TD-2 MICROWAVE RADIO
TRANSMITTER-RECEIVER BAY
GENERAL
DESCRIPTION

CONTENTS — PAGE

1. SCOPE

1.01 This section describes the TD-2 radio J68331 transmitter-receiver (T-R) bay. Descriptions cover the T-R bay as used in both repeater stations and main stations. Block diagrams are given for the receiver portion and the transmitter portion of the T-R bay. Following the block diagram descriptions are more detailed descriptions of the individual units which make up the T-R bay. These descriptions include equipment features, circuit description, and transmission characteristics.

2. PURPOSE OF EQUIPMENT

2.01 The J68331 transmitter-receiver bay is the basic unit of the TD-2 radio system which is a microwave radio relay system operating in the frequency range of 3700 to 4200 MHz. The TD-2 radio relay system transmits television programs and multiplex telephone messages across several thousand miles.

3. EQUIPMENT FEATURES

3.01 The J68331 transmitter-receiver bay (Fig. 1) provides the radio repeater equipment for a single one-way channel at a repeater station when the 40-MHz shifter is used or the transmitting and receiving equipment at a terminal point when the receiver microwave generator is installed. The equipment consists of a single frame which has two fundamental divisions: a receiver and a transmitter. The equipment is so arranged that either a receiver, a transmitter, or both, may be furnished.

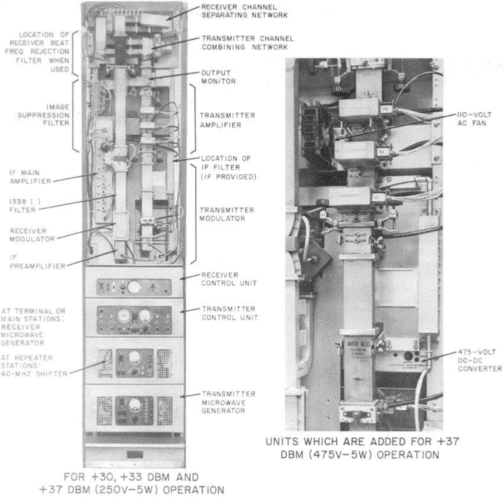


Fig. 1—Typical Transmitter-Receiver Bay With J68387P (S-Bar) Receiver Modulator and IF Preamplifier

3.02 The J68331 transmitter-receiver bay is coded either as a J68331A type or as a J68331B type bay. The basic difference is in the wiring of the B-type bay to accept the newer, or List 4, microwave generator. However, the A type may be modified to use the List 4 generator. A bay consists of a 9-foot duct-type framework. The bay is approximately 15 inches deep and 22-3/8 inches wide. The bottom half of the bay is occupied by units arranged for 19-inch panels. The lower units project 9-3/8 inches from the front of the uprights where solid-state microwave generators are provided and 9-3/4 inches where tube-type generators are provided. These units, starting at the bottom of the bay, are:

Transmitter microwave generator

Receiver microwave generator, at main or terminal station (or a 40-MHz shifter at a repeater station)

Transmitter control unit

Receiver control unit.

3.03 The upper half of the bay is occupied by the receiver, IF, and transmitter components and may be enclosed with hinged-type casing doors. The receiver equipment mounted within this casing consists of the IF equalizer and/or IF filter (at interstitial channel installations), the IF main amplifier, the receiver converter and IF preamplifier unit, the image suppression filter, and the receiver beating-frequency rejection filter if the bay is equipped with the J68330D or P receiver converter and IF preamplifier. If the solid-state IF main amplifier (J68330T) is used, an additional bandpass filter (1080A) must be added along with the solid-state amplifier. The solid-state main amplifier includes a gate circuit which opens the normal signal path and applies the carrier resupply signal to the transmitter. Only one carrier resupply generator is provided for each bay lineup (maximum of 6 bays) with the unit mounted on the first bay and the output of the generator connected in series to each bay in the lineup. The transmitter portion includes the buffer amplifier (at main or terminal stations only), the transmitter modulator, the transmitter amplifier, and the output monitor. The channel combining and separating networks for the transmitter and receiver are mounted at the extreme top of the bay in a horizontal position. These networks are arranged for waveguide coupling to the antenna waveguide for the first bay in the lineup or to preceding and succeeding networks in adjacent bays for an intermediate bay of a lineup. A removable cover, held in place with release fasteners, may be provided in front of the channel networks. Forced air cooling may be used for particular tubes and units of the bay.

3.04 The local cable wiring between units on the bay is run in forms housed in the ducts at the right and left side of the bay. Separate cables are provided for the receiver and the transmitter in order that only the required wiring need be furnished where only a receiver or a transmitter is furnished. The cable connections to the units are made by means of plugs and jacks to facilitate removal of units for bench maintenance. Coaxial cables, with the exception of direct patches between units, also are housed in the regular wiring ducts.

3.05 The maximum power drain for the T-R bay is as follows:

(a) For +30 dBm (1-watt) operation

VOLTS	AUX STATION AMPS	MAIN RCVR AMPS	MAIN TRMTR AMPS
+250	0.200	0.070	0.175
+130	0.330	0.330	0.125
−12	15.4	10.0	11.1

(b) For +33 dBm (2-watt) operation, equipped with the J68330-type receiver converter — IF preamplifier

VOLTS	AUX STATION AMPS	MAIN RCVR AMPS	MAIN TRMTR AMPS
+250	0.245	0.070	0.220
+130	0.330	0.330	0.125
−12	15.4	10.0	11.1

(c) For +33 dBm (2-watt) operation, equipped with the J68387P receiver modulator — IF preamplifier

VOLTS	AUX STATION AMPS	MAIN RCVR AMPS	MAIN TRMTR AMPS
+250	0.245	0.070	0.220
+130	0.255	0.255	0.125
−24	0.200	0.200	—
−12	14.5	9.1	11.1

(d) For +37 dBm (5-watt) @475V operation, equipped with tube type microwave generator

VOLTS	AUX STATION AMPS	MAIN RCVR AMPS	MAIN TRMTR AMPS
+250	0.200	0.070	0.175
+130	0.530	0.170	0.485
−24	0.200	0.200	—
−12	11.3	5.9	11.1

(e) For +37 dBm (5-watt) @250V operation, equipped with solid-state microwave generator and IF main amplifier

VOLTS	AUX STATION AMPS	MAIN RCVR AMPS	MAIN TRMTR AMPS
+250	0.235	—	0.210
+130	0.120	0.120	—
−24	0.200	0.200	—
−12	9.2	3.8	8.5

Note: Early in 1959, transmitter-receiver bays were shipped with filters in the +130 volt and 250-volt battery feeders in the bays. Earlier bays have been, or may be, modified to include such filters. These power lead filters effectively eliminate hits on working bays caused by surges in the +130 volt and 250-volt feeder leads.

3.06 The types and complement of the tubes, transistors, diodes, and crystals used in the units in the T-R bay are listed in Table A.

4. BLOCK DIAGRAM DESCRIPTIONS

4.01 A block diagram of the overall transmitter-receiver bay is shown in Fig. 9. In addition to showing signal flow direction, the overall block diagram includes a short description of the function of each block and three level diagrams: one for the +30 dBm transmitter, one for the +33 dBm transmitter, and one for the +37 dBm transmitter. More detailed block diagram descriptions of the receiver and transmitter portions of the T-R bay are given in the remainder of Part 4.

A. Receiver Equipped With the J68330D or J68330P Receiver Converter and IF Preamplifier

4.02 The J68330( ) receiver converter and IF preamplifier is now rated for addition and maintenance (A&M) only. New receiver installations will have the J68387P receiver modulator and IF preamplifier described in Part 4B.

