POLARAD

INSTRUCTION MANUAL

MODULATOR
MODEL 1020A

polarad electronics inc

5 Delaware Drive / Lake Success, New York 11040 / 516-328-1100 TWX 510-223-0414

APRIL 1979

Instrumentation

Warranty

polarad electronics inc.

We warrant each new instrument to be free of defects in materials and workmanship.

We will service, repair and adjust as required any instrument which proves defective within one year after date of delivery and which is returned to our factory (or other authorized depot) for that purpose.

For warranty information or other assistance, please contact Polarad Customer Service Department in Lake Success, New York, or an authorized regional service depot.

No other warranty is expressed or implied. No liability is assumed for consequential damages.

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INSTRUCTION MANUAL CHANGE BULLETIN

THIS BULLETIN APPLIES TO:

MODEL(S): 1020A
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Page 6-3, Table 6-1: Add the following:

MFR CODE	NAME AND ADDRESS
09353	C & K Components 103 Morse Street Newtown, Mass. 02518

This bulletin should be carefully examined since it contains information vital for updating this manual and for incorporating changes made after publication date. Bulletins are issued to insure that the manual contains current information and reflects the characteristics of the instrument for which it is intended.

For additional information, please contact Polarad's instrument application specialists for maintenance assistance, or our Customer Service Department.

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SECTION I

INTRODUCTION

1-1. SCOPE OF MANUAL.

1-2. This manual contains instructions for the use and maintenance of the Model 1020A Modulator (figure 1-1), manufactured by Polarad Electronic Instrument Division of Polarad Electronics Corporation, Lake Success, New York. The manual includes a general description of the equipment, operating instructions, theory of operation, maintenance data, and a parts list.

1-3. PURPOSE AND USE OF THE EQUIPMENT.

1-4. Model 1020A Modulator is used for the modulation of signal generators, signal sources and oscillators. It is used in the testing of microwave radars, beacons and communication systems.

1-5. Model 1020A is capable of modulating Polarad Series 1100 Microwave Signal Generators and Series 1200 Microwave Signal Sources. It can be used with most commercially available signal generators.

1-6. GENERAL DESCRIPTION.

1-7. The Polarad Model 1020A Modulator is a function generator which provides adjustable well-defined precise pulses, square waves, and sawtooth waveforms. It is a valuable accessory for the 0.80-21 GHz Series 1100 Signal Generators and Series 1200 Signal Sources. It can also be used with many other instruments. The repetition rates of all output waveforms are variable from 10 to 10,000 Hz. Pulse outputs are from 0.2 to 2000 microseconds. The linear sawtooth output is adjustable in amplitude to vary FM deviation. The 1020A Modulator can be synchronized internally, or externally by positive pulses, negative pulses, or sine waves. Sharp 25 volt sync pulses are also generated. Sync outputs are undelayed and delayed from .3 to 2,000 microseconds. The compact Polarad Model 1020A Modulator is provided in a 1-3/4" high modular cabinet which permits convenient rack mounting or stacking with other modular units of this series of Polarad instruments. Four side mounting brackets are supplied for rigid attachment to any companion Polarad instruments. When the top cover is removed all parts are available for accessibility and ease of servicing.

1-8. EQUIPMENT SUPPLIED.

1-9. Table 1-1 lists the equipment supplied with the Model 1020A Modulator.

TABLE 1-1. EQUIPMENT SUPPLIED

NAME	POLARAD PART NO.
Microwave Modulator	Model 1020A
Rack Mount	A165931-1
Rack Mount	A165931-2
Video Cable (2 supplied)	C147363
Power Cable	B160833

1-10. EQUIPMENT SPECIFICATIONS.

1-11. Table 1-2 lists the equipment specifications for the Model 1020A.

TABLE 1-2. EQUIPMENT SPECIFICATIONS

CHARACTERISTIC	SPECIFICATION
Output Waveforms	Pulse, sawtooth and square wave
Internal Modulation:	
a. Square Wave Frequency	10 to 10,000 Hz, continuously adjustable
b. Pulse Repetition Rate	10 to 10,000 pps, continuously adjustable
Pulse Width	0.2 to 2000 microseconds, continuously adjustable
Synchronization	Internal or external
c. FM Type	Sawtooth
Frequency	10 to 10,000 Hz, continuously adjustable
Synchronization	Internal or external
External Modulation:	
Repetition Rate	Single pulse to 1 MHz
Pulse Width	0.5 to 2500 microseconds
Polarity	Positive or negative
Amplitude	5 to 50 volts peak
Synchronization:	
a. Internally Generated Outputs Type	Delayed and undelayed (separate outputs)

Continued on page 1-2.

TABLE 1-2. EQUIPMENT SPECIFICATIONS (Cont'd)

CHARACTERISTIC	SPECIFICATION
a. Internal Generated Outputs (cont'd)	
Repetition Rate	10 to 10, 000 pps
Polarity	Positive
Amplitude	25 volts peak, minimum into 1K ohm load
Delay	0.3 to 2000 microseconds continuously adjustable
b. External Sinewave Input	
Frequency	10 to 10, 000 Hz
Amplitude	5 to 70 volts rms
c. External Pulse Input	
Repetition Rate	Single pulse to 10, 000 pps
Amplitude	5 to 50 volts peak
Polarity	Positive or negative
Pulse Width	0.5 to 5 microseconds
Rise Time	0.1 to 1 microsecond
Weight	5 pounds
Size	1-3/4" H x 16-3/4" W x 16-3/8" D
Power Requirements	115 or 230 volts ±10%, 50 to 60 Hz single phase, 15 watts

SECTION II

OPERATION

2-1. GENERAL.

2-2. The Model 1020A is shipped complete and ready to operate; no special or permanent installation procedures are required. The instrument should be unpacked upon receipt, observing the usual precautions customary when unpacking an electronic instrument.

2-3. INSTALLATION.

2-4. After unpacking the instrument, plan its installation. The Model 1020A is supplied mounted in a cabinet for either bench or cart use or may be rack-mounted as shown in figure 2-2. The instrument requires 115 or 230 volts, single phase, 50 to 60 Hz ac power.

NOTE

The Model 1020A is shipped ready for 115-volt operation. If the instrument is to be operated from a 230-volt source, set the 115/230 volt SELECTOR switch, located at the rear of the unit, to the 230-volt position. The location of the switch is shown in figure 2-1.

2-5. Connect power cable B160833 between the AC INPUT connector and an ac power source receptacle. If the ac power source receptacle is not a grounding type, an adapter will be required.

2-6. OPERATING PROCEDURES.

2-7. The operating procedures for the Model 1020A are described in paragraphs 2-8 through 2-15.

2-8. OPERATING CONTROLS, INDICATORS, AND CONNECTORS. The operating controls, indicators, and connectors of the instrument are shown in figure 2-1. Their functions are listed in table 2-1.

2-9. CONNECTIONS AND PRELIMINARY OPERATION. To operate the Model 1020A, proceed as follows:

a. Connect instrument to signal source or generator and device under test as shown in figure 2-3.

b. Set POWER switches to ON and allow the instruments to warm up for 15 minutes.

2-10. FM OPERATION – INTERNAL SYNCHRONIZATION. Connect FM OUT jack of the Model 1020A to the instrument being modulated and proceed as follows:

a. Couple DELAYED SYNC OUT connector and/or UNDELAYED SYNC OUT connector, as required, to the instrument being tested or to monitoring equipment.

b. Set SYNC SELECTOR switch to INT.

c. Set the FUNCTION selector switch to its FM position.

d. Adjust RATE control and X1-X10-X100 multiplier switch to obtain the desired repetition rate which may be varied from 10 to 10, 000 pps.

e. Adjust FM DEV AMPLITUDE control to obtain desired frequency excursion of the modulated signal.

2-11. FM OPERATION – EXTERNAL SYNCHRONIZATION. Model 1020A may be synchronized by externally applied positive or negative pulses or sine waves with an amplitude of 5 to 50 volts peak for the pulses or 5 to 50 volts rms for the sine waves. The same operational procedure is followed as for internally synchronized FM operation except that the selector switch is placed in EXT(+) or EXT(-) position as determined by the nature of the externally-supplied synchronizing signal. The RATE control and X1-X10- X100 multiplier switch must be set so that the free running sawtooth rate is lower than the externally supplied synchronizing signal in order for synchronization to be effective.

2-12. INTERNALLY SYNCHRONIZED SQUARE-WAVE OPERATION. To obtain a square-wave modulated output from the instrument being modulated, proceed as follows:

a. Couple DELAYED SYNC OUT connector and/or UNDELAYED SYNC OUT connector, as required, to the instrument being tested or to monitoring equipment.

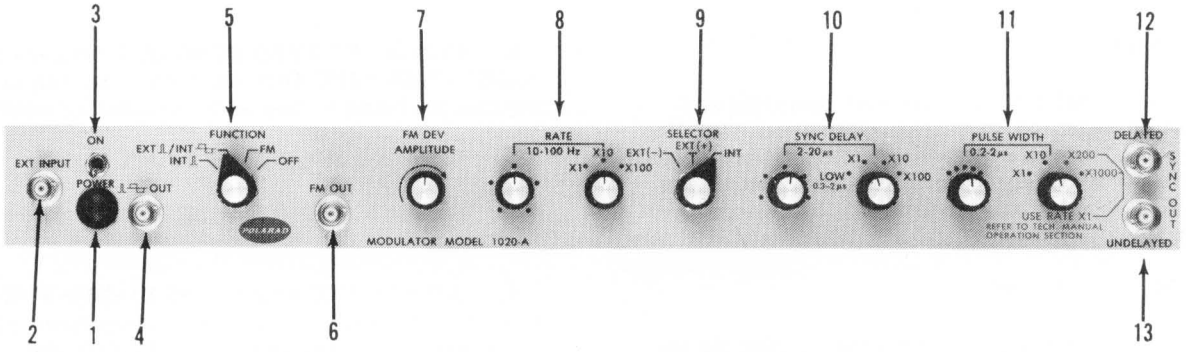
b. Connect ⎍ ⊓ OUT jack of the Model 1020A to the instrument being modulated.

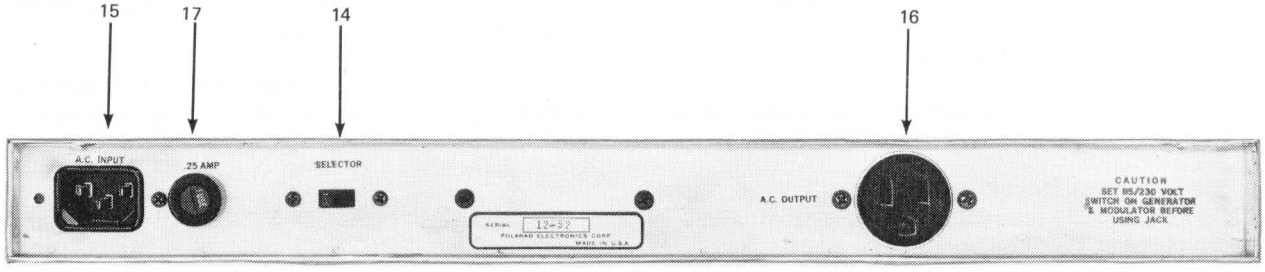
c. Set the FUNCTION selector switch to its EXT⎍/INT⊓ position.

d. Set the SELECTOR switch to INT.

e. Adjust RATE control and X1-X10-X100 multiplier switch to obtain the desired repetition rate.

f. DUTY CYCLE – DELAY LIMITATIONS. Figure 2-4 includes the pulse width to 2000 μsec. The regions for stable operation are below the curves.

