for positive triangle peak of 5.00V ±2mv. Adjust negative peak adjust for negative peak of triangle to be 5.00V ±2mv.

9. Using DVM on most sensitive range, probe test point LSB. Adjust LSB balance adjust for 0V ±.1mv. NOTE: Use TP243 as ground point during these measurements.

10. Reset frequency dial to 000.Hz and connect DVM to test point MSB. Adjust MSB balance adjustment for 0.00V ±.1mv.

11. Connect DVM to rear side of R267 and adjust VCF balance control for a voltage reading of 0.00 ±.2mv.

12. Readjust frequency for a reading of 001Hz and note DVM reading as connected in previous adjustment. Connect DVM across R251 and adjust minus drive balance for the same voltage reading as obtained in the noted adjustment. Connect DVM across R270 and adjust plus drive balance adjust for same voltage reading as obtained in previous test.

13. Reprogram generator for frequency to 00XHz. Take reading across R270. Connect DVM across R276 and adjust positive current balance for new reading. Connect DVM across the combination of R256 and potentiometer R257. Adjust the negative current balance adjust for the same reading obtained in the positive current balance adjust.

14. Program generator for a positive pulse output. Connect frequency counter to the generator output and adjust the time interval of the output pulse by manipulating the generator frequency controls until a reading of 150.0µs is achieved. Switch counter from reading time interval to reading period of the pulse and adjust ramp time adjust for a reading of 1000µs.

15. Program generator for a positive square output and set counter to read time interval. Adjust the symmetry adjust until time symmetry can be obtained by reading both time intervals of the square signal.

16. Program generator for an 80.0KHz squarewave output signal. Connect counter to squarewave and read frequency. Adjust the 80F adjustment for 80.0KHz output

6.3.0 (Continued)

signal. Reprogram generator for 40.0KHz and adjust the 40F adjustment for 40.0KHz. Reprogram generator for 20.0KHz and adjust the 20F adjust for a 20.0KHz signal. Reprogram generator for 10.0KHz and adjust the 10F adjust for 10.0KHz signal. Reprogram generator for 08.KHz and adjust the 8F adjust for 8KHz output signal. Reprogram generator for 04.0KHz and adjust the 4F adjust for 4KHz output signal.

17. Reprogram generator for an 800KHz squarewave and adjust high frequency comp adjustment for 800.0KHz. Reprogram generator for a 100KHz squarewave and adjust the 80KHz adjust for 100.0KHz.

18. Reprogram generator for an 80.0KHz squarewave and readjust the 80F adjust for 80.0KHz. Readjust the 8F adjust for 8.0KHz.

19. Repeat steps 16 through 18 until a satisfactory adjustment has been achieved.

20. Reprogram generator for a frequency of 10.00KHz. Adjust the 10KHz adjust for 10.00KHz. Reprogram generator for 1000Hz. Adjust the 1000Hz adjust for 1000Hz. Reprogram generator for 100.0Hz. Adjust the 100Hz adjust for 100.0Hz. Reprogram generator for 10.00Hz and adjust the 10Hz adjust for 10.00Hz.

21. Reprogram generator for a frequency of 1000mHz. Adjust 1000mHz timing adjust for 1000mHz.

22. Adjust 10mHz symmetry adjust for a time symmetry.

23. Repeat steps 20 through 21 as needed.

24. With generator operating at 1000mHz, switch CAL NORM switch to CAL and record reading of frequency counter. Reprogram generator for a frequency of 100mHz and adjust 100mHz timing adjust for a frequency reading one decade lower than obtained in the CAL position at 1000mHz. Reprogram generator for a frequency of 10mHz and adjust frequency for one decade value lower than obtained in previous tests. Return CAL NORM switch to NORMAL.

25. Program generator for a 1000Hz triangle and monitor the output of the amplifier at R751. Adjust the balance adjust for triangle peaks to be within 2MV absolute value one another.

26. Program generator for sinewave output. Connect distortion analyzer to output and adjust sine input adjust for minimum sine distortion. Readjust distortion adjust 1, 2, 3, and 4 for minimum distortion. Interaction between adjustments may necessitate readjusting certain adjustments.

27. Program generator for an output voltage of 0.00V and adjust output amplitude balance for 0V ±5MV.

6.3.0 (Continued)

28. Reprogram generator for an output voltage of 8.00V sinewave. Adjust sine peaks A and B along with the gain adjust control for an output sinewave of 8V P-P ±2MV. Sine peak A and sine peak B adjustments are used to control the DC component.

29. Reprogram generator for a triangular wave output signal and adjust triangle amplitude adjust for triangle output amplitude of 8.00V P-P ±5MV.

30. Reprogram generator for a positive square output and adjust the + square adjust and - square adjust for an output amplitude of 8.00V P-P ±10MV.

31. Program generator for Offset function. Adjust Offset adjust for the negative peak value to be 0V ±10MV and adjust the Gain/2 adjust for the positive peak to be 4.0V ±10MV.

32. Program generator for an inverted phase output signal. Adjust the inverting gain adjust and the inverting balance adjust for 8V P-P ±10MV.

33. Program generator for an output voltage of 4.00V P-P and adjust the 40 adjust for 4.00V. Program generator for 2.00V output signal. Adjust 20 adjust for 2V. Program generator for 1.00V output level. Adjust 10 adjust for 1.00V. Program generator for .8V P-P output level. Adjust 8 adjust for .8V P-P. Program generator for .4V P-P. Adjust 4 adjust for .4V P-P output level.

34. Program generator for a ramp function at 8V P-P. Switch trigger mode to Gate. adjust the Ramp Offset Adjust so that the start level is at -4.00V ±10MV.

35. Reprogram for free running ramp and adjust L.O. Offset adjust for the negative peak of the ramp to be -4.00V ±10MV.

36. Reprogram generator for a Haversine waveform and adjust the Sine Offset adjust for minimum distortion.

37. Reprogram generator for ramp output in Gate mode and adjust the Ramp L.O. adjust for -4.00V ±10MV at the output.

38. Reprogram for triangle output in the Gate mode and adjust the Triangle L.O. adjust for 0V ±10MV.

39. Reprogram frequency multiplier for 010.Hz and adjust the X100 L.O. Balance for 0V ±10MV.

40. Reprogram generator for 999KHz squarewave and probe the amplifier at R751 and adjust the Comp adjust for minimum ringing and overshoot.

41. Probe the Inverting Amplifier at R811 and adjust the Inv Comp adjust for minimum ringing and overshoot.

6.3.0 (Continued)

42. Monitor output waveform and adjust the Output Comp adjust for minimum overshoot and ringing while also checking for minimum deviation of sine wave output amplitude.

