MAINTENANCE SUPPORT
PERFORMANCE MONITORING

Contents **Page**

MAINTENANCE SUPPORT
PERFORMANCE MONITORING

Contents

Page

MAINTENANCE SUPPORT
PERFORMANCE MONITORING

Contents **Page**

PERFORMANCE MONITORING

The performance monitor features of the DR 6/11-40-140 system are very powerful and should be used to help isolate unusual problems. Understanding the performance monitor is very important. Following is an explanation of the three principle operating modes of the performance monitor.

a. *Normal Mode:* In the normal mode, a performance alarm is sent to the alarm center and is indicated on the CHANNEL MONITOR or the CHANNEL CONTROLLER if either of the following conditions exist:

   - Any 3 of 48 consecutive half-hour periods have error bursts of 10^{-9} or greater
   - Out-of-frame events occur.

b. *Performance Verify Mode:* When parts of the system have been repaired or maintained, a performance verify mode is available to eliminate the minimum wait of 1-½ hours in case some error bursts still remain after the repair. In this mode, error bursts of 10^{-11} or greater and out-of-frame events will be immediately reported to the alarm center as a 10-second performance alarm scan point. Remote indication of this mode is by means of the performance test active scan point. The performance verify mode lasts for 15 minutes; then the normal performance alarm operation is restored. If no event occurs during this test period, the performance alarm 24-hour data base is completely reset. The performance verify command should be used to reset performance alarms.

c. *Continuous Monitoring Mode:* The best way to monitor all the performance scan points in the entire switch section is to use the Continuous Monitoring mode of the built-in performance monitoring system. In this mode, every performance alarm scan point in the system is put in the verify mode. The 15-minute intervals are continually reactivated by the sequence programming capability of the alarm center. Continuous monitoring is simply the repetitive use of the performance verify mode. This enables continuous monitoring of the entire system for acceptance tests, determining the location of subtle problems, or any reason that a transmission engineer may have for testing the system in this manner.

   Continuous monitoring will immediately report any performance or system alarm to the alarm center. In most instances, the alarm will be isolated to a single location. Occasionally, the alarm will be helpful in isolating the trouble to a direction of transmission at a single radio hop.

DIFFERENTIAL ABSOLUTE DELAY EQUALIZATION FOR PROTECTION SWITCHING

When service is transferred from a regular channel to the protection channel, "hitless" switching can be achieved if both channels are approximately the same electrical length. In the DR 6/11-40-140 digital radio system, the absolute delay difference between any two channels to be switched must be less than 150 nanoseconds. This means that the protection channel can be 150 ns shorter or 150 ns longer than the channel switching to protection. The switching system is equipped with alignment circuits that delay equalize the two channels if they are within these limits. If the limit is exceeded, cable must be used to lengthen the shorter channel. As radio channels are added to a bay lineup, equipment that is furthest from the antenna generally requires the greatest amount of envelope delay equalization. This increased equalization will normally introduce more absolute delay.

This procedure explains how to determine whether or not the limits are exceeded, and how to lengthen a shorter channel when necessary. An end-to-end operating system is required for these tests. Perform the following protection switch control functions:

1. Execute a receiving end-regular transmit bridge.
2. Execute a receiving end-manual record.

This action will display the alignment status of the regular channel as a code number on the RECEIVING STATUS unit. Interpretation of the code determines the course of action to be taken. The displayed code will be a number from 1 through 14 unit intervals, or the number 72. The two channels are considered to be in reasonable alignment when the code is between 2 and 13. For this case, the automatic alignment equipment will adjust one of the two channels to match the other. A reading of 8 is ideal, but not necessary. When the code number is 1 or 14, the two channels are at the end of the automatic alignment range and should be equalized to insure operating margin, by adding cable to the shorter channel.

When cable is added, it is inserted at IF where the 140 Mb/s signal is being processed as four 35 Mb/s signals. This means that one complete cycle takes about 28 nanoseconds of time per unit interval. The cable delay is 1.5 nanoseconds per foot. Therefore, to shift the code number from either 1 or 14 to 2 or 13, a 20 foot length of cable is needed to delay the shorter channel about 30 nanoseconds or one unit interval. Equalization jacks are provided to insert this cable at the proper IF interface. When the code number is 72, the two channels are beyond the alignment range and the shorter channel must be lengthened. Cable should be distributed within a switch section if it is longer than 50 feet. If the code number is 72, the following procedure should be used to measure and adjust channels that are out of limits.

TEST EQUIPMENT

The following supplies are required to perform this test:

1 - Dual-trace wideband oscilloscope (Tektronix Model 485 or equivalent)

2 - Coaxial cables each equipped with a BNC(M) and a SMB(F) connector

3 - Various lengths of RG-59B/U coaxial cable equipped with 440-type connectors.

ABSOLUTE DELAY MEASUREMENT AND ADJUSTMENT

Note: A good CMI signal is required to perform this test.

1. At the receiving terminal of a switch section, connect the oscilloscope vertical inputs to the DS 139 MON jacks on the protection and regular channel CMI CODER units.
2. If using a Tektonix Model 485 oscilloscope, set the controls as shown in Table A. If using another oscilloscope, set the controls to the corresponding positions.

   Note: It may help to use automatic triggering until the traces are properly positioned.
3. Set the scope to trigger from the protection channel signal. Adjust the trigger level for a stationary protection channel signal (Fig. 1). (The oscilloscope triggers on digital "ones" chosen at random by the trigger circuit.)

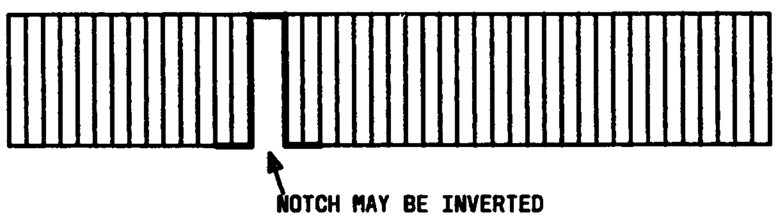


Fig. 1—Stationary Pattern for Protection Channel CMI Signal

TABLE A OSCILLOSCOPE SETTINGS	
CONTROL	**POSITION**
Time/Division	50 ns
Horizontal Display	A
A Triggering:	
Sweep mode	Normal trigger
Slope	+ or -
Level	Adjust for stationary trace
Coupling	AC or LF Reject
Source	Internal
Channels 1 and 2:	
Volts/Div	0.5
Coupling	AC
Impedance	50 ohms
Internal Triggering	Channel 1 or 2 (as required)
Vertical Mode	Alternate
BW Limit	Off

4. Observe the regular channel signal. It should show one of the following conditions:
   - ***Blurred:*** This condition indicates that the protection and regular channels are not driven from the same source. (This is normal for the second and subsequent channels when no switch or head-end bridge is up for that channel.)
   - ***Stationary (1):*** A notch in the regular channel signal appears to have a fixed time displacement relative to the notch on the protection trace. This indicates that the two signals originate in a single source.
     - i. Perform a manual switch to the channel under test and observe the regular channel lagging the protection channel by approximately 55 ns (Fig. 2).
     - ii. Release the manual switch and perform a TRMT BRIDGE switch on the same channel. Note the offset between the two traces.

