TELEPHONICS
A Griffon Company
815 Broad Hollow Rd., Farmingdale, New York 11735 (631) 755-7625 Fax: (631) 755-7046

This word document contains figures representing the operational description for the Receiver Transmitter RT-1401B. These figures are scanned images from section I of the maintenance manual part number 006-05342-0002, Revision 2 dated June 1994. Additional operational information is contained in the operators manual and is included as a separate attachment. See file “Pilot’s Guide.DOC”. It should be noted that those pages “Intentionally Left Blank” were not scanned and are therefore not included here.

TELEPHONICS
A Griffon Company
815 Broad Hollow Rd., Farmingdale, New York 11735 (631) 755-7625 Fax: (631) 755-7046

BENDIX/KING

MAINTENANCE MANUAL
RT-1401B RECEIVER-TRANSMITTER

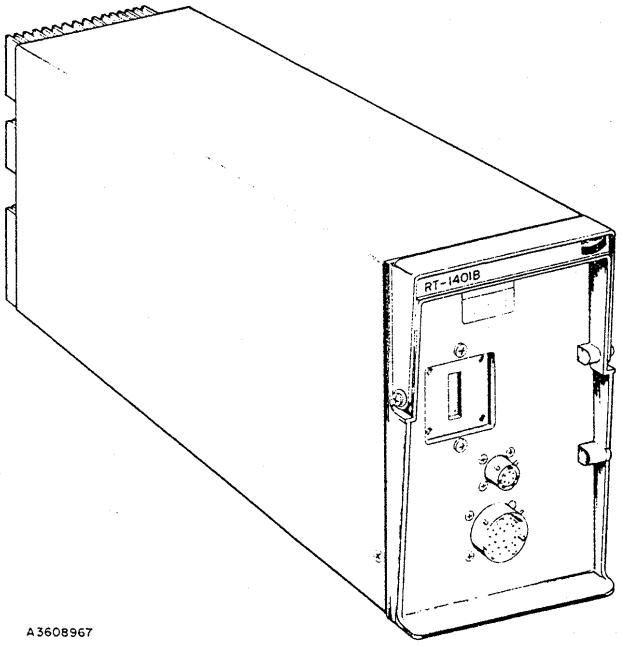
LIST OF TABLES

Table/Title		Page
1-1	RT-1401B Receiver-Transmitter Part Numbers	1-2
1-2	RT-1401B Subassemblies and Connectors	1-2
1-3	Mode Decoder U8008 Input-Output Relationship	1-32
1-4	U3517 Data Selector Configuration	1-37
1-5	Partial List of Address Counter Outputs (256 States)	1-39
1-6	Mode Select Addresses for EPROM	1-39
1-7	Last Four STC EPROM Addresses	1-40
2-1	Test Equipment	2-1
3-1	PNP Transistor Testing Procedure	3-11
3-2	NPN Transistor Testing Procedure	3-12
3-3	Transistors and Base Configurations	3-12.1
3-4	54/74 Series IC Alpha Character Significance	3-15
3-5	Summary of Possible IC Failures	3-16
3-6	Index to Integrated Circuits	3-17
3-7	Alignment Test Equipment	3-42

815 Broad Hollow Rd., Farmingdale, New York 11735 (631) 755-7625 Fax: (631) 755-7046

BENDIX/KING

MAINTENANCE MANUAL
RT-1401B RECEIVER-TRANSMITTER



RT-1401B Receiver-Transmitter
Figure 1-0

TELEPHONICS
A Griffon Company
815 Broad Hollow Rd., Farmingdale, New York 11735 (631) 755-7625 Fax: (631) 755-7046

BENDIX/KING

MAINTENANCE MANUAL
RT-1401B RECEIVER-TRANSMITTER

SECTION I DESCRIPTION AND OPERATION

1. General

This section provides a general description and operation of the RT-1401B Receiver-Transmitter. Subsequent information includes operation, equipment part numbers, block diagram discussion, and theory of operation.

NOTE: General information for the RDR-1400C Colorvision Weather Radar System, such as system description, system leading particulars, system operation, and a system operational check is contained in the Radar System Installation Manual, I.B. 21400-4. Maintenance information for the DA-1203A Radar Antenna is contained in PART 1 of the Weathervision System Antennas Maintenance Manual, I.B. 21000A.