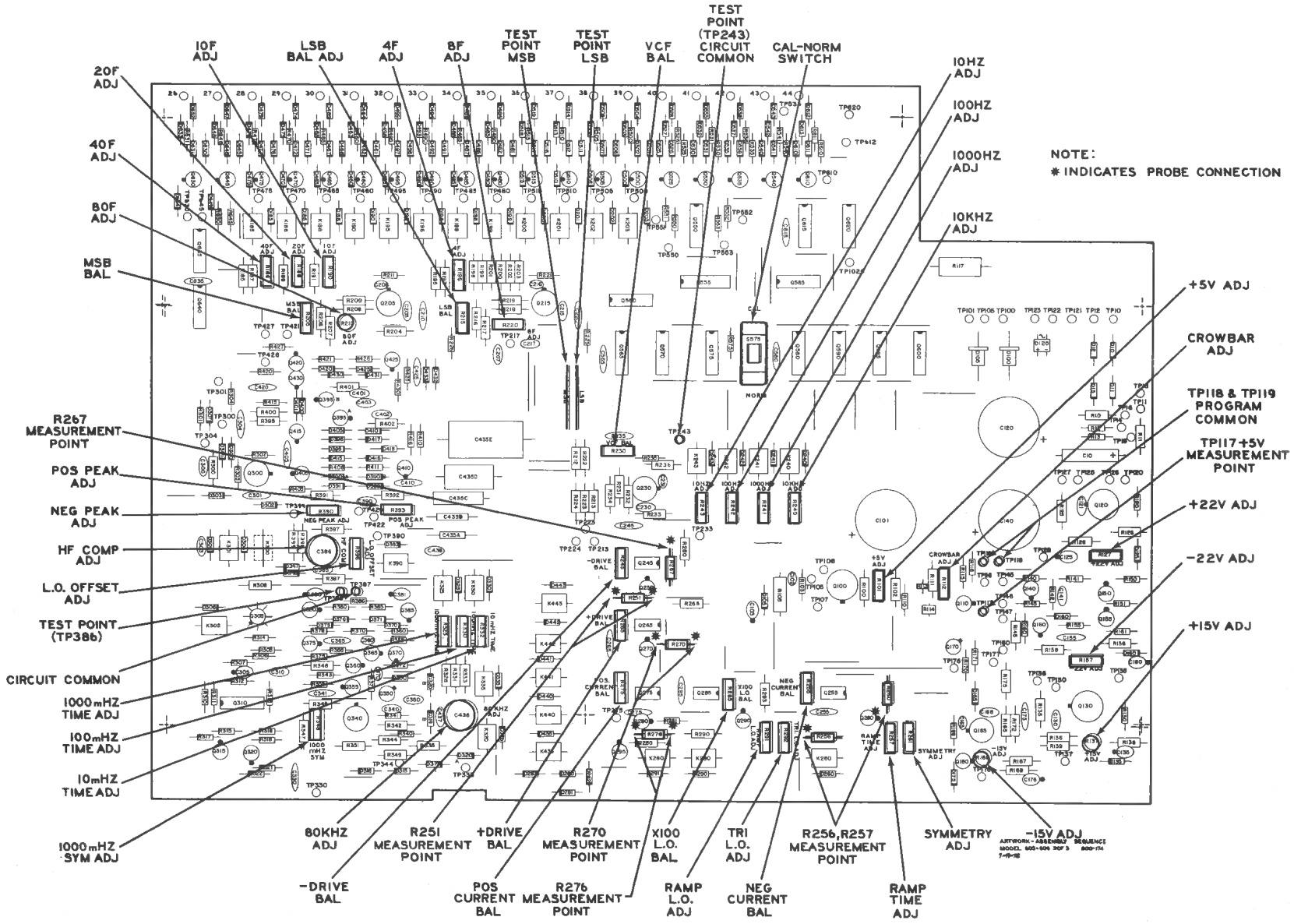


FIGURE 6.3.1 ADJUSTMENT LOCATION DETAIL

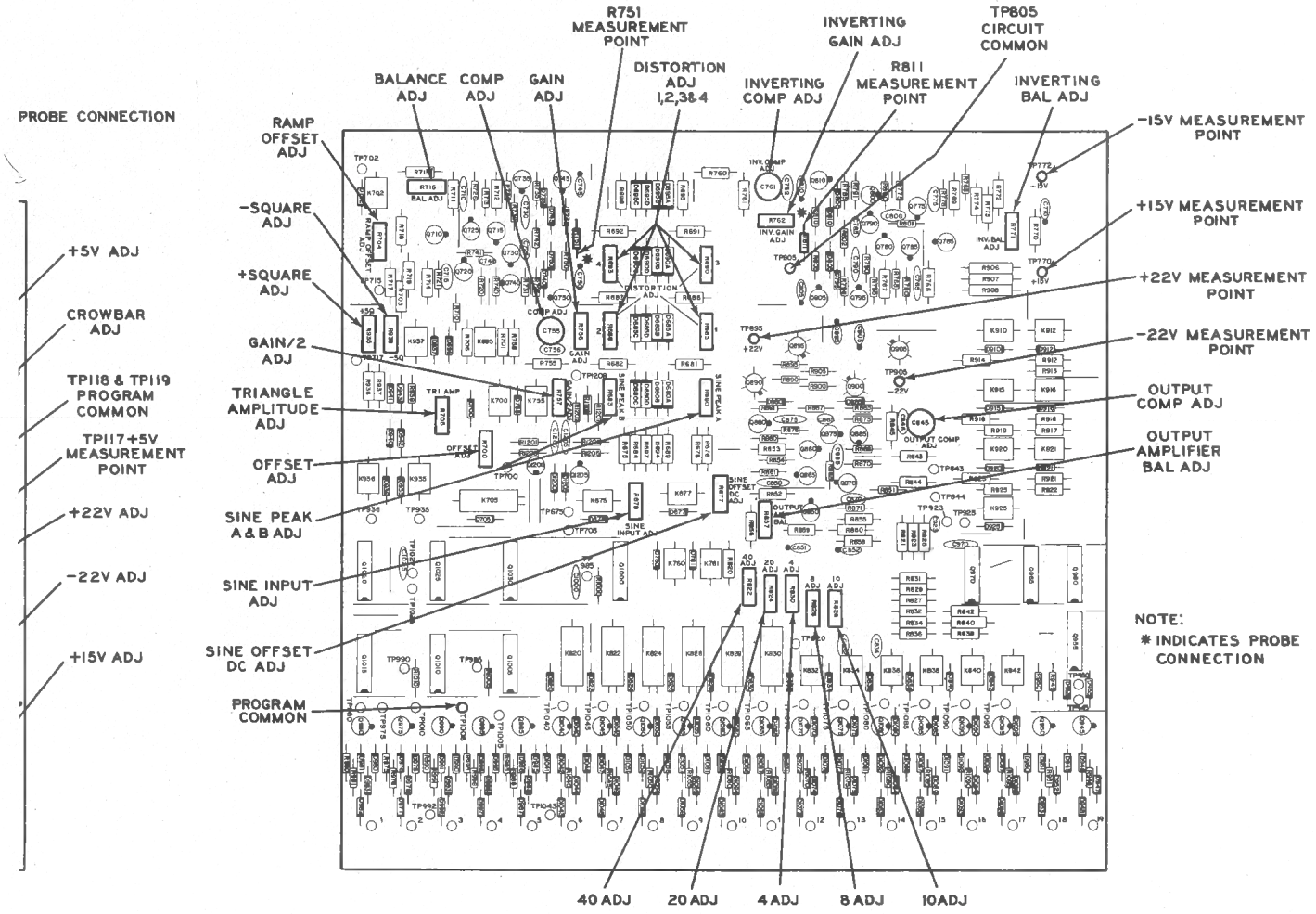


FIGURE 6.3.2 ADJUSTMENT LOCATION DETAIL

SECTION 7

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Sprgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidaire Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00915	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. Ordill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04272	Hi-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co. Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semicon. Prod.	Phoenix, Arizona
04732	Filtron Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire/Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bossick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	F.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst.Co.	Penacook, N.H.
06751	U.S. Semcor Div. of Nuclear Corp/Amer.	Phoenix, Ariz.
06812	Farrington Mfg.Co. West Div.	Van Nuys, Calif.
06813	Nutsville Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Bircher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elec. Co. Phoenix Div.	Phoenix, Ariz.
08792	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mal-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Aichm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10214	Gen. Trans. Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10597	Exact Electronics, Inc.	Hillsboro, Oreg.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	Gen'l Inst/Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Metabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Deven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Conoga Park, Calif.
17474	Tronex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electro Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesburn, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Muter Co.	Chicago, Illinois
43980	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
64294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorensen and Co., Inc.	S. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	West Inst. Div. Daystrom	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Altmetal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Illinois
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co, Inc.	Willimantic, Conn.
72619	Cota Coil, Co., Inc.	Providence, R.I.
72354	John E East and Company	Chicago, Illinois
72656	Dialight Corp.	Brooklyn, N.Y.
72699	General Ceramics Corp.	Keasbey, N.J.
72758	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72765	Girard-Hopkins	Oakland, Calif.
72825	Drake Mfg. Co.	Chicago, Illinois
72928	Hugh H. Eby, Inc.	Philadelphia, Pa.
72965	Gudeman Co.	Chicago, Illinois
72982	Robert M. Hadley Co.	Los Angeles, Calif.
73061	Erie Resistor Corp.	Erie, Pa.
73076	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	H. M. Harper Co.	Chicago, Illinois
	Helipot, Div. Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Phillips Co., Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.
74455	J. H. Winn and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littlefuse, Inc.	Des Plaines, Illinois
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77968	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Phoenix Manufacturing Co.	Chicago, Illinois
77252	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Assoc. Any brand tube meeting EIA standards.	Washington D.C.
80207	Unimax Switch, Div. of W L Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro, Div. Robershaw Fulton Controls Co.	Columbus, Ohio Columbus, Ohio
80486	All Star Products, Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co,	Norwalk, Conn.
81349	Military Specifications	.....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82142	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs. Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Nebr.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.
85474	R.M. Bracamonte and Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco
87664	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Tower Mfg. Co.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89462	Waldes Kohinoor, Inc.	Combridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia
91737	Gremar Mfg Co., Inc.	Wakefield, Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith, Inc.	Port Monmouth, N.J.
93929	G.V. Controls	Livingston, N.J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Comp. Div, Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lenco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methods Mfg. Co.	Chicago, Illinois
95712	Dage Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner, Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel brothers, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Sealectro Corp.	Mamaraneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div.	El Segundo, Calif
99800	Delevan Electronics Corp.	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
C0010	CAPACITOR, 5 UFD 150 VOLT	2900016	56289
C0100	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0101	CAPACITOR, 6500MFD 15V	2900049	853
C0102	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0103	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0105	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0110	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0111	CAPACITOR, 220PF MICA	2810555	853
C0120	CAPACITOR, 2500MFD 35V	2900034	853
C0121	CAPACITOR, 470PF MICA	2810539	853
C0125	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0130	CAPACITOR, 470PF MICA	2810539	853
C0135	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0140	CAPACITOR, 2500MFD 35V	2900034	853
C0141	CAPACITOR, 270PF MICA	2810540	853
C0155	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0160	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0165	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0166	CAPACITOR, 220PF MICA	2810555	853
C0175	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0176	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0205	CAPACITOR, 220PF MICA	2810555	853
C0206	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0207	CAPACITOR, 100PF MICA	2810537	853
C0210	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0215	CAPACITOR, 220PF MICA	2810555	853
C0216	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0220	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0230	CAPACITOR, 220PF MICA	2810555	853
C0231	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0235	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0245	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0255	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0265	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0275	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0285	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0300	CAPACITOR, 10PF MICA	2810529	853
C0301	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0302	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0303	CAPACITOR, 220PF MICA	2810555	853
C0304	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0304	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0305	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0310	CAPACITOR, 100PF MICA	2810537	853
C0330	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0340	CAPACITOR, 100PF MICA	2810537	853
C0341	CAPACITOR, 0,01 UF DISCAP	2830005	91418
C0350	CAPACITOR, 5PF MICA	2810501	853
C0360	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0365	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0370	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0380	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0381	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0385	CAPACITOR, 68PF MICA	2810523	853
C0386	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0390	CAPACITOR, 18PF MICA	2810552	14655
C0401	CAPACITOR, 68PF MICA	2810523	853
C0402	CAPACITOR, 3PF MICA	2810500	853
C0405	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0410	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0420	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0425	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0426	CAPACITOR, 47PF MICA	2810532	853
C0435	CAPACITOR, TIMING SET	2950004	10597
C0436	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0437	CAPACITOR, 82PF MICA	2810533	853
C0438	CAPACITOR, 10PF MICA	2810529	853
C0565	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0580	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0615	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0635	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0710	CAPACITOR, 0,01 UF DISCAP	2830005	91418
C0715	CAPACITOR, 220PF MICA	2810555	853
C0725	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0730	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0740	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0745	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0750	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0755	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0756	CAPACITOR, 5PF MICA	2810501	853
C0761	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0762	CAPACITOR, 5PF MICA	2810501	853
C0765	CAPACITOR, 0,01 UF DISCAP	2830005	91418
C0770	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0775	CAPACITOR, 220PF MICA	2810555	853
C0785	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0790	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0800	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0805	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0810	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0832	CAPACITOR, 5PF MICA	2810501	853
C0832	CAPACITOR, 5PF MICA	2810501	853
C0834	CAPACITOR, 5PF MICA	2810501	853
C0834	CAPACITOR, 5PF MICA	2810501	853
C0845	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0846	CAPACITOR, 5PF MICA	2810501	853
C0850	CAPACITOR, 0,01 UF DISCAP	2830005	91418
C0851	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0852	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0865	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0870	CAPACITOR, 220PF MICA	2810555	853
C0875	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0885	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0895	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0905	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0923	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0970	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1000	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1025	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1200	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1205	CAPACITOR, 0,05 UF DISCAP	2830010	91418
D0010	DIODE, 1N4005	1524005	4713
D0011	DIODE, 1N4005	1524005	4713
D0012	DIODE, 1N4005	1524005	4713
D0013	DIODE, 1N4005	1524005	4713
D0100	DIODE, 1N4719	1524719	4713
D0105	DIODE, 1N4719	1524719	4713
D0105	DIODE, 1N4001	1524001	1295
D0110	TUNNEL DIODE, 1N3716	1523716	3508
D0120	RECTIFIER BRIDGE, MDA920A	1520920	4713
D0125	DIODE, 1N4001	1524001	1295
D0135	DIODE, 1N4001	1524001	1295
D0160	DIODE, 1N914	1520914	7910
D0160	DIODE, 1N4001	1524001	1295
D0165	DIODE, 1N757	1520757	1295
D0175	DIODE, 1N4001	1524001	1295
D0185	DIODE, 1N914	1520914	7910
D0186	DIODE, 1N914	1520914	7910
D0188	DIODE, 1N914	1520914	7910
D0190	DIODE, 1N914	1520914	7910
D0195	DIODE, 1N914	1520914	7910
D0196	DIODE, 1N914	1520914	7910
D0198	DIODE, 1N914	1520914	7910
D0199	DIODE, 1N914	1520914	7910
D0200	DIODE, 1N914	1520914	7910
D0201	DIODE, 1N914	1520914	7910
D0202	DIODE, 1N914	1520914	7910
D0203	DIODE, 1N914	1520914	7910
D0240	DIODE, 1N914	1520914	7910
D0241	DIODE, 1N914	1520914	7910
D0242	DIODE, 1N914	1520914	7910
D0243	DIODE, 1N914	1520914	7910
D0260	DIODE, 1N914	1520914	7910
D0280	DIODE, 1N914	1520914	7910
D0281	DIODE, 1N914	1520914	7910
D0282	DIODE, CD1541	1521541	14655
D0283	DIODE, CD1541	1521541	14655
D0290	DIODE, 1N914	1520914	7910
D0291	DIODE, 1N914	1520914	7910
D0300	DIODE, 1N914	1520914	7910
D0301	DIODE, 1N914	1520914	7910
D0302	DIODE, 1N748	1520748	1295
D0303	DIODE, 1N757	1520757	1295
D0304	DIODE, 1N914	1520914	7910
D0305	DIODE, 1N914	1520914	7910
D0306	DIODE, 1N914	1520914	7910
D0307	DIODE, 1N914	1520914	7910
D0315	DIODE, 1N914	1520914	7910
D0316	DIODE, CD1541	1521541	14655
D0319	DIODES, MATCHED CD1541	1531541	10597
D0320	DIODE, SELECTED	1530016	10597
D0325	DIODE, 1N914	1520914	7910
D0326	DIODE, 1N914	1520914	7910
D0330	DIODE, 1N914	1520914	7910
D0335	DIODE, 1N914	1520914	7910
D0370	DIODE, 1N914	1520914	7910
D0371	DIODE, 1N914	1520914	7910
D0375	DIODE, 1N914	1520914	7910
D0376	DIODE, 1N914	1520914	7910
D0390	DIODE, SELECTED	1530016	10597
D0391	DIODE, 1N914	1520914	7910
D0392	DIODE, 1N914	1520914	7910
D0393	DIODE, 1N914	1520914	7910
D0395	DIODE, 1N914	1520914	7910
D0396	DIODE, 1N914	1520914	7910
D0400	DIODE, 1N914	1520914	7910
D0401	DIODE, 1N914	1520914	7910
D0405	DIODE, 1N914	1520914	7910
D0410	DIODE, 1N914	1520914	7910
D0415	DIODE, 1N914	1520914	7910
D0416	DIODE, 1N914	1520914	7910
D0417	DIODE, 1N914	1520914	7910
D0418	DIODE, 1N914	1520914	7910
D0420	DIODE, 1N914	1520914	7910
D0425	DIODE, 1N914	1520914	7910
D0430	DIODE, 1N914	1520914	7910
D0431	DIODE, 1N914	1520914	7910
D0432	DIODE, 1N914	1520914	7910
D0433	DIODE, 1N914	1520914	7910
D0435	DIODE, 1N914	1520914	7910
D0440	DIODE, 1N914	1520914	7910
D0441	DIODE, 1N914	1520914	7910
D0442	DIODE, 1N914	1520914	7910
D0443	DIODE, 1N914	1520914	7910
D0460	TO		
D0519	DIODE, 1N914	1520914	7910
D0525	TO		
D0543	DIODE, 1N914	1520914	7910
D0610	TO		
D0613	DIODE, 1N914	1520914	7910
D0630	TO		
D0633	DIODE, 1N914	1520914	7910
D0634	DIODE, 1N695	1520695	3877
D0645	TO		
D0648	DIODE, 1N914	1520914	7910
D0649	DIODE, 1N695	1520695	3877
D0675	DIODE, 1N914	1520914	7910
D0677	DIODE, 1N914	1520914	7910
D0680	DIODES, MATCHED SET 1N914	1530914	10597
D0685	DIODES, MATCHED SET 1N914	1530914	10597
D0690	DIODES, MATCHED SET 1N914	1530914	10597
D0695	DIODES, MATCHED SET 1N914	1530914	10597
D0696	DIODE, 1N914	1520914	7910
D0697	DIODE, 1N914	1520914	7910
D0700	DIODE, 1N914	1520914	7910
D0702	DIODE, 1N914	1520914	7910