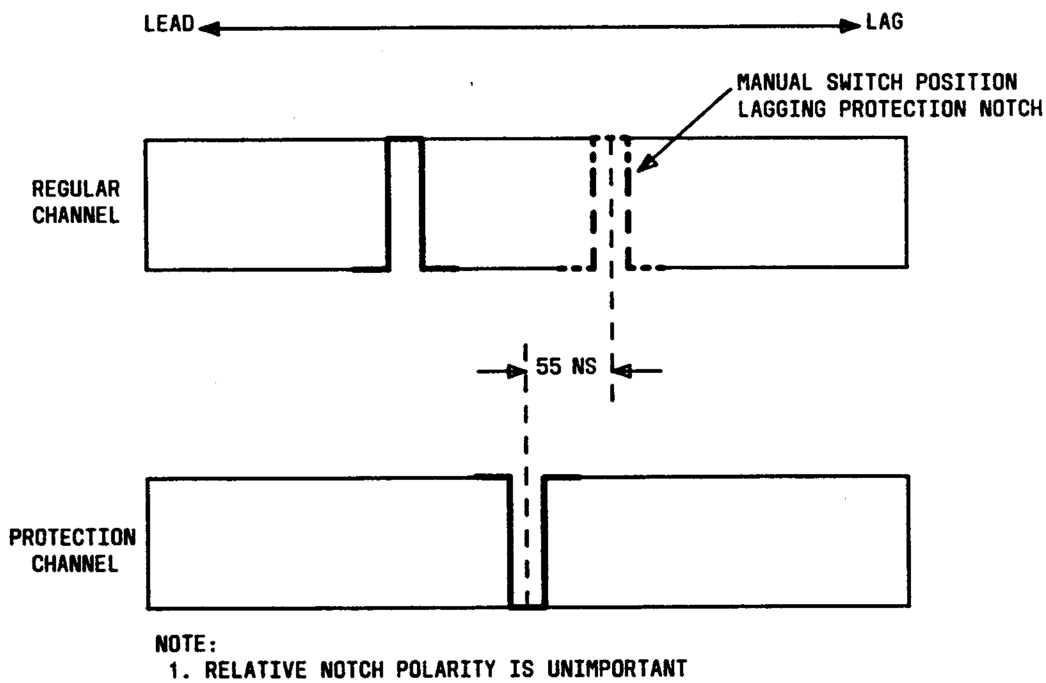


Fig. 2—Manual Switch Display

- *Stationary (2):* No notch is seen on the regular channel signal. In this case, the regular channel signal *leads* the protection channel signal.
  i. Trigger the oscilloscope from the regular channel signal.
  ii. Perform a TRMT BRIDGE switch and note the time offset (Fig. 3).

  Requirement: The resultant notch must be within ±150 ns (±3 divisions) of the position with a completed manual switch to assure hitless switching.

  Note: An offset greater than ±215 ns (±4.3 divisions) will cause reframing during switch transfer.

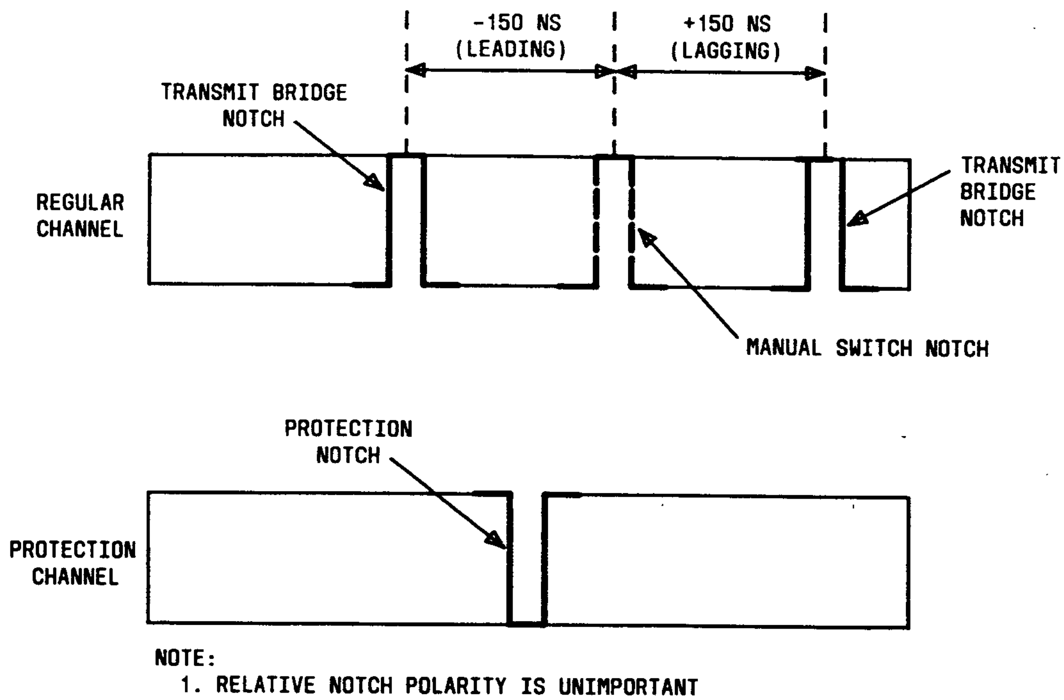


Fig. 3—Transmit Bridge Display

5. To correct for excessive ***lead,*** add coaxial cable at a convenient point in the switch section. This causes a delay of 1.5 ns per foot. To correct for excessive ***lag*** in a regular channel, remove cable from that channel or add cable to the protection channel.

   Note 1: Adding cable to the protection channel may affect the operation of other channels.

   Note 2: Cable can be added between the IF OUT jack on the RECEIVER DOWN CONV & MWV GEN unit and the IF IN jack on the LINEAR DELAY EQUALIZER unit. Lengths up to 33 feet may be used to provide up to 50 ns delay.

6. When suitable alignment is obtained, restore all protection switches.

7. If a diagnostic code 72 appears on the RECEIVING STATUS unit, the associated channel ( ) has not found alignment within its range. The above tests should be re-examined.

Note 1: The protection channel is normally "parked" on channel 1 when not required elsewhere.

Note 2: The dynamics of finding alignment can be observed. Connect to the regular and protection channels and observe the relative notch positions during a manual exerciser or CPU reset operation. The regular channel will jump to a starting position and then "walk" into the normal switched position as alignment is found. Channel 1 will remain parked in this position. Other channels will be seen momentarily.