4.03 Block diagrams for receivers equipped with the J68330( ) receiver converter and IF preamplifier are shown in Fig. 10 (for repeater stations) and Fig. 11 (for terminal stations). The input to a particular receiver is waveguide-coupled to the antenna waveguide if the receiver is in the first bay in a lineup or to a preceding bay if the receiver is in an intermediate bay in a lineup. At the receiver, the incoming microwave signal may contain any combination of one to six channel signals. At the receiver channel separating network: (1) the desired channel frequency is selected for the particular receiver and (2) all other signals are transmitted through the network to succeeding receivers. The incoming signal selected in the channel separating network is passed through the receiver beating-frequency rejection filter (if provided) and the image suppression filter to the RF input of the receiver converter.

4.04 In the receiver converter, the incoming signal is combined with the locally generated beating frequency which is 70 MHz removed from the incoming carrier. The beating frequency is supplied by the receiving microwave generator or the 40-MHz shifter. One of the modulation products that results from this combination in the converter is the desired 70-MHz frequency-modulated IF signal which is amplified in the preamplifier section of the unit. The output of the preamplifier is patched to a 315A IF equalizer, which compensates for phase distortion and/or a 574A IF filter, which is used at stations along interstitial routes to prevent adjacent channel crosstalk during fading. The 70-MHz signal is then applied to the input of the IF main amplifier where the major IF gain of the receiver is provided. An automatic gain control, which is located in the receiver control panel, controls the overall IF main amplifier gain (tube-type) to compensate for fading and variations in transmission. If the solid-state IF main amplifier is being used, the automatic gain control is an integral part of the amplifier. The IF output from the IF main amplifier may be patched directly to the transmitter section of the same bay; or, at

TABLE A

TUBE, TRANSISTOR, DIODE, AND CRYSTAL COMPLEMENT

UNIT OF EQUIPMENT	TUBES									PLUG-IN DIODES			DIODES					TRANSISTORS										CRYSTALS		
	6AQ5	6AU6	313C	396A	404A	416	417A	418A	VR150	416C	405B	406A	458C	459B	473A	474A	497A	44A	45B	45C	45D	45G	45J	51A	62A	62C	66C	28AA	28AB	108AC
Receiver Converter										2																				
IF Preamplifier (J68330C)							2																							
(J68330N)							3																							
J68387P Receiver Modulator and IF Preamplifier																	1		3			1	1							
IF Main Amplifier (J68330A)					6		1	1																						
(J68330T)													5	2		6		2		6				1			1			
Receiver Control Unit (J68330B)			*	*																										
(J68330W)																														
IF Buffer Amplifier (J68330F)								1																						
(J68330S)																			1	1										
Transmitter Modulator						1																								
Transmitter Amplifier						3																								
Microwave Generator (J68330G)		2		1		3		1																				1		
(J68387R-2)													3	1	1						2				1	1				1
40-MHz Shifter	1			1							2																		1	
Output Monitor												1																		

*Depending on the option used. The options are shown on SD-59405-01.

terminals and main stations, it may be cabled to an IF patching bay. At the patching bay, switching, monitoring, terminating, and distribution taps may be provided for flexibility in establishing and maintaining a network.

B. Receiver Equipped With the J68387P Receiver Modulator and IF Preamplifier

4.05 As shown in the block diagrams of Fig. 12 and 13, the receiver equipped with the J68387P (S-bar*) receiver modulator and IF preamplifier has the same arrangement from the antenna to the channel separating networks as the receiver described in 4.03. The S-bar modulator portion of the J68387P receiver modulator and IF preamplifier combines the incoming microwave signal with the beating-frequency signal. (The arrangement of the beating-frequency supplies and the function of the microwave generators and the 40-MHz shifter are described under D.) The incoming microwave signal and the beating-frequency signal are injected into the 1338 waveguide directional filter which applies the combined signals to the S-bar modulator unit. The 1338 filter also isolates the received signal from the beating oscillator and the beating-frequency signal from the waveguide path toward the channel separating network. The 8A or 19A isolator, which is ahead of the 1338 filter, provides impedance matching at the S-bar modulator input and additional isolation of the received and beating-frequency signals. One of the modulation products in the modulator is the desired 70 MHz which is then amplified in the solid-state preamplifier.

*Since the modulator portion of the J68387P receiver modulator and IF preamplifier uses a Schottky-barrier (S-bar) diode, it is called the S-bar modulator.

4.06 The 70-MHz output of the modulator is coupled directly into the IF preamplifier. The output of the preamplifier is connected through a 315A equalizer and/or either a 574A filter and 19D pad or a 574A filter and 1080A filter to the IF main amplifier. The 315A equalizer compensates for phase distortion and the 574A filter and 1080A filter are used at stations along interstitial channel routes to prevent adjacent channel crosstalk during fading. The 19D pad attenuates the IF power to keep the tube-type IF main amplifier within its gain control range.

4.07 The receiver control unit supplies dc power and control and test functions for the receiver modulator and IF preamplifier and the IF main amplifier. The receiver control units which are used with the J68387P receiver modulator and IF preamplifier also include a −19 volt regulator circuit. This circuit supplies the −19 volts to the solid-state preamplifier and the bias current to the S-bar diode in the modulator.

C. Transmitter

4.08 (See Fig. 14.) In the transmitter, when the transmitter-receiver bay is used as a repeater bay, the frequency-modulated IF signal from the receiver output is patched directly, by means of a coaxial patch cord, through a 5-dB pad to the transmitter modulator IF input. When used as a main station or terminal station transmitter, the frequency-modulated IF signal from the IF patching bay is connected, by means of coaxial cable, through a buffer amplifier to the transmitter modulator IF input. The buffer amplifier, by providing a good terminating impedance, reduces reflections (echoes) between the radio transmitter and the IF patching bay. In the modulator, the 70-MHz IF signal is combined with the output of the local microwave generator to produce the transmitted microwave frequency. The output of the microwave generator must be a frequency 70 MHz removed from the desired transmitted channel frequency. The output of the transmitter modulator is waveguide-coupled directly to the input of the RF transmitter amplifier which amplifies the signal to the required output power. The output of the RF amplifier is waveguide-coupled through the output monitor to the transmitter channel combining network. In this network, the channel then may be combined with a maximum of five other transmitted channels. The output of the channel combining network is directly waveguide-coupled to the network of the next transmitter or, in the case of the first bay in a lineup, to the antenna waveguide. The output monitor samples a small amount of the output power to provide means to (1) monitor the output power and (2) energize alarms in the event of an RF output power failure.