2. Operation

The receiver-transmitter (R-T) operates by emitting very short, intense pulses of microwave energy which are reflected within the range of the radar system. A portion of the radiated energy, reflected by an object having reflective characteristics, is returned along the same general path to the aircraft where it is received and converted into digital data that is representative of the target size. The digital data is then routed to the radar indicator where it is processed to give a visual presentation of the target.

The receiver-transmitter is housed in a short 1/2 ATR form factor case. Overall dimensions can be found on the receiver-transmitter outline drawing. The mounting tray for the R-T unit, which is designed for front loading, provides positive positioning and holding of the unit to the aircraft. The mounting tray is mounted to the aircraft, and the R-T unit can easily be removed and replaced for servicing. Depending upon installation requirements, different models of the mounting tray are available.

For ease of maintenance, all circuits are contained on plug-in PC boards. These PC boards are interconnected by way of a ribbon cable which makes all connections between PC boards. An interconnect PC board replaces the conventional wiring harness arrangement.

The RT-1401B uses a frequency trimmable magnetron for reliable interrogation of beacon transponders; input frequency is an accurate 9375 $\pm$5 MHz.

The RT-1401B functions as a short range pulse radar for high resolution ground mapping (search) and a long range pulse radar for conventional weather. The reflected signal is received by the system's sector scanning antenna, amplified and digitized by the R-T unit, and then routed to the radar indicator. All system power requirements are routed via the R-T unit to the radar indicator and the antenna.

3. Equipment Part Numbers

Table 1-1 lists the Bendix/King part number for the RT-1401B Receiver-Transmitter. A brief description of the unit is also provided. Table 1-2 lists the major assemblies in the RT-1401B.

BENDIX/KING PART NUMBER	TYPE	DESCRIPTION
4000831-0105	RT-1401B	Provides X-band output to sector-scanning antenna. Reflected signal is amplified by receiver, digitized, and routed to the radar indicator. The magnetron is frequency trimmable and is designed to operate at 9375 ±5 MHz to permit reliable triggering of the beacon transponder. Operating parameters permit optimum performance in each of the five modes (3 search modes, weather mode, and beacon mode) similar to other RT-1401B units, but complies with TSO certification C102 for ground target approach to within 1000 feet.
4000831-0106	RT-1401B	Same as -0105, except capable of turning off sensitive equipment when transmitting.

RT-1401B Receiver-Transmitter Part Numbers
Table 1-1

MODULE OR ASSEMBLY NAME	PART NUMBER	REFERENCE SERIES	CONNECTORS
Interconnect (Mother) Board	*3606464-0501 †3606464-0502	1200	J1204, J1205, J1208, J1217, J1218
Front Panel Connector Board	3606465-0501	1100	P1101, P1103
Receiver Board	3606458-0501	2000	J2006, J2016, P2020, P2021
Analog/Video Board	3606459-0501	3000	J3007, J3009, J3022
Mode-Decode Board	3606460-0501	8000	J8023

* = Used in 4000831-0105 Units.
† = Used in 4000831-0106 Units.

RT-1401B Subassemblies and Connectors
Table 1-2 (Sheet 1 of 2)

3.

MODULE OR ASSEMBLY NAME	PART NUMBER	REFERENCE SERIES	CONNECTORS
Power Supply Assembly	4007721-0504	5000	J5011
PS Control Board Assembly	4007714-0501	5000	
Power Supply Module	4007715-0501	5000	
Local Oscillator Assembly	4007932-0501	6000	P6012
Beacon Amplifier Assembly	3606473-0501	7000	P7016, P7019
Beacon Receiver Module	3606457-0501	7000	

RT-1401B Subassemblies and Connectors
Table 1-2 (Sheet 2)

4. Block Diagram Discussion (Refer to figure 1-1.)

A. Waveform Synchronization and Transmitter Function

Basic synchronization signals for the radar system are generated by a crystal controlled oscillator located in the radar indicator. The clock frequency is counted down to 800 Hz for range selections of 20 NM or less in search-one and search-two modes. For all other ranges and modes the clock frequency is counted down to 200 Hz. Either the 800 Hz or the 200 Hz system trigger is routed to the R-T unit where it keys the transmitter and provides other timing functions. On -0106 units, the system trigger also keys the suppression pulse generator to turn off sensitive equipment when the R-T unit transmits. The incoming clock signal is buffered and then applied to the timing circuit, which controls the AFC gate, the STC-function gate, the AFC-AGC trigger, and the test-pattern-generator circuits. The buffered incoming clock is also routed to the modulator driver where selection of either the modulator short pulse (0.5 usec) or the modulator long pulse (2.35 usec) is selected.