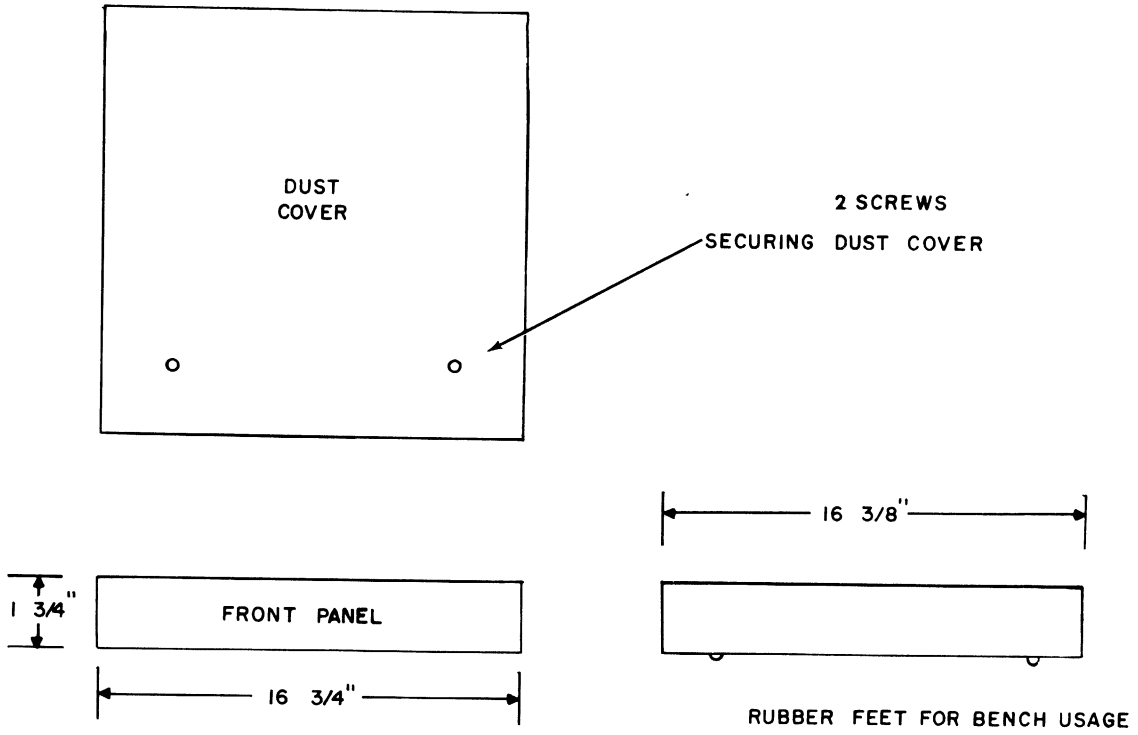




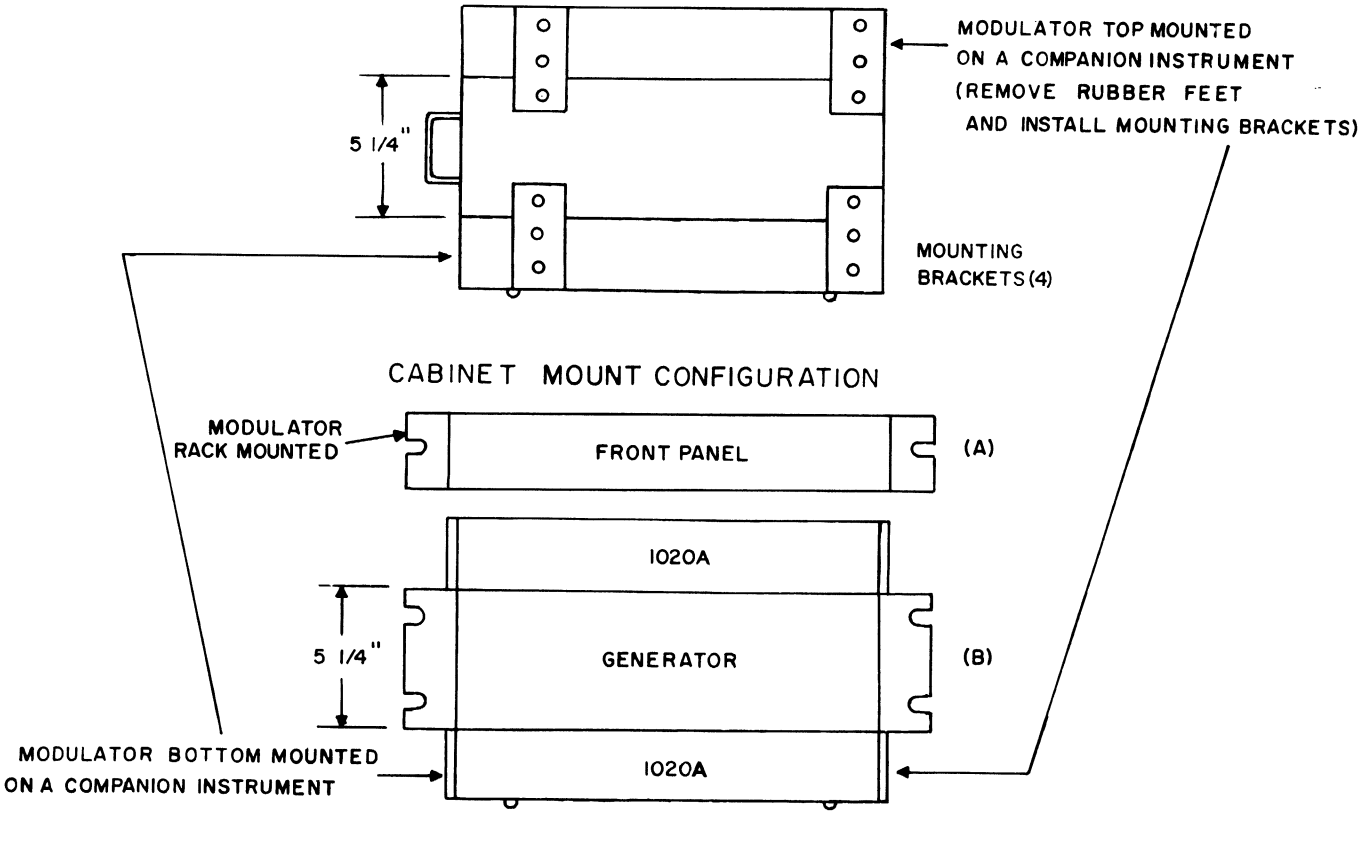
REAR PANEL CONTROLS

(See Table 2-1)

Figure 2-1. Model 1020A Operating Controls, Indicators and Connectors



MODULATOR MODEL 1020A OUTLINE DIMENSIONS



RACK MOUNT CONFIGURATION

Figure 2-2. Installation Outline Drawings, Model 1020A Modulator

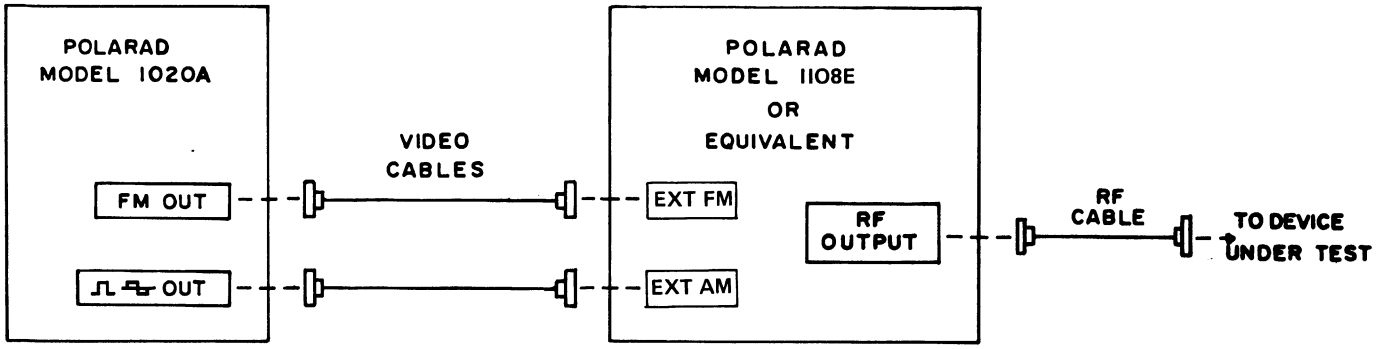


Figure 2-3. Operational Setup for the Model 1020A

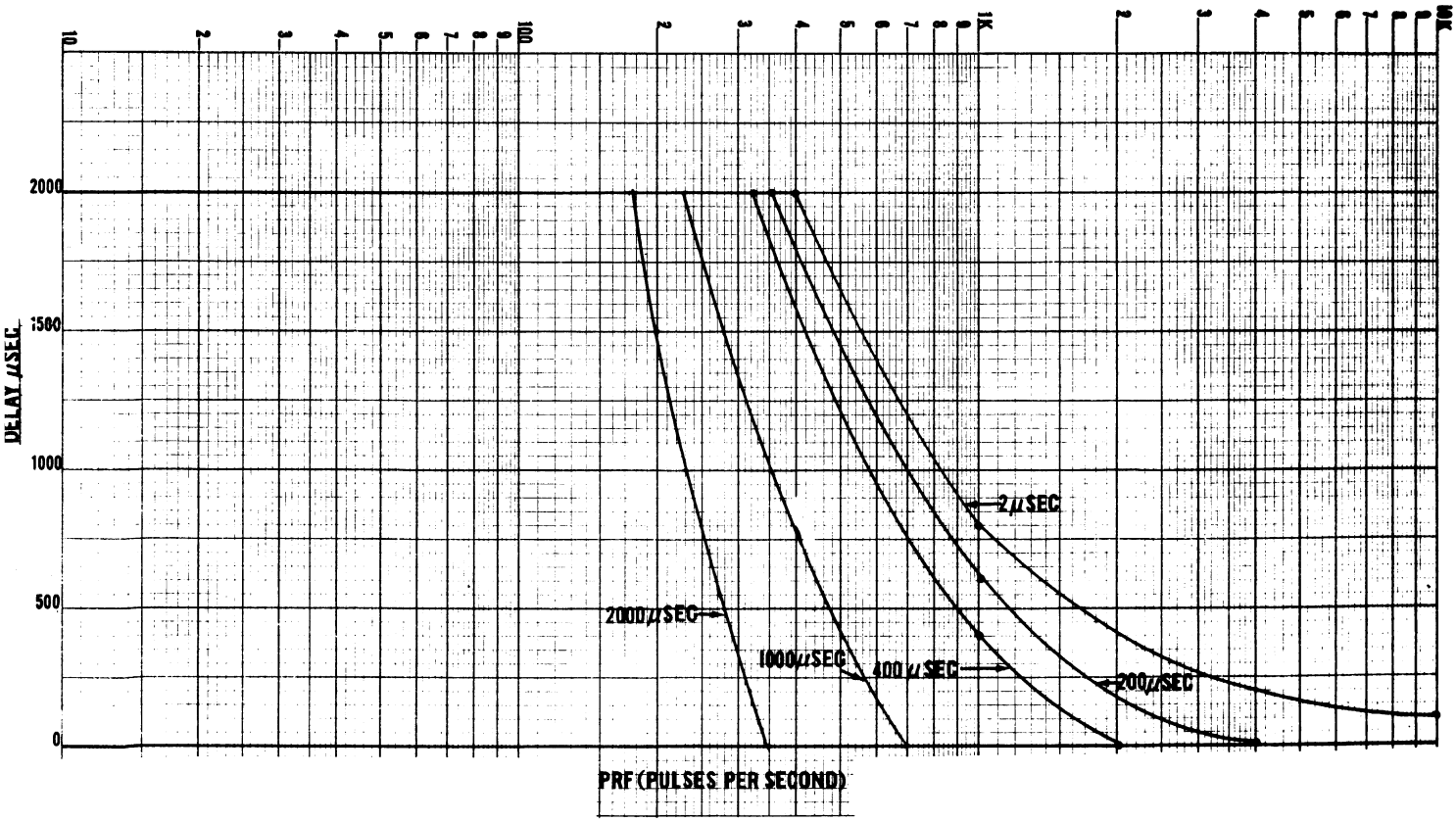


Figure 2-4. Maximum Pulse Delay Versus Repetition Rate

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Figure 2-1 Index No.	Control, Indicator, or Connector	Function
1	ON indicator lamp	Lights when power is applied to instrument.
2	EXT INPUT connector	Connects the Model 1020A to either externally synchronizing or externally pulse modulating signals.
3	POWER switch	Controls application of ac power.
4	⎍⎍ OUT connector	Couples output pulse or output square wave waveforms to EXT PULSE input jack on signal generator.
5	FUNCTION switch	Selects internal pulse, internal square wave, FM, external pulse modulation, or no modulation.
6	FM OUT connector	Couples output sawtooth waveform to EXT FM input jack on signal generator.
7	FM DEV AMPLITUDE control	Adjusts amplitude of output sawtooth. (Adjusts deviation about center frequency of rf output when MODULATION SELECTOR switch on signal source is set to EXT FM position.)
8	RATE control and X1-X10-X100 multiplier switch	Adjusts modulation repetition rate from 10 to 10, 000 pps.
9	SELECTOR switch	Enables Modulating Output signals to be either internally or externally controlled as follows: a. Must be set to EXT(+) when a positive synchronizing pulse or a positive modulating pulse is externally applied. b. Must be set to EXT(-) when a negative synchronizing pulse or a negative modulating pulse is externally applied. c. May be set to EXT(+) or EXT( ) when a sine wave synchronizing signal is externally applied. d. Must be set to INT when no external synchronizing signal is applied.
10	SYNC DELAY control and LOW-X1-X10-X100 multiplier switch	Adjusts delay between both rf output pulse and delayed sync output pulse from 0.3 to 2000 microseconds.
11	PULSE WIDTH control and X1-X10-X200-X1000 multiplier switch	Adjusts width of rf output pulse from 0.2 to 2000 μsec. X1 0.2 to 2 μsec X200 40 to 400 μsec X10 2.0 to 20 μsec X1000 200 to 2000 μsec Pulse width range overlap on the X10 and X200 multiplier positions provides pulse width from 20 μsec to 40 μsec.
12	DELAYED SYNC OUT connector	Provides positive video trigger pulse in time coincidence with leading edge of rf output pulse.
13	UNDELAYED SYNC OUT	Provides positive video trigger pulse which leads both rf output pulse and delayed sync output pulse in time.
14	115/230 SELECTOR switch*	Selects input power voltage level.
15	AC INPUT connector*	Connection for external ac power source.
16	AC OUTPUT connector*	Connection for ac power cable between Model 1020A and other equipment.
17	Fuse .25 AMP *	Circuit protection