PART	DESCRIPTION	EXACT NO	MFG
D0705	DIODE, 1N914	1520914	7910
D0735	DIODE, 1N914	1520914	7910
D0740	DIODE, 1N914	1520914	7910
D0745	DIODE, 1N914	1520914	7910
D0750	DIODE, 1N914	1520914	7910
D0755	DIODE, 1N914	1520914	7910
D0760	DIODE, 1N914	1520914	7910
D0761	DIODE, 1N914	1520914	7910
D0795	DIODE, 1N914	1520914	7910
D0800	DIODE, 1N914	1520914	7910
D0805	DIODE, 1N914	1520914	7910
D0810	DIODE, 1N914	1520914	7910
D0820	TO		
D0842	DIODE, 1N914	1520914	7910
D0880	DIODE, 1N914	1520914	7910
D0885	DIODE, 1N914	1520914	7910
D0925	DIODE, 1N914	1520914	7910
D0935	DIODE, 1N914	1520914	7910
D0936	DIODE, 1N914	1520914	7910
D0937	DIODE, 1N914	1520914	7910
D0940	DIODE, 1N914	1520914	7910
D0941	DIODE, 1N914	1520914	7910
D0942	DIODE, 1N914	1520914	7910
D0943	DIODE, 1N914	1520914	7910
D0945	DIODE, 1N914	1520914	7910
D0946	DIODE, 1N914	1520914	7910
D0947	DIODE, 1N914	1520914	7910
D0948	DIODE, 1N914	1520914	7910
D0950	DIODE, 1N914	1520914	7910
D0951	DIODE, 1N914	1520914	7910
D0952	DIODE, 1N914	1520914	7910
D0953	DIODE, 1N914	1520914	7910
D0955	DIODE, 1N695	1520695	3877
D0956	DIODE, 1N695	1520695	3877
D0975	DIODE, 1N914	1520914	7910
D0976	DIODE, 1N914	1520914	7910
D0977	DIODE, 1N914	1520914	7910
D0978	DIODE, 1N914	1520914	7910
D0980	DIODE, 1N914	1520914	7910
D0981	DIODE, 1N914	1520914	7910
D0982	DIODE, 1N914	1520914	7910
D0983	DIODE, 1N914	1520914	7910
D0985	DIODE, 1N914	1520914	7910
D0986	DIODE, 1N914	1520914	7910
D0987	DIODE, 1N914	1520914	7910
D0988	DIODE, 1N914	1520914	7910
D0990	DIODE, 1N914	1520914	7910
D0991	DIODE, 1N914	1520914	7910
D0992	DIODE, 1N914	1520914	7910
D0993	DIODE, 1N914	1520914	7910
D0995	DIODE, 1N914	1520914	7910
D0996	DIODE, 1N914	1520914	7910
D0997	DIODE, 1N914	1520914	7910
D0998	DIODE, 1N914	1520914	7910
D1040	TO		
D1099	DIODE, 1N914	1520914	7910
D1200	DIODE, 1N914	1520914	7910
D1205	DIODE, 1N914	1520914	7910
F0100	FUSE, 3AG 1/2 AMP SLO BLO	1590024	71400
I0010	PILOT LIGHT	1360045	100005
I0550	LAMP, NEON A1D	1500004	24455
I0551	LAMP, NEON A1D	1500004	24455
I0552	LAMP, NEON A1D	1500004	24455
I0955	LAMP, NEON A1D	1500004	24455
I0956	LAMP, NEON A1D	1500004	24455
I0957	LAMP, NEON A1D	1500004	24455
J0100	BINDING POST, BLACK	3550536	10597
J0101	BINDING POST, WHITE	3550535	10597
J0102	BINDING POST, BLACK	3550536	10597
J0103	BINDING POST, WHITE	3550535	10597
J1300	CONNECTOR, 50 PIN	1310063	71468
K0185	RELAY, SPST REED 5 VOLT	2600328	10597
K0186	RELAY, SPST REED 5 VOLT	2600328	10597
K0188	RELAY, SPST REED 5 VOLT	2600328	10597
K0190	RELAY, SPST REED 5 VOLT	2600328	10597
K0195	RELAY, SPST REED 5 VOLT	2600328	10597
K0196	RELAY, SPST REED 5 VOLT	2600328	10597
K0198	RELAY, SPST REED 5 VOLT	2600328	10597
K0199	RELAY, SPST REED 5 VOLT	2600328	10597
K0200	RELAY, SPST REED 5 VOLT	2600328	10597
K0201	RELAY, SPST REED 5 VOLT	2600328	10597
K0202	RELAY, SPST REED 5 VOLT	2600328	10597
K0203	RELAY, SPST REED 5 VOLT	2600328	10597
K0240	RELAY, SPST REED 5 VOLT	2600328	10597
K0241	RELAY, SPST REED 5 VOLT	2600328	10597
K0242	RELAY, SPST REED 5 VOLT	2600328	10597
K0243	RELAY, SPST REED 5 VOLT	2600328	10597
K0260	RELAY, SPST REED 5 VOLT	2600328	10597
K0280	RELAY, SPST REED 5 VOLT	2600328	10597
K0290	RELAY, SPST REED 5 VOLT	2600328	10597
K0301	RELAY, SPST REED 5 VOLT	2600328	10597
K0302	RELAY, SPST REED 5 VOLT	2600328	10597
K0320	RELAY, SPST REED 5 VOLT	2600328	10597
K0325	RELAY, SPST REED 5 VOLT	2600328	10597
K0330	RELAY, SPST REED 5 VOLT	2600328	10597
K0335	RELAY, SPST REED 5 VOLT	2600328	10597
K0390	RELAY, SPST REED 5 VOLT	2600328	10597
K0435	RELAY, SPST REED 5 VOLT	2600328	10597
K0440	RELAY, SPST REED 5 VOLT	2600328	10597
K0441	RELAY, SPST REED 5 VOLT	2600328	10597
K0442	RELAY, SPST REED 5 VOLT	2600328	10597
K0443	RELAY, SPST REED 5 VOLT	2600328	10597
K0675	RELAY, SPST REED 5 VOLT	2600328	10597
K0677	RELAY, SPST REED 5 VOLT	2600328	10597
K0695	RELAY, SPST REED 5 VOLT	2600328	10597
K0700	RELAY, SPST REED 5 VOLT	2600328	10597
K0702	RELAY, SPST REED 5 VOLT	2600328	10597
K0705	RELAY, SPDT REED 5 VOLT	2600336	10597
K0755	RELAY, SPST REED 5 VOLT	2600328	10597
K0760	RELAY, SPST REED 5 VOLT	2600328	10597
K0761	RELAY, SPST REED 5 VOLT	2600328	10597
K0820	TO		
K0830	RELAY, SPDT REED 5 VOLT	2600336	10597
K0832	TO		
K0842	RELAY, SPST REED 5 VOLT	2600328	10597
K0910	RELAY, SPST REED 5 VOLT	2600328	10597
K0912	RELAY, SPST REED 5 VOLT	2600328	10597
K0915	RELAY, SPST REED 5 VOLT	2600328	10597
K0916	RELAY, SPST REED 5 VOLT	2600328	10597
K0920	RELAY, SPST REED 5 VOLT	2600328	10597
K0921	RELAY, SPST REED 5 VOLT	2600328	10597
K0925	RELAY, SPST REED 5 VOLT	2600328	10597
K0935	RELAY, SPST REED 5 VOLT	2600328	10597
K0936	RELAY, SPST REED 5 VOLT	2600328	10597
K0937	RELAY, SPST REED 5 VOLT	2600328	10597
L0110	BEAD, FERRITE G303	1140034	1121
L0111	BEAD, FERRITE G303	1140034	1121
L0387	BEAD, FERRITE G303	1140034	1121
L0395	BEAD, FERRITE G303	1140034	1121
L0396	BEAD, FERRITE G303	1140034	1121
L0420	BEAD, FERRITE G303	1140034	1121
L0420	BEAD, FERRITE G303	1140034	1121
L0421	BEAD, FERRITE G303	1140034	1121
L0421	BEAD, FERRITE G303	1140034	1121
Q0100	INTEGRATED CIRCUIT, UA723	1580012	7263
Q0105	TRANSISTOR, 2N4898	1564898	4713
Q0110	TRANSISTOR, 2N4121	1564121	7263
Q0115	CONTROLLED RECTIFIER, 2N4167	1564167	4713
Q0120	INTEGRATED CIRCUIT, UA723	1580012	7263
Q0125	TRANSISTOR, 2N4910	1564910	4713
Q0130	INTEGRATED CIRCUIT, UA723	1580012	7263
Q0135	TRANSISTOR, 2N4910	1564910	4713
Q0140	TRANSISTOR, TIS87	1560087	1295
Q0145	TRANSISTOR, 2N4898	1564898	4713
Q0150	TRANSISTOR, 2N4121	1564121	7263
Q0155	TRANSISTOR, 2N4121	1564121	7263
Q0160	TRANSISTOR, EN2484	1562484	7263
Q0165	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0170	TRANSISTOR, 2N2905	1562905	1295
Q0175	TRANSISTOR, 2N4898	1564898	4713
Q0180	TRANSISTOR, EN2484	1562484	7263
Q0205	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0215	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0230	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0245	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0250	TRANSISTOR, 2N5462	1565462	4713
Q0255	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0260	TRANSISTOR, 2N5485	1565485	4713
Q0265	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0270	TRANSISTOR, 2N5485	1565485	4713
Q0275	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0280	TRANSISTOR, 2N5462	1565462	4713
Q0285	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0290	TRANSISTOR, 2N4250	1564250	7263
Q0295	TRANSISTOR, 2N4250	1564250	7263
Q0300	INTEGRATED CIRCUIT, UA710C	1580020	7263
Q0305	TRANSISTOR, 2N2219	1562219	1295
Q0310	INTEGRATED CIRCUIT, SN7440N	1580026	1295
Q0315	TRANSISTOR, MPS3640	1563640	4713
Q0320	TRANSISTOR, MPS3640	1563640	4713
Q0340	TRANSISTOR, 2N5454	1565454	61637
Q0350	TRANSISTOR, 2N4416	1564416	4713
Q0355	TRANSISTOR, 2N4250	1564250	7263
Q0360	TRANSISTOR, 2N4250	1564250	7263
Q0365	TRANSISTOR, MPS6543	1566543	4713
Q0370	TRANSISTOR, TIS87	1560087	1295
Q0375	TRANSISTOR, 2N4121	1564121	7263
Q0380	TRANSISTOR, TIS87	1560087	1295
Q0385	TRANSISTOR, 2N4121	1564121	7263
Q0395	TRANSISTORS, MATCHED TIS87	1570087	10597
Q0405	TRANSISTOR, TIS87	1560087	1295
Q0410	TRANSISTOR, 2N4121	1564121	7263
Q0415	TRANSISTOR, MPS3640	1563640	4713
Q0420	TRANSISTOR, TIS87	1560087	1295
Q0425	TRANSISTOR, 2N4121	1564121	7263
Q0430	TRANSISTOR, MPS3640	1563640	4713
Q0460	TO		
Q0515	TRANSISTOR, 2N5223	1565223	4713
Q0525	TO		
Q0540	TRANSISTOR, 2N5223	1565223	4713
Q0550	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0555	INTEGRATED CIRCUIT, SN7442N	1580027	1295
Q0560	INTEGRATED CIRCUIT, SN7440N	1580026	1295
Q0565	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0570	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0575	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0580	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0585	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0590	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0595	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0600	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0610	TRANSISTOR, 2N3643	1563643	4713
Q0615	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0620	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0630	TRANSISTOR, 2N5223	1565223	4713
Q0635	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0640	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0645	TRANSISTOR, 2N5223	1565223	4713
Q0710	TRANSISTOR, 2N4045	1564045	7263
Q0715	TRANSISTOR, 2N4250	1564250	7263
Q0720	TRANSISTOR, 2N5245	1565245	1295
Q0725	TRANSISTOR, 2N4250	1564250	7263
Q0730	TRANSISTOR, MPS6543	1566543	4713
Q0735	TRANSISTOR, 2N4121	1564121	7263
Q0740	TRANSISTOR, TIS87	1560087	1295
Q0745	TRANSISTOR, TIS87	1560087	1295