D. Beating-Frequency Supplies

4.09 Two arrangements are provided for obtaining the local microwave frequencies required to combine (1) with the received signal in the receiver converter to produce the 70-MHz IF frequency and (2) with the 70-MHz IF signal in the transmitter modulator to produce the transmitted frequency. The arrangement applicable to auxiliary repeater station repeater bays employs a single microwave generator and a 40-MHz shifter. With this arrangement, the output of the microwave generator is applied to a directional coupler in the 40-MHz shifter where the signal is divided into two parts: one part is applied to the transmitter modulator and the second part is combined with a 40-MHz source to produce an RF signal which is 40 MHz removed from the microwave generator frequency. The output signal of the 40-MHz shifter then supplies the beating frequency to the receiver converter. The primary advantage of a single generator with the closely controlled 40-MHz shift is that any variation in the frequency of the generator from the nominal desired value does not adversely affect the transmitted carrier frequency. Thus, in a long-haul system, the use of such an arrangement avoids cumulative carrier frequency drift. To illustrate this, assume an incoming 3730-MHz signal. The local microwave generator will have a nominal frequency of 3840 MHz. Part of the generator output is coupled to a 40-MHz shifter of closely controlled frequency to produce a new frequency of 3840 − 40 = 3800 MHz. This is mixed in the receiver converter with the received 3730-MHz signal to produce a 70-MHz intermediate frequency. This 70-MHz and the 3840-MHz generator frequency are combined in the transmitter modulator to produce 3840 − 70 = 3770 MHz, the transmitted carrier. If the generator frequency drifts to 3841 MHz, the shifter output goes to 3801 MHz and the IF becomes 71 MHz. The 71-MHz signal and the 3841-MHz frequency from the generator mix in the transmitter modulator to produce 3770 MHz which is the same as before. An analysis of the case where the generator frequency drifts above the signal frequency will give similar results. It can be seen, therefore, that drift in the microwave generator frequency results in a change in intermediate frequency but not in the transmitted carrier frequency. At terminal and main stations, two separate microwave generators are provided: one to supply the receiver and one to supply the transmitter. With this arrangement, the receiver and transmitter can be used independently to provide flexibility.

5. CHANNEL COMBINING AND SEPARATING NETWORKS

5.01 The TD-2 radio system is so designed that, by the use of proper frequency arrangements, as many as six broadband channels may be used in a tandem arrangement. This requires filtering equipment at the receiving end of the radio circuit to select the proper channel frequency and, at the transmitting end, to combine the various channels without causing interference. The 1400-type networks and 1401-type networks are used in the receiver and transmitter, respectively. The basic difference between 1400-type and 1401-type networks is the orientation of the hybrid junctions. The 1401-type network is shown in Fig. 2.

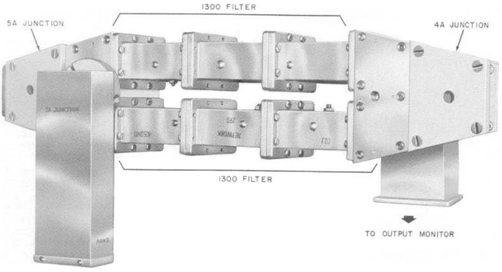


Fig. 2—Single Unit Combining Network (Type 1401)

A. Equipment Features

5.02 The overall dimensions of each of these networks with the movable arms of each hybrid junction facing inward are approximately 4-5/16 by 5-5/16 by 19 inches long. In the following table, the letter code of the 1400- or 1401-type network and the associated channel frequency are shown:

	REGULAR			ALTERNATE	
CHANNEL	FREQ (MHZ)	NETWORK CODE	CHANNEL	FREQ (MHZ)	NETWORK CODE
1	3730	A	7	3710	N
1	3770	B	7	3750	P
2	3810	C	8	3790	R
2	3850	D	8	3830	S
3	3890	E	9	3870	T
3	3930	F	9	3910	U
4	3970	G	10	3950	W
4	4010	H	10	3990	Y
5	4050	J	11	4030	AA
5	4090	K	11	4070	AB
6	4130	L	12	4110	AC
6	4170	M	12	4150	AD

The input side of a channel network consists of a 4A junction followed by two 1300-type band-rejection filters. The output side employs a 5A junction. The 4A junction is a waveguide hybrid consisting of two pairs of conjugate arms (1 and 2, 3 and 4). Arm 1 is connected to arms 3 and 4 by a waveguide "Y". Arm 2 is connected to arms 3 and 4 by a coaxial line and can be rotated through 360 degrees and locked in any position. A waveguide tuner is incorporated in arm 2. The 5A junction is similar to the 4A junction except that a waveguide termination is connected to arm 2 in place of the waveguide tuner. In earlier networks, a 1A junction, with a 400A-type tuner connected to arm 2, was used in place of the 4A junction. Likewise, a 1A junction, with a 500A-type termination connected to arm 2, was used in place of the 5A junction. In the 1400-type network, arms 2 of the 4A and 5A junctions appear on the same side of the network. In the 1401-type, arms 2 of the 4A and 5A junctions are on opposite sides of the network. The 1300-type band-rejection filter, shown in Fig. 3, is a waveguide filter consisting of ***factory-adjusted*** inductive and capacitive elements electrically spaced 3/4 wavelength apart.

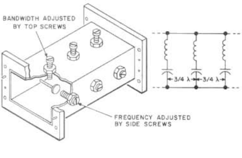


Fig. 3—Principles of Construction of the 1300-Type Filter

B. Circuit Description

5.03 Figure 4 shows the general block schematic of a channel separating network. The waveguide hybrid is a 4-arm unit, a version of which is shown in Fig. 5 as the 1A junction. Input to arm 1 divides equally between arms 3 and 4 with no output to arm 2 when 3 and 4 have identical impedances. Although equal outputs are always obtained in arms 3 and 4 with an input to either 1 or 2, the relative phase of the outputs in 3 and 4 differs in the two cases. When the input is from arm 2, the outputs in arms 3 and 4 are in phase; whereas, when the input is from arm 1, the outputs in arms 3 and 4 are in phase opposition. This difference in phasing may readily been seen to result from the circuit shown in the circuit equivalent of Fig. 5. With the input from branch 1, current circulates around the series loop including 3 and 4, say, clockwise in both, at any given instant, and no power appears at 2. With the input from branch 2, on the other hand, 3 and 4 are effectively in parallel instead of in series and the current in one is clockwise and counterclockwise in the other. Furthermore, no power appears at 1.

5.04 Considering power flow in the opposite directions, if, in 3 and 4, equal voltages are applied which are effectively in phase around the series circuit of 3 and 4, all of the power flows into 1 and none into 2. If either one of these 3 and 4 voltages is reversed with respect to the other, they become effectively in parallel instead of in series and deliver all of their power to 2 and none to 1. With this behavior of the hybrid in mind, one may easily follow the action of the circuit shown in Fig. 4. Input to arm 1 at the top divides equally into arms 3 and 4 with no output to arm 2. The band-rejection filters in arms 3 and 4 reflect one band of frequencies, which may be assumed to be that corresponding to channel 1, and pass all other frequencies. The unreflected frequencies continue on and enter the lower hybrid by way of its arms 3 and 4 adding to each other and appearing at arm 1. No output is transmitted to arm 2. The bands reflected from the filters in arms 3 and 4, on the other hand, travel back to enter arms 3 and 4 of the upper hybrid. These rejection filters, however, are not symmetrically located in arms 3 and 4. In arm 3, the connection between the filter and the upper hybrid is 1/4 wavelength shorter than that between the filter in arm 4 and the upper hybrid. The band that is reflected by the filter in arm 4 thus travels a path 1/2 wavelength farther than that traveled by the band reflected in arm 3, 1/4 wavelength before reflection, and another 1/4 wavelength after reflection. As a result, the reflected waves reaching the upper hybrid in arm 4 have been reversed in phase with respect to those in arm 3 and thus they add to give full output in arm 2 and have no effect on arm 1.

5.05 The net result of the arrangement shown in Fig. 4 is to transmit all but one frequency band and to drop off that band for amplification. By connecting a number of such arrangements in tandem, as indicated in Fig. 6, each drops off one channel for amplification and passes the remaining channels on to the next section of the arrangement. For a 6-channel system, there will be six of these channel separating networks connected in tandem and each will supply one channel receiver. The transmitting outputs similarly are connected to a chain of networks.

