

Concord Instrument Division

INSTRUCTION MANUAL



MODEL 6016
MICROWAVE
FREQUENCY COUNTER
SERIAL NO.

(A)

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SYSTRON  **DONNER**
CORPORATION

TEN SYSTRON DRIVE, CONCORD, CALIFORNIA 94518 U.S.A.
Tel: (415) 682-6161, TWX: 910-481-9479, Cable: SYSTRONDONNER



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Whenever a Systron-Donner instrument requires service, the nearest Systron-Donner representative should be contacted; all representatives will provide immediate service or arrange factory returns when necessary.

Please specify both model and serial number in all correspondence concerning Systron-Donner instruments. Address all inquiries on operation or applications to your nearest sales representative; or, Sales Manager, Concord Instrument Division, Systron-Donner Corporation, 10 Systron Drive, Concord, California 94518.

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CHAPTER 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Systron-Donner Model 6016 Frequency Counter automatically measures continuous-wave (CW) and amplitude-modulated (AM) frequencies from 20 Hz to 18 GHz. The ACTO* (Automatic Computing Transfer Oscillator) technique is used in this counter which eliminates any calculations or adjustments by the operator when measuring microwave inputs.

A single BNC input connector accepts frequencies from 20 Hz to 200 MHz with 10 mV rms sensitivity and 1 M Ω input impedance. Frequencies from 200 MHz to 18 GHz are applied to the type "N" connector; and, one of two ranges, 200 MHz to 3 GHz or 3 GHz to 18 GHz, can be selected from the front panel or via remote input.

A wide choice of high-stability oscillators, complete remote programming, and BCD output are a few of the standard options available.

1.2 SPECIFICATIONS

Table 1.1 lists the specifications applicable to the Model 6016:

TABLE 1.1 SPECIFICATIONS

DIRECT COUNT MODE

Frequency Range:	20 Hz to 200 MHz (ac coupled).
Resolution:	1 Hz to 1 MHz in decade steps.
Input Sensitivity:	10 mV rms.
Attenuation:	Selectable with factors of X1, X10, X100 and X1000.
Maximum Input (without damage):	600 volts dc or 200 volts rms at 1 kHz with X1000 attenuation.
Input Impedance:	1 M Ω shunted by approximately 20 pF.
Input Connector:	BNC type.

*ACTO [®] Systron-Donner Corp.

TABLE 1.1 SPECIFICATIONS (Cont'd)

HIGH FREQUENCY MODE

Frequency Range:	200 MHz to 18 GHz.
Resolution:	1 Hz to 1 MHz in decade steps.
Input Sensitivity:	50 mV rms (-13 dBm) 200 MHz to 9 GHz; 100 mV rms (-7 dBm) 9 to 12.4 GHz; 160 mV rms (-3 dBm) 12.4 to 18 GHz.
Maximum Input:	+20 dBm, without damage.
Input Impedance:	50 ohms, nominal.
Input Connector:	N type.
Phase-Lock Range:	Approximately 2% of input frequency.

STANDARD TIME BASE

Crystal Frequency:	1 MHz.
Stability:	See Oscillator Specifications.
External Time Base:	Accepts 1 MHz, 1 volt rms (nominal) into 1 k Ω via rear panel BNC type connector. Rear panel switch selects internal or external time base.
Time Base Output:	1 MHz from rear panel BNC type connector. Approximately 3 volts p-p from 1 k Ω source.

GENERAL

Display:	9 digits in-line.
Display Storage:	Built-in storage provides continuous display of most recent measurement.

TABLE 1.1 SPECIFICATIONS (Cont'd)

GENERAL (Cont'd)

Sample Rate:	Rear panel switch selects FAST (25 ms) or SLOW (100 ms) sample times. Also includes HOLD position.
Operating Temperature:	0°C to 50°C.
Dimensions:	5-1/4" H x 8-3/8" W x 15-1/8" D (13.3 x 21.3 x 38.4 cm).
Weight:	Approximately 25 lbs, net.
Power:	115/230 volts ($\pm 10\%$), 50-60 Hz.

OPTIONS

11(B3)	Oscillator (see Oscillator Specifications).
12(B)	Oscillator (see Oscillator Specifications).
13(B4)	Oscillator (see Oscillator Specifications).
17	Digital Outputs: +5 volt (nom.) positive true logic levels, DTL/TTL compatible. 1-2-4-8 coded. +5 volt positive and 0 volt negative reference levels. +15 volt (nom.) print command at end of conversion. Accepts +15 volt inhibit.
20	Remote Programming: Group binary control of range, resolution and attenuator controls. Ground true logic. DTL/TTL compatible.
21	Remote Programming: Single line control of range, resolution and attenuator controls. Ground true logic. DTL/TTL compatible.

Table 1.2 lists the oscillator specifications applicable to the Model 6016.

TABLE 1.2 OSCILLATOR SPECIFICATIONS

	STANDARD	OPTION 11	OPTION 12	OPTION 13
Aging rate after warm-up	±7 parts in 10 ⁹ /24 hrs. ±2 parts in 10 ⁸ /24 hrs.	<±3 parts in 10 ⁹ /24 hours	<+1 part in 10 ⁹ /24 hours	±5 parts in 10 ¹⁰ /24 hours
Maximum warm-up for 'off' periods to 1 week	30 days 72 hours	72 hours	72 hours	72 hours
Frequency retrace for 'off' periods to approx. 24 hrs.	72 hrs. typical to reach ±2 parts in 10 ⁸	1 hr. typ. to reach ±6 parts in 10 ⁸ maximum	1 hr. typ. to reach ±6 parts in 10 ⁸ maximum	1 hr. typical to reach <±5 parts in 10 ⁹
Short-term aging rate	±5 parts in 10 ⁹ rms for 10 sec. average	±1 part in 10 ¹⁰ rms for 1 sec. average	±1 part in 10 ¹⁰ rms for 1 sec. average	1 hr. typical to reach <±5 parts in 10 ⁹
Temperature variation	±5 parts in 10 ⁹ /°C from -20 to +50°C	Typically <±2 parts in 10 ¹⁰ /°C; worst case is ±4 parts in 10 ⁹ over 20° change within -20 to +55°C		
±10% change in line voltage from specified	<±2 parts in 10 ⁸	±5 parts in 10 ¹⁰	±5 parts in 10 ¹⁰	±5 parts in 10 ¹¹
Long-term aging rate	±3 parts in 10 ⁹ /24 hrs. after 45 days dynamic	±3 parts in 10 ⁸ /30 days	±3 parts in 10 ⁸ /30 days	±1.5 parts in 10 ⁸ /30 days

CHAPTER 2 INSTALLATION

2.1 INTRODUCTION

Procedures for inspection and initial installation of SD Model 6016 are outlined below. Reshipment instructions have been included should the instrument be returned to Systron-Donner Corporation for repair or recalibration.

2.2 RECEIVING INSPECTION

Before accepting the instrument from the shipper, inspect the shipping container for signs of external damage. Any sign of such damage must be noted by both the shipper and customer; then, should be reported to the insurance investigator.

As soon as the instrument is unpacked, inspect it for shipping damage. Check for scratches or dents, broken or cracked knobs, and damaged connectors. Should any damage be found, notify your nearest Systron-Donner representative -- do not use the instrument until instructed to do so by the representative.

2.3 INSTALLATION

Initial installation of the Model 6016 includes power connection and verification of internal cooling.

2.3.1 Power

The Model 6016 may be operated from a 115 or 230-volt ac ($\pm 10\%$) power source. Conversion from one source to another is performed by changing the rear panel power switch and installing the proper fuse.

The instrument is factory-supplied with a 1 A, 3AG fuse for 115 V operation. Be sure to replace this fuse with a .5 A, 3AG fuse when operating with 230 V.

CAUTION

Before connecting instrument into ac power line, be certain that power switch is set for proper voltage.

The Model 6016 is equipped with a standard three-conductor power cord that automatically grounds the unit when a matching power

outlet is available. An adapter which provides the instrument ground should be used whenever the power cord is connected to a two-conductor outlet.

2.3.2 Cooling

The Model 6016 Counter uses forced-air cooling. The air intake is located on the rear panel of the instrument. Make sure the air intake filter is clean and in place before applying power to the instrument. Under no circumstance should the air intake be obstructed while the instrument is operating.

2.4 RESHIPMENT

Should it become necessary to reship the instrument, contact the nearest Systron-Donner field office for shipping instructions. If possible, use the original packaging materials, or replace the packing in accordance with MIL-P-116 and MIL-E-17555E. The field office can provide materials similar to those used for original factory packaging. All correspondence should refer to the full nomenclature and serial number of the instrument.

CHAPTER 3
OPERATION

3.1 INTRODUCTION

This chapter describes the SD Model 6016 controls, connectors and indicators. Initial turn-on and operational checks are included, along with step-by-step operating procedures listing each counter function.

3.2 CONTROLS, CONNECTORS, AND INDICATORS

3.2.1 Front Panel

Front panel control functions for the Model 6016 are described in this section as follows (see Figure 3.1 and Table 3.1):

TABLE 3.1 FRONT PANEL CONTROLS

Index	Name	Function
1	POWER (Pushbutton)	Press to turn on power; Press to turn off power.
2	RESET (Pushbutton)	Momentary press to reset counter.
3	1 M Ω , 20 Hz-200 MHz (Connector)	Type BNC connector provides input for signal.
4	ATTENUATOR (Pushbuttons)	Attenuates the input applied to the 20 Hz to 200 MHz input by a factor of 1, 10, 100, or 1000.
5	3 GHz (Pushbutton)	When pressed, disables other frequency ranges and enables the 200 MHz to 3 GHz range.
6	18 GHz (Pushbutton)	When pressed, disables other frequency ranges and enables the 3 to 18 GHz range.
7	50 Ω , 200 MHz-18 GHz (Connector)	Type N connector provides input for signal.
8	SENSITIVITY (Knob)	Controls the video gain.
9	RESOLUTION/Hz (Pushbuttons)	Seven pushbuttons select desired resolution.
10	KHz (Indicator)	LED lamp indicates KHz units.
11	MHz (Indicator)	LED lamp indicates MHz units.
12	GHz (Indicator)	LED lamp indicates GHz units.

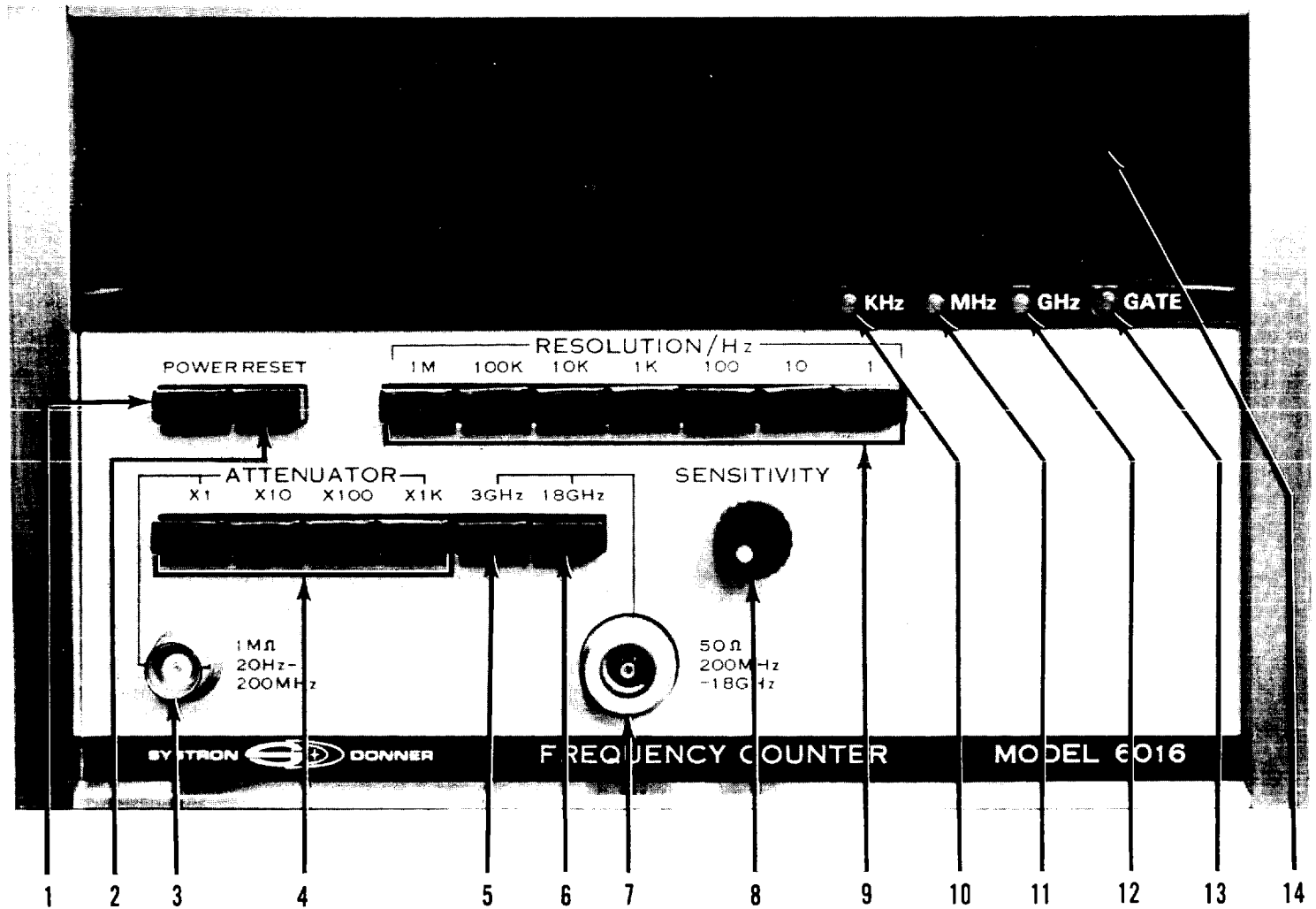


FIGURE 3.1 FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS

TABLE 3.1 FRONT PANEL CONTROLS (Cont'd)

Index	Name	Function
13	GATE (Indicator)	LED lamp indicates opening and closing of the GATE.
14	READOUT (Indicator)	9-digit in-line, 999,999,999 maximum display.

3.2.2 Rear Panel

Rear Panel control functions for the Model 6016 are described in this section as follows (see Figure 3.2 and Table 3.2):

TABLE 3.2 REAR PANEL CONTROLS

Index	Name	Function
1	REMOTE (Connector)	Allows remote control of all front panel pushbutton switches with the exception of the POWER pushbutton.
2	FAN FILTER	Filters the forced cooling air for the counter. Filter screen should be cleaned periodically.
3	FUSE	Fuse holder for 1A-115 V or .5A-230 V fuses.
4	115/230 V (Connector)	Power cord receptacle.
5	LINE (Switch)	Sets instrument for operation with 115 or 230 V power source.
6	TEST (Switch)	Supplies an internal 1 MHz frequency to the counting circuits when in the ON position.
7	INT/EXT (Switch)	Selects 1 MHz internal or external time base.
8	1 MHz (Connector)	BNC receptacle for INT 1 MHz-OUT or EXT 1 MHz-IN connection.
9	FREQ. ADJ. COARSE, FINE	Screwdriver adjustment of internal 1 MHz oscillator frequency.
10	RECYCLE RATE (Switch)	Controls the recycle rate of the counter (either FAST, SLOW, or HOLD).
11	BCD OUTPUT (Connector)	Supplies 1-2-4-8 BCD output logic levels.

3.3 INITIAL TURN-ON AND OPERATIONAL CHECK

The following procedures verify operation of the Model 6016 prior to on-line usage. Successful completion of these checks should precede any performance tests.

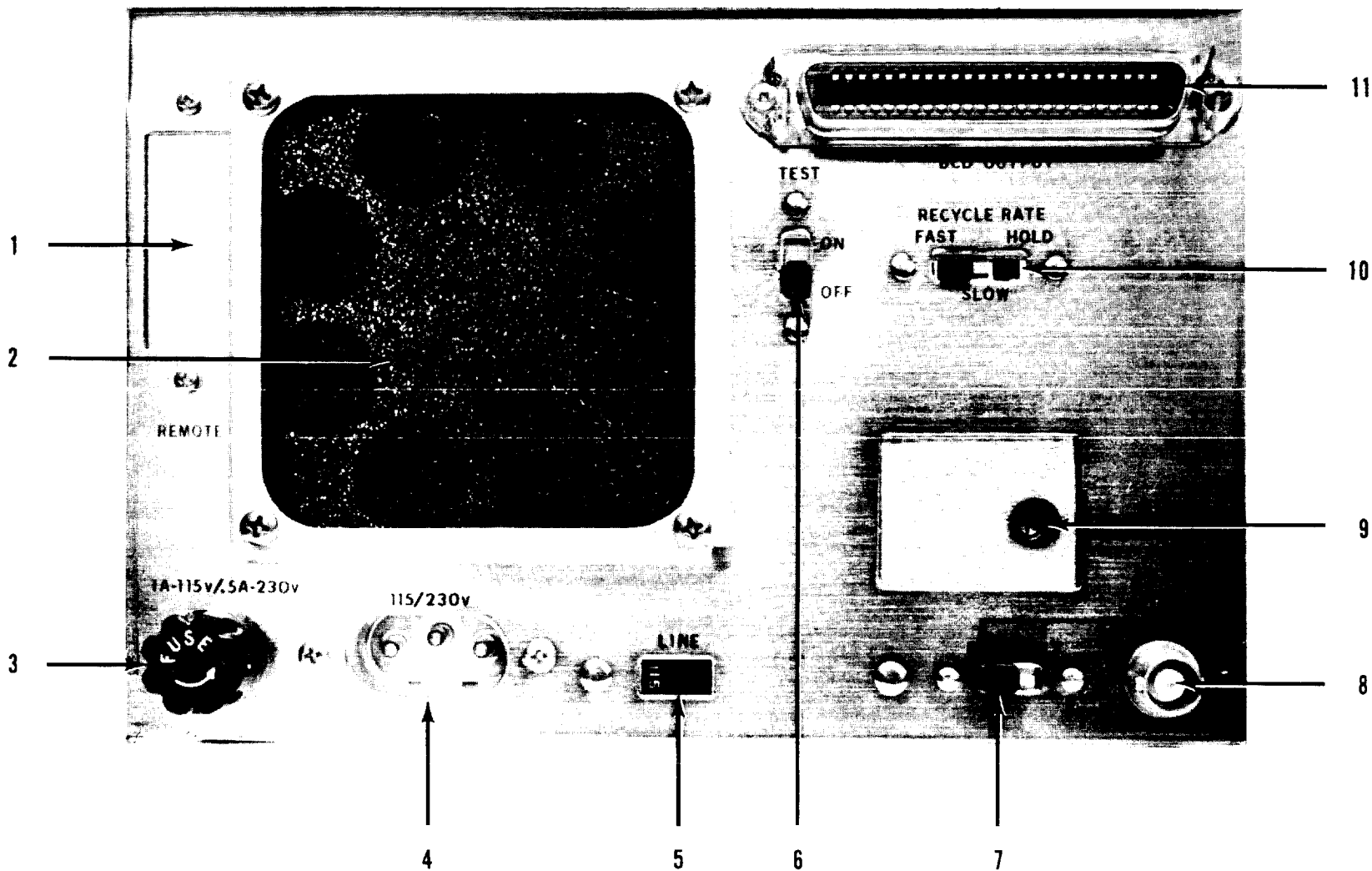


FIGURE 3.2 REAR PANEL CONTROLS, INPUTS, AND OUTPUTS

- 1) Connect instrument to 115 volt ac source.

CAUTION

Be sure line switch on rear panel is in the 115 V position.

- 2) Position the 1 MHz INT/EXT switch to the INT position.
- 3) Press POWER pushbutton.
- 4) Position the TEST slide switch (on the rear panel) to the ON position.
- 5) Check the instrument readout while pressing each of the resolution pushbuttons.

TABLE 3.3 PERFORMANCE CHECK, IN TEST

Resolution	Readout	Annunciator
1 Hz	001000.000 ±1 count	KHz
10 Hz	0001000.00 ±1 count	KHz
100 Hz	00001.0000 ±1 count	MHz
1 kHz	000001.000 ±1 count	MHz
10 kHz	0000.00100 ±1 count	GHz
100 kHz	00000.0010 ±1 count	GHz
1 MHz	000000.001 ±1 count	GHz

- 6) Return the TEST slide switch to the OFF position.

3.4 OPERATING PROCEDURES

The following procedures outline the general method for operating the Model 6016.

3.4.1 20 Hz to 200 MHz Range

- 1) Press POWER pushbutton to ON.
- 2) Apply a frequency between 20 Hz and 200 MHz with an amplitude of at least 10 mV rms to the BNC input connector.
- 3) Press desired attenuator pushbutton. If input level is unknown, select highest attenuation level, then proceed to lower attenuation levels to obtain consistent readings.
- 4) Select desired resolution.
- 5) Measurement is automatic.

3.4.2 200 MHz to 3 GHz Range CW Measurement

- 1) Press the 3 GHz pushbutton.
- 2) Apply a frequency between 200 MHz and 3 GHz to the Type N input connector. The amplitude must be at least 50 mV rms (-13 dBm) and no more than 500 mV rms (+7 dBm).
- 3) Slowly increase the SENSITIVITY until a phase lock is achieved. This will be indicated by the proper frequency being displayed on the readout.
- 4) Select the desired resolution.
- 5) Measurement is automatic.

3.4.3 3 GHz to 18 GHz Range CW Measurement

- 1) Press the 18 GHz pushbutton.
- 2) Apply a frequency between 3 GHz and 18 GHz to the Type N input connector. The amplitude must be 50 mV rms (-13 dBm) below 9 GHz; 100 mV rms (-7 dBm) 9 to 12.4 GHz; 160 mV rms (-3 dBm) 12.4 to 18 GHz; and no more than 500 mV rms (+7 dBm).
- 3) Slowly increase the SENSITIVITY until a phase lock is achieved. This will be indicated by the proper frequency being displayed on the readout.
- 4) Select the desired resolution.
- 5) Measurement is automatic.

CHAPTER 4
MAINTENANCE

4.1 INTRODUCTION

This chapter contains procedures for maintenance and calibration of the Model 6016 to aid the user in maintaining the instrument in proper operating condition. Whenever a Systron-Donner instrument requires service, the nearest SD representative should be contacted. He can provide field service, or arrange factory returns, when necessary. Address all inquiries on operation or application to your nearest sales representative; or, Sales Manager:

*SYSTRON-DONNER CORPORATION
CONCORD INSTRUMENT DIVISION
10 Systron Drive
Concord, California 94518
Phone: (415) 682-6161
TWX: 910-481-9479
Cable: SYSTRONDONNER*

Specify both model and complete serial number in all correspondence.

Listed in Table 4.1 is reference designator, description, and drawing information for P.C. assemblies used in this instrument.

TABLE 4.1 MODEL 6016 P.C. ASSEMBLY INFORMATION

Ref	Description	Assy/Part #	Schematic #
A1	200 MHz Amp and Decade	33921	33918
A2	Oscillator Board	33883	39220
A3	Frequency Shifter	33983	33980
A4	Video Amplifier	33972	33973
A5	N Channel IF Amplifier	33962	33959
A6	Power Supply	33927	45374
A7	N Computer and Time Base	33940	33941
A8	Programming Board	33936	33937
A8	Programming Board (Opt. 20)	39887	39888
A8	Programming Board (Opt. 21)	39876	39877
A9	Readout Board	45372	45371
A10	BCD Output (Opt. 17)	39926	39923
A11	Diode Board	45375	45374
U2,3	Mixers	39733	39796
—	3 MHz Oscillator Power (Opt. 11, 12, 13)	39947	39944

4.2 TEST EQUIPMENT

Test equipment recommended for maintaining and checking performance is listed in Table 4.2. Equivalent test equipment having similar characteristics may be substituted when necessary.

TABLE 4.2 RECOMMENDED TEST EQUIPMENT

Type	Characteristics	Recommended Type
Oscilloscope	80 MHz Bandwidth	Tektronix Model 581
Vertical Plug-in	10 mV/cm Sensitivity	Tektronix Model 82
Digital Voltmeter	0.1% dc - 1% ac	SD Model 7005A
Signal Gen.	10 Hz to 10 MHz	HP Model 651B
Signal Gen.	10 MHz to 480 MHz	HP Model 608C
Signal Gen.	450 MHz to 1.2 GHz	HP Model 612A
Signal Gen.	.8 GHz to 2.4 GHz	HP Model 8614A
Signal Gen.	1.8 GHz to 4.5 GHz	HP Model 8616A
Signal Gen.	3.8 GHz to 7.6 GHz	HP Model 618A
Signal Gen.	7 GHz to 11 GHz	HP Model 620B
Signal Gen.	10 GHz to 15.5 GHz	HP Model 626A
Signal Gen.	15 GHz to 21 GHz	HP Model 628A
RF Voltmeter	1 mV to 3 V	HP Model 411A
Frequency Standard	1 MHz Output	General Technology Model 304B
Auto Transformer	Variable 103 V ac to 127 V ac	Superior Model UCIM

4.3 PERFORMANCE VERIFICATION

Operation and performance of all circuits in the counter can be verified by the following procedures:

4.3.1 Test

- 1) Set counter controls:

RECYCLE RATE	FAST
INT/EXT	INT
TEST	ON
RESOLUTION/Hz (Front Panel)	1 MHz

- 2) Press the RESOLUTION/Hz pushbuttons sequentially and check for proper display in accordance with information contained in Table 3.3.

4.3.2 200 MHz Range Frequency Measurements

1) Set counter controls:

RECYCLE RATE	FAST
INT/EXT	INT
TEST	OFF
RESOLUTION/Hz	1 KHz
ATTEN (200 MHz)	X1

- 2) Connect a BNC "T" connector to the 1 M Ω , 20 Hz - 200 MHz range input connector. Connect to the "T" connector, the 10 Hz - 10 MHz signal generator and the vertical input of the oscilloscope.
- 3) Adjust the signal generator from 20 Hz to 10 MHz, maintaining 30 mV p-p input amplitude. The counter should properly display all frequencies in this range.
- 4) Change the counter input to the 10 MHz - 480 MHz signal generator and monitor the input through a "T" connector with the RF voltmeter.
- 5) Adjust the signal generator from 10 MHz to 200 MHz while maintaining 10 mV rms input amplitude. The counter should properly display all frequencies in this range.

4.3.3 3 GHz Range Frequency Measurements

1) Set counter controls:

RECYCLE RATE	FAST
INT/EXT	INT
TEST	OFF
RESOLUTION/Hz	1 KHz
RANGE	3 GHz
SENSITIVITY	MAXIMUM CCW

- 2) Connect the 10 MHz - 480 MHz signal generator to the 50 Ω , 200 MHz - 18 GHz front panel input, and adjust signal generator output level to -13 dBm at 200 MHz. Adjust the sensitivity control until a phase-lock condition exists as exhibited by the counter display.
- 3) Adjust the signal generator from 200 MHz to 480 MHz. Slight readjustment of the sensitivity control may be necessary as the input frequency is varied. The counter should properly display all frequencies in this range.

- 4) Change signal generators, as necessary, to cover the remainder of the frequencies from 480 MHz to 3 GHz while maintaining the input level at -13 dBm. The counter should properly display all frequencies in this range.

4.3.4 18 GHz Range Frequency Measurements

- 1) Set counter controls:

RECYCLE RATE	FAST
INT/EXT	INT
TEST	OFF
RESOLUTION/Hz	1 KHz
RANGE	18 GHz
SENSITIVITY	MAXIMUM CCW

- 2) Proceed as in Section 4.3.3 except use signal generators which cover the range of 3 GHz to 18 GHz while maintaining the input level at -13 dBm to 9 GHz; -7 dBm to 12.4 GHz; and -3 dBm to 18 GHz.

4.3.5 Recycle Rate and Reset

- 1) Set counter controls:

RECYCLE RATE	FAST
INT/EXT	INT
TEST	ON
RESOLUTION/Hz	1 Hz

- 2) Check that the counter indicates 1000.000 KHz, the GATE lamp is on for 1 second and the time between flashes is very short.
- 3) Set the RECYCLE RATE switch to SLOW and observe that the gate lamp is still on for 1 second; but, the time between flashes is approximately 1 second.
- 4) Place the RECYCLE RATE switch to HOLD and observe that the gate lamp is out and the last counter reading is displayed.
- 5) Depress the front panel RESET button. All indicators should read zero until the button is released. The gate lamp should flash on for 1 second and a reading of 1000.000 KHz should be displayed. No further measurements should occur until the RESET button is pushed.

4.4 CALIBRATION

4.4.1 Power Supply, A6

- 1) Connect the counter line cord to the variable auto-transformer. Monitor output voltage with an ac DVM. Adjust autotransformer for 115 volt indication.
- 2) Connect the DVM to A6TP3 and adjust A6R14 for +15.0 V.
- 3) Connect the DVM to A6TP4 and adjust A6R19 for -15.0 V.
- 4) Connect the DVM to A6TP1 and adjust A6R2 for +5.00 V.
- 5) Connect the DVM to A6TP2 and adjust A6R8 for -5.20 V.
- 6) Connect the DVM to A6TP5 and adjust A6R22 for +5.00 V.

4.4.2 200 MHz Amplifier and Decade, A1

- 1) Set counter controls:

ATTENUATOR	X1
RESOLUTION/Hz	1 KHz
RECYCLE RATE	FAST
TEST	OFF

- 2) Connect a BNC "T" connector to the 1 M Ω , 20 Hz - 200 MHz front panel input. Connect the 10 MHz - 480 MHz signal generator and the RF voltmeter to the BNC "T" connector. Set the signal generator to 200 MHz at 25 mV rms as read on the RF voltmeter.
- 3) Reduce the output level until the counter display is unstable. Adjust A1R47 for a stable display. Repeat this procedure until unable to obtain a stable reading. Increase signal level until the display just becomes stable. Input level, as read on RF voltmeter, should be 10 mV rms or less.
- 4) Connect 10 Hz - 10 MHz signal generator and monitor the input signal at the BNC "T" connector with the oscilloscope.
- 5) Set signal generator to 10 MHz at minimum input level to give a stable readout.
- 6) Change ATTENUATOR pushbutton to X10 and increase the input level by a factor of 10.
- 7) Adjust A1R50 to obtain a stable readout.

- 8) Change ATTENUATOR pushbutton to X100 and increase input level to obtain a stable readout. Input level, as monitored on the oscilloscope, should be approximately ten times greater than in the previous step.

4.4.3 ACTO Oscillator Board, A2

- 1) Set counter controls:

RANGE	18 GHz
RESOLUTION/Hz	10 KHz
SENSITIVITY	MAXIMUM CCW

- 2) Connect oscilloscope to A2TP1 and adjust A2R54 for a triangular waveform 20 V p-p and approximately 100 ms/cycle.
- 3) Remove the A2 assembly from the instrument and reinstall using a 50-pin extension, P.C. board (SD #39153).
- 4) Using clip leads, connect A2TP1 and A5TP1 to ground (instrument chassis).
- 5) Using an insulated screwdriver, adjust A2L2 for a counter readout of 19430 MHz.

CAUTION

Do not remove oscillator P.C. board shield. Removing shield will alter oscillator adjustments.

- 6) Change RANGE pushbutton to 3 GHz and adjust A2L4 for a counter readout of 7343 MHz.
- 7) Reinstall A2, P.C. board in normal position.
- 8) Connect the horizontal input of the oscilloscope to A2TP1 and adjust the horizontal attenuation to produce a trace 10 cm in length. Connect the vertical input of the oscilloscope to U2 Mixer/A4, Video Amplifier input. Set the oscilloscope for dc coupling at 2 V/cm deflection.
- 9) Alternately adjust A2C26 and A2C27 for maximum linear negative deflection while switching between the 18 GHz and 3 GHz range on the front panel. The average negative voltage is 4 volts (-4 V).

4.4.4 ACTO Frequency Shifter, A3

- 1) Set counter controls:

RANGE	18 GHz
SENSITIVITY	MAXIMUM CCW

- 2) Remove the A3 assembly from the instrument and reinstall using a 50-pin extension, P.C. Board (SD #39153).
- 3) Connect oscilloscope vertical input to A3U5, pin 2, using a short ground connection. Adjust A3T1 for maximum and overall flatness of the displayed signal.
- 4) Connect oscilloscope external trigger to A7TP1. Adjust A3C39 for minimum amplitude modulation as observed on A3U5, pin 2. Reinstall A3 assembly in the normal position.
- 5) Connect the horizontal input of the oscilloscope to A2TP1 and adjust the horizontal attenuation to produce a trace 10 cm in length. Connect the vertical input of the oscilloscope to U3 Mixer/A5, N Channel IF Amplifier input. Set the oscilloscope for dc coupling at 2 V/cm deflection.
- 6) Alternately adjust A3C63 and A3C64 for maximum linear negative deflection while switching between the 18 GHz and 3 GHz ranges. The average negative voltage is 2 volts (-2 V)

4.4.5 ACTO Video Amplifier, A4

The filter on the A4 assembly, A4L3 and A4L4 is not used on the Model 6016.

4.4.6 ACTO N Channel IF Amplifier, A5

- 1) Set counter controls:

INT/EXT	EXT
RANGE	18 GHz
SENSITIVITY	MAXIMUM CCW

- 2) Remove the A5 assembly from the instrument and reinstall using a 50-pin extension, P.C. board (SD #39153).
- 3) Connect the vertical input of the oscilloscope to A5U5, pin 6. Set the horizontal time to .1 μ s/div.
- 4) Adjust A5C26 for a signal as close as possible to .1 μ s/cycle (10 MHz).
- 5) Connect oscilloscope external sync to the rear panel, 1 MHz output BNC connector. Change the INT/EXT switch to the INT position. Observe that the 10 MHz signal is in sync and does not drift on the oscilloscope. This indicates the 10 MHz is phase locked to the 1 MHz.

- 6) Connect the 10 Hz - 10 MHz signal generator to the U3 Mixer/A5 N Channel IF Amplifier input. Set to 10 MHz at .5 mV rms input level.
- 7) Connect oscilloscope to A5U2, pin 5.
- 8) Adjust A5L3 and A5L4 for maximum 10 MHz signal.

CAUTION

All adjustments to A5L3 and A5L4 must be done with the P.C. shield in place to prevent spurious oscillations.

- 9) Connect the .8 GHz - 2.4 GHz signal generator to the 50 Ω , 200 MHz - 18 GHz front panel input connector. Set to 875 MHz at -25 dBm input level.
- 10) Connect the horizontal input of the oscilloscope to A2TP1, vertical input to A5U2, pin 5.
- 11) Adjust A5L3 and A5L4 for the waveform shown in Figure 4.1. Very minor adjustment should be required.
- 12) Reinstall the A5 assembly in the instrument.

4.4.7 Sensitivity Adjustment, ACTO Mode

- 1) Set counter controls:

RANGE	18 GHz
RESOLUTION/Hz	1 KHz
SENSITIVITY	MAXIMUM CW

- 2) Connect the 1.8 GHz - 4.5 GHz signal generator to the front panel 50 Ω , 200 MHz - 18 GHz input. Set generator to 3 GHz at -20 dBm input level.
- 3) Adjust A4R33 to obtain a phase-lock indication as shown by the input frequency readout display.
- 4) Decrease the signal generator output level while adjusting A4R33 to obtain the best phase-lock sensitivity.
- 5) Connect the vertical input of the oscilloscope to A5TP1 and the external sync to A7TP1. Set signal generator to 12 GHz at 0 dBm.
- 6) Adjust A5R23 for the best signal-to-noise ratio.

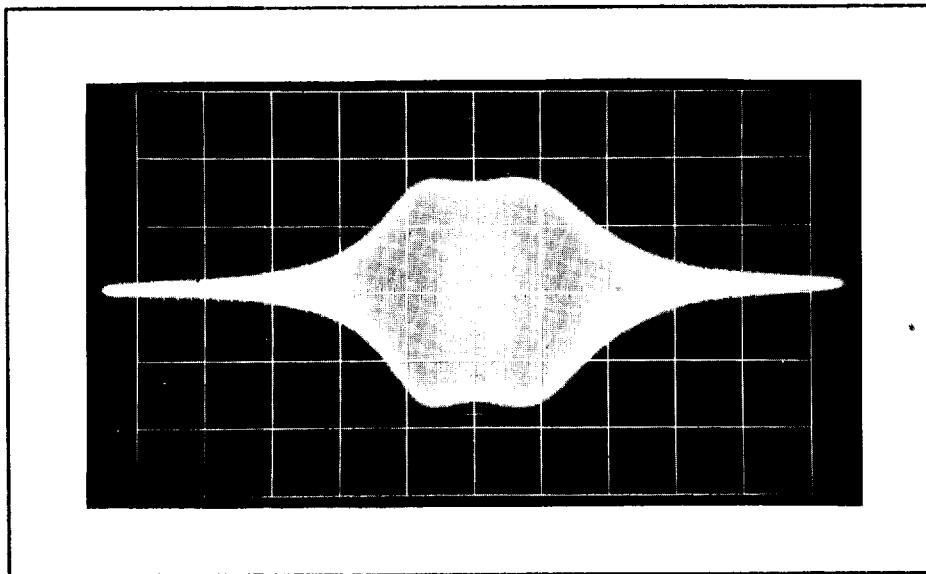


FIGURE 4.1 N CHANNEL IF AMPLIFIER BANDPASS WAVEFORM; A5U2 PIN 5 (.5V/DIV VERTICAL), A2TP1 (ACTO SWEEP HORIZONTAL).

4.4.8 1 MHz Oscillator, U4

The 1 MHz oscillator is the only component in the instrument requiring routine calibration in order to maintain best accuracy. Periodic adjustment of oscillator frequency is a requirement for normal calibration. When calibration is required, be sure the instrument has been on and operating continuously for 72 hours.

- 1) Connect the 1 MHz frequency standard to the external sync input of the oscilloscope.
- 2) Connect the 1 MHz output signal on the rear panel, BNC connector to the vertical input of the oscilloscope. Set the horizontal sweep rate to 10 ns/cm.
- 3) Set the FINE/COARSE frequency adjustment on the oscillator as required to produce a stationary waveform.
- 4) If the waveform moves at a rate of 1 cm/second, the two frequencies are within ± 1 part in 10^8 of each other. A rate of 1 cm/10 second interval indicates the frequencies are within ± 1 part in 10^9 of each other.

4.5 ROUTINE MAINTENANCE

A regular program for maintenance and inspection every five to

six months is recommended for this unit. As part of these regular procedures, the instrument should be checked in the following manner:

- 1) Disconnect ac power and remove the top and bottom covers.
- 2) Make a thorough visual inspection of all wiring and cables. Check for frayed, loose, or burned wires.
- 3) Check the physical integrity of all components. Look for burned or cracked components, loose solder connections, leakage of insulation compounds, and general physical damage. When a printed-circuit board contains integrated-circuit packages, ensure that all packages are firmly mounted. Never unnecessarily remove and replace a package.
- 4) Check all front panel switches and controls for loose or broken terminals, loose or sticking shafts, etc.
- 5) If the internal panel surfaces and components have an excessive amount of dust deposited on them, use a soft brush and low-pressure stream of air to remove the foreign material.

CAUTION

Do not clean P.C. boards or small internal components with a stiff brush or solvents, since damage to the circuits may result. A high-powered vacuum cleaner device should not be used on small internal components.

