TRANSMITTER-RECEIVER BAYS
LEVEL DIAGRAMS
TD-3D MICROWAVE RADIO

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1. GENERAL

1.01 This section provides block diagram information showing the levels of signal power and local oscillator power at various points in the J68386J, K, L, M, N, and P transmitter-receiver bays of the TD-3D Microwave Radio System. Also indicated are some of the adjustments which can be used to obtain the levels shown. For detailed information on alignment and adjustment of the receiver and transmitter, refer to Sections 415-301-500, 415-301-501, and 415-301-502 when using the 45A test set; Sections 415-401-500 and 415-401-501 when using the 92A test set; or Sections 415-501-500 and 415-501-501 when using the 28A test set.

1.02 This section is reissued to add information on the 713( ) integrated circuit (RF combiner) and associated 95A control unit for use in space diversity radio hops. Figures 1 and 3 have been revised. Change arrows have been used to indicate changes.

The Equipment Test List is not affected.

1.03 Actual receiver input carrier powers are a function of the previous station transmitter output power, antenna gains, waveguide losses, path length, propagation variations (fading), and operating frequency. Therefore, signal levels at the receiver input and at various points up to the automatic-gain-controlled stages may differ in any particular station from the levels given in this practice. The levels herein are nominal values that would be encountered in an average station.

1.04 The signal levels in a repeater station T-R bay are basically the same as in a main station bay. The block diagrams are essentially the same; the major difference is that a single microwave generator, working in conjunction with a 40-MHz shifter, is used for both the receiver and the transmitter in a repeater station bay, whereas two microwave generators are used in a main station bay. Figures 1 and 2 are block and level diagrams of a main station bay, and Fig. 3 shows the repeater station bay. Figures 4 and 5 are block diagrams of the T-R bays in a hot standby (HS) only and a hot standby/space diversity (HS/SD) arrangement.

1.05 The following description is given for a main station bay, but the same description can be applied to a repeater station bay with the noted exception of the microwave generator and 40-MHz shifter circuits.

2. RECEIVER CIRCUIT

2.01 Figure 1 is a block diagram showing signal levels and principal adjustments in a main station receiver. The receiver accepts an input signal on one of 24 radio channels in the 3710- through 4170-MHz frequency range. The signals received by the receiving antenna are separated by polarization and applied through waveguide to a 2A circulator and bandpass filter combination which selects a specific channel for application to the associated receiver and passes on to the succeeding T-R bays any remaining received channels outside the selected band. The selected signal at the output of the bandpass filter is typically at a level of −26 dBm for an average repeater spacing of about 26 miles and a transmitter output power of 5 watts without the use of a 652A RF preamplifier.

2.02 A 652A RF preamplifier may be used in the common receiving waveguide run feeding the bay lineup to reduce the repeater noise figure and hence the thermal noise of the radio hop. A major application of the 652A RF preamplifier has been in conjunction with 1500 or 1800 message circuit loading on the TD-3D radio channels. For example, with 1500 circuit loading, the use of the 652A RF preamplifier on hops having less than −27 dBm normal received carrier power permits systems noise objectives to be met with 2-watt rather than 5-watt operation of the transmitters. For 1800 circuit loading, the 652A RF preamplifier must be used on all hops having less than −23 dBm normal received carrier power to meet system noise objectives. The 652A RF preamplifier is installed in the receiving waveguide run ahead of the 2A circulator and bandpass filter combination. The 652A amplifies the received carrier signals for all bays in the lineup on that receiving waveguide run. The preamplifier has a typical gain of 10 dB when powered, and a maximum insertion loss of 13 dB when unpowered. For 652A RF preamplifier descriptive information and replacement procedures, refer to Section 420-802-100.