* Rear Panel

For example, at 2.0 μsec width and pulse repetition rate of 1000 Hz, the maximum stable delay would be 800 μsec. The graph in figure 2-4 is based on the following equation:

$$\text{DELAY} = \left(\frac{(0.7)\,10^6}{\text{PRF}} - \text{PULSE WIDTH} \right) \quad (1)$$

Where Delay is in μsec, width is in μsec, and PRF is in pulses/sec.

g. The front panel of the Model 1020A has a caution notice to the use of the RATE X1 multiplier when in the X200 and X1000 PULSE WIDTH position. The caution notice is to provide a guideline for stable pulsing at any selected pulse width and delay combination. Other stable combinations of width, rate, and delay are available. These are the parameters falling below the graph line in figure 2-4. To illustrate, if the pulse width is 400 μsec and the delay 200 μsec, stable operation can be maintained up to 1166 pps, as shown in figure 2-4.

h. The STABILITY SAFETY formula contains a 70% safety factor. Any combination of Delay, Width, and PRF that satisfy this formula will result in stable pulsing. Stable operation may be maintained in most control combinations up to the instrument's pulsing capability, without the safety factor. This can be derived by dropping the 0.7 multiplier in Equation No. 1, resulting in the equation:

$$\text{DELAY} = \frac{10^6}{\text{PRF}} - \text{PULSE WIDTH} \quad (2)$$

If the controls are set beyond limits of the curve, figure 2-4 (Operations Settings above the curves), use of an external scope is recommended to be sure of stable operation. There cannot be stable pulsing beyond the limits of Equation No. 2.

NOTE

Do not exceed duty cycle. Refer to figure 2-4.

2-13. INTERNALLY SYNCHRONIZED PULSE OPERATION. To obtain a pulse-modulated output from the instrument being modulated, proceed as follows:

a. Couple DELAYED SYNC OUT connector and/or UNDELAYED SYNC OUT connector, as required, to the instrument being tested or to monitoring equipment.

b. Connect ⎍ ⊓ OUT jack of the Model 1020A to the instrument being modulated.

c. Set the FUNCTION selector switch to its INT position.

d. Set SELECTOR switch to INT.

e. Adjust RATE control and X1-X10-X100 multiplier switch to obtain desired pulse repetition rate.

f. Adjust PULSE WIDTH control to obtain desired pulse width.

g. Adjust SYNC DELAY control and X1-X10-X100 multiplier switch to obtain desired delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the pulse-modulated rf output signal.

NOTE

Do not exceed duty cycle. Refer to figure 2-4.

2-14. EXTERNALLY SYNCHRONIZED PULSE OPERATION. The Model 1020A may be synchronized by externally applied positive or negative pulses or sine waves with an amplitude of 5 to 50 volts peak for the pulses or 5 to 50 volts rms for the sine waves. The same operational procedure is followed as for internally synchronized pulse operation (paragraph 2-13) except that SELECTOR switch is placed in either EXT(-) or EXT(+) position, as determined by the nature of the externally supplied synchronizing signal.

NOTE

Do not exceed duty cycle. Refer to figure 2-4.

2-15. EXTERNAL PULSE OPERATION. To obtain a pulse-modulated output from the instrument being modulated, programmed by an external pulse source, proceed as follows:

a. Couple DELAYED SYNC OUT connector and/or UNDELAYED SYNC OUT connector, as required to the equipment being tested or to monitoring equipment.

b. Connect ⎍ ⊓ OUT jack of the Model 1020A to the instrument being modulated.

c. Set the FUNCTION switch to its EXT ⎍ / INT ⊓ position.

d. Set SELECTOR switch to EXT(+) or EXT(-).

e. The pulse width and repetition rate are both a function of the settings on the external pulse source.

NOTE

Do not exceed duty cycle. Refer to figure 2-4.

2-16. PACKAGING INSTRUCTIONS.

2-17. PACKAGING FOR SHORT-TERM STORAGE. If the Model 1020A is to be stored for a relatively short period, cover it with a suitable protective covering such as a sheet of plastic or paper. Put the accessories and instruction manual in a carton or bag and fasten it to the unit to prevent loss. Store the Model 1020A in a clean dry area where it will not be subject to extreme temperatures.

2-18. PACKAGING FOR LONG-TERM STORAGE OR SHIPMENT. If the Model 1020A is to be stored for a long period of time, or shipped, proceed as follows:

a. If the original wrappings and carton have been saved, use them to package the equipment as shown in figure 2-5.

b. If new packing materials are to be used, assemble the necessary wrappings and carton.

c. Wrap the equipment in a moisture- and vapor-proof barrier such as plastic or water proof paper.

d. Wrap the accessories and instruction manual in a moisture- and vapor-proof barrier.

e. Place the package in a suitable carton. Fill all empty spaces in the carton with suitable packing to prevent shifting of the packages within the carton.

f. Seal and mark the carton.

g. If the storage or shipping conditions make it necessary, enclose the carton within an outer carton or wooden box.

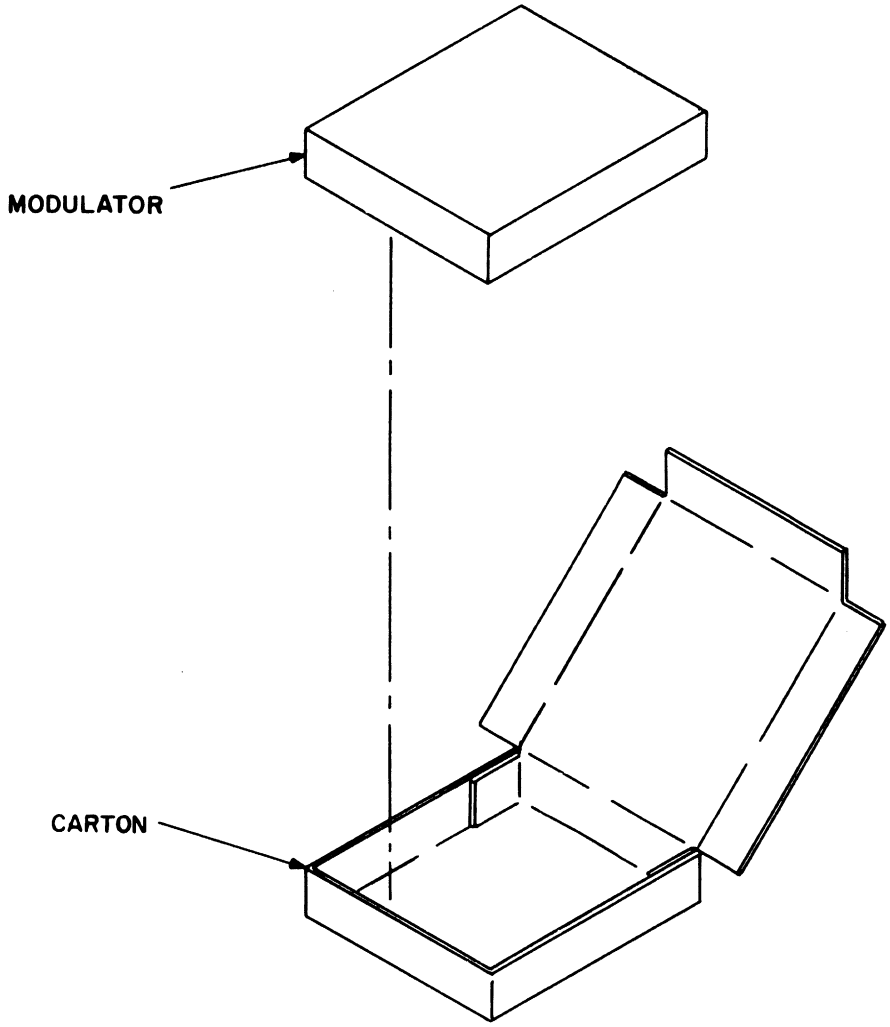


Figure 2-5. Packaging Diagram, Model 1020A

SECTION III

THEORY OF OPERATION

3-1. GENERAL.

3-2. The Model 1020A Modulator is a precision pulse, square-wave, sawtooth generator designed for use with the Polarad Series 1100 Signal Generators, Polarad Series 1200 Signal Sources, and most other available commercial signal generators and sources.

3-3. BLOCK DIAGRAM ANALYSIS. (Figure 3-1)

3-4. The Model 1020A is comprised of a group of circuits which generate, shape and delay the various waveforms as required. The Rate Generator is a free-running unijunction oscillator which serves to generate the basic pulse repetition rates. This circuit is also the source of the sawtooth for FM operation. When the FUNCTION switch, S2, is set at its INT⎍ position and the SELECTOR switch, S3, is set at its INT position, the pulse output of the Rate Generator, divided by two by means of the ÷ 2 Flip/Flop, is applied to the Schmitt Trigger. The Schmitt Trigger output, a square wave, is applied to the Pulse Generator where the output pulses of desired width and delay are generated. The Pulse Generator consists of two integrated circuit monostable multivibrators IC1 and IC2. IC1 develops the desired pulse delay of 2 to 2000 usec in conjunction with front panel controls DELAY uSEC, R41, and LOW-X1-X10-X100 multiplier switch, S4. IC1 has two outputs; one output is applied to the Undelayed Sync Amp for amplitude and impedance conditioning prior to appearing at the UNDELAYED SYNC OUT output connector J3. The other output is applied to IC2 where the desired output pulse width of 0.2 to 2000 usec is developed in conjunction with PULSE WIDTH control, R76 and X1-X10-X200-X1000 switch, S7. IC2 also has two outputs; one output is applied to the Delayed Sync Amp for amplitude and impedance conditioning prior to appearing at the DELAYED SYNC OUT connector J2. The other output is routed through the FUNCTION switch to the ⎍ ⊓ Output Amplifier prior to appearing at the OUT output connector J5. With the FUNCTION switch set at its EXT⎍ /INT⊓ position and the SELECTOR switch set at INT, the square wave output of the Schmitt Trigger is applied to the ⎍ ⊓ Output Amplifier rather than the output of IC1 and the resultant output at the ⎍ ⊓ OUT output connector is a square wave. With the FUNCTION switch set at its EXT ⎍ /INT ⊓ position and the SELECTOR switch set at its EXT (-) or EXT (+) position, an external signal connected to the EXT INPUT connector, J1, is processed through the EXT Signal Amplifier to the Schmitt Trigger input. The output signals appearing at the ⎍ ⊓ OUT, UNDELAYED SYNC OUT, and DELAYED SYNC OUT connectors J5, J3 and J2 respectively are directly related to the external input signal applied to the EXT INPUT connector J1. With the FUNCTION switch set at its FM position and the Selector Switch set at INT, the sawtooth output of the Rate Generator is processed through the Sawtooth Amplifier. The output of the Sawtooth Amplifier is applied across FM AMPLITUDE control R21. The wiper of the FM AMPLITUDE control is the output sawtooth and is connected to the FM OUT output connector, J4. With the function switch set at FM and the selector switch set at EXT (+), the rate of the Rate Generator will be synchronized with the rate of the externally applied synchronizing signal provided that the RATE control and X1, X10, X100 switches are set to a rate lower than the incoming synchronizing rate.