DS139 BER/CMI PERFORMANCE CHECK

INTRODUCTION

This procedure describes how to measure the error performance for a test signal transmitted over the air from one terminal station to another. This test may be required when errors are being reported but are not detected by normal performance monitoring.

The following units are not included in normal monitoring and could be the source of errors:

- INPUT DIRECTOR
- CMI DECODER
- CMI CODER
- OUTPUT DIRECTOR

Caution: This testing must be done out-of-service.

Note: A technician is required at each terminal station.

TEST EQUIPMENT

The following equipment is required to perform this test:

2 - Bit-error-rate test sets (Anritsu Model ME518A or equivalent)

2 - Coaxial cables each equipped with a BNC(M) and an SMB(F) connector.

Optional Equipment

1 - Digital timer and printer (Anritsu Model MS012A or equivalent).

TEST PROCEDURE

1. If testing a regular channel, transfer the service to the protection channel.

   If testing the protection channel, put the protection channel in the access mode.
2. At the transmitting station, condition the test set to send a DS139 CMI coded signal in a pseudorandom pattern of (2^{23})-1 bits.
3. At the receiving station, condition the test set to receive the test signal.
4. If code violations are to be measured, set the ERROR selection on the test set receiver to the CODE position.

   If the bit-error-rate is to be measured, set the ERROR selection on the test set receiver to the BINARY position.
5. Apply the DS139 test signal to the appropriate REG TRMT INTERFACE, or the PROTN TRMT INTERFACE unit.

Requirement: There should be no LEDs lighted on the following units:

- CMI DECODER
- TRANSMIT ELASTIC ST
- ENCODER
- MODULATOR

6. If there are any LEDs lighted, first re-check the test setup.

   Note: Any LEDs lighted on the above units should have generated an alarm.

7. If the test setup is good, one of the following units in the associated channel is faulty:
   - REG TRMT INTERFACE, or PROTN TRMT INTERFACE
   - CMI DECODER
   - TRANSMIT ELASTIC ST

8. Connect the BER test set receiver to the appropriate REG RCV INTERFACE or the PROTN RCV INTERFACE.

   Requirement: The only LED that should be lighted is the CDR SW LED on the CMI CODER.

The previous steps describe how to set up the equipment to measure bit-error-rate or code violations. The description of how to use this test in troubleshooting is found in the "Nonalarm Trouble Isolation" tab.

DS139, HIGH- AND LOW-FREQUENCY JITTER MEASUREMENT

INTRODUCTION

This procedure describes how to measure jitter on the high- and low-frequency components of the high speed CMI coded DS139 signal. Jitter is measured over the entire switch section, that is, from transmitting terminal station to receiving terminal station. ***When making a jitter measurement, it is necessary to switch the service on the channel to be tested to the protection channel.*** The high-frequency jitter requirement for a switch section is 0.075 unit intervals peak to peak. The low-frequency jitter requirement for a switch section is 0.4 unit intervals peak to peak.

Most test sets used to measure jitter add a negligible amount of jitter (intrinsic jitter) to the test parameters. When measuring high frequency jitter on the CMI coded DS139 signal, however, the intrinsic jitter of the test sets can have significant bearing on the overall result. Therefore, it is necessary to determine the intrinsic jitter of both the test signal source and the measuring set. ***Careful attention to details must be observed; otherwise, the accuracy of the high-frequency jitter measurement will be questionable.***

TEST EQUIPMENT

To measure jitter on the CMI coded DS139 signal, the following test equipment or its equivalent is recommended:

- Anritsu* ME518A Error Rate Measuring Equipment or a signal source capable of sending a 139-Mb/s (PRBS 2^{23}-1) signal
- Hewlett Packard+ Model 3764A Digital Transmission Analyzer or a test set capable of measuring a 139 Mb/s PRBS signal to the 0.001 unit interval peak-to-peak level.

Experience has shown that the test equipment listed above has approximately 0.03 unit interval peak-to-peak intrinsic jitter when operated together.

TEST PROCEDURE

The following procedure is used to measure the high- and low-frequency jitter of the DS139 signal:

Determine the Intrinsic Jitter of the Test Sets

1. Connect the CMI OUTPUT from the test signal generator to the REC DATA INPUT on the measuring set.
2. On the measuring set, set the REC I/P INTERFACE to CMI (TERM).

---

* Registered trademark of the Anritsu Electric Company, Ltd.

\+ Registered trademark of the Hewlett-Packard Company.

3. On the measuring set, set the PATTERN to PRBS.
4. On the measuring set, select peak-to-peak MAX jitter measurement with AMP RANGE set to 1UI (unit interval).
5. On the measuring set, set the FLT to LP/HP2 (10 kHz to 3.5 MHz).
6. On the measuring set, use the START/STOP button (GATING LED ON) to measure the input test for 30 seconds. Record the measurement.

Note: The intrinsic jitter of the two test sets is typically from 0.02 to 0.03 unit intervals for high-frequency jitter.

7. On the measuring set, set the FLT to LP/HP1 (200 Hz to 3.5 MHz).
8. Repeat Step 6.

Note: The intrinsic jitter of the two test sets is typically from 0.02 to 0.04 unit intervals for low-frequency jitter.

Measure CMI Coded DS139 Jitter Over Switch Section

9. ***Ensure service on channel to be tested is switched to protection.***
10. At transmitting terminal station, connect test signal generator to DS139 IN jack (J3) on right side of digital terminal shelf under test.
11. At receiving terminal station, connect measuring test set to DS139 OUT jack (J4) on right side of digital terminal shelf under test.
12. At receiving terminal station, repeat Steps 2 through 6.
13. Subtract the test set measurement recorded in Step 6 from the switch section measurement recorded in Step 12.

Requirement: High frequency (10 kHz to 3.5 MHz) jitter, when measured over 30 seconds, should be less than 0.075 unit intervals peak to peak.

14. At receiving terminal station, repeat Steps 2 through 4.
15. At receiving terminal station, on the measurement set, set the FLT to LP/HP1 (200 Hz to 3.5 MHz).
16. At receiving terminal station, repeat Step 6.
17. Subtract the test set measurement recorded in Step 8 from the switch section measurement recorded in Step 16.

Requirement: Low frequency (200 Hz to 3.5 MHz) jitter, when measured over 30 seconds, should be less than 0.4 unit intervals peak-to-peak.

More than one switch section can be tested at a time. When testing two or more switch sections at a time, the following must be done in addition to Steps 1 through 17:

- The test signal generator must be connected to the far-end transmitting terminal station.
- The measuring test set must be connected to the last receiving terminal station in the switch section under test.
- The high- and low-frequency jitter requirement for the switch sections under test must be less than 1.5 unit intervals peak to peak when measured over 30 seconds.