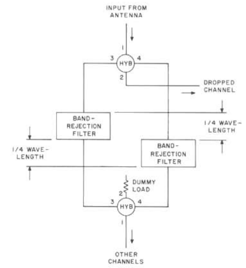


Fig. 4—1400-Type Network—Block Diagram

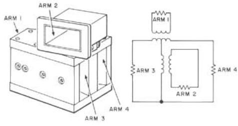


Fig. 5—1A Junction

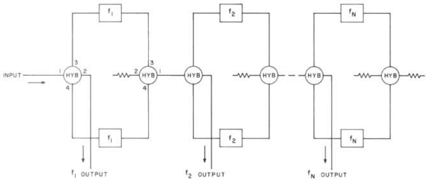


Fig. 6—3-Section Channel Separating Network—Block Diagram

C. Transmission Characteristics

5.06 Typical return loss and transmission loss characteristics from the input to the drop arm for such a network are as follows:

FREQUENCY MHZ	RETURN LOSS dB	TRANSMISSION LOSS dB
f_o −20	—	1.00 ±0.20
f_o −15	—	0.57 ±0.07
f_o −10	27	0.49 ±0.06
f_o −5	—	0.47 ±0.04
f_o	33	0.46 ±0.04
f_o +5	—	0.47 ±0.05
f_o +10	27	0.49 ±0.06
f_o +15	—	0.56 ±0.10
f_o +20	—	1.00 ±0.35

6. RECEIVER BEATING-FREQUENCY REJECTION FILTER

6.01 The received signal, selected in the 1400-type network, passes through either a receiver beating-frequency rejection filter or a section of flexible waveguide. The filter is employed to prevent signals, at the receiver beating frequency, from being transmitted into the channel separating networks. These signals would be transmitted through the network to the adjacent channel where they would appear as interfering signals at the edge of the received frequency band. This filter is not required and is replaced by the section of flexible waveguide in bays equipped with the J68387P (S-bar) receiver modulator and IF preamplifier.

A. Equipment Features

6.02 The receiver beating-frequency rejection filter in accordance with ED-59009-30, Group ( ) is a waveguide assembly consisting of a 400-type tuner, a 1303-type filter, and a waveguide spacer. Mounting studs are provided in the waveguide spacer for mounting the assembly in the bay. The overall length of the filter assembly is approximately 11-13/16 inches. The group numbers of the 1303-type filters for the various channels and received frequencies are shown in the following table:

CHANNEL	REGULAR RCV FREQ MHZ	GROUP NO.	CHAN-NEL	ALTERNATE RCV FREQ MHZ	GROUP NO.
1	3730	1	7	3710	13
1	3770	2	7	3750	14
2	3810	3	8	3790	15
2	3850	4	8	3830	16
3	3890	5	9	3870	17
3	3930	6	9	3910	18
4	3970	7	10	3950	19
4	4010	8	10	3990	20
5	4050	9	11	4030	21
5	4090	10	11	4070	22
6	4130	11	12	4110	23
6	4170	12	12	4150	24

B. Circuit Description

6.03 The 400-type tuner is employed to correct for a slight impedance mismatch presented by the filter at the received frequency. The 1303-type filter is a 2-section peak rejection filter tuned to reject the receiver beating frequency and to pass all other frequencies. The length of the waveguide spacer is determined by the electrical separation which is required between the 1303-type filter and the following image suppression filter to prevent distortion of the characteristic of either filter. The filter assembly has a peak suppression of 50 dB at the receiver beating frequency. The length of the tuner is varied to compensate for variations in the length of the spacer.

7. IMAGE SUPPRESSION FILTER

7.01 The signal from the rejection filter or flexible waveguide section passes through the image suppression filter. This filter is a waveguide type bandpass filter, which passes the received frequency band and suppresses the image frequency, 140 MHz removed from the desired signal. The filter also provides additional attenuation to any unwanted signals outside the passband.

A. Equipment Features

7.02 This image suppression filter is a 1301-type bandpass filter. It is a 4-cavity waveguide filter having an overall length of 19-13/32 inches. The letter codes of the 1301-type filters and the associated channel frequencies are shown in the following table:

CHAN-NEL	REGULAR FREQ (MHZ)	NET-WORK CODE	CHAN-NEL	ALTERNATE FREQ (MHZ)	NET-WORK CODE
1	3730	A	7	3710	N
1	3770	B	7	3750	P
2	3810	C	8	3790	R
2	3850	D	8	3830	S
3	3890	E	9	3870	T
3	3930	F	9	3910	U
4	3970	G	10	3950	W
4	4010	H	10	3990	Y
5	4050	J	11	4030	AA
5	4090	K	11	4070	AB
6	4130	L	12	4110	AC
6	4170	M	12	4150	AD

B. Transmission Characteristic

7.03 Figure 7 shows a typical insertion loss characteristic.

8. 1338 DIRECTIONAL FILTER

8.01 The 1338 waveguide directional filter is used in receivers equipped with the J68387P receiver modulator and IF preamplifier. The 1338 waveguide directional filter (Fig. 8) combines the incoming microwave signal with the microwave signal from the beating oscillator (BO) which is either the receiving microwave generator or the 40-MHz shifter. There is a 1338 filter for each required BO frequency and each directional filter has the corresponding BO frequency stamped on it. The 1338 filter codes and their corresponding BO frequencies are listed in Table B. The directional filter consists of a band-rejection filter and a bandpass filter. Both of these filters are tuned to the BO frequency. This provides the required isolation between the received signal port and the BO signal port, thereby keeping the received microwave frequencies out of the waveguide toward the beating oscillator and the beating oscillator signal out of the waveguide toward the antenna.

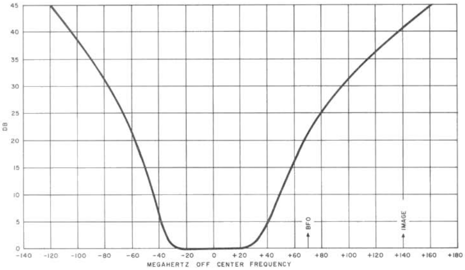


Fig. 7—Typical Insertion Loss Characteristic of 1301-Type Image Suppression Filter

TABLE B	
1338 FILTER CODE	BO FREQUENCY (MHZ)
1338A	3780
1338B	3800
1338C	3820
1338D	3840
1338E	3860
1338F	3880
1338G	3900
1338H	3920
1338J	3940
1338K	3960
1338L	3980
1338M	4000
1338N	4020
1338P	4040
1338R	4060
1338S	4080
1338T	4100