PART	DESCRIPTION	EXACT NO	MFG
Q0750	TRANSISTOR, 2N4121	1564121	7263
Q0765	TRANSISTOR, 2N4045	1564045	7263
Q0775	TRANSISTOR, 2N5245	1565245	1295
Q0780	TRANSISTOR, 2N4250	1564250	7263
Q0785	TRANSISTOR, 2N4250	1564250	7263
Q0790	TRANSISTOR, MPS6543	1566543	4713
Q0795	TRANSISTOR, 2N4121	1564121	7263
Q0800	TRANSISTOR, TIS87	1560087	1295
Q0805	TRANSISTOR, TIS87	1560087	1295
Q0810	TRANSISTOR, 2N4121	1564121	7263
Q0850	TRANSISTOR, UC2138	1562138	61637
Q0860	TRANSISTOR, 2N4250	1564250	7263
Q0865	TRANSISTOR, 2N4250	1564250	7263
Q0870	TRANSISTOR, 2N5245	1565245	1295
Q0875	TRANSISTOR, MPS6543	1566543	4713
Q0880	TRANSISTOR, 2N4121	1564121	7263
Q0885	TRANSISTOR, TIS87	1560087	1295
Q0890	TRANSISTOR, 2N2219	1562219	1295
Q0895	TRANSISTOR, 2N2219	1562219	1295
Q0900	TRANSISTOR, 2N2905	1562905	1295
Q0905	TRANSISTOR, 2N2905	1562905	1295
Q0945	TRANSISTOR, 2N5223	1565223	4713
Q0950	TRANSISTOR, 2N5223	1565223	4713
Q0955	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0960	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0965	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0970	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0975	TRANSISTOR, 2N5223	1565223	4713
Q0980	TRANSISTOR, 2N5223	1565223	4713
Q0985	TRANSISTOR, 2N5223	1565223	4713
Q0990	TRANSISTOR, 2N5223	1565223	4713
Q0995	TRANSISTOR, 2N5223	1565223	4713
Q1000	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q1005	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q1010	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q1015	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q1020	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q1025	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q1030	INTEGRATED CIRCUIT, SN7440N	1580026	1295
Q1040	TO		
Q1065	TRANSISTOR, 2N3643	1563643	4713
Q1070	TO		
Q1095	TRANSISTOR, 2N5223	1565223	4713
Q1200	TRANSISTOR, EN2484	1562484	7263
Q1205	TRANSISTOR, 2N4250	1564250	7263
R0010	RESISTOR, 51K OHM 1/2W 5% CARBON	3010513	1121
R0011	RESISTOR, 33K OHM 1/2W 5% CARBON	3010333	1121
R0012	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R0013	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R0100	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500	7115
R0101	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0102	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0103	RESISTOR, 56 OHM 1/4W 5% CARBON	3070560	1121
R0105	RESISTOR, 0.5 OHM WIREWOUND	3000005	75042
R0110	RESISTOR, 91 OHM 1/4W 5% CARBON	3070910	1121
R0111	RESISTOR, 909 OHM 1/4W 1% METAL FILM	3139090	7115
R0112	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0115	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121	1121
R0116	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R0117	RESISTOR, 68K OHM 2W 10% CARBON	3060683	1121
R0120	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0125	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0126	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0127	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0128	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0130	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R0135	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0136	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0137	POTENTIOMETER, 1K OHM SUBMIN	3110138	80294
R0138	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0139	RESISTOR, SELECTED VALUE		
R0140	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R0141	RESISTOR, 18K OHM 1/4W 5% CARBON	3070183	1121
R0142	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0145	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0145	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0150	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R0151	RESISTOR, 13K OHM 1/4W 5% CARBON	3070133	1121
R0155	RESISTOR, 7500 OHM 1/4W 5% CARBON	3070752	1121
R0156	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0157	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0158	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0160	RESISTOR, 332 OHM 1/4W 5% CARBON	3070331	1121
R0161	RESISTOR, 13K OHM 1/4W 5% CARBON	3070133	1121
R0165	RESISTOR, 15000 OHM 1/4W 1% METAL FILM	3131502	7115
R0166	POTENTIOMETER, 500 OHM PC TRIM	3110090	80294
R0167	RESISTOR, 15000 OHM 1/4W 1% METAL FILM	3131502	7115
R0168	RESISTOR, 7500 OHM 1/4W 5% CARBON	3070752	1121
R0169	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0170	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0171	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0172	RESISTOR, SELECTED VALUE		
R0175	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0185	RESISTOR, 10200 OHM 1/4W 1% METAL FILM	3131022	7115
R0186	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0187	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R0188	POTENTIOMETER, 2.5K OHM TRIM	3110148	71450
R0189	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
R0190	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0191	RESISTOR, 80600 OHM 1/4W 1% METAL FILM	3138062	7115
R0195	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0196	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0197	RESISTOR, 19600 OHM 1/4W 1% METAL FILM	3131962	7115
R0198	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
R0199	RESISTOR, 80600 OHM 1/4W 1% METAL FILM	3138062	7115
R0200	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0201	RESISTOR, 200K OHM 1/4W 1% METAL FILM	3132003	7115
R0202	RESISTOR, 402K OHM 1/4W 1% METAL FILM	3134023	7115
R0203	RESISTOR, 806K OHM 1/4W 1% METAL FILM	3138063	7115
R0204	RESISTOR, SELECTED VALUE		
R0205	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0206	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0207	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0208	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0209	RESISTOR, 2150 OHM 1/4W 1% METAL FILM	3132151	7115
R0210	POTENTIOMETER, 500 OHM PC TRIM	3110090	80294
R0211	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0212	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0213	RESISTOR, 15000K OHM 1/4W 5% CARBON	3070156	1121
R0214	POTENTIOMETER, 10K OHM WITH SWITCH	3110333	71450
R0215	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0216	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0217	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0218	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0219	RESISTOR, 2150 OHM 1/4W 1% METAL FILM	3132151	7115
R0220	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0221	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0222	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0223	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0224	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0230	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0231	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0232	RESISTOR, 2372 OHM 1/4W 1% METAL FILM	3132371	7115
R0233	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0234	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0235	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0236	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0240	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0241	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0242	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0243	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0245	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0250	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0251	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0255	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0256	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0257	POTENTIOMETER, 250 OHM	3110145	71450
R0260	RESISTOR, 4750 OHM 1/4W 1% METAL FILM	3134751	7115
R0261	POTENTIOMETER, 250 OHM	3110145	71450
R0265	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0266	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0267	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0270	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0275	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0276	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0280	RESISTOR, 1450 OHM 1/4W 1% METAL FILM	3131051	7115
R0281	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0285	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0290	RESISTOR, 1690 OHM 1/4W 1% METAL FILM	3131691	7115
R0291	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0292	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0293	RESISTOR, 2370 OHM 1/4W 1% METAL FILM	3132371	7115
R0300	RESISTOR, 10K OHM 1/2W 5% CARBON	3010103	1121
R0301	RESISTOR, 150K OHM 1/4W 5% CARBON	3070154	1121
R0302	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0303	RESISTOR, 82K OHM 1/4W 5% CARBON	3070823	1121
R0304	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563	1121
R0305	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0306	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R0307	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0308	RESISTOR, 100 OHM 1/2W 5% CARBON	3010101	1121
R0310	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0311	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0312	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0313	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0314	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0315	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121
R0316	RESISTOR, 5600 OHM 1/4W 5% CARBON	3070562	1121
R0317	RESISTOR, 1800 OHM 1/4W 5% CARBON	3070182	1121
R0318	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0321	RESISTOR, 5600 OHM 1/4W 5% CARBON	3070562	1121
R0322	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0325	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0326	RESISTOR, 2150 OHM 1/4W 1% METAL FILM	3132151	7115
R0330	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0331	RESISTOR, 23200 OHM 1/4W 1% METAL FILM	3132322	7115
R0332	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0333	RESISTOR, 2100K OHM 1/4W 1% METAL FILM	3132103	7115
R0335	RESISTOR, 221 OHM 1/4W 1% METAL FILM	3132210	7115
R0340	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0341	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0342	RESISTOR, 324K OHM 1/4W 1% METAL FILM	3133243	7115
R0343	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0344	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R0345	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0346	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0347	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0348	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0349	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0350	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0351	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0355	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123	1121
R0360	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0365	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161	1121
R0366	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0370	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0371	RESISTOR, 100K OHM 1/4W 5% CARBON	3070104	1121
R0372	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0375	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R0376	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R0380	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0385	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0386	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200	1121
R0387	RESISTOR, 1002 OHM 1/4W 1% METAL FILM	3131001	7115
R0390	POTENTIOMETER, 250 OHM	3110145	71450
R0391	RESISTOR, 2742 OHM 1/4W 1% METAL FILM	3132741	7115

PART	DESCRIPTION	EXACT NO	MFG
R0392	RESISTOR, 2742 OHM 1/4W 1% METAL FILM	3132741	7115
R0393	POTENTIOMETER, 250 OHM	3110145	71450
R0395	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R0396	POTENTIOMETER, 250 OHM	3110145	71450
R0397	RESISTOR, 2870 OHM 1/4W 1% METAL FILM	3132871	7115
R0400	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R0401	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0402	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0405	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0406	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0410	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0411	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0415	RESISTOR, 820 OHM 1/4W 5% CARBON	3070821	1121
R0416	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R0420	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0421	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0425	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0426	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0427	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0430	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R0460	TO		
R0515	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R0525	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0526	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R0530	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0531	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R0535	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0536	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R0540	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0541	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R0550	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0551	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0552	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0553	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0575	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0610	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0611	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R0630	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0631	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R0645	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0646	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R0675	RESISTOR, 324 OHM 1/4W 1% METAL FILM	3133240	7115
R0676	RESISTOR, 121 OHM 1/4W 1% METAL FILM	3131210	7115
R0677	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0678	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0679	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0680	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0681	RESISTOR, 22100 OHM 1/4W 1% METAL FILM	3132212	7115
R0682	RESISTOR, 22100 OHM 1/4W 1% METAL FILM	3132212	7115
R0683	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0684	RESISTOR, 75.0 OHM 1/4W 1% METAL FILM	3130750	7115
R0685	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0686	RESISTOR, 17400 OHM 1/4W 1% METAL FILM	3131742	7115
R0687	RESISTOR, 17400 OHM 1/4W 1% METAL FILM	3131742	7115
R0688	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0689	RESISTOR, 187 OHM 1/4W 1% METAL FILM	3131870	7115
R0690	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0691	RESISTOR, 5902 OHM 1/4W 1% METAL FILM	3135901	7115
R0692	RESISTOR, 5902 OHM 1/4W 1% METAL FILM	3135901	7115
R0693	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0694	RESISTOR, 140 OHM 1/4W 1% METAL FILM	3131400	7115
R0695	RESISTOR, 9312 OHM 1/4W 1% METAL FILM	3139311	7115
R0696	RESISTOR, 9312 OHM 1/4W 1% METAL FILM	3139311	7115
R0697	RESISTOR, 324 OHM 1/4W 1% METAL FILM	3133240	7115
R0700	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0701	RESISTOR, 2742 OHM 1/4W 1% METAL FILM	3132741	7115
R0703	RESISTOR, 2742 OHM 1/4W 1% METAL FILM	3132741	7115
R0704	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0705	POTENTIOMETER, 250 OHM	3110145	71450
R0706	RESISTOR, 909 OHM 1/4W 1% METAL FILM	3139090	7115
R0710	RESISTOR, 1602 OHM 1/4W 5% CARBON	3070162	1121
R0711	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0712	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0713	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R0714	RESISTOR, 324K OHM 1/4W 1% METAL FILM	3133243	7115
R0715	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0716	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0717	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0718	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0719	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R0720	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0721	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0725	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0726	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123	1121
R0730	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0731	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161	1121
R0735	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R0736	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R0740	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0741	RESISTOR, 100K OHM 1/4W 5% CARBON	3070104	1121
R0742	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0745	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0750	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0751	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0755	RESISTOR, 953 OHM 1/4W 1% METAL FILM	3139530	7115
R0756	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0757	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0758	RESISTOR, 953 OHM 1/4W 1% METAL FILM	3139530	7115
R0760	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0761	RESISTOR, 1912 OHM 1/4W 1% METAL FILM	3131911	7115
R0762	POTENTIOMETER, 250 OHM	3110145	71450
R0765	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0766	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0767	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0768	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R0769	RESISTOR, 324K OHM 1/4W 1% METAL FILM	3133243	7115
R0770	RESISTOR, 16502 OHM 1/4W 1% METAL FILM	3131652	7115
R0771	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0772	RESISTOR, 16502 OHM 1/4W 1% METAL FILM	3131652	7115
R0773	RESISTOR, 10002 OHM 1/4W 1% METAL FILM	3131002	7115
R0774	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R0775	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0776	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0780	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123	1121
R0785	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0790	RESISTOR, 2202 OHM 1/4W 5% CARBON	3070222	1121
R0791	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161	1121
R0795	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R0796	RESISTOR, 627 OHM 1/4W 5% CARBON	3070621	1121
R0800	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0801	RESISTOR, 100K OHM 1/4W 5% CARBON	3070104	1121
R0802	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0805	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0810	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0811	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0820	RESISTOR, 75.0 OHM 1/4W 1% METAL FILM	3130750	7115
R0821	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R0822	POTENTIOMETER, 250 OHM	3110145	71450
R0823	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0824	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0825	RESISTOR, 10002 OHM 1/4W 1% METAL FILM	3131002	7115
R0826	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0827	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R0828	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0829	RESISTOR, 24902 OHM 1/4W 1% METAL FILM	3132492	7115
R0830	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0831	RESISTOR, 49902 OHM 1/4W 1% METAL FILM	3134992	7115
R0832	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0834	RESISTOR, 200K OHM 1/4W 1% METAL FILM	3132003	7115
R0836	RESISTOR, 249K OHM 1/4W 1% METAL FILM	3132493	7115
R0838	RESISTOR, 499K OHM 1/4W 1% METAL FILM	3134993	7115
R0840	RESISTOR, 1000K OHM 1/2W 1% METAL FILM	3101004	7115
R0842	RESISTOR, 2000K OHM 1/4W 5% CARBON	3070205	1121
R0843	RESISTOR, 2002 OHM 1/4W 1% METAL FILM	3132001	7115
R0844	RESISTOR, 2002 OHM 1/4W 1% METAL FILM	3132001	7115
R0845	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R0851	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751	1121
R0852	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0853	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0854	RESISTOR, 472 OHM 1/4W 5% CARBON	3070471	1121
R0855	RESISTOR, 402K OHM 1/4W 1% METAL FILM	3134023	7115
R0856	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0857	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0858	RESISTOR, 16502 OHM 1/4W 1% METAL FILM	3131652	7115
R0859	RESISTOR, 10002 OHM 1/4W 1% METAL FILM	3131002	7115
R0860	RESISTOR, 1202 OHM 1/4W 1% METAL FILM	3131201	7115
R0861	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0865	RESISTOR, 11K OHM 1/4W 5% CARBON	3070113	1121
R0870	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0871	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0875	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161	1121
R0876	RESISTOR, 4302 OHM 1/4W 5% CARBON	3070432	1121
R0880	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R0881	RESISTOR, 362 OHM 1/4W 5% CARBON	3070361	1121
R0885	RESISTOR, 100K OHM 1/4W 5% CARBON	3070104	1121
R0886	RESISTOR, 5602 OHM 1/4W 5% CARBON	3070562	1121
R0887	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0890	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0895	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0900	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0905	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0906	RESISTOR, 150 OHM 1/2W 1% METAL FILM	3101500	7115
R0907	RESISTOR, 150 OHM 1/2W 1% METAL FILM	3101500	7115
R0908	RESISTOR, 150 OHM 1/2W 1% METAL FILM	3101500	7115
R0912	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750	7115
R0913	RESISTOR, SELECTED VALUE		
R0914	RESISTOR, 56.2 OHM 1/4W 1% METAL FILM	3130562	7115
R0916	RESISTOR, 40.2 OHM 1/8W 1% METAL FILM	3180402	7115
R0917	RESISTOR, SELECTED VALUE		
R0918	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100	7115
R0919	RESISTOR, 41.2 OHM 1/8W 1% METAL FILM	3180412	7115
R0921	RESISTOR, 40.2 OHM 1/8W 1% METAL FILM	3180402	7115
R0922	RESISTOR, SELECTED VALUE		
R0923	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100	7115
R0925	RESISTOR, 41.2 OHM 1/8W 1% METAL FILM	3180412	7115
R0935	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0936	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741	7115
R0937	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741	7115
R0938	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0939	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0945	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0946	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R0950	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0951	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R0975	RESISTOR, 2220 OHM 1/4W 5% CARBON	3070222	1121
R0976	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R0980	RESISTOR, 2220 OHM 1/4W 5% CARBON	3070222	1121
R0981	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R0985	RESISTOR, 2220 OHM 1/4W 5% CARBON	3070222	1121
R0986	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R0990	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0991	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R0995	RESISTOR, 2207 OHM 1/4W 5% CARBON	3070222	1121
R0996	RESISTOR, 22K OHM 1/4W 5% CARBON	3070203	1121
R1000	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R1005	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R1010	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R1040	TO		
R1065	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R1070	TO		
R1095	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203	1121
R1200	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R1201	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1202	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R1235	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R1206	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121

