1. GENERAL

This practice is used to test and adjust both radio and line terminal equipment. These procedures will be referred to from the alarm-clearing procedures in the MAINTENANCE tab and the REPAIR VERIFICATION and the ANNUAL FCC TESTS tabs. These procedures are also used on a stand-alone basis to determine if a particular radio hop is performing properly.

Each procedure lists the recommended test equipment and accessories. Each piece of equipment is keyed with an item number (for example, Item A1) that corresponds to an item number in Table A, B, or C under the TEST EQUIPMENT AND ACCESSORIES tab. These tables provide the minimum specifications for each piece of test equipment, and these specifications allow the technician to select alternate test equipment.

Using other than the recommended test equipment may require a slightly different test setup to perform the following procedures.

Follow the manufacturer's setup and/or operation procedures for test equipment, accessories, and tools.

1.1 UPDATE INFORMATION

This practice is reissued to revise Parts 2, 3, and 4 and Figures 3, 4, 5, 6, and 7. The practice is used in binders 421-102-090 and 421-102-100.

1.2 ADMONISHMENTS

Admonishments are strategically-placed reminders to assure the safety of personnel ***(DANGER)***, minimize service interruptions ***(Caution)***, and prevent equipment damage ***(Warning)***. The technician should read and become familiar with the admonishments in the MAINTENANCE tab.

1.3 SERVICE PROTECTION

Service protection is necessary before performing the tests in this section. The preface information for each procedure contains the following:

> ***Caution: THIS IS AN OUT-OF-SERVICE PROCEDURE.***

The ***Caution*** means that manual service protection operations ***must*** be performed to avoid interrupting service. The appropriate manual operation is referenced at the appropriate step in the procedure.

Service on the regular equipment to be tested ***must*** be manually switched to protection to prevent service interruptions. If the protection equipment is to be tested, it ***must*** be manually locked out to prevent the regular equipment from switching to it during the procedure.

If necessary, refer to the SERVICE PROTECTION tab and/or OPERATIONS tab to perform or verify proper service protection.

2. OVER-THE-AIR PROPAGATION DISTORTION PERFORMANCE CHECK

OVERVIEW

This procedure is used to check the performance of the receiver circuits that correct for distortion caused by propagation disturbances in the radio channel air path. The circuits include the Adaptive Slope Equalizer (ASE) unit and, if equipped, the Transversal Equalizer (TE) unit. The tests are performed on an over-the-air basis using the normal 64 quadrature amplitude modulation (QAM) payload and must be made during stable propagation conditions since simulated distortions are used to evaluate performance.

The stress tests are normally used when performance alarms or other observations indicate that digital transmission may be abnormally degraded during fading periods. They are used to determine whether such degradations are because of equipment failures or external propagation influences. The tests are also recommended during the annual station visits required by the FCC. Here, the purpose is to verify that the adaptive circuits are capable of performing their corrective actions when fading occurs. The tests help to reduce the probability of a "silent failure" and to verify that the hop transmission characteristics are normal under normal propagation conditions.

DESCRIPTION OF BASIC TEST PROCEDURES

Three separate tests are included:

1. ASE Distortion Capability
2. TE Distortion Capability
3. Receiver Recovery.

ASE AND TE DISTORTION CAPABILITY TESTS

The basic approach for checking the functionality of the ASE and TE units is to observe the bit-error-rate (BER) performance while each of the corrective circuit functions are stressed by an appropriate simulated distortion. Thus, the ASE function is checked by introducing "slope" distortion, and the TE is checked by using a "notch" type distortion. Both distortions are simulated and introduced in the radio receiver IF path ahead of the IF AGC amplifier.

For ASE evaluations a 10-dB/30-MHz positive and negative static slope is used. For TE testing, use a dynamic stress with a fixed depth (12 dB) notch that is swept back and forth across the IF payload band at about 40 MHz per second.

While the ASE must be in place and functioning properly for a valid TE test, the ASE ***must*** be tested with the TE bypassed or disabled. This latter constraint is necessary since the TE is capable of compensating for slope and as a result could mask a malfunctioning ASE unit. Whether a bypass or disable function is employed for the ASE test depends on the vintage of the digital receiver used.[1] Performance is evaluated, in either case, by meeting a specified BER requirement while the receiver is under stress of the simulated distortion.

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1. For digital receivers equipped with the Analog TE, a bypass plug-in card (AMR47) is used to eliminate the TE function. For Digital TE receivers, the TE is disabled by a control switch on the TE.

   Analog TE systems are identified by an AMR34 ( ) or 234 ( ) CRLTR plug-in card in position 4 of the digital receiver shelf. Digital TE systems have an AMR 184 ( ) TE unit in position 6 of the receiver shelf.

