# TOLL SYSTEMS
# TD RADIO
# APPLICATION SCHEMATIC
# FOR TD-3D
# TRANSMITTER-RECEIVER BAY

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# SECTION I - GENERAL DESCRIPTION

## 1. PURPOSE OF CIRCUIT

1.01 This circuit provides a radio receiver and a radio transmitter for the TD-3 Microwave Radio System. The receiver accepts a microwave signal in the 3700- to 4200-MHz frequency band and provides a 70-MHz IF output signal to other circuits. The transmitter accepts a frequency modulated IF input signal from other circuits and provides an output signal in the microwave band. At a repeater station, the transmitter-receiver (T/R) bay operates as a repeater on a single one-way channel in one direction of transmission. At a main station, provision is made for operating a receiver on a single one-way channel in one direction of transmission, and a transmitter on a single one-way channel in the opposite direction of transmission.

1.02 The equipment provided by the T/R bay is electrically compatible with that of the TD-2, TD-3, and TD-3A T/R bays, which the present circuit replaces. The equipment provided by this circuit will interface properly into bay lineups of the earlier equipment that are not complete.

1.03 The circuit provides an application of the T/R bay in either a hot standby-space diversity (HS/SD) or hot standby (HS) only arrangement. These arrangements provide protection in systems having only one or two regular radio channels and no frequency diversity (DIV) protection channel.

1.04 The circuit provides test access points for connecting into the circuit, without opening waveguide, both a portable microwave repeater and the T/R bay test equipment. The portable repeater is used as a substitute on a temporary basis for an out-of-service T/R bay. This is a reliability feature that enables circuit continuity to be maintained on regular channels in systems using frequency diversity protection while routine maintenance or troubleshooting is performed on the bay to which the portable repeater is connected. This arrangement frees the protection channel from maintenance or troubleshooting duty. The portable repeater also may provide a temporary replacement for a protection channel bay taken out of service. The access points in the circuit are located in a manner to permit the T/R bay channel frequency determining filters to be used by the portable repeater. This simplifies the tuning procedure of the portable repeater.

## 2. GENERAL DESCRIPTION OF OPERATION

2.01 The circuit consists of the wiring and figure arrangement for a microwave receiver and a microwave transmitter. Information Fig. 101 shows the circuit of a receiver and transmitter connected in a repeater station arrangement. Fig. 102 shows the circuit connections of a main station receiver and a main station transmitter. Fig. 110 shows the circuit connections when the repeater station bay is used in an HS/SD or HS only arrangement, and Fig. 111 shows these arrangements for a main station.

2.02 For general purposes, the repeater bay (Fig. 101) will be described.

### RADIO RECEIVER CIRCUIT OPERATION

2.03 A circulator and bandpass filter are provided at the input to the radio receiver to select the desired radio channel. The circulator is a three-port magnetic-ferrite device which interacts with the microwave signal injected at any port, causing it to circulate in one direction only and exit at the next adjacent port. The circulator acts in conjunction with the receiver channel bandpass filter to select the desired radio channel from others in the common waveguide run. From the receiving antenna, all channels on a given polarization enter the first port of a circulator in the first bay in a lineup. Here all channels circulate to the adjacent port (labeled TERM). Assuming a standard bay lineup in which the bays are installed in ascending frequency order from the antenna, the channel bandpass filter in the first bay selects and passes the lowest frequency channel to the receiver-modulator in that bay. The remainder of the channels see essentially a short circuit since they fall outside the passband of the filter. These channels are reflected back into the circulator where they circulate to the next port and exit. From there they proceed to the first port of the next circulator in the lineup which will drop the next lowest frequency channel and so on down the bay lineup until all channels have been dropped. Up to six receivers, each separated by 80 MHz, may be interconnected in this fashion in a bay lineup.

2.04 In addition to helping separate the incoming channels, the receiver channel bandpass filter provides selectivity against adjacent channel interference. The selected channel, appearing at the output of the filter, is shifted to an IF signal in the 70-MHz range by a low noise receiver modulator and IF preamplifier. A receiver modulator filter is used to apply both the signal and beat oscillator (BO) power to the receiver modulator. BO power is supplied by a 40-MHz shift modulator circuit fed from a microwave generator described in the transmitter section of SECTION II, paragraph 2.26. An IF filter following the preamplifier provides additional bandpass selectivity. This is followed by a basic equalizer which provides equalization for the delay distortion of the receiver and transmitter channel bandpass filter. An IF main amplifier follows which provides automatic gain control (AGC) to maintain the receiver IF output signal constant during up-fades and down-fades of the RF input signal.

## RADIO TRANSMITTER CIRCUIT OPERATION

2.05 The IF signal from the output of the receiver is applied to the driver amplifier-transmitter modulator circuit which converts the IF signal to a microwave output signal. The transmitter modulator filter, which is tuned to the transmitter channel frequency, selects the desired sideband at the modulator output and attenuates other, unwanted, products generated in the modulator. BO power from a microwave generator is applied to the modulator through one output of the distribution network, a microwave integrated circuit. The other output of the distribution network is applied to the 40-MHz shift modulator which, in turn, supplies BO power to the receiver modulator. Thus, the shift modulator provides a 40-MHz frequency difference required between the receiver and transmitter BO frequencies. The output signal from the transmitter modulator filter is amplified by a transmitter amplifier to the power required for transmission. The output signal is delivered through a bandpass filter-circulator combination which combines the signal, along with the signals from other channels, for delivery to the transmitting antenna. The bandpass filter provides additional selectivity required at the transmitter output. The bandpass filter-circulator combination permits connecting up to six radio transmitters, each separated by 80 MHz, in a common bay lineup.

2.06 To combine radio channels for transmission onto a waveguide run the circulators perform in a similar manner as described in paragraph 2.03 for dropping channels. Starting at a transmitter bay at the end of the bay lineup farthest from the antenna, the output signal from this first bay is passed through its frequency selective bandpass filter and enters one port of the associated circulator. The signal energy propagates to the adjacent port of the circulator and exits toward the next bay in the lineup where it enters the circulator in that bay. The signal exits at the adjacent port to which is connected the transmitter bandpass filter for that bay. This bandpass filter provides a reflection to signals outside the pass band. Thus, the signal from the preceding bay is reflected back into the circulator. The transmitter output signal from the second bay also enters this circulator. These signals exit at the next adjacent port of the circulator in the direction toward the circulator of the third transmitter bay. Continuing in this manner, the output signal from each transmitter is combined in the waveguide run.

## DC POWER DISTRIBUTION - FIG. 65

2.07 All of the active circuits in the T/R bay, with the exception of the transmitter amplifier, require regulated -19 volts dc. The three stage, electron tube, transmitter amplifier requires dc input voltages of -12 and +250 volts, while the replacement solid-state transmitter amplifier operates from the -24 volt supply. Depending on the voltages available at the station, various plug-in regulators or dc-to-dc converters are required in the T/R bay to supply these voltages. Converters that perform this function are the 88A power unit, Fig. 21, which converts an input dc voltage of -12 volts to a regulated -19 volt dc output; a 75A/76A power unit in the control, alarm, and meter circuit, Fig. 15, which supplies -12 volts dc and +250 volts dc from a -24 volt dc input at TD-3 stations; and a 281A (Fig. 67) or 305B (Fig. 69) power unit which supplies -24 volts (from a -12 volt input) for the 2 watt or 5 watt, respectively, solid-state transmitter amplifier in TD-2 stations with insufficient -24 volts. Regulated -19 volts dc output from a -24 volt dc input supply is provided by the 92B power unit, Fig. 20. In a station equipped with only a -24 volt battery plant, for example, the T/R bay would require a -12/250 volt converter to supply the transmitter amplifier and a 92B power unit to supply regulated -19 volts dc to all of the other circuits.

2.08 The following table shows the number of converter-regulators and the wiring option required in a T/R bay for the type of station shown. TD-2 repeater (auxiliary) stations, as indicated in the table, may have a -24 volt battery which may be sufficient (SUFF) or insufficient (INSUFF) to supply the required current for a bay lineup. The V or Z wire option, shown on Fig. 65, is used at repeater stations to apportion the output of either one 92B, Fig. 20, or two 88A converter-regulators, Fig. 21, to feed the T/R bay circuits. The V option permits one 92B power unit to feed both transmitter and receiver circuits. This is done by strapping the A2 terminals on J1 and J2. The Z option apportions the output of the two 88A power units between the transmitter and receiver circuits so as not to exceed the output current capacity of one 88A power unit. Since the dc current output from one 88A is sufficient to power only one microwave generator, the Z option straps provide for one 88A to power the microwave generator and the other 88A to power the remaining receiving circuits plus the transmitter modulator. Since the -19 volts



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| | TYPE OF STATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | MAIN | | | | REPEATER | | | | |
| | TD-3 TD-3A TD-3D | | TD-2 | | TD-3 TD-3A TD-3D | TD-2 | | | |
| | | | | | | SUFF -24V | INSUFF -24V | | |
| | | | | | | | TUBE TYPE TRMTR AMPL | SOLID STATE TRMTR AMPL | |
| | TRMTR | RCVR | TRMTR | RCVR | | | | 2W | 5W |
| WIRING OPTION | - | V | - | V | V | V | Z | Z,ZS | Z,YD |
| PWR UNIT 92B | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| 88A | | | | | | | 2 | 2 | 2 |
| CONVERTER -24V TO -12V+250V | 1 | | 1* | | 1 | 1* | | | |
| PWR UNIT 281A | | | | | | | | 1 | |
| PWR UNIT 305B | | | | | | | | | 1 |

*Used in TD-2 stations where the 425A power plant, (-12V, +130V, +250V), has been replaced by the 111A power plant (-24V).

output from the 88A appears only at the A1 terminal of jacks J1 and J2, it is necessary to tie terminal A1 on J1 to A2 on J1 and J2 via the Z option strap.

2.09 A 500-uF capacitor is connected across the -19 volt output of the 88A converter-regulator, in Fig. 21, to suppress and prevent noise at the chopping frequency of this unit from affecting circuits in the bay.

2.10 Filters, Fig. 34, may be placed in the -12 or -24 volt dc power leads to provide ligntning or other transient protection for the bay circuits.

2.11 As noted in the preceding paragraphs, the T/R bay may be powered from either a -24 volt or from a -12 volt, +250 volt battery plant or both. -12 volt and +250 volt plants are used typically for powering TD-2 Systems, and -24 volt plants are used for TD-3 Systems. Leads 9 and 9 RTN connect to -24 volts to power either a repeater station bay or a main station transmitter. Leads 10 and 10 RTN connect to -24 volts to power a main station receiver bay. Leads 11 and 11 RTN connect to -12 volts, and leads 12 and 12 RTN connect to +250 volts. This connection would be made typically at a TD-2 station where these voltages are available. If there is insufficient -24 volts, however, the Z option is made which straps leads 9 and 10 to lead 11 (the RTNs are common) and no external voltage is brought to leads 9 or 10. This permits the -12 volts to feed the bay circuits through leads 9 and 10. In this arrangement, a lightning filter, FL9, Fig. 34, is connected in lead 10 (T option). Leads 9 and 10 will feed two 88A power units for conversion to -19 volts, and the -12 volts on lead 11 will feed the transmitting amplifier circuit.

## HS/SD DC POWER DISTRIBUTION

2.12 When the transmitter-receiver bays are arranged in an HS or HS/SD application, sufficient -24 volt dc station power is necessary and is supplied to the regular and standby T/R bays through separately fused buses. The RF switch and relay, Fig. 31, located in the regular bay, receives its operating current from a connection to terminal A3 of J2 in the standby bay at either a repeater or a main station.

## SECTION II - DETAILED DESCRIPTION

### 1. REPEATER STATION RECEIVER CIRCUIT OPERATION - FIG. 101

1.01 Microwave signals in the 34700- to 4200-MHz frequency band are received at circulator AT1, Fig. 1 (see Fig. 127). The desired 20-MHz wide channel to which the receiver is tuned is selected by the channel bandpass filter FLT1, Fig. 2. Other channel frequencies are reflected and pass back through AT1 to succeeding receivers as described in paragraph 2.03. The selected signal passes through the monitor shutter assembly MT3, Fig. 3, in Fig. 127. This assembly may be used to connect a portable repeater at port B, as described in SECTION I, paragraph 1.04, and to inject a test signal, eg, a swept RF for aligning the receiver, at port A. The shutter assembly functions by inserting three externally supplied shorting plates across the guide and two externally supplied coaxial probes. This effectively makes the shutter assembly into two back-to-back waveguide-to-coaxial transducers.

1.02 The signal passes through isolator AT2, Fig. 4 in Fig. 101, which absorbs the image frequency and other unwanted products produced in the receiver modulator. The signal is then fed to the directional filter FLT2, Fig. 5, where it is combined with the BO signal and fed to the receiver modulator for down conversion. The BO signal is supplied from the 40-MHz oscillator-shift modulator circuit which shifts the microwave generator frequency by 40 MHz to obtain the BO frequency required by the receiver. The output of the shift modulator is passed to the BO port of the FLT2 through bandpass filter FLT3, Fig. 18, which removes the unwanted 40-MHz sideband and other products generated in the modulator. The directional filter FLT2, provides low-loss transmission from the signal and BO ports to the output port; but provides isolation between the signal and BO ports. The output of filter FLT2, is connected to the input of the low noise receiver modulator-IF preamplifier circuit, Fig. 6. The incoming channel RF signal mixes with the BO input in the nonlinear diode of the receiver modulator and produces an IF output signal. The preamplifier provides gain for the IF signal. Jack J8, Fig. 65, which connects to the receiver modulator-IF preamplifier, provides leads for applying dc power and for metering two functions; the modulator diode bias current and a dc analog voltage inversely proportional to BO power.

1.03 The IF signal at the IF OUT jack of the receiver modulator-IF preamplifier is applied to IF filter FLT4, Fig. 7, which is a combined bandpass-low-pass filter. The bandpass portion of the filter provides additional selectivity to reduce adjacent channel interference and to prevent interfering carriers from affecting the AGC or carrier resupply circuits in the bay. The low-pass portion prevents harmonics of the 70-MHz carrier generated in the IF preamplifier circuit from reaching the IF main amplifier where they could recombine with the fundamental and cause distortion (cross-modulation noise).