2.03 The signal, after being amplified by a 652A preamplifier (if equipped) and then separated for specific channel selection by the 2A circulator and bandpass filter, ♦may be directed to one of two optional paths. The normal path is through a monitor shutter and an isolator into the band-rejection segment of the directional filter (option A in Fig. 1 and 3). The alternate path is provided when the bay is equipped with a 713( ) RF combiner and used in a space diversity hop. The 713( ) combiner and associated 95A control unit are placed in the waveguide run at the top of the bay. One leg of the combiner connects to the diversity antenna waveguide channel separation network and the other leg connects to the regular antenna waveguide channel separation network. The common output is connected to the monitor shutter and resumes the standard path (option B, Fig. 1 and 3).♦ The local oscillator signal from the receiving microwave generator is applied to the bandpass segment of the directional filter. (The local oscillator signal in a repeater station comes from the 40-MHz oscillator—shift modulator.) The received and local oscillator signals differ in frequency by 70 MHz. Both the band-rejection filter and the bandpass filter segments of the directional filter are tuned to the local oscillator signal frequency. The band-rejection filter directs the local oscillator signal towards the receiver modulator and, together with the isolator, prevents the local oscillator signal from getting into the waveguide and causing interference in other channels. The bandpass filter portion of the directional filter serves to direct the received signal towards the receiver modulator and prevents the signal from entering the local oscillator path.

2.04 The combined local oscillator and received signal output from the directional filter is applied to the input of the receiver modulator, an unbalanced-type downconverter which uses a single Schottky barrier diode. The receiver modulator mixes (or modulates) the two RF input signals together in the diode, and the 70-MHz difference frequency product which is generated forms the desired IF output signal. This IF output signal is applied directly to the IF preamplifier. The preamplifier gain normally is adjusted to provide an IF signal level of either 0 dBm (without 652A RF preamplifier) or +3 dBm (with 652A RF preamplifier) at its output under nonfading conditions.

2.05 The output from the preamplifier is applied to the IF main amplifier through an IF bandpass filter, 918C equalizer (in most bays), and a mop-up equalizer, if required. This equipment combination has a combined inband insertion loss of about 8 dB.

2.06 Where the 652A RF preamplifier is not equipped, the IF main amplifier provides 18 dB of gain to the IF signal under normal (nonfaded) conditions (−8 dBm input and a +10 dBm output). During fading of the radio signal at the receiver input, the operation of the automatic gain control (AGC) causes the IF main amplifier to provide additional gain of up to 40 dB and still maintain approximately a +10 dBm output. When the 652A RF preamplifier is equipped, the output of the IF preamplifier is 3 dB higher. Thus, the normal gain of the main amplifier is 15 dB, (−5 dBm input to +10 dBm output) and the AGC range is 43 dB.

2.07 The output signal of the IF main amplifier is supplied through a 19E pad to the receiver IF output. Provisions have been made for mounting an adjustable amplitude equalizer at the output of the IF amplifier. Proper adjustment of this equalizer will be determined by measurements on the overall IF-to-IF switching section. The value of the 19E pad will vary depending on the particular application of the receiver, IF interconnecting circuit, and type of protection switching being used.

3. TRANSMITTER CIRCUIT

3.01 The input to the transmitter (Fig. 2) is an IF signal originating from the FM terminal equipment or from a previous receiver in a repeater station. The IF signal, at a normal level of −7 dBm, is applied to the amplifier section of the IF driver amplifier—transmitter modulator. The IF driver amplifier raises the level of the IF signal to about +21 dBm and applies it to the transmitter modulator. The local oscillator signal for the transmitter modulator, at a frequency of either 70 MHz above or below the transmitting channel frequency, is obtained from the microwave generator. The microwave generator provides a signal of about +25 dBm to the 28B integrated circuit. The integrated circuit delivers the local oscillator signal to the transmitter modulator at a level of approximately +20 dBm.

3.02 The transmitter modulator, an unbalanced upconverter using a single Schottky barrier diode, mixes or modulates the local oscillator and IF signals. The output products of the modulator include signals centered at the local oscillator frequency plus 70 MHz and at the local oscillator frequency minus 70 MHz. These outputs are returned through the 28B integrated circuit to a bandpass filter which passes the desired frequency and rejects all others. The signal level at the output of the bandpass filter is +12 dBm.