PART	DESCRIPTION	EXACT NO	MFG
R1207	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R1208	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561	1121
S0100	SWITCH, TOGGLE SPDT	2600103	100005
S0101	SWITCH, SLIDE	2600319	10597
S0304	SWITCH, PUSHBUTTON SPDT	2600086	100005
S0460	SWITCH, BCD ROTARY	2600324	10597
S0480	SWITCH, BCD ROTARY	2600324	10597
S0500	SWITCH, BCD ROTARY	2600324	10597
S0550	SWITCH, BCD ROTARY WITH INH,	2600325	10597
S0575	SWITCH, SLIDE DPDT	2600212	76854
S0610	SWITCH, ROTARY 7 POSITION	2600326	10597
S0630	SWITCH, LEVER 5P3T	2600251	10597
S0955	SWITCH, BCD ROTARY WITH INH,	2600325	10597
S0985	SWITCH, TOGGLE SPDT	2600103	100005
S0990	SWITCH, TOGGLE SPDT	2600103	100005
S1040	SWITCH, BCD ROTARY	2600324	10597
S1060	SWITCH, BCD ROTARY	2600324	10597
S1080	SWITCH, BCD ROTARY	2600324	10597
T0100	TRANSFORMER, POWER	1200040	10597

SECTION 8

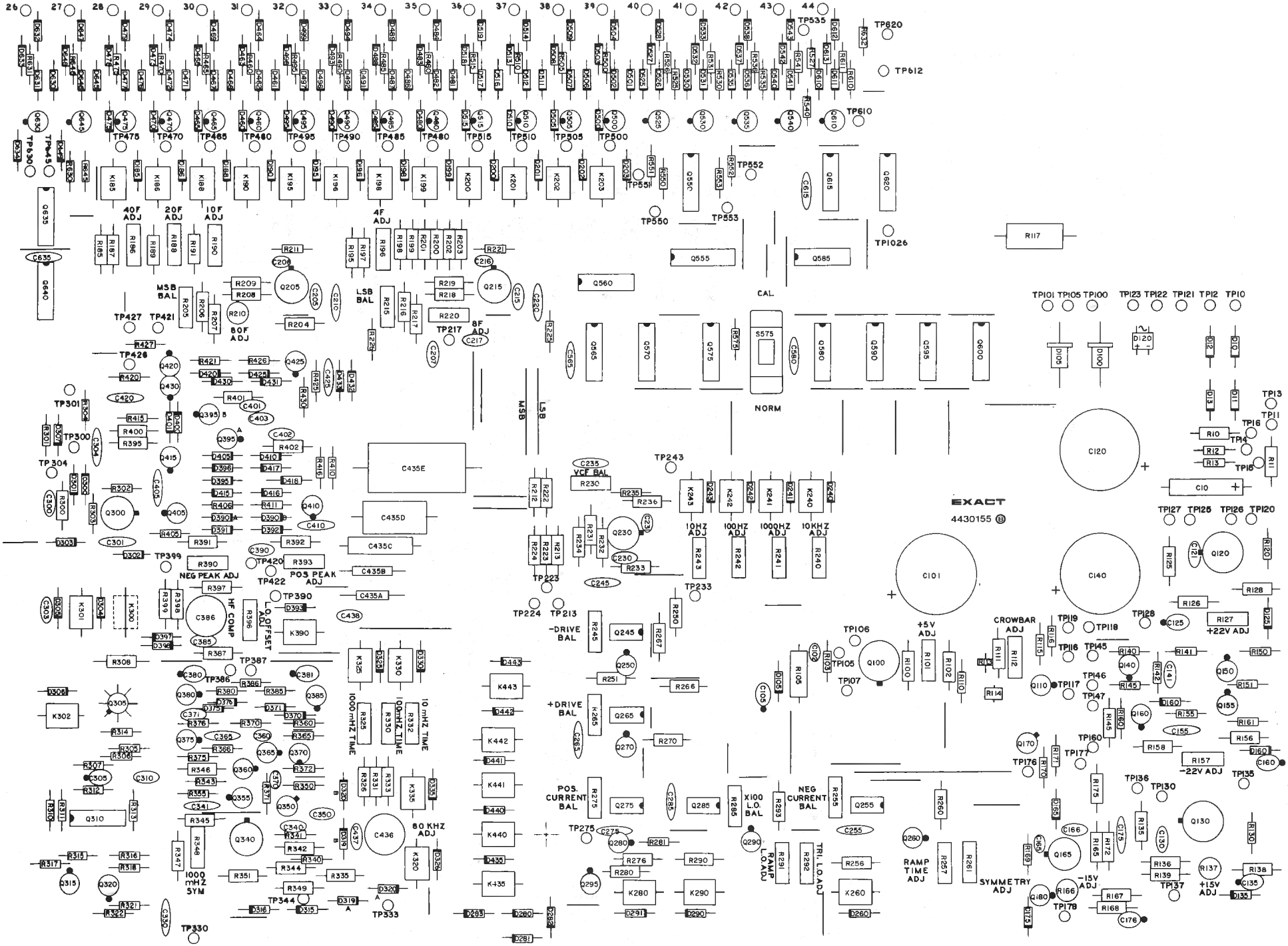
PARTS LAYOUT AND SCHEMATICS

SECTION 8

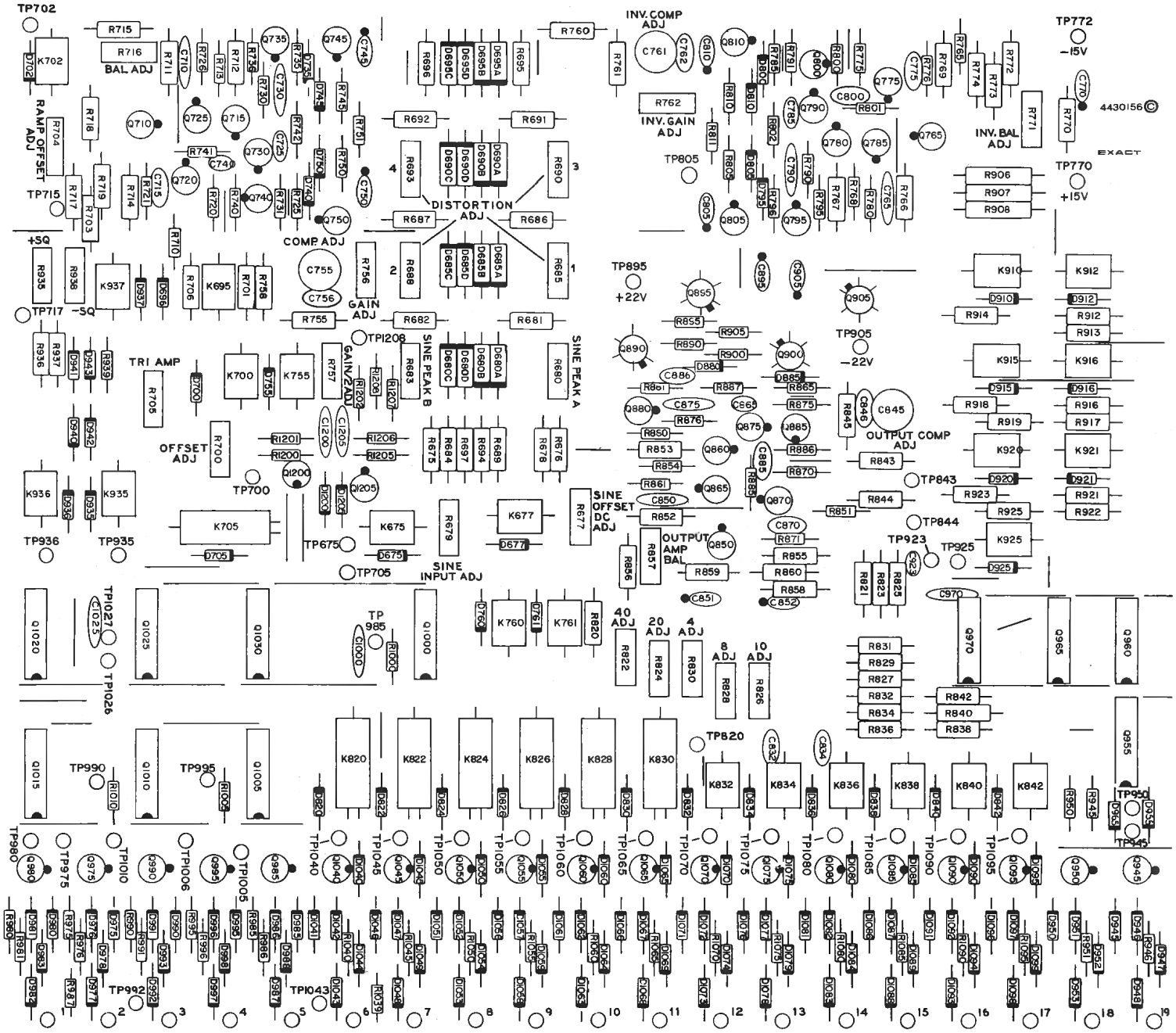
FOREWORD TO SCHEMATICS

For purposes of clarity, power supply connections to the integrated circuits used in control circuitry have been omitted. The following rules apply. All integrated circuits S/N 7400N or equivalent pin number 7 connected to programming common ∇_p, and pin number 14 connected to +5V. All integrated circuits S/N 7440N or equivalent (except Q310) pin number 7 connected to programming common, and pin number 14 connected to +5V. Q310 is isolated from program common and has its own power supply which is derived from +15V. All integrated circuits S/N 7442N or equivalent pin number 8 connected to programming common and pin number 16 connected to +5V.

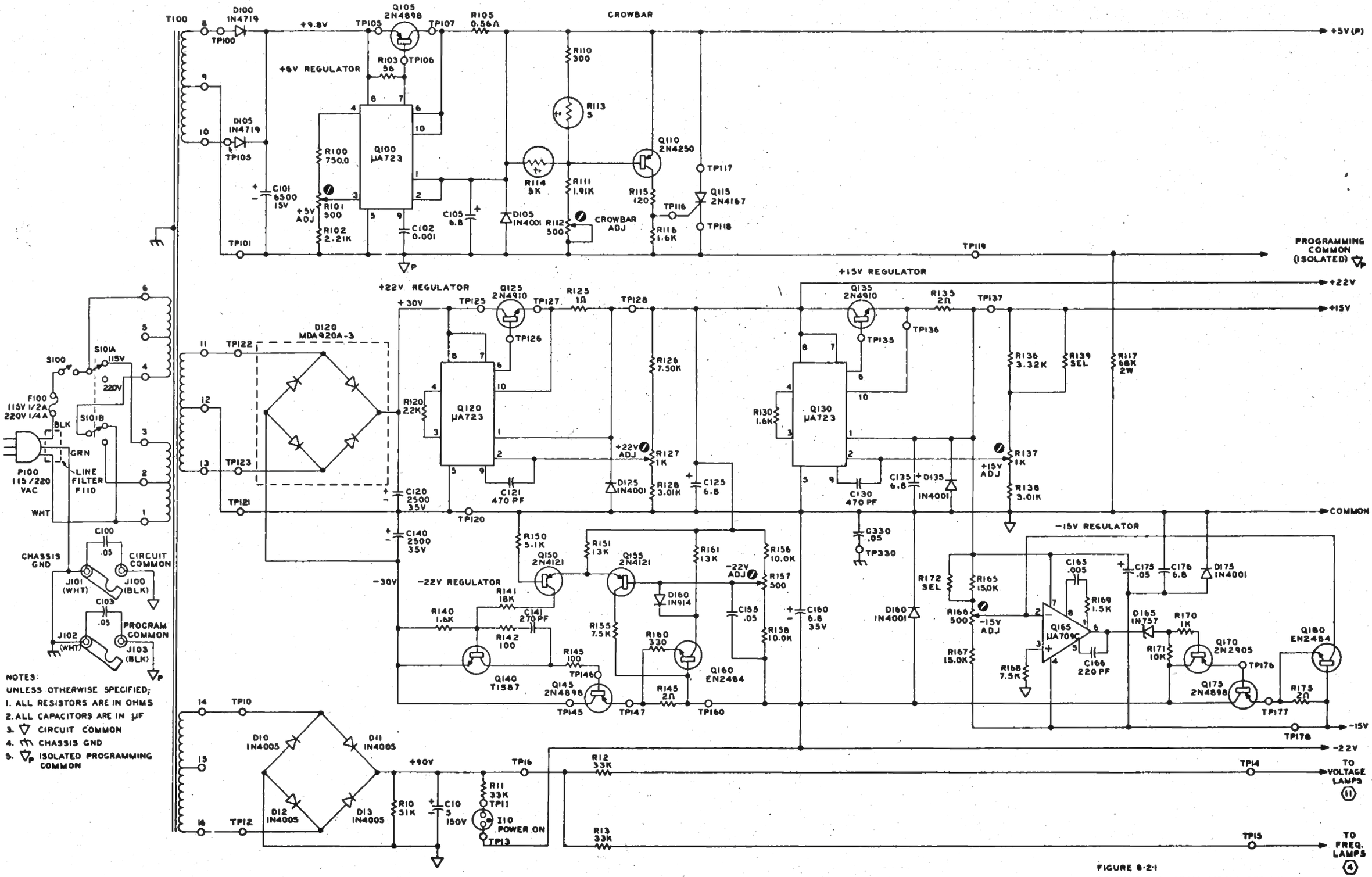
To facilitate quick reference to inter-connections from one schematic to another, a system of numbers has been utilized. For instance, the relays involved in the control circuitry have relay coils on one schematic and relay contacts on another. Each schematic carries its own identifying number located in a large hexagonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection.