Pulse width selection is made depending on the operation mode selected on the radar indicator. Modulator long pulse is selected for modes using a 200-Hz trigger; modulator short pulse is selected for modes using an 800 Hz trigger. With either modulator pulse, a negative-going, 330-volt, 110-ampere pulse is applied to the pulse transformer. The pulse transformer supplies the magnetron with a 5.5 kV, 4.5 A, negative-going pulse that causes the magnetron to oscillate at its 9375 MHz resonant frequency. A 10-kW nominal peak power rf output pulse is generated by the magnetron and is directed through the four-port, E-plane circulator to the radar antenna.

B. Receiver Function

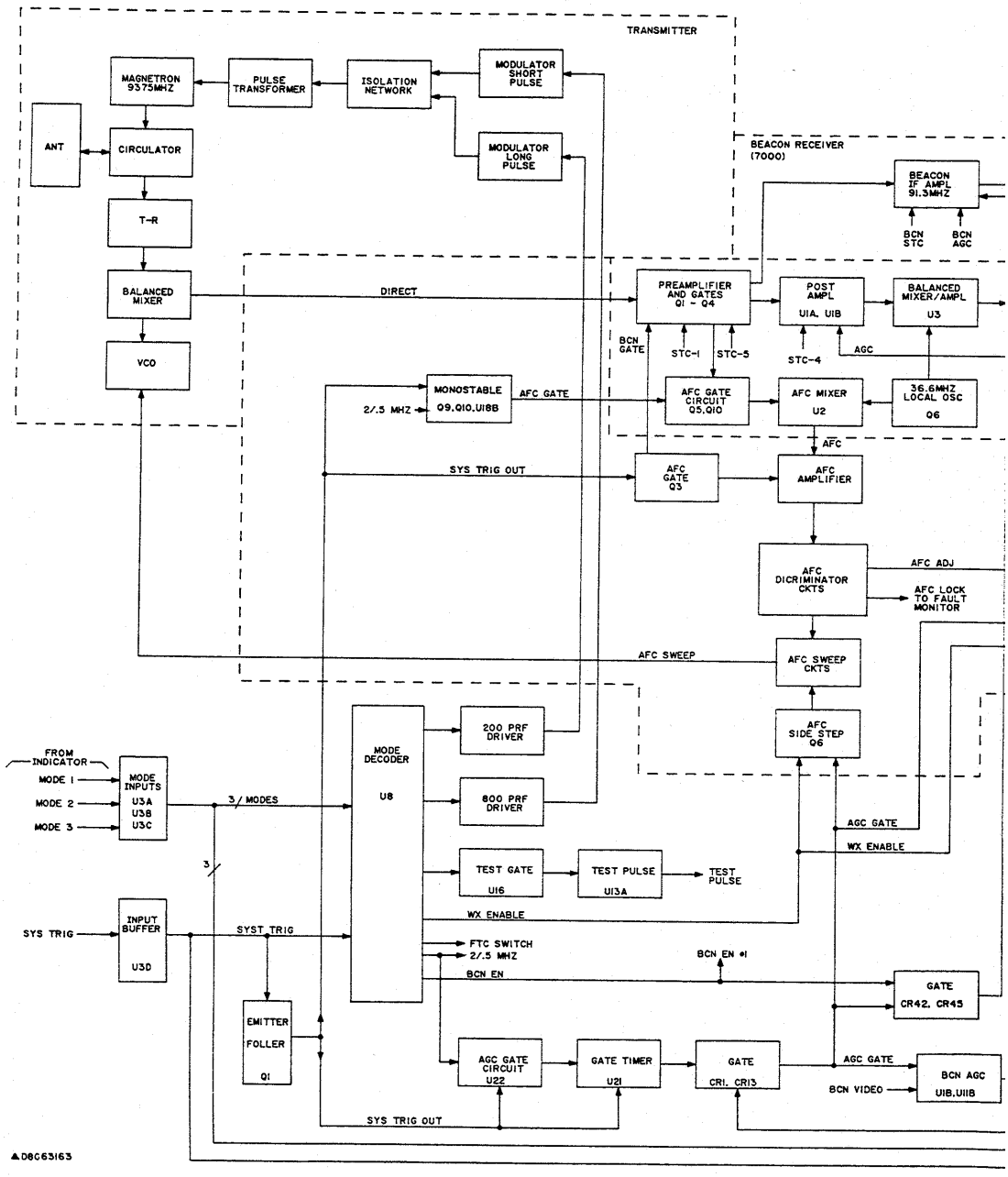
The R-T unit employs a dual-conversion, superheterodyne receiver. Signals received by the radar antenna are routed through the four-port,