3-5. DETAILED CIRCUIT ANALYSIS. (Figure 5-1)

3-6. Paragraphs 3-7 through 3-17 contain a detailed analysis of the various circuits of the Model 1020A.

3-7. RATE GENERATOR Q1, Q23. The rate generator is a free-running unijunction oscillator. With the FUNCTION switch in its INT⎍ or EXT⎍ /INT⊓ position and the RATE X1-X10-X100 switch set at its X100 position the basic repetition rate is determined by RC components R4, R5, R6, and C3 and will be in the range of 2,000 to 20,000 pps. The actual rate will depend upon the setting of front panel RATE control R5. When the RATE X1-X10-X100 switch is placed in its X1 position the repetition rate will be in the range of 20-200 pps due to the addition of C1 which increases the charging time constant in the unijunction emitter circuit. Q23 is a feedback current source which linearizes the sweep. As the capacitive components charge in the emitter circuit a positive going sawtooth waveform is developed. When the firing potential is reached at the emitter, Q1 turns on and allows the capacitive components to discharge through R2 and L1 creating sharp positive pulses across R2 and L1. These pulses are fed to the ÷2 Flip/Flop which divides the input pulses in half to develop the output repetition rates of 10 to 10,000 pps.

3-8. When the FUNCTION switch is placed in its FM position additional capacitive components are added to the emitter charging circuit. The components are C7, C8 and C9, in the RATE X1-X10-X100 positions respectively. No division takes place in this mode of operation and the rates developed are the output rates. The sawtooth waveform developed in the Q1 emitter circuit is fed to the Sawtooth Amplifier for further processing. R6 in the Q1 emitter circuit is adjusted in conjunction with R5 to provide the high repetition rate which is approximately 10,000 pps. The adjustment of R6 is described in paragraph 4-13. When the selector switch is placed in the external positions, an external positive signal (selector set to EXT (+), an external negative signal (selector set to EXT (-), or a sinewave may be used to synchronize the sawtooth waveform. This is performed by transistor Q22. Q22 is turned on by the undelayed signal pulse. This causes the unijunction transistor Q1 to fire.

3-9. ÷ 2 FLIP/FLOP Q2, Q3. The ÷ 2 Flip/Flop accepts the positive going pulses from the Rate Generator, in the range of 20-20,000 pps, and produces a square wave at the collector of Q3, at the output rate of 10-10,000 Hz. The square wave is routed through

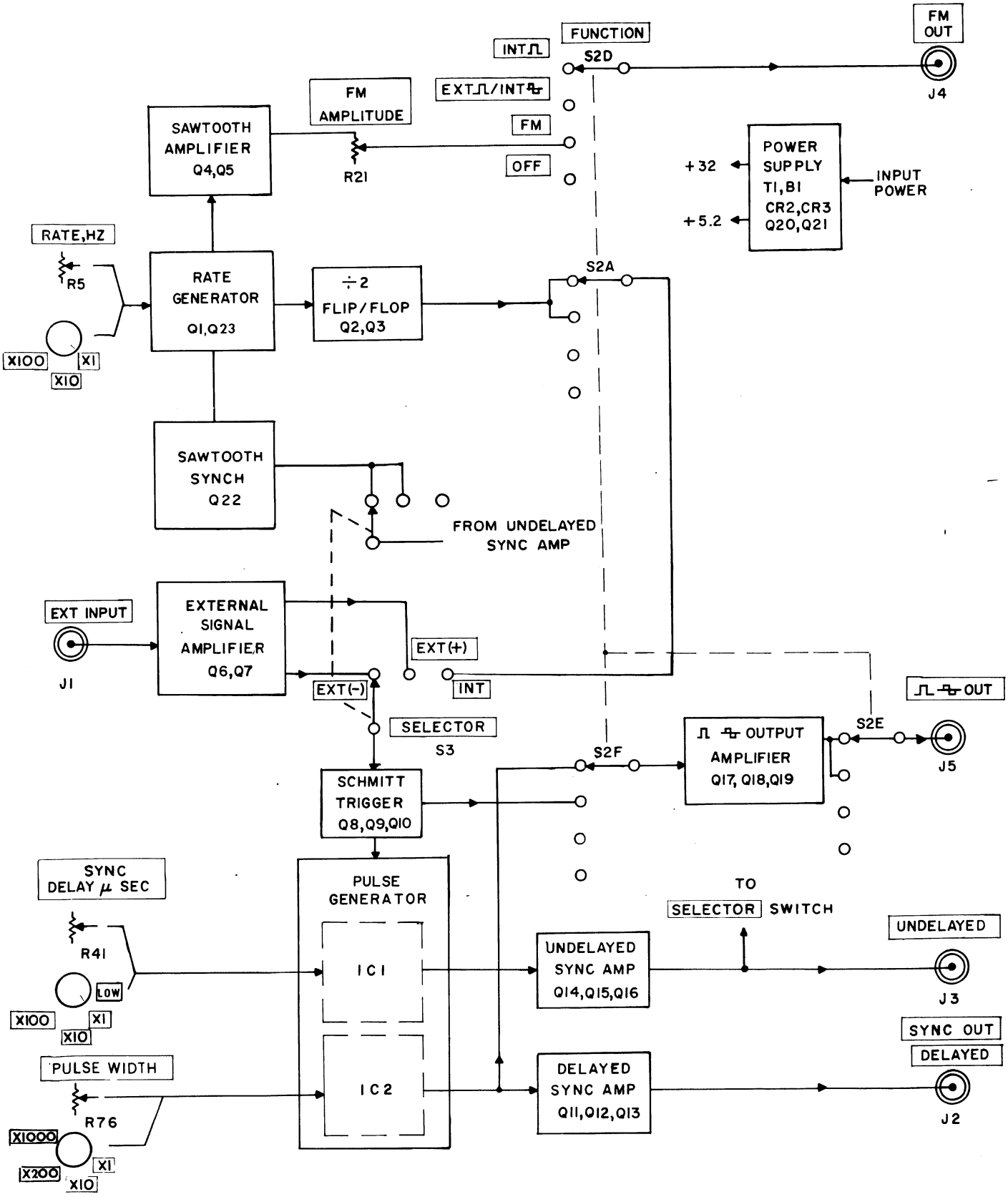


Figure 3-1. Model 1020A Modulator, Block Diagram

the FUNCTION switch to the INT position of the SELECTOR switch S3. When the SELECTOR switch is in the INT position the square wave is fed to the Schmitt Trigger circuit for further processing.

3-10. SCHMITT TRIGGER Q8, Q9, Q10. The input to the Schmitt Trigger is determined by the position of the SELECTOR switch. When the SELECTOR switch is in its INT position, a square wave from the ÷ 2 Flip/Flop will be applied to the input. When the SELECTOR switch is in its EXT - or EXT + position the output of the Ext Sig Amplifier will be applied to the input. The output waveform of the Ext Sig Amplifier will depend upon the type of signal waveform connected to the EXT SYNC connector J1. The Schmitt Trigger circuit composed of Q8 and Q9 is a dc coupled amplifier used to improve the rise and fall time of the input waveform. Q10 is an emitter follower used to provide a low output impedance for the circuit. A positive going signal will provide a positive going signal at the emitter of Q9. The Schmitt Trigger provides two outputs; a square wave which is direct coupled through the FUNCTION switch, when it is in its EXT ⎍ /INT ⎍ position, to the ⎍ Output Amplifier. The other output is differentiated by C16 and R38 and routed to the Pulse Generator for pulse shaping and delay.

3-11. PULSE GENERATOR IC1, IC2. The Pulse Generator consists of two integrated monostable multivibrators IC1 and IC2. As the integrated circuits are connected, they require a positive going signal to activate the output. The positive going output of the Schmitt Trigger used to initiate pulse generation is differentiated by C16 and R38 and applied to the input of IC1. The pulse output of IC1 is a negative going waveform whose duration is determined by C17, C18, C38 or C39, C40 and the front panel SYNC DELAY controls R41 and S4. The output pulse of IC1 is differentiated by C19 and R42, the leading or negative going edge is routed to the Undelayed Sync Amp while the positive going edge, which represents the fall of the pulse developed by IC1, is connected to the input of IC2. The positive input to IC2 initiates pulse generation by IC2 which is a positive going waveform whose duration is the output pulse width determined by C36, C37, C48 or C49/C50 and PULSE WIDTH, R76 and S7. The duration of the pulse generated by IC1 therefore represents the delay time between the undelayed sync pulse and the output and delayed sync pulse. The leading edge of the output pulse and the delayed sync pulse are coincident.

3-12. UNDELAYED SYNC AMP Q14, Q15, Q16. The undelayed sync amplifier input transistor Q14, a pnp type, is quiescently cut off. The negative going pulse from the differentiating network of C19 and R42 causes Q14 to conduct allowing the collector to go positive causing Q15 to conduct dropping its collector to ground potential. When the collector of Q15 assumes its low potential state Q16 conducts allowing its collector to go positive and somewhat less than +32 volts. The collector of Q16 is connected to the UNDELAYED SYNC OUT connector J3 through R73.

3-13. DELAYED SYNC AMP Q11, Q12, Q13. The delayed sync amplifier input transistor Q11, an npn type, is quiescently cut off. The positive going pulse from the differentiating network of C25 and R57 causes Q11 to conduct and develop a positive going signal across R58. The positive potential applied to Q12, which is also quiescently cut off causes Q12 to conduct dropping its collector to ground potential. When the collector of Q12 assumes its low potential state Q13 conducts allowing its collector to go positive and somewhat less than +32 volts. The collector of Q13 is connected to the DELAYED SYNC OUT connector J2 through R62.

3-14. ⎍ ⎍ OUTPUT AMPLIFIER Q17, Q18, Q19. The ⎍ ⎍ output amplifier input transistor, Q17, is quiescently cut off and is caused to conduct by applying positive going waveforms to its base. Q18, a pnp type, and Q19, an npn type, act in a complementary fashion. When Q17 is in cutoff Q18 is also cut off and Q19 is conducting maintaining the output seen at OUT output connector J5 at ground potential. When Q17 conducts it causes Q18 to conduct and Q19 to be cut off allowing the output to rise to a positive level somewhat less than +32 volts.

3-15. EXT INPUT AMPLIFIER Q6, Q7. The external input applied to the ext input amplifier is applied to the EXT INPUT connector J1. The input signal is coupled through the network of R22 and C12 and applied to the gate of Q6. The signal appearing at the gate of Q6 may be positive or negative and is held to a potential of approximately 2.4 volts due to the clamping action of diodes CR5 through C12. The drain of Q6 is coupled to paraphase amplifier Q7 which will provide two signals of opposing phase to the front panel SELECTOR switch S3.

3-16. SAWTOOTH AMPLIFIER Q4, Q5. The input to the sawtooth amplifier is a positive going sawtooth waveform developed across the capacitors in the emitter circuit of the Rate Generator. Q4 is an emitter follower applying a positive going sawtooth waveform to Q5. The positive going waveform causes Q5 to conduct developing a negative going sawtooth which is applied across front panel FM DEV AMPLITUDE control R21. The wiper arm of R21 routes the output sawtooth waveform through the FUNCTION switch to the FM OUT connector J4. The emitter resistor of Q4 is a potentiometer and is adjusted to achieve a proper base level for the output sawtooth. This adjustment is described in paragraph 4-14.

3-17. POWER SUPPLY. The power supply develops two regulated dc voltages; +32 volts and +5.2 volts. The input power is routed through cable W1, power switch S6, fuse F1, voltage selector switch S5 to transformer T1. T1 steps the input voltage down to the required level which is then full-wave rectified by bridge B1. The output of B1 is applied to the collector of Q20, the +32 volt output transistor. The base of Q20 is held at +33 volts by zener diode CR2.

The +32 volt output appears at the emitter of Q20 and is distributed throughout the modulator circuitry. The +32 volt output is also applied to the collector of Q21, the +5.2 volt output transistor. The base of Q21 is held at +6 volts by zener diode CR3. The +5.2 volt output appears at the emitter of Q21 and is used primarily in the pulse generator circuitry which utilizes integrated circuits.

SECTION IV

MAINTENANCE

4-1. GENERAL.