1.04 The IF signal at the output of filter FLT4 is applied to either a parabolic delay equalizer, Fig. 8, plus a fixed, positive or negative, delay slope equalizer, Fig. 25 or 53, or the slope equalizer only. The various arrangements are shown in Fig. 122, 123, and 124. The basic parabolic equalizer is treated as a mop-up equalizer and is installed in receivers on an as-required basis, as determined by switching section envelope delay distortion (EDD) tests. These equalizers compensate for the EDD produced by the bay waveguide filters in the signal path. Any one of several slope equalizers can be placed in Fig. 124 or 125 to compensate (mop-up) for whatever residual delay accrues in a switching section due to variations not matched by the parabolic equalizer. This mop-up equalization is installed on the basis of field measurements. Until a selection of delay equalizers is made, an IF cable, Fig. 45, is provided for circuit continuity.

1.05 The IF signal, after equalization, is applied to the IF IN jack of the IF main amplifier, Fig. 9. This amplifier provides normally about 18 dB of gain under a nonfade condition. During downfaces (typically, down to 40 dB) or unfades (up to 6 dB) of the radio signal at the receiver input, the amplifier gain changes under the control of an internal AGC circuit which maintains a nearly constant output power at the IF OUT jack. The IF main amplifier also provides a carrier resupply circuit, in frequency diversity systems, which is switched on and off by the AGC voltage. Whenever the IF input at IF IN drops to a predetermined level due to, for example, very deep fading of the radio signal at the receiver input, the resupply circuit switches on. The resupply inserts a high loss in the normal through path and substitutes a 70-MHz carrier, frequency modulated by a 9-MHz tone, at the IF OUT jack. The 9-MHz tone is used to inform an external protection switching system that the channel is out of service. The resupplied carrier maintains the normal gain condition in the IF main amplifiers of the succeeding repeaters in a switching section. This prevents amplification and subsequent spillover of noise into adjacent channels. When the IF input power is reestablished at IF IN, the carrier resupply circuit switches off and the normal through transmission path through the amplifier is restored. In the event the carrier resupply circuit is turned on for more than 45 seconds, an alarm, in the form of a ground, appears on terminal 3 of J9, Fig. 65. To provide the carrier resupply and delayed alarm features, option Y for the IF main amplifier is required. The IF main amplifier also provides indications to an external switch control circuit when used in an HS/SD arrangement. Jack J9 provides leads for dc power, for connecting the delayed alarm, for transmitting switching information in HS/SD applications, and for metering the AGC voltage. The AGC voltage is used to monitor the received carrier power. This is designated as RCVD CARR PWR on the meter selector switch.

1.06 The IF output signal from the IF main amplifier is applied to Fig. 104. Fig. 104 provides a connecting cable and pad which reduces the normal +10 dBm output of the IF main amplifier to a value of -7 dBm, the normal input power to the IF driver amplifier-transmitter modulator, Fig. 10.

REPEATER STATION BRIDGING CONNECTION - FIG. 101

1.07 Provision is made for diverting a portion of the IF output of the radio receiver to other circuits, for example, a TV drop, by means of the bridging arrangement in Fig. 119. The bridging is accomplished by means of an equal split hybrid transformer HYB 3, Fig. 30. The drop or "bridge" port is accessible for the bridged facility. The available IF output power at this port is +6.8 dBm as indicated in Circuit Note 121. Pad AT3 adjusts for the proper IF input power at the input to the transmitter-modulator due to the insertion loss added by HYB 3, which is approximately 3 dB.

## 2. REPEATER STATION TRANSMITTER CIRCUIT OPERATION - FIG. 101

2.01 The repeater station transmitter accepts an IF signal at the IF IN jack of the IF driver amplifier-transmitter modulator circuit. The input signal is amplified by the IF driver amplifier and is mixed in the nonlinear diode of the transmitter modulator (upconverter) with a BO signal to produce two RF sidebands at frequencies equal to the BO frequency plus and minus the IF. The modulator has a single RF port which serves as input for the BO and as output for the two sidebands. Jack J12, Fig. 65 provides dc power to the modulator circuit.

MICROWAVE DISTRIBUTION NETWORK

2.02 The RF signals contained in the output of the transmitter modulator are the two RF sidebands plus a portion of the original BO signal and, to a lesser extent, harmonics of these signals. These signals are applied to port 2 of the distribution network Fig. 11. The distribution network is a microwave integrated circuit composed of stripline components which divides the microwave generator power into two parts; one for the receiver, the other for the transmitter. The 40-MHz shift modulator for the receiver and the transmitter modulator units are attached to waveguide ports of the distribution network with separation of the input and output microwave signals for these units being accomplished by circulators within the network. The microwave generator (MWG) signal is fed to port 1 and then to circulator F. The signal travels counterclockwise in F, exits at the nearest port, and appears at the power splitter (PWR SPLIT). The latter item is a factory adjusted capacitor connected in shunt with the 50-ohm stripline. Since the added capacity disturbs the line impedance, part of the incident power will be reflected back toward circulator F and the remainder will continue onward to circulator E. The reflected signal travels through circulator G, which serves as an isolator, to circulator A and then to the diode in the shift modulator connected to port 4. There, it is combined with the 40-MHz oscillator signal to produce signals at frequencies 40 MHz above and below the frequency of the MWG signal. These signals, together with MWG power not converted by the diode, appear at output port 5. The wanted frequency signal flows through the filter FLT3, to the receiver modulator. The unwanted signals are reflected by the filter and are dissipated in the termination connected to circulator B. In a manner similar to that just described, MWG power flowing through the power splitter is delivered to the transmitter modulator connected to port 2. The power splitter is adjusted to provide an uneven BO power division of +20 dBm to the transmitting modulator and +18 dBm to the 40 MHz shifter. The RF signals from the transmitter modulator pass through circulators D and C in a clockwise direction and exit at port 3.

2.03 A monitoring diode in the distribution circuit is coupled to the stripline circuit between circulators E and D. Its dc output, at terminals A and G, is a measure of the output power of the microwave generator and is indicated as MWV GEN OUT on the meter selector switch. Circulator E provides additional isolation between the receiver and transmitter portions of the repeater.

2.04 The transmitter modulator bandpass filter FLT5, Fig. 12, selects the sideband corresponding to the transmitter frequency and reflects the unwanted sideband and any other products of modulation not passed by the filter. These reflected signals are dissipated in the termination connected to circulator C in Fig. 11.

TRANSMITTER AMPLIFIER CIRCUIT, GENERAL - FIG. 106 (See Fig. 143)

Note: T/R bays manufactured beginning with SD-51546-01, Issue 28B, will be equipped with a solid-state transmitter amplifier, Fig. 66 or Fig. 69. For the



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description, refer to Part 11 of this SECTION. Fig. 66 or Fig. 69 function in the circuit as an RF power amplifier in the same manner as Fig. 106.

2.05 The signal at the desired transmitter frequency, passed by filter FLT5, Fig. 12, is amplified by the transmitter-amplifier, Fig. 106. The transmitter-amplifier is composed of three, grounded grid, triode amplifier stages and is capable of an output power of approximately +37 dBm (5 watts), with an approximate gain of 25 dB. Each stage consists of a 416-type electron tube, Fig. 35, operating in a structure, Fig. 28, in which the input and output cavities are tunable. Fig. 36 is recommended for the last stage when 5-watt operation is desired.

DESCRIPTION OF TYPICAL STAGE

2.06 The first two stages are alike except for the RF powers at which they operate. The last stage is similar to the first two stages with the addition of a filter section for broadbanding.

INPUT CIRCUIT TO EACH STAGE

2.07 The input to each stage is fed to a capacitively loaded iris at the input to the cavity assembly through an impedance tuner (part of the tuner-transducer, Fig. 27) capable of tuning out a standing wave of 8 dB.

2.08 The input of each cavity is loaded by the input conductance and the ceramic loss of the tube. Coupling into the cavity is adjusted by rotating a capacitive screw in the input iris. Thus, the input circuit without the impedance matching section is a single tuned circuit heavily loaded by the input conductance of the tube. Since no adjustment is available in the input conductance of the tube and since no loading resistance is provided in the input cavity, the tuner is required to obtain a good impedance match.

2.09 The tuner portion of the tuner-transducer assembly consists of two antiresonant circuits separated by approximately 1/8 wavelength; this combination is separated by approximately 1/8 wavelength from the input iris capacitive screw. The two rods act as inductances, and the two screws act as adjustable capacitances.

FREQUENCY BANDWIDTH OF INPUT CIRCUIT (EACH STAGE)

2.10 An impedance match having a bandwidth of over 20 MHz can be obtained in the input circuit when both the input and output circuits are matched. The adjustment of these circuits is done using an in-bay alignment procedure in which the input and output tuning of the stage is adjusted for maximum power transfer.

INTERSTAGE CIRCUIT

2.11 The output circuit of one stage and the input circuit of the next, each of which is antiresonant, are separated by an odd number of 1/4 wavelengths by a tuner-transducer assembly. This forms a bandpass filter which is approximately 30 MHz wide at the 1-dB down points.

2.12 Z1, Z2, and Z3, Fig. 27, are tuner-transducers that permit the in-bay alignment of the amplifier to be made without mechanical disassembly. This interstage allows access to the through-signal via a threaded coaxial probe and a waveguide short circuit which slides into place behind the probe to form a waveguide to coaxial transducer.

PLATE CIRCUIT OF THE TUBE

2.13 A small resonant section of coaxial line is connected to the plate of the tube with the high-impedance end of the line located at the plate. A 1/4 wavelength coaxial transformer is located at the low impedance point of this line which transforms the impedance at this point to match a 47-ohm coaxial line. The 47-ohm coaxial line terminates in a broad-band transducer with variable capacitive loading. Variation of the position of the 1/4 wave transformer changes the inductance of the resonant section of line for tuning. Variation of the capacitive loading of the transducer varies the coupling between the plate circuit and the transducer.

OUTPUT CIRCUIT OF AMPLIFIER

2.14 The output circuit consists of the equivalent of a two-section bandpass filter terminated on one end by the variable loading and plate resistance of the tube and, on the other end, by the characteristic impedance of the waveguide. Effectively, the plate circuit and associated cavity form one antiresonant circuit, and a single building-out filter section (antiresonant circuit in waveguide) is the other circuit. These circuits are electrically separated by an odd number of 1/4 wavelengths forming a bandpass filter with a bandwidth of approximately 30 MHz at 0.1 dB down and approximately 80 MHz at 3 dB down.

BUILDING OUT FILTER SECTION, FLT7

2.15 This section is spaced approximately 1/4 wavelength from the electrical position of the plate circuit. It consists of a resonant iris, the hole forming an inductance, and the two posts forming a capacitance shunted across the inductance.

The filter is tuned by means of a screw which varies the capacitance. The bandwidth at the 3-dB down points is approximately 100 MHz.

2.16 A 19A isolator AT4, on Fig. 143, is added to the output filter FLT7, Fig. 106, to provide a good impedance match to the transmitter channel bandpass filter FLT6, Fig. 101. The monitor shutter assembly, Fig. 3, in Fig. 101, permits an in-bay tuning of AMPL3, the final stage of the transmitter amplifier. An external probe may be connected to port A for this purpose. The detector MON1, at port B, detects a portion of the RF output power for metering and alarm purposes. (For additional information on the monitor-shutter assembly, see SECTION II, paragraph 1.01.)

TYPICAL CHARACTERISTICS OF COMPLETE TRANSMITTER AMPLIFIER

A. Bandwidth

2.17 The transmission band is capable of being tuned flat to 0.1 dB for approximately 20 MHz and is approximately 70 MHz wide at the 3-dB down points.

B. Gain and Output Power

2.18 The output stage normally delivers +37 dBm (5 watts) with a gain of approximately 4 dB. The second stage delivers an output of approximately +33 dBm with a gain of 7 dB. The first stage delivers an output power of typically +26 dBm with an approximate gain of 12 dB to 14 dB. The amplifier may be adjusted to give lower output power. This may be necessary because of interference or other considerations at a particular station.

OUTPUT CIRCUIT OF TRANSMITTER

2.19 The output of the transmitter amplifier passes through the monitor shutter assembly where a portion of the RF signal is detected by an RF detector MON1, Fig. 14. The dc output voltage of the detector is used for meter and alarm purposes.

2.20 The transmitter channel bandpass filter FLT6 provides additional suppression of unwanted products generated in the transmitter modulator and contributes to the total selectivity required in the repeater to minimize interference between adjacent channels.

2.21 The output from filter FLT6 enters circulator AT5 and, due to the directional properties of the circulator, combines the channel along with others in the waveguide run where it is conducted to the transmitting antenna. A more complete description of this method of combining channels is given in SECTION I, paragraph 2.06.

BEAT OSCILLATOR POWER

2.22 The microwave generator circuit, Fig. 16, is the primary source of BO power for the shift modulator and transmitter modulator circuits. Jacks J10 and J11, Fig. 65, provide dc power and metering leads for the microwave generator circuit. BO power is applied from P16 of the microwave generator circuit through a semirigid coaxial cable, Fig. 49, to port 1 of the distribution network, Fig. 11. From port 1, the BO power passes through the distribution network as described in paragraph 2.02 of this SECTION to supply BO power to both the 40-MHz shift modulator, Fig. 17, and the transmitter modulator, Fig. 10.

## 3. REPEATER STATION CONTROL, ALARM AND METER CIRCUITS - FIG. 65

ALARM CIRCUITS

3.01 A repeater bay is equipped with only two alarms, one for the receiver, M option, and one for the transmitter. The receiver alarm is initiated by a predetermined drop in received carrier power as indicated by the AGC detector voltage in the IF main amplifier, Fig. 9. This alarm is delayed by 45 seconds for those instances when, as a result of normal fading, the alarm is quickly restored. If an alarm is still in after 45 seconds due to a prolonged fade or outage, information in the form of a transistor ground appears on terminal 3 of J9. This is conducted to the control, alarm, and metering circuit, Fig. 15 or Fig. 68, by the leads designated ALM and ALM RTN, terminals 3 and 2 on J9, which initiates a relay closure in this circuit. This closure, in turn, operates audible and visual indicators at remote and local locations. The same alarm condition is activated whenever the MAN-AGC switch, on the IF main amplifier, is operated to the manual gain position (MAN), however, in this case, without any time delay.

3.02 The transmitter alarm is initiated by a predetermined drop in RF output power. A portion of the RF signal power in monitored at the transmitter monitor shutter assembly, Fig. 101, and rectified by the detector in MON1, Fig. 14. The detected output in the form of an analog dc voltage is proportional to the RF signal power. The dc voltage is conducted from the connector P2, at MON1 to either terminal 6 of J3 (Fig. 15) or terminal 47 of TS1 (Fig. 68), at the control, alarm, and metering circuit. In this circuit, the dc voltage is metered and also is delivered to an alarm circuit. In the event of a drop in voltage at MON1 beyond a predetermined point (usually 3 dB), a relay closure occurs which causes audible and visual indicators at remote and local locations to operate. Means are provided to delay the alarm for 45 seconds. This delay feature suppresses unnecessary alarms due to signal fading where recovery usually occurs within 45 seconds.