- 6) Wipe the external surfaces of the instrument with a soft damp cloth to remove dirt, fingerprints, and other foreign materials.
- 7) Replace the top and bottom covers and reconnect ac power. Check instrument performance in accordance with procedures given in Section 4.3. If performance does not match or exceed the specifications listed in Chapter 1 of this manual, corrective maintenance may be required.

4.6 PRINTED-CIRCUIT BOARD REPAIR

When replacing integrated circuits or other electronic components soldered to printed-circuit boards, the procedures indicated below must be followed or damage to the board may result:

- 1) Determine by troubleshooting techniques, which integrated circuit or discrete component(s) has failed.
- 2) Remove the defective component(s) from the board by cutting the pins or leads with a small diagonal clipping tool. (Always remove and replace the entire component).
- 3) Apply heat (40-50 W soldering iron) sparingly to each of the cut pins or leads and remove from the board; clean the hole(s) with a toothpick or solder suction tool.

- 4) Form the tinned leads of the replacement part and insert in the printed-circuit holes; solder, then trim leads to extend 1/16-inch beyond the back surface of the board. (Use only 63-37 solder with maximum 1/16-inch diameter.)

CAUTION

Always trim semiconductor leads only after soldered installation is complete. This procedure greatly lessens the possibility of component failure due to shock-wave damage caused by the trimming tool.

- 5) When soldering semiconductor devices and all small components, be sure to use a heat sink tool or long-nosed plier connected to the component lead(s) while each is being soldered. Allow the soldered connection to cool before removing the heat sink.
- 6) Clean all dirt and solder-flux from the printed-circuit traces by liberal application of isopropyl alcohol or freon-type solvents.



CHAPTER 5

PRINCIPLES OF OPERATION

5.1 INTRODUCTION

In this chapter, operating principles of the Model 6016 are discussed. Operation of the instrument centers on two distinct counting techniques: 1) direct counting mode; and, 2) Automatic Computing Transfer Oscillator mode (ACTO*).

5.2 FUNCTIONAL DESCRIPTION

The instrument automatically measures continuous wave (CW) and amplitude modulated (AM) signals from 20 Hz to 18 GHz. Frequency measurements from 20 Hz to 200 MHz are made in the direct counting mode through the front panel "BNC" type input connector. Measurements from 200 MHz to 18 GHz, in two ranges, are made using the ACTO mode. These signals are connected into the front panel "N" type input connector.

5.2.1 Direct Counting Mode (20 Hz to 200 MHz)

Figure 5.1 shows the basic block diagram for the direct counting mode of operation. The circuits used in this mode include an input amplifier and shaper, a 1 MHz crystal oscillator and shaper, a series of $\div 10$ time base dividers, a control circuit and gate, and a series of decade counting units (DCU) with associated indicators.

The direct counting technique compares the frequency of an unknown signal to a time base derived from the reference frequency. When an unknown signal is connected to the instrument, the input amplifier shaper converts that signal into square waves or pulses which are subsequently applied to the gate circuit. The output from the gate circuit then passes to the first DCU, the second DCU etc, for a period controlled by the selected time base. The serialized signal, at this point, is coded into BCD format to drive the readout tubes and optional external BCD output. Measurement unit indication and decimal point placement provide accurate (± 1 count ambiguity) readout.

5.2.2 Automatic Computing Transfer Oscillator, ACTO* (200 MHz to 18 GHz)

Figure 5.2 shows the basic block diagram of the Automatic Computing Transfer Oscillator. In the absence of an RF input signal, there is no signal present at the output of the video amplifier. The sweep oscillator runs free, therefore, sweeping

*ACTO [®] Systron-Donner Corp.

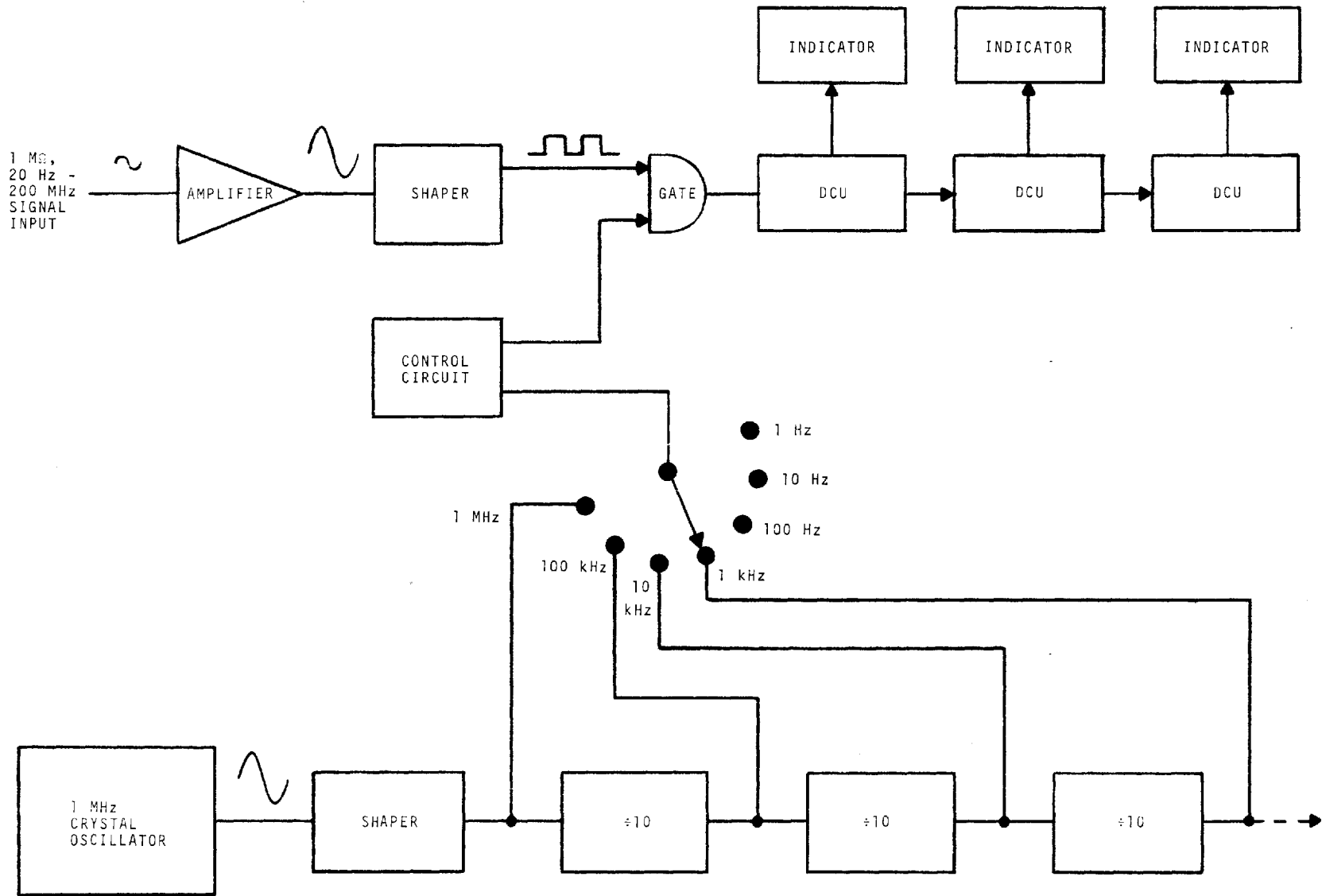


FIGURE 5.1 DIRECT COUNTING MODE

over a narrow band of frequencies. The output of the VCO goes to the harmonic mixer. The mixer has a built-in harmonic generator capable of generating strong harmonics of the VCO.

The RF input signal is applied to both harmonic mixers through a resistive power divider.

Any of several harmonics of the VCO are capable of mixing with the RF input signal. When an RF input signal is applied to the mixer and mixed with a harmonic of the VCO, a difference signal is developed in the mixer and applied to the video amplifier. When the difference frequency in the video amplifier is 10 MHz, it is divided by 10 and applied to a phase detector where it is phase-compared with 1 MHz from the counter. The output of the phase detector is a dc control voltage which controls the frequency of the VCO. As soon as this occurs, the sweep oscillator is overridden, and is no longer able to sweep the VCO. The VCO is now tuned to an exact submultiple of the input frequency with an offset of the video amplifier frequency.

A second output from the VCO is applied to the count input of the counter so that the exact frequency of the VCO can be measured.

A third output from the VCO is used to drive a single-sideband generator. This generator is modulated at a 1 kHz rate and the resultant output is equal to the VCO frequency shifted in frequency by 1 kHz. The shifted frequency is then amplified and applied to a second harmonic mixer.

When the first channel is phase locked to the RF input, an exact 10 MHz video frequency is produced since it is phase-locked to 1 MHz. However, the second harmonic mixer would not be exactly 10 MHz because the signal driving this mixer is different by 1 kHz. The actual output frequency would be 10 MHz, plus or minus 1 kHz, times the harmonic number. This is amplified in the IF amplifier, applied to a mixer, and mixed with 10 MHz. The difference in the frequency is then 1 kHz times the harmonic number (N).

Since the original 1 kHz modulation frequency and the 1 kHz X N are present, the two frequencies can be compared and N extracted. This expands the counting period by the factor N and correctly indicates the input frequency on the counter readout.

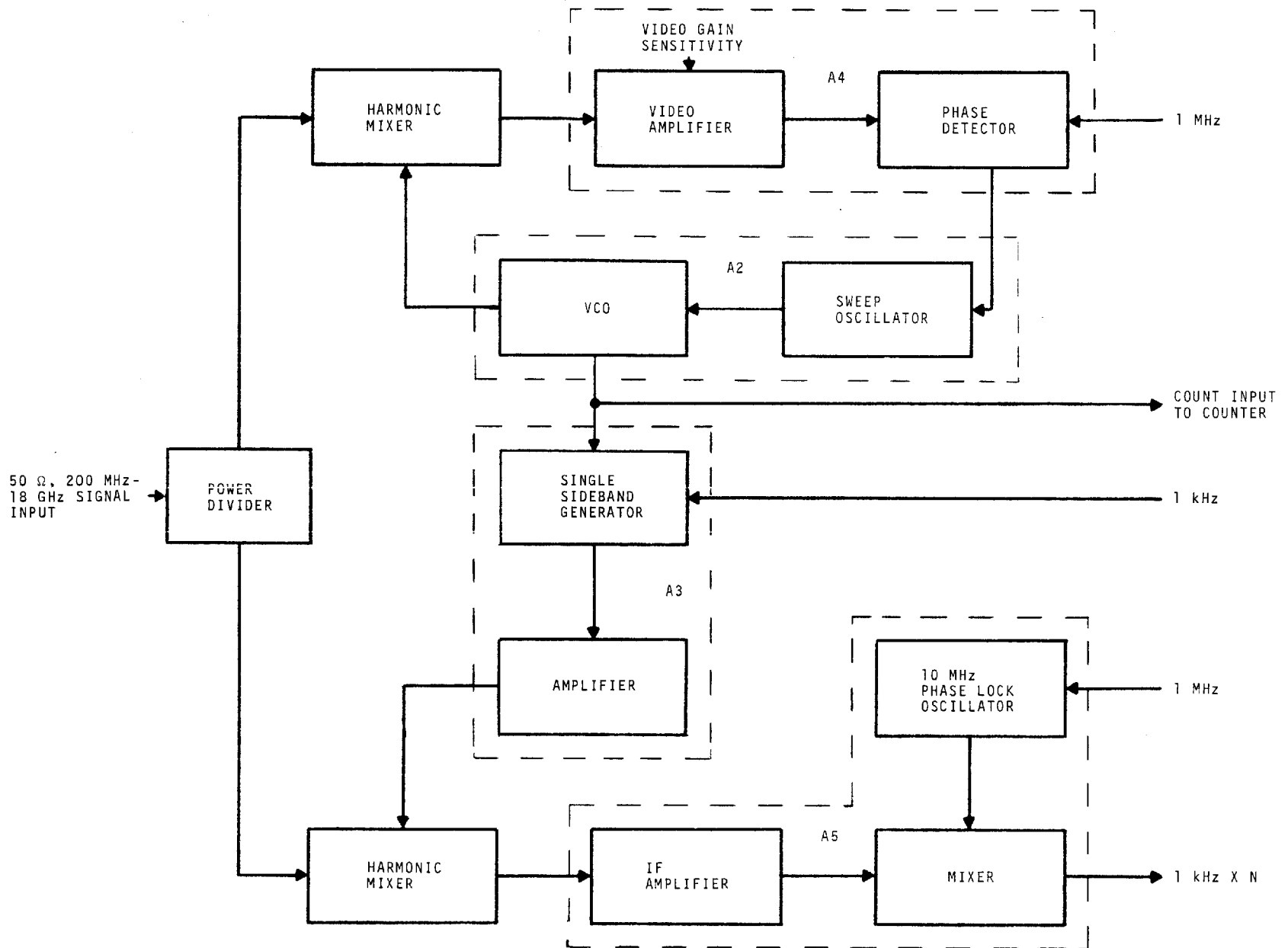


FIGURE 5.2 ACTO* COUNTING MODE

CHAPTER 6
CIRCUIT DESCRIPTIONS, DRAWINGS, AND PARTS LISTS

6.1 INTRODUCTION

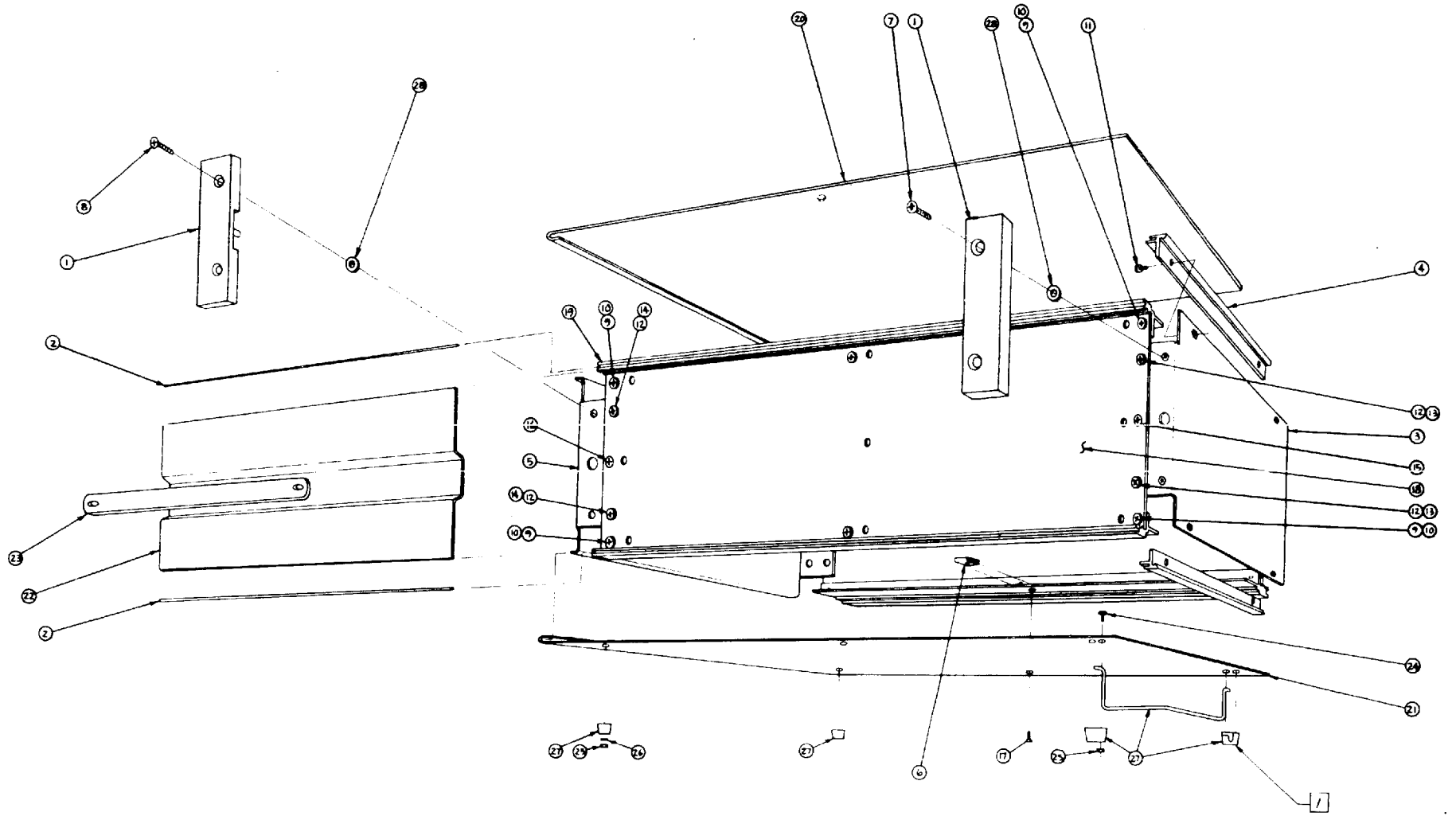
This chapter contains final assembly drawings/parts lists and block diagram for the Model 6016 Frequency Counter. Also included in this section are the circuit board descriptions, drawings, and parts lists which appear in board number sequence. Options and Modifications for the instrument are described in Chapter 7.

6.2 DESCRIPTIONS AND DRAWINGS

Listed in Table 6.1, for reference purposes, is an index to final assembly and printed-circuit board drawings provided in this chapter.

TABLE 6.1 DRAWING INDEX INFORMATION

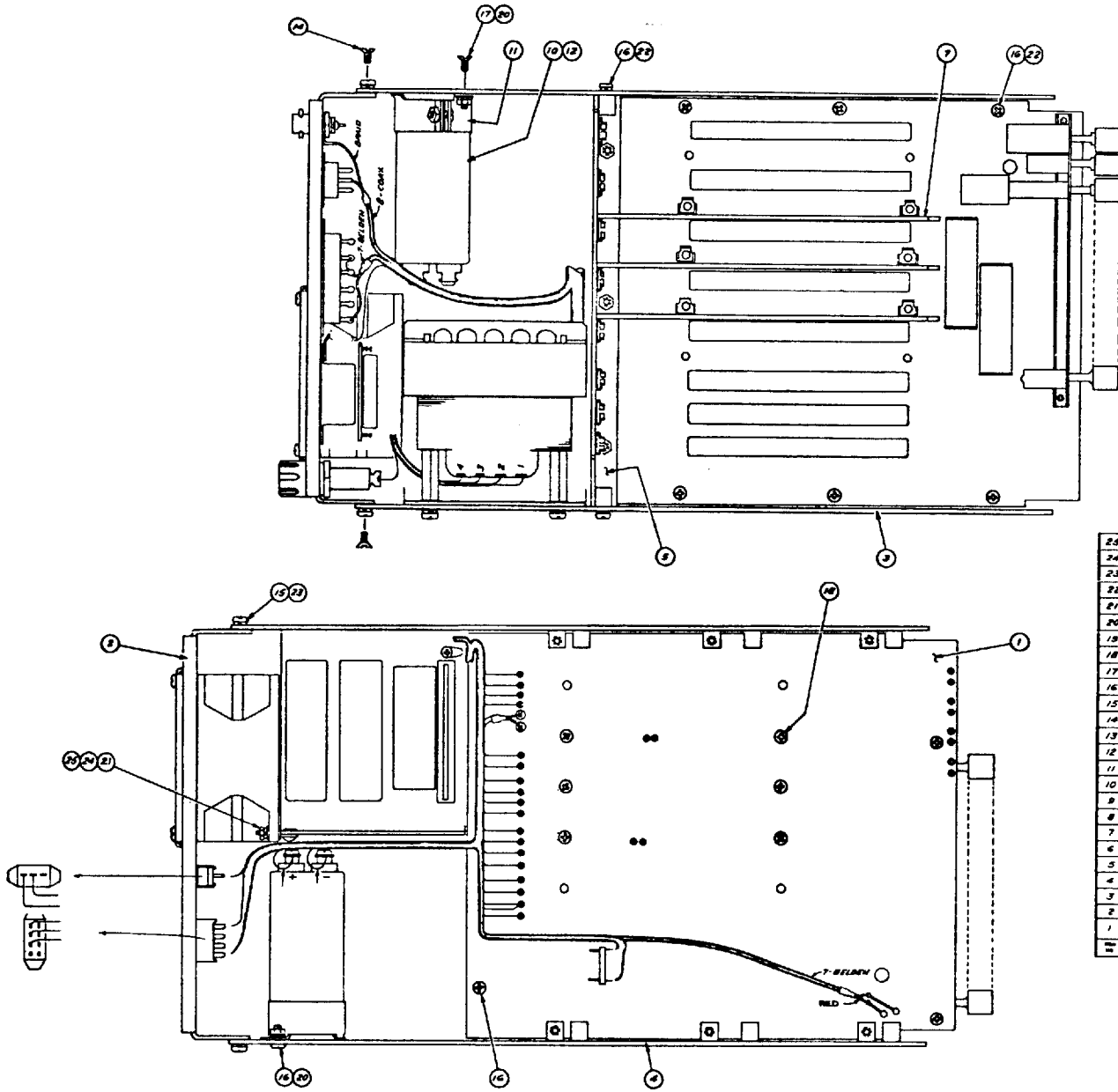
Ref	Description	Dwg #	Page #
	Final Cabinet Assembly	33845	6-2
	Universal Chassis Assembly	45150	6-4
	Test Assembly	45382	6-5
	Front Panel Assembly	45380	6-6
	Rear Panel Assembly	33909	6-7
	Capacitor Chassis Assembly	39240	6-8
	Mother Board P.C. Assembly	33967	6-9
	Block Diagram	45376	6-15
A1	200 MHz Amplifier and Decade	33918	A1-1
A2	Oscillator Board	39220	A2-1
A3	Frequency Shifter	33980	A3-1
A4	Video Amplifier	33973	A4-1
A5	N Channel IF Amplifier	33959	A5-1
A6	Power Supply	45374	A6-1
A7	N Computer and Time Base	33941	A7-1
A8	Programming Board	33937	A8-1
A9	Readout Board	45371	A9-1
All	Diode Board (Supplement to A6)	45374	All-1
U1	Power Divider	39035	U1-1
U2,3	Mixers	39796	U2,3-1



MODEL 6016 FINAL CABINET ASSEMBLY #33845E

FINAL CABINET ASSEMBLY PARTS LIST

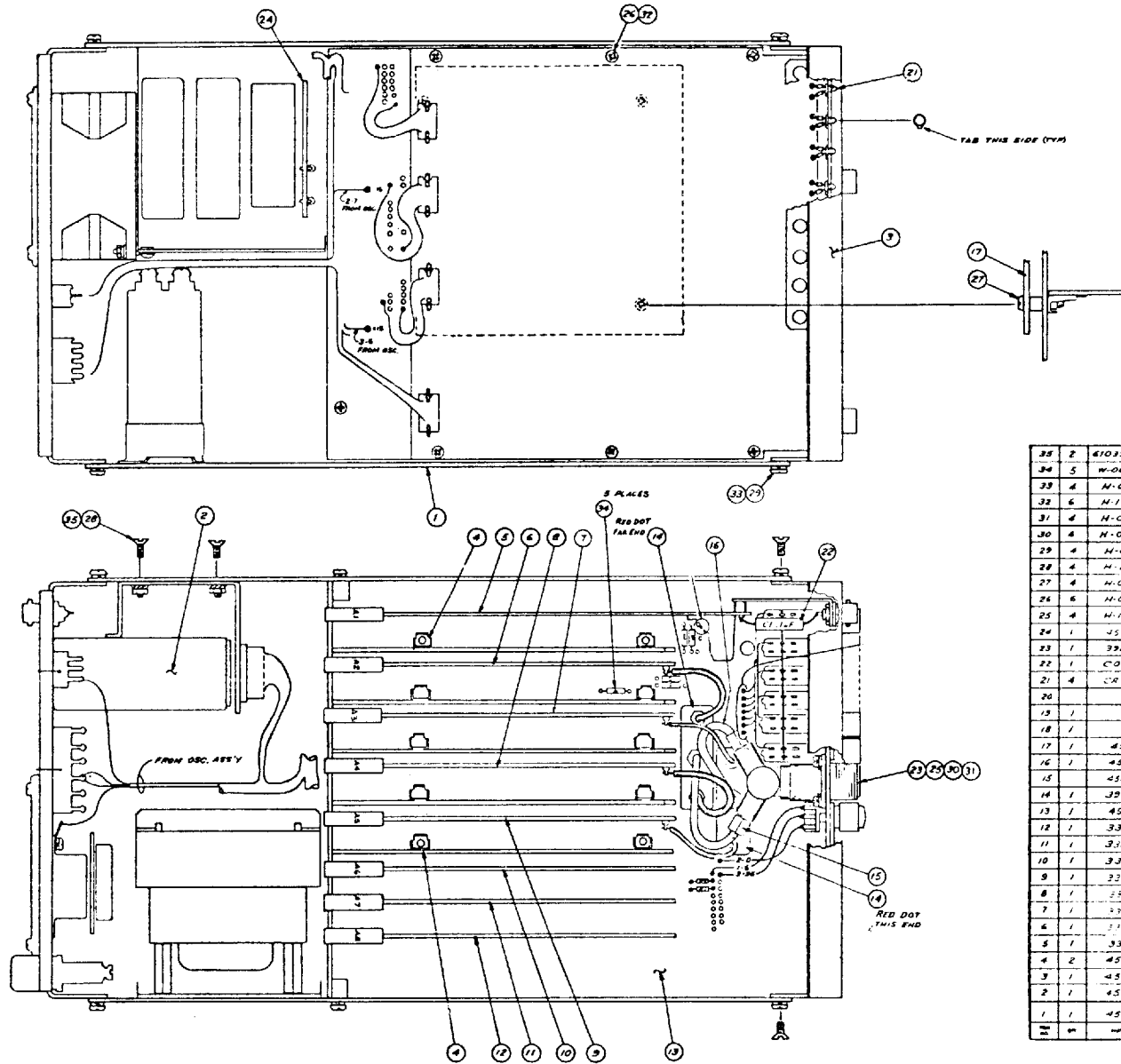
Ref	Description	SD Part No.	Qty.
	5-1/4 Half Rack Assembly	33845	1
1	End Trim	33674-1	4
2	Vinyl Cord	H1902	A/R
3	Sub Panel, Front	33561-3	1
4	Front Trim	33566	1
5	Rear Panel	33560-3	1
6	Nut, Tinnerman	H1907	4
7	Screw, 8-32 x 1/2", 100°	H1258	4
8	Screw, 8-32 x 5/8", 100°	H1733	4
9	Screw, 6-32 x 1/4"	H0986	12
10	Split Lockwasher, #6	H0783	12
11	Screw, 4-40 x 3/16"	H1120	4
12	Split Lockwasher, #8	H0784	8
13	Screw, 8-32 x 1/4"	H0751	4
14	Screw, 8-32 x 3/8"	H0987	2
15	Screw, 8-32 x 1/4", 100°	H1756	2
16	Screw, 8-32 x 3/8", 100°	H1634	2
17	Screw, 6-32 x 5/16", 100°	H0287	4
18	Gusset	33562-4	2
19	Side Trim	33564-4	4
20	Top Cover	33567-4	1
21	Bottom Cover	33568-4	1
22	Side Cover	33565-4	2
23	Handle	33570-4	2
24	Screw, 6-32 x 1/2"	H0283	6
25	Speed Nut, 6-32	H2062	6
26	Not Used		
27	Feet, Set	H2037	1
28	Short Bail	H2035	1



25	2	N-5029	WASHER, #4 FLAT	
24	1	N-0708	WASHER, #4 SPLIT	
23	4	N-0960	WASHER, #8 SPLIT	
22	11	N-1274	WASHER, #6 SPLIT	
21	1	N-0510	NUT, #4-40	
20	2	N-1736	NUT, 6-32 NEP	
18	4	N-12B1	SCREW, 6-32 x 1/16 PHMS	
17	1	N-0430	SCREW, 6-32 x 1/8 PHMS	
16	18	N-0986	SCREW, 6-32 x 1/8 PHMS	
15	4	N-0987	SCREW, 6-32 x 3/16 PHMS	
14	2	N-1756	SCREW, 8-32 x 1/8 PHMS	
13				
12	2	E-0120	SOLDER LUG, CAPACITOR	
11	1	N-0827	CAPACITOR CLAMP	
10	1	C-1182	CAPACITOR, 18000P.F., 12V	C1
9				
8				
7	2	45151	SHIELD PLATE ASS'Y	
6				
5	1	39255	PC GUIDE ASS'Y	
4	1	45063-1	LEFT GUSSET ASS'Y	
3	1	39240	CAPACITOR CHASSIS ASS'Y	
2	1	33909	REAR PANEL ASS'Y	
1	1	33967	MOTHER PC BOARD ASS'Y	

UNIVERSAL CHASSIS ASSEMBLY #45150A

6016-11-72



35	2	41033-450	KEP NUT, #8-32	
34	5	W-0887	MOLDED JUMPER	
33	4	N-0360	WASHER, #8 SPLIT	
32	6	N-1274	WASHER, #6 SPLIT	
31	4	N-0248	WASHER, #4 SPLIT	
30	4	N-0758	WASHER, #4 FLAT	
29	4	N-0887	SCREW, 8-32 x 3/8 FHMS	
28	4	N-1756	SCREW, 8-32 x 1/8 FHMS	
27	4	N-0846	SCREW, 6-32 x 5/8 FHMS	
26	6	N-0586	SCREW, 6-32 x 1/2 FHMS	
25	4	N-1547	SCREW, 4-40 x 1/2 RHMS	
24	1	45310	ASSY, PC, DIOODE	
23	1	33035	POWER DIVIDER	
22	1	C0791	CAPACITOR, 1UF 600V	
21	4	CR0367	LED	CR1,CR2,CR3,CR4
20				
19	1			
18	1			
17	1	45159	MOTHER BOARD SHIELD PLATE ASSY	
16	1	45009	SPECIFICATION, SEMI-RIGID COAX ASSY	
15	1	45010	SPECIFICATION, SEMI-RIGID COAX ASSY	
14	1	33733	MIXER ASSY	U2, U1
13	1	45172	READOUT PC ASSY	A9
12	1	33936	PROGRAMING PC ASSY	A8
11	1	33940-1	N COMPUTER PC ASSY	A7
10	1	33927	POWER SUPPLY PC ASSY	A6
9	1	33952	N CHANNEL 16 PC ASSY	A5
8	1	33972	VIDEO AMP PC ASSY	A4
7	1	33953	VIDEO PC ASSY	A3
6	1	33952	OSCILLATOR PC ASSY	A2
5	1	33921	200MAK AMP & OSCADPC PC ASSY	A1
4	2	45161	SHIELD PLATE ASSY	
3	1	45330	FRONT PANEL ASSY	
2	1	45040	OSC & BKT ASSY	
1	1	45150	UNIVERSAL CHASSIS ASSY	

6-5

TEST ASSEMBLY #45382B

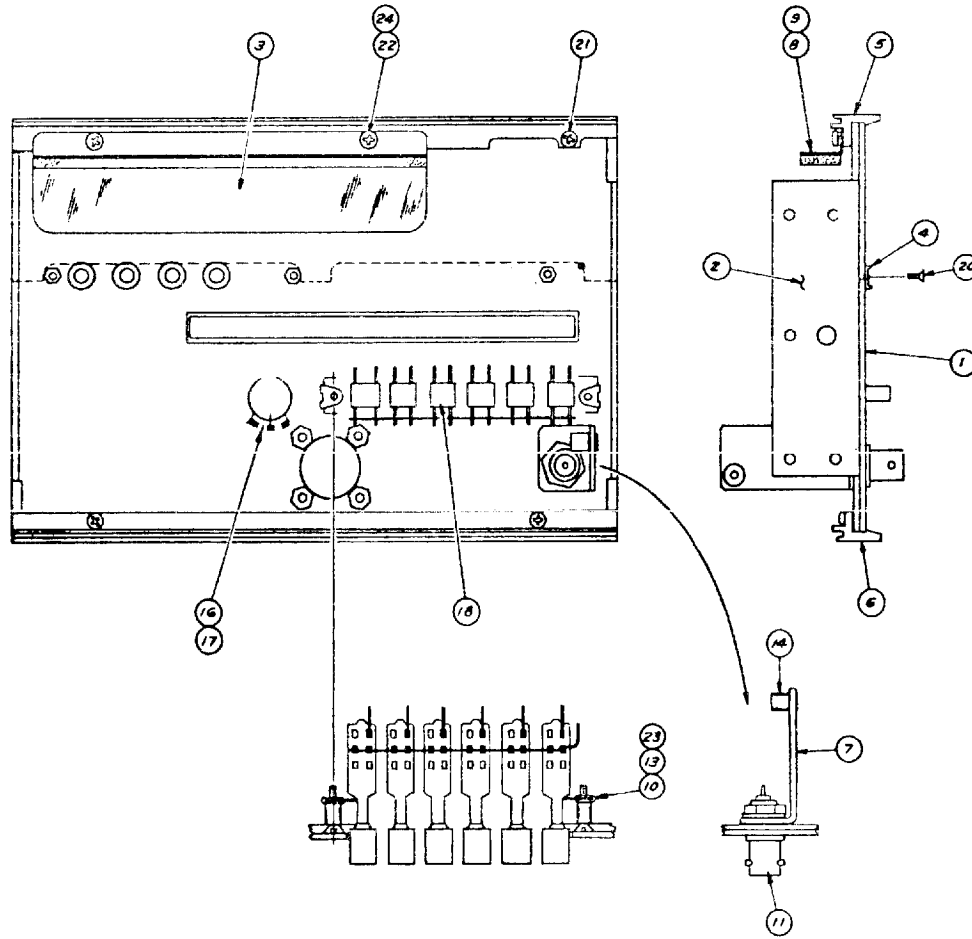
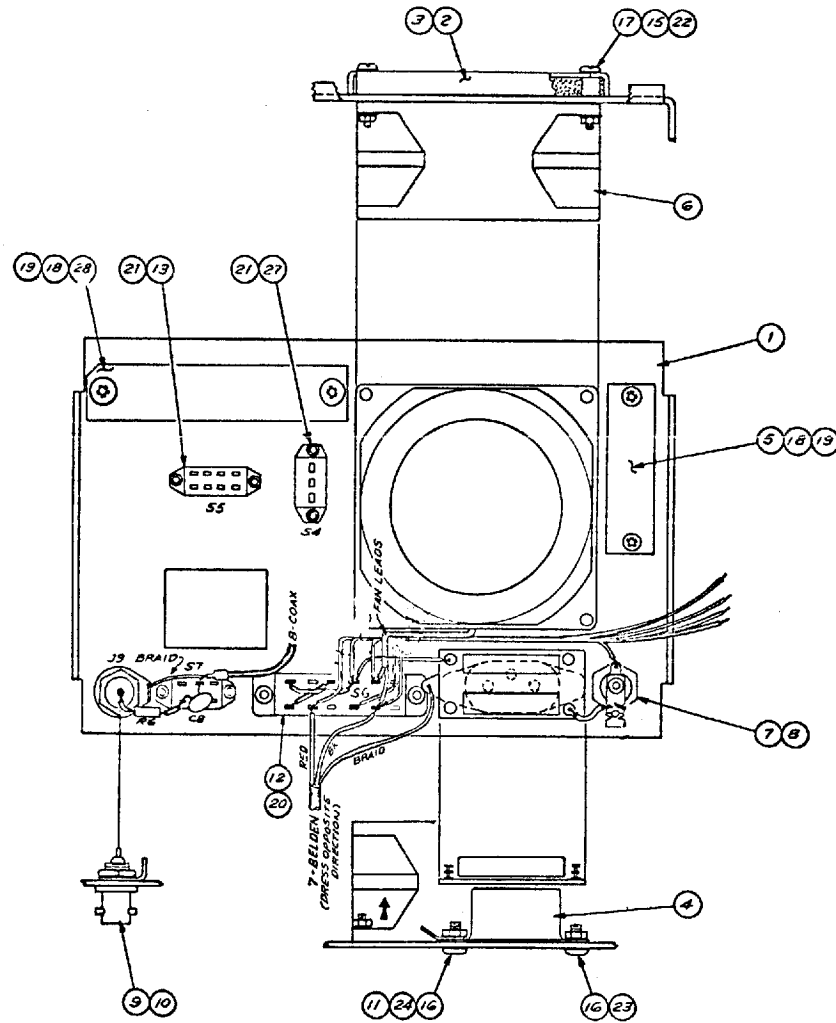


FIG. NO.	QTY.	PART NUMBER	DESCRIPTION	SCHEMATIC REF. NO.
26	1	45381	WIRE LIST	
25				
24	2	H-0248	WASHER, #4 SPLIT	
23	2	H-0814	SCREW, #4-40 x 3/4 FN	
22	2	H-0440	SCREW, #4-40 x 1/4 PH	
21	3	H-1120	SCREW, #4-40 x 3/16 PH	
20	3	H-0306	SCREW, #2-56 x 3/16 FH	
19				
18	1		PUSH BUTTON SWITCH ASSY	51
17	1	4501350	KNOB, 1/8 SHAFT (NOT SHOWN)	
16	1	R-1665	POT, 5K (SENSITIVITY)	R5
15				
14	1	E-0271	SPACER, SWAGE 4-40 x 1/2	
13	2	H-1996	SPACER, 3/16 DIA. x 3/8 L.	
12				
11	1	J-0260	BNC, LONG	JB
10	2	H-0453	SPEED-NUT, #4-40	
9	5"	H-1998	FOAM 1/8 x 1/2	
8	1	45051	TUBE SUPPORT	
7	1	39905	BNC GND CLIP	
6	1	33566	FRONT TRIM, BOTTOM	
5	1	33932	FRONT TRIM, TOP	
4	1	33929	TRIM-STRIP	
3	1	45043	POLARIZED WINDOW	
2	1	45015	SUB-PANEL, FRONT	
1	1	45014	DECORATIVE PANEL	

FRONT PANEL ASSEMBLY #45380A

6016-11-72



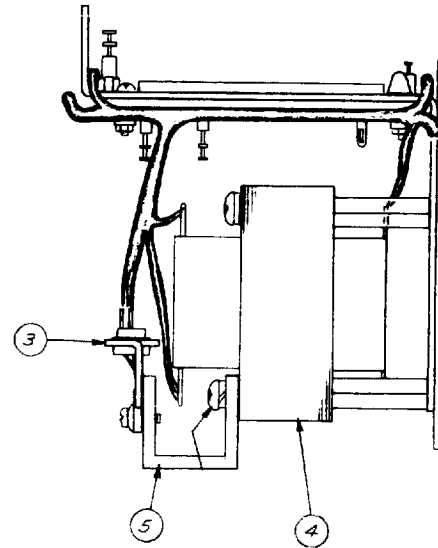
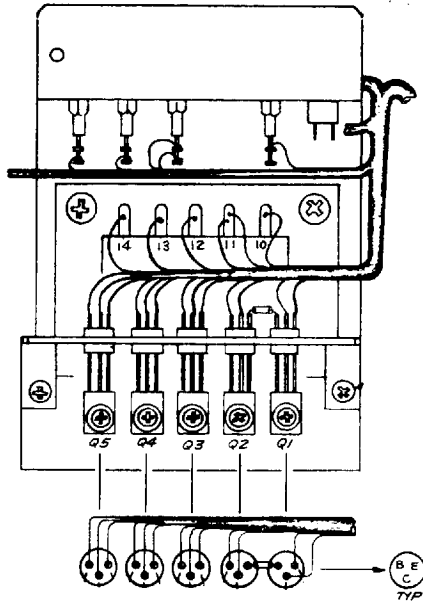
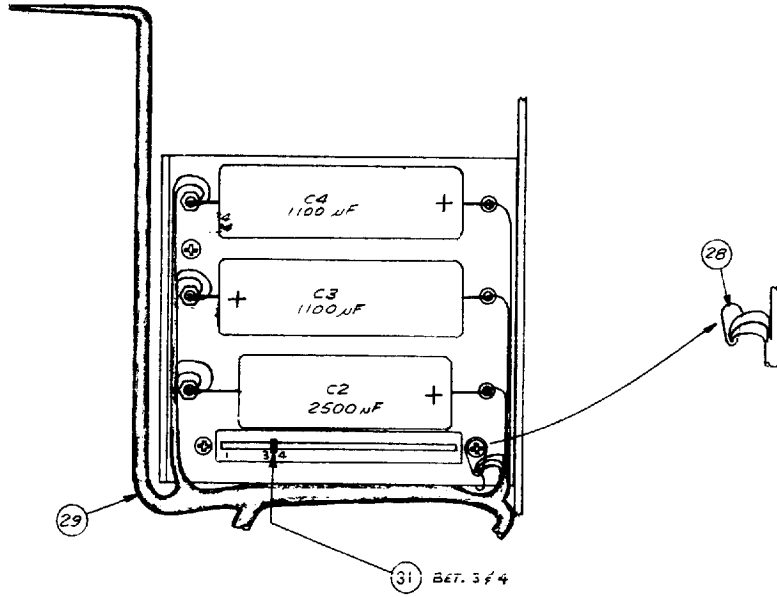
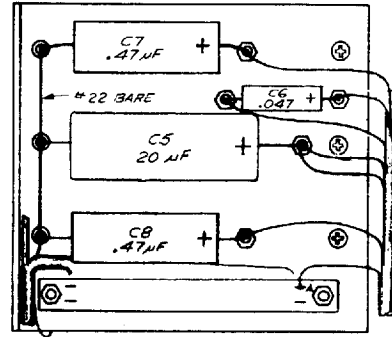
NOTE:

1) JUMPER WIRES - #22 SOLID W/TEFLON SLEEVE.