3.03 The output of the bandpass filter is applied to the transmitter amplifier where the signal is amplified to the power required for transmission. Originally, the transmitter was a 3-stage electron tube-type amplifier. The normal signal level at the output of this transmitter amplifier is +37 dBm. For applications requiring a lower output power, +30 or +33 dBm power outputs can be obtained by strapping out a heater resistor in the control circuit and readjusting (lowering) the plate currents of the tubes.

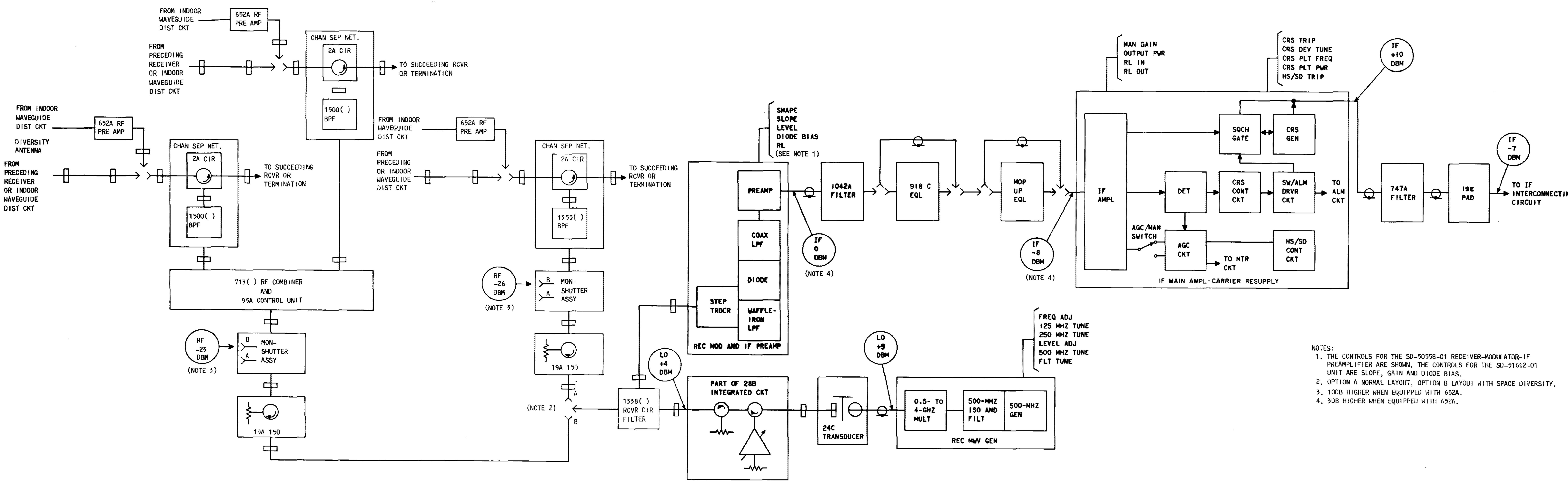
3.04 Two-watt (+33 dBm) or five-watt (+37 dBm) operation can also be achieved by retrofitting the solid-state power amplifier, coded 660( ) IC, into the TD-3D transmitter in place of the 416 tube-type transmitter amplifier assembly. When the 660( ) IC amplifier is used, the 19A isolator at the output of the transmitter amplifier is not required. A minimum of 2-watt output power over the 3.7 to 3.94 GHz requires the 660A IC amplifier and 3.94 to 4.2 GHz requires the 660B IC amplifier. A minimum of 5-watt output power over the same frequency bands requires a 660C and 660D IC amplifier, respectively. For 660( ) IC amplifier descriptive information, refer to Section 415-200-100.

3.05 The output signal is delivered through an isolator, monitor-shutter assembly, and bandpass filter—circulator combination to the transmitting antenna via a common waveguide run. The bandpass filter and circulator combination permits connecting up to six radio transmitters, each separated by 80 MHz, to the common waveguide run.