FADE MARGIN AND INTERFERENCE TESTS

In multihop analog radio systems, thermal noise and interference from a cochannel, an adjacent channel, or other signal source can accumulate from hop to hop. In contrast, multihop regenerative digital radio systems, such as DR 6/11-140, operate without such hop-to-hop accumulation and can give acceptable performance even when the S/N (signal-to-noise) ratio on one or more hops in a terminal section approaches values as low as 30 dB. Thus, if each hop is engineered to keep the noise contributors on that hop to acceptable levels, satisfactory end-to-end performance over multiple hop systems is virtually guaranteed, even during periods of extreme radio path fading. This situation is usually achieved when the engineering guidelines normally used for locating and laying out radio hops are followed.

If each hop is properly engineered, the signal-to-noise ratios achieved for the various possible interference components are usually more than adequate to give acceptable fade margins. However, problems created by improper installation, defective antenna system components, or unanticipated interferences can result in radio hops with unacceptable fade margins. Such situations may go undetected during the normal S/I (signal-to-interference) stress checks made on each radio hop at installation time. Also, equipment and/or environmental degradations that increase the impact of existing interferences or noise sources, which were originally under control, may occur after the system is in service. New interferences, which degrade the usable fade margin, may also be introduced after a system is put in service. This can occur by adding growth channels on the same system or from the deployment of other radio systems nearby. As a result of all these factors, test procedures for evaluating the fade margin capability of radio hops at initial turn-up are necessary to ensure proper system performance. These tests are also necessary as diagnostic tools for maintenance on in-service systems.

This practice satisfies the above objectives by providing the techniques necessary to determine and evaluate the FFM (flat fade margin) of a DR 6/11-140 regenerative radio hop which is divided into three basic parts.

> *Note:* There are two types of radio fading, that which simply attenuates the level of the received signal and that which introduces both attenuation and amplitude-versus-frequency distortions into the received signal spectrum. The first type, which is discussed in this practice, is commonly referred to as a "flat-fade." With this type of fading, all components of the signal spectrum are attenuated equally. Procedures for determining the capability of DR 6/11-140 systems to handle the second type of shape-producing fades, which are generally caused by multipath propagation disturbances, appear elsewhere in the DR 6/11-40-140 manuals. (See "Over-the-Air Propagation Distortion Check" in the applicable station O&M manual under the "Station Test" tab.)

Part 1, TEST PROCEDURES FOR DETERMINING FADE MARGIN PARAMETERS, gives the procedures for determining the noise and interference parameters that are necessary to calculate the FFM.

Part 2, FLAT FADE MARGIN CALCULATION PROCEDURES, gives the equations and details for determining and evaluating the FFM of a hop using the parameters obtained via Part 1.

Part 3, MEASUREMENT APPROACH AND IDENTIFICATION OF NOISE SOURCES, provides background and tutorial information to introduce first-time or inexperienced users with the basic techniques for evaluating and the parameters which can influence the FFM of a digital radio hop. The basic measurement approach and the origin and characteristics of the various noise and interference sources that can limit the FFM of a radio hop are described. The symbols that are used throughout the test procedures of Parts 1 and 2 are also defined.

Generally, experienced users need only follow the procedures in Parts 1 and 2 to perform an FFM evaluation of a digital radio hop. Inexperienced users must first become familiar with the information in Part 3 before performing the procedures and evaluations required in Parts 1 and 2.

PART 1—TEST PROCEDURES FOR DETERMINING FADE MARGIN PARAMETERS

This part of the Fade Margin and Interference Tests practice gives the procedures for determining the types and levels of the fade-limiting noise and interference that may be present in a DR 6/11-140 digital radio hop. When necessary, the test procedures direct the user to more detailed subroutines. The subroutines give the detailed procedures for determining the S/N or S/I ratios for the various types of noise and interference that are necessary for calculating the FFM of the digital radio hop under test. Each subroutine also gives techniques for diagnosing an out-of-limit condition that may be encountered during its execution. The flowchart in Fig. 1 outlines the overall procedural sequence necessary to achieve the desired objectives.