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SCHEMATIC SH. NO.
30	1	45058	WIRE LIST	
29				
28	1	39443-2	COVER PLATE, 50 PIN	
27	1	05034990	SWITCH, SPDT	S4
26	1	R-1044	RESISTOR, 470Ω, 1/4W, 5%	R6
25	1	C-0556	CAPACITOR, .01μF, 100V	C8
24	1	H-0763	NUT, #4-40	
23	1	H-1872	KEP NUT, #4-40	
22	4	H-1736	KEP NUT, #6-32	
21	6	H-1841	RIVET, .088 DIA. X .125 LG	
20	2	H-0404	RIVET, .125 DIA. X .125 LG	
19	4	H-0481	WASHER, #2 SPLIT-LOCK	
18	4	H-0433	SCREW, 2-56 X 1/4 PHMS	
17	4	H-0394	SCREW, 6-32 X 3/4 PHMS	
16	2	H-0440	SCREW, 4-40 X 1/4 PHMS	
15	4	H-0672	SPACER, 1/4 LONG	
14	2	S-0362	SWITCH, DPDT	S7
13	1	05036570	SWITCH, DPT	S5
12	1	S-0363	SWITCH, 4 PDT	S6
11	1	E-0193	SOLDER LUG, #4	
10	1	E-0137	BNC GND LUG	
9	1	J-0165	CONNECTOR, BNC	J3
8	1	F-0001	FUSE, 1 AMR, FAST BLOW	F1
7	1	X-0034	FUSE HOLDER	XF1
6	1	H-1786	BLOWER	B1
5	1	39443-3	COVER PLATE, 24 PIN	
4	1	31331-4-1	LINE FILTER ASS'Y	
3	1	81005591	FILTER, FAN	
2	1	37095	HOUSING, FAN FILTER	
1	1	33880	REAR PANEL	

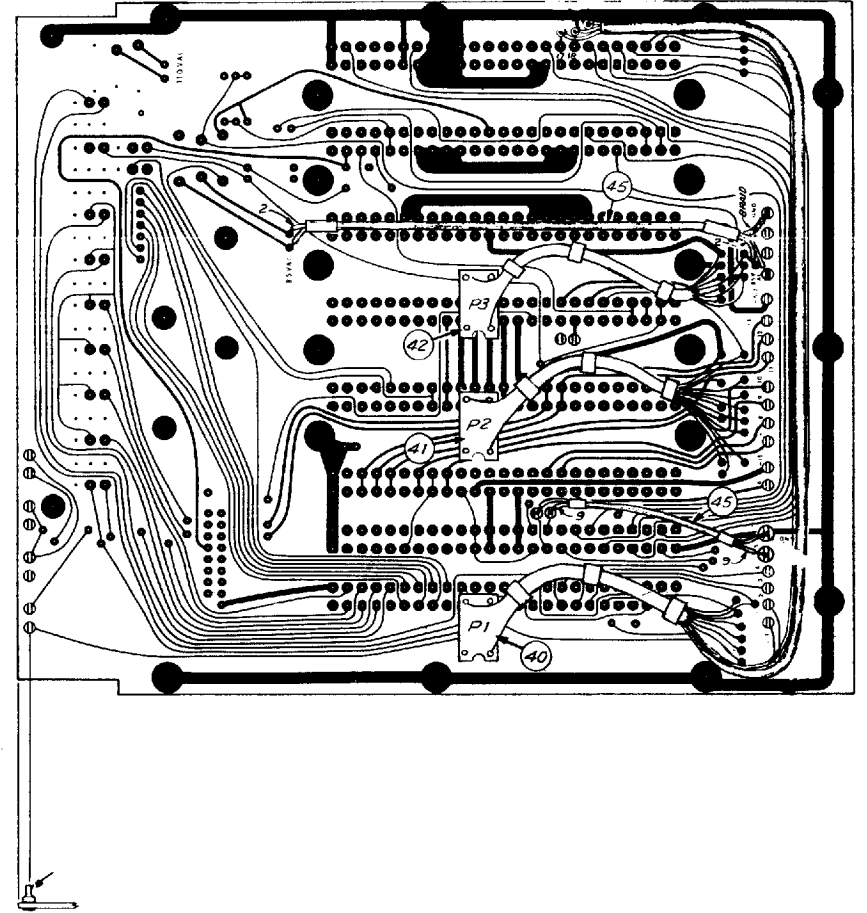
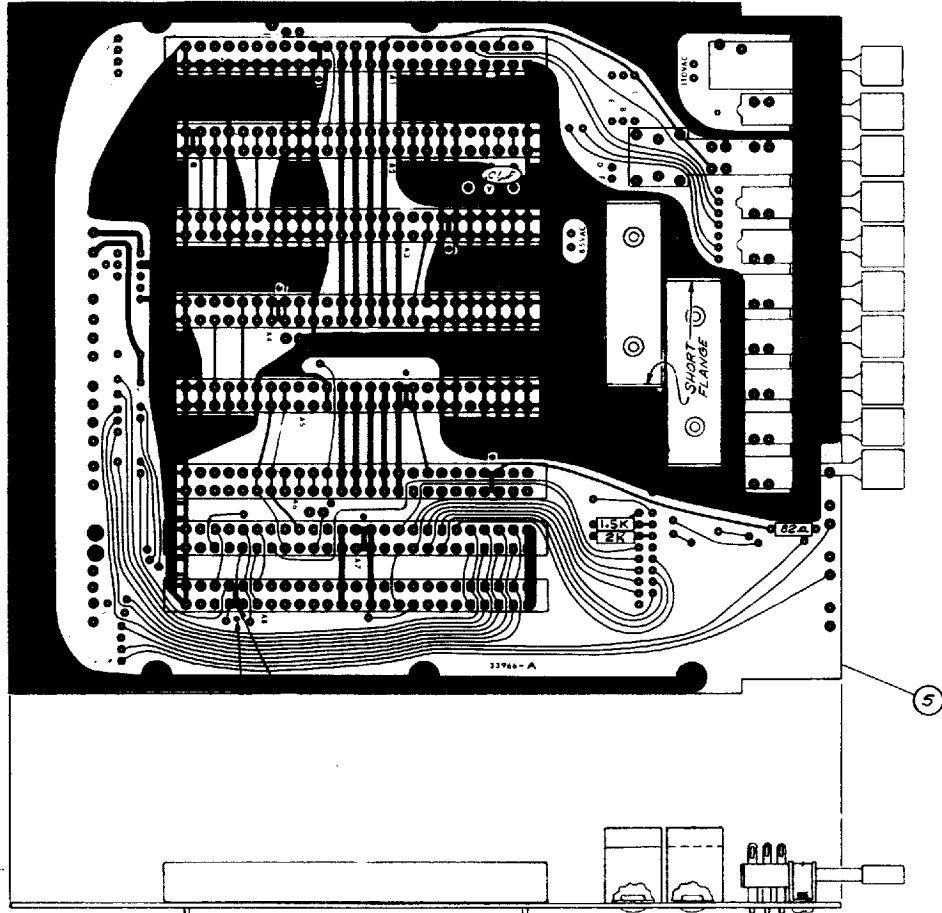
6-7

REAR PANEL ASSEMBLY #33909A



CAPACITOR CHASSIS ASSEMBLY #39240A

6016-11-72



6-9

MOTHER BOARD P.C. ASSEMBLY #33967B

FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.	Qty.
3	Model 6016 Block Diagram	45376	
7	Test Assembly	45382	1
9	Bottom Cover Assembly	33827-4	1
10	Top Cover	33567-4	1
11	Side Cover	33565-4	2
12	End Trim	33674-1	4
14	Side Trim	339859-4	4
15	Handle	33570-4	2
16	Mounting Bracket, Cover	39857	4
19	50 Pin Extender Assembly	39153	1
	Test Assembly	45382	
1	Universal Chassis Assembly	45150	1
2	Oscillator and Bracket Assembly	45040	1
3	Front Panel Assembly	45380	1
4	Shield Plate Assembly	45151	2
	Shield Plate	39860	1
A1	200 MHz Amplifier and Decade Assembly	33921	1
A2	Oscillator P.C. Assembly	33883	1
A3	Shifter P.C. Assembly	33983	1
A4	Video Amplifier P.C. Assembly	33972	1
A5	N Channel IF P.C. Assembly	33962	1
A6	Power Supply P.C. Assembly	33927	1
A7	N Computer P.C. Assembly	33940-1	1
A8	Programming P.C. Assembly	33936	1
	Binary Remote (Option 20)	39887	1
	Single Line Remote (Option 21)	39876	1
A9	Readout P.C. Assembly	45372	1
A10	BCD Output (Option 17)	39926	1
A11	Diode P.C. Assembly	45375	1
U2,U3	Mixer Assembly	39733	2
	Option 11, 3 MHz Oscillator	45301-8-1	1
	Option 12, 3 MHz Oscillator	45301-8-2	1
	Option 13, 3 MHz Oscillator	45301-8-3	1
	Option 17, BCD Output	45499-8-1	1
	Option 20, Binary Remote	45512-8-1	1
	Option 21, Single Line Remote	45514-8-1	1
17	Mother Board Shield Plate Assembly	45153	1
21	LED, CR1, CR2, CR3, CR4	CR0367	4
22	Capacitor, .1 μ F, 600 V	C0791	1
U1	Power Divider	39035	1

FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.	Qty.
	50 Pin Extender Assembly	39153	
1	Extender P.C. Board, 50 Pin	39152	1
2	Connector Modification, 50 Pin	39562	1
	Universal Chassis Assembly	45150	1
1	Mother P.C. Board Assembly	33967	1
2	Rear Panel Assembly	33909	1
3	Capacitor Chassis Assembly	39240	1
4	Left Gusset Assembly	45063-1	1
5	P.C. Guide Assembly	39255	1
7	Shield Plate Assembly	45151	3
C1	Capacitor, 13000 μ F, 12 V	C1122	
11	Capacitor Clamp	H0827	1
12	Capacitor Solder Lug	E0130	
	Oscillator and Bracket Assembly	45040	
1	Oscillator Mounting Bracket	39248	1
2	Oscillator Clamp Assembly	39251	1
U4	Oscillator	Y0023	1
XU4	Octal Socket	X0004	1
C3	Capacitor, .01 μ F, 500 V	C0423	1
C4	Capacitor, .01 μ F, 500 V	C0423	1
C5	Capacitor, 1 μ F, 35 V	C0524	1
C6	Capacitor, 1 μ F, 35 V	C0524	1
C7	Capacitor, .01 μ F, 500 V	C0423	1
	Oscillator Clamp Assembly	39251	
1	Oscillator Clamp	39250	1
2	Spade Lug, #4-40	H0597	2
	Front Panel Assembly	45380	
1	Decorative Panel	45014	1
2	Sub Panel, Front	45015	1
3	Polarized Window	45043	1
4	Trim Strip	33929	1
5	Front Trim, Top	33932	1
6	Front Trim, Bottom	33566	1
7	BNC Ground Clip	39905	1
8	Tube Support	45051	1
J8	BNC, Long	J0260	1

FINAL ASSEMBLY PARTS LIST (Cont'd)

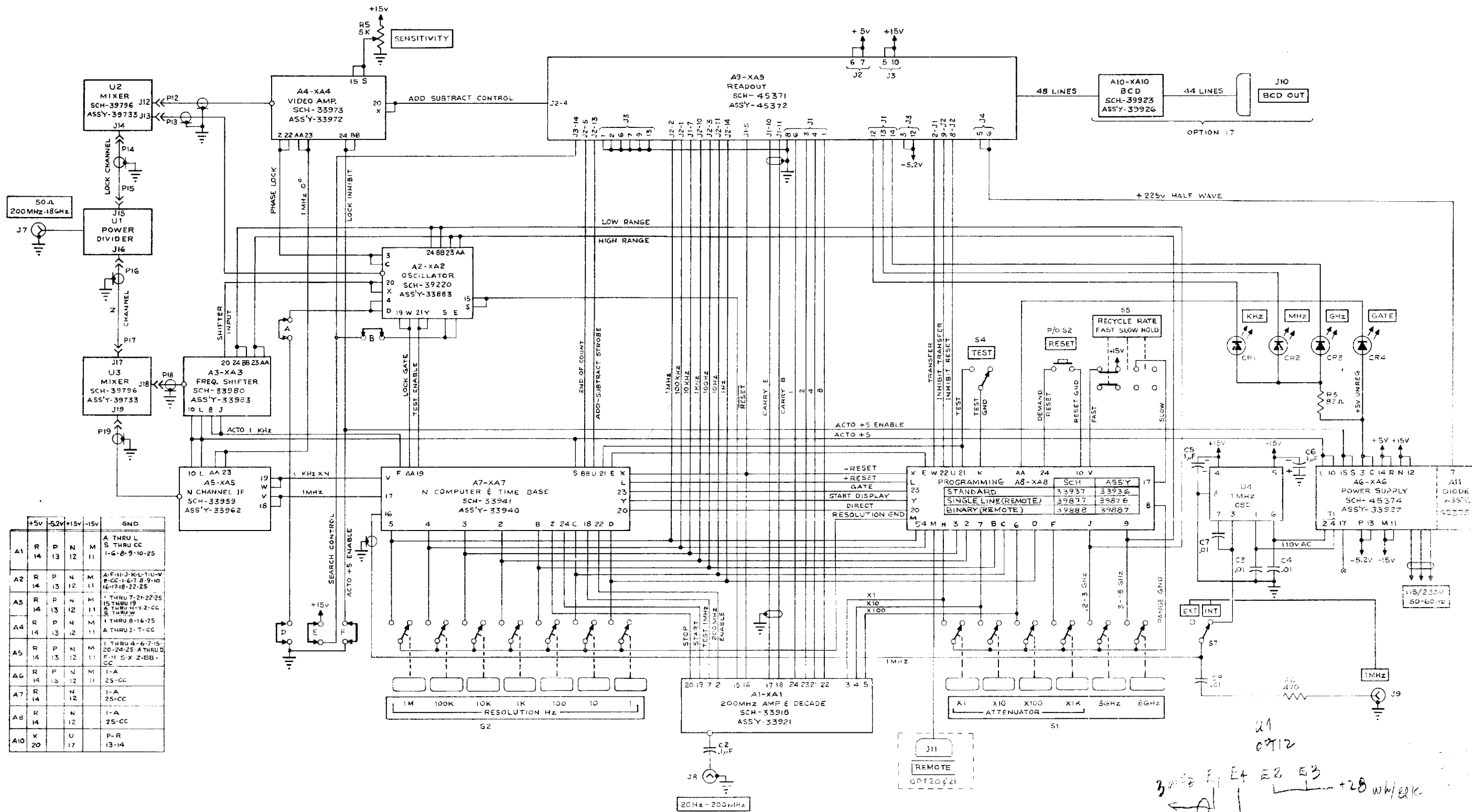
Ref.	Description	SD Part No.	Qty.
R5	Resistor, Potentiometer, 5 k	R1665	1
17	Knob, 1/8 Shaft	45011350	1
S1	Pushbutton Switch Assembly	045825	1
	Mixer Assembly	39733	
2	Diode Clip	39731	1
C1	Capacitor, 15 pF, Chip	C1163	1
C2	Capacitor, 15 pF, Chip	C1163	1
CR1	Diode, 1N4151	CR0150	1
CR2	Diode, HP0151	CR0269	1
CR3	Diode, D5506	CR0334	1
J1	RF Connector	J0625	1
J2	RF Connector	J0625	1
J3	Connector, Modified	39729	1
R1, L1	Resistor, 100 Ω , 1/8 W, 5%	R1441	1
R2	Resistor, 1.5 k, 1/8 W, 5%	R2463	1
R3	Resistor, 50 Ω , 1%, Disc	R2873	1
9	Resistor Probe	39730	1
12	Mixer Block	39722	1
13	Mixer Cover	39732	1
	Line Filter Assembly	31331-4-1	
2	Line Filter P.C. Board	31331-1-1	1
C1	Capacitor, .01 μ F, 500 V	C0423	1
C2	Capacitor, .01 μ F, 500 V	C0423	1
J1	Receptacle	J0566	1
L1	Hash Filter	L0166	1
L2	Hash Filter	L0166	1
	Capacitor Chassis Assembly	39240	
1	Capacitor Chassis	33869	1
2	Gusset Assembly, Right	45063-2	1
3	Transistor Bracket Assembly	39624	1
4	T1, Transformer	39206	1
5	Transistor Mounting Channel	39884	1
C2	Capacitor, 2500 μ F	C1148	1
C3	Capacitor, 1100 μ F	C1103	1
C4	Capacitor, 1100 μ F	C1103	1
C5	Capacitor, 20 μ F	C1094	1
C6	Capacitor, .047 μ F	C0793	1
C7	Capacitor, .47 μ F	C1281	1
C8	Capacitor, .47 μ F	C1281	1
Q1	Transistor, 2N5190	Q0281	1
Q2	Transistor, 2N5190	Q0281	1

FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.	Qty.
Q3	Transistor, 2N5193	Q0300	1
Q4	Transistor, 2N4921	Q0267	1
Q5	Transistor, 2N4918	Q0268	1
28	#4 Ground Lug	E0193	1
29	Capacitor Chassis Cable Assembly	39241	1
30	Spade Lug	H1380	1
31	Key, Polarizing	H1369	1
	Capacitor Chassis Cable Assembly	39241	
P4	Connector, 14 Pin	J0605	1
R1	Resistor, 180 k, 5%, 1/2 W	R0283	1
XAL0	Connector, 30 Pin	J0504	1
	Transistor Bracket Assembly	39624	
1	Transistor Mounting Bracket	39438	1
2	Transistor Socket	X0187	5
3	Transistor Socket Retainer	H1966	5
	Mother Board P.C. Assembly	33967	
C1	Capacitor, .01 μ F, 100 V, Disc	C0556	1
P1	Plug Assembly	44097	1
P2	Plug Assembly	45098	1
P3	Plug Assembly	45099	1
	Plug, 14 Pin	J0605	3
R1	Resistor, 2 k, 1/4 W, 5%	R0734	1
R2	Resistor, 1.5 k, 1/4 W, 5%	R0783	
R3	Resistor, 82 Ω , 1/4 W, 5%	R1059	
S2	Switch, Pushbutton, 10 Position	045824	1
XAL-8	Connector, 50 Pin, P.C.	J0606	8
47	Key, Polarizing	09065840	8
	Rear Panel Assembly	33909	
1	Rear Panel	33880	1
2	Housing, Fan Filter	37095	1
3	Filter, Fan	81005591	1
4	Line Filter Assembly	31331-4-1	1
5	Cover Plate, 24 Pin	39443-3	
B1	Blower	H1786	1
F1	Fuse, 1 Amp Fast Blow	F0001	1
XF1	Fuse Holder	X0034	1

FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.	Qty.
J9	Connector, BNC	J0165	1
10	BNC Ground Lug	E0137	1
11	Solder Lug, #4	E0193	1
S5	Switch, DPTT	05036570	1
S6	Switch, 4PDT	S0363	1
S7	Switch, DPDT	S0362	2
C8	Capacitor, .01 μ F, 100 V	C0556	1
R6	Resistor, 470 Ω , 1/4 W, 5%	R1044	1
S4	Switch, SPDT	05034990	1
28	Cover Plate, 50 Pin	39443-2	1



u1
OPT12
3 MHz E1 E2 E3 +28 W/CLK
MODEL 6016
BLOCK DIAGRAM #45376B



MODEL 6057/6016
CIRCUIT DESCRIPTION
A1, 200 MHz AMPLIFIER AND DECADE
SCHEMATIC #33918

The A1, 200 MHz Amplifier and Decade consists of the following sections: attenuator, wideband amplifier, Schmitt trigger, signal gate, and a 200 MHz decade counter and translator.

ATTENUATOR

The 20 Hz to 200 MHz signal is connected to input BNC, J8, and capacitor-coupled by C2 to the input attenuator on A1. Two operations occur when the attenuator buttons are depressed: the gain-controlled input stage is actuated, and the proper attenuation is selected. To activate the gain-controlled input stage a ground appears on one of the A8 pins H, 7, 6, or F. This produces a low on A8 pin 20, DIRECT, which places a low on A7 pin 20. Thus, A7 pin 22, 200 MHz ENABLE is gated low, pulling A1 pin 2 low and turning on AlQ15. Now the gate G2 of AlQ2 is properly biased and the gain-controlled input is on. The proper attenuation is selected at the same time. The X1 line, A1 pin 3, activates relay AlK1 via AlQ16, 17, bypassing the X100 attenuation network (AlR1, 2, 3, 6, 39, 63, 64, 65 and AlC3, 4, 5, 6, 11) and biasing AlQ2 gate G2 for a gain of 2. The X10 attenuation line, A1 pin 4, activates relay AlK1, bypassing the X100 attenuator. With AlQ14 off the gain of AlQ2, controlled by gate G2, is .2. The X100 attenuation line, A1 pin 5, biases AlQ2 gate G2 for a gain of 2 leaving the AlK1 deactivated in the X100 position. The X1000 attenuation line neither activates AlK1 nor biases AlQ2 so the X100 attenuator is used along with the .2 gain of AlQ2.

During the ACTO mode (3 GHz and 18 GHz button positions) and the TEST mode of operation, the 200 MHz ENABLE line is high which disables AlQ15, placing a negative voltage on the gate G2, shutting off AlQ2. The local oscillator frequency is then fed in on the ACTO IN line, A1 pin 15, through AlQ1 to the wideband amplifier.

WIDEBAND AMPLIFIER

The 200 MHz wideband amplifier consists of an emitter follower, AlQ3, which dc-couples the input through diode AlQ4 to the wideband amplifier AlQ5 through AlQ8. This amplifier consists of two stages of emitter follower transistors. The output of AlQ8 is applied to the input of the Schmitt trigger circuit AlQ9 through Q12. The operational amplifier AlU1, by comparing the dc voltage at the input to the Schmitt trigger and the voltage at the trigger level potentiometer AlR47, adjusts the bias on the base of AlQ1, causing the two voltages to become equal.

SCHMITT TRIGGER

The Schmitt trigger, AlQ9 through AlQ12, is a conventional high-speed bistable circuit. The input is applied to the base of transistor AlQ9 which drives emitter follower AlQ11 and transistor AlQ10. The output of AlQ10 is coupled to the signal gate, AlU2 pin 4, by another emitter follower, AlQ12.

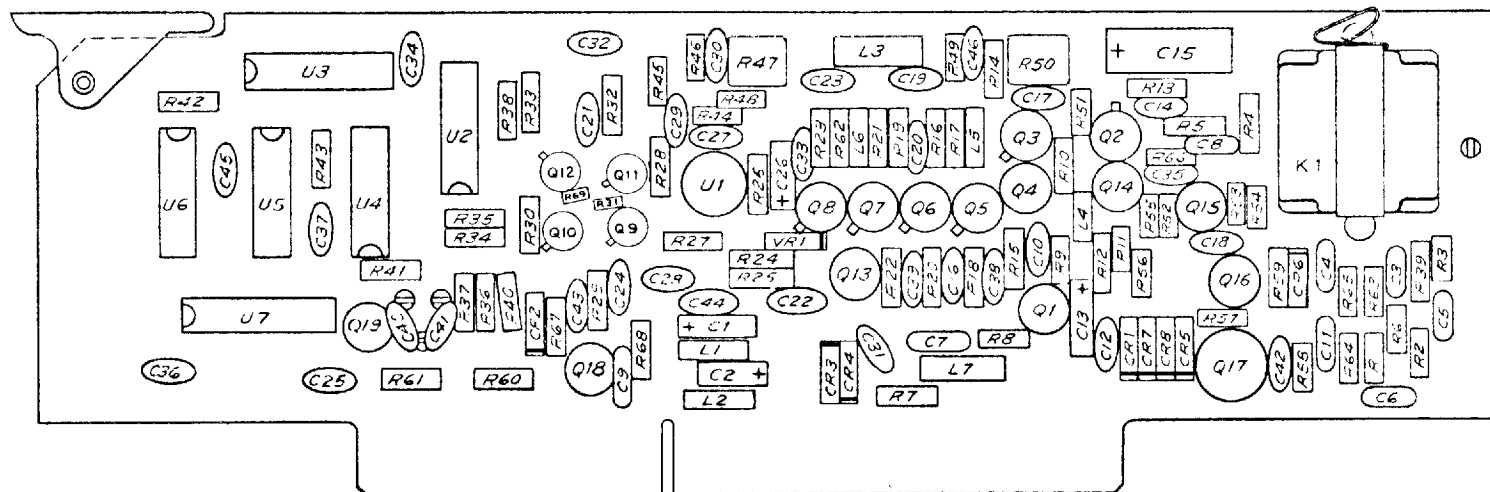
SIGNAL GATE

One of the high-speed NOR gates in AlU2 is driven by the Schmitt trigger and controlled by START/STOP lines from A7. The output from AlU2, pin 3 drives the clock line pin 7 of AlU3.

200 MHz DECADE AND TRANSLATOR

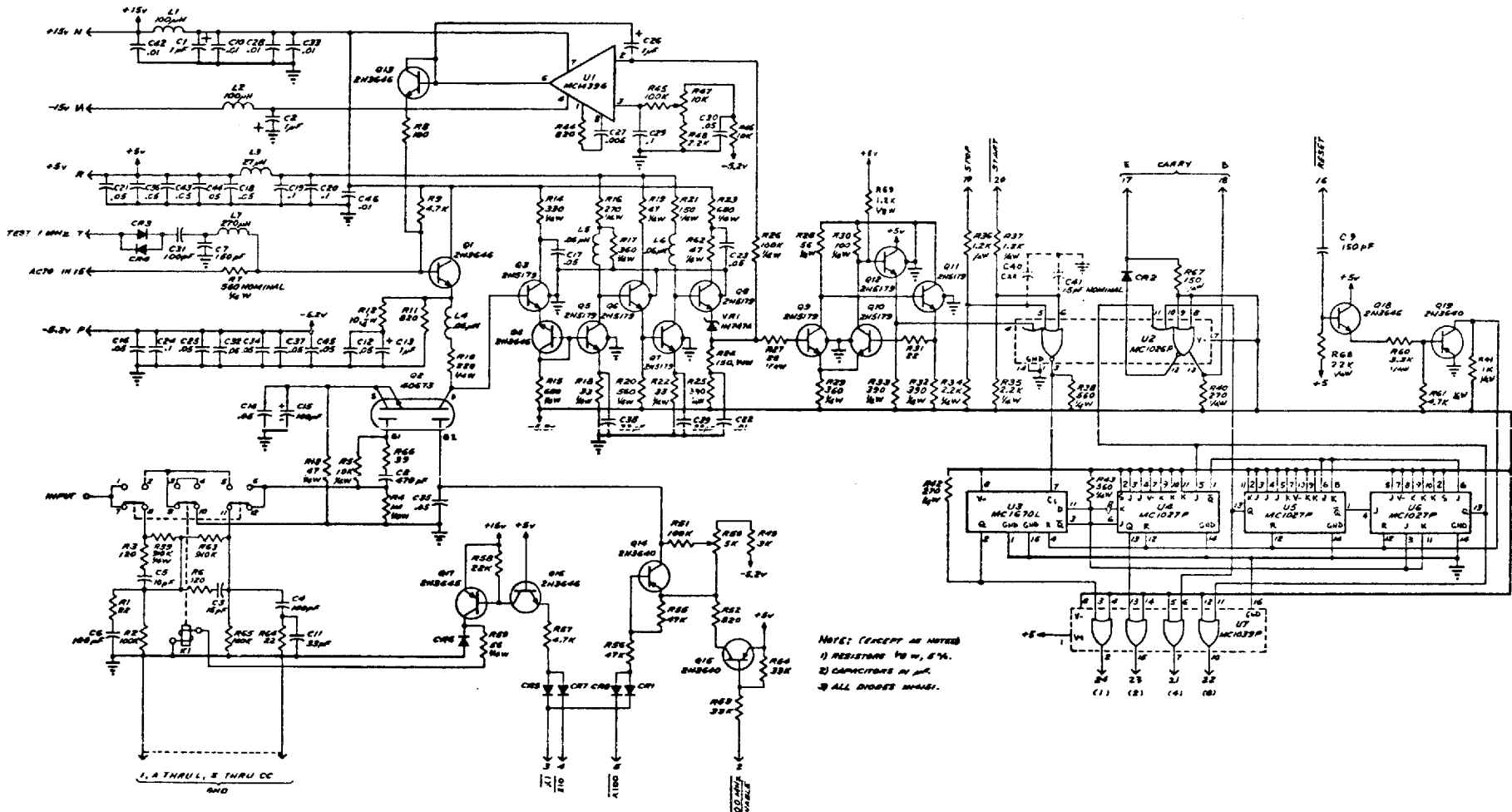
AlU3, U4, U5, and U6 are wired as a divide-by-two; then, by five 200 MHz decade with AlU3 activated on the leading edge of the positive transition pulse from signal gate AlU2. The resulting MECL BCD logic levels are translated to TTL logic levels by translator AlU7.

33918-11-72



A1-3

A1, 200 MHz AMPLIFIER AND DECADE P.C. ASSEMBLY #33921B



NOTE: (EXCEPT AS NOTED)
 1) RESISTORS 1% W, 5%.
 2) CAPACITORS IN pF.
 3) ALL DIODES 1N4148.

A1, 200 MHz AMPLIFIER AND DECADE SCHEMATIC #33918B

A1, 200 MHz AMP & DECADE P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A1	200 MHz Amp & Decade P.C. Assembly	33921
	200 MHz Amp & Decade P.C. Schematic	33918
C1	Capacitor, 1 μ F, 35 V, tant	C0524
C2	Capacitor, 1 μ F, 35 V, tant	C0524
C3	Capacitor, 15 pF, DM10	C1267
C4	Capacitor, 100 pF, DM10	C1156
C5	Capacitor, 10 pF, DM10	C1193
C6	Capacitor, 100 pF, DM10	C1156
C7	Capacitor, 150 pF, DM15	C0537
C8	Capacitor, 470 pF	C0542
C9	Capacitor, 150 pF, DM15	C0537
C10	Capacitor, .01 μ F, 100 V, disc	C0556
C11	Capacitor, 33 pF, DM10	C1268
C12	Capacitor, .05 μ F, 12 V, disc	C0672
C13	Capacitor, 1 μ F, 35 V, tant	C0524
C14	Capacitor, .05 μ F, 12 V, disc	C0672
C15	Capacitor, 100 μ F, 10 V, tant	C0660
C16	Capacitor, .05 μ F, 12 V, disc	C0672
C17	Capacitor, .05 μ F, 12 V, disc	C0672
C18	Capacitor, .05 μ F, 12 V, disc	C0672
C19	Capacitor, .1 μ F, 10 V, disc	C0661
C20	Capacitor, .1 μ F, 10 V, disc	C0661
C21	Capacitor, .05 μ F, 12 V, disc	C0672
C22	Capacitor, .01 μ F, 100 V, disc	C0556
C23	Capacitor, .05 μ F, 12 V, disc	C0672
C24	Capacitor, .1 μ F, 10 V, disc	C0661
C25	Capacitor, .05 μ F, 12 V, disc	C0672
C26	Capacitor, 1 μ F, 35 V, tant	C0524
C27	Capacitor, .005 μ F, 150 V, disc	C0325
C28	Capacitor, .01 μ F, 100 V, disc	C0556
C29	Capacitor, .1 μ F, 10 V, disc	C0661
C30	Capacitor, .05 μ F, 12 V, disc	C0672
C31	Capacitor, 100 pF, DM10	C1156
C32	Capacitor, .05 μ F, 12 V, disc	C0672
C33	Capacitor, .01 μ F, 100 V, disc	C0556
C34	Capacitor, .05 μ F, 12 V, disc	C0672
C35	Capacitor, .05 μ F, 12 V, disc	C0672
C36	Capacitor, .05 μ F, 12 V, disc	C0672
C37	Capacitor, .05 μ F, 12 V, disc	C0672
C38	Capacitor, 22 pF, DM15	C0529

A1, 200 MHz AMP & DECADE P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
C39	Capacitor, 22 pF, DM15	C0529
C40	Capacitor, Factory selected	Cxxxx
C41	Capacitor, 15 pF, DM10	C1267
C42	Capacitor, .01 μ F, 100 V, disc	C0556
C43	Capacitor, .05 μ F, 12 V, disc	C0672
C44	Capacitor, .05 μ F, 12 V, disc	C0672
C45	Capacitor, .05 μ F, 12 V, disc	C0672
C46	Capacitor, .01 μ F, 100 V, disc	C0556
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
CR7	Diode, 1N4151	CR0150
CR8	Diode, 1N4151	CR0150
K1	Relay Printact, 12 BP3G	K0135
L1	Inductor, 100 μ H	L0073
L2	Inductor, 100 μ H	L0073
L3	Inductor, 27 μ H	L0076
L4	Inductor, .06 μ H	L0158
L5	Inductor, .06 μ H	L0158
L6	Inductor, .06 μ H	L0158
L7	Inductor, 270 μ H	L0067
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 40673	Q0297
Q3	Transistor, 2N5179	Q0269
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N5179	Q0269
Q6	Transistor, 2N5179	Q0269
Q7	Transistor, 2N5179	Q0269
Q8	Transistor, 2N5179	Q0269
Q9	Transistor, 2N5179	Q0269
Q10	Transistor, 2N5179	Q0269
Q11	Transistor, 2N5179	Q0269
Q12	Transistor, 2N5179	Q0269
Q13	Transistor, 2N3646	Q0218
Q14	Transistor, 2N3640	Q0178
Q15	Transistor, 2N3646	Q0178

A1, 200 MHz AMP & DECADE P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
Q16	Transistor, 2N3640	Q0178
Q17	Transistor, 2N3645	Q0215
Q18	Transistor, 2N3646	Q0218
Q19	Transistor, 2N3640	Q0178
R1	Resistor, 22 Ω , 5%, 1/8 W	R1448
R2	Resistor, 100 k, 5%, 1/8 W	R2465
R3	Resistor, 120 Ω , 5%, 1/8 W	R2459
R4	Resistor, 1 M, 5%, 1/4 W	R0962
R5	Resistor, 10 k, 5%, 1/4 W	R0766
R6	Resistor, 120 Ω , 5%, 1/8 W	R2459
R7	Resistor, 560 Ω , 5%, 1/4 W	R0819
R8	Resistor, 100 Ω , 5%, 1/8 W	R1441
R9	Resistor, 4.7 k, 5%, 1/8 W	R1733
R10	Resistor, 220 Ω , 5%, 1/4 W	R0760
R11	Resistor, 820 Ω , 5%, 1/8 W	R2462
R12	Resistor, 10 Ω , 5%, 1/4 W	R0739
R13	Resistor, 47 Ω , 5%, 1/4 W	R0743
R14	Resistor, 330 Ω , 5%, 1/4 W	R0662
R15	Resistor, 680 Ω , 5%, 1/4 W	R1234
R16	Resistor, 270 Ω , 5%, 1/4 W	R0694
R17	Resistor, 360 Ω , 5%, 1/4 W	R1571
R18	Resistor, 33 Ω , 5%, 1/4 W	R1550
R19	Resistor, 47 Ω , 5%, 1/4 W	R0743
R20	Resistor, 560 Ω , 5%, 1/4 W	R0819
R21	Resistor, 150 Ω , 5%, 1/4 W	R0983
R22	Resistor, 33 Ω , 5%, 1/4 W	R1550
R23	Resistor, 680 Ω , 5%, 1/4 W	R1234
R24	Resistor, 150 Ω , 5%, 1/4 W	R0983
R25	Resistor, 390 Ω , 5%, 1/4 W	R0880
R26	Resistor, 100 k, 5%, 1/4 W	R0741
R27	Resistor, 22 Ω , 5%, 1/4 W	R1436
R28	Resistor, 56 Ω , 5%, 1/4 W	R1554
R29	Resistor, 360 Ω , 5%, 1/4 W	R1571
R30	Resistor, 100 Ω , 5%, 1/4 W	R0966
R31	Resistor, 22 Ω , 5%, 1/8 W	R1448
R32	Resistor, 390 Ω , 5%, 1/4 W	R0880
R33	Resistor, 390 Ω , 5%, 1/4 W	R0880
R34	Resistor, 2.2 k, 5%, 1/4 W	R0749
R35	Resistor, 2.2 k, 5%, 1/4 W	R0749
R36	Resistor, 1.2 k, 5%, 1/4 W	R0809

A1, 200 MHz AMP & DECADE P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R37	Resistor, 1.2 k, 5%, 1/4 W	R0809
R38	Resistor, 560 Ω , 5%, 1/4 W	R0819
R39	Resistor, 910 k, 5%, 1/4 W	R2312
R40	Resistor, 270 Ω , 5%, 1/4 W	R0694
R41	Resistor, 1 k, 5%, 1/4 W	R0765
R42	Resistor, 270 Ω , 5%, 1/4 W	R0694
R43	Resistor, 560 Ω , 5%, 1/4 W	R0819
R44	Resistor, 820 Ω , 5%, 1/8 W	R2462
R45	Resistor, 100 k, 5%, 1/8 W	R2465
R46	Resistor, 10 k, 5%, 1/8 W	R1437
R47	Resistor, 10 k, potentiometer	R2412
R48	Resistor, 2.2 k, 5%, 1/8 W	R1476
R49	Resistor, 3 k, 5%, 1/8 W	R2378
R50	Resistor, 5 k, potentiometer	R2076
R51	Resistor, 100 k, 5%, 1/8 W	R2465
R52	Resistor, 820 Ω , 5%, 1/8 W	R2462
R53	Resistor, 33 k, 5%, 1/8 W	R1432
R54	Resistor, 33 k, 5%, 1/8 W	R1432
R55	Resistor, 47 k, 5%, 1/8 W	R1433
R56	Resistor, 47 k, 5%, 1/8 W	R1433
R57	Resistor, 4.7 k, 5%, 1/8 W	R1733
R58	Resistor, 22 k, 5%, 1/8 W	R1742
R59	Resistor, 56 Ω , 5%, 1/4 W	R1554
R60	Resistor, 3.3 k, 5%, 1/4 W	R0742
R61	Resistor, 4.7 k, 5%, 1/4 W	R0892
R62	Resistor, 47 Ω , 5%, 1/4 W	R0743
R63	Resistor, 910 k, 5%, 1/8 W	R2438
R64	Resistor, 22 Ω , 5%, 1/8 W	R1448
R65	Resistor, 100 k, 5%, 1/8 W	R2465
R66	Resistor, 39 Ω , 5%, 1/8 W	R1829
R67	Resistor, 150 Ω , 5%, 1/4 W	R0983
R68	Resistor, 22 k, 5%, 1/4 W	R0768
R69	Resistor, 1.2 k, 5%, 1/8 W	R2458
U1	Integrated Circuit, MC1439G	25729
U2	Integrated Circuit, MC1026P	25780
U3	Integrated Circuit, MC1670L	25765
U4	Integrated Circuit, MC1027P	25719
U5	Integrated Circuit, MC1027P	25719
U6	Integrated Circuit, MC1027P	25719
U7	Integrated Circuit, MC1039P	25774
VR1	Diode, 1N747A	CR5005

MODEL 6016
CIRCUIT DESCRIPTION
A2, OSCILLATOR BOARD
SCHEMATIC #39220

The A2, Oscillator Board consists of a 3 GHz range oscillator, an 18 GHz range oscillator, mixer-driver amplifier, sweep oscillator, and a phase-lock detector.