The simulated distortions for the ASE or TE evaluations are created by external test equipment. Depending on the model used, these distortions may come from either a common test set or separate test sets. In either case, these procedures call for using a Slope Equalizer Propagation Distortion Simulator (SE PDS) test set for ASE testing and a TE PDS for TE testing.

RECEIVER RECOVERY TEST

The ability of a digital receiver to recover synchronization following a total interruption of signal is made by using a manual IF interruption/reinsertion technique. For this test the radio receiver IF signal ahead of the AGC IF amplifier is interrupted by opening a coaxial connection. The connection is then reestablished and the "lock" status indicators on the digital receiver are observed to see how long recovery takes. Acceptable performance here is judged by recovering "carrier lock" in a specified time following the reinsertion of the signal. Again, the test conditions and the requirement depend on the options equipped (TE vs no TE) and on the vintage of the receiver being tested (for example: Non-Robust, Robust or Digital TE).

The digital receivers are most easily identified by observing the codes, for example:

Analog TE — TRANSV FLTs and AMR234 CRLTR
Digital TE — AMR184 TE
Non Robust — AMR29/30 DEMOD
Robust — AMR229/230 DEMOD.

TESTING SEQUENCE AND FLOWCHART

While the ASE, TE, and receiver recovery test procedures are to be used independently, correct TE evaluation depends on the ASE being present and meeting requirements. Similarly, proper receiver recovery testing depends on both the ASE and TE being present and meeting requirements. The test sequence flowchart is designed to ensure that testing is done in the proper sequence and should be followed to achieve proper results. Tests and test setups referred to in the flowchart are explained in more detail in the procedure that follows the flowchart.

EVALUATING RESULTS

Whether a hop fails to meet the requirements on any of the tests, the source of the problem is not necessarily limited to a defective ASE or TE unit. Other sources, such as excessive static distortion in some transmission characteristic of the hop, an abnormal external interference, or some other abnormal propagation problem, may be the cause. As a result, additional testing techniques such as Radio Transmission of Fade Margin testing may be necessary before the source of such a failure can be eliminated.

The test configurations used for the over-the-air propagation distortion ASE and TE performance tests are shown in Figures 1 and 2, respectively. The interrupt tests are performed with the setup in Figure 2, less the TE PDS for the non-robust, with or without TE, and robust, without TE, cases.

These procedures apply to any channel, regular or protection.

Note: When performing this procedure and using these test equipment specifications, the radio bay should be located so that the LED indicators on the associated digital receiver can be seen during the procedure. If the bay arrangement does not permit this and qualified help is not available, up to 50 feet of test cabling can be added to the radio receiver test setup so that the digital receiver can be seen.

Caution: THIS PROCEDURE IS SERVICE-AFFECTING UNLESS THE PROPER SWITCHING OPERATION HAS BEEN PERFORMED.

Warning: To prevent electrostatic discharge (ESD) damage to plug-in units, ensure that all ESD precautions are followed.

TEST EQUIPMENT

- Refer to Figure 1.

For recommendations and specifications of equivalent test equipment, see the TEST EQUIPMENT AND ACCESSORIES tab.

PROCEDURE

Establish Protection

1. Prepare channel for testing.

   (a) If testing a regular channel, protect service by performing a line switch (even if an automatic line switch exists).

   OR

   If testing the protection channel, perform a protection lockout.

   (b) Remove the right front side panel of the terminal bay to be tested.

ASE Performance Test Setup

2. At the radio receiver, remove the bay cable between the IF IN jack on the IF AGC AMPL unit and the IF OUT jack on the IF FILTER AND BASIC EQUALIZER unit.

3. Establish setup for ASE Performance test (Figure 1)

   a. Set the SE PDS to the "FLAT" position.

   b. On the terminal shelf patch panel, remove the IF input cable from the RCV IF IN jack for the digital receiver to be evaluated.

   c. Using the power meter, measure the power of the IF input cable as shown in Figure 1, Option A.

   Requirement:

   Standard IF interconnect cable (less than or equal to 50 feet), –7.2 to –9.2 dBm

   Long IF interconnect cable (greater than 50 feet), –10.5 to –12.9 dBm.

   If the requirement is met, go to Step 4.

   If the requirement is not met, check the test connections and equipment setup. If the requirement is still not met, go to Step 27.