E-plane circulator, and the TR limiter to a balanced mixer. A TR limiter is a microwave switch used to prevent damage to the receiver crystals, from the magnetron oscillator high power microwave pulses or from other radars in the vicinity. The balanced mixer combines the echo signal with a signal from the first local oscillator (operating at 9401.3 MHz) to produce a difference frequency of 26.3-MHz. After amplification in the preamplifier stage, the 26.3-MHz signal is mixed with a 36.6-MHz signal from the second local oscillator to produce a 10.3-MHz i-f signal.

A bandwidth switch selects either a 2-MHz bandwidth for search-mode operation or a 0.5-MHz bandwidth for weather-mode operation. The 10.3-MHz logarithmic-gain amplifier following the bandwidth switch provides for a great variance (approximately 50 dB) in signal levels usable by the R-T unit. Following the logarithmic-gain amplifier, is the video detector and buffer. The detected, buffered video (in the search 1 mode) is acted upon by the FTC circuit (fast time constant) and is used to remove noise caused by sea clutter. In the A/D converter following the FTC circuit the amplitude of the detected video signal is compared to three preset dc thresholds. A two-bit logic code tells the radar indicator the highest threshold level exceeded by the echo return. The two-bit codes for the four thresholds, in increasing level, are 00, 01, 11, and 10.