The voltage-controlled oscillators for the two ACTO ranges consist of Q2 and Q3. These transistors are dual-gate MOSFET'S connected in a Colpitts configuration, and are voltage-tuned using variable capacitance diodes. The 3 GHz range tunes from 28 MHz to 38 MHz.

The 18 GHz range tunes from 89 MHz to 98 MHz. IC, U1 is a self-contained voltage regulator that supplies the oscillators with a well-filtered supply voltage. When the TEST mode of operation is selected, Q6 shuts off the output of U1, which disables the oscillators.

The output of the selected VCO is applied to U2, a quad 2-input OR/NOR gate. The first section is connected as an amplifier. The remaining sections distribute and buffer the VCO signal to the count input of the counter, the frequency shifter, and the mixer-driver amplifier.

The mixer-driver amplifier consists of a push-pull amplifier with Q7, Q8, and Q9, a class C amplifier with a broad-tuned output. The mixer output amplifier must deliver uniform power to the mixer over the range of 28 MHz to 38 MHz, and 89 MHz to 98 MHz. A π matching network, C25, C26, L9, and C27 properly matches the Q9 collector to the load of the mixer.

The search oscillator generates a triangle waveform that sweeps the voltage-controlled oscillators while in the ACTO mode of operation. Transistors Q13 and Q14 form a binary switch. In the following example, with no RF input, Q13 and Q14 are both in the off condition. Current flows from the -5.2 volt supply through R45 into the input of amplifier U3, pin 2. U3 inverts, and due to the feedback network R39 and C30, produces a linear rise in voltage at the output of pin 6.

When the output voltage reaches +10V, Zener diode VR1 conducts, forward biasing Q14. Q14 conducting causes Q13 to conduct. This action causes the amplifier U3 to draw current from the +5 volt supply through R45 and Q13, which in turn, drives the output of amplifier U3 in a negative direction until it reaches -10V. At -10V, VR2 conducts and turns off Q13 and Q14. The overall effect is a triangular waveform varying between +10V and -10V at A2TP1.

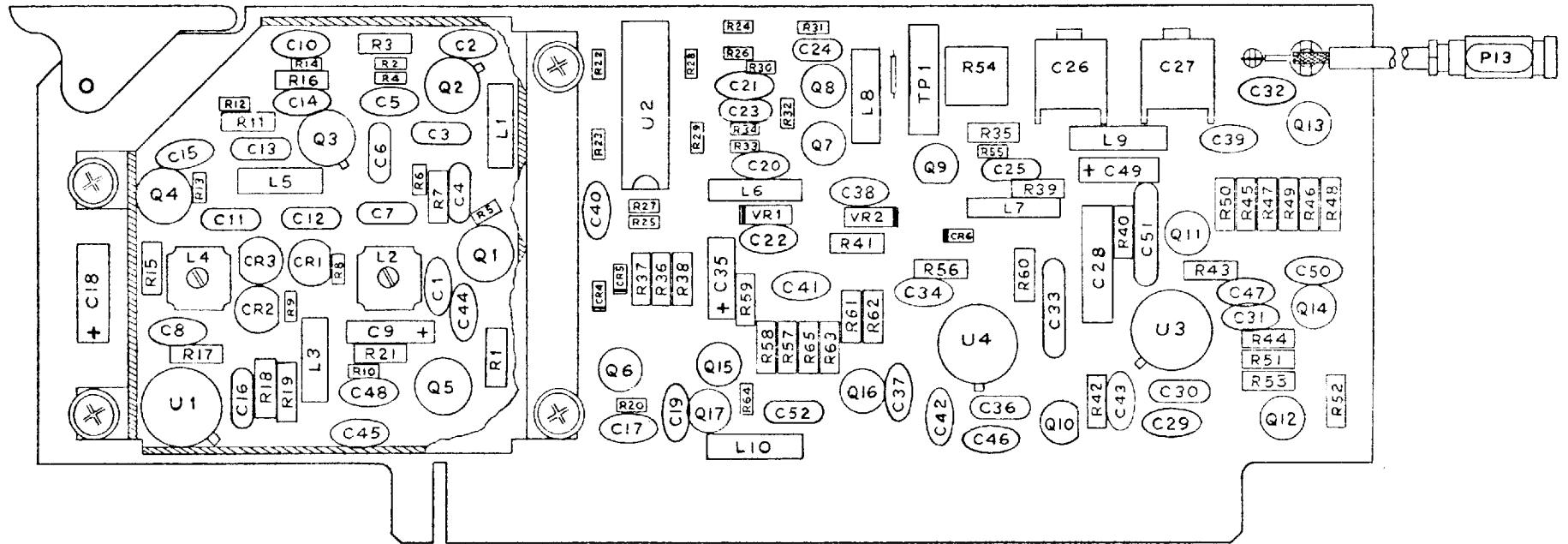
The triangular waveform is now applied to the base of emitter follower Q5 and into the VCO's frequency determining tank circuits and capacitance diodes.

The capacitance-versus-voltage curve of a capacitance diode is nonlinear. To compensate for this nonlinearity, a corrective network consisting of R37, CR5 and R36, CR4 is placed across the triangle waveform generator load resistor, R38. The effect of the corrective network is a nonlinear curve which opposes the capacitance diode curve, resulting in a more linear sweep.

Control R54, in a voltage divider on the input of amplifier U3, corrects for any offset of the phase detector which would cause the triangle waveform to be nonsymmetrical.

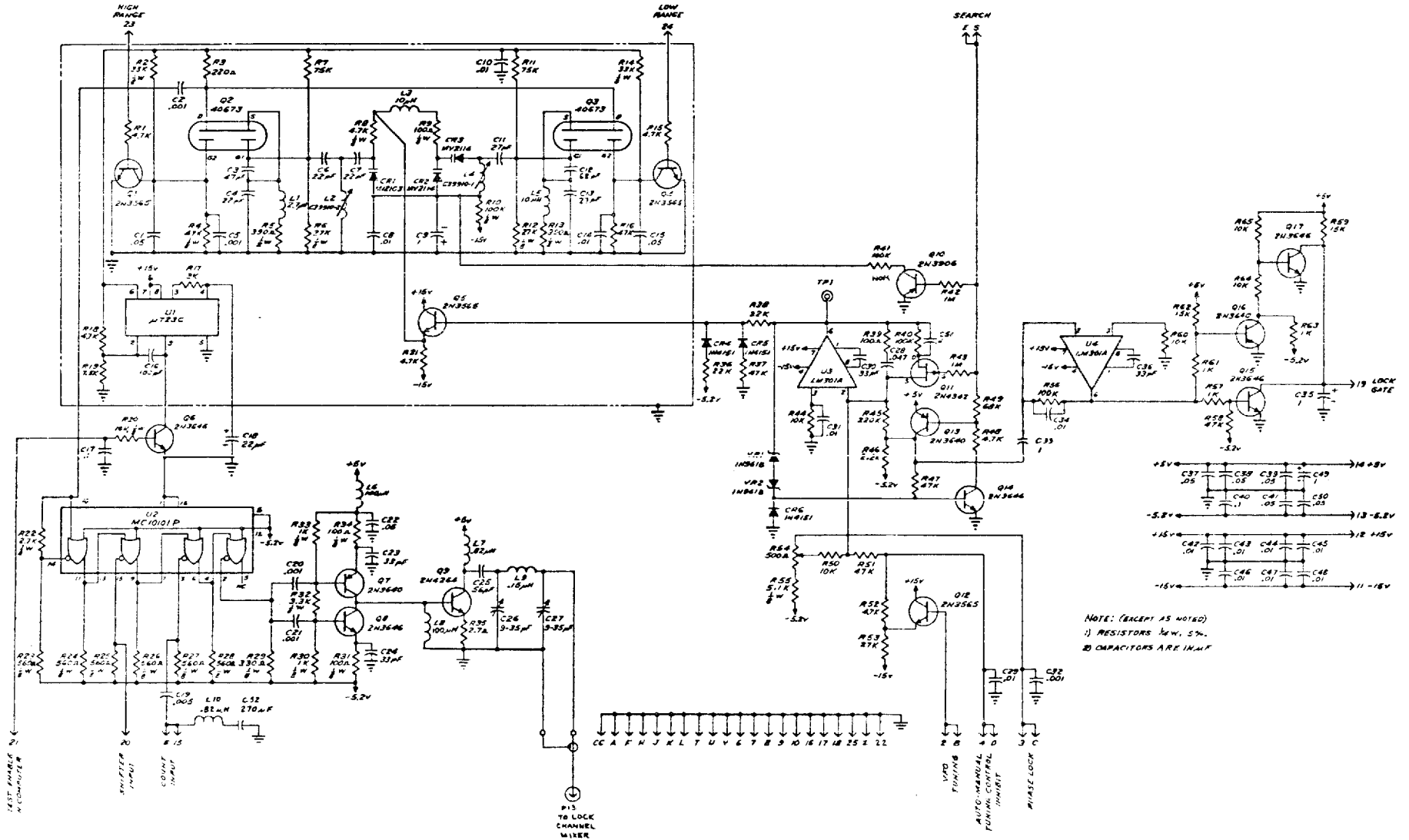
On the oscillator P.C. is the lock detector circuit. This circuit detects the presence of the triangle waveform and inhibits the counter readout until the ACTO is phase locked to the RF input signal. When phase locked, the triangle waveform generator has a constant dc output. The operation of the detector assumes that the unit is phase locked to an RF input signal. Amplifier U4 is connected as a differentiator across the triangle waveform binary. When phase locked, the output voltage of U4 will be 0 V and transistors Q15, Q16, and Q17 are off, allowing the lock gate to be near +5V potential indicating the system is phase locked. With no RF input, the triangle waveform generator is operating. Amplifier U4 differentiates the binary waveform and alternately turns on and off transistors Q15 and Q16, which in turn, switches Q17. Q15 and Q17 are driven out-of-phase so the voltage on the lock gate line is near ground.

39220-11-72



A2-3

A2, OSCILLATOR BOARD P.C. ASSEMBLY #33883E



A2, OSCILLATOR BOARD SCHEMATIC #39220D

A2, OSCILLATOR BOARD P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A2	Oscillator Board P.C. Assembly	33883
	Oscillator Board Schematic	39220
C1	Capacitor, .05 μ F, 12 V, disc	C0672
C2	Capacitor, .001 μ F, ceramic disc	C0424
C3	Capacitor, 47 pF, DM10, dip mica	C0848
C4	Capacitor, 22 pF, DM10, dip mica	C1285
C5	Capacitor, .001 μ F, ceramic disc	C0424
C6	Capacitor, .22 pF, DM10, dip mica	C1285
C7	Capacitor, .22 pF, DM10, dip mica	C1285
C8	Capacitor, .01 μ F, 100 V, disc	C0556
C9	Capacitor, 1 μ F, 35 V	C0524
C10	Capacitor, .01 μ F, 100 V, disc	C0556
C11	Capacitor, 27 pF, DM10, dip mica	C1286
C12	Capacitor, 68 pF, DM10, dip mica	C1284
C13	Capacitor, 27 pF, DM10, dip mica	C1286
C14	Capacitor, .01 μ F, 100 V, disc	C0556
C15	Capacitor, .05 μ F, 12 V, disc	C0672
C16	Capacitor, 100 pF, DM10, dip mica	C1156
C17	Capacitor, .1 μ F, 10 V, disc	C0661
C18	Capacitor, 22 μ F, 15 V	C0693
C19	Capacitor, .005 μ F, ceramic disc	C0425
C20	Capacitor, .001 μ F, ceramic disc	C0424
C21	Capacitor, .001 μ F, ceramic disc	C0424
C22	Capacitor, .05 μ F, 12 V, disc	C0672
C23	Capacitor, 33 μ F, dip mica	C0531
C24	Capacitor, 33 μ F, dip mica	C0531
C25	Capacitor, 56 pF, dip mica	C0534
C26	Capacitor, 9-35 pF, trim	C0792
C27	Capacitor, 9-35 pF, trim	C0792
C28	Capacitor, .047 μ F, met. mylar	C0381
C29	Capacitor, .01 μ F, 100 V, disc	C0556
C30	Capacitor, 33 pF, dip mica	C0531
C31	Capacitor, .01 μ F, 100 V, disc	C0556
C32	Capacitor, .001 μ F, ceramic disc	C0424
C33	Capacitor, 1 μ F, 25 V	C0879
C34	Capacitor, .01 μ F, 100 V, disc	C0556
C35	Capacitor, 1 μ F, 35 V	C0524
C36	Capacitor, 33 pF, dip mica	C0531
C37	Capacitor, .05 μ F, 12 V, disc	C0672
C38	Capacitor, .05 μ F, 12 V, disc	C0672

A2, OSCILLATOR BOARD P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
C39	Capacitor, .05 μ F, 12 V, disc	C0672
C40	Capacitor, .1 μ F, 10 V, disc	C0672
C41	Capacitor, .05 μ F, 12 V, disc	C0672
C42	Capacitor, .01 μ F, 100 V, disc	C0556
C43	Capacitor, .01 μ F, 100 V, disc	C0556
C44	Capacitor, .01 μ F, 100 V, disc	C0556
C45	Capacitor, .01 μ F, 100 V, disc	C0556
C46	Capacitor, .01 μ F, 100 V, disc	C0556
C47	Capacitor, .01 μ F, 100 V, disc	C0556
C48	Capacitor, .01 μ F, 100 V, disc	C0556
C49	Capacitor, 1 μ F, 35 V	C0524
C50	Capacitor, .05 μ F, 12 V, disc	C0672
C51	Capacitor, .1 μ F, 50 V	C0881
C52	Capacitor, 270 pF, 500 V	C0539
CR1	Diode, MV2103	CR0353
CR2	Diode, MV2114	CR0359
CR3	Diode, MV2114	CR0359
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
L1	Inductor, 2.7 μ H	L0048
L2	Inductor Assembly	39910-2
L3	Inductor, 10 μ H	L0153
L4	Inductor Assembly	39910-1
L5	Inductor, 10 μ H	L0153
L6	Inductor, 100 μ H	L0073
L7	Inductor, .82 μ H	L0163
L8	Inductor, 100 μ H	L0073
L9	Inductor, .15 μ H	L0069
L10	Inductor, .82 μ H	L0163
Q1	Transistor, 2N3565	Q0237
Q2	Transistor, 40673	Q0297
Q3	Transistor, 40673	Q0297
Q4	Transistor, 2N3565	Q0237
Q5	Transistor, 2N3565	Q0237
Q6	Transistor, 2N3646	Q0218
Q7	Transistor, 2N3640	Q0178
Q8	Transistor, 2N3646	Q0218
Q9	Transistor, 2N4264	Q0310
Q10	Transistor, 2N3906	Q0248
Q11	Transistor, 2N4342	Q0243

A2, OSCILLATOR BOARD P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
Q12	Transistor, 2N3565	Q0237
Q13	Transistor, 2N3640	Q0178
Q14	Transistor, 2N3646	Q0218
Q15	Transistor, 2N3646	Q0218
Q16	Transistor, 2N3640	Q0178
Q17	Transistor, 2N3646	Q0218
R1	Resistor, 4.7 k, 5%, 1/4 W	R0892
R2	Resistor, 33 k, 5%, 1/8 W	R1432
R3	Resistor, 220 Ω , 5%, 1/4 W	R0760
R4	Resistor, 47 k, 5%, 1/8 W	R1433
R5	Resistor, 390 Ω , 5%, 1/8 W	R1450
R6	Resistor, 27 k, 5%, 1/8 W	R2432
R7	Resistor, 75 k, 5%, 1/4 W	R0976
R8	Resistor, 4.7 k, 5%, 1/8 W	R1733
R9	Resistor, 100 Ω , 5%, 1/8 W	R1441
R10	Resistor, 100 k, 5%, 1/8 W	R2465
R11	Resistor, 75 k, 5%, 1/4 W	R0976
R12	Resistor, 27 k, 5%, 1/8 W	R2432
R13	Resistor, 390 Ω , 5%, 1/8 W	R1450
R14	Resistor, 33 k, 5%, 1/8 W	R1432
R15	Resistor, 4.7 k, 5%, 1/4 W	R0892
R16	Resistor, 47 k, 5%, 1/4 W	R0777
R17	Resistor, 3 k, 5%, 1/4 W	R0711
R18	Resistor, 4.7 k, 5%, 1/4 W	R0892
R19	Resistor, 7.5 k, 5%, 1/4 W	R0884
R20	Resistor, 10 k, 5%, 1/8 W	R1437
R21	Resistor, 4.7 k, 5%, 1/4 W	R0892
R22	Resistor, 2.7 k, 5%, 1/8 W	R1749
R23	Resistor, 560 Ω , 5%, 1/8 W	R1452
R24	Resistor, 560 Ω , 5%, 1/8 W	R1452
R25	Resistor, 560 Ω , 5%, 1/8 W	R1452
R26	Resistor, 560 Ω , 5%, 1/8 W	R1452
R27	Resistor, 560 Ω , 5%, 1/8 W	R1452
R28	Resistor, 560 Ω , 5%, 1/8 W	R1452
R29	Resistor, 330 Ω , 5%, 1/8 W	R1444
R30	Resistor, 1 k, 5%, 1/8 W	R1453
R31	Resistor, 100 Ω , 5%, 1/8 W	R1441
R32	Resistor, 3.3 k, 5%, 1/8 W	R1456
R33	Resistor, 1 k, 5%, 1/8 W	R1453
R34	Resistor, 100 Ω , 5%, 1/8 W	R1441

A2, OSCILLATOR BOARD P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R35	Resistor, 2.7 Ω , 5%, 1/4 W	R1697
R36	Resistor, 22 k, 5%, 1/4 W	R0768
R37	Resistor, 47 k, 5%, 1/4 W	R0777
R38	Resistor, 22 k, 5%, 1/4 W	R0768
R39	Resistor, 100 Ω , 5%, 1/4 W	R0966
R40	Resistor, 100 k, 5%, 1/4 W	R0741
R41	Resistor, 100 k, 5%, 1/4 W	R0741
R42	Resistor, 1 M, 5%, 1/4 W	R0962
R43	Resistor, 1 M, 5%, 1/4 W	R0962
R44	Resistor, 10 k, 5%, 1/4 W	R0766
R45	Resistor, 220 k, 5%, 1/4 W	R0967
R46	Resistor, 2.2 k, 5%, 1/4 W	R0749
R47	Resistor, 47 k, 5%, 1/4 W	R0777
R48	Resistor, 4.7 k, 5%, 1/4 W	R0892
R49	Resistor, 68 k, 5%, 1/4 W	R0891
R50	Resistor, 10 k, 5%, 1/4 W	R0766
R51	Resistor, 47 k, 5%, 1/4 W	R0777
R52	Resistor, 4.7 k, 5%, 1/4 W	R0892
R53	Resistor, 27 k, 5%, 1/4 W	R0824
R54	Resistor, 500 Ω , potentiometer	R2448
R55	Resistor, 5.1 k, 5%, 1/8 W	R1746
R56	Resistor, 100 k, 5%, 1/4 W	R0741
R57	Resistor, 1 k, 5%, 1/4 W	R0765
R58	Resistor, 47 k, 5%, 1/4 W	R0777
R59	Resistor, 15 k, 5%, 1/4 W	R0728
R60	Resistor, 10 k, 5%, 1/4 W	R0766
R61	Resistor, 1 k, 5%, 1/4 W	R0765
R62	Resistor, 15 k, 5%, 1/4 W	R0728
R63	Resistor, 1 k, 5%, 1/4 W	R0765
R64	Resistor, 10 k, 5%, 1/4 W	R0766
R65	Resistor, 10 k, 5%, 1/4 W	R0766
TP1	Test Point, Black	E0234
U1	Integrated Circuit, μ 723C	25756
U2	Integrated Circuit, MC10101P	25791
U3	Integrated Circuit, LM301A	25745
U4	Integrated Circuit, LM301A	25745
VR1	Diode, 1N961B	CR0201
VR2	Diode, 1N961B	CR0201

A2, OSCILLATOR BOARD P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
	Mylar Insulator	H1838
	Circuit Shield Assembly	45155
	Circuit Shield	45114
	Input Cable Assembly	45112
	Connector, input signal	J0624
	Component Shield	45113

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MODEL 6057/6016
CIRCUIT DESCRIPTION
A3, FREQUENCY SHIFTER
SCHEMATIC #33980

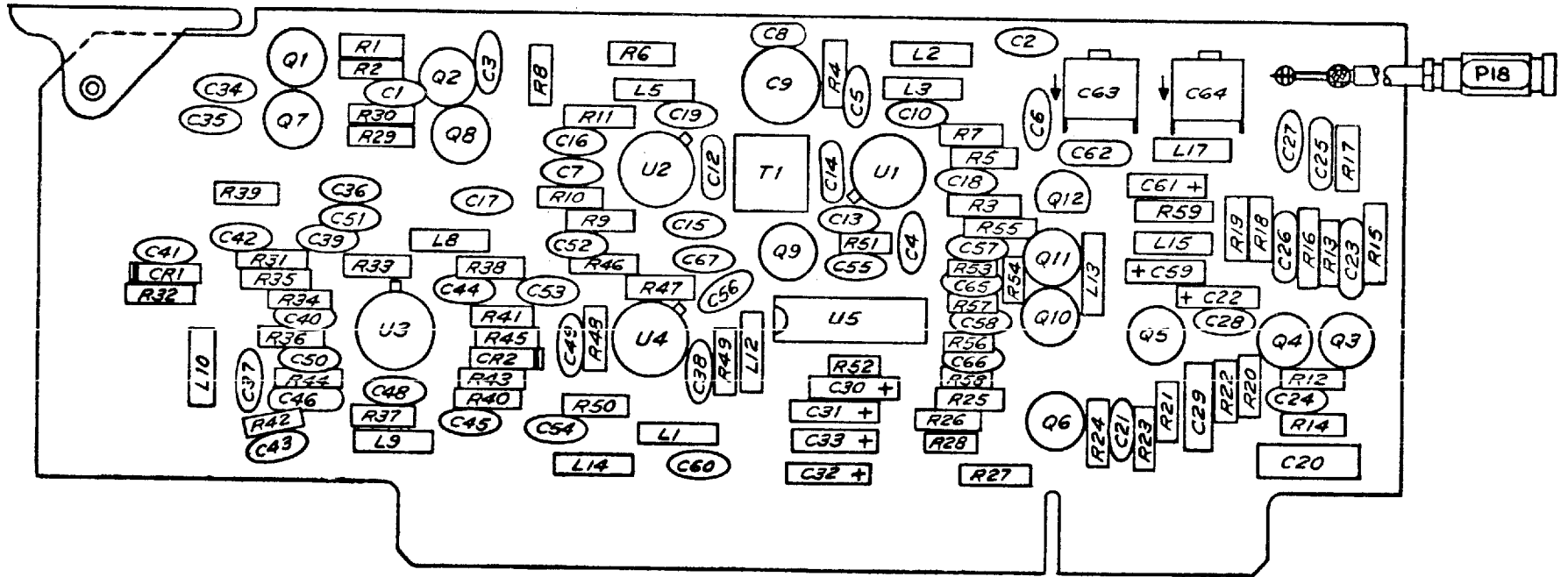
The output frequency of the 3 GHz and 18 GHz VCO must be shifted in frequency by 1 kHz in order to properly drive the N channel mixer, U3. There are two frequency shifters on the A3 assembly, one for each range. The proper shifter is selected by the RANGE switches on the front panel.

The VCO signal is obtained from A2U2, pin 15 and drives both shifters. Frequency selective phase shift networks L10 and C46 on the 3 GHz range, and C9 and L5 on the 18 GHz range, separate the VCO signals and also split each signal into two components separated in phase by 90°. Phase separation is accomplished by the LR phase-lag action L10, R32 and L5, R8, and by CR phase-lead by C46, R42 and C9, R4 in the 3 GHz and 18 GHz range shifters. The resultant signals are used to drive balanced modulators. Only the 3 GHz range shifters will be described here. Both shifters operate essentially the same.

Simultaneously with the VCO signal, a 1 kHz signal from the counter time base is routed to the base of Q3. Transistor Q3 inverts and amplifies the signal. A twin "T" notch filter on the collector of Q3 is tuned to block the 1 kHz signals passing all other frequencies. Q4, FET transistor provides a negative feedback path for all frequencies except the 1 kHz signal. The remaining 1 kHz signal at the collector of Q3, is now capacitively coupled to the base of phase-splitting amplifier Q5. Two separate 1 kHz signals, 90° out of phase, are taken from Q5 to drive one balanced modulator of each shifter. The midpoint of the phase shifter Q5, C29, and R22 drives the base of Q6 which produces two more 1 kHz signals 90° out of phase with each other, but shifted an additional 90° with reference to the first two signals. These signals drive the other balanced modulator in each frequency shifter.

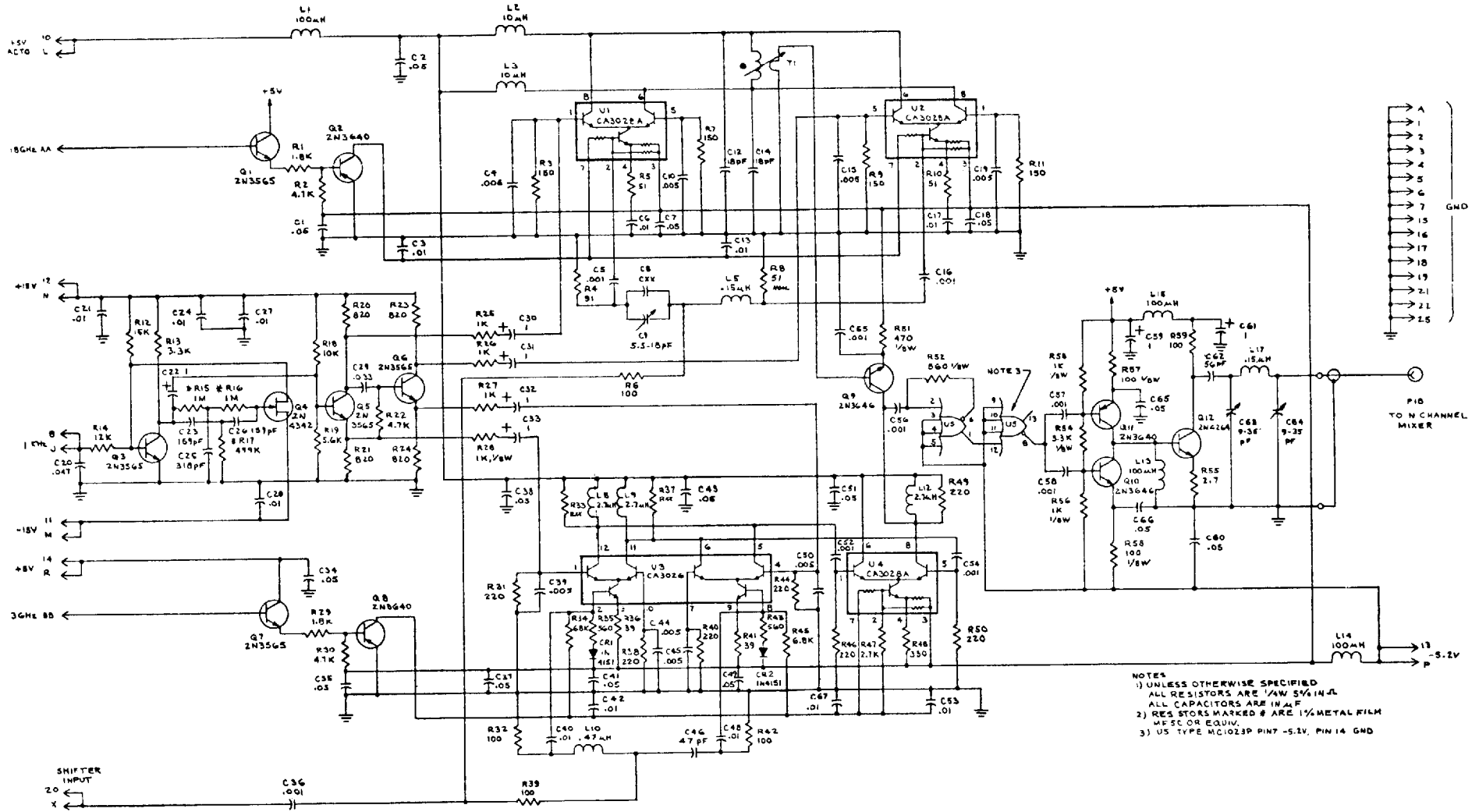
There are now two frequencies of signals being fed to the shifter. The first balanced modulator removes the carrier frequency, the second modulator removes one sideband resulting in a single sideband signal. This has the effect of shifting the carrier (VCO) by 1 kHz. The balanced modulators U1, U2, and U3 are a pair of differential amplifiers utilizing the carrier to drive the common mode inputs. U4 and T1 sums the outputs of the balanced modulators and converts them to a single output.

The output of the selected frequency shifter drives U5, a dual 4-input clock driver. The first section is connected as a linear amplifier and the second section as a buffer to drive Q10 and Q11. Q10 and Q11 are a broad-band push-pull amplifier which drives Q12, a class C amplifier with an impedance matching π network, to couple the shifter output to the N channel mixer.



A3, FREQUENCY SHIFTER P.C. ASSEMBLY #33983A

33980-11-72



NOTES
 1) UNLESS OTHERWISE SPECIFIED
 ALL RESISTORS ARE 1/4W 5% IN TL
 ALL CAPACITORS ARE 1W 50V
 2) RESISTORS MARKED # ARE 1/4 METAL FILM
 WESC OR EQUIV.
 3) US TYPE MC1023P PIN 7 -5.1V, PIN 14 GND

A3-3

A3, FREQUENCY SHIFTER SCHEMATIC #33980A

A3, FREQUENCY SHIFTER P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A3	Frequency Shifter P.C. Assembly	33983
	Frequency Shifter Schematic	33980
C1	Capacitor, .05 μ F, 12 V, disc	C0672
C2	Capacitor, .05 μ F, 12 V, disc	C0672
C3	Capacitor, .01 μ F, 150 V, disc	C0556
C4	Capacitor, .005 μ F, 150 V, disc	C0325
C5	Capacitor, .001 μ F, 1 kV, disc	C0235
C6	Capacitor, .01 μ F, 150 V, disc	C0556
C7	Capacitor, .05 μ F, 12 V, disc	C0672
C8	Capacitor, selected	Cxxxx
C9	Capacitor, 5.5-18 pF, trimmer	C0712
C10	Capacitor, .005 μ F, 150 V, disc	C0325
C11	Not Used	
C12	Capacitor, 18 pF, DM10	C0697
C13	Capacitor, .01 μ F, 150 V, disc	C0556
C14	Capacitor, 18 pF, DM10	C0697
C15	Capacitor, .005 μ F, 150 V, disc	C0325
C16	Capacitor, .001 μ F, 1 kV, disc	C0235
C17	Capacitor, .01 μ F, 150 V, disc	C0556
C18	Capacitor, .05 μ F, 12 V, disc	C0672
C19	Capacitor, .005 μ F, 150 V, disc	C0325
C20	Capacitor, .047 μ F, mylar	C0700
C21	Capacitor, .01 μ F, 150 V, disc	C0556
C22	Capacitor, 1 μ F, 35 V, tant	C0524
C23	Capacitor, 159 pF, DM15	C1146
C24	Capacitor, .01 μ F, 150 V, disc	C0556
C25	Capacitor, 318 pF, DM15	C1145
C26	Capacitor, 159 pF, DM15	C1146
C27	Capacitor, .01 μ F, 150 V, disc	C0556
C28	Capacitor, .01 μ F, 150 V, disc	C0556
C29	Capacitor, .033 μ F, mylar	C0735
C30	Capacitor, 1 μ F, 35 V, tant	C0524
C31	Capacitor, 1 μ F, 35 V, tant	C0524
C32	Capacitor, 1 μ F, 35 V, tant	C0524
C33	Capacitor, 1 μ F, 35 V, tant	C0524
C34	Capacitor, .05 μ F, 12 V, disc	C0672
C35	Capacitor, .05 μ F, 12 V, disc	C0672
C36	Capacitor, .001 μ F, 1 kV, disc	C0235
C37	Capacitor, .05 μ F, 12 V, disc	C0672
C38	Capacitor, .05 μ F, 12 V, disc	C0672

A3, FREQUENCY SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
C39	Capacitor, .005 μ F, 150 V, disc	C0325
C40	Capacitor, .01 μ F, 150 V, disc	C0556
C41	Capacitor, .05 μ F, 12 V, disc	C0672
C42	Capacitor, .01 μ F, 150 V, disc	C0556
C43	Capacitor, .05 μ F, 12 V, disc	C0672
C44	Capacitor, .005 μ F, 150 V, disc	C0325
C45	Capacitor, .005 μ F, 150 V, disc	C0325
C46	Capacitor, 47 pF, DM15	C0533
C47	Not Used	
C48	Capacitor, .01 μ F, 150 V, disc	C0556
C49	Capacitor, .05 μ F, 12 V, disc	C0672
C50	Capacitor, .005 μ F, 150 V, disc	C0325
C51	Capacitor, .05 μ F, 12 V, disc	C0672
C52	Capacitor, .001 μ F, 1 kV, disc	C0235
C53	Capacitor, .01 μ F, 150 V, disc	C0556
C54	Capacitor, .001 μ F, 1 kV, disc	C0235
C55	Capacitor, .001 μ F, 1 kV, disc	C0235
C56	Capacitor, .001 μ F, 1 kV, disc	C0235
C57	Capacitor, .001 μ F, 1 kV, disc	C0235
C58	Capacitor, .001 μ F, 1 kV, disc	C0235
C59	Capacitor, 1 μ F, 35 V, tant	C0524
C60	Capacitor, .05 μ F, 12 V, disc	C0672
C61	Capacitor, 1 μ F, 35 V, tant	C0524
C62	Capacitor, 56 pF, DM15	C0534
C63	Capacitor, 9-35 pF, trimmer	C0792
C64	Capacitor, 9-35 pF, trimmer	C0792
C65	Capacitor, .05 μ F, 12 V, disc	C0672
C66	Capacitor, .05 μ F, 12 V, disc	C0672
C67	Capacitor, .01 μ F, 150 V, disc	C0556
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
L1	Inductor, 100 μ H	L0073
L2	Inductor, 10 μ H	L0153
L3	Inductor, 10 μ H	L0153
L4	Not Used	
L5	Inductor, .15 μ H	L0069
L6	Not Used	
L7	Not Used	
L8	Inductor, 2.7 μ H	L0048
L9	Inductor, 2.7 μ H	L0048

A3, FREQUENCY SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
L10	Inductor, .47 μ H	L0154
L11	Not Used	
L12	Inductor, 2.7 μ H	L0048
L13	Inductor, 100 μ H	L0073
L14	Inductor, 100 μ H	L0073
L15	Inductor, 100 μ H	L0073
L16	Not Used	
L17	Inductor, .15 μ H	L0069
Q1	Transistor, 2N3565	Q0237
Q2	Transistor, 2N3640	Q0178
Q3	Transistor, 2N3565	Q0237
Q4	Transistor, 2N4342	Q0243
Q5	Transistor, 2N3565	Q0237
Q6	Transistor, 2N3565	Q0237
Q7	Transistor, 2N3565	Q0237
Q8	Transistor, 2N3640	Q0178
Q9	Transistor, 2N3646	Q0218
Q10	Transistor, 2N3646	Q0218
Q11	Transistor, 2N3640	Q0178
Q12	Transistor, 2N4264	Q0310
R1	Resistor, 1.8 k, 5%, 1/4 W	R0959
R2	Resistor, 4.7 k, 5%, 1/4 W	R0892
R3	Resistor, 150 Ω , 5%, 1/4 W	R0983
R4	Resistor, 91 Ω , 5%, 1/4 W	R1213
R5	Resistor, 51 Ω , 5%, 1/4 W	R1246
R6	Resistor, 100 Ω , 5%, 1/4 W	R0966
R7	Resistor, 150 Ω , 5%, 1/4 W	R0983
R8	Resistor, 51 Ω , 5%, 1/4 W	R1246
R9	Resistor, 150 Ω , 5%, 1/4 W	R0983
R10	Resistor, 51 Ω , 5%, 1/4 W	R1246
R11	Resistor, 150 Ω , 5%, 1/4 W	R0983
R12	Resistor, 15 k, 5%, 1/4 W	R0728
R13	Resistor, 3.3 k, 5%, 1/4 W	R0742
R14	Resistor, 12 k, 5%, 1/4 W	R0759
R15	Resistor, 1 M, 1%, 1/8 W, MF5C	R2371
R16	Resistor, 1 M, 1%, 1/8 W, MF5C	R2371
R17	Resistor, 499 k, 1%, 1/8 W, MF5C	R2372
R18	Resistor, 10 k, 5%, 1/4 W	R0766
R19	Resistor, 5.6 k, 5%, 1/4 W	R0821
R20	Resistor, 820 Ω , 5%, 1/4 W	R0762

A3, FREQUENCY SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R21	Resistor, 820 Ω , 5%, 1/4 W	R0762
R22	Resistor, 4.7 k, 5%, 1/4 W	R0892
R23	Resistor, 820 Ω , 5%, 1/4 W	R0762
R24	Resistor, 820 Ω , 5%, 1/4 W	R0762
R25	Resistor, 1 k, 5%, 1/4 W	R0765
R26	Resistor, 1 k, 5%, 1/4 W	R0765
R27	Resistor, 1 k, 5%, 1/4 W	R0765
R28	Resistor, 1 k, 5%, 1/8 W	R1453
R29	Resistor, 1.8 k, 5%, 1/4 W	R0959
R30	Resistor, 4.7 k, 5%, 1/4 W	R0892
R31	Resistor, 220 Ω , 5%, 1/4 W	R0760
R32	Resistor, 100 Ω , 5%, 1/4 W	R0966
R33	Resistor, selected	Rxxxx
R34	Resistor, 6.8 k, 5%, 1/4 W	R0696
R35	Resistor, 560 Ω , 5%, 1/4 W	R0819
R36	Resistor, 39 Ω , 5%, 1/4 W	R1552
R37	Resistor, selected	Rxxxx
R38	Resistor, 220 Ω , 5%, 1/4 W	R0760
R39	Resistor, 100 Ω , 5%, 1/4 W	R0966
R40	Resistor, 220 Ω , 5%, 1/4 W	R0760
R41	Resistor, 39 Ω , 5%, 1/4 W	R1552
R42	Resistor, 100 Ω , 5%, 1/4 W	R0966
R43	Resistor, 560 Ω , 5%, 1/4 W	R0819
R44	Resistor, 220 Ω , 5%, 1/4 W	R0760
R45	Resistor, 6.8 k, 5%, 1/4 W	R0696
R46	Resistor, 220 Ω , 5%, 1/4 W	R0760
R47	Resistor, 2.7 k, 5%, 1/4 W	R0937
R48	Resistor, 330 Ω , 5%, 1/4 W	R0662
R49	Resistor, 220 Ω , 5%, 1/4 W	R0760
R50	Resistor, 220 Ω , 5%, 1/4 W	R0760
R51	Resistor, 470 Ω , 5%, 1/8 W	R1451
R52	Resistor, 560 Ω , 5%, 1/8 W	R1452
R53	Resistor, 1 k, 5%, 1/8 W	R1453
R54	Resistor, 3.3 k, 5%, 1/8 W	R1456
R55	Resistor, 2.7 Ω , 5%, 1/4 W	R1697
R56	Resistor, 1 k, 5%, 1/8 W	R1453
R57	Resistor, 100 Ω , 5%, 1/8 W	R1441
R58	Resistor, 100 Ω , 5%, 1/8 W	R1441
R59	Resistor, 100 Ω , 5%, 1/4 W	R0966

A3, FREQUENCY SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
T1	Transformer	25072-4
U1	Integrated Circuit, CA3028A	25702
U2	Integrated Circuit, CA3028A	25702
U3	Integrated Circuit, CA3026	25724
U4	Integrated Circuit, CA3028A	25702
U5	Integrated Circuit, MC1023P	25718
	Input Cable Assembly	45112
	Connector, input signal	J0624

MODEL 6016
CIRCUIT DESCRIPTION
A4, VIDEO AMPLIFIER
SCHEMATIC #33973

The A4, Video Amplifier raises the output level of lock channel mixer U2 to a level suitable for application to the phase detector and video output. The amplifier has a dual bandwidth, controlled by the AUTO pushbutton on the front panel. In AUTO, the amplifier has a narrow-band IF with a center frequency of 10 MHz. The Model 6016 uses only the narrow-band portion of the amplifier (AUTO button is omitted).