3.03 Facilities are provided in the alarm circuit, Fig. 15 or Fig. 68, for audible alarm cutoff (ACO) at the radio bay as well as externally and for a visual alarm indication on the bay. No distinction is made between a receiver or a transmitter alarm. Both alarms are multipled inside the alarm circuit and an alarm for either causes a contact closure between leads 5 and 5 RTN and 6 and 6 RTN, Fig. 65. In TD-2 stations, this closure is made between leds 7 and 7 RTN.

3.04 An ABS alarm may be provided in Fig. 15 or Fig. 68 at repeater stations if a manned station opts to receive alarms locally. This provision gives local alarm indications whenever the ABS circuit breaker trips or is turned OFF. Without this feature, only a remote alarm indication is provided by the ABS circuit breaker, and if the station opts to receive alarms locally, no alarm, local or remote, is provided.

3.05 When a main station bay is used as a repeater and the transmitter and receiver are equipped in the same bay, ZG option provides the common T/R bay alarm connection. This alarm connection is controlled by Circuit Note 136.

3.06 When a main station receiver and a main station transmitter are equipped in separate bays and connected as a repeater and the receiver is not equipped with receiver alarm relays, K option provides a connection from terminal 3 of J9 in the main station receiver to either terminal 8 of P5 (Fig. 15) or terminal 46 of TS1 (Fig. 68) in the control, alarm, and meter circuit in the main station transmitter to provide the common T/R bay alarm. This alarm connection is controlled by Circuit Note 124.

3.07 In Fig. 15, an alternate means of connecting alarm lead 6 to the control, alarm, and metering circuit, SD-51549-01, is provided via ZH and ZI options which may also be applied in main stations. Alarm lead 6 is normally connected per ZH option. In offices with centralized lamp display and E-type Alarm System equipped with memory, connection is made via ZI option. ZI option connects a diode in series with alarm lead 6 in the control alarm and metering circuit to prevent loss of memory in the E-type Alarm System, which otherwise would be caused by interference from the external -24 volt ABS supply.

METERING - FIG. 65

3.08 Metering is provided in the control, alarm, and meter circuit, Fig. 15 or Fig. 68, principally for those circuits requiring adjustment or alignment for maintenance purposes. The bay points that are metered are:

(a) Microwave generator - There are 6 metered points which are used for tuning the microwave generator Fig. 16. These connect to terminals 3, 4, 5, and 6 of J10 and terminals 3 and 4 of J11.

(b) -19 volts - In bays equipped with a single 92B power unit, the metering point connects to terminal 3 of J2. In bays equipped with two 88A power units, the metering points connect to terminal 3 of J1 and terminal 3 of J2.

(c) Received carrier power - This function is metered in the IF main amplifier, Fig. 9, and appears on leads designated MTR+ and MTR- on terminals 6 and 9 of J9.

(d) Receiver modulator diode bias - This point connects to terminals 3 and 4 of J8.

(e) Voltages that are metered internal to the control, alarm, and metering circuit (Fig. 15) are -12 volts and +250 volts. Metering is also provided in Fig. 15 for monitoring the three currents in each stage of the transmitter amplifier, Fig. 106.

## 4. MAIN STATION RECEIVER CIRCUIT OPERATION - FIG. 102

4.01 The operation of a main station receiver circuit is similar to that described for the repeater station receiver, Fig. 101. However, since a main station receiver operates independently of the transmitter, it is equipped with its own microwave generator, Fig. 24. Since much less microwave power is required than that for the transmitter, a low power version of the microwave generator is used in main station receivers. The receiver requires one 92B voltage regulator to supply -19 volts dc to the solid-state receiver circuits.

VOLTAGE REGULATOR - FIG. 65

4.02 The voltage regulator requires an input of -24 volts dc. Station dc supply voltage is provided to the voltage



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regulator over a pair of leads designated 10 and 10 RTN. FLT9, T option, provides lightning and transient protection on the input side of the regulator. The lead designated -24V(R)LINE is connected to a circuit breaker, which provides short circuit protection, located in the control, alarm, and metering circuit. The lead from the circuit breaker is designated -24V(R)LOAD and connects to terminal A3 of J1. The wiring strap option V permits the 92B power unit in a main station receiver to supply -19 volts to the alarm circuit, in the control, alarm, and metering circuit.

MICROWAVE GENERATOR - FIG. 24

4.03 Microwave generator power is supplied to the receiver modulator, Fig. 6, by way of the directional filter FLT2, and the receiver section of the distribution network, Fig. 22. The microwave generator supplies BO power from P20 through a semirigid coaxial cable, Fig. 47, and transducer, Fig. 26, to port 4 of the distribution network. The power passes through circulators A and B to port 5 where it is applied to the BO port of FL2. The variable reactance and termination connected to circulator A provides a variable attenuator for use in setting the BO power to the required value. DC power and metering is supplied by J5, Fig. 65.

4.04 The IF output from the IF main amplifier, Fig. 9, may connect to external circuits in a TD-2 or TD-3 main station, in any of the following ways: by a low-pass filter (LPF) and pad, for -7 dBm output, at TD-3 main stations, Fig. 125; or a LPF only for +10 dBm out, Fig. 126. (Connecting circuits requiring a +10 dBm output are shown in the title of Fig. 126.) Additional padding arrangements may be provided in the future to obtain different output powers required for other applications. The LPF eliminates a potential source of cross-modulation noise by suppressing harmonics of the 70-MHz IF signal. If these harmonics are allowed to pass through a passive network (such as a delay equalizer) which presents different delays to the 70-MHz signal and its harmonics, they may recombine or mix in a following nonlinear device (such as an IF amplifier in compression or an FM receiver). One or more of the products formed may fall back onto the 70-MHz IF signal as a delayed replica of the original signal. The result is the same as if there were an echo. In FM systems, a delay echo can be a major source of cross-modulation noise.

5. MAIN STATION TRANSMITTER CIRCUIT OPERATION - FIG. 102

5.01 The operation of this circuit is the same as that described for the repeater station transmitter, Fig. 101, with the exception of the method of distributing BO power and generating and distributing regulated supply voltage. Because of the need for independent operation of a transmitter at a main station, the transmitter has its own microwave generator and voltage regulator.

VOLTAGE REGULATOR - FIG. 65

5.02 The 92B voltage regulator distributes a regulated -19 volt dc to two solid-state circuits in the transmitter. These are the microwave generator, Fig. 16, and the transmitter-modulator, Fig. 10. -19 volts dc is also supplied to the alarm circuit in the control, alarm, and metering circuit, Fig. 15 or Fig. 68. Station dc supply voltage of -24 volts is supplied to the voltage regulator on leads designated 9 and 9 RTN in Fig. 65. FLT8 provides lightning and transient protection for the input lead designated -24V(T)LINE. A circuit breaker, located in the control, alarm, and metering circuit, provides protection against short circuits. The connection between the circuit breaker and the input to the voltage regulator, at terminal A3 of J2, is by the lead designated -24V(T)LOAD.

MICROWAVE GENERATOR - FIG. 16

5.03 BO power is conducted from the microwave generator by the semirigid coaxial cable, Fig. 49, to port 1 of the distribution network, Fig. 22. The BO power passes through circulators E and D to port 2 where it is distributed to the transmitter modulator, Fig. 10. The variable reactance and termination connected to circulator E in Fig. 22 provides a variable attenuator for use in setting the BO power to the proper value.

MAIN STATION BAYS USED AS REPEATERS - FIG. 102

5.04 Main station bays may be arranged in a repeater configuration. There are two ways in which the transmitter and receiver may be arranged. These are: The transmitter and receiver may each be located in separate bays or the transmitter and receiver may be located in the same bay framework. The latter is the normal main station bay arrangement except that the



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transmission will be "repeatered" in the same direction. Main station bays are used as repeaters in situations where other than the normal 40-MHz shift in transmitted frequency is desired at a repeater station, for example, to avoid interference if, otherwise, two channels on the same frequency should enter a route junction.

5.05 When the transmitter and receiver are in the same bay, the IF output from the receiver is patched to the IF input of the transmitter, per Fig. 104, which is the same arrangement used in a repeater bay.

5.06 When the transmitter and receiver are in separate bays, Fig. 46 is used which provides a +10 dBm IF output signal for trunking to an IF patch and access bay, per SD-51394-01. If no IF patch and access bay is provided, interbay cabling is provided per SD-50993-01. In this arrangement, Fig. 131 is provided for a 0-dBm IF output power.

5.07 The alarm arrangements for main station bays used as repeaters is described in SECTION II, paragraph 3.05.

## 6. MAIN STATION ALARM AND METER CIRCUITS - FIG. 65

### ALARM CIRCUITS

6.01 The transmitter alarm function in a main station is identical to that described for the repeater station bay in paragraph 3.02.

6.02 Main station receivers may be provided with receiver alarm relays in the control, alarm, and metering circuit and are connected via ZC option, Fig. 65. If so equipped, a receiver alarm will be initiated by a predetermined drop in received carrier power. In this event, the TRIP lamp on the IF main amplifier lights, and after a delay of 45 seconds, a transistor ground will appear on terminal 3 of J9. Operating the AGC-MAN switch to MAN also puts a ground on this terminal. This ground activates the receiver relays in the control, alarm, and metering circuit which, in turn, grounds lead 8 in Fig. 65 to give local and remote audio and visual alarm indications. A loss of the ABS power will also activate the receiver relays.

6.03 In addition to the receiver alarm relays, ABS alarm relays are provided with the receiver relays at main stations. An alarm is initiated in the event the ABS circuit breaker trips or is turned OFF. This alarm functions in the manner described for repeater stations, see paragraph 3.04.

6.04 In hot standby systems, if receiver alarm relays are provided, the alarm leads, RCVR( )ALM and RCVR( )ALM RTN, from the switch control circuit, are connected, via the ZE wiring option, to the control, alarm, and metering circuit. At repeater stations, no receiver alarm relays are provided, and the RCVR( )ALM and TRMTR( )ALM leads (and RTN leads) are multipled per the ZD wiring option to provide a common T/R alarm.

6.05 If a main station is not equipped with receiver alarm relays, the receiver alarm lead, M option, is not connected as is done for a common T/R alarm at repeater stations. Instead, a receiver failure will be detected and alarmed, at that station, by the receiving portion of the Frequency Diversity IF Protection Switching System (100A or 400A).

6.06 Main station bays serve opposite directions of transmission. In stations where the receiver and ABS relays are not equipped, the common T/R alarm feature is retained when main station bays are used in a repeater station and connected as repeater station bays (such as when connected per SD-51394-01). For each channel in this arrangement, the receiver alarm lead, K option, of the main station receiver, terminal 3 of J9, is multipled, via terminal 8 of J3, to the control, alarm, and meter circuit of the associated main station transmitter serving the same direction of transmission. The same alarm wiring configuration, K option, is used for a common alarm arrangement for the opposite direction of transmission. This alarm arrangement is controlled by Circuit Note 124.

6.07 When a main station bay, not provided with receiver alarm relays, connects to a TN-1 System T/R bay at a repeater station, the TD-3D receiver alarm is made common with the TN-1 transmitter alarm for the same direction of transmission. The J option wiring provides the TD-3D receiver alarm lead connection to the TN-1 alarm circuit. Thus, a TD-3D receiver failure will be recognized by the TN-1 alarm circuit. A T/R common alarm is not provided for the opposite direction of transmission since the TN-1 System receiver provides a separate alarm. This alarm arrangement is controlled by Circuit Note 128.

### METERING - FIG. 65

6.08 Additional metering points are provided in a main station for the second microwave generator. The metered points, for this generator, connect to terminals 3, 4, 5, and 6 of J5. The second 92B power unit is metered at terminal 3 of J1.

## 7. ADDITIONAL CIRCUITS FOR HS AND HS/SD APPLICATIONS - FIG. 110 AND 111

7.01 Additional circuits required for an HS or HS/SD application are indicated in Fig. 110 for a repeater station bay and in Fig. 111 for a main station bay.

HS AT A REPEATER STATION - FIG. 110

7.02 An HS arrangement protects the regular (REG) T/R bay, ie, the receiver and transmitter as a unit, by switching in a standby (STBY) T/R bay in the event of a circuit interruption. Switching between the REG and STBY bay is done by the switch control circuit, Fig. 56.

7.03 The STBY receiver obtains its RF signal input from a directional coupler located in the receiving waveguide run (see CD Fig. 1). In this manner, the REG and STBY receivers are double fed with the STBY receiver receiving about an 11-dB weaker signal. (In some arrangements, a splitting hybrid may be used. In this case, the RF signal to both the REG and STBY receivers will suffer a 3-dB loss.) The IF output of the REG and STBY receivers connect to corresponding REG and STBY transmitters by means of a pad and cable arrangement, Fig. 104. The squelch gate, in the IF main amplifier, in both the REG and STBY receivers normally remains closed, permitting transmission. This state is established by omitting the Y option connection in the REG and STBY receivers and also by omitting the W option resistor, in the STBY receiver, Fig. 65. X option, Fig. 65, is connected, in both REG and STBY receivers, which provides a lamp indication and permits a delayed alarm to be initiated in the event of no or low transmission.

7.04 The RF output power is switched between the REG and STBY transmitters. Fig. 115 (A&M) and Fig. 116 provide the additional circuits (see also CD Fig. 2). An RF switch and relay, Fig. 31 (A&M), is located in the REG transmitter bay. In the normal state, the REG transmitter RF power is transferred through the switch to the output circulator AT5, located in the REG bay, Fig. 115. The RF output from the STBY transmitter is transduced from waveguide to a semirigid coaxial cable at port B of the monitor transducer assembly, Fig. 116. From here, the RF output is conducted over the cable (shown on SD-50575-01) to port 1 of the RF switch in the REG bay transmitter, Fig. 115, where it normally terminates through the switch path in a high power coaxial termination, Fig. 32, at port 2. The STBY transmitter is not provided with FLT6 or AT5.

7.05 The monitor transducer assembly, Fig. 33, permits a quick and convenient means of converting the coaxial port A into a waveguide-to-coaxial transducer. Normally, the loosely coupled detector MON1 is connected to the coaxial port A. To connect the full RF output power from the STBY radio transmitter to external test equipment, the detector MON1 is replaced by an external probe assembly, and at the same time, a shorting plate is inserted behind the probe to convert the assembly to a waveguide-to-coaxial transducer.