PARTS OVERLAY (figure 8.1.0)



PARTS OVERLAY (figure 8.1.1)



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN µF
3. ▽ CIRCUIT COMMON
4. ⏚ CHASSIS GND
5. ▽P ISOLATED PROGRAMMING COMMON

FIGURE 8-2-1
(1) SCHEMATIC DIAGRAM MODEL 605-606 POWER SUPPLY CIRCUIT
10-18-71

LOCK OUT LOGIC
R308 100 1/2W
R305 4.7K
Q305 2N2219
C305 6.8
R307 1K
R306 2.7K
R310 2.2K
R311 1.5K
C303 220 PF
AVAILABLE AS OPTION
K300 INHIBIT RELAY
D302 IN748
Q300 LM710C
TRIGGER INPUT COMPARATOR
D307
C300 10 PF
R304 56K
TP301
S304 MANUAL
C304 .05
R300 10K 1/2W
TP304
+15V
REAR
TRIG IN J304
J303 TRIG IN
C302 0.05
FRONT MODEL 605 ONLY
D301
D300
TP300
R321 5.6K
R318 1K
R316 5.6K
Q320 MPS3640
Q315 MPS3640
R315 1.2K
R322 2K
R317 1.8K
Q310 SN7440
K302 RUN RELAY
K301 GATE RELAY
R314 1.3K
C301 0.05
R303 82K
R302 10K
R301 150K
D303 IN757
R312 1.5K
R313 1.3K
C310 100PF
L420 BEAD
INV. SQ.
TP420
L421 BEAD
POS. SQ.
TP421
TP422
INTEGRATOR
LEVEL DETECTOR
R345 274K
R346 274K
R347 16.5K
R355 12K
C341 .01
R343 1K
C371 10PF
R376 620
R375 51
Q375 2N4121
R371 100K
C380 6.8
K390 90° PHASE RELAY
R396 250 L.O. OFFSET ADJ
Q380 TI587
R390 250 POS PEAK
R405 150
R415 820
R395 4.22K
R400 4.22K
R420 150
C420 0.05
C405 0.05
Q405 TI587
Q415 MPS3640
D400
D401
Q430 MPS3640
Q420 TI587
J426 REAR
SYNC OUT
TP427
J427 FRONT
SYNC OUT
MODEL 605 ONLY
R421 22
R427 100
C426 47PF
R426 22
Q425 2N4121
R391 2.74K
R406 22
D405
D410
D415
D416
D417
D418
D420
D425
D430
D431
D432
D433
TP426
R340 2.2K
A
B
R351 10K
R348 5K 1000 mHZ SYM
R344 332
TP344
Q340 2N3454
R342 324K
R349 16.5K
Q355 2N4250
Q360 2N4250
C365 0.05
R366 2.2K
R370 27
D375
D376
D371
D370
C360 0.001
Q365 MPS6543
Q370 TI587
C370 0.005
R380 22
R386 20
R385 22
Q385 2N4121
R387 1K
C385 68 PF
HF COMP
C386 5.5-18 PF
C381 6.8
TP386
TP 387
R397 2.67K
D391
D390A
D390B
D392
R411 22
R392 2.74K
C390 18PF
NEG PEAK
R393 250
Q410 2N4121
R410 150
C410 0.05
R416 2.7K
D395
D396
Q395A TI587
Q395B TI587
L395 BEAD
L396 BEAD
C401 68 PF
C403 22PF
R401 1.00K
C402 3PF
R402 3.01K
R430 1.6K
R425 150
C425 0.05
C340 100 PF
R341 68
Q350 2N4416
R350 10K
R360 15K
R365 160
R372 10K
C350 5PF
R398 10K
R399 10K
D398
D397
J399 Ø LOCK
D316 D315 D319B D320B
CD1541
CD1541
CURRENT SHARING NETWORK
TP333
TIMING CAPACITORS
SHORT TO S.J. RELAY
K320
R326 2.15
R331 24.3K
R333 210K
R325 100
R330 1K
R332 10K
C436 5.5-18 PF
1000mHZ TIME
100mHZ TIME
10mHZ TIME
800KHZ ADJ
D319A D320A
CD1541
K325 2.15K RELAY
K330 23.7K RELAY
K335 R335 221
221Ω RELAY
C437 82PF
C438 10PF
C435A 910 PF
C435B 0.01
C435C 0.1
C435D 1.0
C435E 10.0
K435 K440 K441 K442 K443
MATCHED SET
L387 BEAD
INTEGRATOR INPUT 3
-15V
LEVEL DET. OUTPUT
TO POS. CURRENT SOURCE SWITCH
FROM L.O. CURRENT SOURCE
INTEGRATOR OUTPUT 6

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ▽ CIRCUIT COMMON

FIGURE 6.2.2
2 SCHEMATIC DIAGRAM MODEL 605-606 GENERATOR LOOP CIRCUITRY
10-18-71 REV B

D/A CONVERTER

K208 R203 806K
K202 R202 402K
K201 R201 200K
K200 R200 100K
K199 R199 80.6K
K198 R198 40.2K
K197 R197 19.6K
K196 4F ADJ R196 1K
K195 R195 10K
K190 10F ADJ R190 5K R191 80.6K
K189 20F ADJ R188 2.5K R189 40.2K
K186 40F ADJ R186 1K R187 20K
K185 R185 10.2K

R219 2.15K
R220 500 8F ADJ
C215 220 PF
R216 100K
R218 2.21K
R215 20K LSB BAL
R217 100 TP217
Q215 µA709C
C216 .005
R221 1.5K
R225 51
C220 0.05
C217 270
LSB TEST POINT

R204 SELECT
R209 2.15K
R210 500 80F ADJ
C205 220PF
R206 100K
R208 2.21K
R205 20K MSB BAL
R207 100
Q205 µA709C
C206 .005
R211 1.5K
R226 51
MSB TEST POINT
R212 4.99K
C207 270
C210 0.05

FREQ VERNIER
R214 10K
R213 15M TP213

MODEL 605 FRONT PANEL ONLY
R231 100K
R230 20K VCF BAL
R232 2.37K
R233 100 TP233

R222 49.9K
R234 4.99K
C230 220PF
Q230 µA709C
C231 .005
R235 1.5K
C235 0.05

SUMMING AMPLIFIER

R236 100K

K240 K241 K242 K243

10KHZ ADJ R240 20K
1000KHZ ADJ R241 20K
100 KHZ ADJ R242 20K
10KHZ ADJ R243 20K TP243

R223 4.99K TP223
R224 4.99K TP224

MODEL 605 ONLY
VCF INPUT J223 FRONT
VCF INPUT J222 REAR

L.O. CURRENT SOURCE

+22V
R290 1.69K
R291 100 RAMP LO ADJ
R293 2.37K
TRIANGLE L.O. ADJ
R292 100
K290 TRIANGLE L.O. RELAY (7)
X100 L.O. BAL
Q285 741C
C285 0.05
R285 10K
Q290 2N4250

TO L.O. DIODES (2)

POSITIVE CURRENT SOURCE

+15V (1)
R270 1K
R276 1K
K280 (7) RAMP RESET RELAY
R280 1.05K
+22V
R281 1K
Q275 741C
C275 0.05
Q295 2N4250
Q280 2N5462
R275 10K POS CURRENT BAL
TP275

C265 0.05
Q265 741C
R266 100
Q270 2N5485
+DRIVE BAL R265 10K
R267 1K

D282 CD1541
D281
FROM LEVEL DETECTOR OUTPUT (2)
D280
D283 CD1541
TO INTEGRATOR INPUT (2)

NEGATIVE CURRENT SOURCE

R250 2K
Q250 2N5462
Q245 741C
-DRIVE BAL R245 10K
C245 0.05
R251 2K
C255 .05
Q255 741C
R255 10K NEG CURRENT BAL
Q260 2N5465
-22V
R260 4.75K
R261 SYMMETRY ADJ 250
R257 250 RAMP TIME ADJ
R256 3.32K
K260 (7) TRIANGLE SLOPE RELAY
-15V (1)

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ▽ CIRCUIT COMMON

FIGURE 8.2.3
(3) SCHEMATIC DIAGRAM MODEL 605-606
D/A CONVERTER & CURRENT SOURCES
11-18-70

TP535

FREQUENCY REMOTE INHIBIT BUS (5)

(1) FROM LAMP SUPPLY

+5V(P) (1)

S550 FREQUENCY CONTROL MODEL 605 ONLY FRONT PANEL

S550A S550B S550C S550D S550E S550F

100-1000KHZ
10-100KHZ
1-10KHZ
100-1000HZ
10-100HZ
1-10HZ
100-1000mHZ
10-100 mHZ
1-10mHZ
REMOTE

R527 1K
R526 20K
R525 2.2K
R550 2.2K
TP550
D527 D526 D525
Q525 2N5223
Q550B
J1300 40
D528

R531 20K
R530 2.2K
R551 2.2K
TP551
D532 D531 D530
Q530 2N5223
Q550A
41 D533

R536 20K
R535 2.2K
R552 2.2K
TP552
D537 D536 D535
Q535 2N5223
Q550D
42 D538

R541 20K
R540 2.2K
R553 2.2K
TP553
D542 D541 D540
Q540 2N5223
Q550C
43 D543

A1D 1550 A1D 1551 A1D 1552

(1) -22V

Q555 SN7442N

15 A, 14 B, 13 C, 12 D; 0 1 2 3 4 5 6 7 9

Q565A Q565B Q565C Q565D
Q560B SN7440N
Q560A SN7440N
D326
(2) K320 SHORT TO S.J. RELAY

D325 K325 2.15K RELAY (2)
D330 K330 24.3K RELAY (2)
D443 K443 10µF RELAY (2)
D335 K335 221Ω RELAY (2)

Q570A Q570B Q570C Q570D
Q575A Q575B Q575C Q575D

C565 0.05
R575 2.2K
D243 (3) K243 10µF TRIM RELAY

Q585A Q585B Q585C Q585D
Q580B Q580C
Q590B Q590C
Q595B Q595C
Q600B Q600C

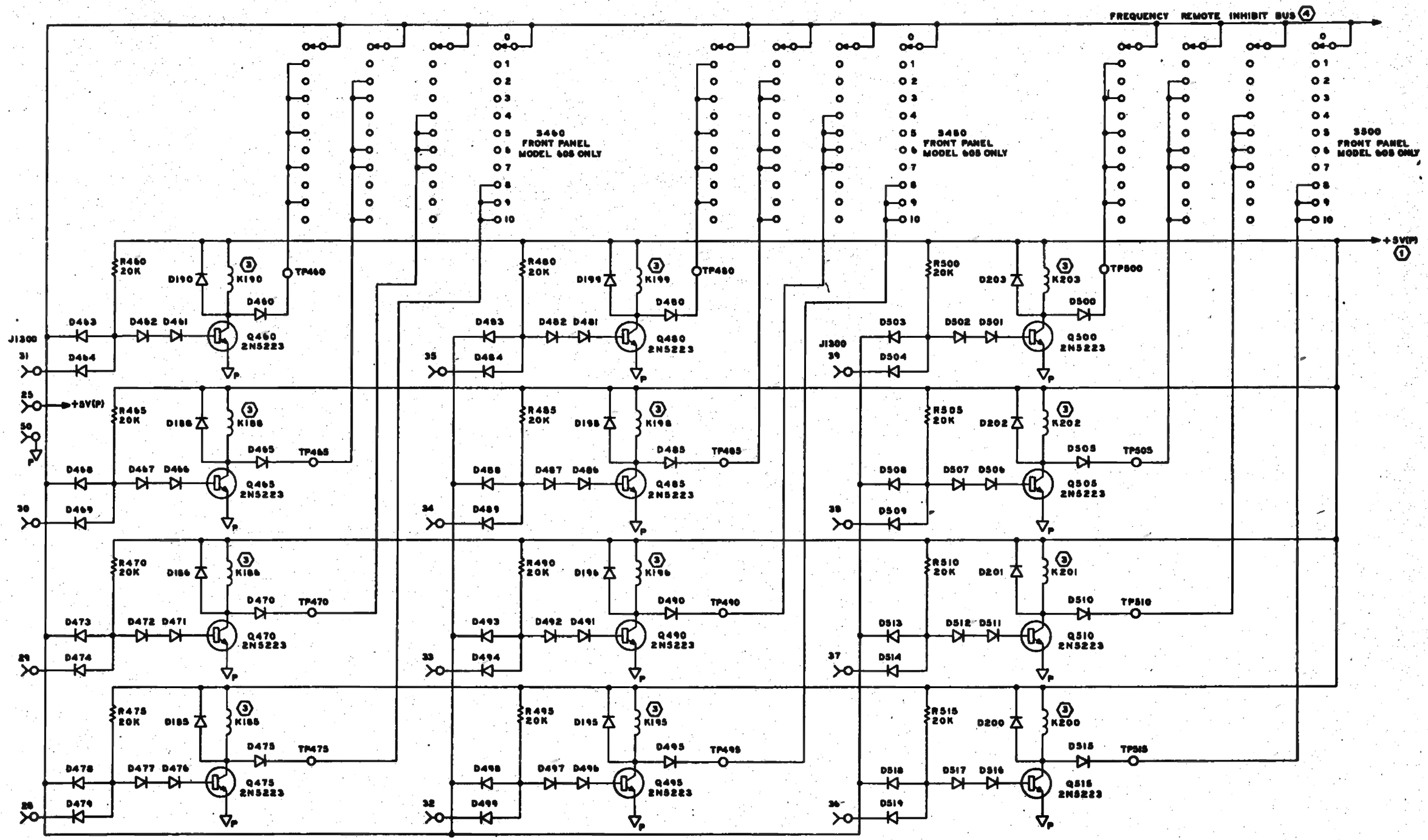
D442 K442 1µF RELAY (2)
D441 K441 0.1µF RELAY (2)
D440 K440 0.01µF RELAY (2)
D435 K435 910PF RELAY (2)