4-2. This section contains maintenance and alignment procedures for the Model 1020A Modulator. Included are a list of test equipment required, minimum performance standards that are used to ascertain equipment capability, and troubleshooting procedures.

4-3. TEST EQUIPMENT REQUIRED.

4-4. The test equipment required for maintenance and adjustment of the Model 1020A is listed in Table 4-1.

4-5. MINIMUM PERFORMANCE STANDARDS.

4-6. The purpose of the minimum performance standards listed in Table 4-2 is to determine if the Model 1020A is operating in compliance with the specifications listed in Section I.

4-7. TROUBLESHOOTING.

4-8. Should the Model 1020A fail to meet any of the minimum performance standards given in Table 4-2, the trouble may be determined and corrected through the use of Table 4-2 by following the instructions given in the "If Indication is Abnormal" column. The Model 1020A Block Diagram and Schematic, figures 3-1 and 5-1 respectively, should be referred to when troubleshooting.

4-9. DISASSEMBLY AND REASSEMBLY INSTRUCTIONS. (See Figures 4-2 and 4-3.)

4-10. The top which forms the dust cover for the Model 1020A, is removed by unscrewing the two screws which hold the top cover in place, thereby making adjustments and components accessible.

4-11. ADJUSTMENT PROCEDURES.

4-12. Adjustment procedures for the Model 1020A are given in paragraphs 4-13 and 4-14.

4-13. SETTING HIGH REPETITION RATE ADJ. CONTROL R6. To adjust the repetition rate of the rate generator at the high repetition rate, proceed as follows:

a. Set the FUNCTION switch to its EXT ⎍ /INT ⎓ position.

b. Set the SELECTOR switch to INT.

c. Set the RATE control fully clockwise.

d. Set the RATE X1-X10-X100 multiplier switch to X100.

e. Connect the Model 7370R electronic counter to the ⎍.⎓ OUT connector.

f. Note the indication of the electronic counter. It should indicate a repetition rate of 10,000 pps. If it does not, proceed to step g.

g. Adjust R6 to obtain an electronic counter indication of 10,000 pps.

4-14. SETTING THE FM SAWTOOTH BASELINE CONTROL, R17. To adjust the FM sawtooth baseline, proceed as follows:

a. Set the Function switch to its FM position.

b. Set the SELECTOR switch fully clockwise.

c. Set the RATE control to 100.

d. Set the RATE X1-X10-X100 multiplier switch to X100.

e. Connect the Model 545A Oscilloscope to the FM OUT connector.

f. Turn the FM DEV AMPLITUDE control fully clockwise. Note the display on the oscilloscope. The sawtooth wave form displayed should be as shown in figure 4-1A with no flat portions. If it does not, but looks like figure 4-1B, proceed to step g.

g. Adjust R17 to obtain the waveform shown in figure 4-1A.

4-15. PREVENTIVE MAINTENANCE.

4-16. PERIODIC INSPECTION. Table 4-3 contains the criteria for a visual inspection. A regular schedule for this inspection should be adhered to so that minor faults can be caught and corrected before more serious damage results.

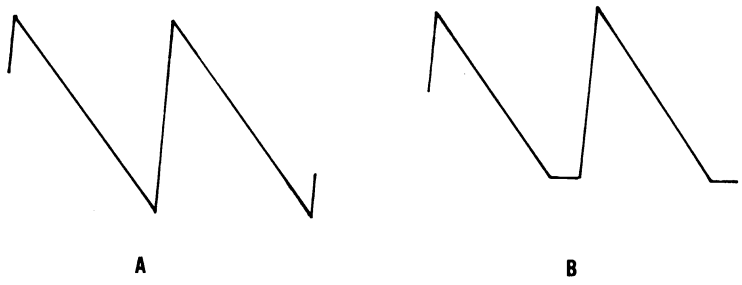


Figure 4-1. FM Sawtooth Baseline Waveforms

TABLE 4-1. TEST EQUIPMENT REQUIRED OR EQUIVALENT

Name	Manufacturer and Model No.	Use
Multimeter	Triplett 630	Checking voltages and resistances
Oscilloscope	Tektronix 545A	Checking waveshapes
Multipulse Generator	Polarad MP-1A	Checking external sync
Frequency Counter	Berkeley 7370R	Adjusting rate generator
Variac	General Radio W5MT3A	Adjusting line voltage
Plug-in	Tektronix Type CA	Checking waveshapes

NOTE

If a potentiometer is replaced on the printed-circuit board, rotate its arm to the center of its range before applying power to the equipment.