7.06 Instead of the RF switch and relay, Fig. 31, a solid-state switch, Fig. 60, may be provided to accomplish the switching function from the STBY to the REG transmitters. In this arrangement, the mechanical RF switch (TRANSCO) is replaced by a solid-state RF switch, the 409A. (Refer to CD Fig. 8.) In the 409A, switching is done by an internal driving circuit that switches a bias voltage, off and on, to a set of diodes in the transmission path. The driver circuit is supplied with the same logic signal as was supplied to the relay circuit in Fig. 31. The logic switching signal is applied to terminal 5 in Fig. 60. Fig. 141 shows the circuit when the 409A switch is connected in the REG bay. The semirigid coaxial cable (shown on SD-50575-01) conducts the RF power from the STBY bay to the STBY IN port on the 409A switch where it normally terminates in an internal high power termination. A miniature coaxial connector, similar to that used for port 1 on the TRANSCO switch, is used for the STBY IN port. The IN and OUT ports of the switch receive waveguide connections.

7.07 The 409A switch incorporates the monitor transducer assembly feature. Therefore, the monitor transducer which performs this function, when the TRANSCO RF switch and relay circuit, Fig. 31, are provided, is not required when the 409A switch is provided.

7.08 RF detectors MON1 in both the REG and STBY transmitter bays, Fig. 110, continuously monitor the output power (see also the diagram in CD Fig. 2). The voltages from these RF detectors are each converted to a logic zero or one signal in the alarm circuit of Fig. 15 or Fig. 68 and exit via leads designated ( ) PWR DET and RTN, Fig. 65. The switch control circuit, Fig. 56, accepts the logic signals and, accordingly, activates the RF switch. In the event that the RF output power of the REG transmitter drops a preset amount due to either equipment failure or loss of IF input power, the RF switch located in the REG bay transfers the output of the STBY transmitter to port 3 of the TRANSCO RF switch, or to the OUT port of the 409A switch, Fig. 141, where it is passed to the channel filter FLT6, and circulator AT5, also located in the REG bay transmitter.



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At the same time, the output of the REG transmitter is transferred to the high power termination. For the TRANSCO switch, the termination is a separate unit, Fig. 32, connected to port 2 of the switch. The high power termination is mounted internally in the 409A switch. The RF switching function is revertive and will transfer back to the REG transmitter when its output power is restored. The dc power which operates the TRANSCO RF switch through contacts of the 337A relay, Fig. 31, is supplied from the STBY bay on leads designated -24V RF SW and RTN, at terminals A3 and A4 of J2 Fig. 65. The dc power which operates the 409A switch is supplied, redundantly, from the REG and STBY bay. Terminals 1 and 3, on the 409A switch, Fig. 60, receive dc power, respectively, from terminal A3 of J2 in the REG bay and terminal A3 of J2 in the STBY bay. Terminal 3 on the switch, GRD, connects to A4 of J2 in both bays.

HS AT A MAIN STATION - FIG. 111

7.09 At a main station, the IF inputs to the REG and STBY transmitters are each fed externally from separate FM transmitters. (See CD Fig. 3 for a typical transmitting terminal arrangement.) In this case, the RF switch is activated either by a decrease in RF output power or by the absence of a pilot signal, detected from the IF output of each FM transmitter and sensed by the switch control circuit.

7.10 The output at IF from the REG and STBY radio receivers connects to Fig. 135. This figure provides a pad to provide 0 dBm output power. Extra external padding is provided to obtain the required input power to corresponding external REG and STBY FM receivers. (See CD Fig. 4 for a typical receiving terminal arrangement.)

HS/SD AT A REPEATER STATION - FIG. 110

7.11 In this mode of operation, protection is afforded by providing a second diversity antenna, in addition to the main antenna, and a STBY receiver and transmitter which are switched independently in place of the REG receiver and transmitter.

A. Receiver Operation

7.12 The REG radio receiver obtains its signal from the main antenna while the STBY receiver obtains its signal from a second auxiliary antenna, placed typically 30 feet from the main antenna (see CD Fig. 5). The IF output from the STBY and REG receivers connects through suitable padding AT3, Fig. 112 and Fig. 113, to a hybrid transformer HYB1 in Fig. 113, located in the STBY bay. Since either the REG or STBY IF main amplifier is gated on for transmission, only one of the receivers will have an IF output at any one time. The IF output from HYB1 connects to a similar hybrid transformer HYB2, in order to double feed both REG and STBY transmitters.

7.13 A switch to the STBY receiver occurs whenever the received RF signal at the main antenna drops below a threshold level, and at the same time, the signal at the diversity antenna is above the threshold level. Switching from the REG to the STBY path is done by controlling a squelch gate in the IF main amplifier. The AGC voltage which is proportional to the received carrier power is first converted into a logic (0,1) signal in the IF main amplifier and appears on lead 14 of J9. The HS/SD TRIP control on the IF main amplifier is used to set the logic state at the threshold level (typically, for a 35-dB drop in input power to the IF main amplifier). The logic signal provides an input to the switch control circuit, Fig. 70, which, in turn, controls the squelch gate in each IF main amplifier. The sequence involved in switching from the REG receiver to the STBY receiver is a follows:

(a) A logic signal one (0 volts) appears on lead (REG)AGC DET terminal 14 of J9, Fig. 65, and is sent to terminal 15 of J102, Fig. 70, the switch control wiring circuit.

(b) The switch control circuit sends back, via terminals 14 and 22 of P102, a logic zero (-4.3 volts) signal to the squelch gate in the IF main amplifier of the REG receiver on the lead designated (REG) IF SW CONT terminal 12 of J9 and a logic one to the squelch gate in the IF main amplifier of the STBY receiver on the lead designated (STBY) IF SW CONT terminal 12 of J9. This sequence gates off transmission through the REG IF main amplifier and gates on transmission through the STBY amplifier.

(c) The logic signal sent to the REG IF main amplifier returns to the switch control circuit on the lead designated (REG) IF SW VER, to provide a verification signal back to the switch control circuit.

(d) At the switch control circuit after a delay of 45 seconds, a signal is sent to the control, alarm, and metering circuit, Fig. 15 or Fig. 68, in the REG bay to operate audible and visual indicators at remote and local locations. This alarm signal is carried on the lead from the switch control circuit, designated RCVR (REG) ALM, terminals 11 and 24 of P102. In addition, an indicator lamp in each

IF main amplifier operates whenever the IF input signal drops below a preset point. The REG receiver will normally recover during periods of fading within 45 seconds. Longer outages usually indicate equipment failure.

7.14 In paragraph 7.13(c), the verification signal operates local lamp indications on the switch control circuit. No corresponding verification signal is sent from the STBY IF main amplifier to the switch control circuit. In the event the signal at the diversity antenna is below a threshold, a logic signal from the switch control circuit holds the squelch gate off in the STBY IF main amplifier and therefore no switch will occur. The HS/SD TRIP control on the STBY IF main amplifier is adjusted in a similar manner as the REG receiver. However, now if the signal to the STBY receiver is below threshold, the switch control circuit inhibits a switch to STBY. The IF switching logic is revertive and, in the normal state, favors the REG receiver whenever the received signal at the main antenna is above a threshold. Provision is made in the switch control circuit such that a switch can be forced to STBY, either locally or remotely.

7.15 For HS/SD operation, the jumper, Y option, in Fig. 65, between terminals 7 and 11 of J9, is not connected. In this condition, the gate in the amplifier will remain closed, permitting transmission. Since the gate will be operated by external voltages in HS/SD operation, it is necessary to prevent the tone modulated 70-MHz carrier from being resupplied whenever a gate is opened. The resupplied carrier is disabled by adjusting the CRS PILOT PWR control, on the amplifier, full counterclockwise. The W option resistor R1, Fig. 65, is provided only for an IF main amplifier operating in a STBY receiver. This resistor and an internal resistor form a voltage divider which applies a blocking voltage to the squelch gate in the STBY IF main amplifier. This feature prevents transmission through the amplifier in the event it is necessary to disconnect the leads ( ) AGC DET and ( ) IF SW CONT at the switch control circuit for troubleshooting or maintenance purposes. When the IF main amplifier is used in an HS/SD arrangement, X option is provided in both the REG and STBY IF main amplifiers. This option, which connects terminals 8 and 10 of J9, permits the HS/SD logic circuit operated by the AGC voltage to operate the indicator lamp and initiate the delayed alarm. The delayed alarm here is redundant as the receiver alarm from the switch control circuit provides the receiver alarm. Provision is made in the switch control circuit such that a switch to STBY can be forced from either a local or remote location.

7.16 The IF output from the REG receiver connects to Fig. 112 and from the STBY receiver to Fig. 113. Fig. 112 provides a pad AT3 at the output of the REG receiver to obtain the required IF power into HYB1 of Fig. 113. A similar pad AT3 is provided at the output of the STBY receiver in Fig. 113. Fig. 113 contains two hybrid transformers connected in an arrangement which permits independent switching between receiver and transmitter. The REG and STBY transmitters are double fed through HYB2 from the output of either REG or STBY receiver feeding into HYB1.

B. Transmitter Operation

7.17 The switching between the REG and STBY transmitters in an HS/SD arrangement is similar to that described for HS only in paragraphs 7.04 and 7.08 (see CD Fig. 2).

HS/SD AT A MAIN STATION - FIG. 111

7.18 At main stations, Fig. 136 and 137 provide a connection for the IF output of radio receivers for connection to external FM receivers. In Fig. 111, IF circuits are accepted from external FM transmitters for delivery to the IF driver amplifier and transmitter modulator, Fig. 10, in the REG and STBY radio transmitters (see CD Fig. 3).

A. Receiver Operation

7.19 The IF output from the REG or STBY radio receiver is fed to an external REG and STBY FM receiver via the equal splitting hybrids in Fig. 137. The external REG FM receiver is favored. In this arrangement, either the REG or STBY main station radio receiver drives the REG FM receiver as contrasted to the HS arrangement where each radio receiver is associated with its own FM receiver (see CD Fig. 4 and CD Fig. 5). Fig. 136 provides a pad AT3 to obtain the correct level at the input to HYB1. Pad AT3 in Fig. 137 provides a similar function for the STBY receiver.

B. Transmitter Operation

7.20 The REG and STBY transmitters accept IF inputs from external FM transmitters. The manner of switching from the REG to STBY with the RF switch, Fig. 115, is the same as that described for the HS arrangement in a repeater station in paragraph 7.04 (see CD Fig. 3).

HS OR HS/SD, IF ACCESS ARRANGEMENT - FIG. 111

7.21 A circuit arrangement, Fig. 117, is provided whereby the IF output of the REG or STBY receiver can be trunked to an external IF patch and access circuit. Similarly, an IF trunk from the IF patch and access circuit can be brought to the REG and STBY transmitter. This arrangement at IF is used, eg, to feed one or two channels of a spur or sideleg route which is split from a main route via a patch and access bay.

7.22 This arrangement requires the control of the squelch gating in the IF main amplifiers to switch between receivers. The switching is identical to that described for the HS/SD at a repeater station in SECTION II, paragraph 7.09. CD Fig. 6 shows the circuit connection of the radio receivers to the IF patch and access bay. A hybrid, in the STBY receiver bay, couples the selected IF output to the cable run to the patch and access bay. The designation RCVR OUT, in Fig. 117, is that of the hybrid output. The interconnection to the patch and access bay is shown on SD-51576-01. A 19D pad in the cable run adjusts the IF power for the proper level at the patch and access bay. A single pad, in this case, replaces the need for a separate pad at the output of each IF main amplifier. The 21A pad is provided for monitoring purposes at the patch and access bay.

7.23 The circuit connections from the IF patch and access bay to the REG and STBY transmitter are shown simplified in CD Fig. 7. A hybrid, mounted in the STBY bay, is used to split the IF signal coming from the patch and access bay. In Fig. 117, the input to the hybrid is designated TRMTR IN. The interconnection information for the cable run from the patch and access bay is shown on SD-51576-01. This run is composed of a cable and pad assembly and is the same assembly that is used on the receiving side. A single pad adjusts the level to both transmitters. A 21A pad provides for monitoring the IF signal at the patch and access bay. The switching between transmitters is identical to that described in SECTION II, paragraph 7.04, etc, for HS at a repeater station.

DIRECT MAIN STATION INTERCONNECTION

7.24 Fig. 134 provides means for trunking the IF output of the REG or STBY main station radio receiver directly to another main station REG and STBY radio transmitter. The figure is composed of a cable and pad assembly, Fig. 58. This arrangement may be used in those situations where an IF patch and access bay is not used.

AUXILIARY SQUELCH CONTROL CIRCUIT - FIG. 57

A. Purpose of Circuit

7.25 An auxiliary squelch control circuit, Fig. 57, is provided for HS or HS/SD Systems that use receiver switching. The purpose of the circuit is to squelch noise that would otherwise build up in the remainder of the system in the event the RF signal to both the REG and STBY receivers were to fail simultaneously. Normally, one receiver of a REG/STBY pair is active, while the other is muted. A simultaneous failure of the RF signal to both receivers would result in noise buildup in the unmuted portion of th system. The auxiliary squelch control circuit is applied in HS/SD Systems with and without IF access and HS only systems with IF access. (In the IF access arrangement, the outputs of the IF main amplifiers in the REG and STBY receivers are connected through a hybrid transformer to provide a single output. see paragraph 7.21.)

7.26 The auxiliary squelch control circuit is an applique unit which is inserted between the bay cable socket J9 and the IF main amplifier power plug. The circuit interfaces between the external switch control circuit, Fig. 56, and the IF main amplifier, Fig. 9. One applique is required in each REG and STBY receiver.

7.27 There is also a provision for muting the active receiver in an HS only system which does not use receiver switching (see paragraph 7.31).

B. Operation

7.28 When a fade occurs to the IF input signal at either the REG or STBY receiver, th HS/SD control lead in the IF main amplifier, terminal 14 of J9, changes state. This change causes the switch control circuit, Fig. 56, to gate off transmission through the affected IF main amplifier by operating the squelch gate and, at the same time, gate on the unaffected IF main amplifier, provided its IF input signal is not faded by more than 35 dB. A through connection is provided in the auxiliary squelch control circuit for the HS/SD control lead. Normally, the REG to STBY switching operates whenever either input fades to 35 dB. However, when the fade reaches 40 dB, the output of the IF main amplifier then drops dB for dB. When the output has dropped 10 dB, to 0 dBm or lower, the logic signal from the CRS control circuit in the affected IF main amplifier appearing on terminal 4 of J9 will change state. The auxiliary control circuit receives this change in state, on terminal 4 of J21, and operates the squelch gate in the affected IF main amplifier to gate OFF transmission. Thus, if the two input signals fail simultaneously and the REG receiver is providing transmission (the normal situation if the switch control circuit is in the automatic mode), the auxiliary squelch control circuit will squelch the REG receiver, while the STBY receiver remains squelched, under the control of the external switch control circuit. If the switch control circuit is in the manual mode and forced switched to STBY, the STBY receiver will be muted by the auxiliary squelch control circuit. The point at which the CRS control circuit changes state is adjustable by the CRS TRIP control on the IF main amplifier. For just the STBY receiver, a change in the value of resistor R1, Fig. 65, is required, ZE option. R1 performs the same function as R1, W option, described in paragraph 7.15.