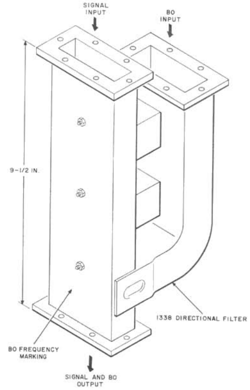


Fig. 8—1338-Type Directional Filter

FUNCTIONS

RECEIVER CHANNEL SEPARATING NETWORK	PASSES DESIRED MICROWAVE CHANNEL TO ASSIGNED BAY. ALL OTHER MICROWAVE CHANNELS DIRECTED TOWARD FOLLOWING CHANNEL SEPARATING NETWORKS.
BEAT FREQUENCY REJECTION FILTER (M) OR FLEXIBLE WAVEGUIDE (L)	FILTER REJECTS RECEIVER CONVERTER BEAT FREQUENCY.
IMAGE SUPPRESSION FILTER	REJECTS IMAGE FREQUENCY THAT IS 140 MHZ REMOVED FROM DESIRED MICROWAVE SIGNAL.
RECEIVER LOCAL MICROWAVE GENERATOR (MAIN OR TERMINAL STATION ONLY)	QUARTZ CRYSTAL-CONTROLLED HARMONIC GENERATOR PRODUCES LOCAL MICROWAVE FREQUENCY THAT IS 70 MHZ REMOVED FROM INCOMING MICROWAVE SIGNAL.
40-MHZ SHIFTER — 40-MHZ GENERATOR (AUXILIARY STATION ONLY)	QUARTZ CRYSTAL-CONTROLLED 40-MHZ OSCILLATOR AND AMPLIFIER.
40-MHZ SHIFTER — CONVERTER (AUXILIARY STATION ONLY)	COMBINES 40-MHZ SIGNAL WITH COMMON MICROWAVE SIGNAL TO PRODUCE LOCAL MICROWAVE FREQUENCY THAT IS 70 MHZ REMOVED FROM INCOMING MICROWAVE SIGNAL.
8A OR 19A ISOLATOR	PROVIDES IMPEDANCE MATCHING AT MODULATOR INPUT. PROVIDES ISOLATION OF RECEIVED AND BEATING FREQUENCY SIGNALS.
1338 WAVEGUIDE DIRECTIONAL FILTER	INSERTS THE LOCAL MICROWAVE (BEATING FREQUENCY) SIGNAL AND PROVIDES ADDITIONAL ISOLATION.
RECEIVER CONVERTER OR MODULATOR	COMBINES INCOMING MICROWAVE SIGNAL WITH LOCAL MICROWAVE FREQUENCY TO PRODUCE 70-MHZ IF SIGNAL. THE BF FILTER SELECTS PROPER SIDEBAND AND REJECTS UNWANTED SIDEBANDS.
IF PREAMPLIFIER	PROVIDES IF AMPLIFICATION DIRECTLY AT OUTPUT OF CONVERTER TO GIVE LOWER NOISE FIGURE (TO AVOID NOISE PICKUPS).
IF EQUALIZER	COMPENSATES FOR ENVELOPE DELAY DISTORTION. (≈ 0.5-DB LOSS)
IF FILTER(S)	PROVIDES FREQUENCY DISCRIMINATION BETWEEN ADJACENT CHANNELS ALONG AN INTERSTITIAL CHANNEL ROUTE. ((FD) 2.5-DB LOSS) ((FE) 7.5-DB LOSS)
19D PAD	ADJUSTS IF LEVEL. FOR RECEIVE SIGNALS HIGHER THAN -34 DBM USE A 15-DB PAD, BETWEEN -34 AND -39 DBM A 10-DB PAD, AND LESS THAN -39 DBM A 5-DB PAD.
IF MAIN AMPLIFIER	PROVIDES ADDITIONAL IF AMPLIFICATION. APPROXIMATE 65 DB (FD) AND 58 DB (FE) FULL GAIN.
AUTOMATIC VOLUME CONTROL	AUTOMATICALLY REGULATES GAIN TO CONSTANT OUTPUT OF +10 DBM.
PAD	SELECTED TO GIVE THE DESIRED LEVEL AT THE INPUT TO THE PATCHING EQUIPMENT.
IF BUFFER AMPLIFIER (MAIN OR TERMINAL STATION ONLY)	ACCEPTS +3 TO +5DBM (TUBE-TYPE) OR -7 TO +3DBM (SOLID STATE) INPUT AND PUTS OUT AN ADJUSTABLE LEVEL AS REQUIRED FOR THE TRANSMITTER MODULATOR.
5-DB PAD (AUXILIARY STATIONS ONLY)	IMPROVES THE IF INPUT IMPEDANCE TO THE TRANSMITTER MODULATOR.
COMMON MICROWAVE GENERATOR (AUXILIARY STATIONS ONLY)	QUARTZ CRYSTAL-CONTROLLED HARMONIC GENERATOR PRODUCES LOCAL MICROWAVE FREQUENCY. ALSO PROVIDES LOCAL MICROWAVE SIGNAL FOR USE WITH 40-MHZ SHIFTER.
TRANSMITTER MODULATOR	AN ELECTRON TUBE MODULATOR COMBINES 70-MHZ IF FM SIGNAL WITH LOCAL MICROWAVE FREQUENCY TO PRODUCE MICROWAVE TRANSMITTING SIGNAL, >5-DB GAIN. BF FILTER SELECTS PROPER SIDEBAND AND REJECTS UNWANTED SIDEBANDS.
TRANSMITTER MODULATOR FILTER	PASSES ONLY DESIRED FM MICROWAVE SIDEBAND.
TRANSMITTER LOCAL MICROWAVE GENERATOR (MAIN OR TERMINAL STATION ONLY)	QUARTZ CRYSTAL-CONTROLLED HARMONIC GENERATOR PRODUCES LOCAL MICROWAVE FREQUENCY THAT IS 70 MHZ REMOVED FROM OUTGOING MICROWAVE SIGNAL.
TRANSMITTER AMPLIFIER	A 3-STAGE ELECTRON TUBE AMPLIFIER WHICH AMPLIFIES TRANSMITTED SIGNAL.
17-TYPE ISOLATOR	SIMULATES A GOOD IMPEDANCE MATCH TO THE AMPLIFIER OUTPUT. USE (H) OPTION FOR +33 AND +37 DBM OPERATION.
POWER OUTPUT MONITOR	SAMPLES OUTPUT POWER FOR BAY TRANSMISSION TESTS, POWER OUTPUT METER, AND TO INITIATE LOW POWER OUTPUT ALARM. (OUTPUT / 60A PAD: +30 DBM NONE; +33 DBM 4-DB; +37 DBM 8-DB)
TRANSMITTER CHANNEL COMBINING NETWORK	PASSES THIS MICROWAVE SIGNAL TOWARDS ANTENNA AND COMBINES THE SIGNAL WITH SIGNALS FROM OTHER CHANNELS TO BE TRANSMITTED.

LEVEL AND POWER DIAGRAM (APPROXIMATE)

	OPTION (L)	(L) (WHEN 19D PAD IS 15 DB) (OPTION FE)	OPTION (M)	(M)
BEAT FREQUENCY REJECTION FILTER OR FLEXIBLE WAVEGUIDE	*-33, *-30, *-26	+-65, -68	*-33, *-30, *-26	+-62
IMAGE SUPPRESSION FILTER	-33.5, -30.5, -26.5	-65.5, -68.5	-33.5, -30.5, -26.5	-62.5
8A OR 19A ISOLATOR	-34, -31, -27	-66, -69		
RECEIVER CONVERTER OR MODULATOR	-38, -35, -31	-70, -73	-39.5, -36.5, -32.5	-68.5
IF PREAMPLIFIER	-5, -2, -0	-37, -40	-23, -20, -16	-52
IF EQUALIZER	-5.5, -2.5, -0.5, -0.5	-37.5, -40.5	-23.5, -20.5, -16.5	-52.5
IF FILTER(S)	-8 (15-DB PAD), -5 (15-DB PAD), -3 (15-DB PAD), -8 (OPTION FE)	-40 (15-DB PAD)	-26, -23, -19	-55
19D PAD	-23, -20, -18, -8	-55, -48		
IF MAIN AMPLIFIER	+10, +10, +10	+10	+10, +10, +10	+10
TERMINAL OR MAIN STATION EQUIPMENT	+30 DBM TRANSMITTER OUTPUT (1-WATT), +33 DBM TRANSMITTER OUTPUT (2-WATT), +37 DBM TRANSMITTER OUTPUT (5-WATT)		+30 DBM TRANSMITTER OUTPUT (1-WATT), +33 DBM TRANSMITTER OUTPUT (2-WATT), +37 DBM TRANSMITTER OUTPUT (5-WATT)	
COMMON MICROWAVE GENERATOR	+5, +5, +5		+5, +5, +5	
TRANSMITTER MODULATOR	+12, +12, +12		+12, +12, +12	
TRANSMITTER MODULATOR FILTER	+12, +12, +12		+12, +12, +12	
17-TYPE ISOLATOR	+30, +33, +37	—	+30, +33, +37	—