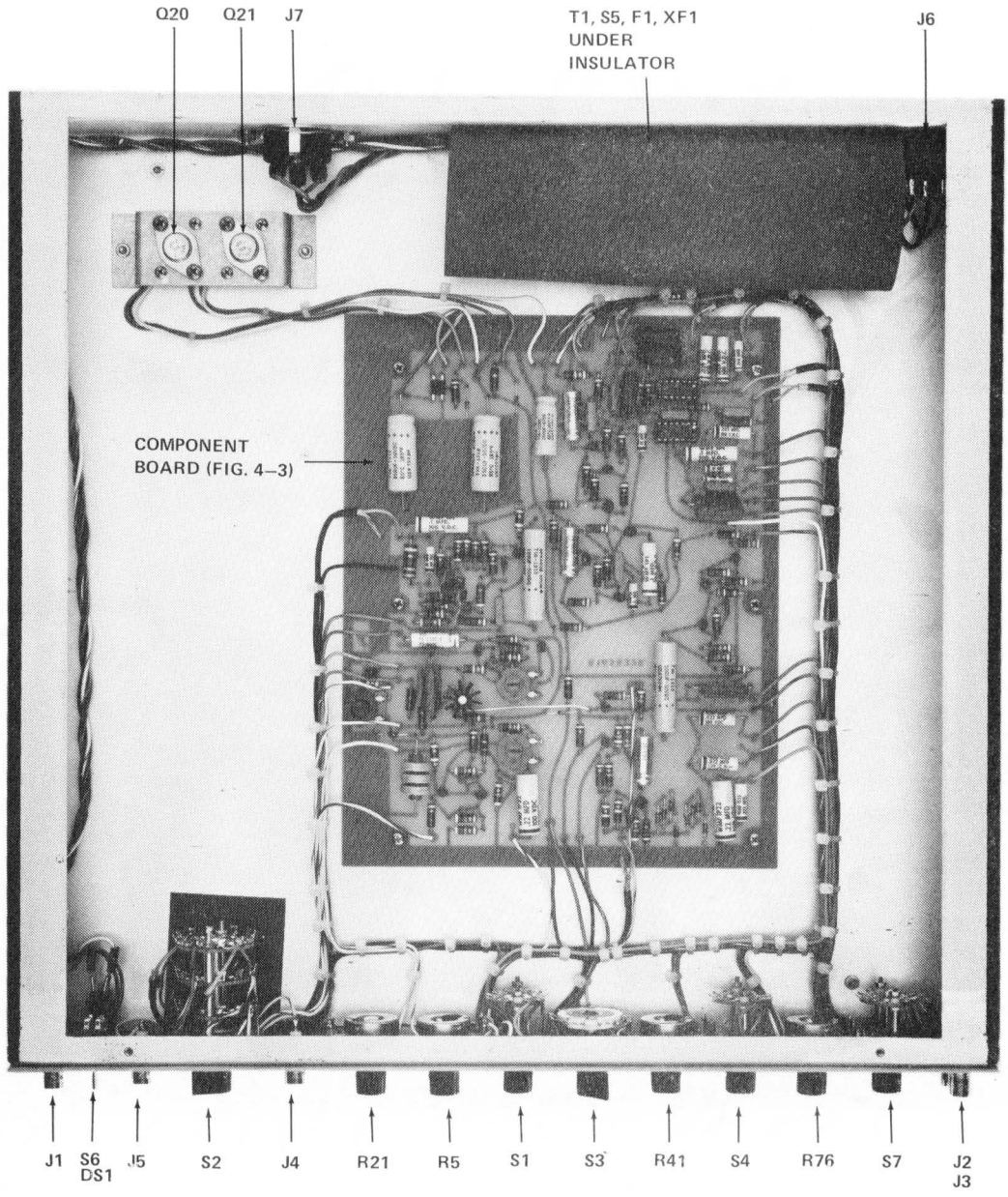


Figure 4-2. Top View of Chassis, Model 1020A Modulator

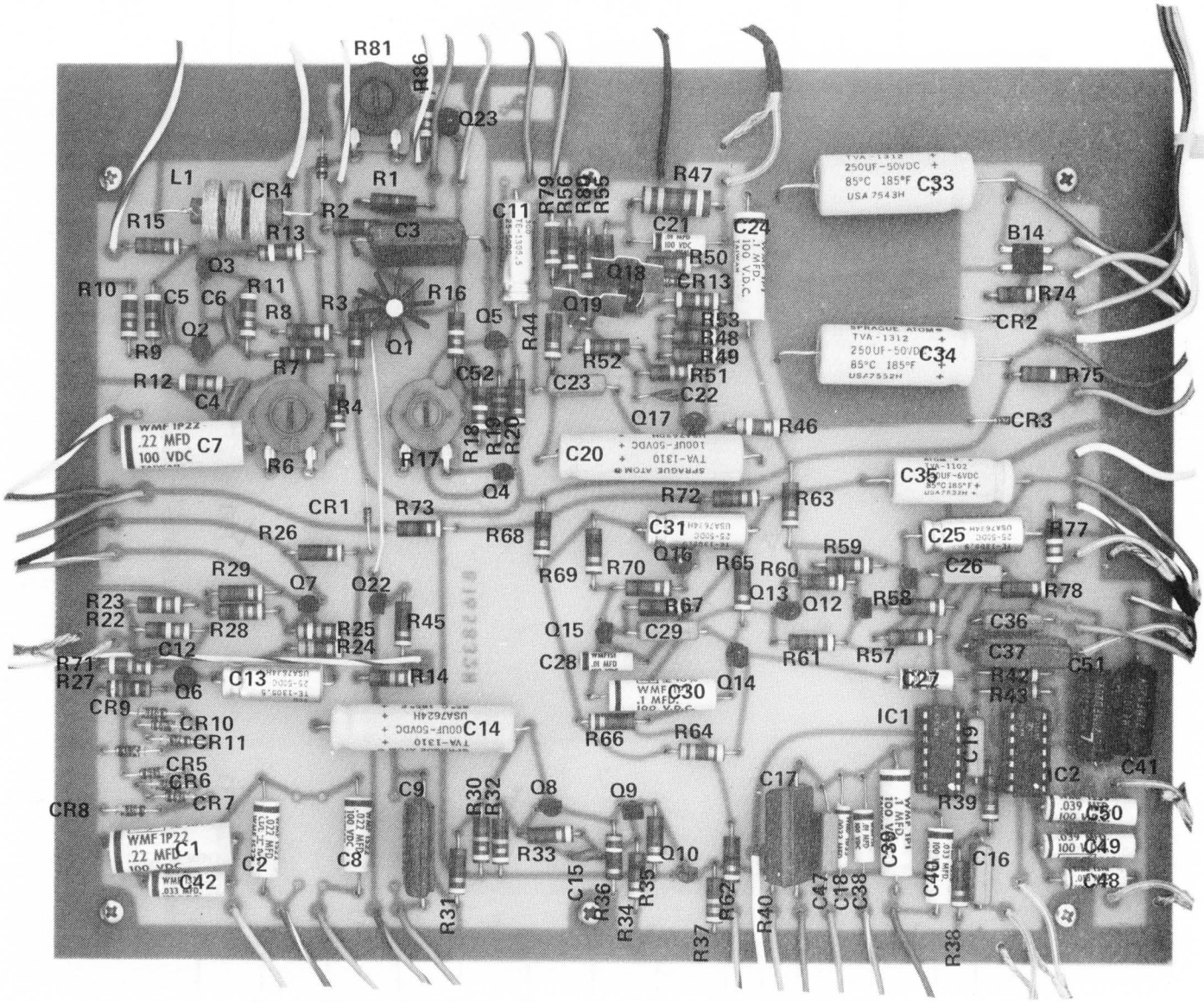


Figure 4-3. Printed Circuit Board Component Layout

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS

Step	Purpose	Procedure	Normal Indication	If Indication is Abnormal
1	To evaluate operating power conditions.	Connect power cable (and adaptor, if necessary) to power source outlet. Set power switch to ON.	Power indicator lights.	Check DS1, 115/230 voltage selector switch, F1, power switch and power cable W1.
2	To evaluate FM operation.	Couple FM OUT connector on the Model 1020A front panel to the vertical input terminals of the Model 545A oscilloscope and proceed as follows: a. Set the FUNCTION switch to FM. b. Set SELECTOR switch to INT. c. Rotate FM OUTPUT control fully clockwise. d. Set RATE control and multiplier switch as follows and note repetition rates on the oscilloscope screen: RATE Control / Multiplier Switch 10 / X1 100 / X100	A sawtooth waveshape appears on the oscilloscope screen. Repetition rate is adjustable from 10 to 10,000 sweeps/sec. 10 sweeps/sec 10,000 sweeps/sec	No Output a. Check power supply for +32v ±5%. b. Check FUNCTION switch S2, wafer D. c. Check FM AMPLITUDE control R21. d. Check Sawtooth Amplifier, Q4, Q5. e. Check Rate Generator Q1. Incorrect Repetition Rate a. Check power supply for +32v ±5%. b. Check FUNCTION switch S2, wafers A and C. c. Check RATE control R5 and multiplier switch S1. d. Check high repetition rate adjustment R6 as per the procedure given in paragraph 4-13.
3	To evaluate internal square wave operation.	Couple ⎍⎍ OUT connector to the vertical input terminals of the oscilloscope and proceed as follows: a. Set the FUNCTION switch to EXT ⎍/INT ⎍ b. Set SELECTOR switch to INT. c. Set RATE control and multiplier switch as follows and note display on the oscilloscope screen: RATE Control / Multiplier Switch 10 / X1 100 / X100	Square wave frequency is variable from 10 to 10,000 Hz. 10 sweeps/sec 10,000 sweeps/sec	No Output a. Check power supply for +32v ±5%. b. Check FUNCTION switch, wafer E. c. Check ⎍⎍ Output Amplifier Q17, Q18, Q19. d. Check FUNCTION switch S2, wafer F. e. Check Schmitt Trigger Q8, Q9, Q10. f. Check SELECTOR switch S3. g. Check FUNCTION switch S2, wafer A.

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS (Cont'd)

Step	Purpose	Procedure	Normal Indication	If Indication is Abnormal
3 Cont				h. Check ÷ 2 Flip/Flop Q2, Q3. i. Check Rate Generator Q1. Incorrect Repetition Rate a. Check power supply for +32v ±5%. b. Check RATE control R5 and multiplier switch S1. c. Check high repetition rate adjustment R6 as per the procedure given in paragraph 4-13. d. Check ÷ 2 Flip/Flop Q2, Q3.
4	To evaluate internal pulse operation.	Couple ⊓ ⊔ OUT connector to the vertical input terminals of the oscilloscope and proceed as follows: a. Set the FUNCTION switch to INT. b. Set SELECTOR switch to INT. c. Rotate DELAY uSEC control fully counterclockwise and the multiplier switch to X1. d. Adjust PULSE WIDTH control, RATE control and multiplier switch as follows and note displays on the oscilloscope screen: PULSE WIDTH Control / RATE Control / RATE Multiplier Switch 0.2 / 10 / X1 0.2 / 100 / X100 200 / 10 / X1	Pulse width variable from .2 to 2000 microseconds. Pulse repetition rate variable from 10 to 10,000 pps. 0.2 uS 10 pps 0.2 uS 10,000 pps 2000 uS 10pps	No Output a. Check power supply for +5.2 volts and +32 volts ±5%. b. Check FUNCTION switch S2, wafer E. c. Check ⊓ ⊔ Output Amplifier Q17, Q18, Q19. d. Check FUNCTION switch S2, wafer F. e. Check IC2. f. Check IC1. g. Check Schmitt Trigger Q8, Q9, Q10. h. Check SELECTOR switch S3. i. Check ÷ 2 Flip/Flop Q2, Q3. j. Check Rate Generator Q1.

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS (Cont'd)

Step	Purpose	Procedure	Normal Indication	If Indication is Abnormal
4 Cont				Incorrect Repetition Rate a. Check power supply for +32v ±5%. b. Check Rate control R5 and multiplier switch S1. c. Check high repetition rate adjustment R6 as per the procedure given in paragraph 4-13. d. Check ÷ 2 Flip/Flop. Incorrect Pulse Width a. Check power supply for +5.2 volts ±5%. b. Check PULSE WIDTH control R76. c. Check IC2.
5	To evaluate external input signal operation. (External synchronization).	Connect EXT INPUT connector to the Multipulse Generator Model MP-1A and ⎍⎣⎤ OUT connector to the vertical input terminals of the oscilloscope. Proceed as follows and note the displays on the oscilloscope screen: a. Set the FUNCTION switch to INT b. Set SELECTOR switch to EXT (+). c. Adjust PULSE WIDTH control and the Multipulse Generator Repetition Rate control as follows and note the displays on the oscilloscope screen: PULSE WIDTH Control — Rate Generator Repetition Rate Control	Pulse width of externally synchronized output pulse is adjustable from 0.2 to 2000 microseconds. Repetition rate is determined by that of the external pulse generator. NOTE Do not exceed duty cycle. Refer to figure 2-4.	No Output a. Check power supply for +5.2 volts ±5% and +32 volts ±5%. b. Check FUNCTION switch S2, wafer E. c. Check ⎍⎣⎤ Output Amplifier Q17, Q18, Q19. d. Check FUNCTION switch S2, wafer F. e. Check IC2. f. Check IC1. g. Check Schmitt Trigger Q8, Q9, Q10. h. Check SELECTOR switch S3.

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS (Cont'd)

Step	Purpose	Procedure	Normal Indication	If Indication is Abnormal
5 Cont				Incorrect Pulse Width a. Check power supply for +5.2 volts ±5%. b. Check PULSE WIDTH control R76. c. Check IC2.
6	To evaluate characteristics of undelayed sync output pulse.	Couple UNDELAYED SYNC OUT connector to the vertical input terminals of the oscilloscope. Program the Model 1020A for internal pulse operation. (Refer to paragraph 2-12.) Note oscilloscope displays for the following settings of RATE control and multiplier switch: RATE Control — Multiplier Switch 10 — X1 100 — X100	Pulse obtained is +25 volts peak (minimum) and has a rise time of 0.1 to 1.0 microsecond. Pulse repetition rate is variable from 10 to 10,000 pps. 10 pps 10,000 pps	No Output a. Check power supply for +5.2 volts ±5% and +32volts ±5%. b. Check Undelayed Sync Amp Q14, Q15, Q16. c. Check IC1. d. Check Schmitt Trigger Q8, Q9, Q10. e. Check SELECTOR switch S3. f. Check ÷2 Flip/Flop Q2, Q3. g. Check FUNCTION switch S2, wafer A. h. Check Rate Generator Q1. Incorrect Repetition Rate a. Check power supply for +32v ±5%. b. Check Rate control R5 and multiplier switch S1. c. Check high repetition rate adjustment R6 as per the procedure given in paragraph 4-13. d. Check ÷2 Flip/Flop.

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS (Cont'd)

Step	Purpose	Procedure	Normal Indication	If Indication is Abnormal
4 Cont				Incorrect Repetition Rate a. Check power supply for +32v ±5%. b. Check Rate control R5 and multiplier switch S1. c. Check high repetition rate adjustment R6 as per the procedure given in paragraph 4-13. d. Check ÷ 2 Flip/Flop. Incorrect Pulse Width a. Check power supply for +5.2 volts ±5%. b. Check PULSE WIDTH control R76. c. Check IC2.
5	To evaluate external input signal operation. (External synchronization).	Connect EXT INPUT connector to the Multipulse Generator Model MP-1A and ⎍⎓ OUT connector to the vertical input terminals of the oscilloscope. Proceed as follows and note the displays on the oscilloscope screen: a. Set the FUNCTION switch to INT b. Set SELECTOR switch to EXT (+). c. Adjust PULSE WIDTH control and the Multipulse Generator Repetition Rate control as follows and note the displays on the oscilloscope screen: PULSE WIDTH Control / Rate Generator Repetition Rate Control 0.2 / 10 10 / 10 0.2 / 100 10 / 100	Pulse width of externally synchronized output pulse is adjustable from 0.2 to 2000 microseconds. Repetition rate is determined by that of the external pulse generator. NOTE Do not exceed duty cycle. Refer to figure 2-4. 0.2 uS 10 pps 10 uS 10 pps 0.2 uS 100 pps 10 uS 100 pps	No Output a. Check power supply for +5.2 volts ±5% and +32 volts ±5%. b. Check FUNCTION switch S2, wafer E. c. Check ⎍⎓ Output Amplifier Q17, Q18, Q19. d. Check FUNCTION switch S2, wafer F. e. Check IC2. f. Check IC1. g. Check Schmitt Trigger Q8, Q9, Q10. h. Check SELECTOR switch S3. i. Check EXT Input Amplifier Q6, Q7.

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS (Cont'd)

Step	Purpose	Procedure	Normal Indication	If Indication is Abnormal
5 Cont				Incorrect Pulse Width a. Check power supply for +5.2 volts ±5%. b. Check PULSE WIDTH control R76. c. Check IC2.
6	To evaluate characteristics of undelayed sync output pulse.	Couple UNDELAYED SYNC OUT connector to the vertical input terminals of the oscilloscope. Program the Model 1020A for internal pulse operation. (Refer to paragraph 2-12.) Note oscilloscope displays for the following settings of RATE control and multiplier switch: RATE Control / Multiplier Switch 10 / X1 100 / X100	Pulse obtained is +25 volts peak (minimum) and has a rise time of 0.1 to 1.0 microsecond. Pulse repetition rate is variable from 10 to 10,000 pps. 10 pps 10,000 pps	No Output a. Check power supply for +5.2 volts ±5% and +32volts ±5%. b. Check Undelayed Sync Amp Q14, Q15, Q16. c. Check IC1. d. Check Schmitt Trigger Q8, Q9, Q10. e. Check SELECTOR switch S3. f. Check ÷2 Flip/Flop Q2, Q3. g. Check FUNCTION switch S2, wafer A. h. Check Rate Generator Q1. Incorrect Repetition Rate a. Check power supply for +32v ±5%. b. Check Rate control R5 and multiplier switch S1. c. Check high repetition rate adjustment R6 as per the procedure given in paragraph 4-13. d. Check ÷2 Flip/Flop.

TABLE 4-2. MINIMUM PERFORMANCE STANDARDS (Cont'd)

Step	Purpose	Procedure	Normal Indication	If Indication is Abnormal
7	To evaluate characteristics of delayed sync output pulse.	Connect DELAYED SYNC OUT connector to the vertical input terminals of the oscilloscope and UNDELAYED SYNC OUT connector to the external trigger terminals of the oscilloscope. Program the Model 1020A for internal pulse operation. (Refer to paragraph 2-12.) Set RATE control to 100 and multiplier switch to X1 and note oscilloscope displays for the following settings of DELAY uSEC control and amplifier switch: DELAY uSEC Control — Multiplier Switch 2 — LOW 20 — X100	Pulse obtained is +25 volts peak (minimum) and has a rise time of 0.1 to 1.0 microseconds. Delay variable from .3 to 2000 microseconds. 0.3 microseconds maximum 2000 microseconds minimum	No Output a. Check power supply for +5.2 volts ±5% and +32 volts ±5%. b. Check Delayed Sync Amp Q11, Q12, Q13. c. Check IC2. d. Check IC1. e. Check Schmitt Trigger Q8, Q9, Q10. f. Check SELECTOR switch S3. g. Check FUNCTION switch S2, wafer A. h. Check ÷2 Flip/Flop Q2, Q3. i. Check Rate Generator Q1. Incorrect Delay a. Check power supply for +5.2 volts ±5%. b. Check DELAY uSEC control R41 and multiplier switch S4. c. Check IC1.
8	To evaluate external pulse operation. For pulse modulation programmed from an external pulse source.	Connect EXT INPUT connector to the Multipulse Generator Model MP-1A and ⎍ ⊓ OUT connector to the vertical input terminals of the oscilloscope. Proceed as follows and note the display on the oscilloscope screen: a. Set the FUNCTION switch to EXT ⎍ /INT ⊓ b. Set SELECTOR switch to EXT (+) or EXT (-).	Pulse width and repetition rate is determined by the external pulse source within the following: Pulse Width: 0.5 to 2500 uS Rep Rate: Single pulse to 1 MHz. NOTE Do not exceed duty cycle. Refer to figure 2-4.	Follow procedure given for step 5, omitting procedural steps e. and f.