C. Detailed Description

7.29 When the output power of the IF main amplifier is above 0 dBm, -17 volts (referred to here as the "good" condition) appears on the CRS control lead, terminal 4 of J21. This voltage causes transistor Q1 to saturate which then applies a regulated -4.3 volts to both inputs of IC1C, terminals 6 and 7. Resistor R4 and Zener diode CR3 provide a regulated -4.3 volts to the collector of Q1, and this voltage also powers IC1. R2 and R5 bias Q1. The output of IC1C, terminal 5, is 0 volt which comprises one input to the NAND gate, IC1B. The other input to IC1B is returned from the switch control circuit via terminal 12 of P4 and is 0 volt (good) if the input to the IF main amplifier is above the 35-dB fade point. In this condition, the output of IC1B is -4.5 volts (good) which is inverted to 0 volt by IC1A. The 0-volt output of IC1A, terminal 12 of J21, opens the squelch gate in the IF main amplifier, allowing transmission. As long as -17 volts (good) appears on the CRS control circuit lead, terminal 4 of J21, the HS/SD switching functions in the normal manner. When the IF signal fades more than 50 dB, the logic signal on the CRS lead, terminal 4 of J18, changes state and 0 volt (bad) appears. This action turns off transistor Q1 and applies a 0-volt signal (bad) to both inputs of IC1C. At the output of IC1C, terminal 5, -4.5 volts (bad) appears and connects to terminal 2 of IC1B. Since the fade is below 35 dB, the HS/SD control lead has changed state to -4.5 volts (bad) via terminal 12 of P4 to the other input of IC1B, terminal 3. The logic state at terminal 12 of P4 is returned to the switch control circuit via terminal 13 to provide the verification signal. Since both inputs to IC1B are bad, the output of IC1B on terminal 4 is 0 volt which, upon inversion by IC1A, becomes 4.5 volts (bad) at the output, terminal 11. The -4.5 volt output of IC1A is applied to the REG IF main amplifier via terminal 12 of J21, thereby gating off transmission. A similar action, as described, takes place in the auxiliary squelch logic circuit associated with the STBY IF main amplifier. Truth Table A below shows the logic states which open or close the squelch gate in the IF main amplifier as a function of the fade depth of the IF input signal power. There is transmission through the IF main amplifier when the squelch gate is open and no transmission when the squelch gate is closed. A logic zero represents the low state (negative voltage) and a logic one represents the high state (0 volt).

7.30 The TRIP light on the IF main amplifier provides the means of indicating the HS/SD trip and CRS trip points. Since the TRIP lamp will remain lighted at any fade depth below that used to set the HS/SD trip point, it would not be possible, without additional circuitry, to use the same trip light indicator to adjust the CRS trip point on an IF input power typically 15 dB below that used for the HS/SD trip point. An OR circuit is provided in the auxiliary squelch control to use the same trip light as an indicator for both settings. The OR circuit is comprised of diodes CR1 and CR2 and resistor R3. When the HS/SD control circuit in the IF amplifier requests a switch, the voltage at terminal 8 of J21 changes state from -17 volts to 0 volt. The CRS control circuit produces a similar voltage change on terminal 4 of J21 which occurs when the IF output power of the IF main amplifier is made to drop from +10 dBm to 0 dBm. There is -17 volts applied to terminal 4 and 8 of J21 under the condition of no trip on both the HS/SD and CRS leads. One side of R3 is connected to -19 volts at terminal 1 of J21. Therefore, the voltage at the common point where CR1 and CR2 and R3 join will be about -17.5 volts. The common point is connected to the SW/ALM driver circuit in the IF main amplifier via terminal 10 of J21 where -17.5 volts holds the TRIP lamp off. When, as the result of a switch request, either control circuit applies 0 volt to the anode of either diode CR1 or

TRUTH TABLE A

| IN MAIN AMPL INPUT | IC1C | | IC1B | | | IC1A | | IF MAIN AMPL SQUELCHED |
|---|---|---|---|---|---|---|---|---|
| | IN(6,7) | OUT(5) | IN(2) | IN(3) | OUT(4) | IN(9,10) | OUT(11) | |
| 0-35 dB FADE | 0 | 1 | 1 | 1 | 0 | 0 | 1 | NO |
| 35-50 dB FADE | 0 | 1 | 1 | 0 | 1 | 1 | 0 | YES |
| >50 dB FADE | 1 | 0 | 0 | 0 | 1 | 1 | 0 | YES |



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CR2, the common point drops to about -0.5 volt. This low state, when applied to the SW/ALM driver circuit in the IF main amplifier, causes the TRIP lamp to light. Different test arrangements are applied to the IF main amplifier so that the HS/SD TRIP and CRS trip points may be adjusted independently.

AUXILIARY SQUELCH IN HS ONLY SYSTEMS

7.31 In an HS only system where receiver switching is not used, a feature is provided which will mute the active receiver in the event of loss of signal. This feature is implemented via the Y option connection to the IF main amplifier. This option, which is applied to both REG and STBY receivers, permits internal control of the squelch gate in the IF main amplifier, plus furnishing a delayed alarm ground. This is the same means used for squelch in frequency diversity systems (see paragraph 1.05). If the squelch feature is not desired, the X option is furnished to provide the delayed alarm ground.

CONNECTION OF RECEIVERS TO A 401C 1 X 1 IF PROTECTION SWITCHING SYSTEM - FIG. 102 AND FIG. 111

7.32 In HS Systems at main stations, a rearrangement in the receiver IF output circuits has been made when connecting a 401C 1 X 1 IF Protection Switching System, SD-51669-01. In this arrangement, receiver switching is not used, but receiver squelch is provided and controlled externally for HS only and HS/SD receivers. A 0-dBm IF output power from the receiver is provided by means of a pad AT3, in Fig. 130. Y option is used at J9 since, for this application, the switch control circuit, Fig. 56, is not used to switch from the regular to the standby receiver. The switching in this application is done by the 401C IF switch on SD-51669-01.

8. RECEIVING SPACE DIVERSITY SWITCH ~~ELECTROMAGNETIC SCIENCES, INC. (EMS) - FIG. 128 AND 129; 409B - FIG. 138, 139 AND 140~~

EMS SWITCH - FIG. 54

A. Purpose of Circuit

8.01 An arrangement is provided for connecting the radio receiver to a space diversity antenna system to improve the reliability of the received signal power in frequency diversity systems. The EMS switch provides a means for switching between the regular and space diversity antennas. This is accomplished by a waveguide switch using switchable, latching, circulators in conjunction with its own associated logic circuit.

B. Operation

8.02 Switching is accomplished by a logic signal from the IF main amplifier. This logic signal may be 0 or -4.3 volts, and the point where it changes state (threshold) is determined by the AGC level which, in turn, is controlled by the power of the IF input signal. The threshold at which the logic will change state is adjusted, typically, for a 35-dB fade. The HS/SD TRIP control on the IF main amplifier is used to set the switch point. The logic signal from the IF main amplifier appears on pin 14 of J9 and connects to P3 on the EMS switch logic unit. As long as a good signal is received from (say) the regular antenna, the AGC is above threshold (0 volt) and the diversity switch remains operated to the regular antenna. If the signal fades below the AGC threshold, the logic signal changes to -4.3 volts and initiates a change in the diversity switch state to connect the diversity antenna to the receiver. If a good signal is received from the diversity antenna, the AGC is above threshold and the switch remains operated to the diversity antenna. The switch stays in this state until either a fade occurs which causes the switch to operate back to the regular antenna or until a 30-minute time interval has passed when an automatic reversion to the regular antenna takes place. In either case, the switch remains operated to the regular antenna if a good signal is found there. If simultaneous below threshold fades occur on the regular and diversity antennas, the switch cycles between the two antennas at a 10-second rate until an above threshold signal is found on either. The diversity switch logic can be programmed, by a switch setting, to prefer either antenna, and there is also provision for locking (forced) to either antenna. In the event of a loss of -24 volt dc power to the switch, the switch remains operated to the antenna to which it was connected just prior to the loss of power.

8.03 The sequence of events which cause the switch logic to operate is described in Truth Table B below.

TRUTH TABLE B
FOR EMS, INC, AND 409B DIVERSITY SWITCH

| | | REGULAR | DIVERSITY |
|---|---|---|---|
| THRESHOLD | ABOVE | Stay on regular | Stay for 30 minutes, then switch to regular |
| | BELOW | Switch to diversity and remain for 30 minutes | Switch to regular* |

*Whenever the signal to both antennas is below threshold, the switch will cycle between antennas at intervals of 10 seconds until either antenna is above threshold.

409B SWITCH - FIG. 138, 139, AND 140

A. Purpose of Circuit

8.04 An alternate means of providing a transfer between the REG and DIV antennas is by means of the 409B switch, Fig. 61. Switching is accomplished by changing the logic state (0,1) applied to the internal switch drive circuit. The drive circuit then alters the state of the bias to a set of PIN diodes, shunt mounted in a microstrip circuit. When 0 volt (logic one) is applied to the switch drive input, terminal 5, the RF signal flows from the waveguide IN port to the waveguide OUT port. With -4.3 volts (logic zero) applied, transmission is from the DIV IN coaxial port to the waveguide OUT port. The nontransmitted signal is terminated in a resistive termination within the switch.

8.05 The 409B switch, unlike the EMS switch, does not contain its own switching logic circuitry. The 409B switch receives its switching logic function from a separate logic circuit, space DIV control, Fig. 62. The switch logic circuit, in turn, receives its logic command from the AGC developed logic in the IF main amplifier.

8.06 In addition to the switching function, the 409B switch has special access ports for patching around the switch or they may be used to monitor or inject test signals without dismounting the switch from the waveguide run. This access feature takes the place of the monitor shutter assembly, Fig. 3, and performs the same function.

8.07 The space DIV control, Fig. 62, provides for selecting any one of four modes to operate the 409B switch: A, B, FSA, and FSB. Position A programs the logic to the automatic mode which assigns the low-loss transmission path from the waveguide IN port to the waveguide OUT port. The regular or preferred antenna will normally be connected to the IN port of the 409B switch, and the switch will revert to this position after time-out on the diversity or nonpreferred antenna. Position B reverses the priority of the automatic selection, and instead, the preferred antenna is received from the DIV IN port. Switch positions FSA and FSB provide a means of locking to either A or B antenna. Lamps are provided to indicate which antenna is in service. A receiver alarm is initiated, as well as the lighting of an alarm lamp on the unit, in the event that the nonpreferred antenna is providing service for 1 hour or if, due to loss of signal on both antennas, the switch has been cycling between the two antennas for 1 hour. The same alarm is initiated immediately whenever positions FSA or FSB are selected.

B. Operation

8.08 The 409B switch and associated space diversity control circuit operate as follows, assuming antenna A is preferred and the regular antenna is connected to the IN port of the 409B switch: when the signal to the REG antenna is above threshold, a logic zero output (-4.5 volts appears on terminal 14 of J9. A lead delivers the logic signal to terminal 8 on the space diversity control circuit, Fig. 62. A logic signal one output appears at terminal 10 and is conducted to terminal 5 on the 409B switch. This is the drive signal that operates the switch to provide a low-loss transmission path from the IN port to the OUT port. If the signal to the REG antenna falls below a preset threshold (which is adjustable by the HS/SD TRIP control on the IF main amplifier), the logic signal from the IF main amplifier changes state, and a logic one (0 volt) appears on terminal 14 of J9. This action causes the space diversity control circuit to change state and produce a logic zero to terminal 5 on the 409B switch. The switch then transfers such that the low-loss path is from the DIV IN to the OUT port. If the signal to the DIV antenna is above threshold, the switch will remain in this state for 30 minutes, at which time an automatic reversion to the regular antenna occurs.

8.09 The sequence of events which cause the switching action is shown in Truth Table B.

8.10 In the event the -24 volt dc power to the 409B switch fails, an approximately 8-dB insertion loss occurs to both the regular and diverstiy signals since no bias is being applied to the switching diodes. Thus, both signals will arrive at the OUT port of the switch approximately 8 dB below normal where they will combine. The resultant signal power delivered to the receiver will vary over a wide range, depending on the phase of the two signals at the point where they combine within the switch.

TD-2 STATIONS

A. EMS, Inc. Diversity Switch

8.11 Fig. 128 shows the circulator and waveguide arrangement when TD-3D bays, equipped with the EMS, Inc., diversity switch, are installed in an existing TD-2 bay lineup. The signal received from the diversity antenna is connected to the last receiver in the bay lineup (ie, the bay farthest from the regular receiving antenna connection) and is conducted to each receiver in the lineup in the direction opposite to signal flow from the regular antenna. This arrangement requires an additional circulator AT6, which is oriented for signal flow in a direction opposite to that of AT1. The function of filter FLT11 is similar to that described for PLT1 in SECTION II, paragraph 1.01. The desired channel received from the DIV antenna, to which the receiver is tuned, is selected by the channel BPF, FLT11, and other channel frequencies are reflected and pass back through AT6 and through AT1 to the next receiver toward the regular antenna.

B. 409B Diversity Switch

8.12 Fig. 138 and Fig. 139 show the circulator and waveguide arrangement when TD-3D bays, equipped with the 409B diversity switch, are installed in an existing TD-2 bay lineup. This arrangement is similar to that described in 8.11 for the EMS, Inc., switch. Fig. 138 and 139 differ only in the manner of orientating the circulators. The 409B switch uses a coaxial connection that is dedicated to be used for the diversity path. A transducer MT6, and a short length of semirigid coaxial cable, Fig. 50, are added for the diversity path. With this arrangement, the regular and diversity ports are not interchangeable. Therefore, the assignment of the regular antenna waveguide connection to either the right or left side of the bay is contingent on providing the correct orientation of circulators, AT1 and AT6. Fig. 138 shows the circulator orientation for bays connecting to the regular antenna on the left side, and Fig. 139 shows the orientation for a right hand fed bay.