4. REFERENCES

4.01 The following drawings are related to this section:

NUMBER	TITLE
SD-51546-01	Toll Systems—Application Schematic—TD-3D Radio Transmitter-Receiver Bay
SD-50575-01	TD-3 Radio Indoor Waveguide Distribution Circuit
SD-51463-01	Toll Systems—Application Schematic for 4-GHz Heterodyne Systems Using Hot Standby/Space Diversity Switching
SD-50558-01	Receiver Modulator—IF Preamplifier
SD-51612-01	Receiver Modulator—IF Preamplifier
SD-51548-01	IF Main Amplifier—Carrier Resupply
SD-50585-02	IF Driver Amplifier—Transmitter Modulator
SD-50574-02	Microwave Generator
SD-50586-01	40-MHz Oscillator—Shift Modulator
SD-59404-02	Transmitter—Amplifier
SD-51549-01	Control, Alarm, and Meter Circuit



NOTES:

1. THE CONTROLS FOR THE SD-50558-01 RECEIVER-MODULATOR-IF PREAMPLIFIER ARE SHOWN. THE CONTROLS FOR THE SD-51612-01 UNIT ARE SLOPE, GAIN AND DIODE BIAS.
2. OPTION A NORMAL LAYOUT, OPTION B LAYOUT WITH SPACE DIVERSITY.
3. 10DB HIGHER WHEN EQUIPPED WITH 652A.
4. 3DB HIGHER WHEN EQUIPPED WITH 652A.