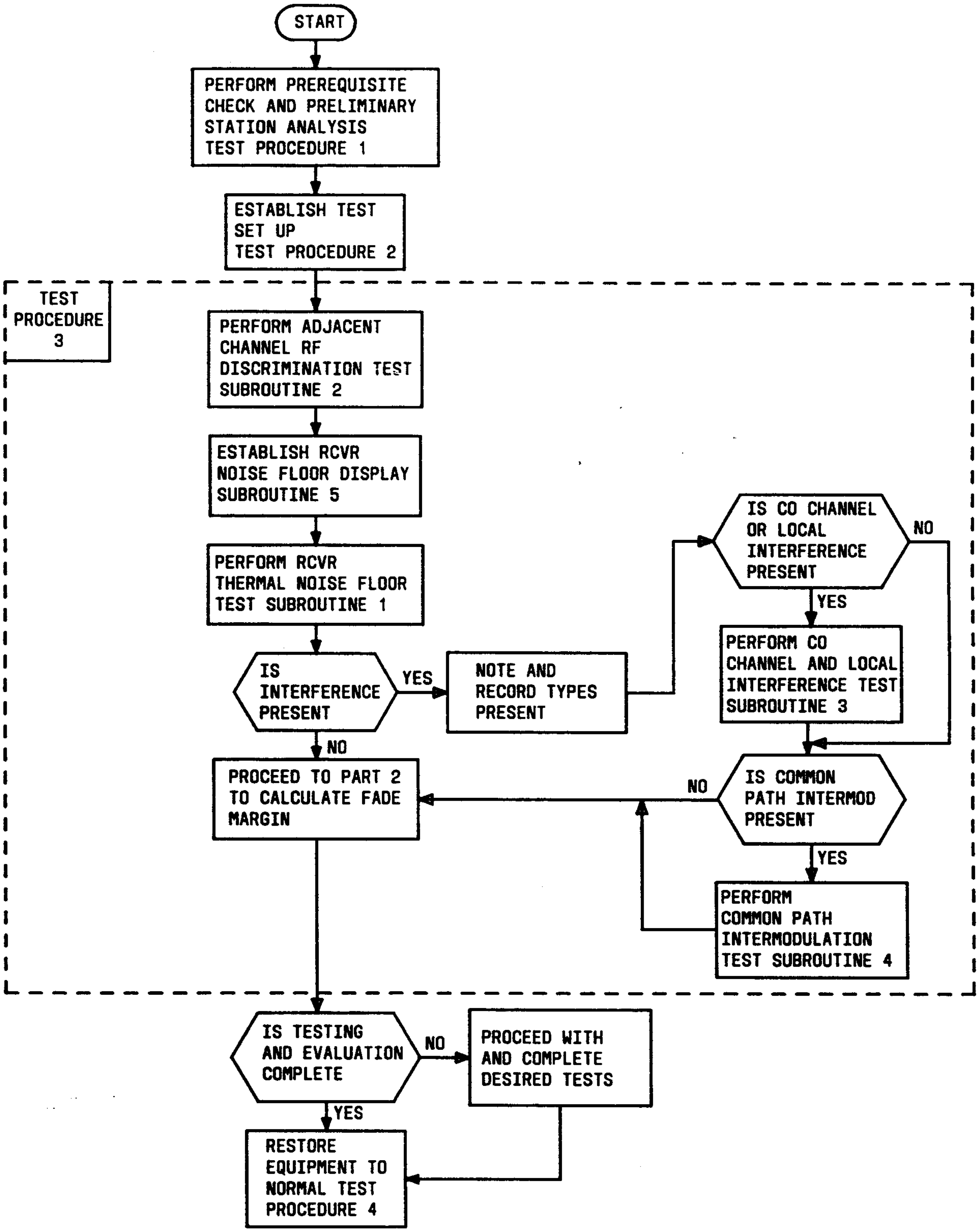


Fig. 1—Flowchart of Test Procedures Process

TEST PROCEDURE 1—PREREQUISITES AND PRELIMINARY ANALYSIS

A prerequisite, especially for inexperienced users, is familiarity with the information, terminology, and symbols in Part 3. This information will enable the user to properly perform the procedures and evaluate the results.

Once the user is familiar with Part 3, the next step in preparing for the interference and fade margin tests is to identify the lineup of 6- and/or 11-GHz radio channels assigned to the same receiving antenna as the channel to be evaluated. This can normally be done by using the station records for the receive-end station of the hop to be tested. (See Table A for the corresponding Channel Number versus Frequency information on 6-GHz hops and Table B or C for the corresponding information on 11-GHz hops.) Use a diagram like that shown in Fig. 2 to identify and locate, on a relative position basis, all the radio channels (of both polarities) assigned to the same antenna. Figure 3(a) gives a specific example for a 6-GHz radio lineup.

If an 11-GHz lineup is being evaluated, begin testing after determining the lineup configuration. If a 6-GHz receiver lineup is being evaluated, first determine whether the channel to be tested has any adjacent channels present. If it does, note which ones are present, and using the information given in Fig. 4(a) or 4(b), determine and sketch how the IF spectrum will appear on the spectrum analyzer at the receiver down-converter output. Figure 3(b) gives an example of this step for the lineup example shown in Fig. 3(a).

If it is not known whether the hop and transmitter-receiver combination to be evaluated for fade margin meets the over-the-air S/I hop performance requirement under normal signal conditions, do that performance check before proceeding. Otherwise, the calculations to evaluate fade margins using the results of the procedures given here may be incorrect. Follow the procedures for the Over-The-Air S/I Test given in the applicable station operation and maintenance manual.

When these prerequisites are met and the preliminary analyses are completed, establish the test setup by performing Test Procedure 2.

TABLE A FREQUENCY ASSIGNMENTS	
CHANNEL NUMBER	FREQUENCY (MHZ)
1	6460
2	6500
3	6540
4	6580
5	6620
6	6660
7	6700
8	6740
1'	6800
2'	6840
3'	6880
4'	6920
5'	6960
6'	7000
7'	7040
8'	7080

TABLE B

11-GHZ REGULAR FREQUENCY PLAN

CHANNEL NUMBER	HALF-BAND LOCATION	CHANNEL FREQUENCY (MHz)
1	Low	10715
2	Low	10755
3	Low	10795
4	Low	10835
5	Low	10875
6	Low	10915
7	Low	10955
8	Low	10995
9	Low	11035
10	Low	11075
11	Low	11115
12	Low	11155
1'	High	11245
2'	High	11285
3'	High	11325
4'	High	11365
5'	High	11405
6'	High	11445
7'	High	11485
8'	High	11525
9'	High	11565
10'	High	11605
11'	High	11645
12'	High	11685

TABLE C

11-GHZ ALTERNATE FREQUENCY PLAN

CHANNEL NUMBER	HALF-BAND LOCATION	CHANNEL FREQUENCY (MHz)
2I	Low	10735
3I	Low	10775
4I	Low	10815
5I	Low	10855
6I	Low	10895
7I	Low	10935
8I	Low	10975
9I	Low	11015
10I	Low	11055
11I	Low	11095
12I	Low	11135
1'I	High	11225
2'I	High	11265
3'I	High	11305
4'I	High	11345
5'I	High	11385
6'I	High	11425
7'I	High	11465
8'I	High	11505
9'I	High	11545
10'I	High	11585
11'I	High	11625
12'I	High	11665