TD-3 STATIONS

A. EMS, Inc., Diversity Switch

8.13 Fig. 129 shows the diversity antenna arrangement for TD-3 stations or in TD-2 stations when the bay is equipped with the EMS, Inc., diversity switch. This figure applies to a TD-3D bay when it is installed in a new or all TD-3D lineup. In this arrangement, a separate diversity antenna waveguide run is provided. The diversity signal is conducted along a waveguide run parallel to the regular antenna waveguide run and connects to circulator AT6. AT6 and filter FLT11 serve to drop the channels, received from the diversity antenna, to the receivers in a manner identical to that for the regular receiving antenna.

B. 409B Diversity Switch

8.14 Fig. 140 shows the diversity antenna arrangement for TD-3 stations or in TD-2 stations when the bay is equipped with the 409B diversity switch. This figure applies to a TD-3D bay when it is installed in a new or all TD-3D lineup. The addition of the diversity antenna arrangement is similar to that described in 8.13 for the EMS, Inc., switch. The 409B switch uses a coaxial input port to receive from the diversity antenna and requires a short length of semirigid coaxial cable, Fig. 50, and a transducer MT6, to connect to FLT11.

8.15 Fig. 127 shows the arrangement when no diversity switching arrangement is provided. This arrangement was formerly shown in Fig. 101 and Fig. 102.

9. COMMON PREAMPLIFIER FOR A LINEUP OF RECEIVERS - FIG. 63

9.01 Fig. 63 is a broadband, low noise preamplifier which is equipped in the regular receiving waveguide run and also in the space diversity receiving waveguide run, if equipped. This preamplifier provides improved noise performance on hops where the received carrier power is lower than -27 dBm (1500 circuits) or -23 dBm (1800 circuits). The improvement gained in the thermal noise performance can be used to offset an otherwise higher transmitter power, for example, with 1500 circuit loading, the transmitter power can be operated at 2 watts instead of 5 watts, thereby extending the life of the 416( ) transmitter amplifier tubes.

9.02 For the purpose of making dc power and alarm connections, Fig. 63 is provided on this circuit only when a TD-3D receiver is the first bay in the lineup facing the regular antenna and/or the first bay facing a diversity antenna where provided. The -24 volt dc power connection to J22, terminals 1 and 5, is derived from lead 10 and 10 RTN, Fig. 65, via the option ZK wiring for a main station receiver and from lead 9 and 9 RTN for a repeater bay in stations having sufficient -24 volt dc. In stations having insufficient -24 volt dc, the power to Fig. 63 is derived from lead 13 and 13 RTN, the conductors that normally furnish the alarm battery supply, via the option ZL wiring. When a TD-3D bay is equipped in an all TD-3D bay lineup with diversity switching, the regular and diversity antenna receiving waveguide will both enter the first bay in the lineup. The 24-volt dc connections for both Fig. 63, in this case, are multipled via option ZK or ZJ when there is sufficient -24 volts or via option ZL for insufficient -24 volts. When a TD-3D bay is the first or last bay in a mixed lineup of TD-3D and TD-2 bays with receiving space diversity switching, the -24 volt dc connection is made via option ZL at a repeater station (insufficient -24 volts) or via option ZK at a main station (sufficient -24 volts).

9.03 For alarm purposes, Fig. 63 makes a contact closure whenever there is a change, either higher or lower, in direct current applied to it. The contact closure is connected via terminals 2 and 3 of J22 to the alarm and meter circuit, Fig. 15 (MD), or Fig. 68. If Fig. 15 or Fig. 68 does not have receiver alarm relays, connection is made via option ZM which, in turn, brings up the common T/R bay alarm. If Fig. 15 or Fig. 68 is equipped with receiver alarm relays, connection is made via option ZN which brings in a receiver alarm. No distinction is made between a bay alarm and an alarm from Fig. 63.

## 10. IF AMPLITUDE EQUALIZER - FIG. 64

10.01 Fig. 64 provides an IF amplitude equalizer which may be used to compensate for baseband rise or rolloff. This is an active circuit having unit gain. This equalizer is provided for each radio channel in an IF protection switching section when such a section has six or more radio hops and one or more channels is carrying 1500 message circuits. Fig. 64 is applied in Fig. 102 in the last main station receiver of a radio channel in an IF Protection Switching System. The application of Fig. 64 is controlled by Circuit Note 142 and Equipment Note 220.

10.02 The IF amplifier in Fi. 64 requires -19 volts dc. This voltage is derived from the 92B power unit, Fig. 20, via terminals A1 and A4 of J1, Fig. 65, and connect to terminals 1 and 2 of J23. There are no alarm connections provided for this circuit.

## 11. SOLID STATE TRANSMITTER AMPLIFIER - FIG. 66 AND FIG. 69

11.01 Fig. 66 and Fig. 69 provide a solid-state RF power amplifier 660( ) which amplifies the signal at the output of the transmitter modulator, Fig. 10, to provide the transmitter with an output power of 2 watts or 5 watts, respectively. Beginning with T/R bays manufactured per SD-51546-01, Issues 28B and 36B, the amplifier, Fig. 66 and Fig. 69, replaced the previous 416( ) tube power amplifier, Fig. 143. Except for an input attenuator, used to set the output power, the 660( ) has no tuning adjustments or metering points. The amplifier is powered from -24 volts dc. In TD-2 stations having insufficient -24 volt dc power, a converter, Fig. 67 or Fig. 71, is provided which converts -11 volts dc to -24 volts dc. For -24 volt operation, the amplifier is connected per ZR or YC option, Fig. 65. For -11 volt operation, the converter, Fig. 67 or 71, is connected per ZS or YD option, Fig. 65. The -24 volt output form the converter is connected directly to the 660( ) amplifier, Fig. 66 or Fig. 69. There are no circuit breakers associated with the amplifier or the voltage converter. The output of the 660( ) provides a good impedance match to the connecting waveguide, therefore, isolator AT4, Fig. 4, is not provided. When Fig. 66 or Fig. 69 is equipped, the associated control circuitry required with Fig. 143 (per SD-51549-01, control, alarm, and metering circuit) is not provided.

11.02 Two codes for the 660( ) are provided to cover the TD band, 3710 to 4170 MHz. The appropriate code is specified in Table A for the indicated transmitter RF carrier frequency. The 660A provides a 2-watt amplifier for the lower half of the band, and the 660B provides a 2-watt amplifier for the upper half. For the 5-watt amplifier, the 660C is for the lower half and the 660D is for the upper half of the band.

11.03 The operation of the repeater station receiver-transmitter circuit in Fig. 145 is identical to that described for Fig. 101. Fig. 145 shows the use of Fig. 66 or Fig. 69 as the RF power amplifier instead of Fig. 106. The microwave signal received from the transmitter-modulator bandpass filter, Fig. 12, is amplified to the proper level and passes directly to the monitor shutter assembly, Fig. 3, for transmission to the antenna.

11.04 Except for the use of Fig. 66 or Fig. 69 in place of Fig. 143 and the elimination of the isolator, Fig. 4, when Fig. 66 or Fig. 69 is used, Fig. 101, 102, 110, and 111 perform the same function as when Fig. 143 is used.

## 12. OTHER FIGURES AND CABLES

12.01 Figures not assigned other than information figures are as follows: Fig. 13, 37, 38, 39, and 69 through 99, except Fig. 70. Fig. 65 is the repeater or main station bay wiring circuit. Fig. 40 through 51 are IF cables which are used to interconnect the various units in the T/R



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bay. In particular, Fig. 47 is a semirigid coaxial cable, covered in Equipment Note 201. Fig. 48 is a patch plug used to connect HYB1 and HYB2 in Fig. 113 or Fig. 137. Fig. 50 and Fig. 51 are miniature semirigid coaxial cables, used for connecting to the RF switch in a HS/SD arrangement, covered in Equipment Note 202.

12.02 Fig. 130 provides a 0-dBm IF power at the radio receiver output and is applied when connecting to an IF entrance link at main stations within a frequency diversity system.

12.03 Fig. 131 provides a 0-dBm IF power at the radio receiver output and is applied when connecting to a diplexed auxiliary channel at repeater stations within a frequency diversity system.

12.04 Fig. 132 and Fig. 133 are not assigned.

12.05 Fig. 135 provides a 0-dBm IF power at the REG radio receiver output in an HS only arrangement at main stations (see CD Fig. 1).

12.06 Fig. 136 and Fig. 137 are applied to REG and STBY main station bays to provide 0-dBm output pwoer when connecting to a TN-1 System at a repeater station.

# SECTION III - REFERENCE DATA

## 1. WORKING LIMITS

1.01 The dc voltage limits at the bay terminals for the nominal -24 volts, -12 volts, and +250 volts are indicated in Circuit Note 101.

1.02 The temperature and humidity environment in which the bay shall operate is indicated in Information Note 302.

## 2. FUNCTIONAL DESIGNATIONS

2.01 None.

## 3. FUNCTIONS

3.01 The repeater station T/R bay receives a normal or faded microwave signal in the 4-GHz frequency band and restores its power to the extent possible for transmission to the next station.

3.02 The main station receiver receives a microwave signal in the 4-GHz frequency band and provides for down converting the signal to a 70-MHz IF signal. Amplification is provided at the IF for transmission to external circuits.

3.03 The main station transmitter accepts a signal at the IF from external sources and provides for up converting it to a microwave signal in the 4-GHz band. Amplification of the microwave signal is provided to obtain sufficient power for transmission in a line-of-sight air path to the following receiver.

## 4. CONNECTING CIRCUITS

TD-2 STATIONS

4.01 Application Schematic - for IF Amplitude and Equalization Bay - SD-50012-01

4.02 Application Schematic - for Delay Equalization of Dropped or Sideleg Circuits - SD-50195-01

4.03 TD Radio - Application Schematic - for IF Circuits - SD-50405-01 or -02

4.04 TD-2 Indoor Antenna Waveguide Layout - ED-50735-10

4.05 IF Interconnections at Repeater Stations - SD-50993-01

4.06 TN-1 Radio - Application Schematic - for IF Systems - SD-51560-01

4.07 Application Schematic - for Diplexed Auxiliary Channel - SD-51603-01

4.08 Application Schematic - IF Entrance Link Interconnecting Circuits - SD-51611-01

4.09 401C 1 X 1 IF Protection Switching System - SD-51669-01

4.10 Application Schematic - Heterodyne Auxiliary Channel - SD-51758-01

4.11 IF Interconnecting Circuits for 400A Protection Switching System with Provision for ADD-DROP - SD-51779-01

4.12 Distribution Fuse, Individual, Audible and Visual Alarm Circuit - SD-56230-01

4.13 Application Schematic - Main Station IF Circuits - SD-59389-01

4.14 Application Schematic - Auxiliary Station IF Circuits - SD-59390-01

4.15 Automatic Switching - Application Schematic for IF Circuits at Main and Terminal Stations - SD-59560-01

4.16 Program Switch - Application Schematic for IF Circuits - SD-59566-01

4.17 Application Schematic - for Delay Equalizing Circuits - SD-59574-01 or SD-59610-01

4.18 Automatic Switching - Application Schematic - for Auxiliary Station IF Circuit - SD-59618-01

4.19 +250 Volt Supply Circuit - SD-81085-01

4.20 -12 Volt Supply Circuit - SD-81086-01

4.21 -24 Volt Battery Distribution Circuit - SD-81091-01

4.22 TD-2 Office Grounding Circuit - SD-81094-01 and -02

4.23 -24 Volt Battery Distribution Circuit - SD-81111-01

4.24 -12 Volt and +250 Volt Supply Circuit - SD-81153-01 or SD-81161-01

4.25 Discharge Circuit - TD-2 Converter Plant - SD-82309-01

TD-3 STATIONS

4.26 E2 Status Reporting and Control System - Status Input Circuit - SD-1C309-01

4.27 TD-3 Radio - Radio Bay Arrangement and Indoor Waveguide Circuit - SD-50575-01

4.28 Office Audible and Visual Alarm Circuit - SD-50593-01

4.29 Distribution Fuse and Individual Alarm for Common Office and Building Equipment - SD-50594-01

4.30 Medium Haul Radio Alarm Circuit - SD-50957-01

4.31 IF Interconnections at Repeater Stations - SD-50993-01

4.32 Application Schematic - Interconnection of Main Station T/R Bays as Repeaters - SD-51394-01

4.33 Application Schematic for 4-GHz Heterodyne Systems Using Hot Standby-Space Diversity Switching - SD-51463-01

4.34 TN-1 Radio - Application Schematic - for IF Interconnection at a Repeater - SD-51560-01

4.35 Interconnecting Information for Systems Using 401B Protection Switching - SD-51576-01

4.36 Application Schematic - for Diplexed Auxiliary Channel - SD-51603-01

4.37 Application Schematic - IF Entrance Link Interconnecting Circuits - SD-51611-01

4.38 401C 1 X 1 IF Protection Switching System - SD-51669-01

4.39 Application Schematic - Heterodyne Auxiliary Channel - SD-51758-01

4.40 IF Interconnecting Circuits for 400A Protection Switching System with Provision for ADD-DROP - SD-51779-01

4.41 C1 Alarm and Control Indicating Sending Circuit - SD-56189-01 or SD-56187-01

4.42 C1 Alarm and Control System Receiving Director Circuit - SD-56192-01

4.43 C1 Alarm and Control System - Station Sending Alarm Circuit - SD-56193-01

4.44 Auxiliary Receiving Director Circuit - SD-56385-01

4.45 Power Systems - DC Distribution Circuit - SD-81767-01

4.46 Long Haul Radio Grounding Circuit - SD-81805-02

4.47 Power Systems - DC Distribution Circuit - SD-81950-01

4.48 Audible and Visual Alarm Circuits - SD-95163-01 or SD-96188-01

4.49 E1 Status Reporting and Control System - Status Input Circuit - SD-99459-01, or SD-1C309-01, or SD-1C307-01

4.50 E-type Status Reporting and Control Circuit - SD-99461-01 or SD-1C311-01

## 5. MANUFACTURING TESTING REQUIREMENTS

5.01 Manufacturing testing requirements are specified in X-78764.

5.02 Manufacturing testing requirements for the ED-52652-( ) auxiliary squelch control circuit, Fig. 57, are specified in X-79140.



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## SECTION IV - REASONS FOR REISSUE

CHANGES

### B. Changes in Apparatus

B.1 Added

1 - Power Unit - Fig. 71, 305B

B.2 Superseded

| Superseded | Superseded by |
|---|---|
| 1 - Trans Ampl Assy - Fig. 106, | 1 - Integrated Circuit - Fig. 69, 660A or 660B |

### D. Description of Changes

D.1 Table A, Circuit Notes 101 and 103, and Fig. 101, 102, 110, and 111 were changed to make reference to Fig. 69 and Fig. 71.