Fig. 1—Main Station Receiver—Block and Level Diagram

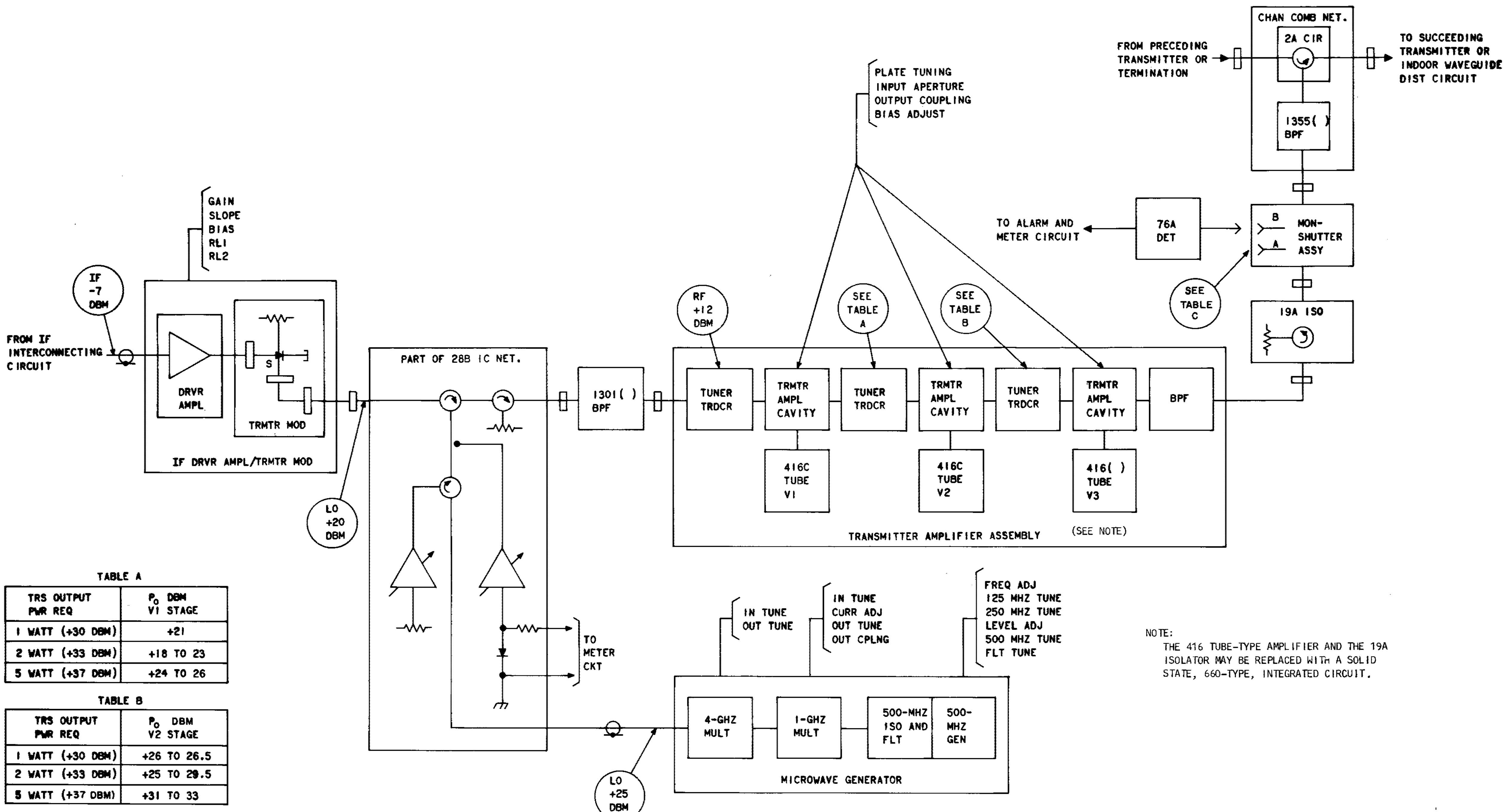


TABLE A

TRS OUTPUT PWR REQ	P_o DBM V1 STAGE
1 WATT (+30 DBM)	+21
2 WATT (+33 DBM)	+18 TO 23
5 WATT (+37 DBM)	+24 TO 26

TABLE B

TRS OUTPUT PWR REQ	P_o DBM V2 STAGE
1 WATT (+30 DBM)	+26 TO 26.5
2 WATT (+33 DBM)	+25 TO 29.5
5 WATT (+37 DBM)	+31 TO 33

TABLE C

TRS OUTPUT PWR REQ	P_o DBM PORT A MON - SHUTTER
1 WATT (+30 DBM)	+30 ± 1.0
2 WATT (+33 DBM)	+33 ± 0.5
5 WATT (+37 DBM)	+37 ± 0.5

Fig. 2—Main Station Transmitter—Block and Level Diagram

NOTES:
1. THE CONTROLS FOR THE SD 50558-01 RECEIVER MODULATOR IF PREAMPLIFIER ARE SHOWN. THE CONTROLS FOR THE SD 51612-01 UNIT ARE SLOPE, GAIN AND DIODE BIAS.
2. THE 416 TUBE-TYPE AMPLIFIER AND THE SUCCEEDING 19A ISOLATOR MAY BE REPLACED WITH A SOLID STATE, 660-TYPE, INTEGRATED CIRCUIT.
3. OPTION A IS NORMAL LAYOUT. OPTION B USED WITH SPACE DIVERSITY.

* 10 dB HIGHER WHEN EQUIPPED WITH 652A RF PREAMPLIFIER
** 3 dB HIGHER WHEN EQUIPPED WITH 652A RF PREAMPLIFIER

TABLE A

TRS OUTPUT PWR REQ	P_O DBM V1 STAGE
1 WATT (+30 DBM)	+21
2 WATT (+33 DBM)	+18 TO 23
5 WATT (+37 DBM)	+24 TO 26

TABLE B

TRS OUTPUT PWR REQ	P_O DBM V2 STAGE
1 WATT (+30 DBM)	+26 TO 26.5
2 WATT (+33 DBM)	+25 TO 29.5
5 WATT (+37 DBM)	+31 TO 33

TABLE C

TRS OUTPUT PWR REQ	P_O DBM PORT A MON-SHUTTER
1 WATT (+30 DBM)	+30 ±1.0
2 WATT (+33 DBM)	+33 ±0.5
5 WATT (+37 DBM)	+37 ±0.5