C580 .05
Q580A Q580D
Q590A Q590D
Q595A Q595D
D242 K242 1µF TRIM RELAY (3)
D241 K241 0.1µF TRIM RELAY (3)
D240 K240 0.01µF TRIM RELAY (3)

NORM S575 CAL

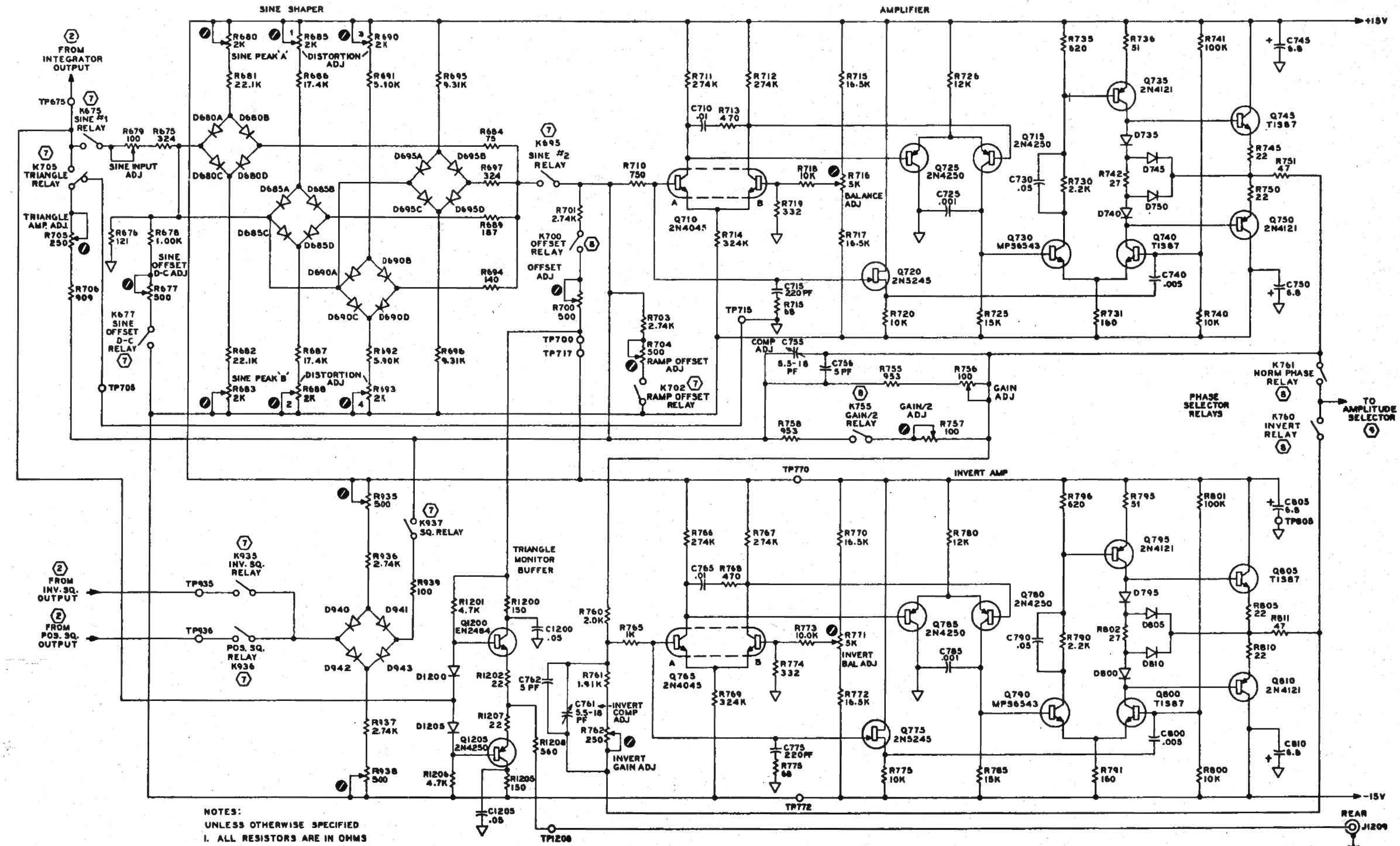
NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ALL IC'S ARE SN7400N OR EQUIVALENT
5. ▽P ISOLATED PROGRAMMING COMMON
6. J1300 PROGRAMMING INPUT CONNECTOR

FIGURE 8.2.4
(4) SCHEMATIC DIAGRAM MODEL 605-606 DECADE FREQUENCY CONTROL CIRCUIT
11-18-70 REV B



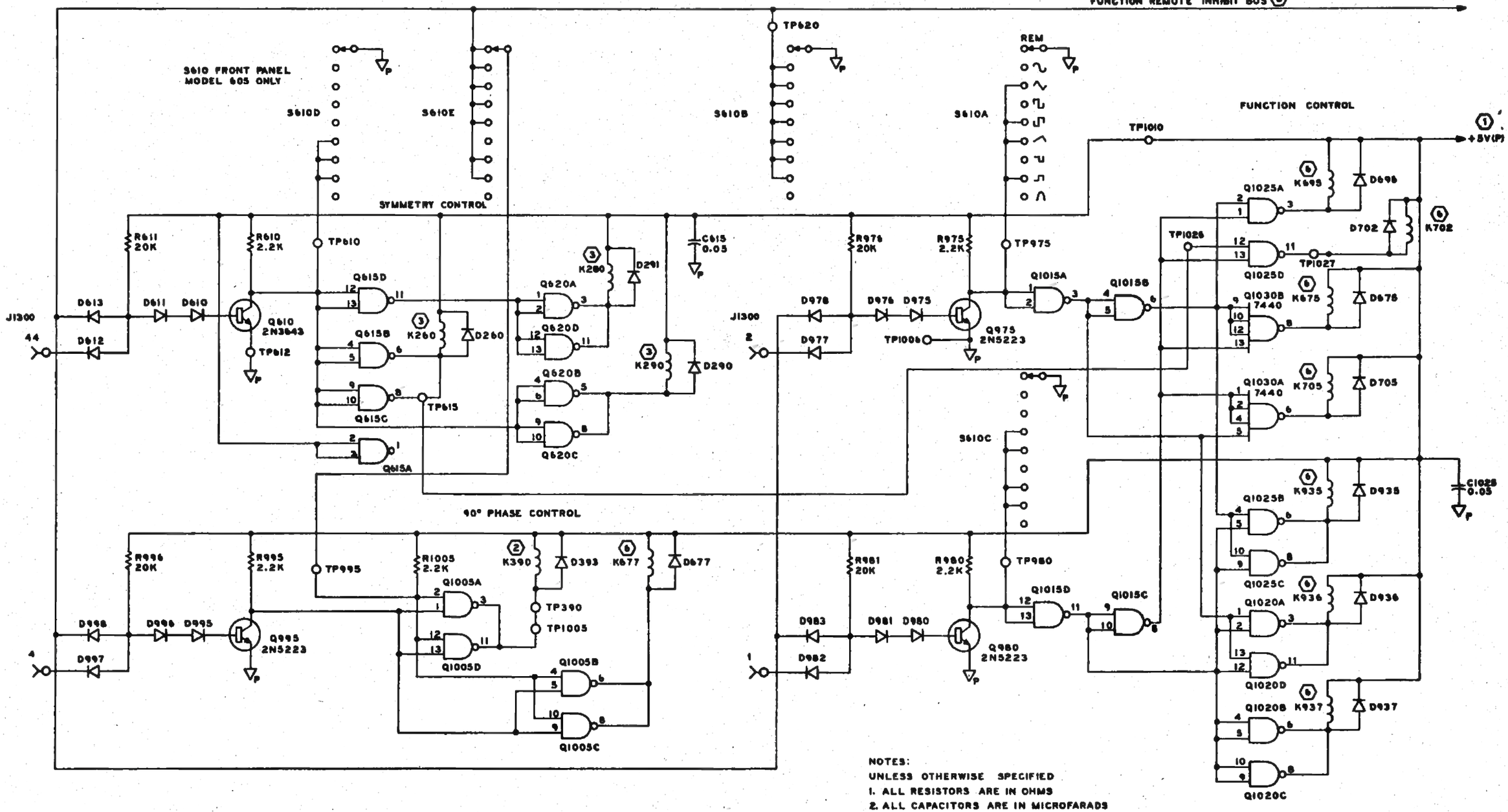
NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ▽P ISOLATED PROGRAMMING COMMON
5. J1300 PROGRAMMING INPUT CONNECTOR

FIGURE 8.2.5
(5) SCHEMATIC DIAGRAM MODEL 605-606
FREQUENCY MULTIPLIER CONTROL CIRCUIT
11-18-70



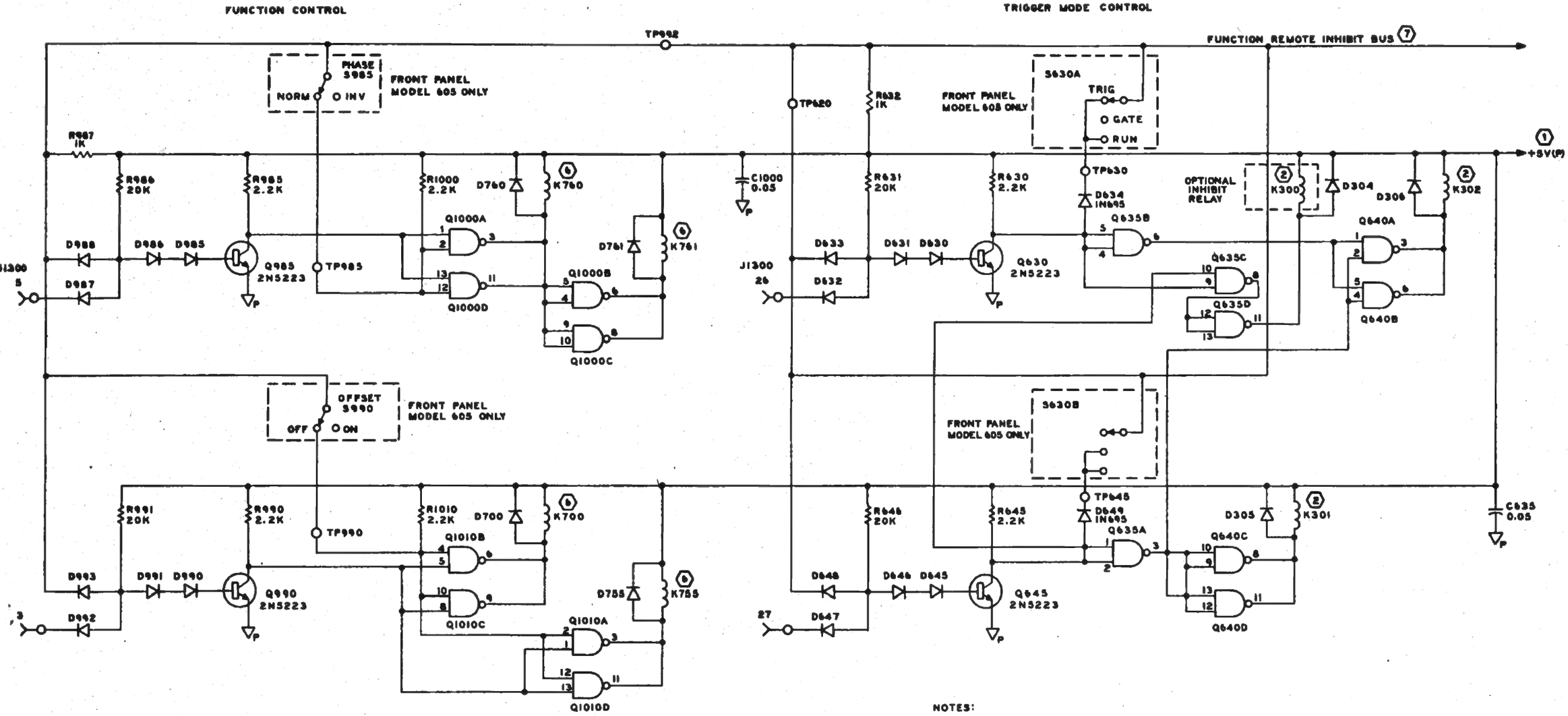
NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN μF
3. ALL DIODES ARE IN914
4. ▽ CIRCUIT COMMON