D.2 Circuit Notes 102 and 143, Fig. 65, and CAD 21 to 25 were changed to make reference to YC and YD option.

D.3 Circuit Notes 148 and 149, Equipment Notes 225 and 226, and Information Note 311 were added.

D.4 J25 Connector information was added to Equipment Note 203.

D.5 Circuit Note 146, Equipment Note 219, and Information Notes 307 and 308 were revised.

D.6 The use of Fig. 27, 28, 29, 35, 36, 106, and 143 were rated MD.

D.7 YE option was added to connector J102 in Fig. 70. Note 3 was added to sheet 15.

D.8 Fig. 69 and Fig. 70 were added.

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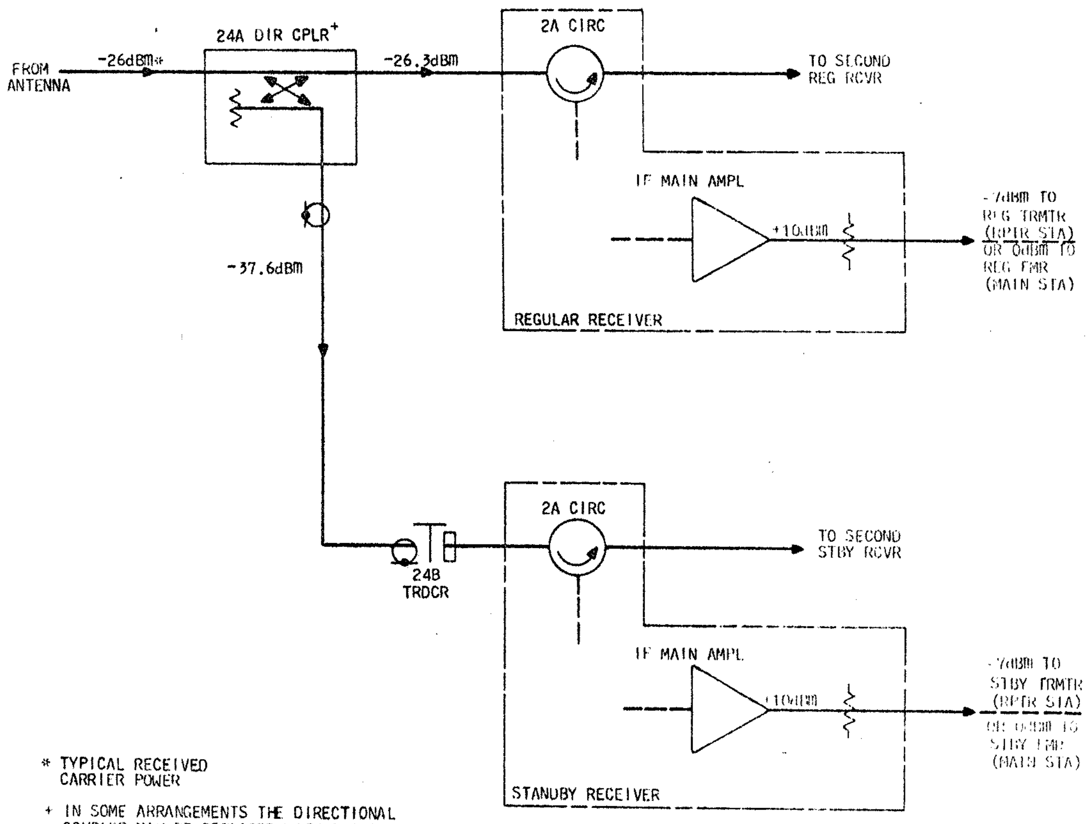
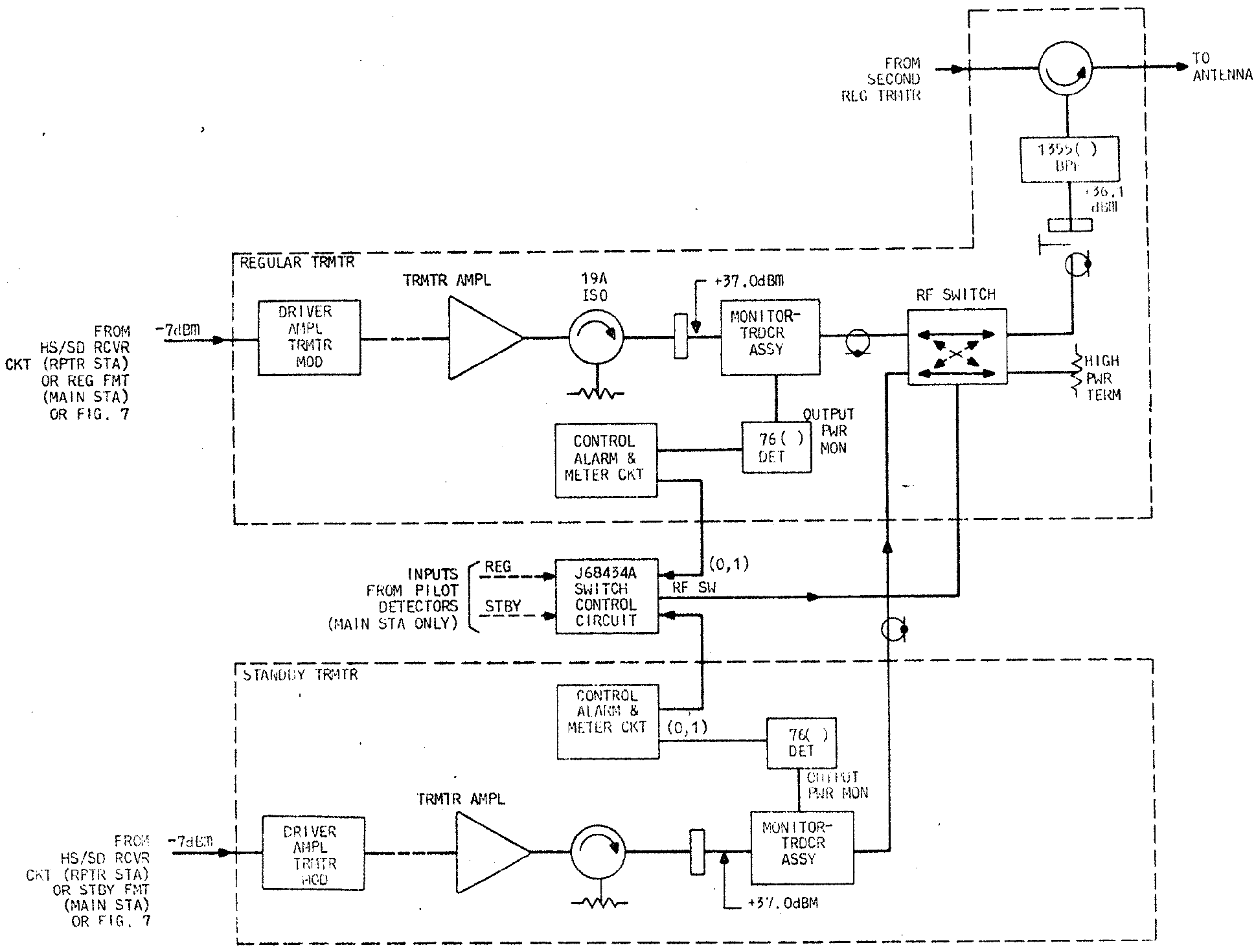



* TYPICAL RECEIVED CARRIER POWER

\+ IN SOME ARRANGEMENTS THE DIRECTIONAL COUPLER MAY BE REPLACED WITH A 3dB EQUAL SPLIT HYBRID.

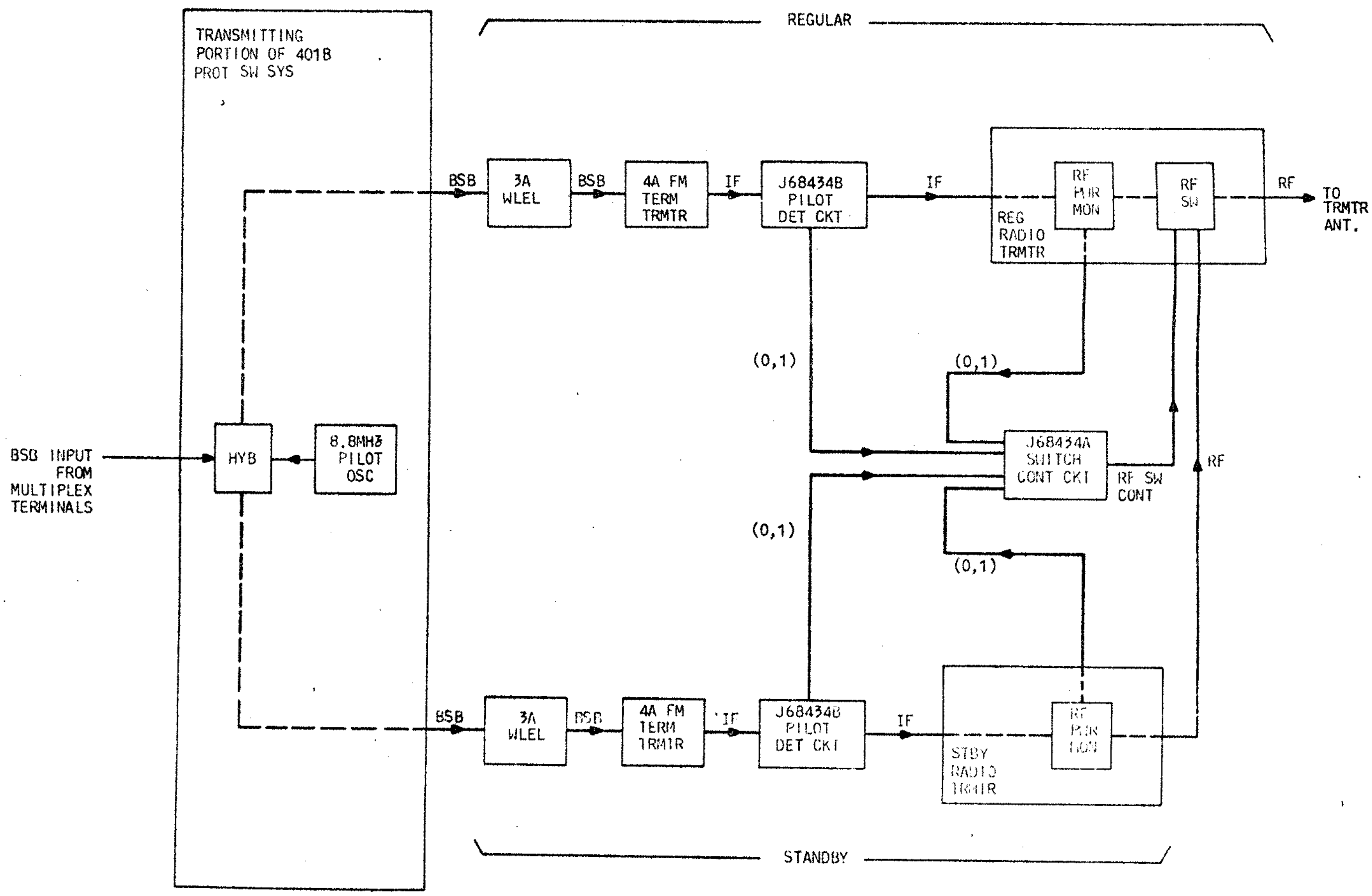
CD Fig. 1 - Receiver Circuit for Hot Standby Only Applications