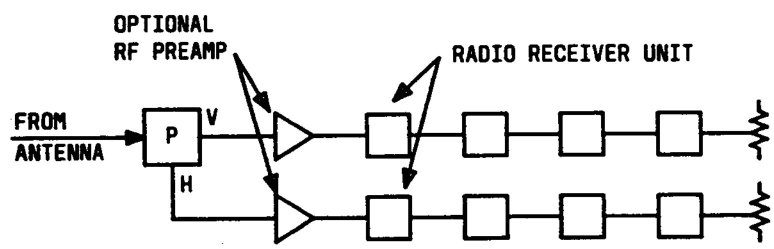


Fig. 2—Suggested Sketch to Show Receiver Lineup of Channels at a Station

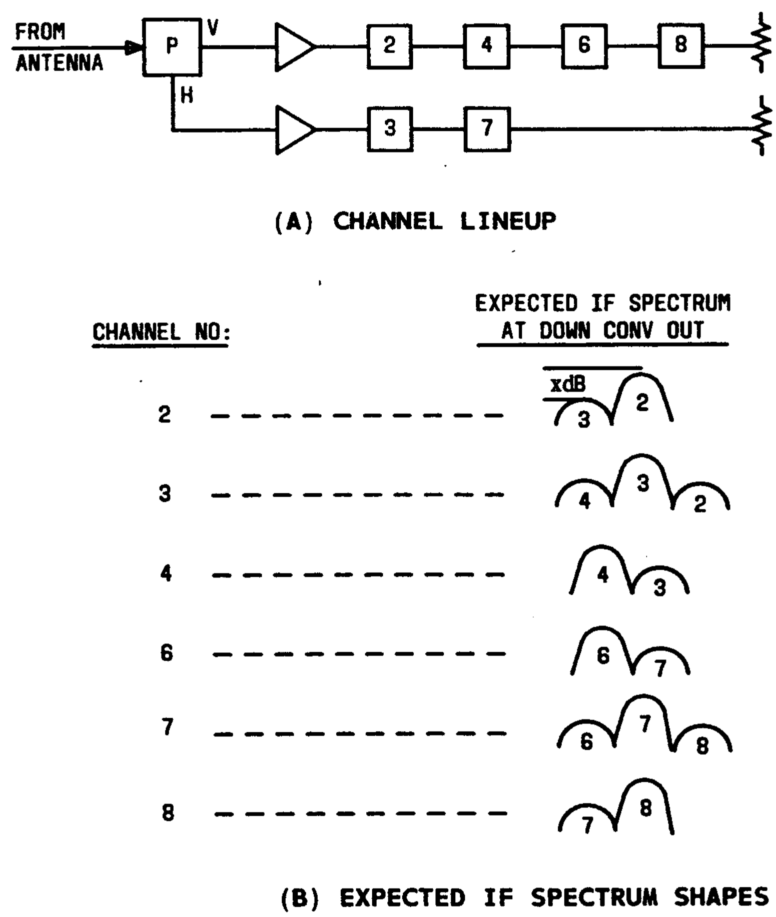
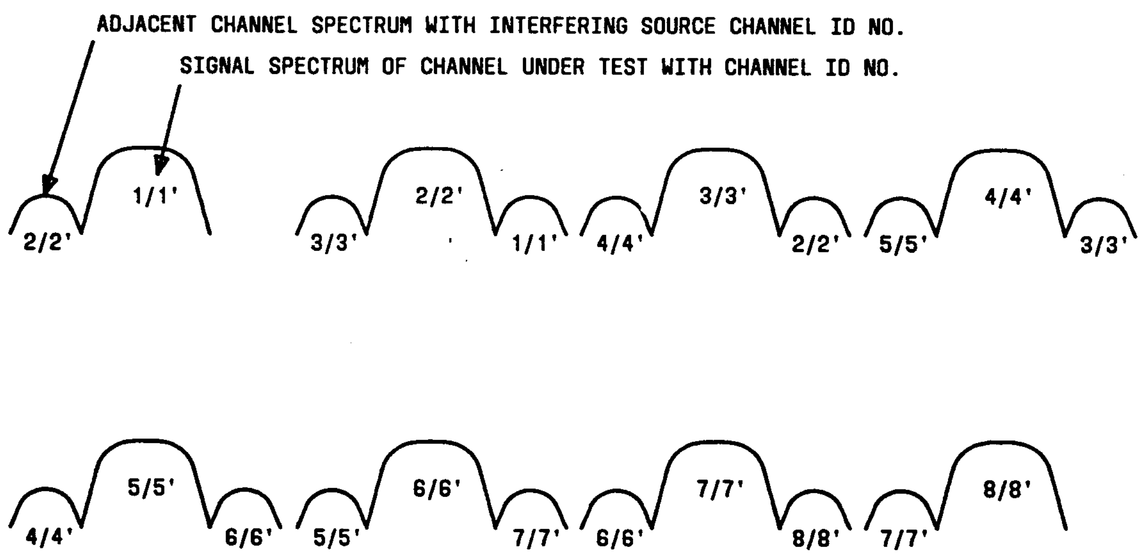


Fig. 3—Example of Station Lineup and IF Spectrum Profile Sketches to Use for Evaluating Typical DR 6 Adjacent Channel Interference



NOTE: NOTICE THAT ADJACENT CHANNEL INTERFERENCE INTO CHANNELS 1-4 AND 1'-4' IS REVERSED IN FREQUENCY AT IF RELATIVE TO THEIR FREQUENCY POSITION AT RF. THIS IS BECAUSE THEIR RECEIVER LOCAL OSCILLATOR'S ARE ABOVE THE CENTER FREQUENCY FOR EACH OF THESE CHANNELS. (SEE TABLE A)

Fig. 4—Received IF Spectrum for Each DR6 Channel With All Adjacent Channels Present

TEST PROCEDURE 2—TEST SETUPS

This procedure establishes the test setup to permit an evaluation of the noise and interference components using the spectrum at the IF output of the radio receiver down-converter. Manual control over the level of the transmitter RF output signal is also necessary. This is controlled via an external IF attenuator inserted in the IF input path to the transmitter up-converter.

A simplified block diagram of the setup is shown in Fig. 5. The objective of this setup procedure is to establish a usable spectrum display of the receiver down-converter IF output and the reference setting of the external IF attenuator (ATT30) to produce an accurate 30-dB drop (fade) in the transmitter RF output signal.

The following equipment is required to perform this procedure.

At transmitting end:

- 1 - RF power meter
- 1 - 0-50 dB IF attenuator (1 dB steps)
- * - Miscellaneous adapters and cables.

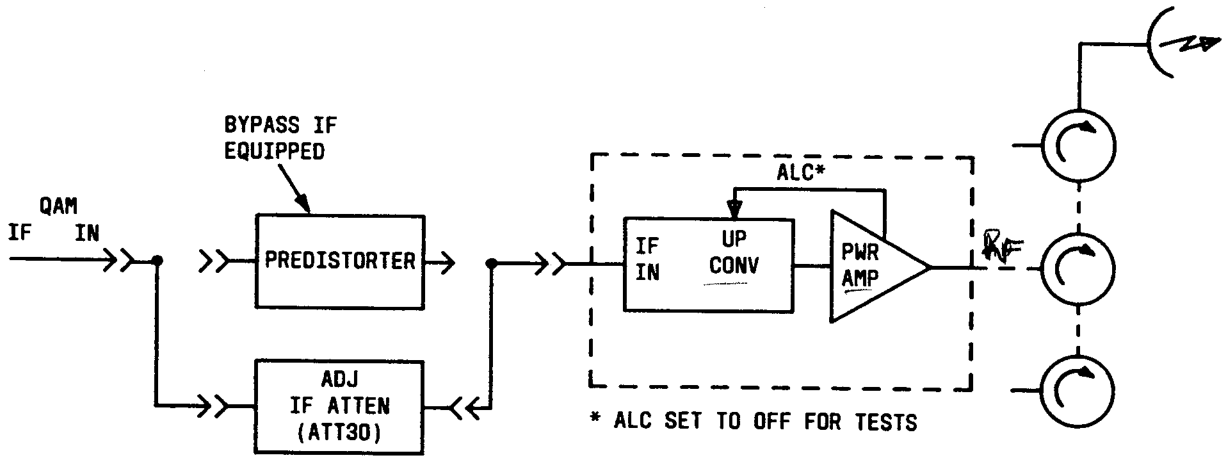
At the receiving end:

- 1 - IF spectrum analyzer
- 1 - IF power meter
- * - Miscellaneous IF pads, adapters, and cables.