NOTES:

1. LEVEL AND POWER DIAGRAM FIGURES IN DBM.
2. FILTER ADDED ON OPTIONAL BASIS ON PRE-1955 BAYS.
3. OPTION:
   - (L) IS FOR RECEIVERS USING THE J68387P RECEIVER MODULATOR AND IF PREAMPLIFIER.
   - (M) IS FOR RECEIVERS USING THE J68330D OR J68330P RECEIVER CONVERTER AND IF PREAMPLIFIER.
   - (FD) IS FOR RECEIVERS USING THE J68330A IF MAIN AMPLIFIER
   - (FE) IS FOR RECEIVERS USING THE J68330T IF MAIN AMPLIFIER

* THE TYPICAL REPEATER SECTION LOSS, MEASURED FROM THE INPUT ARM OF THE TRANSMITTER COMBINING NETWORK OF ONE STATION TO THE DROP ARM OF THE RECEIVER CHANNEL SEPARATING NETWORK AT THE NEXT STATION, IS 63 DB.

† MINIMUM SIGNAL WHICH CAN BE FULLY COMPENSATED WITH IF AMPLIFIER OUTPUT OF +10 DBM AND CORRESPONDS TO A:

(L) 32-DB FADE WHEN RECEIVING FROM A +30 DBM TRANSMITTER
35-DB FADE WHEN RECEIVING FROM A +33 DBM TRANSMITTER } OPTION (FD)
37-DB FADE WHEN RECEIVING FROM A +37 DBM TRANSMITTER
40-DB FADE WHEN RECEIVING FROM A +37 DBM TRANSMITTER > OPTION (FE)
(M) 29-DB FADE WHEN RECEIVING FROM A +30 DBM TRANSMITTER
32-DB FADE WHEN RECEIVING FROM A +33 DBM TRANSMITTER
36-DB FADE WHEN RECEIVING FROM A +37 DBM TRANSMITTER

Fig. 9—TD-2 Transmitter-Receiver Bay—Block Diagram

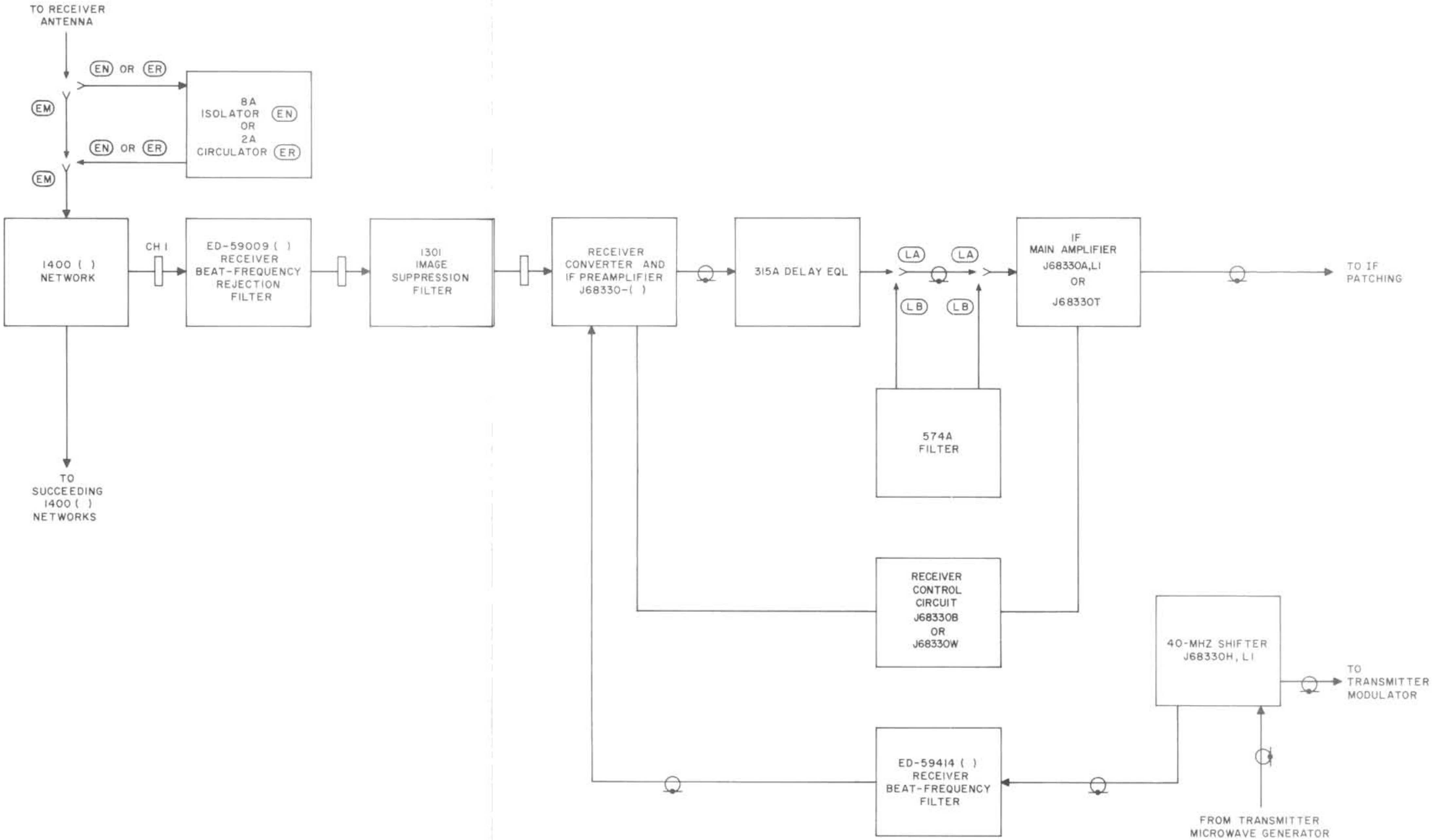


Fig. 10—TD-2 Repeater Station Receiver Equipped With J68330-( ) Receiver Converter and IF Preamplifier—Block Diagram