CD Fig. 2 - Transmitter Circuit for HS or HS/SD Applications



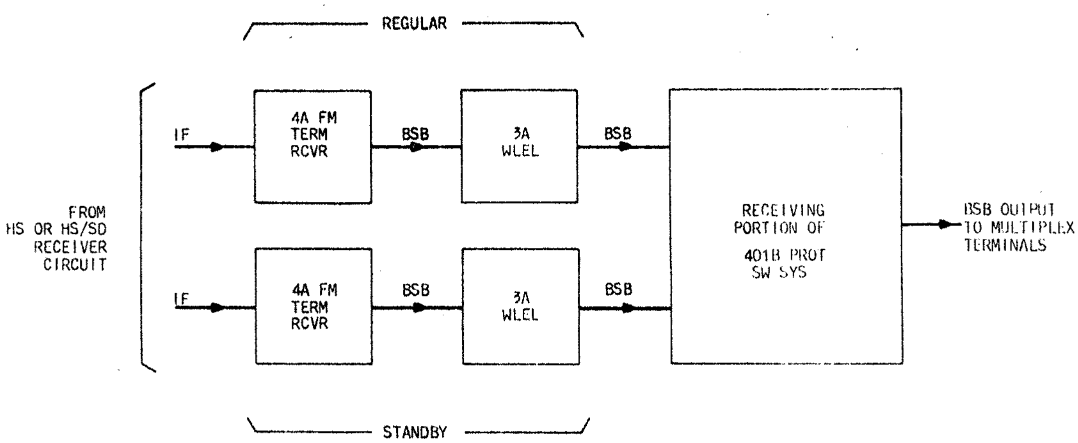
7



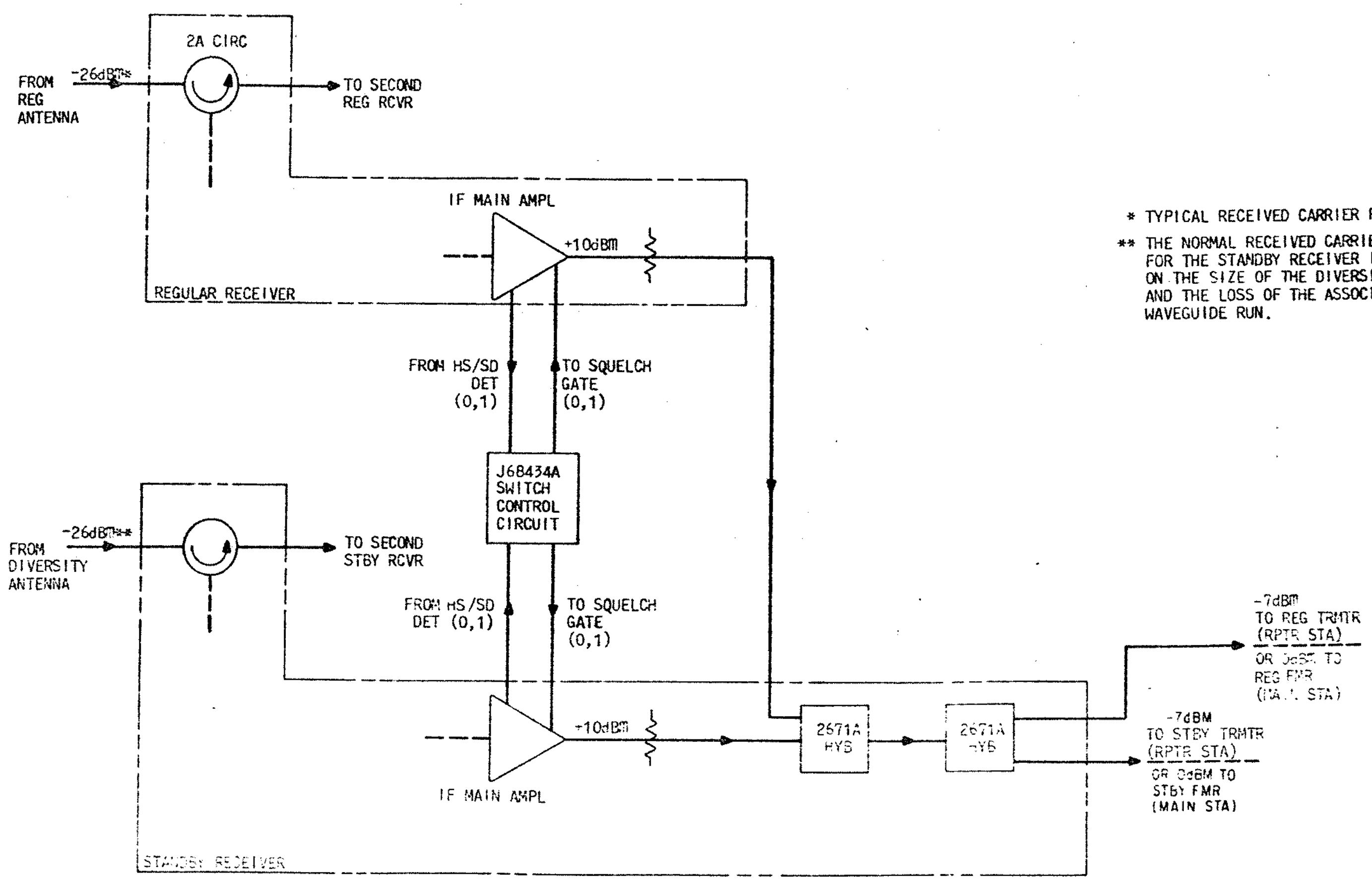

CD Fig. 3 - Typical Transmitting Terminal Arrangement for HS or HS/SD Systems



6



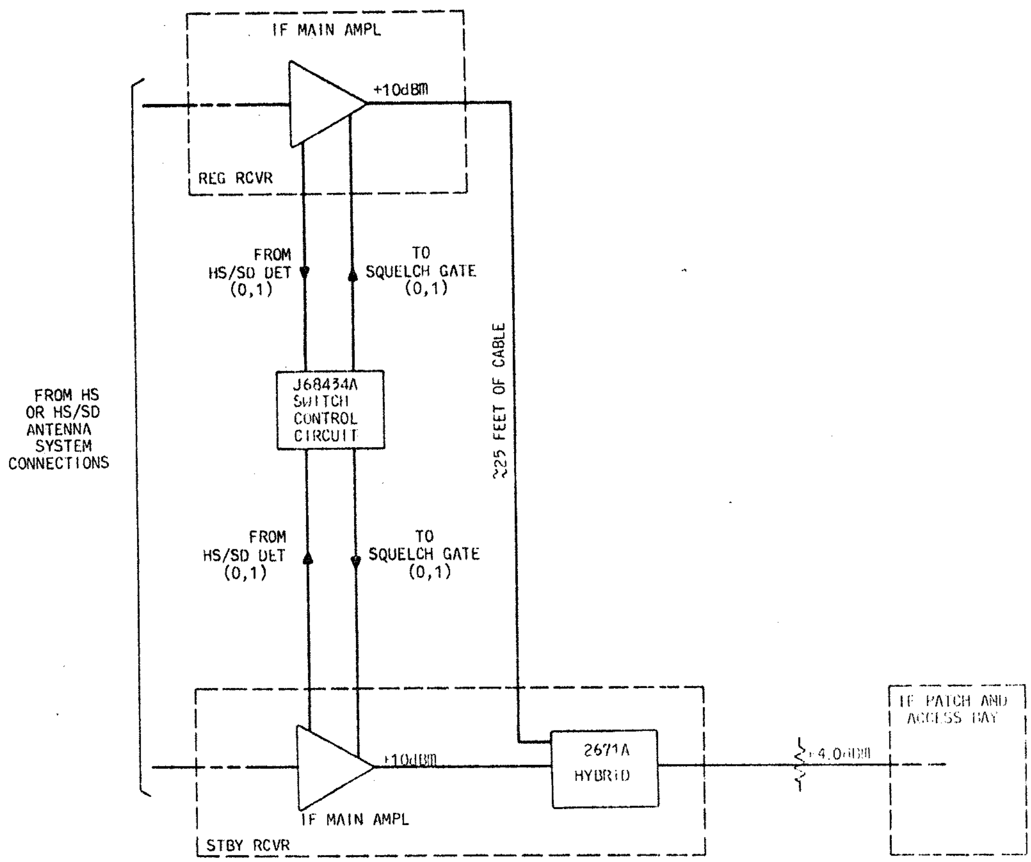

CD Fig. 4 - Typical Receiving Terminal Arrangement for HS or HS/SD Systems



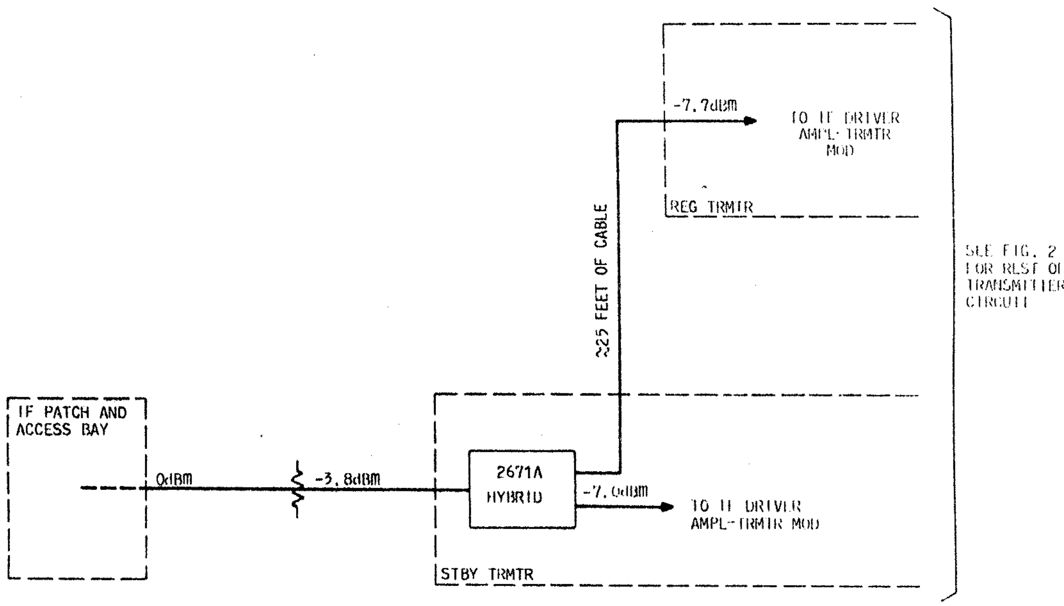

* TYPICAL RECEIVED CARRIER POWER

** THE NORMAL RECEIVED CARRIER POWER FOR THE STANDBY RECEIVER IS DEPENDENT ON THE SIZE OF THE DIVERSITY ANTENNA AND THE LOSS OF THE ASSOCIATED WAVEGUIDE RUN.

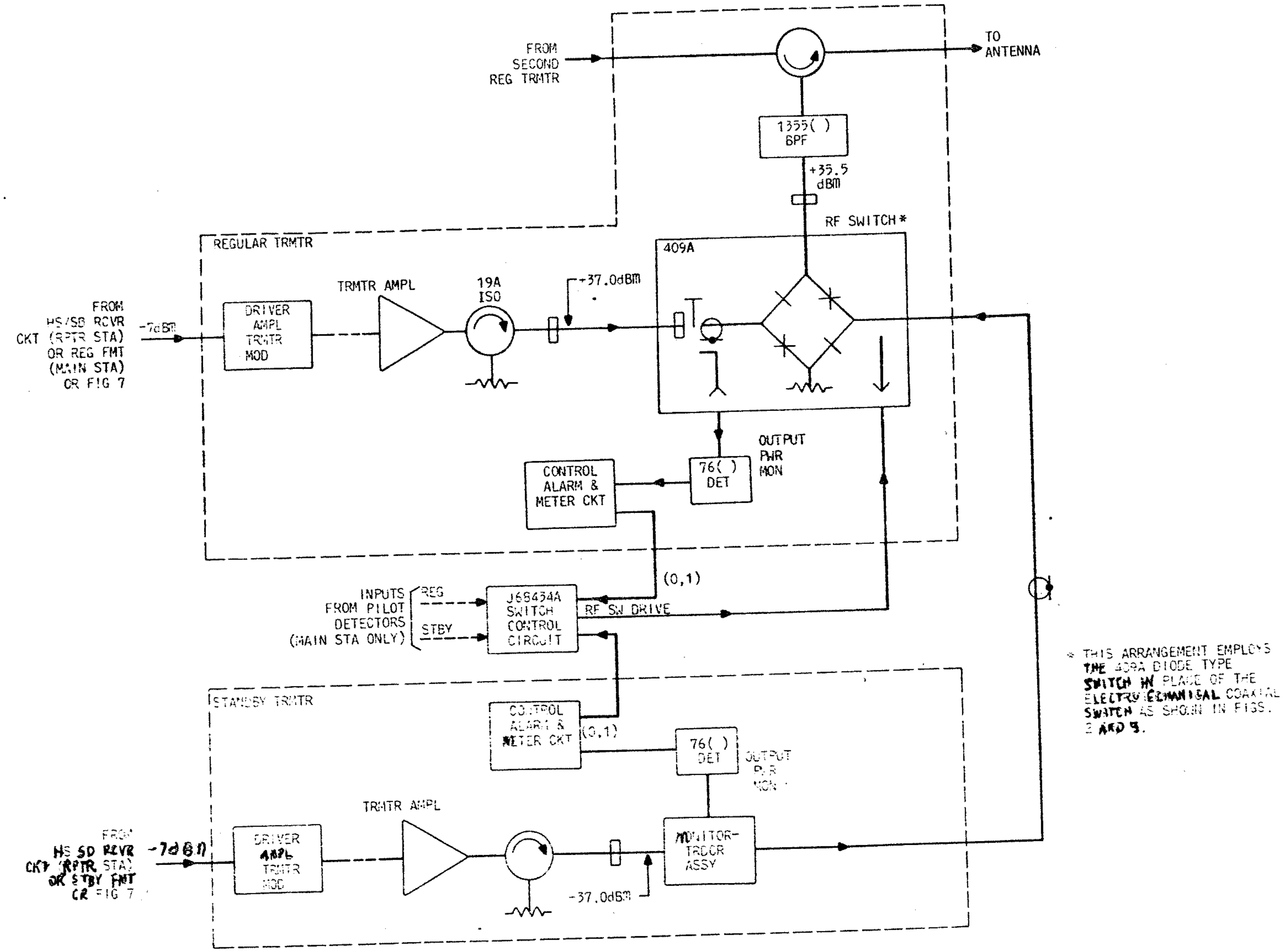
CD Fig. 5 - Receiver Circuit for HS/SD Applications




CD Fig. 6 - Connection for HS or HS/SD Receiver Circuit to Patch and Access Bay




CD Fig. 7 - Connection of HS Transmitter to IF Patch and Access Bay




CD Fig. 8 - Transmitter Circuit for Hot Standby or Hot Standby/Space Diversity Applications

# TOLL SYSTEMS
# TD RADIO
# APPLICATION SCHEMATIC
# FOR
# TD-3D
# TRANSMITTER-RECEIVER BAY

CHANGES

## B. Changes in Apparatus

B.1 Added

CAD 26

1 - Integrated Circuit - P/O Fig. 72
713( )

1 - Control Unit - P/O Fig. 72
95A

1 - Jack J26 - P/O Fig. 72
Cannon or Cinch DAM 3W3S
E/W 1 KS-19820
L26 Contact

## D. Description of Changes

D.01 Fig. 144, 145, and 72 and option YF were added to cover B.1 above.

D.02 In Fig. 65, Sheet 6A, the cable type for the coaxial cable connected to Fig. 14 was changed from KS-19224 L1 to KS-19224 L2 to agree with the manufactured product.

D.03 Fig. 65, Sheet 6B, was modified for repeater or main station bay.

D.04 CADs 1, 2, 3, 4, 9, 10, 11, 12, 13, and 20 were revised.

D.05 CAD 26 was added.

D.06 Option index table was revised.

D.07 The 713( ) IC code was added to Table A.

D.08 Circuit Notes 150 and 151 were added.

D.09 In Circuit Note 101, current drain information for Fig. 72 was added.

D.10 Circuit Note 102 was revised.

D.11 Circuit Note 103 was changed to show the use of Fig. 144 and 145.

D.12 Equipment Note 205 was revised to add jack J26 information.

D.13 In Fig. 101 and 102, reference to Fig. 144 and 145 was added.

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TOLL SYSTEMS
TD RADIO
APPLICATION SCHEMATIC
FOR
TD-3D
TRANSMITTER-RECEIVER BAY

CHANGES

## B. Changes in Apparatus

B.1 Added

CAD 27

2 - Diodes CR9 and CR10 - CAD 20
458A
YL Option

1 - Capacitor C1 - CAD 21
742A
1 uF
YK Option

## D. Description of Changes

D.1 CADs 19 and 20 were changed and Equipment Note 227 and CAD 27 were added to cover the diodes added as YL option.

D.2 CAD 21 was changed to show the addition of C1 to terminals 7 and 8 of TS1.

D.3 Circuit Note 152 was added to explain the use of capacitor C1.

D.4 Circuit Note 103 was revised to show Issue 38B.

D.5 Circuit Notes 111 and 140 were revised.

D.6 Equipment Note 228 was added.

D.7 The option index table was revised.

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