TABLE 4-3. PERIODIC INSPECTION

Item	Inspect For	Inspection Interval
Case and panel	Dirt or corrosion; dents, cracks, scratches, or other physical damage; loose or missing hardware.	Monthly
Switches and potentiometers	Loose or missing knobs; defective switch action; loose mounting; bent, broken or loose terminals; proper detent or snap action; smooth potentiometer rotation from stop to stop; cracked, damaged.	Weekly
Connectors	Bent, broken, or corroded pins; damaged threads; cracked shell; loose or missing hardware.	Monthly
Panel lamps	Cracked or broken lens; missing or defective lamps; loose or missing hardware; bent, broken, or corroded terminals.	Weekly
Wiring	Frayed, broken, or abraded insulation; loose connections; broken wires.	Monthly
Electrical parts	Loose connections or mounting; evidence of overheating such as being cracked, broken, blistered or charred.	Monthly
Cables	Frayed, broken, kinked, or abraded insulation; loose or missing clamps; broken wires; damaged connectors.	Weekly
Fuses	Cracked, damaged, or corroded fuse holders and fuses; correct current rating of fuses; fuse holders securely mounted.	Monthly

SECTION V

SCHEMATIC DIAGRAMS

5-1. GENERAL.

5-2. This section contains the schematic diagram for the Model 1020A.

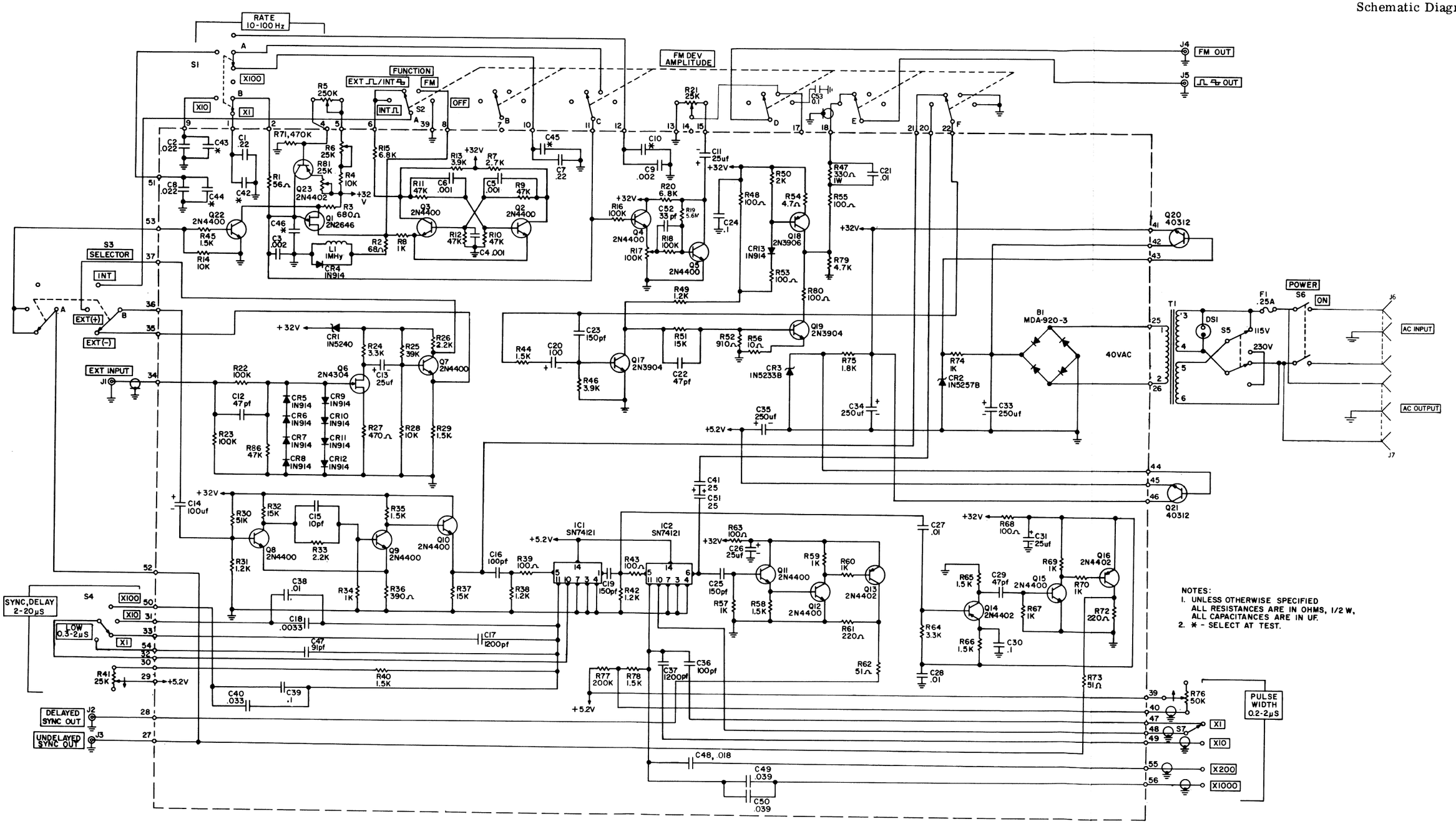


Figure 5-1. Model 1020A Modulator, Schematic Diagram

SECTION VI

PARTS LIST

6-1. INTRODUCTION.

6-2. This parts list provides an alpha-numerical listing, in reference symbol sequence of the replaceable electrical, certain electro-mechanical, and mechanical parts of the equipment.

6-3. ORDERING INFORMATION. Orders for parts should contain the following information:

a. Equipment name and model.

b. Serial number.

c. Reference symbol of part.

d. Manufacturer's part number and MSC.

6-4. HOW TO USE THE PARTS LIST

6-5. An explanation of the structure of the parts list, Table 6-2, and the meaning of the entries in the five columns are given in the following paragraphs. (See Figure 6-1.)

SECTION VI
PARTS LIST

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S MSC	UNITS PER ASSY
C101	CAPACITOR, CERAMIC, 2000UUF, 10 PCT, 500WVDC /POLARAD PART NO. B704888	BCD-D1-4	00656	1
C102	NOT USED			
C103 AND C104	SAME AS C101			
S101 THRU S104	SWITCH, ROTARY, 4 SECT, 8 WAFERS, 6 POSITIONS	C23346	82199	1
TB101	TERMINAL BOARD, COMPONENT ASSY	C115625	82199	1
W108	CABLE ASSY, RF	C147158	82199	1
XF101 AND XF102	FUSEHOLDER	HKP-HW	71400	1

Figure 6-1. Parts List Example

6-6. REFERENCE SYMBOL COLUMN. The reference symbol column (1, Figure 6-1) contains the reference symbol assigned to each part, which also identifies the part on the schematic diagram or in an illustration. The listing is in alpha-numerical order.

6-7. DESCRIPTION COLUMN. The description column (2) contains the description for each part. When the same part is used more than once in the equipment, the second and subsequent listings for that part use the phrase "SAME AS " (4) in the description column and the remaining columns (5, 6, and 7) are left blank. When a reference symbol designation has not been used or its assignment has been cancelled, the description column contains the phrase "NOT USED" (3).

6-8. MANUFACTURER'S PART NUMBER COLUMN. The manufacturer's part number column (5) contains the part number assigned by the manufacturer of the part, except for "SAME AS" and "NOT USED" listings.

6-9. MANUFACTURER'S SUPPLY CODE (MSC) COLUMN. The manufacturer's supply code column (6) contains a 5 digit number code identifying the manufacturer of the part. Table 6-1 contains a listing of the codes and the manufacturer's names and addresses.

6-10. UNITS PER ASSEMBLY COLUMN. The units per assembly column indicates the quantity of each part contained in the respective assembly or subassembly listed as shown in (7).

TABLE 6-1. LIST OF MANUFACTURERS

MFR CODE	NAME AND ADDRESS
00853	Sangamo Electric Co. S. Carolina Div. Pickens, S.C.
01295	Texas Instruments Inc. Semiconductor Div. Dallas, Texas 75231
02929	Newark Electronics Corp. 500 N. Pulaski Road Chicago, Ill. 60624
04713	Motorola Semiconductor Products, Inc. 5005 East McDowell Road Phoenix, Arizona 85008
09214	General Electric Co. Semi-Conductor Products Dept. West Genesee Street Auburn, N.Y. 31022
11237	CTS Electronics Inc. 1010 Sycamore Ave. So. Pasadena Calif. 91030
14655	Cornell-Dubilier Electronics Division Federal Pacific Electric Co. 50 Parts St. Newark, N.J. 07105
56289	Sprague Electric Co. Marshall St. North Adams, Mass. 01247
71590	Globe-Union, Ind., Centralab Division P.O. Box 591 Milwaukee, Wis. 53201

MFR CODE	NAME AND ADDRESS
75042	TRW, Inc., IRC Division 401 North Broad St. Philadelphia, Pa. 19108
75915	Littlefuse, Inc. 800 E. Northwest Hwy. Des Plaines, Ill. 60016
81349	Military Specification promulgated by Standardization Div., Directorate of Logistics Services DSA
82389	Switchcraft, Inc. 555 N. Elston Ave. Chicago, Ill.
82199	Polarad Electronics Corporation 5 Delaware Drive Lake Success, New York 11040
91737	ITT Gremar Inc. 10 Micro Drive Woburn, Mass. 01801
93332	Sylvania Electric Products Inc. Semiconductor Products Division 100 Sylvan Rd. Woburn, Mass. 01801
95146	ALCO Electronic Products Inc. P.O. Box 1348 Lawrence, Mass. 01843
99999	Electronic Hardware Inc. 180-08 Liberty Ave. Jamaica, N.Y.

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR CODE	UNITS PER ASSY
B1	BRIDGE, RECTIFIER	MDA920-3	04713	1
CR1	SEMICONDUCTOR DEVICE, DIODE, ZENER	1N5240	04713	1
CR2	SEMICONDUCTOR DEVICE, DIODE, ZENER	1N5257B	04713	1
CR3	SEMICONDUCTOR DEVICE, DIODE, ZENER	1N5233B	04713	1
CR4	SEMICONDUCTOR DEVICE, DIODE	1N914	93332	10
CR5	SAME AS CR4			
CR6	SAME AS CR4			
CR7	SAME AS CR4			
CR8	SAME AS CR4			
CR9	SAME AS CR4			
CR10	SAME AS CR4			
CR11	SAME AS CR4			
CR12	SAME AS CR4			
CR13	SAME AS CR4			
C1	CAPACITOR, FIXED, 0.22 UF, ±10%, 100 VDCW	WMF1P22	14655	2
C2	CAPACITOR, FIXED, MYLAR, 0.022 UF, 100 VDCW	WMF1S22	14655	2
C3	CAPACITOR, FIXED, MICA, 0.002 UF, ±5%, 200 VDCW	CD19FD202J03	00853	2
C4	CAPACITOR, FIXED, CERAMIC, 0.001 UF, ±10%, 600 VDCW	DD102	71590	3
C5	SAME AS C4			
C6	SAME AS C4			
C7	SAME AS C1			
C8	SAME AS C2			
C9	SAME AS C3			
C10	SELECT AT TEST			
C11	CAPACITOR, FIXED, ELECTROLYTIC, 25 UF, 50 VDCW	TE13055	56289	4
C12	CAPACITOR, FIXED, CERAMIC, 47 PF, ±10%, 600 VDCW	DD470	71590	2
C13	SAME AS C11			
C14	CAPACITOR, FIXED, ELECTROLYTIC, 100 UF, 50 VDCW	TVA1310	56289	2
C15	CAPACITOR, FIXED, CERAMIC, 10 PF, ±10%, 600 VDCW	DD100	71590	1
C16	CAPACITOR, FIXED, MICA, 100 PF, ±5% 300 VDCW	CM15E101J	81349	2
C17	CAPACITOR, FIXED, MICA, 1200 PF, ±5%, 200 VDCW	CD19FD122J03	81349	2
C18	CAPACITOR, FIXED, MYLAR, 0.0033 UF, ±10%, 100 VDCW	WMF1D33	14655	1
C19	CAPACITOR, FIXED, MICA, 150 PF, ±5%, 300 VDCW	CM15E151J	81349	3
C20	SAME AS C14			

TABLE 6-2. PARTS LIST (Continued)