The bandwidth is switched by using differential amplifiers and directing the output through the appropriate filter to alter the amplifier characteristics. In the AUTO mode, the output of the mixer is routed to U1, pin 2 and out U1, pin 6 which has L5 and C16 for a collector load. The output on U1, pin 8 is turned off by a positive voltage on U1, pin 1.

The selected signal from U1 is applied to U2 for further amplification, and phase division. Amplifier U3 is a broad-band amplifier that requires a differential driving signal which is provided by U2. U3 output is unloaded by emitter follower Q2 and buffered by Q3 to supply the video output signal to the front panel BNC connector. Video output is not used on the Model 6016.

A second signal is taken from the emitter of Q2 which drives a differential limiting amplifier Q4 and Q9. In the AUTO mode, the signal from the limiting amplifier drives Q5 and Q6, a Schmitt trigger.

The shaped signal from Schmitt trigger, Q5 and Q6 is level-shifted by Q7 and drives U4, a divide-by-ten. The division of ten is necessary to provide the 1 MHz required by the phase detector, U5.

The phase detector senses differences in phase between the 1 MHz output of U4 and the 1 MHz reference source that is applied to pin 4 of U5. It provides an output voltage, the dc component having an amplitude related directly to the instantaneous value of the phase difference. The output voltage is used as a corrective signal in the voltage-controlled oscillator to inhibit the sweep oscillator. The phase detector consists of one section of an exclusive OR gate and a transistor to shift the level of the voltage to a ground reference. The operation of the phase detector is shown in Figure A4.1. As shown by the dashed lines, a change in phase at the IF signal causes a change in the average dc output voltage. This voltage is shifted to a ground reference point and controls the VCO.

Also comparing the output of the IF and the reference is a side-band detector U6. U6 is a D type flip-flop. The 1 MHz reference is applied to the D input and the IF output to the clock input. The

characteristics of a D type flip-flop are that the Q output will take on the level of the D input upon the application of a clock signal. If the output of the IF lags in phase with respect to the 1 MHz reference, the Q output will be in the high state. If the IF output leads in phase, the Q output will be in the low state. The \bar{Q} is out of phase with respect to the Q output and is the signal used to indicate which sideband the ACTO has phase-locked. To achieve a direct readout of the RF input, the sideband detector directs that the 10 MHz IF frequency be added or subtracted to the counter readout.

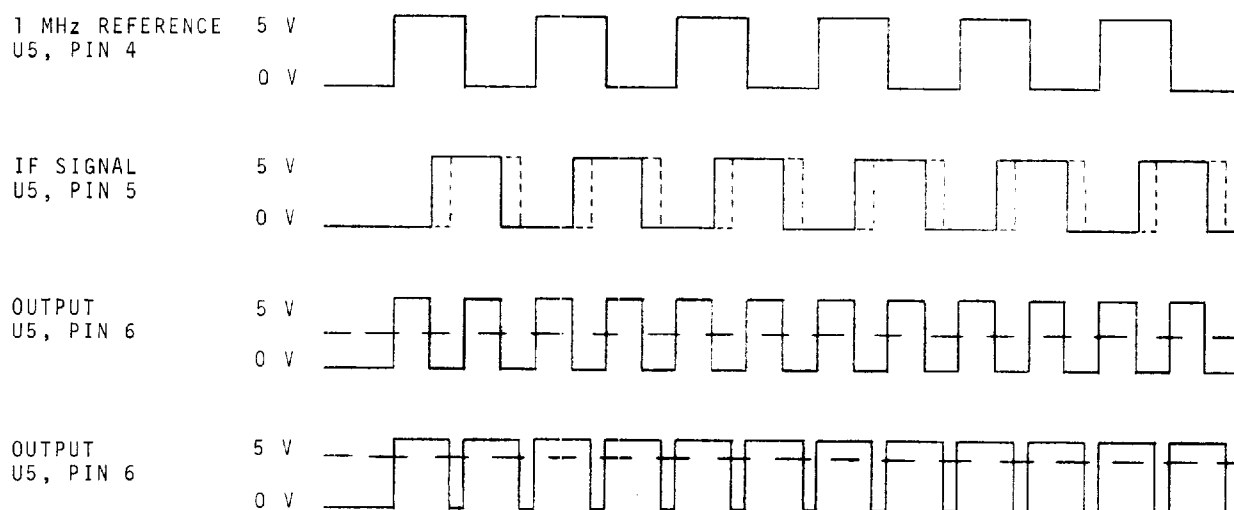
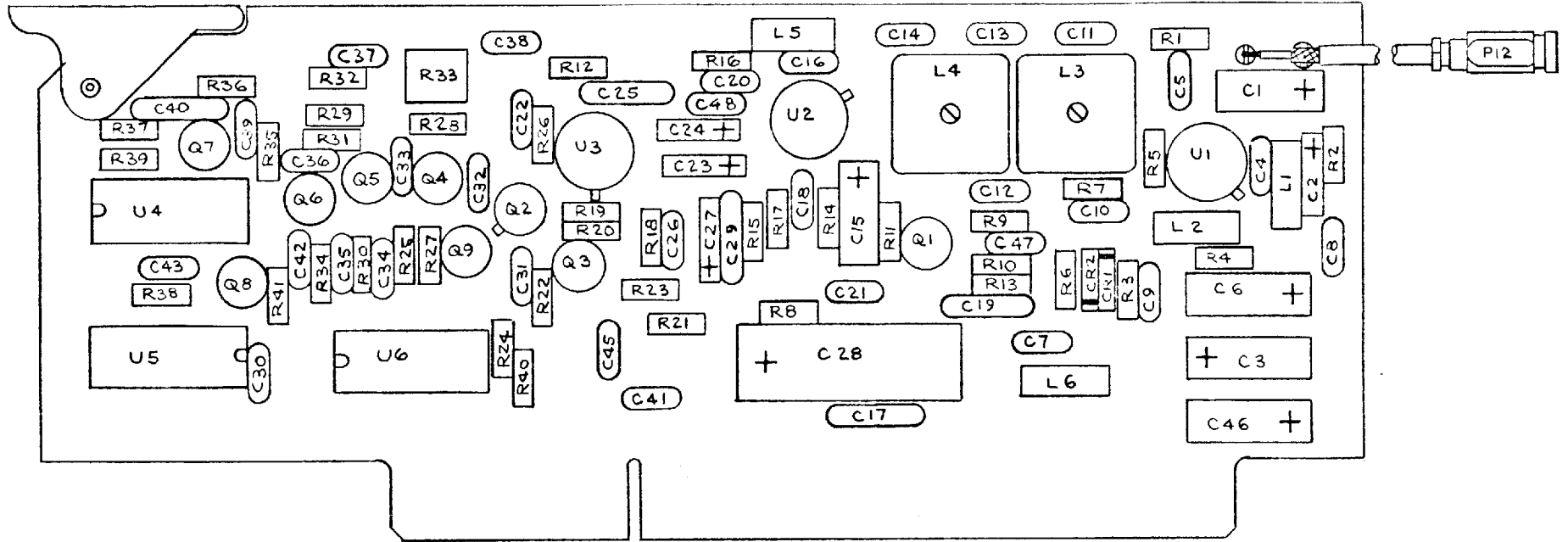


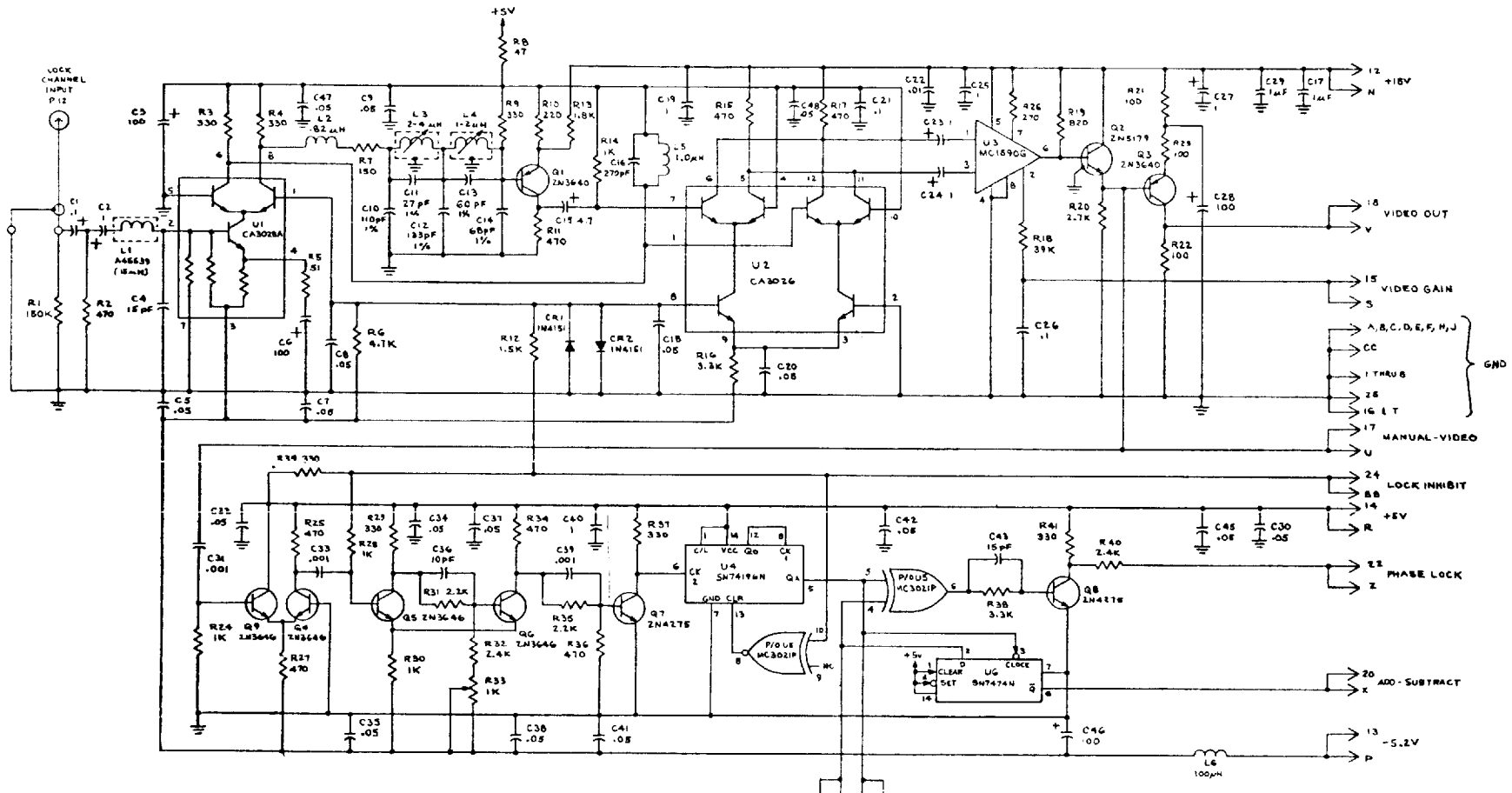
FIGURE A4.1 PHASE DETECTOR WAVEFORMS

33973-11-72



A4-3

A4, VIDEO AMPLIFIER P.C. ASSEMBLY #33972C



NOTES
 1) UNLESS OTHERWISE SPECIFIED:
 ALL RESISTORS ARE 1/4W 5% IN A
 ALL CAPACITORS ARE IN μ F
 2) US MC3021P PIN 7 GND PIN 14 +5V

23 AA 19 W
 0* AUTOMATIC
 1MHE VIDEO

A4, VIDEO AMPLIFIER SCHEMATIC #33973B

A4, VIDEO AMPLIFIER P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A4	Video Amp P.C. Assembly	33972
	Video Amp Schematic	33973
C1	Capacitor, .1 μ F, 35 V, tant	C0806
C2	Capacitor, 1 μ F, 35 V, tant	C0524
C3	Capacitor, 100 μ F, 10 V, tant	C0660
C4	Capacitor, 15 pF, DM15	C0528
C5	Capacitor, .05 μ F, 12 V, disc	C0672
C6	Capacitor, 100 μ F, 10 V, tant	C0660
C7	Capacitor, .05 μ F, 12 V, disc	C0672
C8	Capacitor, .05 μ F, 12 V, disc	C0672
C9	Capacitor, .05 μ F, 12 V, disc	C0672
C10	Capacitor, 110 pF, 1%, DM15	C1277
C11	Capacitor, 27 pF \pm .5 pF, DM15	C1276
C12	Capacitor, 133 pF, 1%, DM15	C1278
C13	Capacitor, 60 pF, 1%, DM15	C1279
C14	Capacitor, 68 pF, 1%, DM15	C1280
C15	Capacitor, 4.7 μ F, 35 V, tant	C0406
C16	Capacitor, 270 pF, DM15	C0539
C17	Capacitor, 1 μ F, 25 V, disc	C0879
C18	Capacitor, .05 μ F, 12 V, disc	C0672
C19	Capacitor, 1 μ F, 25 V, disc	C0879
C20	Capacitor, .05 μ F, 12 V, disc	C0672
C21	Capacitor, .1 μ F, 10 V, disc	C0661
C22	Capacitor, .01 μ F, 100 V, disc	C0556
C23	Capacitor, 1 μ F, 35 V, tant	C0524
C24	Capacitor, 1 μ F, 35 V, tant	C0524
C25	Capacitor, 1 μ F, 25 V, disc	C0879
C26	Capacitor, .1 μ F, 10 V, disc	C0661
C27	Capacitor, 1 μ F, 35 V, tant	C0524
C28	Capacitor, 100 μ F, 25 V, tant	C0832
C29	Capacitor, 1 μ F, 25 V, disc	C0879
C30	Capacitor, .05 μ F, 12 V, disc	C0672
C31	Capacitor, .001 μ F, 1 kV, disc	C0235
C32	Capacitor, .05 μ F, 12 V, disc	C0672
C33	Capacitor, .001 μ F, 1 kV, disc	C0235
C34	Capacitor, .05 μ F, 12 V, disc	C0672
C35	Capacitor, .05 μ F, 12 V, disc	C0672
C36	Capacitor, 10 pF, DM15	C0527
C37	Capacitor, .05 μ F, 12 V, disc	C0672
C38	Capacitor, .05 μ F, 12 V, disc	C0672

A4, VIDEO AMPLIFIER P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref	Description	SD Part No.
C39	Capacitor, .001 μ F, 1 kV, disc	C0235
C40	Capacitor, 1 μ F, 25 V, disc	C0879
C41	Capacitor, .05 μ F, 12 V, disc	C0672
C42	Capacitor, .05 μ F, 12 V, disc	C0672
C43	Capacitor, 15 pF, DM15	C0528
C44	Not Used	
C45	Capacitor, .05 μ F, 12 V, disc	C0672
C46	Capacitor, 100 μ F, 10 V, tant	C0660
C47	Capacitor, .05 μ F, 12 V, disc	C0672
C48	Capacitor, .05 μ F, 12 V, disc	C0672
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
L1	Shielded Inductor Assembly 15 μ H	21103370
L2	Inductor, .82 μ H	L0059
L3	Shielded Inductor Assembly 2-4 μ H	45044-2
L4	Shielded Inductor Assembly 1-2 μ H	45044-1
	Shielded Coil Form	E0304
L5	Inductor, 1.0 μ H	L0081
L6	Inductor, 100 μ H	L0156
Q1	Transistor, 2N3640	Q0178
Q2	Transistor, 2N5179	Q0269
Q3	Transistor, 2N3640	Q0178
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3646	Q0218
Q7	Transistor, 2N4275	26013140
Q8	Transistor, 2N4275	26013140
Q10	Transistor, 2N3646	Q0218
R1	Resistor, 150 k, 5%, 1/4 W	R0961
R2	Resistor, 470 Ω , 5%, 1/4 W	R1044
R3	Resistor, 330 Ω , 5%, 1/4 W	R0662
R4	Resistor, 330 Ω , 5%, 1/4 W	R0662
R5	Resistor, 51 Ω , 5%, 1/4 W	R1246
R6	Resistor, 4.7 k, 5%, 1/4 W	R0892
R7	Resistor, 150 Ω , 5%, 1/4 W	R0983
R8	Resistor, 47 Ω , 5%, 1/4 W	R0743
R9	Resistor, 330 Ω , 5%, 1/4 W	R0662
R10	Resistor, 220 Ω , 5%, 1/4 W	R0760
R11	Resistor, 470 Ω , 5%, 1/4 W	R1044

A4, VIDEO AMPLIFIER P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R12	Resistor, 1.5 k, 5%, 1/4 W	R0783
R13	Resistor, 1.8 k, 5%, 1/4 W	R0959
R14	Resistor, 1 k, 5%, 1/4 W	R0765
R15	Resistor, 470 Ω , 5%, 1/4 W	R1044
R16	Resistor, 3.3 k, 5%, 1/4 W	R0742
R17	Resistor, 470 Ω , 5%, 1/4 W	R1044
R18	Resistor, 39 k, 5%, 1/4 W	R0748
R19	Resistor, 820 Ω , 5%, 1/4 W	R0762
R20	Resistor, 2.7 k, 5%, 1/4 W	R0937
R21	Resistor, 100 Ω , 5%, 1/4 W	R0966
R22	Resistor, 100 Ω , 5%, 1/4 W	R0966
R23	Resistor, 100 Ω , 5%, 1/4 W	R0966
R24	Resistor, 1 k, 5%, 1/4 W	R0765
R25	Resistor, 470 Ω , 5%, 1/4 W	R1044
R26	Resistor, 270 Ω , 5%, 1/4 W	R0694
R27	Resistor, 470 Ω , 5%, 1/4 W	R1044
R28	Resistor, 1 k, 5%, 1/4 W	R0765
R29	Resistor, 330 Ω , 5%, 1/4 W	R0662
R30	Resistor, 1 k, 5%, 1/4 W	R0765
R31	Resistor, 2.2 k, 5%, 1/4 W	R0749
R32	Resistor, 2.4 k, 5%, 1/4 W	R1045
R33	Resistor, 1 k, potentiometer	R2330
R34	Resistor, 470 Ω , 5%, 1/4 W	R1044
R35	Resistor, 2.2 k, 5%, 1/4 W	R0749
R36	Resistor, 470 Ω , 5%, 1/4 W	R1044
R37	Resistor, 330 Ω , 5%, 1/4 W	R0662
R38	Resistor, 3.3 k, 5%, 1/4 W	R0742
R39	Resistor, 330 Ω , 5%, 1/4 W	R0662
R40	Resistor, 2.4 k, 5%, 1/4 W	R1045
R41	Resistor, 330 Ω , 5%, 1/4 W	R0662
U1	Integrated Circuit, CA3028A	25702
U2	Integrated Circuit, CA3026	25724
U3	Integrated Circuit, MC1590G	25788
U4	Integrated Circuit, SN74196N	25784
U5	Integrated Circuit, MC3021P	25789
U6	Integrated Circuit, SN7474N	25241
	Input Cable Assembly	45112
	Connector	J0624



MODEL 6057/6016
CIRCUIT DESCRIPTION
A5, N CHANNEL IF AMPLIFIER
SCHEMATIC #33959

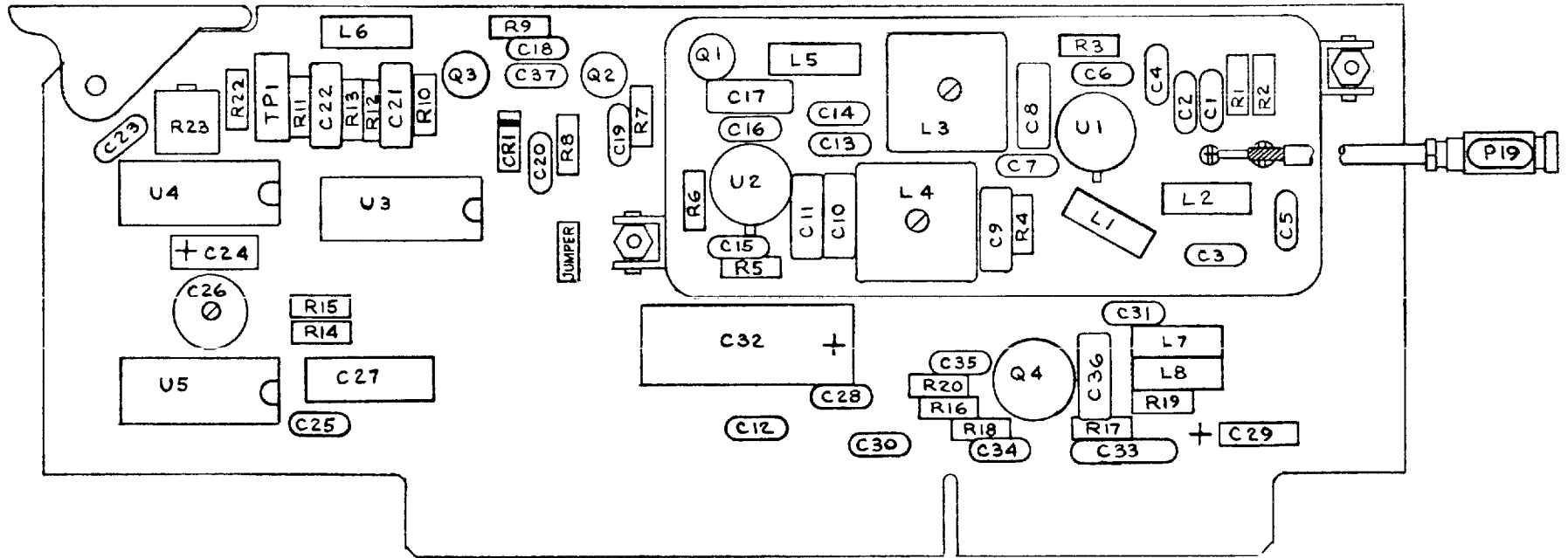
The N Channel IF Amplifier is a bandpass amplifier with a center frequency of 10 MHz. The bandpass is adjustable by means of a filter between U1 and U2. The bandpass is adjusted for ± 200 kHz which will allow uniform amplification for all frequencies that represent harmonic numbers up to 200.

The N channel mixer output is amplified by U1 and coupled to amplifier U2 by a double-tuned, overcoupled filter L3, L4, C8, C9, C10, and C11. Further bandpass shaping occurs in the load impedance for U2 (L5, C17). The output of U2 drives a current mode limiting amplifier Q1, Q2, and level translator Q3 which provides the correct drive for U3, pin 1, an exclusive OR gate used as a mixer. The other input of U3 is driven by a 10 MHz oscillator which is phase locked to the counter 1 MHz.

The mixed output of U3 is followed by a low-pass filter which removes the 10 MHz component of the mixer output but allows 1 kHz X N to pass to U3, pin 5. U3, pins 5 and 6 are connected as a Schmitt trigger which shapes the signal to drive TTL logic in the N computer.

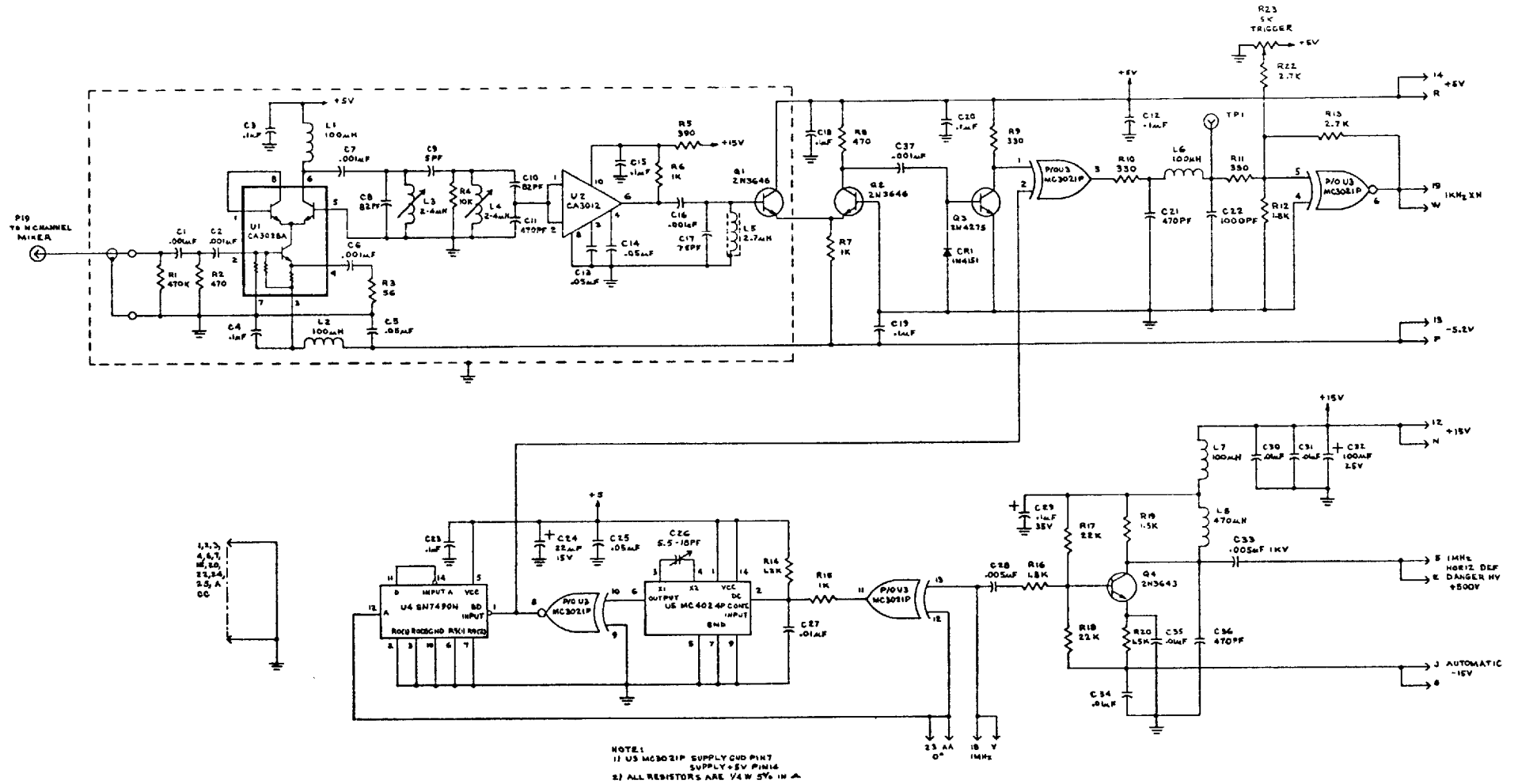
The 10 MHz signal used by the mixer in the N channel IF is derived by an oscillator phase lock to the counter 1 MHz. U5 is a voltage-controlled oscillator whose output is buffered by U3, pins 8 and 10 and divided by ten to drive U3, pin 12. U3, pins 12 and 13 phase-compare the counter 1 MHz with the VCO 1 MHz and develop a dc voltage which is proportional to the phase difference. This voltage is filtered and applied to the dc control input of oscillator U5. Thus, the 10 MHz has an exact phase relationship to the counter 1 MHz.

Also on the N channel IF P.C. assembly is amplifier Q4 that provides the high-amplitude, 1 MHz sine wave used for horizontal deflection of the front panel CRT. The CRT is not used on the Model 6016.



A5, N CHANNEL IF AMPLIFIER P.C. ASSEMBLY #33962C

33959-11-72



A5, N CHANNEL IF AMPLIFIER SCHEMATIC #33959C

A5, N CHANNEL IF AMP P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A5	N Channel IF Amp P.C. Assembly	33962
	N Channel IF Amp Schematic	33959
C1	Capacitor, .001 μ F, 1 kV	C0235
C2	Capacitor, .001 μ F, 1 kV	C0235
C3	Capacitor, .1 μ F, 10 V	C0661
C4	Capacitor, .1 μ F, 10 V	C0661
C5	Capacitor, .05 μ F, 12 V	C0672
C6	Capacitor, .001 μ F, 1 kV	C0235
C7	Capacitor, .001 μ F, 1 kV	C0235
C8	Capacitor, 82 pF, 500 V	C0535
C9	Capacitor, 5 pF, 500 V	C1071
C10	Capacitor, 82 pF, 500 V	C0535
C11	Capacitor, 470 pF, 500 V	C0542
C12	Capacitor, .1 μ F, 10 V	C0661
C13	Capacitor, .05 μ F, 12 V	C0672
C14	Capacitor, .05 μ F, 12 V	C0672
C15	Capacitor, .1 μ F, 10 V	C0661
C16	Capacitor, .001 μ F, 1 kV	C0235
C17	Capacitor, 75 pF	03175250
C18	Capacitor, .1 μ F, 10 V	C0661
C19	Capacitor, .1 μ F, 10 V	C0661
C20	Capacitor, .1 μ F, 10 V	C0661
C21	Not Used	
C22	Capacitor, 1000 pF, 100 V	C0543
C23	Capacitor, .1 μ F, 10 V	C0661
C24	Capacitor, 22 μ F, 15 V	C0693
C25	Capacitor, .05 μ F, 12 V	C0672
C26	Capacitor, 5.5-18 pF	C0712
C27	Capacitor, .01 μ F, 200 V	C0852
C28	Capacitor, .005 μ F, 150 V	C0325
C29	Capacitor, .1 μ F, 35 V	C0806
C30	Capacitor, .01 μ F, 100 V	C0556
C31	Capacitor, .01 μ F, 100 V	C0556
C32	Capacitor, 100 μ F, 25 V	C0832
C33	Capacitor, .005 μ F, 1 kV	C0221
C34	Capacitor, .01 μ F, 100 V	C0556
C35	Capacitor, .01 μ F, 100 V	C0556
C36	Capacitor, 470 pF, 500 V	C0542
C37	Capacitor, .001 μ F, 1 kV	C0235

A5, N CHANNEL IF AMP P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
CR1	Diode, 1N4151	CR0150
L1	Inductor, 100 μ H	L0073
L2	Inductor, 100 μ H	L0073
L3	Shielded Inductor Assembly 2-4 μ H Shielded Coil Form	45044-2 E0304
L4	Shielded Inductor Assembly 2-4 μ H Shielded Coil Form	45044-2 E0304
L5	Inductor, 2.7 μ H	L0048
L6	Inductor, 100 μ H	L0073
L7	Inductor, 100 μ H	L0073
L8	Inductor, 470 μ H	L0019
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N4275	26013140
Q4	Transistor, 2N3643	Q0179
R1	Resistor, 470 k, 5%, 1/4 W	R1060
R2	Resistor, 470 Ω , 5%, 1/4 W	R1044
R3	Resistor, 56 Ω , 5%, 1/4 W	R1554
R4	Resistor, 10 k, 5%, 1/4 W	R0766
R5	Resistor, 390 Ω , 5%, 1/4 W	R0880
R6	Resistor, 1 k, 5%, 1/4 W	R0765
R7	Resistor, 1 k, 5%, 1/4 W	R0765
R8	Resistor, 470 Ω , 5%, 1/4 W	R1044
R9	Resistor, 330 Ω , 5%, 1/4 W	R0662
R10	Resistor, 330 Ω , 5%, 1/4 W	R0662
R11	Resistor, 330 Ω , 5%, 1/4 W	R0662
R12	Resistor, 1.8 k, 5%, 1/4 W	R0959
R13	Resistor, 2.7 k, 5%, 1/4 W	R0937
R14	Resistor, 1.2 k, 5%, 1/4 W	R0809
R15	Resistor, 1 k, 5%, 1/4 W	R0765
R16	Resistor, 1.8 k, 5%, 1/4 W	R0959
R17	Resistor, 22 k, 5%, 1/4 W	R0768
R18	Resistor, 22 k, 5%, 1/4 W	R0768
R19	Resistor, 1.5 k, 5%, 1/4 W	R0783
R20	Resistor, 1.5 k, 5%, 1/4 W	R0783
R21	Resistor, 47 Ω , 5%, 1/4 W	R0743
R22	Resistor, 2.7 k, 5%, 1/4 W	R0937
R23	Resistor, 5 k, potentiometer	R2239
TP1	Test Point, Brown	E0235

A5, N CHANNEL IF AMP P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
U1	Integrated Circuit, CA3028A	25702
U2	Integrated Circuit, CA3012	25703
U3	Integrated Circuit, MC3021P	25789
U4	Integrated Circuit, SN7490N	25732
U5	Integrated Circuit, MC4024P	45206
	Input Cable Assembly	45112
	Connector	J0624
	Component Shield Assembly	45480-4-1
	Component Shield	45480-1-1

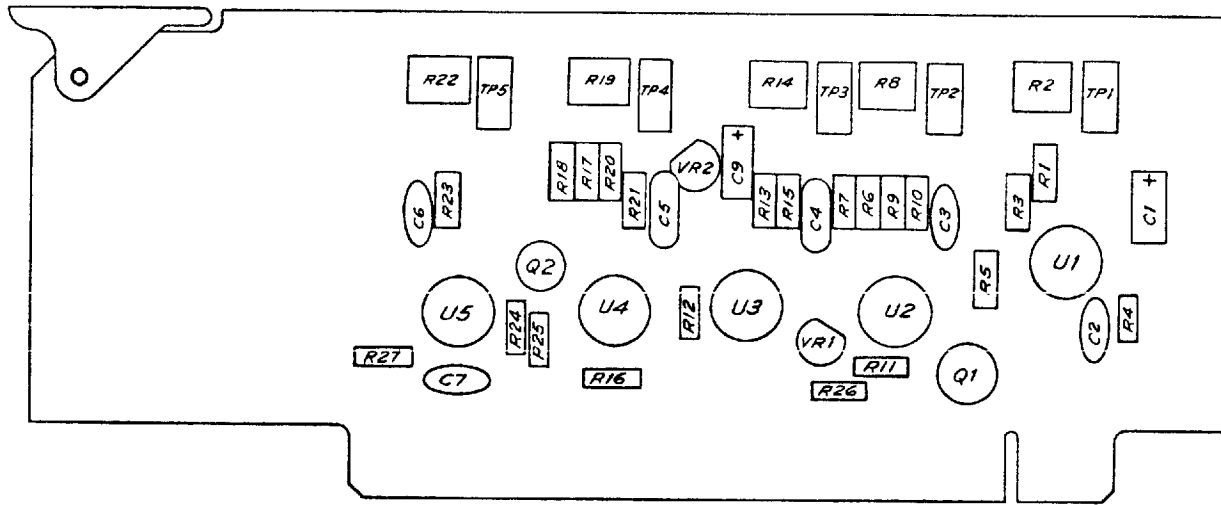
MODEL 6016
CIRCUIT DESCRIPTION
A6, POWER SUPPLY
SCHEMATIC #45374

The A6 Power Supply provides both regulated and unregulated dc voltages from either a 115 V ac or 230 V ac, 50 to 60 Hz power line source.

The regulated dc voltages are +5 V, -5.2 V, +5 V ACTO , +15 V, and -15 V. These voltages are regulated by integrated circuit voltage regulators on the power supply P.C. assembly.