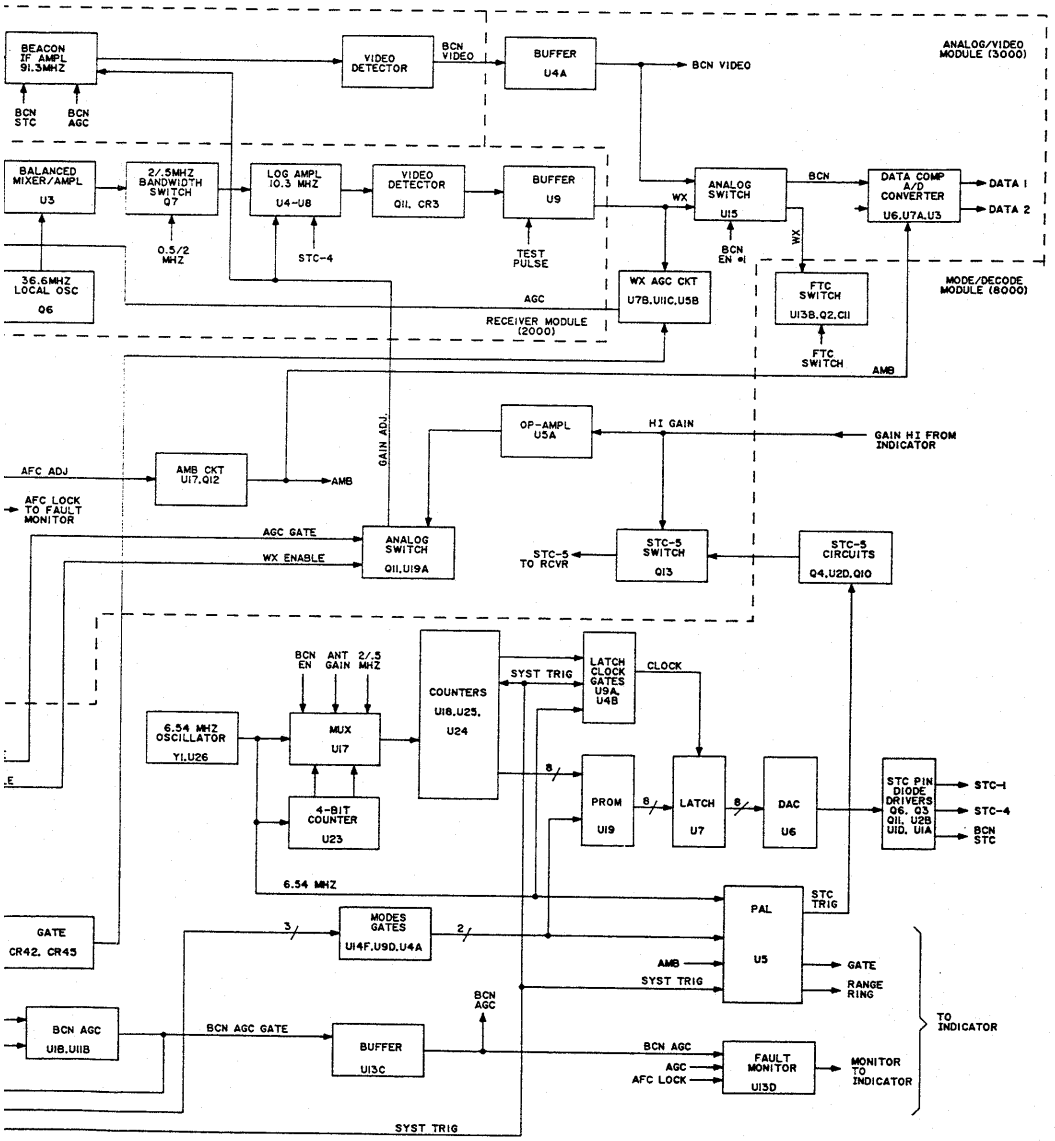
C. AFC Function

After the system trigger, while the magnetron is oscillating, the first local oscillator frequency must be adjusted to ensure a correct i-f echo-return signal. The AFC-AGC trigger circuit turns on the AFC gate, and the i-f signal from the preamplifier is supplied to the AFC mixer. Using the 36.6-MHz signal from the second local oscillator, the mixer converts the 26.3-MHz i-f signal to a 10.3-MHz second i-f. The discriminator following the 10.3-MHz buffer checks the i-f frequency. If the second i-f is exactly 10.3 MHz the AFC circuits remain stabilized. However, if the second i-f is not exactly 10.3 MHz, the discriminator produces a deviation voltage. The deviation voltage is amplified, integrated, buffered, and applied to the varactor in the first local oscillator to adjust the local oscillator frequency. An inverse-logarithmic-gain buffer amplifier is used between the integrator and the first local oscillator to cancel the logarithmic voltage-to-frequency characteristic of the first local oscillator. If the first local oscillator is not very nearly 26.3 MHz above the magnetron frequency when the magnetron fires, the 10.3-MHz second AFC i-f will be outside the discriminator capture range. In this case the stop-sweep, or reset, circuit will initiate integrator reset and AFC sweep. To ensure that the first local oscillator does not lock on the difference frequency 26.3 MHz below the magnetron frequency, the AFC sweep circuit causes the first local oscillator to start at its highest frequency and sweep down. If the first local oscillator does not lock up during the down-sweep, the integrator is reset when the tune voltage reaches zero volts and the sweep begins again.



RT-1401B Receiver-Transmitter, Block Diagram
Figure 1-1

TELEPHONICS
A Griffon Company
815 Broad Hollow Rd., Farmingdale, New York 11735 (631) 755-7625 Fax: (631) 755-7046



4.

D. AGC Function (Wx AGC and BCN AGC)

The AGC circuit in the RT-1401B is noise-level actuated. Gain of the preamplifier circuits is adjusted in response to the noise level received by the AGC threshold circuit from the video- detector buffer. Video detector output must not be monitored immediately after the transmitted radar pulse, however, as the returning echo signal would simulate a high noise level. The AFC-AGC trigger circuit prevents the false reading by shutting off the AGC threshold circuit during the echo-return time. In beacon, weather, or search-three operating modes (when the pulse repetition rate is 200 Hz), the AGC-AFC trigger turns off the AGC threshold circuit for about three milliseconds after the magnetron fires. This is long enough to allow the echo to return, but still leaves time for the AGC threshold circuit to be turned on for noise-level sampling before the next magnetron firing. When the pulse repetition rate is 800 Hz, as it is in search-one and search-two modes, the AGC threshold circuit can only be shut off for about 0.7 milliseconds, if time is to be left for noise-level sampling before the next magnetron firing. To prevent any return after 0.7 milliseconds from affecting the AGC noise-level sampling, the AFC-AGC trigger circuit turns on the AFC side-step circuit. This causes the first local oscillator to be driven off-frequency so that any echo returning is not converted to the intermediate frequency. Therefore, any echo return after 0.7 millisecond in search-one or search-two modes is ignored. The AFC side-step is also used as a 3000 microsecond gate.