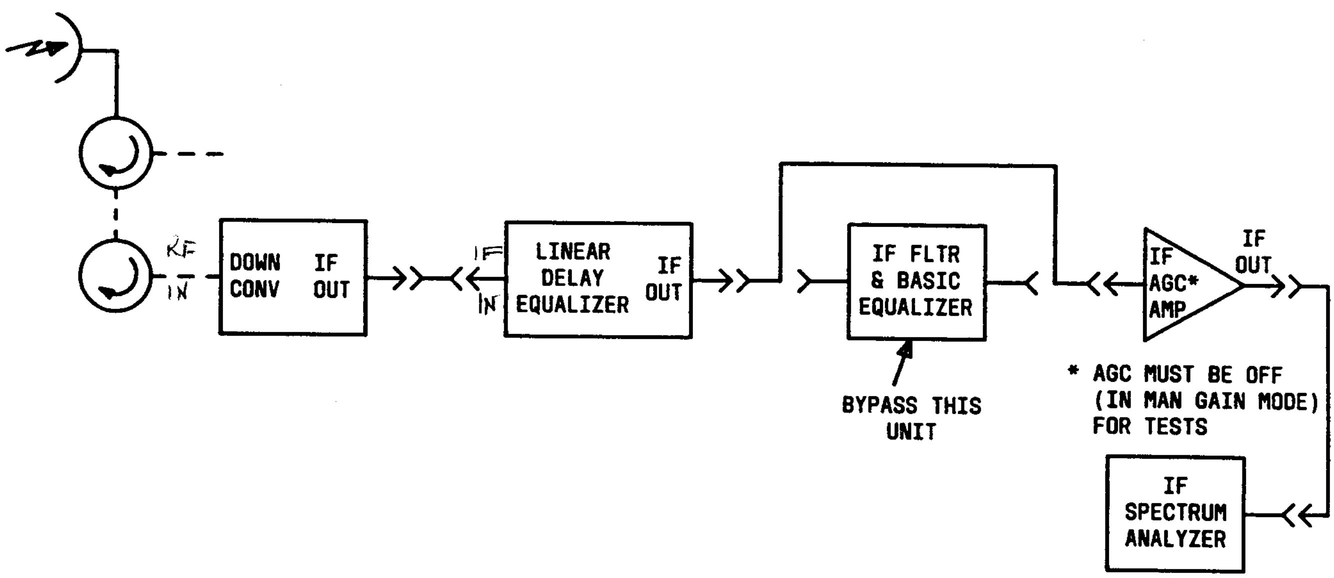
STEP	PROCEDURE
1	Obtain a release on the channel to be tested.
2	At the transmit station, perform the necessary switching operations to put the desired transmitter on the air and perform a manual LOCKOUT switch operation at the transmitter to prevent any switching during testing.
3	With the transmitter set for manual gain operation (ALC OFF), check the IF input to the up-converter and the RF output power at the RF MON jack to ensure that they are correct. If correct, record the IF input level for future use. Call this recorded value UCI (up-converter input). Also check the up- and down-converter generator frequencies and power at both ends of the hop to be evaluated. Follow the procedures given for these measurements in the station O&M manuals, making corrections and adjustments as necessary.
4	With the transmitter still in the ALC OFF mode, insert a calibrated adjustable 0-50 dB IF attenuator between the IF IN on the up-converter and the coaxial cable normally connected to that input.

STEP	PROCEDURE
5	Set the external IF attenuator to 0 dB.
6	Measure the IF power at the cable now connected to the input to the up-converter. Temporarily record this power measurement for future use as P_{in} (power in).
7	Determine the attenuator setting necessary to reduce the level of P_{in} in Step 8 to a reference level that is 30 dB below the normal value measured and recorded as UCI in Step 3. The attenuator value (ATT30) necessary to establish this reference setting may be obtained using the following equation: $$ATT30 = P_{in} - (UCI - 30)\ dB$$ Set the attenuator to this value, and record the setting of the attenuator as ATT30.
8	At the receive end of the hop, connect a spectrum analyzer to view the IF spectrum at the IF OUT jack on the IF AGC AMPL of the receiver to be used for performing the fade margin and interference tests.
9	On this same receiver shelf, bypass the IF FILTER AND BASIC EQUALIZER by connecting the cable from the IF OUT port on the LINEAR DELAY EQUALIZER unit directly to the IF IN port on the IF AGC AMPL unit. ***Note:*** This step is necessary to achieve a bandwidth wide enough to permit any adjacent channel or other interference signals that may be present at the band edges of the channel to be displayed along with the in-channel signal.
10	Set the controls on the spectrum analyzer to view at least a 50-MHz wide spectrum centered at 70 MHz. Use a vertical sensitivity setting of 10 dB per division, and adjust the amplitude and bandwidth controls on the spectrum analyzer to bring the center of the 70 MHz, in-channel, signal spectrum close to the top of the display.
11	Set the IF amplifier to the manual gain position, and adjust its MAN GAIN control in the increasing gain direction (clockwise) to recover the spectrum display.
12	Using the vertical gain and/or position controls on the spectrum analyzer and the IF AMPLIFIER manual gain control, position the center of the displayed signal spectrum at a convenient reference line as close to the top of the display area as possible.
13	The test setup for evaluating noise and interference levels and their characteristics is now complete. When the external IF attenuator is set to the

STEP	PROCEDURE
	reference ATT30 setting established, the displayed in-channel signal will be exactly 30 dB down relative to its normal value. At this point, proceed in accordance with one of the following conditions: a. If a complete flat fade margin evaluation is to be done, go to ***Test Procedure 3—Test Sequence for Determining Flat Fade Margin Parameters***. b. If this setup is being used for assessing a particular interference test in a ***Subroutine*** contained in this practice or for other diagnostic purposes, perform the desired procedure. When complete, go to Test Procedure 4 to restore equipment to normal.



(A) TRANSMITTER SET UP



(B) RECEIVER SET UP

Fig. 5—Simplified Block Diagram of Test Setup for Fade Margin and Interference Tests

TEST PROCEDURE 3—TEST SEQUENCE FOR DETERMINING FLAT FADE MARGIN PARAMETERS

This procedure is used to identify and acquire the S/I and S/N ratios necessary for calculating the flat fade margin of a DR6/11-140 radio hop.

STEP	PROCEDURE

Check for Adjacent Channel Presence

1 Using the test setup established in Test Procedure 2, observe the received spectrum at the down-converter output, and note whether any adjacent channel signals are present. Use the sketches prepared in conjunction with Test Procedure 1 (Fig. 3 examples) and, if necessary, the patterns shown in Fig. 4(a) and 4(b) as a guide.

If one or more adjacent channels ***are*** present, perform ***Subroutine 2—Adjacent Channel RF Discrimination Test*** to determine the S/ACI (Adjacent Channel Interference) ratio for each channel; then go to Step 3.

If ***no*** adjacent channel is present, go directly to Step 3.

Establish Receiver Noise Floor Display

This step establishes a calibrated display of the receiver noise floor, which may be used to determine the S/I and S/N ratios of the significant in-channel noise contributors. Subroutine 5 gives the steps necessary to establish this display.

2 Perform Subroutine 5; then go to Step 3.

Examine Noise Floor for Presence of In-Channel Interference Components

3 Examine the receiver noise floor spectrum at the IF output of the down-converter. Note whether any significant in-channel interference from external sources appears in the channel (examples in Fig. 6). Depending on this observation, proceed with one of the following:

a. ***No Interference Evident:*** If the spectrum of the in-channel noise floor is essentially flat and is 35 dB or more below the established 30 dB down signal reference line, assume that no significant interference exists. When this is the case, the in-channel noise is controlled by the TN (thermal noise) component generated within the receiver. Perform Subroutine 1 to determine the level and acceptability of the displayed TN floor component. After successfully completing Subroutine 1, go to Step 5.