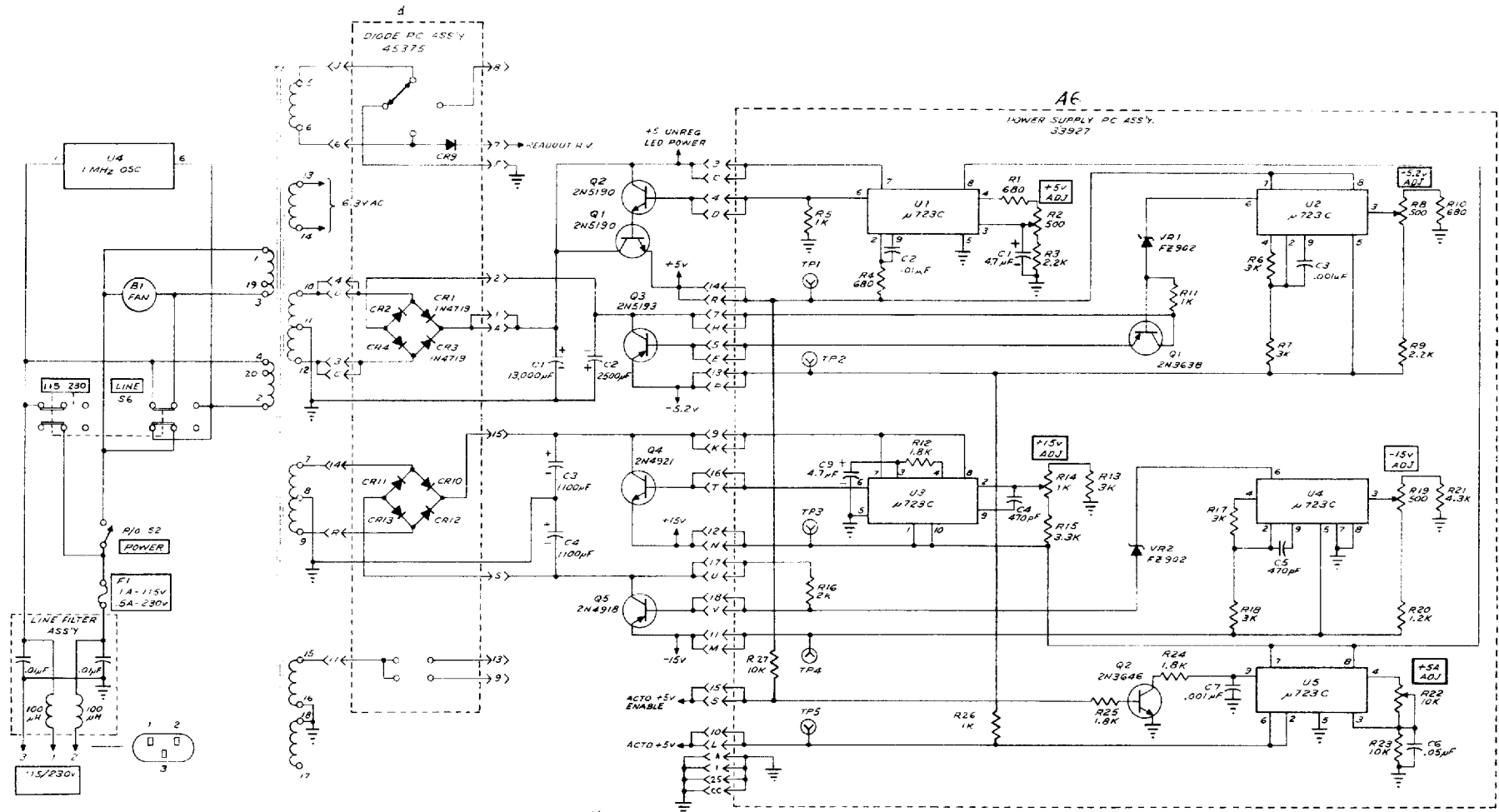
The unregulated dc supply provides +225 V, half-wave rectified, for the readout tubes.

See All, Diode Board (Schematic #D45374) for additional power supply description.



A6, POWER SUPPLY P.C. ASSEMBLY #33927B

45374-11-72



NOTE:
1) RESISTORS 1/4W 5%.
2) DIODES ARE 1N4005.

A6, POWER SUPPLY SCHEMATIC #45374B

A6-3

A6, POWER SUPPLY P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A6	Power Supply P.C. Assembly	33927
	Power Supply, Schematic	45374
C1	Capacitor, 4.7 μ F, 10 V, tant	C1011
C2	Capacitor, .01 μ F, 1000 V	C0556
C3	Capacitor, .001 μ F, 1000 V	C0235
C4	Capacitor, 470 pF, 500 V	C0542
C5	Capacitor, 470 pF, 500 V	C0542
C6	Capacitor, .05 μ F, 12 V, disc	C0672
C7	Capacitor, .001 μ F, 1000 V	C0235
C8	Not Used	
C9	Capacitor, 4.7 μ F, 10 V, tant	C1011
Q1	Transistor, 2N3638	Q0181
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 680 Ω , 5%, 1/4 W	R1234
R2	Resistor, 500 Ω , potentiometer	R2448
R3	Resistor, 2.2 k, 5%, 1/4 W	R0749
R4	Resistor, 680 Ω , 5%, 1/4 W	R1234
R5	Resistor, 1 k, 5%, 1/4 W	R0765
R6	Resistor, 3 k, 5%, 1/4 W	R0711
R7	Resistor, 3 k, 5%, 1/4 W	R0711
R8	Resistor, 500 Ω , potentiometer	R2448
R9	Resistor, 2.2 k, 5%, 1/4 W	R0749
R10	Resistor, 680 Ω , 5%, 1/4 W	R1234
R11	Resistor, 1 k, 5%, 1/4 W	R0765
R12	Resistor, 1.8 k, 5%, 1/4 W	R0959
R13	Resistor, 3 k, 5%, 1/4 W	R0711
R14	Resistor, 1 k, potentiometer	R2330
R15	Resistor, 3.3 k, 5%, 1/4 W	R0742
R16	Resistor, 2 k, 5%, 1/4 W	R0734
R17	Resistor, 3 k, 5%, 1/4 W	R0711
R18	Resistor, 3 k, 5%, 1/4 W	R0711
R19	Resistor, 500 Ω , potentiometer	R2448
R20	Resistor, 1.2 k, 5%, 1/4 W	R0809
R21	Resistor, 4.3 k, 5%, 1/4 W	R0702
R22	Resistor, 10 k, potentiometer	R2412
R23	Resistor, 10 k, 5%, 1/4 W	R0766
R24	Resistor, 1.8 k, 5%, 1/4 W	R0959
R25	Resistor, 1.8 k, 5%, 1/4 W	R0959
R26	Resistor, 1 k, 5%, 1/4 W	R0765

A6, POWER SUPPLY P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R27	Resistor, 10 k, 5%, 1/4 W	R0766
TP1	Test Point, Black	E0234
TP2	Test Point, Red	E0236
TP3	Test Point, Orange	E0237
TP4	Test Point, Yellow	E0238
TP5	Test Point, Green	E0239
U1	Integrated Circuit, μ 723C	25756
U2	Integrated Circuit, μ 723C	25756
U3	Integrated Circuit, μ 723C	25756
U4	Integrated Circuit, μ 723C	25756
U5	Integrated Circuit, μ 723C	25756
VR1	Diode, Zener, FZ902	26015850
VR2	Diode, Zener, FZ902	26015850

* See Final Assembly Parts List for main chassis power supply components (Capacitor Chassis Assembly #C39240).



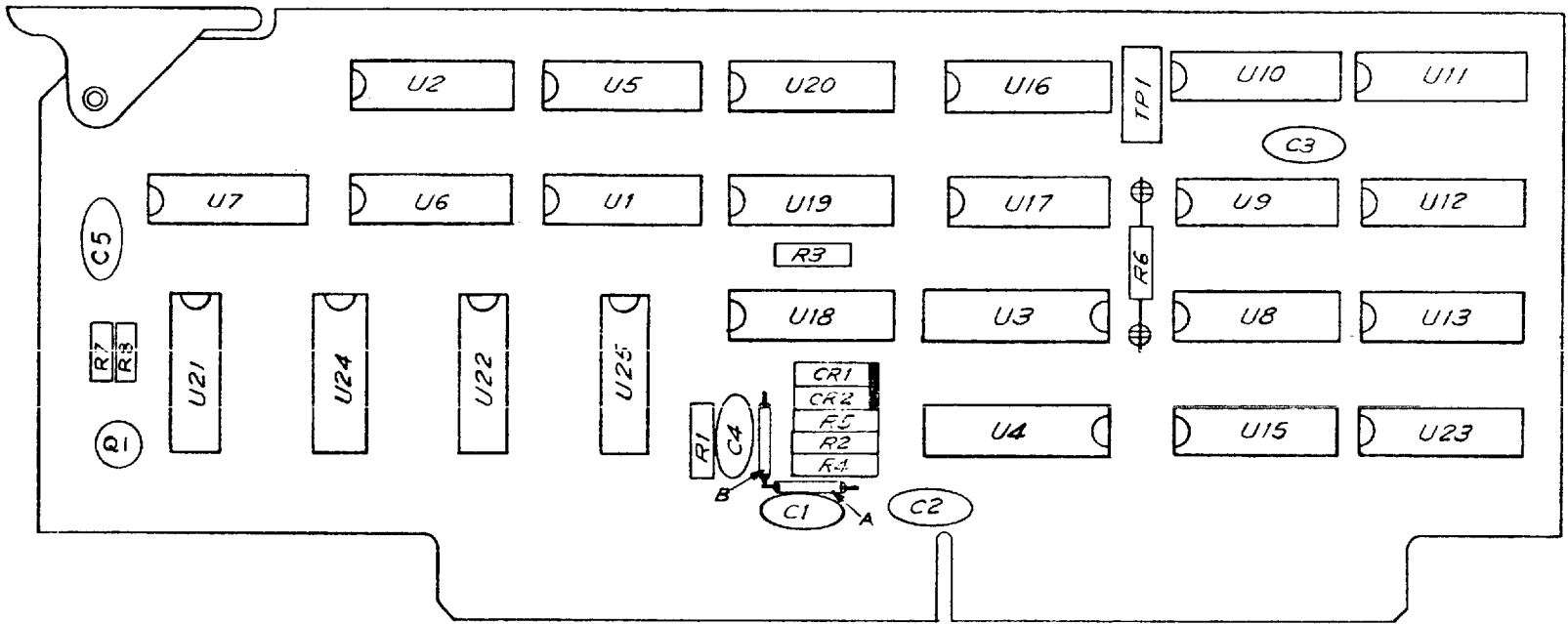
MODEL 6016
CIRCUIT DESCRIPTION
A7, N COMPUTER AND TIME BASE
SCHEMATIC #33941

The "N" Computer and Time Base assembly consists of the following sections: time base or "resolution" selection, "N" computation or manual "N" selection, start-stop binary summing to the counter "gate", and the 1 MHz shaping circuitry.

Time base selection is accomplished as a function of the front panel RESOLUTION/Hz switch. As selected gates U15,23, sum into U19, decade divide chain, U8 through U13, divides the 1 MHz reference signal in decade increments to provide a gate length from 1 microsecond to 1 second. In the 20 Hz to 200 MHz range, the output of U19, pin 11 is applied to the clock inputs of U7A and B. After reset, U7A accepts the first output from U19 and toggles. This establishes the "D" line for U7B and start-of-gate time. U7B then toggles on the next output of U19. This is the stop or "end-of-count" time.

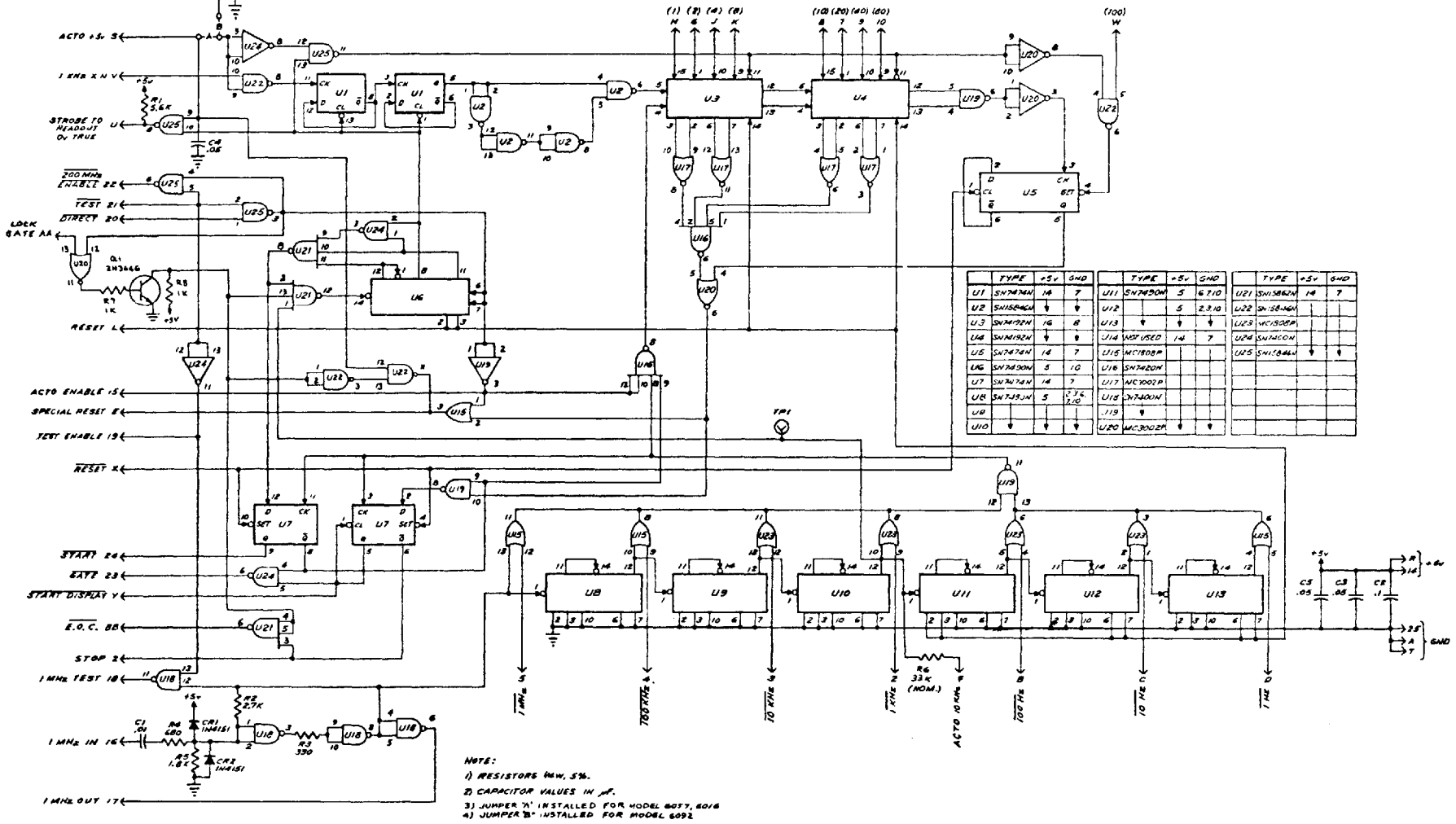
In the ACTO modes, this gate length is modified by the "N" computer circuitry comprised mainly of U1, 2, 3, 4, 5, 6, 16, 17, 20, 21, 22 and 24. The harmonic number is developed by dividing the 1 kHz X N by a factor of four (four millisecond period) as gated by U6. U6 is a scale-of-10 decade. The first four counts of this decade are used to protect against noise pulses. The next four millisecond period is used to accrue 1 kHz X N divided by 4 in presetable registers U3 and U4. The ninth pulse provides a command signal to the main count chain to add or subtract 10 MHz, as determined by the sideband detector. At this time the harmonic number is contained in registers U3, 4, and 5. The main count gate U24 opens and the selected time base is gated through U16 to U3. The register counts the selected time base for "N" times. The zero detector U17, 16, and 20 then provides the stop information thru U19 to U7.

The 1 MHz shaper conditions the reference frequency for use in the instrument. U18 is configured as a Schmitt trigger and buffer.



A7, N COMPUTER AND TIME BASE P.C. ASSEMBLY #33940A

33941-11-72



A7-3

A7, N COMPUTER AND TIME BASE SCHEMATIC #33941A

A7, N COMPUTER & TIME BASE P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A7	N Computer & Time Base P.C. Assembly	33940
	N Computer & Time Base P.C. Schematic	33941
C1	Capacitor, .01 μ F, 100 V	C0556
C2	Capacitor, .1 μ F, 10 V	C0661
C3	Capacitor, .05 μ F, 12 V	C0672
C4	Capacitor, .05 μ F, 12 V	C0672
C5	Capacitor, .05 μ F, 12 V	C0672
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 2.7 k, 5%, 1/4 W	R0937
R3	Resistor, 330 Ω , 5%, 1/4 W	R0662
R4	Resistor, 680 Ω , 5%, 1/4 W	R1234
R5	Resistor, 1.8 k, 5%, 1/4 W	R0959
R6	Resistor, 33 k, 5%, 1/4 W	R0780
R7	Resistor, 1 k, 5%, 1/4 W	R0765
R8	Resistor, 1 k, 5%, 1/4 W	R0765
TP1	Test Point, Black	E0234
U1	Integrated Circuit, SN7474N	25241
U2	Integrated Circuit, SN15846N	19716
U3	Integrated Circuit, SN74192N	25762
U4	Integrated Circuit, SN74192N	25762
U5	Integrated Circuit, SN7474N	25241
U6	Integrated Circuit, SN7490N	25732
U7	Integrated Circuit, SN7474N	25241
U8	Integrated Circuit, SN7490N	25732
U9	Integrated Circuit, SN7490N	25732
U10	Integrated Circuit, SN7490N	25732
U11	Integrated Circuit, SN7490N	25732
U12	Integrated Circuit, SN7490N	25732
U13	Integrated Circuit, SN7490N	25732
U14	Not Used	
U15	Integrated Circuit, MC1808P	25734
U16	Integrated Circuit, SN7420N	25713
U17	Integrated Circuit, MC3002P	25739
U18	Integrated Circuit, SN7400N	19705
U19	Integrated Circuit, SN7400N	19705

A7, N COMPUTER & TIME BASE P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
U20	Integrated Circuit, MC3002P	25739
U21	Integrated Circuit, SN15862N	19719
U22	Integrated Circuit, SN15846N	19716
U23	Integrated Circuit, MC1808P	25734
U24	Integrated Circuit, SN7400N	19705
U25	Integrated Circuit, SN15846N	19716



MODEL 6057/6016/6092
CIRCUIT DESCRIPTION
A8, PROGRAMMING BOARD (STANDARD)
SCHEMATIC #33937

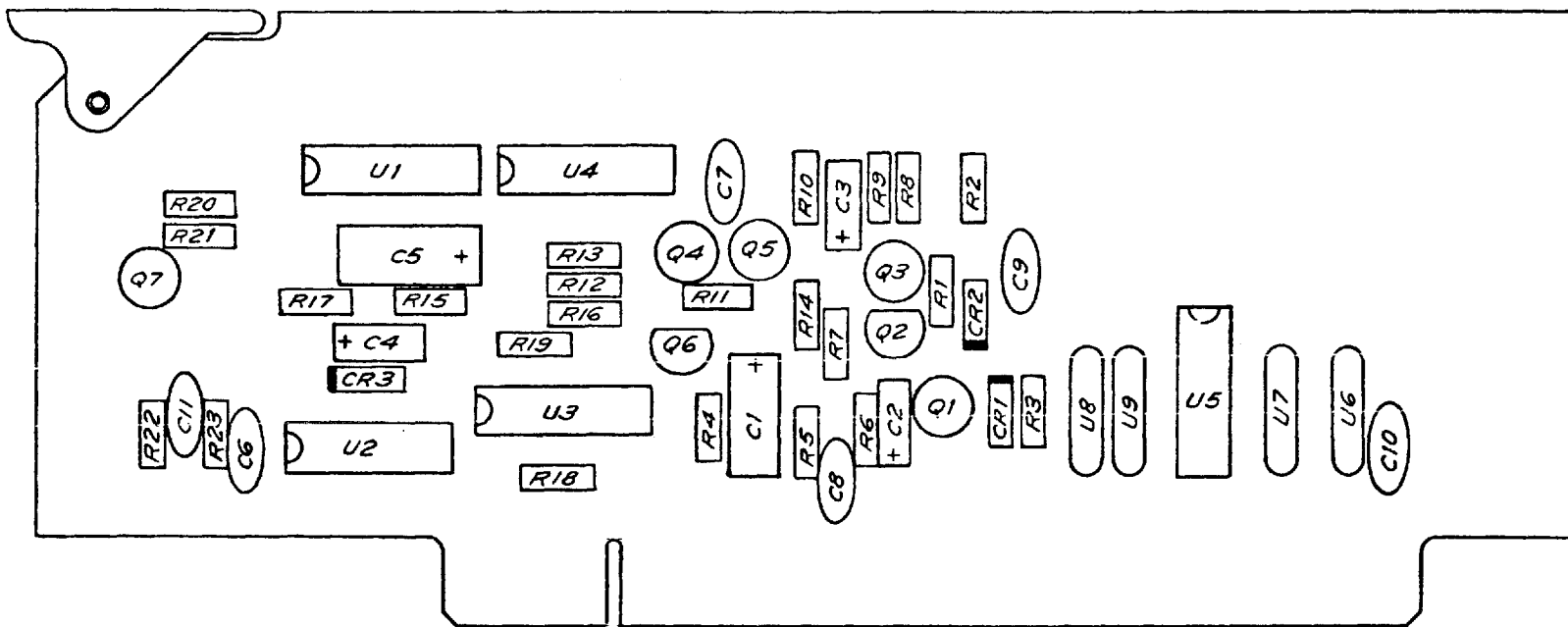
The A8 Programming Board contains the miscellaneous circuitry necessary for correct timing of several events occurring in the instrument.

The display circuitry is composed of Q1 and Q2. At the end-of-gate (INHIBIT RESET), Q1 is turned "off" allowing C1 to charge at an RC rate as a function of R4 or R5. The unijunction transistor then fires, driving the reset one-shot, U4. The output pulse is buffered by Q4 and Q5.

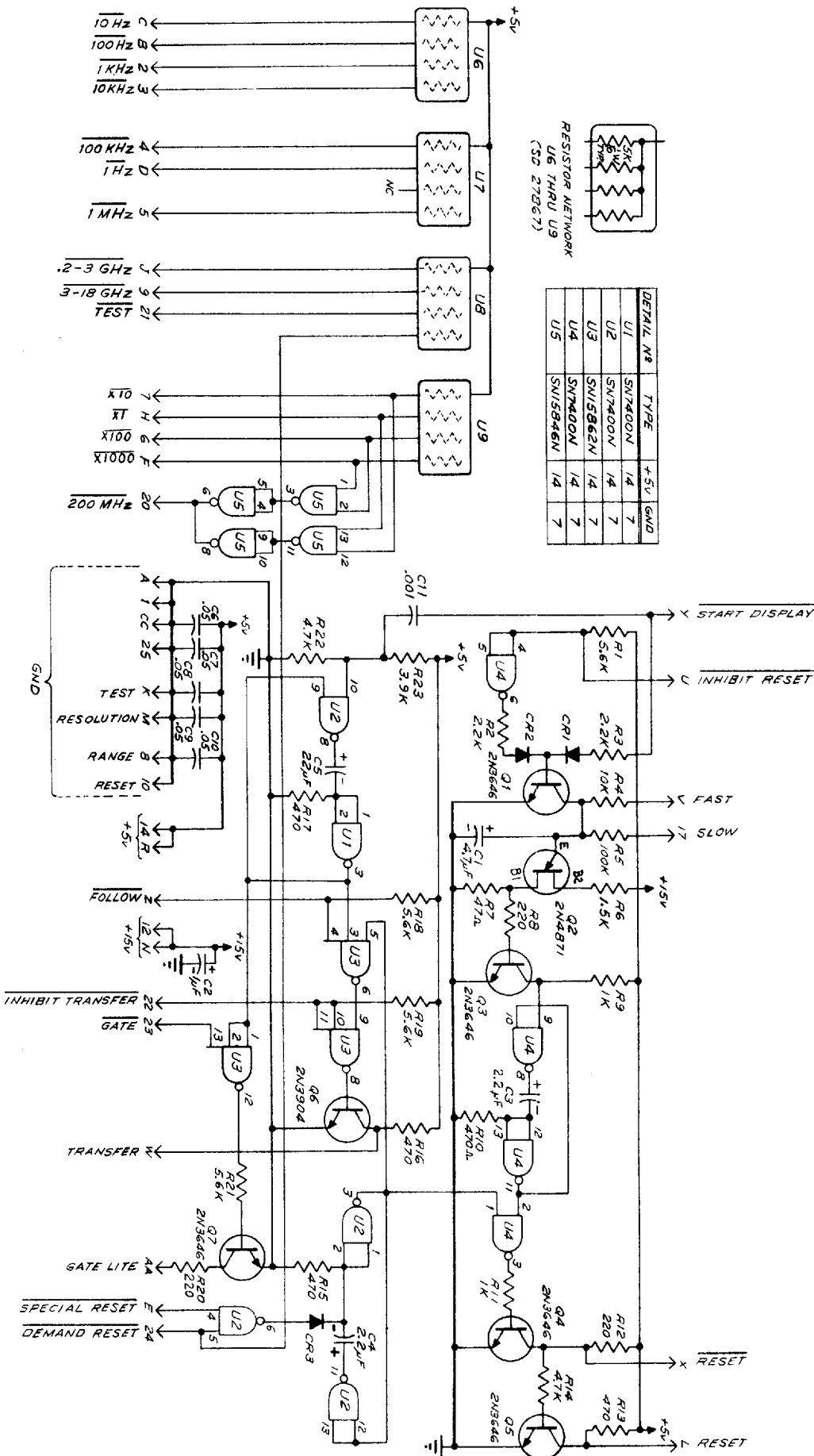
The command to transfer information/gate light one-shot is composed of U2, C5 and U1. At each end-of-count the information in the count chain is transferred to the storage register. The gate lamp will be "on" for a minimum of 10 ms, or the longest gate time selected. This is accomplished in U3 by summing the two signals.

One-shot U2, C4 provides a single pulse for each closure of the front panel RESET pushbutton.

The control lines for resolution, range, and attenuation are brought to this card for the purpose of manipulation when Option 20 or 21 is installed.



A8, PROGRAMMING (STANDARD) P.C. ASSEMBLY #33936A



NOTE: (EXCEPT AS NOTED)
 1) RESISTORS 1/4 W, 5%
 2) CAPACITOR VALUES IN μ F.
 3) DIODES ARE IN4151.

A8, PROGRAMMING (STANDARD) SCHEMATIC #33937A

A8, PROGRAMMING (STANDARD) P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A8	Programming P.C. Assembly Programming Schematic	33936 33937
C1	Capacitor, 4.7 μ F, 35 V	C0406
C2	Capacitor, 1 μ F, 35 V	C0524
C3	Capacitor, 2.2 μ F, 20 V	C1009
C4	Capacitor, 2.2 μ F, 20 V	C1009
C5	Capacitor, 22 μ F, 15 V	C0693
C6	Capacitor, .05 μ F, 12 V	C0672
C7	Capacitor, .05 μ F, 12 V	C0672
C8	Capacitor, .05 μ F, 12 V	C0672
C9	Capacitor, .05 μ F, 12 V	C0672
C10	Capacitor, .05 μ F, 12 V	C0672
C11	Capacitor, .001 μ F, 1 kV	C0235
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N4871	Q0266
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3904	Q0247
Q7	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 2.2 k, 5%, 1/4 W	R0749
R3	Resistor, 2.2 k, 5%, 1/4 W	R0749
R4	Resistor, 10 k, 5%, 1/4 W	R0766
R5	Resistor, 100 k, 5%, 1/4 W	R0741
R6	Resistor, 1.5 k, 5%, 1/4 W	R0783
R7	Resistor, 47 Ω , 5%, 1/4 W	R0743
R8	Resistor, 220 Ω , 5%, 1/4 W	R0760
R9	Resistor, 1 k, 5%, 1/4 W	R0765
R10	Resistor, 470 Ω , 5%, 1/4 W	R1044
R11	Resistor, 1 k, 5%, 1/4 W	R0765
R12	Resistor, 220 Ω , 5%, 1/4 W	R0760
R13	Resistor, 470 Ω , 5%, 1/4 W	R1044
R14	Resistor, 4.7 k, 5%, 1/4 W	R0892
R15	Resistor, 470 Ω , 5%, 1/4 W	R1044

A8, PROGRAMMING (STANDARD) P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R16	Resistor, 470 Ω , 5%, 1/4 W	R1044
R17	Resistor, 470 Ω , 5%, 1/4 W	R1044
R18	Resistor, 5.6 k, 5%, 1/4 W	R0821
R19	Resistor, 5.6 k, 5%, 1/4 W	R0821
R20	Resistor, 220 Ω , 5%, 1/4 W	R0760
R21	Resistor, 5.6 k, 5%, 1/4 W	R0821
R22	Resistor, 4.7 k, 5%, 1/4 W	R0892
R23	Resistor, 3.9 k, 5%, 1/4 W	R0939
U1	Integrated Circuit, SN7400N	19705
U2	Integrated Circuit, SN7400N	19705
U3	Integrated Circuit, SN15862N	19719
U4	Integrated Circuit, SN7400N	19705
U5	Integrated Circuit, SN15846N	19716
U6	Resistor, Network, 4 x 5 k, 1/10 W	27867
U7	Resistor, Network, 4 x 5 k, 1/10 W	27867
U8	Resistor, Network, 4 x 5 k, 1/10 W	27867
U9	Resistor, Network, 4 x 5 k, 1/10 W	27867

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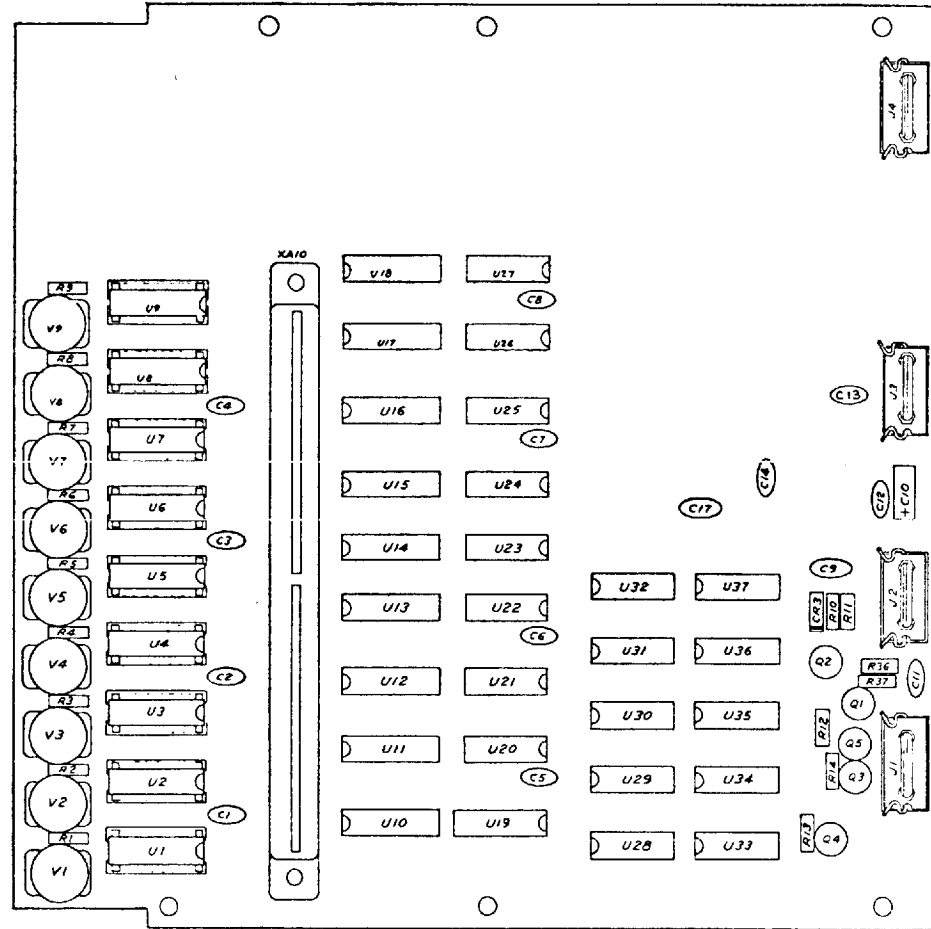
MODEL 6016
CIRCUIT DESCRIPTION
A9, READOUT BOARD
SCHEMATIC #45371

The A9 Counter Readout assembly consists of: count chain dividers, BCD storage elements, BCD to 10-line decoders, decimal point/measurement unit decoding, and IF offset decoding.

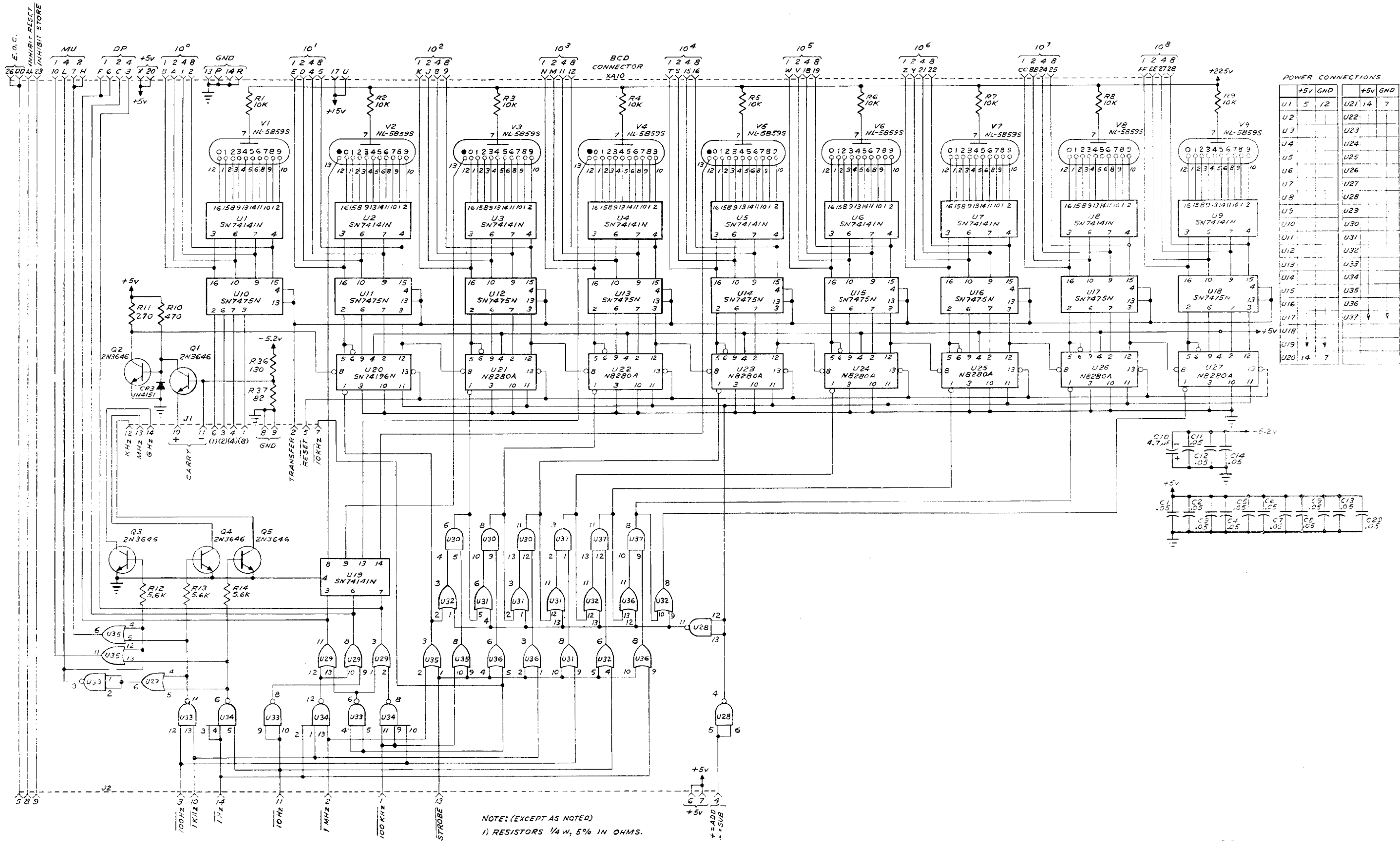
The carry outputs of the 20 Hz to 200 MHz decade are applied to Q1 to drive the remaining decades in the count chain (U20 through U27). Decades U20 through U27 divide the gated input signal by ten. U10 through U18 are the storage elements that store the BCD output of each decade and also drive the BCD to 10-line decoder drivers, U1 through U9; these, in turn, drive the front panel display.

The measurement unit indication and the decimal point placement, depending on selected resolution, is decoded by gates U29, U33, U34, U35, and decoder driver U19.

In the ACTO mode of operation, the IF offset must be added into, or subtracted from the display so that the readout is always the true input frequency. The add/subtract signal from the sideband phase detector on the A4 assembly is decoded in U28, U30, U31, U32, U35, U36, U37, and depending on the resolution selected, the proper offset is applied to the presettable decades U20 through U27. This is done after reset time but before the counter gate is opened.



A9, READOUT BOARD P.C. ASSEMBLY #45372C



POWER CONNECTIONS

	+5V	GND	+5V	GND
U1	5	12	U21	14 7
U2			U22	
U3			U23	
U4			U24	
U5			U25	
U6			U26	
U7			U27	
U8			U28	MC857P
U9			U29	MC1808P
U10			U30	MC1808P
U11			U31	MC1808P
U12			U32	MC1808P
U13			U33	SN1584GN
U14			U34	SN15862H
U15			U35	MC1808P
U16			U36	MC1808P
U17			U37	MC1806P
U18				
U19				
U20	14	7		

NOTE: (EXCEPT AS NOTED)
 1) RESISTORS 1/4w, 5% IN OHMS.
 2) CAPACITOR VALUES IN μF.