4. If the digital receiver under test is equipped with an analog TE, go to Step 5. Otherwise, go to Step 11.

ASE Performance Test, Analog or No Digital TE

5. ***Warning: To prevent ESD damage to the plug-in units, ensure that ESD precautions are followed, including connecting the ESD wrist strap to ground and placing the removed plug-in units in ESD protective containers before disconnecting from ground and transporting units.***

   On the digital receiver under test, replace the TRNSV FLT units with TRNSV PATCH units. For help, refer to the TERMINAL tab under the REPLACEMENT PROCEDURES tab.

   Negative Slope Test

6. Disconnect the power meter and reconnect the IF cable to the RCV IF IN jack of the digital receiver under test (Figure 1, Option B).
7. Set the SE PDS to the "NEG SLOPE" position.
8. Observe the ERR RATE display (bar graph) on the associated CHAN CONTR unit. Wait 10 seconds before determining if the requirement is met.

   Requirement: The bar graph display shall not be lighted above the ***6*** segment. (The BER shall be less than or equal to 5×10^{-6}.)

   If the requirement is met, go to Step 9.

   If the requirement is not met, go to Step 27.

   Positive Slope Test

9. Set the SE PDS to the "POS SLOPE" position.
10. Observe the ERR RATE display (bar graph) on the associated CHAN CONTR unit. Wait 10 seconds before determining if the requirement is met.

    Requirement: The bar graph display shall not be lighted above the ***6*** segment. (The BER shall be less than or equal to 5×10^{-6}.)

    If the requirement is met and the TE option is equipped, replace the TRNSV PATCH units with the TRNSV FLT units (see ***Warning*** in Step 5). Go to Step 14.

    If the requirement is met and the TE option is ***not*** equipped, disconnect the SE PDS test set and go to Step 19.

    If the requirement is not met, go to Step 27.

ASE Performance Test, Digital TE

11. Turn the TE OFF/NORM pushbutton to OFF.

    Requirement: The bar graph display shall not be lighted above the 8-segment mark. (BER $\leq 10^{-8}$)

12. Set the SE PDS to the "NEG SLOPE" position and note bar graph.

    Set the SE PDS to the "POS SLOPE" position and note bar graph.

    Requirement: The bar graph display shall not be lighted above the 5-segment mark for either POS or NEG SLOPE (BER $\leq 10^{-5}$).

    If requirements are not met, go to Step 27.

13. Turn the TE OFF/NORM pushbutton to NORM.

TE Performance Test

14. Establish setup for the TE performance test (Figure 2).

15. Turn the TE PDS control to the ***left stop*** position.

16. On the terminal shelf patch panel, remove the IF input cable from the associated RCV IF IN jack, and measure the power as shown in Figure 2, Option A.

    Requirement:

    Standard IF interconnect cable (less than or equal to 50 feet), –7.2 to –9.2 dBm

    Long IF interconnect cable (greater than 50 feet), –10.5 to –12.9 dBm.

    If the requirement is met, go to Step 17.

    If the requirement is not met, check the test connections and equipment setup. If the requirement is still not met, go to Step 27.

17. Disconnect the power meter and reconnect the test cable to the RCV IF IN jack of the digital receiver under test (Figure 2, Option B).

18. While observing the ERR RATE (bar graph) display on the associated CHAN CONTR unit, turn the TE PDS crank back and forth between the left and right stop posts. Turn the crank at a rate of one end-to-end sweep about every 2 seconds. Continue the sweep action for about 10 seconds.

    Requirement: The bar graph display shall not indicate a frame loss. (Bar graph momentarily lighted to full scale ***FR*** segment.)

    If the requirement is met with the "NON-MIN" output, repeat this step with the "MIN" output of TE PDS. If the requirement is met with both positions, go to Step 19.

    If the requirement is not met, go to Step 27.

Receiver Recovery Performance Test

19. If testing a ***robust*** receiver without TE or a ***non-robust*** receiver—with or without TE, reconnect the normal IF cable between the IF AGC AMPL and IF FILTER AND BASIC EQUALIZER units in the radio receiver.

    OR

    If testing a receiver equipped with Analog TE or Digital TE, turn the TE PDS control to the ***70*** position (about 3/4 turn clockwise between the stop posts).

20. Disconnect the IF input to the IF AGC AMPL unit or TE PDS test set, as appropriate.

21. While observing the CARRIER LOCK LOSS indicator (yellow LED) on the 64QAM DEMOD unit, reconnect the IF input just removed. Note the time required for this indicator to extinguish.

    Requirement for Digital TE: Immediately (1 second or less).

    Requirement for Robust Receiver: Immediately (1 second or less).

    Requirement for Non-Robust Receiver: Delayed (3 seconds or less).