E. STC (Sensitivity Time Control) Function

The STC function generator is initiated after the transmitter output pulse. The generator causes the gain of the 26.3-MHz preamplifier to increase exponentially. The weaker returns from distant objects are thus amplified more than the strong returns from nearer objects. Thus, objects of the same size or density are made to look equal on the radar indicator, regardless of their distance.

F. Test Function

When the system is placed in the test mode, a test ground generated by the radar indicator inhibits the transmitter and keys a test pattern generator. The triangular wave developed by the test pattern generator is injected into the video-detector buffer. A resultant test pattern display on the radar indicator is indicative of system performance. The test pattern exhibits three colors, in five bands.

G. Beacon Amplifier

When operating in beacon mode, or dual mode (e.g., weather plus beacon), the R-T unit must transmit the standard 9375-MHz signal and receive the 9310-MHz transponder signal. To process the 9310-MHz signal, a separate beacon i-f amplifier (91.3 MHz) and beacon video detector are used. The

4.G.

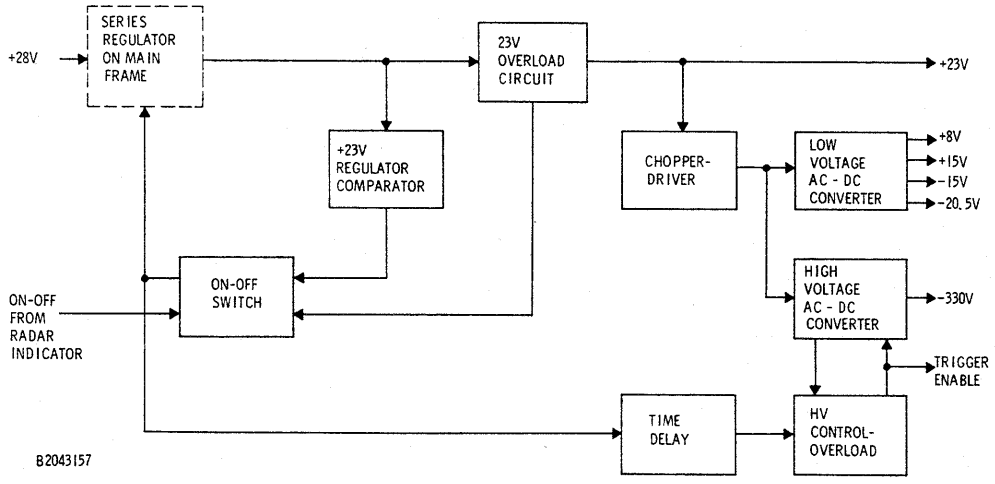
R-T unit first local oscillator operates at 9401.3 MHz to convert the standard 9375-MHz signal to a 26.3-MHz intermediate frequency. The same first local oscillator converts the 9310-MHz transponder signal to 91.3 MHz. The 91.3-MHz signal is amplified by the preamplifier and the 91.3-MHz i-f amplifier, detected, and then applied to the video-detector buffer.

5. Detailed Theory of Operation

A. Power Supply

(1) General (See figure 1-2.)

The power supply for the R-T unit converts +28 Vdc into the dc voltages needed for unit operation: +23V, +8V, +15V, -15V, -20.5V and -330V. Two series transistors mounted on the main frame are driven by the power supply circuits to provide regulated +23 Vdc. An overload circuit in power supply limits current. Since +28 Vdc is continuously applied to the R-T unit, a power supply on-off switch circuit is used to control R-T unit operation in response to commands from the radar indicator. All voltages except the +23 Vdc are developed by chopping the +23 Vdc, then transforming, rectifying, and filtering the chopped voltage. The high voltage control and overload circuit, in addition to protecting the high voltage ac-dc converter from overload, provides the trigger enable signal. Trigger enable is generated after a 80-second, turn-on delay from the time-delay circuit, and is used to switch-on -330 Vdc to the magnetron modulator as well as to enable the modulator trigger on the mode decoder board. A fan is provided for cooling the power supply.



Power Supply Block Diagram
Figure 1-2