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR CODE	UNITS PER ASSY
C21	CAPACITOR, FIXED, MYLAR, 0.01 UF, ±10%, 100 VDCW	WMF1S1	14655	4
C22	SAME AS C12			
C23	SAME AS C19			
C24	CAPACITOR, FIXED, 0.1 UF, ±10%, 100 VDCW	WMF1P1	14655	3
C25	SAME AS C19			
C26	SAME AS C11			
C27	SAME AS C21			
C28	SAME AS C21			
C29	CAPACITOR, FIXED, MICA, 47 PF, ±5%, 300 VDCW	CM15E470J	81349	1
C30	SAME AS C24			
C31	SAME AS C11			
C32	NOT USED			
C33	CAPACITOR, FIXED, ELECTROLYTIC, 250 UF, 50 VDCW	TVA1312	56289	2
C34	SAME AS C33			
C35	CAPACITOR, FIXED, ELECTROLYTIC, 250 UF, 6 VDCW	TVA1102	56289	1
C36	SAME AS C16			
C37	SAME AS C17			
C38	SAME AS C21			
C39	SAME AS C24			
C40	CAPACITOR, FIXED, MYLAR, 0.033 UF, ±10%, 100 VDCW	WMF1S33	14655	1
C41	CAPACITOR, FIXED, ELECTROLYTIC, 25 UF, ±10%, 25 VDCW	500D256G025687	56289	2
C42	SELECT AT TEST			
C43	SELECT AT TEST			
C44	SELECT AT TEST			
C45	SELECT AT TEST			
C46	SELECT AT TEST			
C47	CAPACITOR, FIXED, MICA, 91 PF, ±5%, 300 VDCW	CM15E910J	81349	1
C48	CAPACITOR, FIXED, MYLAR, 0.018 UF, ±10%, 100 VDCW	WMF1S18	14655	1
C49	CAPACITOR, FIXED, MICA, 0.039 UF, ±10%, 100 VDCW	192P3932	56289	2
C50	SAME AS C49			
C51	SAME AS C41			
C52	CAPACITOR, FIXED, CERAMIC, 33 PF, ±10%, 300 VDCW	DD330	71590	1
C53	CAPACITOR, FIXED, 0.1 UF, 600 VDCW	DDG-103	71590	1
DS1	INDICATOR, LIGHT, NEON, 115-125 V, RED	A710147	82199	1

TABLE 6-2. PARTS LIST (Continued

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR CODE	UNITS PER ASSY
F1	FUSE, CARTRIDGE, 1/4 AMP	312-.250	75915	1
1C1	INTEGRATED CIRCUIT	SN74121	01295	2
1C2	SAME AS 1C1			
J1	CONNECTOR, RECEPTACLE, ELECTRICAL, TYPE BNC	UG625B/U	91737	5
J2 thru J5	SAME AS J1			
J6	CONNECTOR, RECEPTACLE	EAC-201	82389	1
J7	CONNECTOR, RECEPTACLE	709781	82199	1
L1	CHOKE, 1 MHY, P1 WOUND	713765	82199	1
MP1 thru MP4	KNOB, ROUND	713395	82199	4
MP5 and MP6	KNOB, POINTER	713410	82199	2
MP7 thru MP9	KNOB, ROUND	7EC1B2	99999	3
Q1	TRANSISTOR	2N2646	09214	1
Q2	TRANSISTOR	2N4400	04713	12
Q3 thru Q5	SAME AS Q2			
Q6	TRANSISTOR	2N4304	04713	1
Q7 thru Q12	SAME AS Q2			
Q13	TRANSISTOR	2N4402	04713	4
Q14	SAME AS Q13			
Q15	SAME AS Q2			
Q16	SAME AS Q13			
Q17	TRANSISTOR	2N3904	04713	2
Q18	TRANSISTOR	2N3906	04713	1
Q19	SAME AS Q17			
Q20	TRANSISTOR	40312	04713	2
Q21	SAME AS Q20			
Q22	SAME AS Q2			
Q23	SAME AS Q13			
R1	RESISTOR, FIXED, COMPOSITION, 56 OHMS, ±5%, 1/2W	RC20GF560J	81349	1
R2	RESISTOR, FIXED, COMPOSITION, 68 OHMS, ±5%, 1/2W	RC20GF680J	81349	1
R3	RESISTOR, FIXED, COMPOSITION, 680 OHMS, ±5%, 1/2W	RC20GF681J	81349	1

TABLE 6-2. PARTS LIST (Continued)

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR CODE	UNITS PER ASSY
R4	RESISTOR, FIXED, COMPOSITION, 10K, ±5%, 1/2W	RC20GF103J	81349	3
R5	RESISTOR, VARIABLE, 250K, ±10%, 1/2W	PQ11-130	75042	1
R6	RESISTOR, VARIABLE, 25K, ±10%, 1/4W	U201R253B	11237	2
R7	RESISTOR, FIXED, COMPOSITION, 2.7K, ±5%, 1/2W	RC20GF272J	81349	1
R8	RESISTOR, FIXED, COMPOSITION, 1K, ±5%, 1/2W	RC20GF102J	81349	9
R9	RESISTOR, FIXED, COMPOSITION, 47K, ±5%, 1/2W	RC20GF473J	81349	5
R10	SAME AS R9			
R11	SAME AS R9			
R12	SAME AS R9			
R13	RESISTOR, FIXED, COMPOSITION, 3.9K, ±5%, 1/2W	RC20GF392J	81349	2
R14	SAME AS R4			
R15	RESISTOR, FIXED, COMPOSITION, 6.8K, ±5%, 1/2W	RC20GF682J	81349	2
R16	RESISTOR, FIXED, COMPOSITION, 100K, ±5%, 1/2W	RC20GF104J	81349	4
R17	RESISTOR, VARIABLE, 100K, ±10%, 1/4W	U201R104B	11237	1
R18	SAME AS R16			
R19	RESISTOR, FIXED, COMPOSITION, 5.6 MEGO, ±5%, 1/2W	RC20GF565J	81349	1
R20	SAME AS R15			
R21	RESISTOR, VARIABLE, 25K, ±10%, 1/2W	PQ11-120	75042	2
R22	SAME AS R16			
R23	SAME AS R16			
R24	RESISTOR, FIXED, COMPOSITION, 3.3K, ±5%, 1/2W	RC20GF332J	81349	2
R25	RESISTOR, FIXED, COMPOSITION, 39K, ±5%, 1/2W	RC20GF393J	81349	1
R26	RESISTOR, FIXED, COMPOSITION, 2.2K, ±5%, 1/2W	RC20GF222J	81349	2
R27	RESISTOR, FIXED, COMPOSITION, 470 OHMS, ±5%, 1/2W	RC20GF471J	81349	1
R28	SAME AS R4			
R29	RESISTOR, FIXED, COMPOSITION, 1.5K, ±5%, 1/2W	RC20GF152J	81349	9
R30	RESISTOR, FIXED, COMPOSITION, 51K, ±5%, 1/2W	RC20GF513J	81349	1
R31	RESISTOR, FIXED, COMPOSITION, 1.2K, ±5%, 1/2W	RC20GF122J	81349	4
R32	RESISTOR, FIXED, COMPOSITION, 15K, ±5%, 1/2W	RC20GF153J	81349	3
R33	SAME AS R26			

TABLE 6-2. PARTS LIST (Continued)

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR CODE	UNITS PER ASSY
R34	SAME AS R8			
R35	SAME AS R29			
R36	RESISTOR, FIXED, COMPOSITION, 390 OHMS, ±5%, 1/2W	RC20GF391J	81349	1
R37	SAME AS R32			
R38	SAME AS R31			
R39	RESISTOR, FIXED, COMPOSITION, 100 OHMS, ±5%, 1/2W	RC20GF101J	81349	8
R40	SAME AS R29			
R41	SAME AS R21			
R42	SAME AS R31			
R43	SAME AS R39			
R44	SAME AS R29			
R45	SAME AS R29			
R46	SAME AS R13			
R47	RESISTOR, FIXED, COMPOSITION, 330 OHMS, ±5%, 1W	RC32GF331J	81349	1
R48	SAME AS R39			
R49	SAME AS R31			
R50	RESISTOR, FIXED, COMPOSITION, 2K, ±5%, 1/2W	RC20GF202J	81349	1
R51	SAME AS R32			
R52	RESISTOR, FIXED, COMPOSITION, 910 OHMS, ±5%, 1/2W	RC20GF911J	81349	1
R53	SAME AS R39			
R54	RESISTOR, FIXED, COMPOSITION, 4.7 OHMS, ±5%, 1/2W	RC20GF4R7J	81349	1
R55	SAME AS R39			
R56	RESISTOR, FIXED, COMPOSITION, 10 OHMS, ±5%, 1/2W	RC20GF100J	81349	1
R57	SAME AS R8			
R58	SAME AS R29			
R59	SAME AS R8			
R60	SAME AS R8			
R61	RESISTOR, FIXED, COMPOSITION, 220 OHMS, ±5%, 1/2W	RC20GF221J	81349	2
R62	RESISTOR, FIXED, COMPOSITION, 51 OHMS, ±5%, 1/2W	RC20GF510J	81349	2
R63	SAME AS R39			
R64	SAME AS R24			
R65	SAME AS R29			
R66	SAME AS R29			
R67	SAME AS R8			

TABLE 6-2. PARTS LIST (Continued)

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR CODE	UNITS PER ASSY
R68	SAME AS R39			
R69	SAME AS R8			
R70	SAME AS R8			
R71	RESISTOR, FIXED, COMPOSITION, 470K, ±5%, 1/2W	RC20GF474J	81349	1
R72	SAME AS R61			
R73	SAME AS R62			
R74	SAME AS R8			
R75	RESISTOR, FIXED, COMPOSITION, 1.8K, ±5%, 1/2W	RC20GF182J	81349	1
R76	RESISTOR, VARIABLE, 50K, ±10%, 1/2W	PQ11-123	75042	1
R77	RESISTOR, FIXED, COMPOSITION, 200K, ±5%, 1/2W	RC20GF204J	81349	1
R78	SAME AS R29			
R79	RESISTOR, FIXED, COMPOSITION, 4.7K, ±5%, 1/2W	RC20GF472J	81349	1
R80	SAME AS R39			
R81	SAME AS R6			
R86	SAME AS R9			
S1	SWITCH, ROTARY	MRA-2-5S	95146	3
S2	SWITCH, ROTARY, 6 POLE, 5 POSITIONS	PA1021	71590	1
S3	SWITCH, ROTARY, 2 POLE, 3 POSITIONS	13604-1	11237	1
S4	SAME AS S1			
S5	SWITCH, SLIDE, DPDT	A709936	82199	1
S6	SWITCH, TOGGLE	CK7201	09353	1
S7	SAME AS S1			
T1	TRANSFORMER, POWER	165928	82199	1
W1	CABLE, POWER	B160833	82199	1
XF1	FUSEHOLDER	005626	82199	1
XQ20	SOCKET, TRANSISTOR	58F328	02929	2
XQ21	SAME AS XQ20			

POLARAD ELECTRONICS INC.

5 Delaware Drive Lake Success, New York 11040 516-328-1100

REQUEST FOR MAINTENANCE

FROM:

COMPANY NAME _____ DATE: _____

ADDRESS: _____ INDIVIDUAL: _____

_____ POSITION: _____

_____ PHONE NO. _____ EXT. _____

_____

SECTION OR DIVISION: _____

EQUIPMENT: _____ DATE OF PURCHASE: _____

MODEL _____ SERIAL NO. _____ ORDER NO. _____

_____

TROUBLE REPORT:

A. Description of trouble _____

_____

_____

_____

_____

_____

B. Has trouble been localized? _____ If so, how and where: _____

_____

_____

_____

_____

_____

C. Instruments used and measurements taken, if any: _____

_____

_____

_____

_____

D. Is trouble intermittent? _____

E. Hours of operation prior to this trouble _____

F. Date troubled occurred _____

G. Was factory consulted by telephone or letter prior to this request? _____

If so, give date and person to whom directed: _____

_____

H. Additional comments: _____

_____

_____

_____

_____

_____

_____

_____

When trouble develops requiring factory assistance, complete this form and send to:

Polarad Electronics Inc.
5 Delaware Drive
Lake Success, New York 11040
Attn: Service Department

After this report has been analyzed by the Service Department, you will be notified when a field service engineer will call on you to make the necessary repairs. If your trouble can best be corrected at the factory, we will notify you with instructions and authorization for returning the equipment.

NO EQUIPMENT MAY BE RETURNED TO THE FACTORY WITHOUT WRITTEN AUTHORIZATION