If the requirement was met (using both "MIN" and "NON-MIN" outputs if using the TE PDS), go to Step 22.

If the requirement was not met, go to Step 27.

Restore Equipment to Normal

22. Disconnect all test connections at both the radio and terminal bay.
23. At the radio receiver, reinstall the normal IF cable between the IF AGC AMPL unit and the IF FILTER AND BASIC EQUALIZER unit.
24. At the terminal, reinstall the normal IF input cable to the RCV IF IN jack if not already done.
25. Replace the side cover on the digital terminal bay if no further access to the IF jacks is required.
26. This completes the terminal Over-the-Air Propagation Distortion Performance Check. If this procedure was referenced from another flowchart or test, return to the instruction that referenced this procedure.
27. Evaluate a failure to meet requirements.
    - (a) If the requirement was not met and this procedure was referenced from another procedure, return to that procedure to see if there are instructions about a failure to meet requirements. If there are no instructions or the given instructions are inadequate or this procedure was not referenced from another, proceed to the next step.
    - (b) Failure to meet the requirements of a performance check is probably because of a defective terminal or radio receiver. Use the loopback check in the Terminal procedures to isolate the trouble to the radio or the terminal. When the trouble is isolated, use the terminal or radio receiver procedures to clear the trouble, and then repeat this procedure.