A9, READOUT BOARD
 SCHEMATIC #45371B

A9, READOUT P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A9	Readout P.C. Assembly	45372
	Readout Schematic	45371
C1	Capacitor, .05 μ F, 12 V, disc	C0672
C2	Capacitor, .05 μ F, 12 V, disc	C0672
C3	Capacitor, .05 μ F, 12 V, disc	C0672
C4	Capacitor, .05 μ F, 12 V, disc	C0672
C5	Capacitor, .05 μ F, 12 V, disc	C0672
C6	Capacitor, .05 μ F, 12 V, disc	C0672
C7	Capacitor, .05 μ F, 12 V, disc	C0672
C8	Capacitor, .05 μ F, 12 V, disc	C0672
C9	Capacitor, .05 μ F, 12 V, disc	C0672
C10	Capacitor, 4.7 μ F, 35 V	C0406
C11	Capacitor, .05 μ F, 12 V, disc	C0672
C12	Capacitor, .05 μ F, 12 V, disc	C0672
C13	Capacitor, .05 μ F, 12 V, disc	C0672
C14	Capacitor, .05 μ F, 12 V, disc	C0672
C15	Not Used	
C16	Not Used	
C17	Capacitor, .01 μ F, 100 V, disc	C0556
CR1	Not Used	
CR2	Not Used	
CR3	Diode, 1N4151	CR0150
J1	Socket, 14 pin	X0186
J2	Socket, 14 pin	X0186
J3	Socket, 14 pin	X0186
J4	Socket, 14 pin	X0186
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
R1	Resistor, 10 k, 5%, 1/4 W	R0766
R2	Resistor, 10 k, 5%, 1/4 W	R0766
R3	Resistor, 10 k, 5%, 1/4 W	R0766
R4	Resistor, 10 k, 5%, 1/4 W	R0766
R5	Resistor, 10 k, 5%, 1/4 W	R0766
R6	Resistor, 10 k, 5%, 1/4 W	R0766
R7	Resistor, 10 k, 5%, 1/4 W	R0766
R8	Resistor, 10 k, 5%, 1/4 W	R0766
R9	Resistor, 10 k, 5%, 1/4 W	R0766

A9, READOUT P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R10	Resistor, 470 Ω , 5%, 1/4 W	R1044
R11	Resistor, 270 Ω , 5%, 1/4 W	R0694
R12	Resistor, 5.6 k, 5%, 1/4 W	R0821
R13	Resistor, 5.6 k, 5%, 1/4 W	R0821
R14	Resistor, 5.6 k, 5%, 1/4 W	R0821
R15-35	Not Used	
R36	Resistor, 130 Ω , 5%, 1/4 W	R1052
R37	Resistor, 82 Ω , 5%, 1/4 W	R1059
U1	Integrated Circuit, SN74141N	25730
U2	Integrated Circuit, SN74141N	25730
U3	Integrated Circuit, SN74141N	25730
U4	Integrated Circuit, SN74141N	25730
U5	Integrated Circuit, SN74141N	25730
U6	Integrated Circuit, SN74141N	25730
U7	Integrated Circuit, SN74141N	25730
U8	Integrated Circuit, SN74141N	25730
U9	Integrated Circuit, SN74141N	25730
U10	Integrated Circuit, SN7475N	19710
U11	Integrated Circuit, SN7475N	19710
U12	Integrated Circuit, SN7475N	19710
U13	Integrated Circuit, SN7475N	19710
U14	Integrated Circuit, SN7475N	19710
U15	Integrated Circuit, SN7475N	19710
U16	Integrated Circuit, SN7475N	19710
U17	Integrated Circuit, SN7475N	19710
U18	Integrated Circuit, SN7475N	19710
U19	Integrated Circuit, SN74141N	25730
U20	Integrated Circuit, SN74196N	25784
U21	Integrated Circuit, SN8280A	25722
U22	Integrated Circuit, SN8280A	25722
U23	Integrated Circuit, SN8280A	25722
U24	Integrated Circuit, SN8280A	25722
U25	Integrated Circuit, SN8280A	25722
U26	Integrated Circuit, SN8280A	25722
U27	Integrated Circuit, SN8280A	25722
U28	Integrated Circuit, MC857P	25753
U29	Integrated Circuit, MC1808P	25734
U30	Integrated Circuit, MC1806P	25733
U31	Integrated Circuit, MC1808P	25734
U32	Integrated Circuit, MC1808P	25734

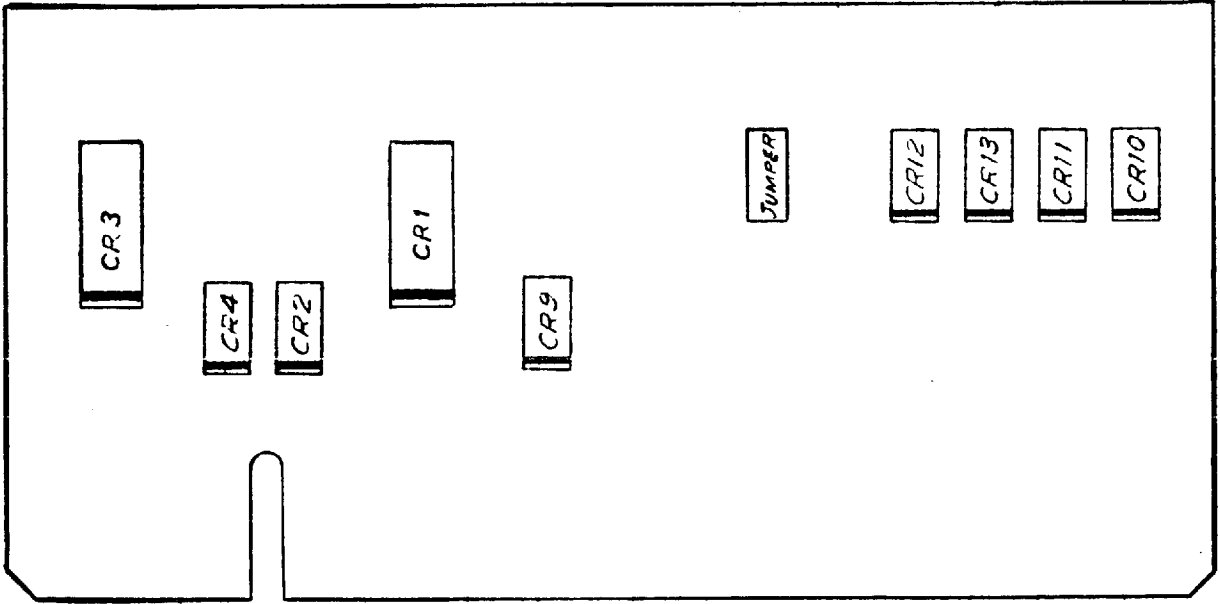
A9, READOUT P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
U33	Integrated Circuit, SN15846N	19716
U34	Integrated Circuit, SN15862N	19719
U35	Integrated Circuit, MC1808P	25734
U36	Integrated Circuit, MC1808P	25734
U37	Integrated Circuit, MC1806P	25733
V1	Tube, Readout, NL5859S	V0131
V2	Tube, Readout, NL5859S	V0131
V3	Tube, Readout, NL5959S	V0131
V4	Tube, Readout, NL5859S	V0131
V5	Tube, Readout, NL5859S	V0131
V6	Tube, Readout, NL5859S	V0131
V7	Tube, Readout, NL5859S	V0131
V8	Tube, Readout, NL5859S	V0131
V9	Tube, Readout, NL5859S	V0131
XV1	Socket, Tube, Readout	X0179
XV2	Socket, Tube, Readout	X0179
XV3	Socket, Tube, Readout	X0179
XV4	Socket, Tube, Readout	X0179
XV5	Socket, Tube, Readout	X0179
XV6	Socket, Tube, Readout	X0179
XV7	Socket, Tube, Readout	X0179
XV8	Socket, Tube, Readout	X0179
XV9	Socket, Tube, Readout	X0179
XA10	Connector, P.C. 56 pin	09060800

MODEL 6016
CIRCUIT DESCRIPTION
A11, DIODE BOARD
SCHEMATIC #45374

The Model 6016, All Diode Board is part of the main power supply assembly. It consists of two bridge full-wave rectifier circuits and one half-wave rectifier circuit mounted on a printed-circuit board assembly.

See A6 Power Supply (Schematic #45374) for additional power supply description.



A11, DIODE BOARD P.C. ASSEMBLY #45375A

A11, DIODE BOARD P.C. ASSEMBLY PARTS LIST

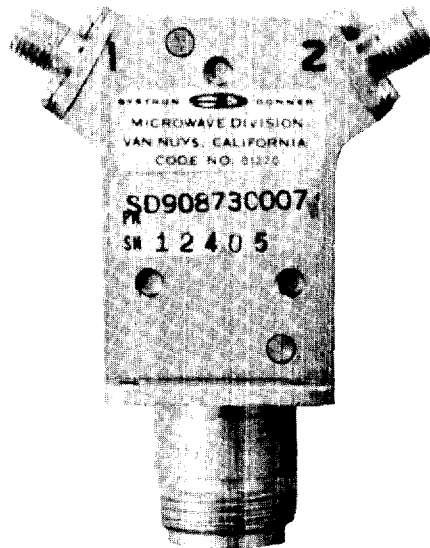
Ref.	Description	SD Part No.
	Diode, P.C. Assembly	45375
	Power Supply Schematic	45374
CR1	Diode, 1N4719	CR0251
CR2	Diode, 1N4005	CR0284
CR3	Diode, 1N4719	CR0251
CR4	Diode, 1N4005	CR0284
CR5	Not Used	
CR6	Not Used	
CR7	Not Used	
CR8	Not Used	
CR9	Diode, 1N4005	CR0284
CR10	Diode, 1N4005	CR0284
CR11	Diode, 1N4005	CR0284
CR12	Diode, 1N4005	CR0284
CR13	Diode, 1N4005	CR0284

* See Final Assembly Parts List for main chassis power supply components (Capacitor Chassis Assembly #39240).



MODEL 6057/6016
CIRCUIT DESCRIPTION
U1, POWER DIVIDER
FINAL ASSEMBLY #39035

The 50 Ω , 200 MHz - 18 GHz power divider input accepts signals in the high frequency range and resistively divides the power into two isolated outputs (6 dB loss per channel). The signal from each port is then fed to Mixers U2 and U3. This unit requires no maintenance and under normal conditions should never be opened for inspection.



U1, POWER DIVIDER



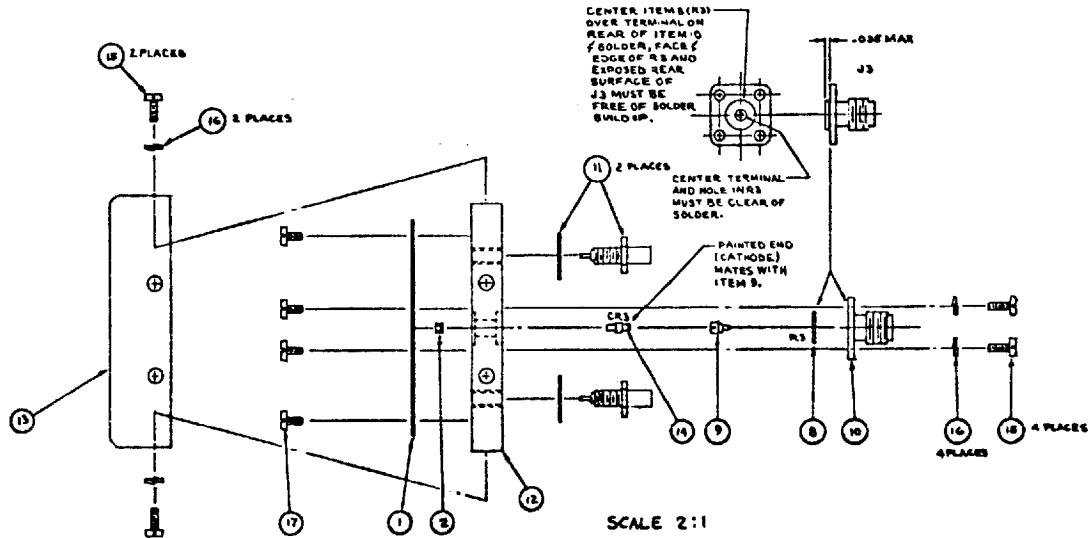
MODEL 6057/6016
CIRCUIT DESCRIPTION
U2, U3 MIXER
SCHEMATIC #39796

The U2, U3 Mixer generates harmonics of the VCO, up to the 180th, and mixes these with the unknown input frequency to produce an IF at 10 MHz.

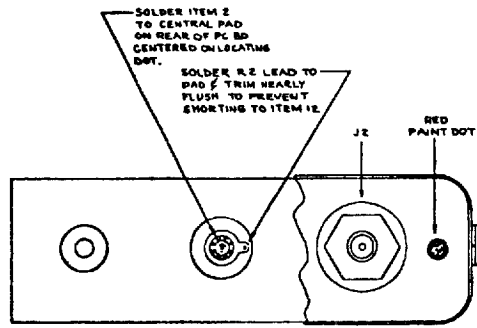
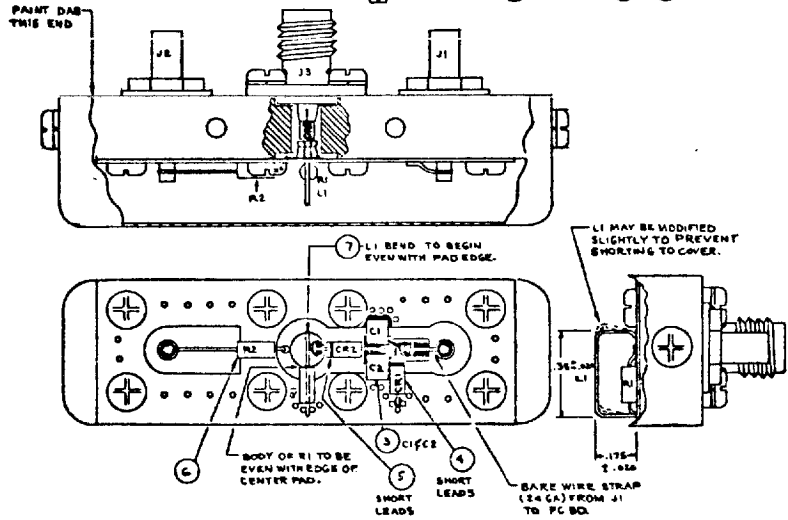
The VCO signal is applied to CR1, C1, C2, and step-recovery diode CR2. The positive portion of the VCO signal drives the anode of CR2. When the voltage reverses, CR2 continues to conduct for a time. When it finally reverses, it does so very abruptly, causing a voltage transient across L1 and R1. A positive pulse is generated and coupled to mixer diode CR3, through C3.

A very fast pulse, approximately 4 volts in amplitude and 150 ps at the baseline, represents harmonics of the VCO. This pulse mixes with the incoming frequency to produce an IF at J3.

The mixer described is used in both the lock channel and the "N" channel circuits.



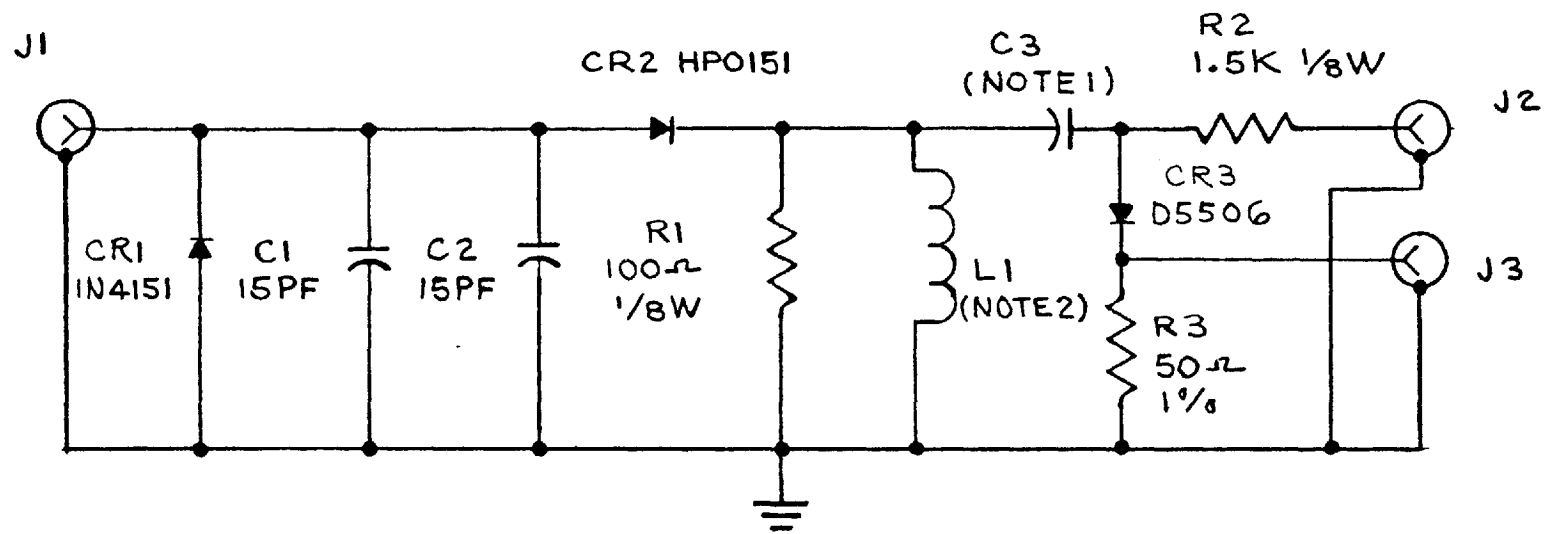
SCALE 2:1



SCALE 4:1

19	REF.	J-0624	RF PLUG	PHOTO WITH 21F.2
18	REF	B 39796	SCHEMATIC, MIXER ASSY	
17	B	H0971	SCREW #2-56 X 1/8	
16	W	H0481	WASHER #2 LOCK	
15	G	H0346	SCREW 2-56 X 1/16	
14	I	C0334	DIODE DESOW	CR3
13	I	B 3732	MIXER COVER	
12	I	C 39722	MIXER BLOCK	
11	Z	J-0625	RF CONNECTOR	J1, J2
10	I	C 39729	CONNECTOR MOD	J3
9	I	B 39730	RES 50R FROZE	
8	I	C 39727	RESISTOR 50A DISC 1/4	R3
7	I	R1441	RESISTOR 2W 5% 100-Ω	R1, L1
6	I	R1463	RESISTOR 1/2 W 5% 1.5K	R2
5	I	CR0269	DIODE 40151	CR2
4	I	CR0150	DIODE 44151	CR1
3	Z	C 43	CAPACITOR 15PF CHIP	CL, C2
2	I	B 39731	DIODE CLIP	
1	I	C 39720	SPEC. MIXER PC BO	

PHOTO



NOTES
1) C3 IS PATTERN ON PC BD
2) L1 IS LEAD ON R1

U2, U3, MIXER ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
U2,U3	Mixer Assembly	39733
	Mixer Schematic	39796
C1	Capacitor, 15 pF, Chip	C1163
C2	Capacitor, 15 pF, Chip	C1163
CR1	Diode, 1N4151	CR0150
CR2	Diode, HP0151	CR0269
CR3	Diode, D5506	CR0334
J1	RF Connector	J0625
J2	RF Connector	J0625
J3	Connector Modifier	39729
L1	Resistor, 100 Ω , 5%, 1/8 W	R1441
R1	Resistor, 100 Ω , 5%, 1/8 W	R1441
R2	Resistor, 1.5 k, 5%, 1/8 W	R2463
R3	Resistor, 50 Ω , 1%, Disc	75D250
	Diode Clip	39731
	Resistor Probe	39730
	Mixer Block	39722
	Mixer Cover	39732

CHAPTER 7
OPTIONS AND MODIFICATIONS

7.1 INTRODUCTION

Included in this chapter are standard options for the Model 6016 Frequency Counter, listed by numerical sequence. Special modifications, ordered by the customer, will also be described in this chapter as required.

TABLE 7.1 OPTION INDEX INFORMATION

Ref	Description	Dwg #	Page #
OPT 11	Oscillator, High-Stability, ±3 parts $10^9/24$ Hrs.	45301	[OPT 11, 12,13-1
OPT 12	Oscillator, High-Stability, ±1 part $10^9/24$ Hrs.	45301	
OPT 13	Oscillator, Very-High Stability, ±5 parts $10^{10}/24$ Hrs.	45301	
OPT 17	A10, BCD Output	45499	OPT 17-1
OPT 20	A8, Programming Board (Binary Remote)	45512	OPT 20-1
OPT 21	A8, Programming Board (Single Line Remote)	45514	OPT 21-1



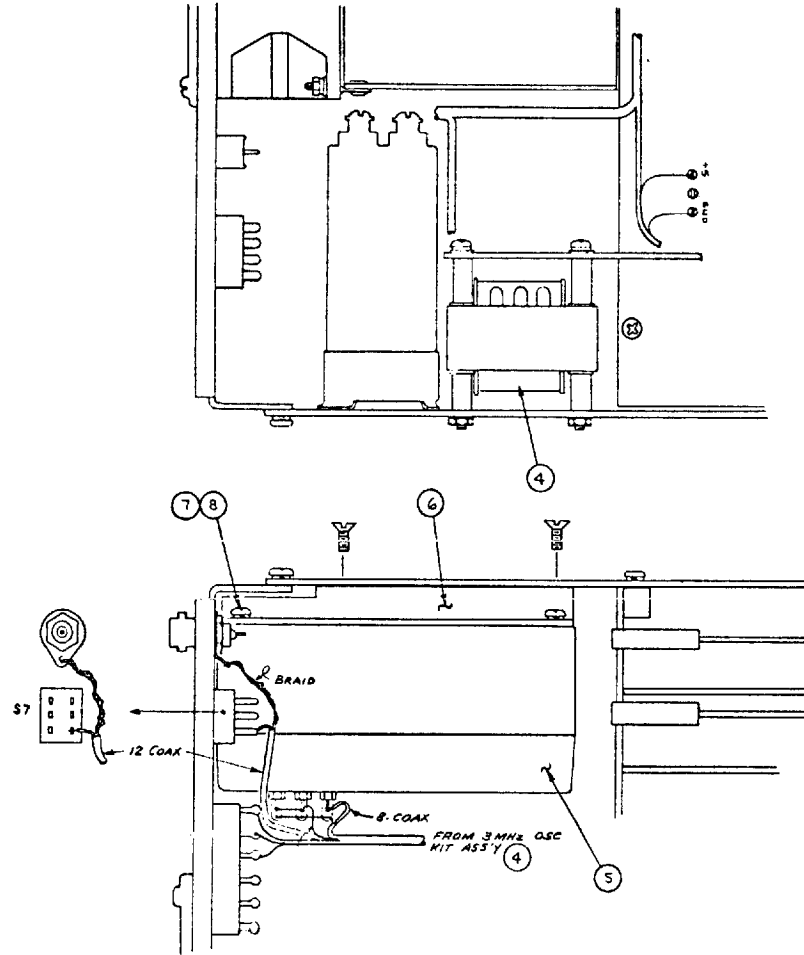
CIRCUIT DESCRIPTION
OPTION 11, 12, 13, 3 MHz OSCILLATOR
FINAL ASSEMBLY #45301

Option 11 provides a high-stability oscillator (± 3 parts in $10^9/24$ hours), which unlike the standard 1 MHz oscillator, has an output frequency of 3 MHz. A divide-by-three circuit is added to convert the oscillator output frequency to 1 MHz. Also included is a separate power supply for the oscillator.

Option 12 provides a high-stability oscillator (± 1 part in $10^9/24$ hours), with divide-by-three circuit to convert the 3 MHz output frequency to 1 MHz, and a separate oscillator power supply.

Option 13 provides a very-high stability oscillator (± 5 parts in $10^{10}/24$ hours) along with the divide-by-three circuit and oscillator power supply.

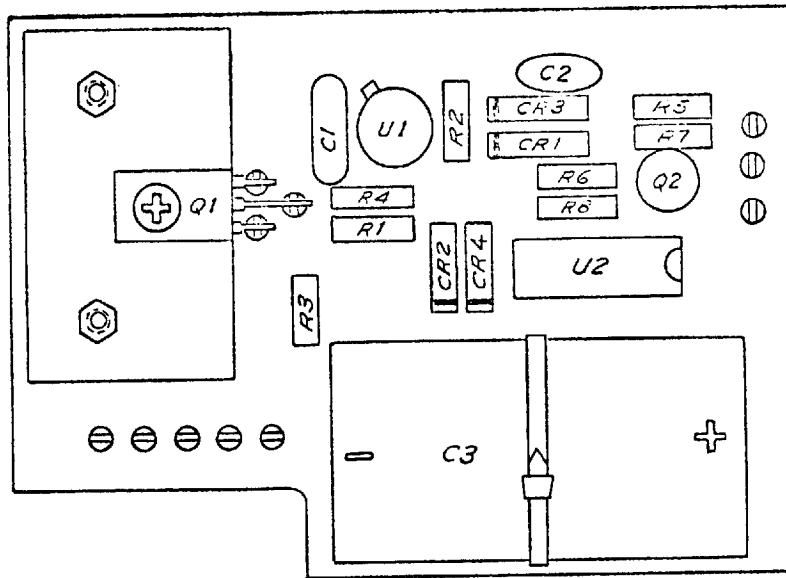
OPT 11,12,13-2



OPTION 11, 12, 13, 3 MHz OSCILLATOR FINAL ASSEMBLY #45301-4-1A

45301-11-72

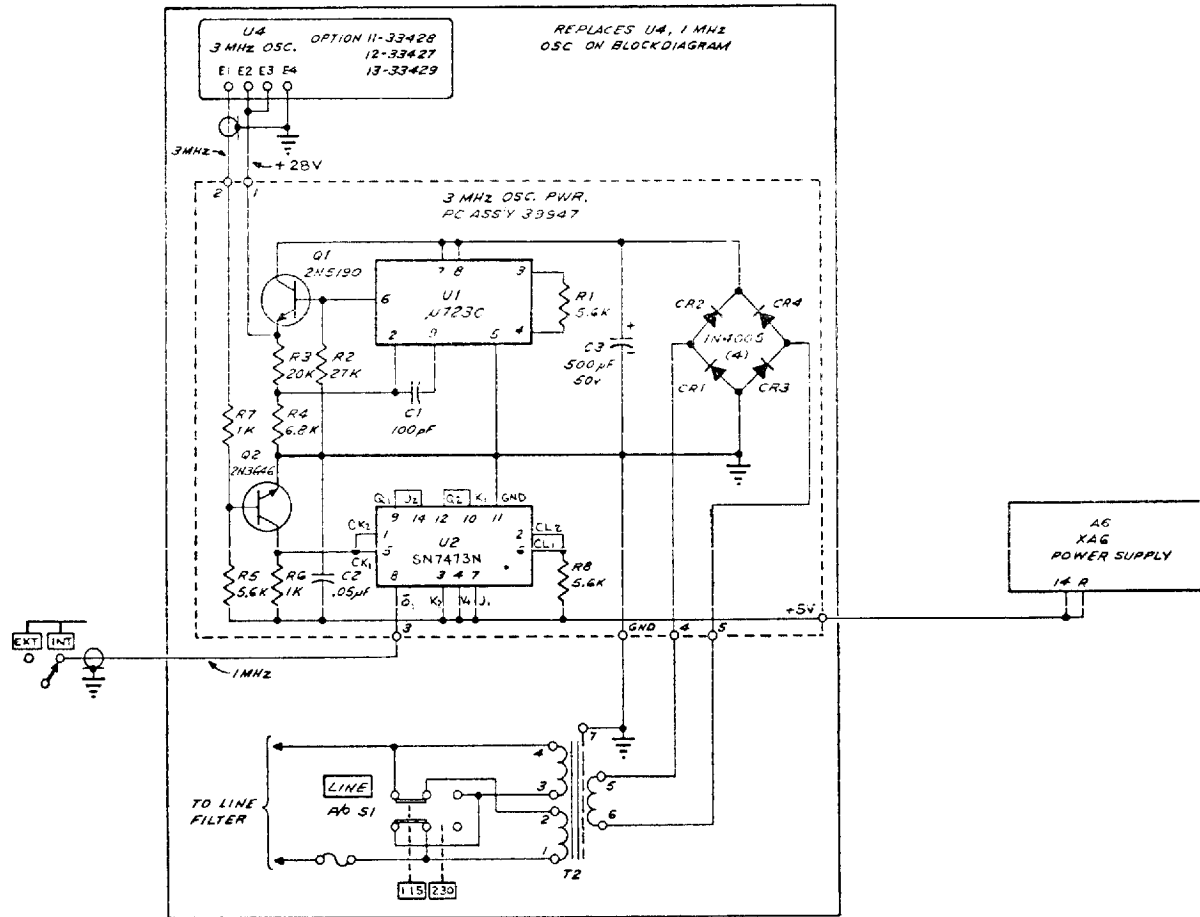
45301-11-72



OPT 11, 12, 13-3

OPTION 11, 12, 13, 3 MHz OSCILLATOR P.C. ASSEMBLY #39947A

OPT 11,12,13-4



45301-11-72

OPTION 11, 12, 13, 3 MHz OSCILLATOR SCHEMATIC #39944A

OPTION 11 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 11, 3 MHz Oscillator Final Assembly	45301
	<u>ADD</u>	
3	3 MHz Option Schematic	39944
	3 MHz Oscillator Kit Assembly	45195
	consists of:	
4	3 MHz Oscillator Power P.C. Assembly	39947
4	Transformer	19805
5	3 MHz Oscillator	33428
6	Oscillator Mounting Bracket	39249
	<u>DELETE</u>	
13	Standard Oscillator Bracket Assembly	45040

OPTION 12 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 12, 3 MHz Oscillator Final Assembly	45301
	<u>ADD</u>	
3	3 MHz Oscillator Option Schematic	39944
	3 MHz Oscillator Kit Assembly consists of:	45195
4	3 MHz Oscillator Power P.C. Assembly	39947
4	Transformer	19805
5	3 MHz Oscillator	33427
6	Oscillator Mounting Bracket	39249
	<u>DELETE</u>	
13	Standard Oscillator Bracket Assembly	45040

OPTION 13 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 13, 3 MHz Oscillator Final Assembly	45301
	<u>ADD</u>	
3	3 MHz Oscillator Option Schematic	39944
	3 MHz Oscillator Kit Assembly	45195
	consists of:	
4	3 MHz Oscillator Power P.C. Assembly	39947
4	Transformer	19805
5	3 MHz Oscillator	33429
6	Oscillator Mounting Bracket	39249
	<u>DELETE</u>	
13	Standard Oscillator Bracket Assembly	45040

3 MHz OSCILLATOR POWER P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	3 MHz Oscillator Power P.C. Assembly	39947
	3 MHz Oscillator Power Schematic	39944
C1	Capacitor, 100 pF, DM15	C0536
C2	Capacitor, .05 μ F, Disc	C0672
C3	Capacitor, 500 μ F, 50 V	C1243
CR1	Diode, 1N4005, 600 V, 1 Amp	CR0284
CR2	Diode, 1N4005, 600 V, 1 Amp	CR0284
CR3	Diode, 1N4005, 600 V, 1 Amp	CR0284
CR4	Diode, 1N4005, 600 V, 1 Amp	CR0284
Q1	Transistor, 2N5190	Q0281
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 27 k, 5%, 1/4 W	R0824
R3	Resistor, 20 k, 5%, 1/4 W	R0964
R4	Resistor, 6.8 k, 5%, 1/4 W	R0696
R5	Resistor, 5.6 k, 5%, 1/4 W	R0821
R6	Resistor, 1 k, 5%, 1/4 W	R0756
R7	Resistor, 1 k, 5%, 1/4 W	R0756
R8	Resistor, 5.6 k, 5%, 1/4 W	R0821
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, SN7473N	19709

CIRCUIT DESCRIPTION
 OPTION 17, BCD OUTPUT
 FINAL ASSEMBLY #45499

This assembly provides a means of interconnecting various BCD options from the stored information of the readout to the BCD output connector. The A10 P.C. assembly provides a 5 kΩ pull-up resistor for each BCD line. Positive true logic is employed; however, to inhibit the automatic reset, a closure to ground is required. The EOC (end-of-count) or "Print Command" is either a positive-going or negative-going signal output. All lines are TTL compatible. It should be noted that the print command signals are from a +15 volt source, through a 1 kΩ resistor, to be compatible with certain printers.

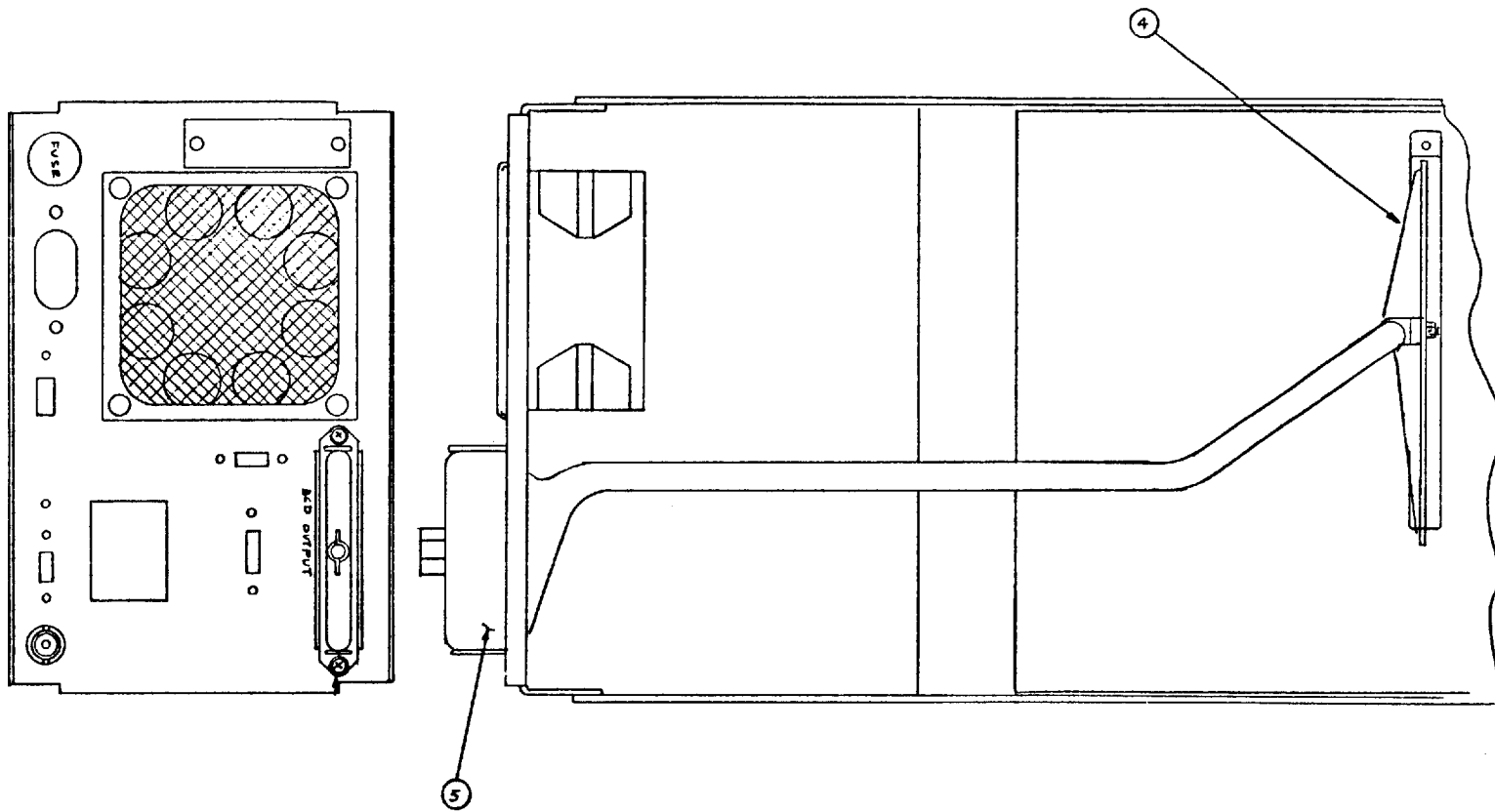
The rear panel BCD connector pin connections are as follows:

FUNCTION	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	3	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35

FUNCTION	BCD	PIN
10 ⁵	1	11
	2	12
	4	36
	8	37
10 ⁶	1	13
	2	14
	4	38
	8	39
10 ⁷	1	15
	2	16
	4	40
	8	41
MU	1	17
	2	18
	4	42
	8	43 (GND)

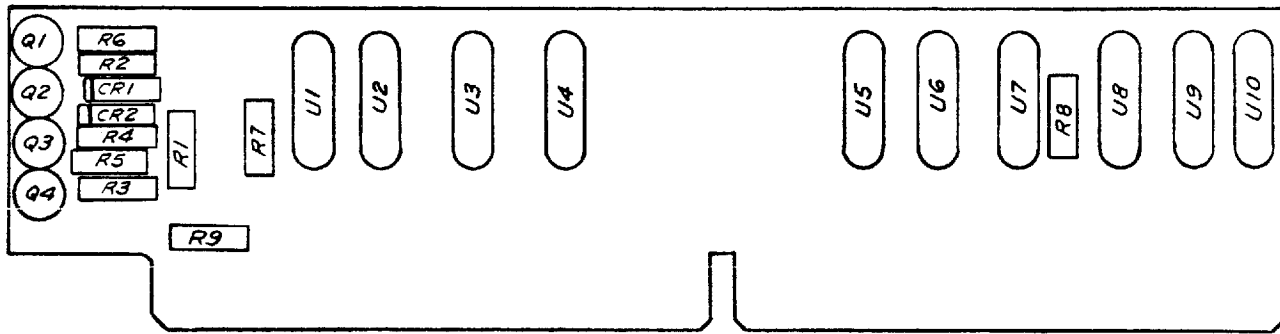
FUNCTION	BCD	PIN
DP (Decimal Point)	1	19
	2	20
	4	44
	8	45 (GND)
+ Reference	+5 V	25
- Reference	0 V	24, 50 (GND)
Print Command	positive	23
Print Command	negative	48
Reset Inhibit	negative	47
BCD MU TRANSLATION		
GHZ = Binary 7 MHz = Binary 1 KHz = Binary 2		
DECIMAL POINT LOCATION		
<p>● ● ● ●</p> <p>DP5 DP4 DP3 DP2</p>		

45499-11-72

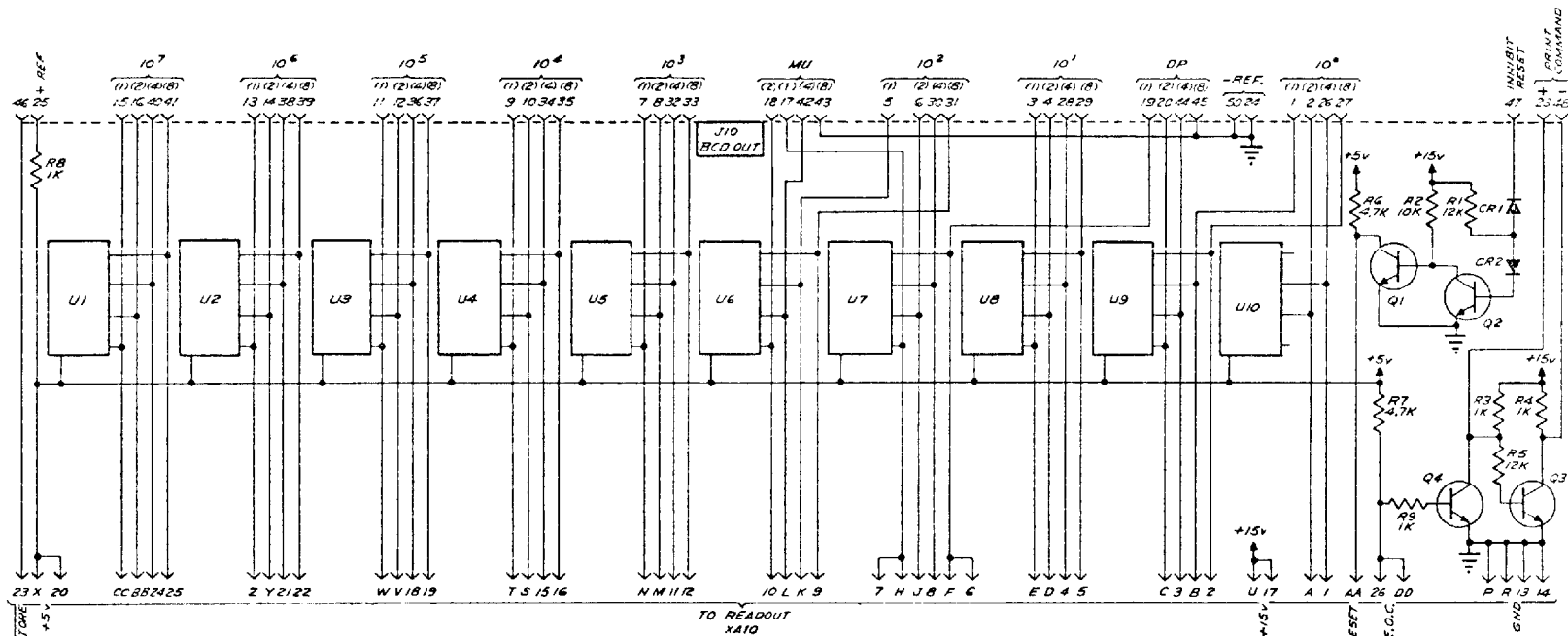


OPT 17-3

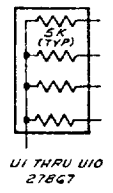
OPTION 17, BCD OUTPUT FINAL ASSEMBLY #45499-4-1A



OPTION 17, BCD OUTPUT P.C. ASSEMBLY #39926A



	1	2	4	8
DP	10 ⁰	0	0	0
	10 ¹	1	0	0
	10 ²	0	1	0
	10 ³	1	1	0
	10 ⁴	0	0	1
	10 ⁵	1	0	1
	10 ⁶	0	1	1
MU	KHZ	0	1	0
	MHZ	1	0	0
	GHZ	1	1	0



- NOTE:
- 1) RESISTORS - 1/4W, 5%.
 - 2) DIODES IN4151.
 - 3) TRANSISTORS 2N3646.
 - 4) J10 - 50 PIN AMPHENOL #57-40500.
P10 - 50 PIN AMPHENOL #57-30500.