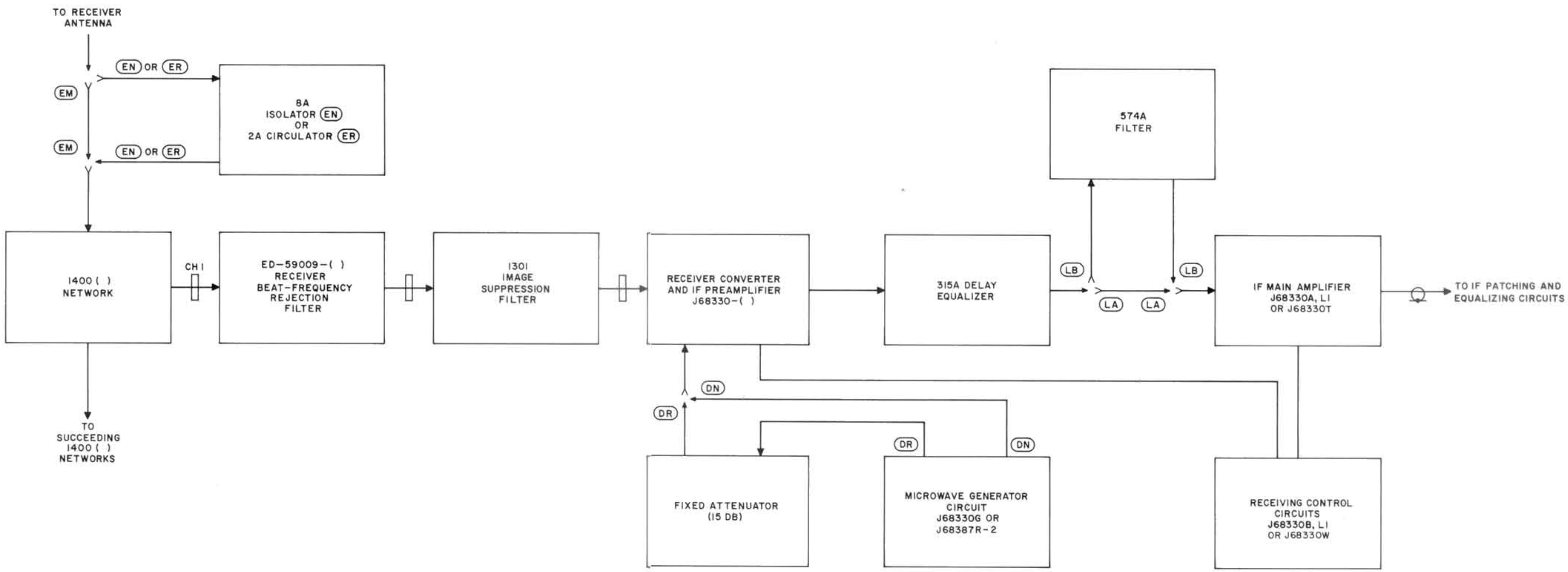


Fig. 11—TD-2 Main Station Receiver Equipped With J68330( ) Receiver Converter and IF Preamplifier—Block Diagram

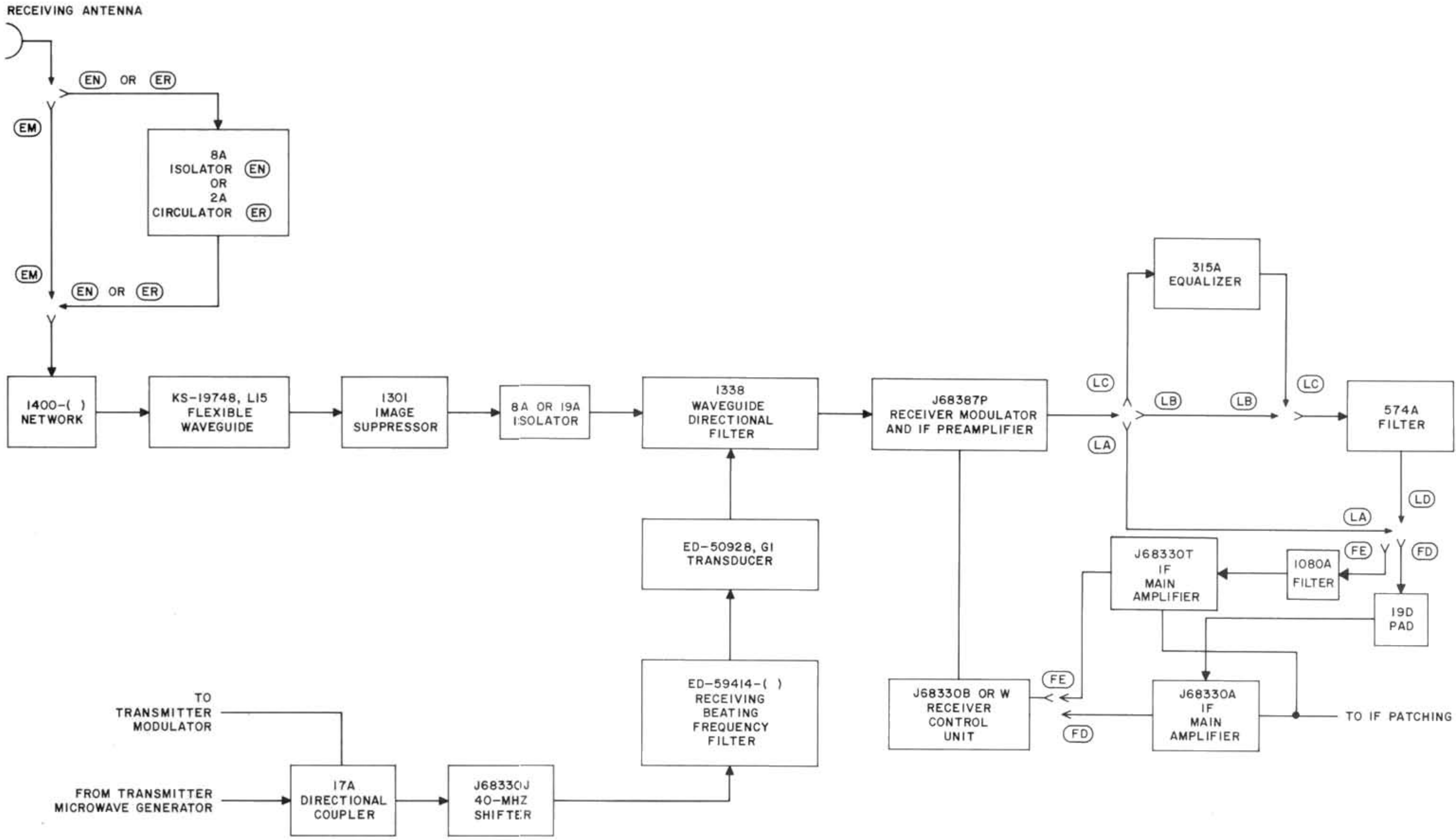


Fig. 12—TD-2 Repeater Station Receiver Equipped With J68387P Receiver Modulator and IF Preamplifier—Block Diagram