FIGURE 6.2.6
⑥ SCHEMATIC DIAGRAM MODEL 605-606
AMPLIFIER AND INVERTING AMPLIFIER CIRCUITS
11-18-76



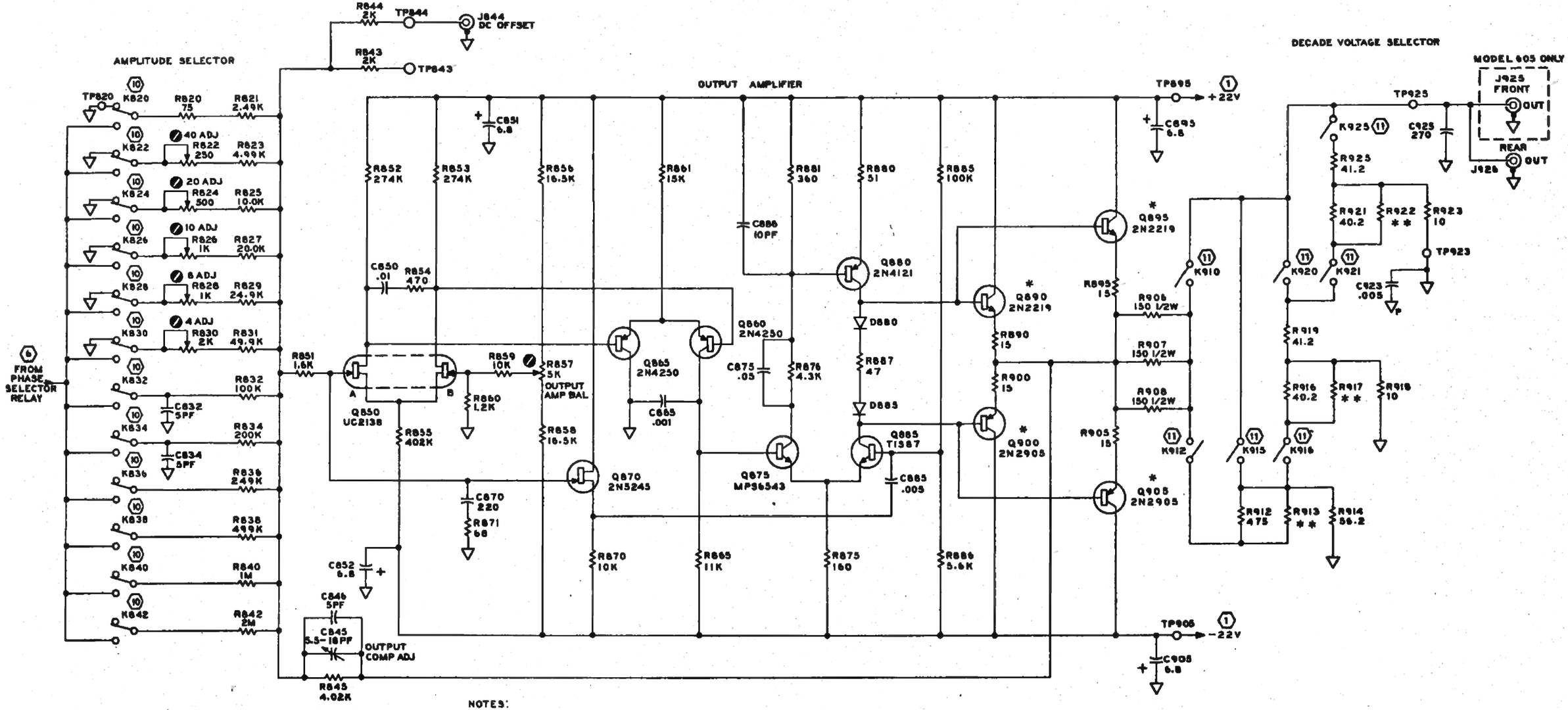
NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ALL IC'S ARE SN7400N
5. ∇_P ISOLATED PROGRAMMING COMMON
6. J1300 PROGRAMMING INPUT CONNECTOR

FIGURE 6.2.7
(7) SCHEMATIC DIAGRAM MODEL 605-606
FUNCTION CONTROL CIRCUITS
10-18-71



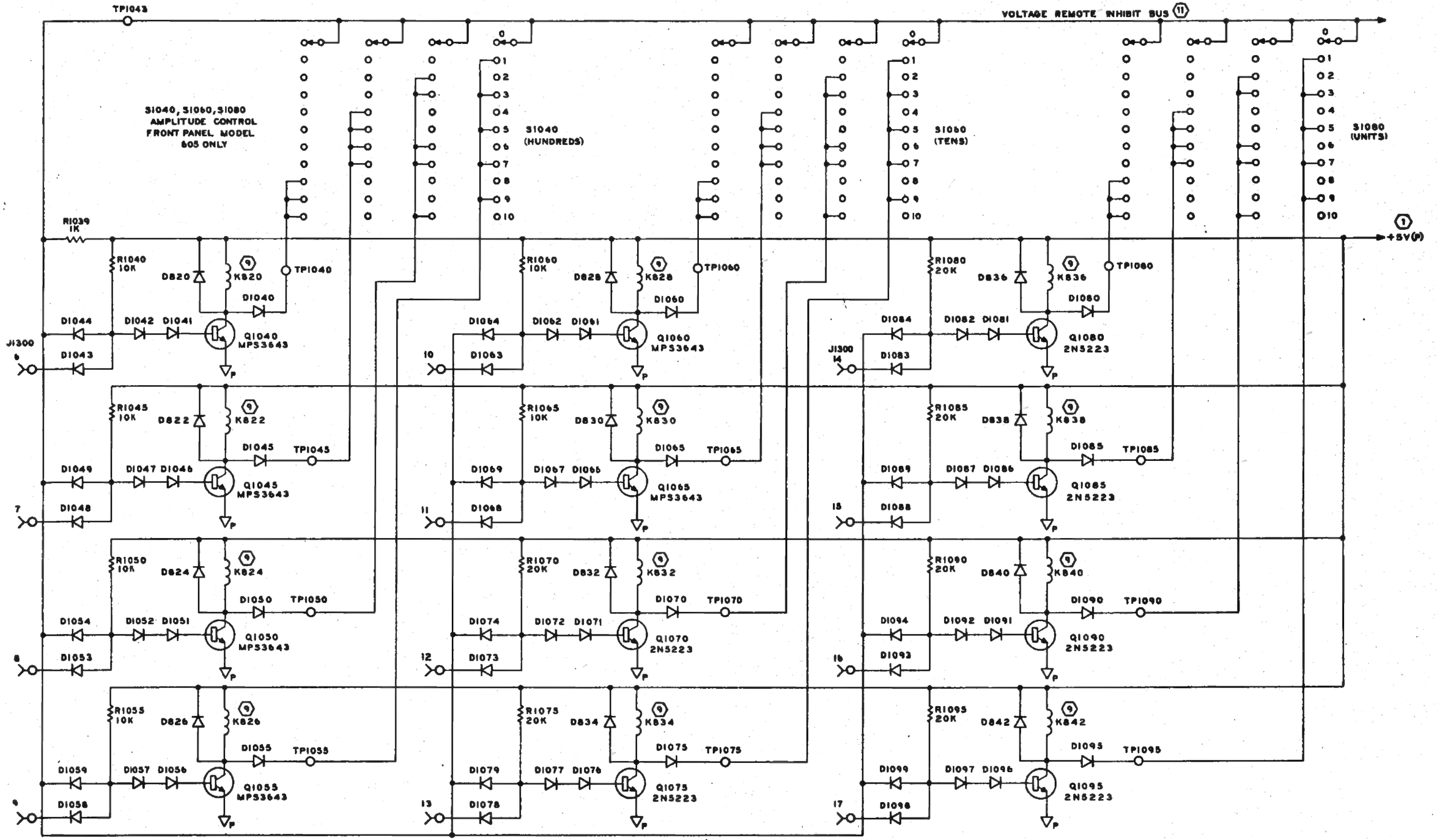
NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ALL IC'S ARE SN7400N
5. ∇_P ISOLATED PROGRAMMING COMMON
6. J1300 PROGRAMMING INPUT CONNECTOR

FIGURE 5.2.8
(8) SCHEMATIC DIAGRAM MODEL 605-606
FUNCTION & TRIGGER MODE INPUT CIRCUITS
11-18-70 REV A



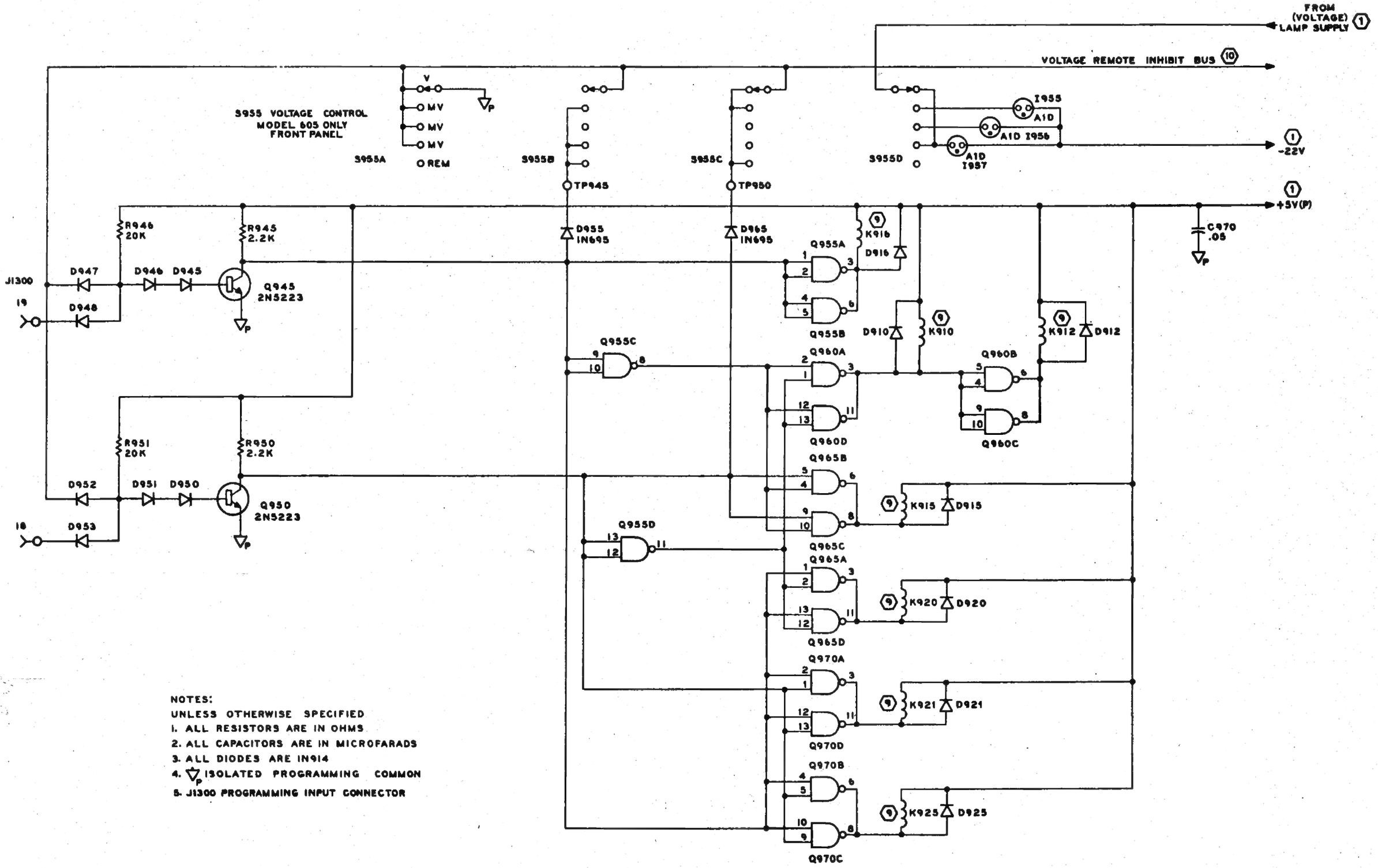
NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN μF
3. ALL DIODES ARE IN914
4. ▽ CIRCUIT COMMON
5. * HEAT SINK
6. ** SELECTED AT FACTORY

FIGURE 8.2.9
(9) SCHEMATIC DIAGRAM MODEL 605-606
OUTPUT AMPLIFIER CIRCUIT
11-18-70 REV. (A)



NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ▽P ISOLATED PROGRAMMING COMMON
5. J1300 PROGRAMMING INPUT CONNECTOR

FIGURE 8.2.10
(10) SCHEMATIC DIAGRAM MODEL 605-606
OUTPUT VOLTAGE CONTROL
10-16-71



NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. ∇_P ISOLATED PROGRAMMING COMMON
5. J1300 PROGRAMMING INPUT CONNECTOR

FIGURE 8.2.11
(11) SCHEMATIC DIAGRAM MODEL 605-606
DECADE VOLTAGE CONTROL
11-18-70