STEP	PROCEDURE
	b. ***Interference Present:*** If in-channel interference ***is evident***, identify and note for future reference the type(s) present (cochannel, local, or common path intermodulation) using Fig. 6 as a guide. Each interference present will ultimately be evaluated using the appropriate subroutine (3 and/or 4). However, before evaluating the interference components, the receiver TN floor component must be evaluated. Therefore, note the type(s) of interference present and then evaluate the TN component via Subroutine 1.
	After successfully completing Subroutine 1, perform the applicable subroutine to evaluate each interference type previously noted.
	Once acceptable S/I ratios (S/CCI [Co-channel Interference], S/NELI [Near-end Local Interference, and/or S/IMN [Common Path Intermodulation Noise]) are obtained for all of the significant interferences present, go to Step 4.
Determine Flat Fade Margin	
4	All significant S/I or S/N ratios (that is, S/TN, S/CCI, S/NELI, S/ACI, and S/IMN) necessary for calculating the flat fade margin should now be acquired. Follow the ***Flat Fade Margin Calculation Procedures*** for the specific interference and noise situation involved.

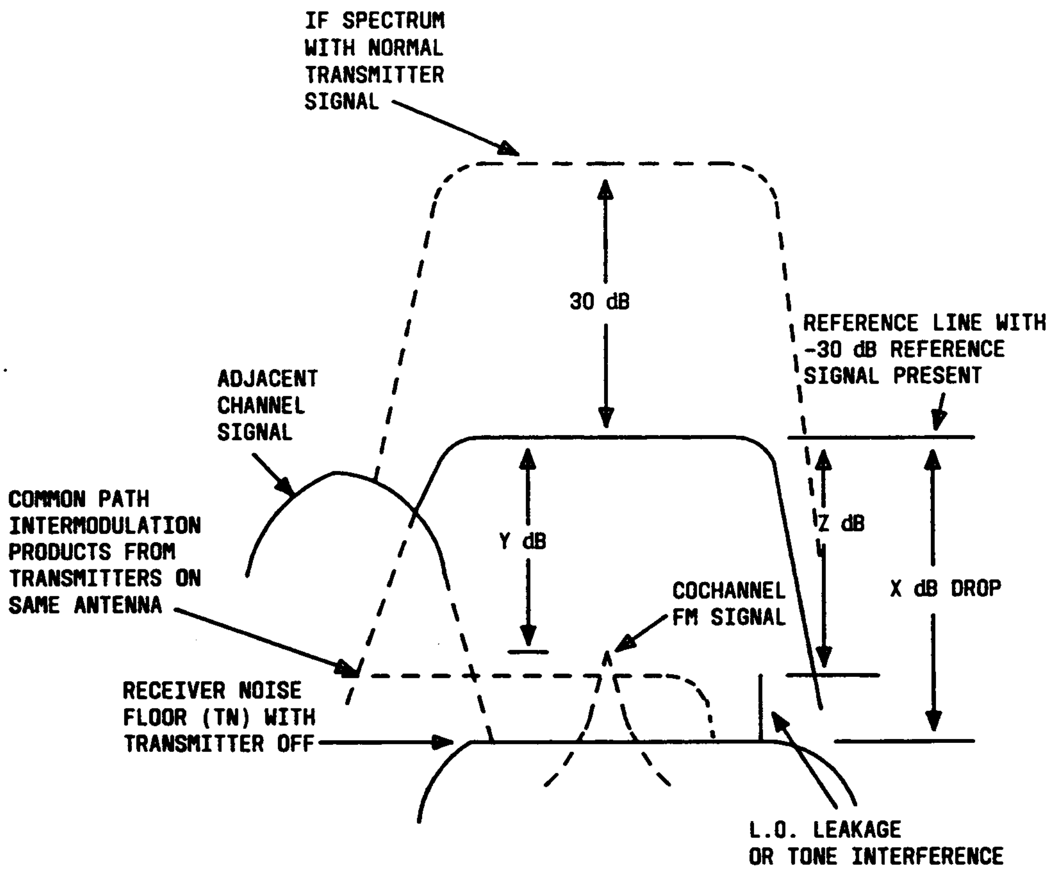


Fig. 6—Example of IF Output Spectrum Display During Process to Determine Receiver Noise Floor and In-Channel Noise Components

TEST PROCEDURE 4—RESTORING EQUIPMENT TO NORMAL

STEP	PROCEDURE
1	When the measurements using the setup established in Test Procedure 2 are complete, leave the protection switching system in the mode established to perform that procedure.
2	Remove all the test equipment, and restore the radio bay connections and all transmitter/receiver unit operating modes to normal.
3	Go to the Repair Verification Procedure given in the applicable station O&M manual and follow the instructions in that procedure to return the system to service.

Subroutine 1—Receiver Thermal Noise Floor Test

This subroutine is used to determine the ratio of the normal signal level to the level of the thermal noise-floor component (S/TN) that is generated within the receiver. This process involves identifying and locating the TN component on the analyzer noise-floor display, then noting how far down this floor is, in dB, from the -30 dB reference signal display line. The S/TN ratio is then calculated by adding 30 dB to the observed dB difference.

If not already completed, Test Procedures 1 and 2 and Subroutine 5 must be completed before doing this procedure.

STEP	PROCEDURE

1 Determine the S/TN ratio.

a. Note the spectrum display with the transmit signal removed. The in-channel spectrum now displayed represents the composite noise-floor of the receiver. Using the examples of Fig. 6 as a guide, identify and locate a horizontal section of the analyzer display trace that represents the thermal noise floor component, TN.

Note: Normally, the TN component of the noise floor is as shown in these examples, obvious even with cochannel, local, or intermodulation interference components present. However, noise-like type interference, such as cochannel interference from another DR-140 radio transmitter operating on the same frequency, may sometimes be present in sufficient magnitude to obscure the true receiver TN noise floor. Such a condition may be suspected if the S/N ratio of the apparent thermal noise floor is several dB lower than the S/TN requirements stated in part c of this step. When this is the case, it generally indicates that an out-of-limit interference condition exists. The source of this out-of-limit noise or interference must be isolated and eliminated before a meaningful measurement can be completed to determine the parameters necessary for calculating the flat fade margin of a radio hop. Unless the source of such an interference is obvious, locating the contaminating source generally involves a trial-and-error approach. Once a suspected source is identified, it must be verified by turning it on and off.

b. Once the vertical position of the TN noise floor component is located on the display, note the number of dB (X) that it is below the horizontal signal reference line that was previously established for the 30 dB down reference signal.

Given the value of X and noting that X is measured relative to the 30 dB down signal, the desired S/TN ratio is calculated using the following equation:

$$S/TN = 30 + X \text{ dB}.$$

c. Compare this S/TN ratio with the MIN S/TN RATIO REQUIREMENTS given in the following table.