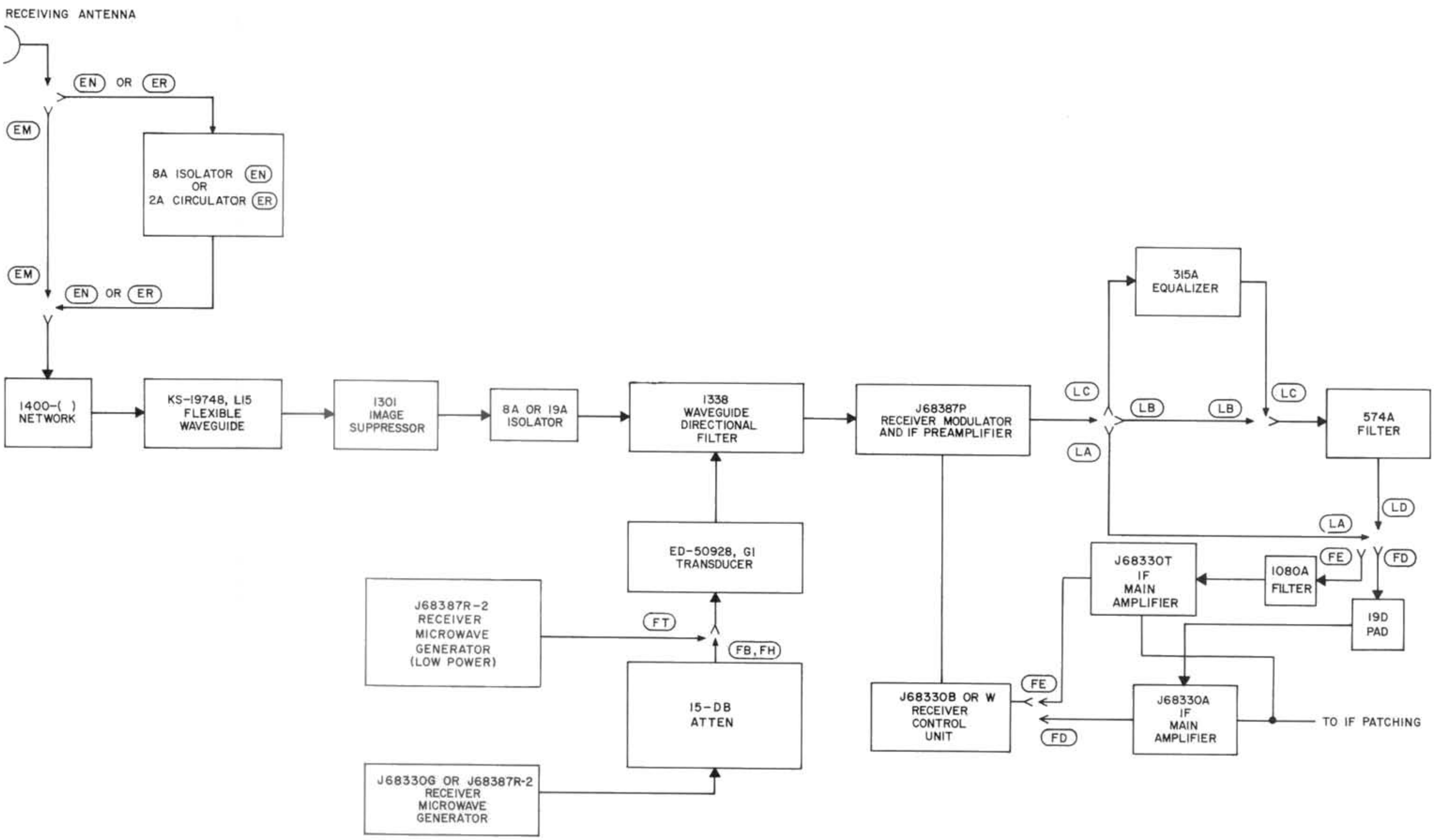
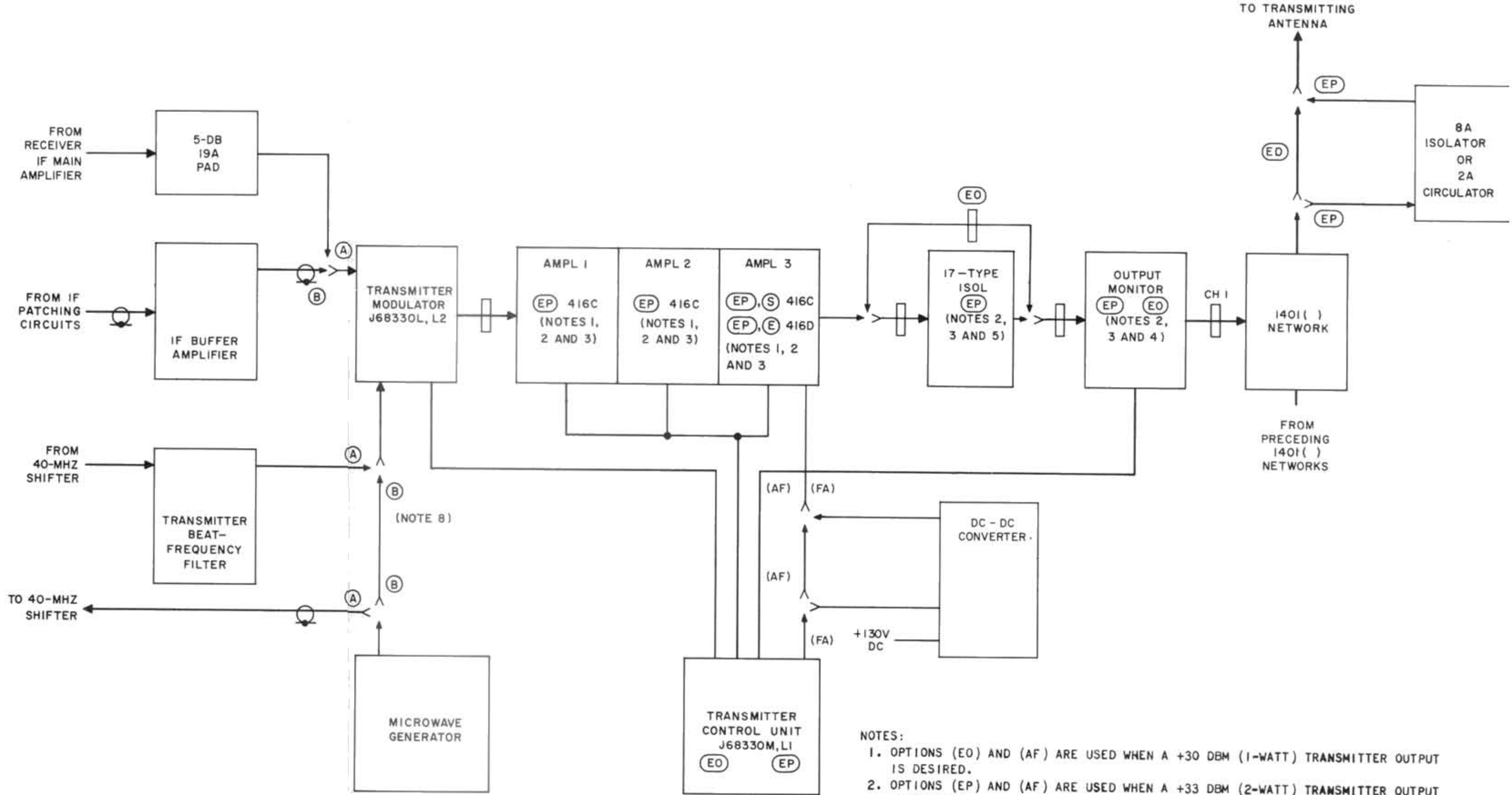


Fig. 13—TD-2 Main Station Receiver Equipped With J68387P Receiver Modulator and IF Preamplifier—Block Diagram



NOTES:

1. OPTIONS (EO) AND (AF) ARE USED WHEN A +30 DBM (1-WATT) TRANSMITTER OUTPUT IS DESIRED.
2. OPTIONS (EP) AND (AF) ARE USED WHEN A +33 DBM (2-WATT) TRANSMITTER OUTPUT IS DESIRED.
3. OPTIONS (EP), (S) AND (FA) MAY BE USED WHEN A +37 DBM (5-WATT) AT 475V TRANSMITTER OUTPUT IS DESIRED AND OPTIONS (EP), (E) AND (AF) MAY BE USED WHEN A +37 DBM (5-WATT) AT 250V TRANSMITTER OUTPUT IS DESIRED.
4. FOR OPERATION WITH A +33 DBM TRANSMITTER, INSERT A 60A PAD PER OPTION (EP) SET AT A 4-DB LOSS IN THE POWER MONITOR ARM. FOR +37 DBM OPERATION, USE OPTION (EP) SET AT 8-DB LOSS. A PAD IS NOT REQUIRED FOR THE +30 DBM TRANSMITTER.
5. SEE LATEST ISSUE OF SD-59411-01 FOR CORRECT NUMBER OF 17-TYPE ISOLATORS FOR FREQUENCY USED.
6. SEE LATEST ISSUE OF SD-59403-03 FOR CURRENT CIRCUIT INFORMATION.
7. OPTION (A) FOR REPEATER STATION; OPTION (B) FOR TERMINAL OR MAIN STATION.

Fig. 14—TD-2 Transmitter—Block Diagram