Fig. 3—Repeater Station T-R Bays—Block and Level Diagram

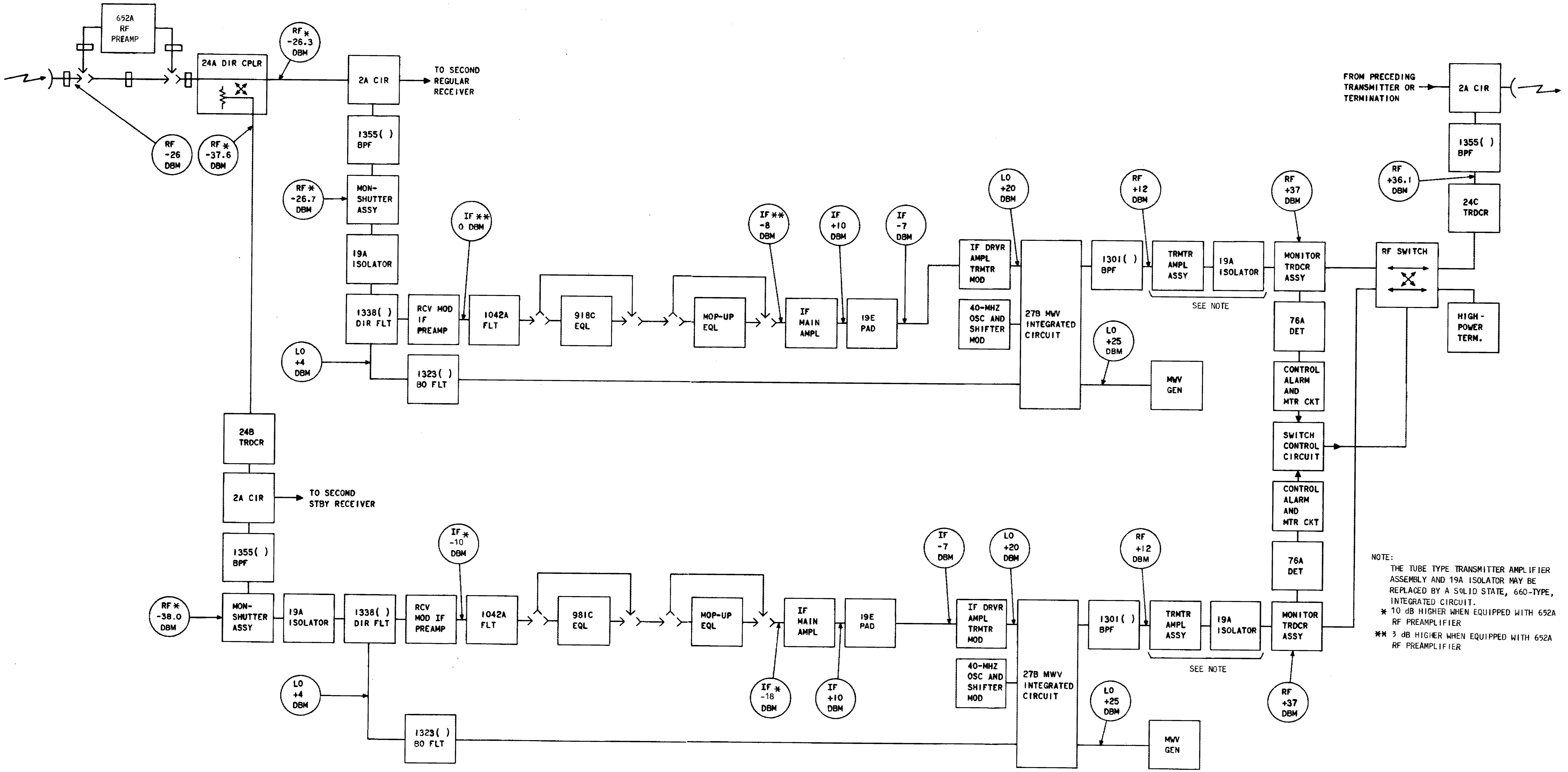
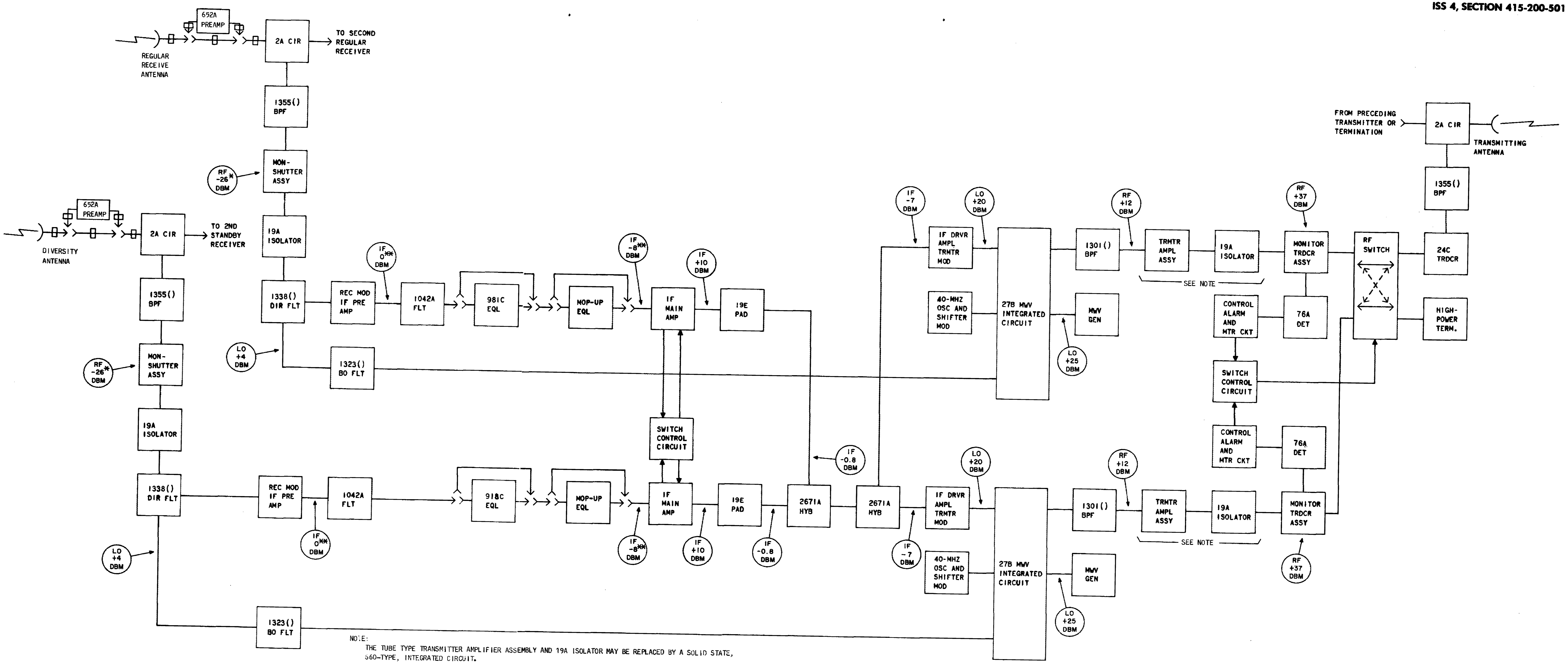


Fig. 4—Repeater Station Hot Standby T-R Bays—Block and Level Diagram



NOTE:
THE TUBE TYPE TRANSMITTER AMPLIFIER ASSEMBLY AND 19A ISOLATOR MAY BE REPLACED BY A SOLID STATE, 560-TYPE, INTEGRATED CIRCUIT.

* 10 dB HIGHER WHEN EQUIPPED WITH 652A RF PREAMPLIFIER.

** 3 dB HIGHER WHEN EQUIPPED WITH 652A RF PREAMPLIFIER.

Fig. 5—Repeater Station Hot Standby/Space Diversity T-R Bays—Block and Level Diagram