OPTION 17, BCD OUTPUT FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 17 Final Assembly	45499-4-1
	<u>ADD</u>	
	BCD Output Assembly consists of:	45498-4-1
4	BCD Output P.C. Assembly	39926
5	BCD Cable Assembly	45067-4-1
5	Connector, 50 Pin	J0171
	* * * * *	
A10	BCD Output P.C. Assembly BCD Output Schematic	39926 39923
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
R1	Resistor, 12 k, 5%, 1/4 W	R0759
R2	Resistor, 10 k, 5%, 1/4 W	R0766
R3	Resistor, 1 k, 5%, 1/4 W	R0765
R4	Resistor, 1 k, 5%, 1/4 W	R0765
R5	Resistor, 12 k, 5%, 1/4 W	R0759
R6	Resistor, 4.7 k, 5%, 1/4 W	R0892
R7	Resistor, 4.7 k, 5%, 1/4 W	R0892
R8	Resistor, 10 k, 5%, 1/4 W	R0766
R9	Resistor, 10 k, 5%, 1/4 W	R0766
U1	Resistor Array, 5 k, 1/10 W	27867
U2	Resistor Array, 5 k, 1/10 W	27867
U3	Resistor Array, 5 k, 1/10 W	27867
U4	Resistor Array, 5 k, 1/10 W	27867
U5	Resistor Array, 5 k, 1/10 W	27867
U6	Resistor Array, 5 k, 1/10 W	27867
U7	Resistor Array, 5 k, 1/10 W	27867
U8	Resistor Array, 5 k, 1/10 W	27867
U9	Resistor Array, 5 k, 1/10 W	27867
U10	Resistor Array, 5 k, 1/10 W	27867

OPTION 17, BCD OUTPUT FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
	* * * * *	
J10	BCD Cable Assembly Connector Chassis Mtg. 50 Pin	45067-4-1 J0170
	<u>DELETE</u>	
	Cover Plate	39443



CIRCUIT DESCRIPTION
OPTION 20, PROGRAMMING BOARD (BINARY REMOTE)
FINAL ASSEMBLY #45512

The A8 Programming Board contains the miscellaneous circuitry necessary for correct timing of several events occurring in the instrument.

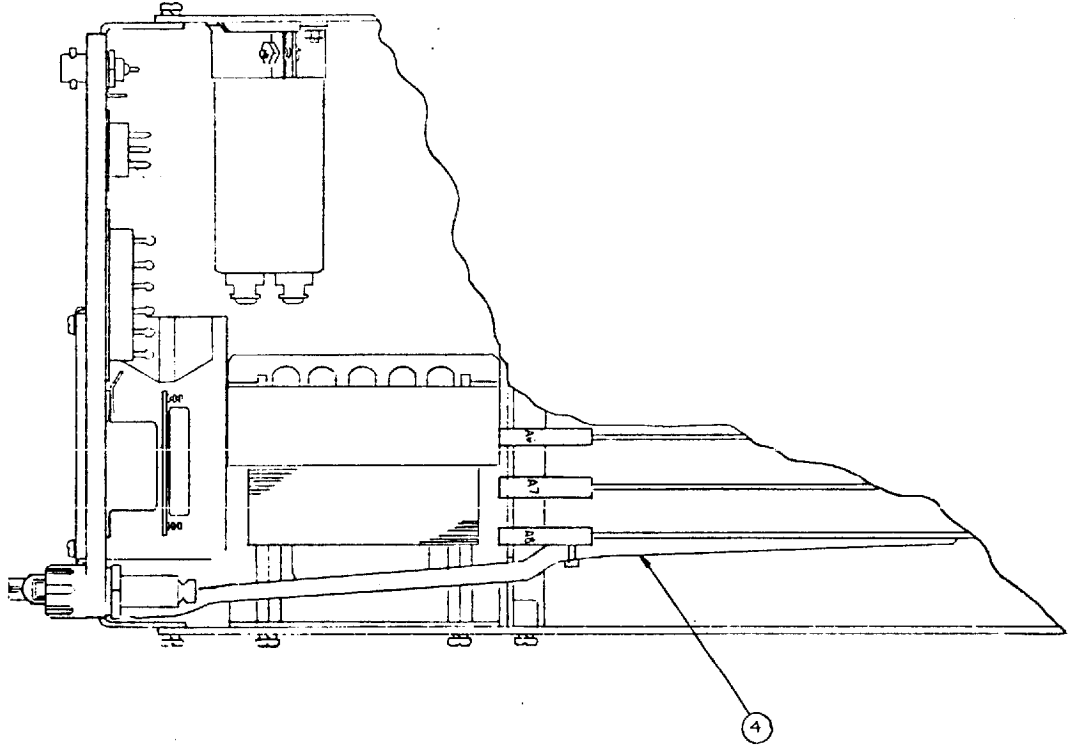
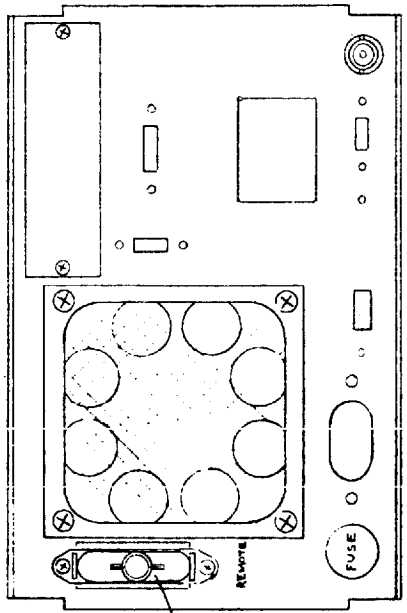
The display circuitry is composed of Q1 and Q2. At the end-of-gate (INHIBIT RESET), Q1 is turned "off" allowing C1 to charge at an RC rate as a function of R2, R4 or R5. The unijunction transistor then fires, driving the reset one-shot, U4. The output pulse is buffered by Q4 and Q5.

The command to transfer information/gate light one-shot is composed of U2, C5 and U1. At each end-of-count the information in this count chain is transferred to the storage register. The gate lamp will be "on" for a minimum of 10 ms, or the longest gate time selected. This is accomplished in U3 by summing the two signals.

One-shot U2, C4 provides a single pulse for each closure of the front panel RESET pushbutton.

The bit-code, as tabulated, is decoded in U5 and U6 to provide for correct signal actuation of the Resolution, Range, and Attenuation controls. When in the REMOTE control condition, as determined by a "0" or low-voltage state on J11, pin 4, the commons of the Range, Test, Reset, and Resolution front panel switches are disconnected from ground by U7 and U9.

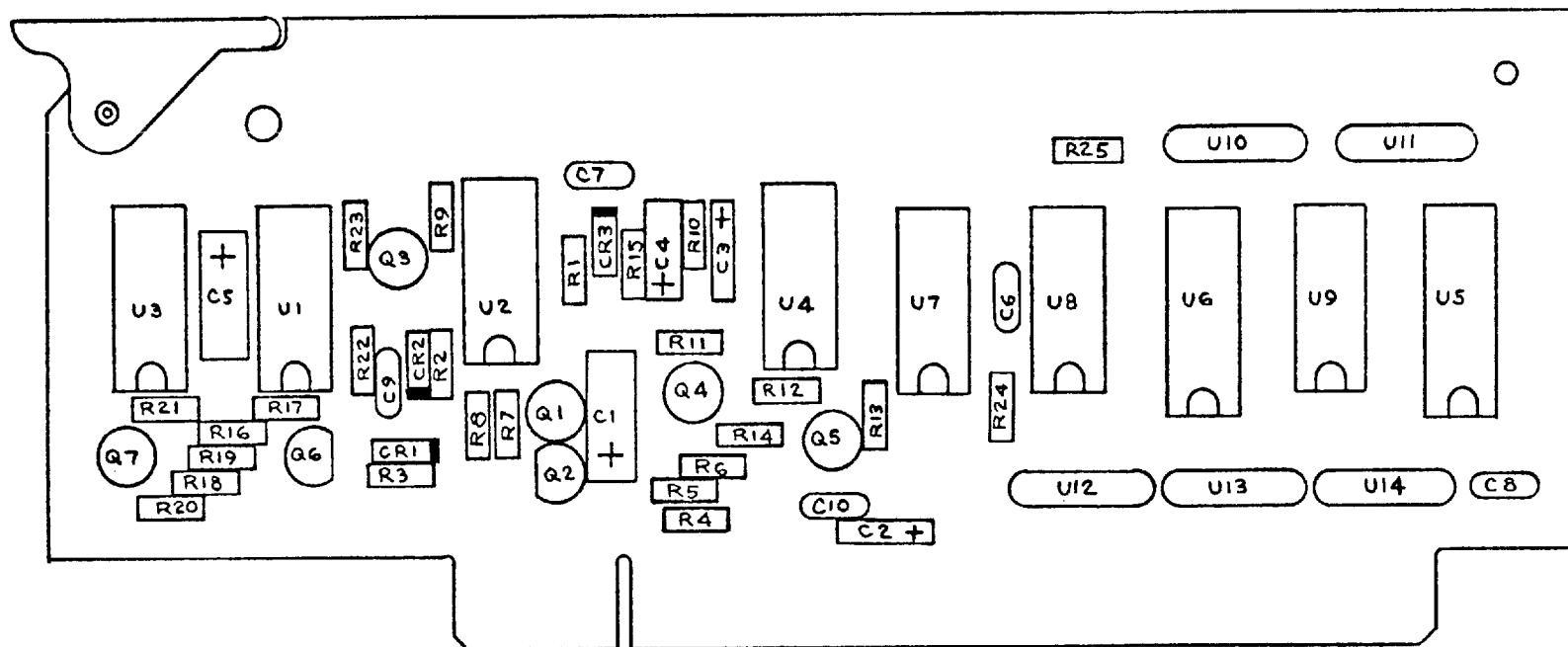
OPT 20-2



45512-11-72

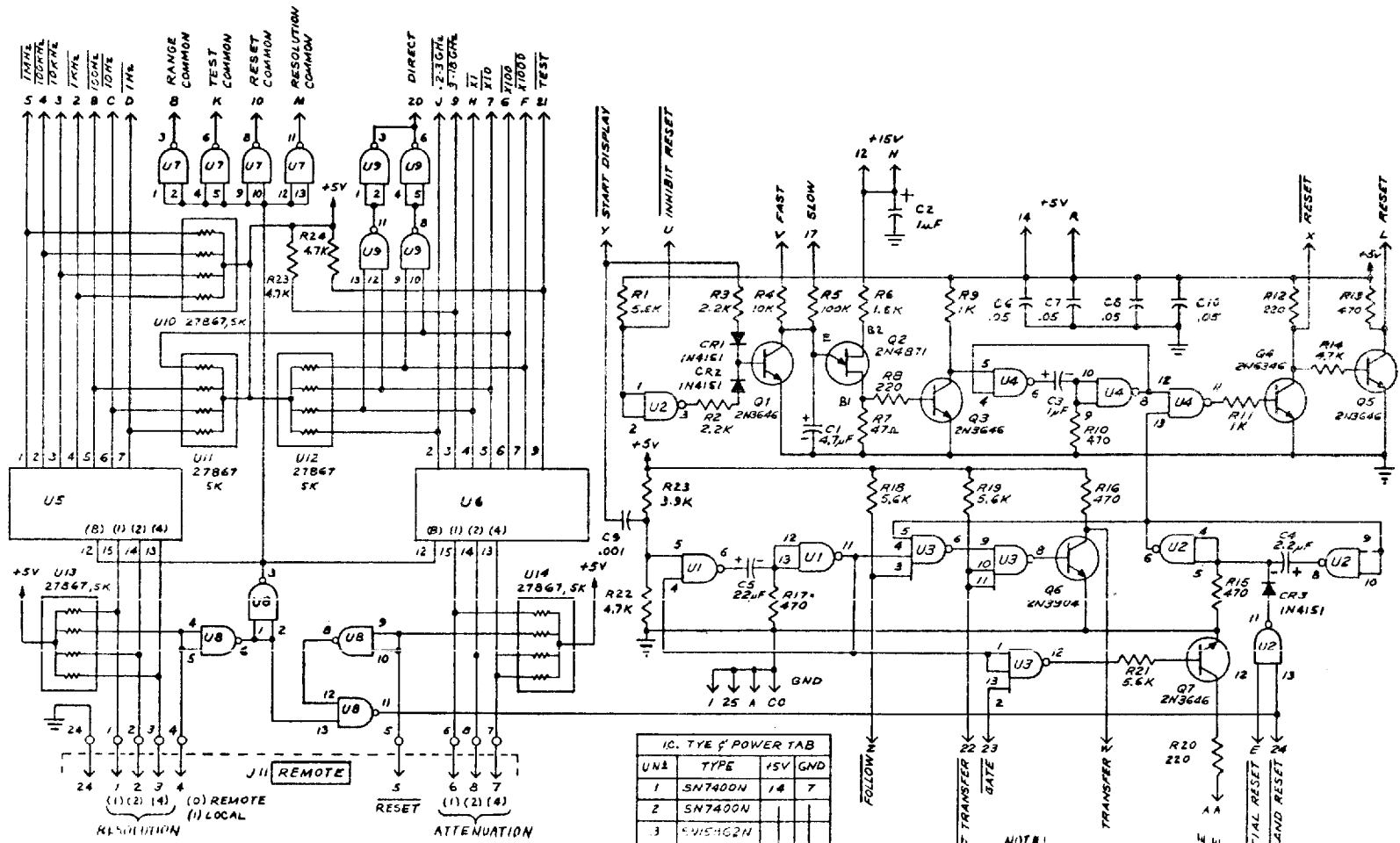
OPTION 20, PROGRAMMING (BINARY REMOTE) FINAL ASSEMBLY #45512-4-1A

45512-11-72



OPT 20-3

OPTION 20, PROGRAMMING (BINARY REMOTE) P.C. ASSEMBLY #39887A



RESOLUTION LEGEND				
FUNCTION	(1)	(2)	(4)	(8)
1MHz	0	0	0	0
100kHz	1	0	0	0
10kHz	0	1	0	0
1kHz	1	1	0	0
100Hz	0	0	1	0
10Hz	1	0	1	0
1Hz	0	1	1	0

ATTENUATION LEGEND				
FUNCTION	(1)	(2)	(4)	(8)
2-3GHz	1	0	0	0
3-10GHz	0	1	0	0
X1	1	1	0	0
X10	0	0	1	0
X100	1	0	1	0
X1000	0	1	1	0
TEST	1	1	1	0

IC. TYPE & POWER TAB				
UNA	TYPE	15V	GND	
1	SN7400N	14	7	
2	SN7400N			
3	SN1546N			
4	SN7400N			
5	SN74145N	16	8	
6	SN74145N	16	8	
7	SN15846N	14	7	
8	SN15846N			
9	SN15846N			

NOTE:
UNLESS OTHERWISE SPECIFIED:
1) ALL RESISTORS ARE 1/4W 5% IN Ω
2) ALL CAPS IN μ F

OPTION 20, PROGRAMMING (BINARY REMOTE) SCHEMATIC #39888A

OPTION 20 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 20 Final Assembly	45512
	<u>ADD</u>	
4	Binary Remote Assembly	45511
	consists of:	
4	Binary Remote P.C. Assembly	39887
5	Binary Remote Cable Assembly	45510
	Connector	J0244
	* * * * *	
A8	Binary Remote P.C. Assembly	39887
	Binary Remote Schematic	39888
C1	Capacitor, 4.7 μ F, 35 V	C0406
C2	Capacitor, 1 μ F, 35 V	C0524
C3	Capacitor, 1 μ F, 35 V	C0524
C4	Capacitor, 2.2 μ F, 20 V	C1009
C5	Capacitor, 22 μ F, 15 V	C0693
C6	Capacitor, .05 μ F, 12 V	C0672
C7	Capacitor, .05 μ F, 12 V	C0672
C8	Capacitor, .05 μ F, 12 V	C0672
C9	Capacitor, .001 μ F, 1000 V	C0235
C10	Capacitor, .05 μ F, 12 V	C0672
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N4871	Q0266
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3904	Q0247
Q7	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 2.2 k, 5%, 1/4 W	R0749
R3	Resistor, 2.2 k, 5%, 1/4 W	R0749
R4	Resistor, 10 k, 5%, 1/4 W	R0766
R5	Resistor, 100 k, 5%, 1/4 W	R0741

OPTION 20 FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R6	Resistor, 1.5 k, 5%, 1/4 W	R0783
R7	Resistor, 47 Ω , 5%, 1/4 W	R0743
R8	Resistor, 220 Ω , 5%, 1/4 W	R0760
R9	Resistor, 1 k, 5%, 1/4 W	R0765
R10	Resistor, 470 Ω , 5%, 1/4 W	R1044
R11	Resistor, 1 k, 5%, 1/4 W	R0765
R12	Resistor, 220 Ω , 5%, 1/4 W	R0760
R13	Resistor, 1 k, 5%, 1/4 W	R0765
R14	Resistor, 4.7 k, 5%, 1/4 W	R0892
R15	Resistor, 470 Ω , 5%, 1/4 W	R1044
R16	Resistor, 470 Ω , 5%, 1/4 W	R1044
R17	Resistor, 470 Ω , 5%, 1/4 W	R1044
R18	Resistor, 5.6 k, 5%, 1/4 W	R0821
R19	Resistor, 5.6 k, 5%, 1/4 W	R0821
R20	Resistor, 220 Ω , 5%, 1/4 W	R0760
R21	Resistor, 5.6 k, 5%, 1/4 W	R0821
R22	Resistor, 4.7 k, 5%, 1/4 W	R0892
R23	Resistor, 3.9 k, 5%, 1/4 W	R0939
R24	Resistor, 4.7 k, 5%, 1/4 W	R0892
R25	Resistor, 4.7 k, 5%, 1/4 W	R0892
U1	Integrated Circuit, SN7400N	19705
U2	Integrated Circuit, SN7400N	19705
U3	Integrated Circuit, SN15862N	19719
U4	Integrated Circuit, SN7400N	19705
U5	Integrated Circuit, SN74145N	25754
U6	Integrated Circuit, SN74145N	25754
U7	Integrated Circuit, SN15846N	19716
U8	Integrated Circuit, SN15846N	19716
U9	Integrated Circuit, SN15846N	19716
U10	Resistor Array, 5 k, 1/10 W	27867
U11	Resistor Array, 5 k, 1/10 W	27867
U12	Resistor Array, 5 k, 1/10 W	27867
U13	Resistor Array, 5 k, 1/10 W	27867
U14	Resistor Array, 5 k, 1/10 W	27867

* * * * *

Binary Remote Cable Assembly	45510
Connector, 24 Pin	J0230

DELETE

Programming P.C. Assembly	33936
Cover Plate	39443

CIRCUIT DESCRIPTION
OPTION 21, PROGRAMMING BOARD (SINGLE LINE REMOTE)
FINAL ASSEMBLY #45514

The A8 Programming Board contains the miscellaneous circuitry necessary for correct timing of several events occurring in the instrument.

The display circuitry is composed of Q1 and Q2. At the end-of-gate (INHIBIT RESET), Q1 is turned "off" allowing C1 to charge at an RC rate as a function of R2, R4 or R5. The unijunction transistor then fires, driving the reset one-shot, U4. The output pulse is buffered by Q4 and Q5.

The command to transfer information/gate light one-shot is composed of U2, C5 and U1. At each end-of-count the information in this count chain is transferred to the storage register. The gate lamp will be "on" for a minimum of 10 ms, or the longest gate time selected. This is accomplished in U3 by summing the two signals.

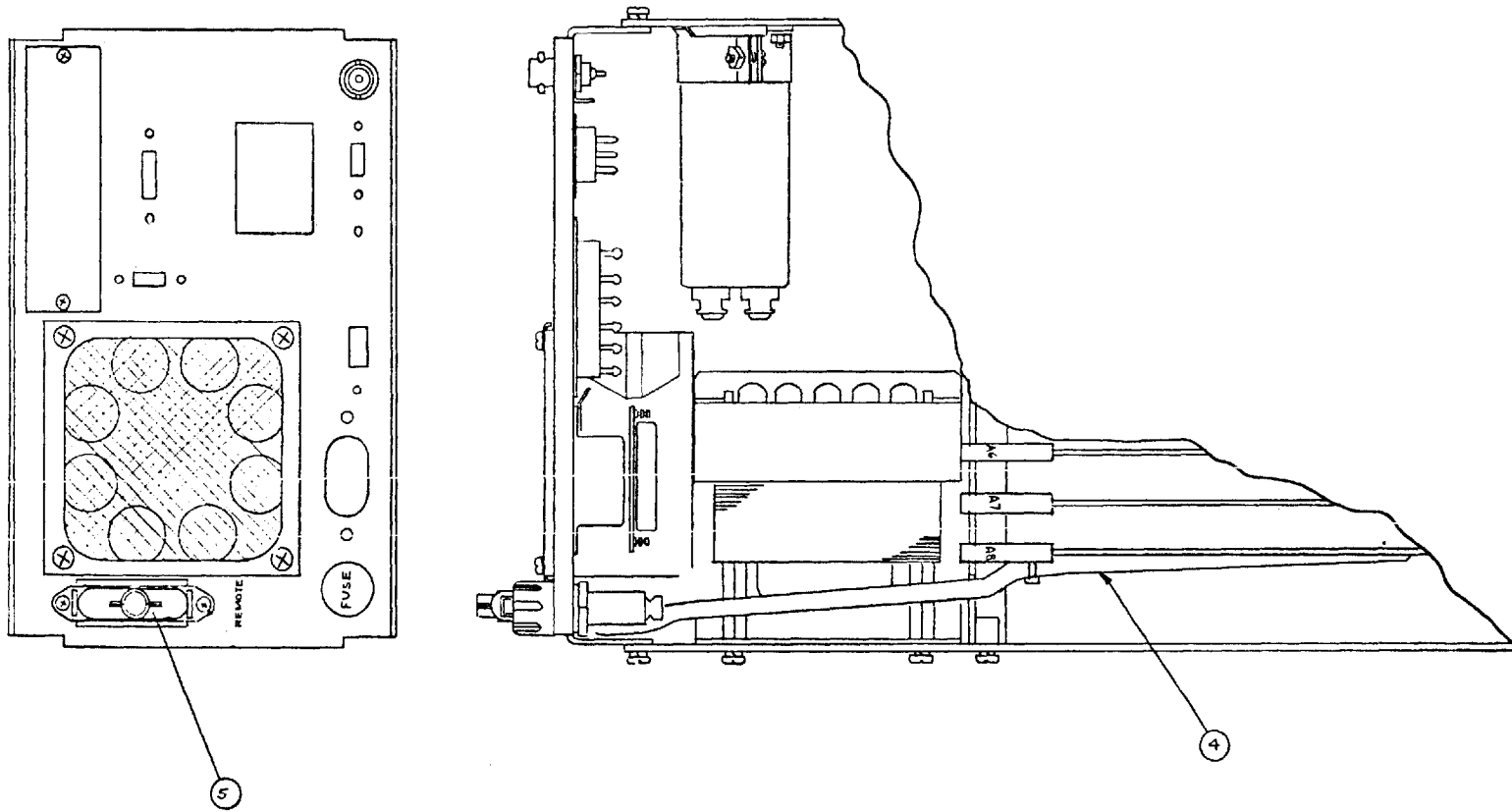
One-shot U2, C4 provides a single pulse for each closure of the front panel RESET pushbutton.

When in the REMOTE control condition, as determined by a "0" or low-voltage state on J11, pin 16 the commons of the Resolution, Test, Range, and Reset front panel switches are disconnected from ground by U10 and U11.

The resolution desired is selected by grounding, or closing to ground through a transistor or TTL circuit, pins 1 through 7 of J11. ACTO ranges are selected by pins 13 and 15. Test is selected by pin 14. The attenuation range is selected by pins 8 through 11. The instrument will reset each time pin 12 is brought to ground. Be sure only one Resolution line, and one Attenuation/Range line is selected at one time when in the REMOTE condition.

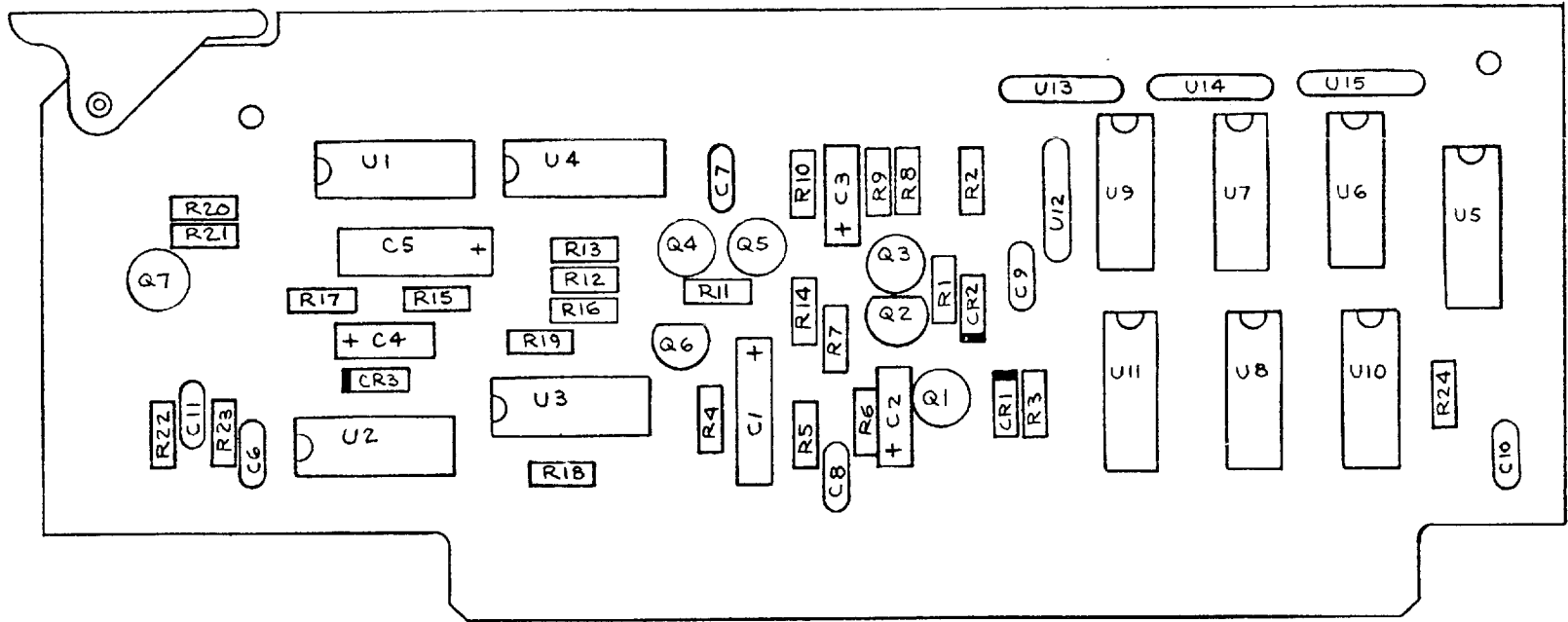
OPT 21-2

45514-11-72



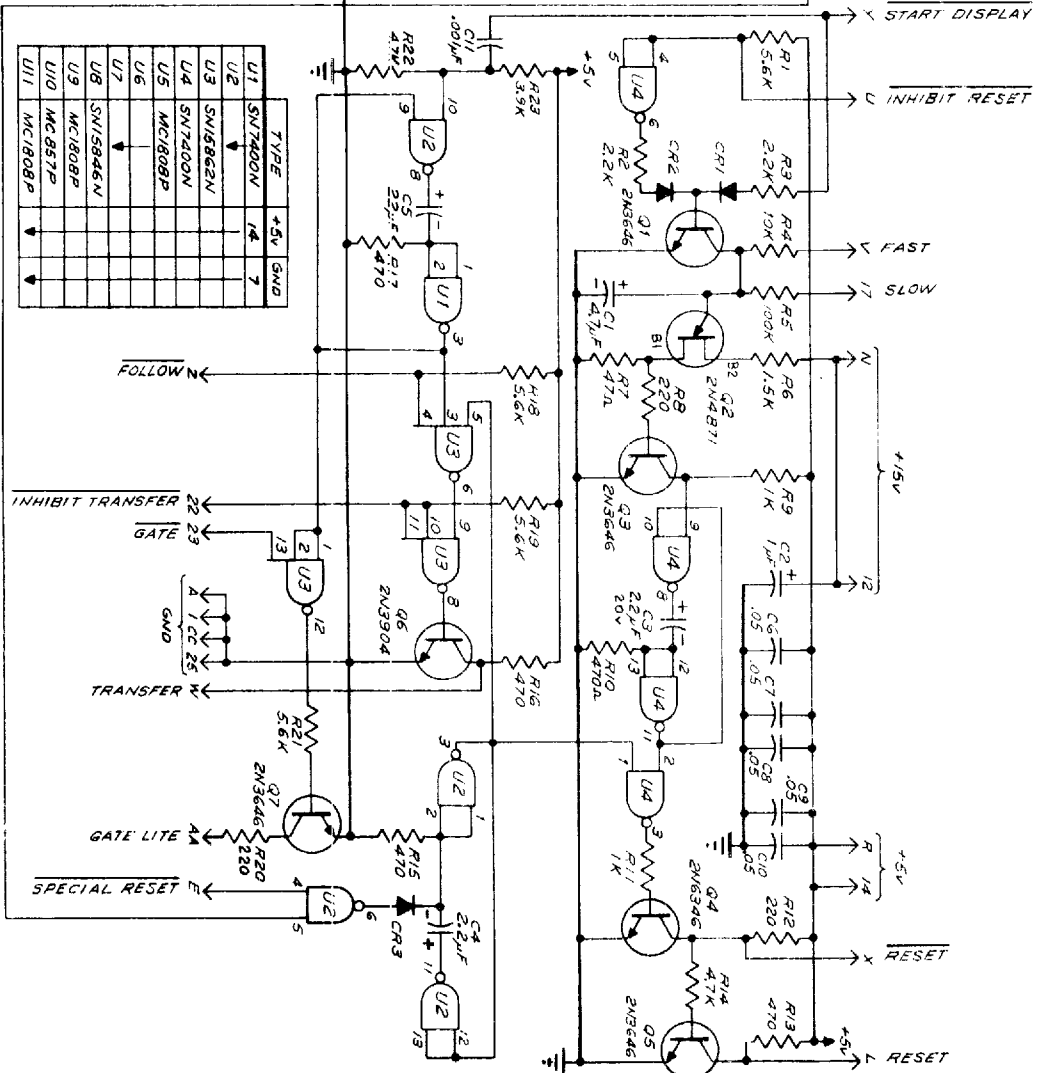
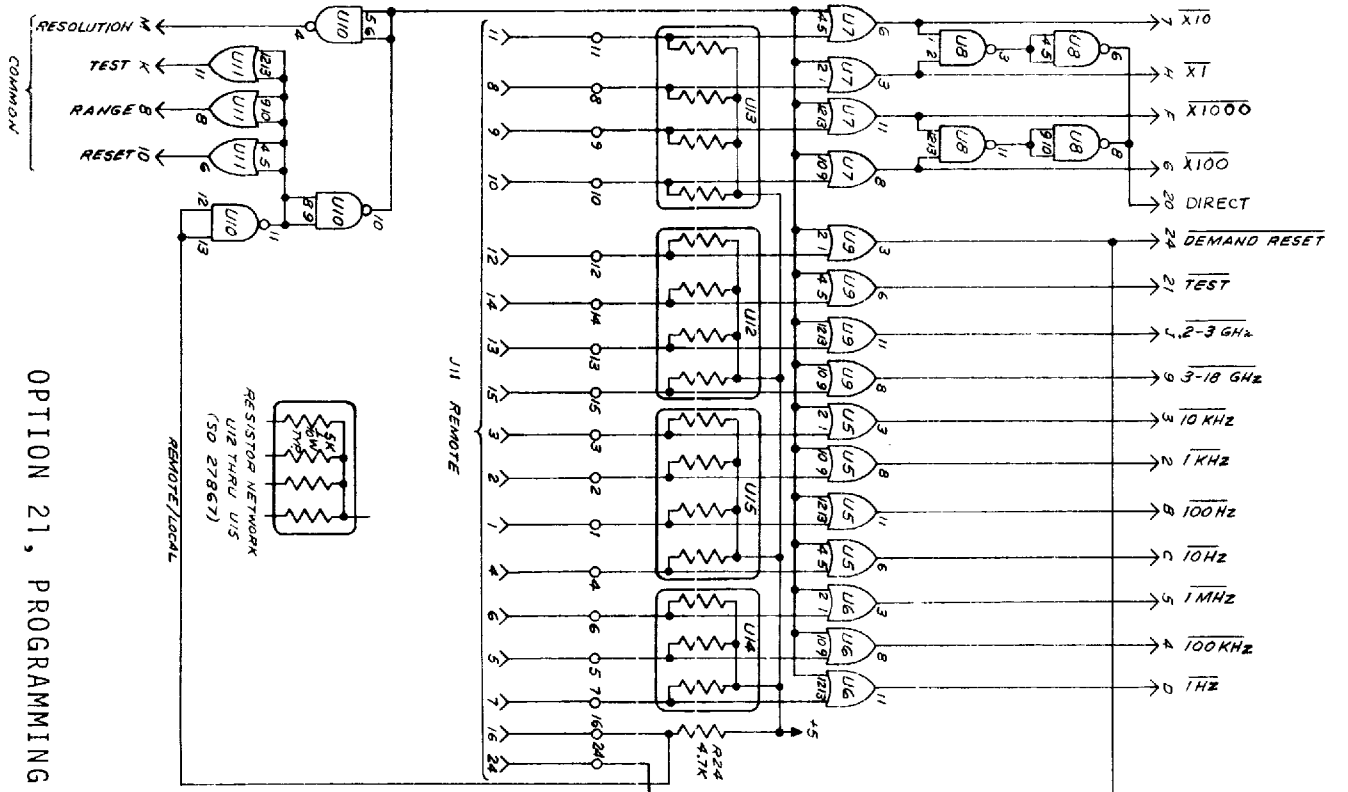
OPTION 21, PROGRAMMING (SINGLE LINE REMOTE) FINAL ASSEMBLY #45514-4-1A

45514-11-72



OPT 21-3

OPTION 21, PROGRAMMING (SINGLE LINE REMOTE) P.C. ASSEMBLY #39876A



NOTE: (EXCEPT AS NOTED)
 1) RESISTORS 1/4 W. 5%.
 2) CAPACITOR VALUES IN µF.
 3) DIODES ARE 1N4151.

OPTION 21, PROGRAMMING (SINGLE LINE REMOTE) SCHEMATIC #39877A

OPTION 21 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 21 Final Assembly	45514
	<u>ADD</u>	
2	Single Line Option 21 Schematic	39877
4	Single Line Remote Assembly consists of:	45513
4	Single Line Remote P.C. Assembly	39876
5	Single Line Remote Cable Assembly	45154
5	Connector	J0244
	* * * * *	
A8	Single Line Remote P.C. Assembly	39876
	Single Line Remote Schematic	39877
C1	Capacitor, 4.7 μ F, 35 V	C0406
C2	Capacitor, 1 μ F, 35 V	C0524
C3	Capacitor, 2.2 μ F, 20 V	C1009
C4	Capacitor, 2.2 μ F, 20 V	C1009
C5	Capacitor, 22 μ F, 15 V	C0693
C6	Capacitor, .05 μ F, 12 V	C0672
C7	Capacitor, .05 μ F, 12 V	C0672
C8	Capacitor, .05 μ F, 12 V	C0672
C9	Capacitor, .05 μ F, 12 V	C0672
C10	Capacitor, .05 μ F, 12 V	C0672
C11	Capacitor, .001 μ F, 1 kV	C0235
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N4871	Q0266
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3904	Q0247
Q7	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 2.2 k, 5%, 1/4 W	R0749

OPTION 21 FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R3	Resistor, 2.2 k, 5%, 1/4 W	R0749
R4	Resistor, 10 k, 5%, 1/4 W	R0766
R5	Resistor, 100 k, 5%, 1/4 W	R0741
R6	Resistor, 1.5 k, 5%, 1/4 W	R0783
R7	Resistor, 47 Ω , 5%, 1/4 W	R0743
R8	Resistor, 220 Ω , 5%, 1/4 W	R0760
R9	Resistor, 1 k, 5%, 1/4 W	R0765
R10	Resistor, 470 Ω , 5%, 1/4 W	R1044
R11	Resistor, 1 k, 5%, 1/4 W	R0765
R12	Resistor, 220 Ω , 5%, 1/4 W	R0760
R13	Resistor, 470 Ω , 5%, 1/4 W	R1044
R14	Resistor, 4.7 k, 5%, 1/4 W	R0892
R15	Resistor, 470 Ω , 5%, 1/4 W	R1044
R16	Resistor, 470 Ω , 5%, 1/4 W	R1044
R17	Resistor, 470 Ω , 5%, 1/4 W	R1044
R18	Resistor, 5.6 k, 5%, 1/4 W	R0821
R19	Resistor, 5.6 k, 5%, 1/4 W	R0821
R20	Resistor, 220 Ω , 5%, 1/4 W	R1059
R21	Resistor, 5.6 k, 5%, 1/4 W	R0821
R22	Resistor, 4.7 k, 5%, 1/4 W	R0892
R23	Resistor, 3.9 k, 5%, 1/4 W	R0939
R24	Resistor, 4.7 k, 5%, 1/4 W	R0892
U1	Integrated Circuit, SN7400N	19705
U2	Integrated Circuit, SN7400N	19705
U3	Integrated Circuit, SN15862N	19719
U4	Integrated Circuit, SN7400N	19705
U5	Integrated Circuit, MC1808P	25734
U6	Integrated Circuit, MC1808P	25734
U7	Integrated Circuit, MC1808P	25734
U8	Integrated Circuit, SN15846N	19716
U9	Integrated Circuit, MC1808P	25734
U10	Integrated Circuit, MC857P	25753
U11	Integrated Circuit, MC1808P	25734
U12	Resistor Network, 4 x 5 k, 1/10 W	27867
U13	Resistor Network, 4 x 5 k, 1/10 W	27867
U14	Resistor Network, 4 x 5 k, 1/10 W	27867
U15	Resistor Network, 4 x 5 k, 1/10 W	27867
* * * * *		
	Single Line Remote Cable Assembly	45154
	Connector, 24 Pin	J0230

OPTION 21 FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
	<u>DELETE</u>	
	Programming P.C. Assembly Cover Plate	33936 39443