END OF PROCEDURE

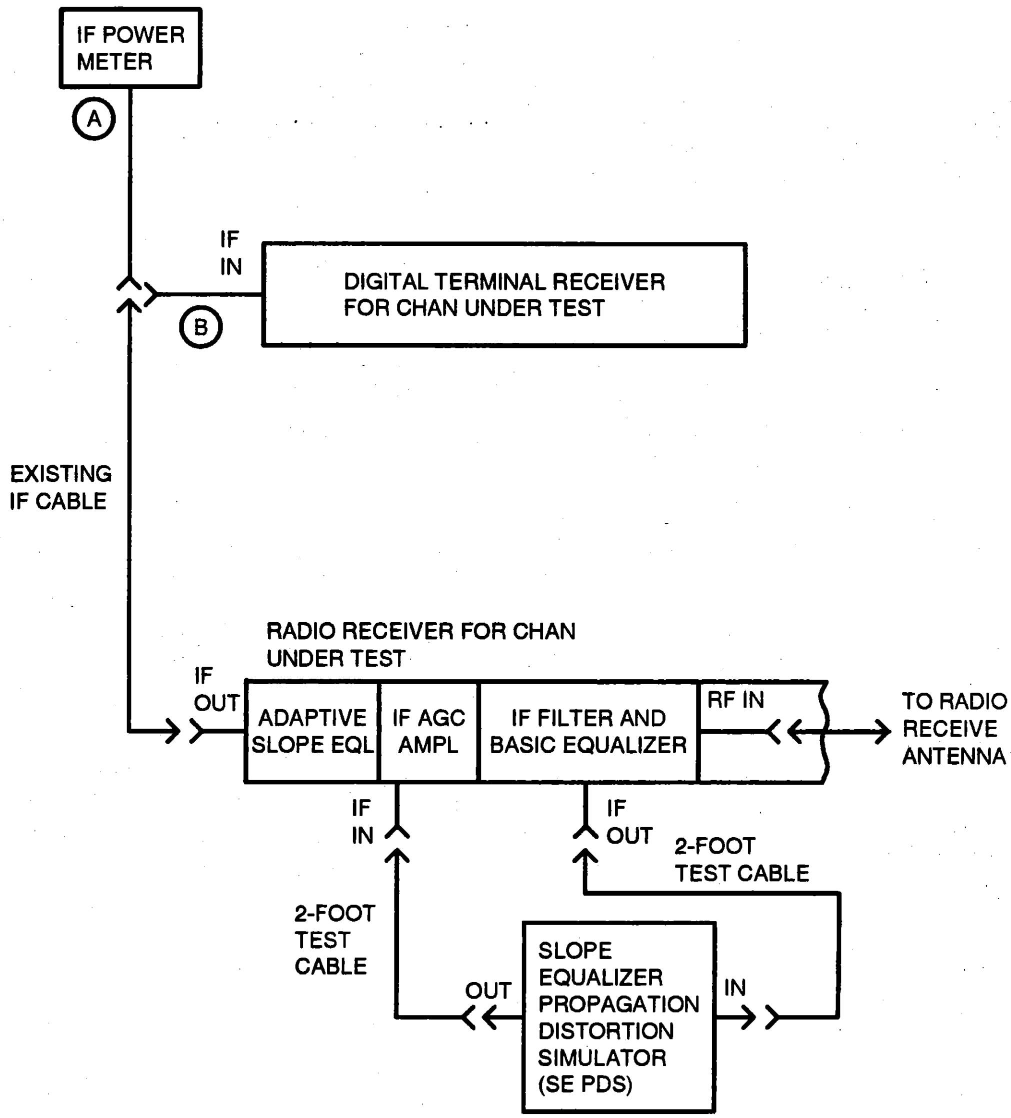

Figure 1 – Slope Equalizer Performance Check Test Setup

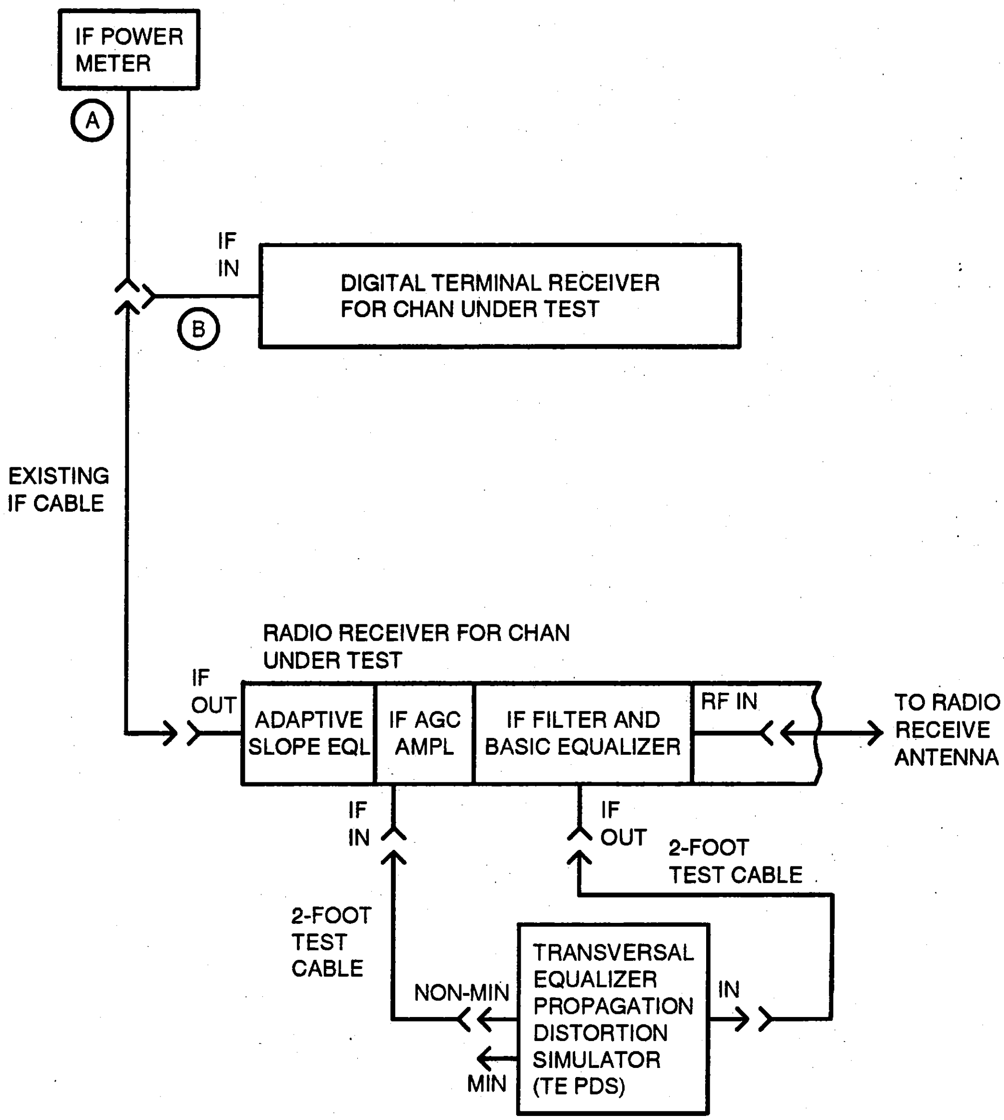

Figure 2–Transversal Equalizer Performance Check Test Setup

3. OVER-THE-AIR S/I STRESS CHECK

This procedure is used to check the overall digital transmission performance of the digital terminal and radio transmitter/receiver equipment associated with a single radio hop. Performance quality is determined by measuring the tolerance of the digital terminal receiver to a 74-MHz interference tone injected into its 64-QAM IF input signal. Performance is evaluated on the BER performance at a specified signal-to-interference (S/I) ratio. This procedure must be performed under normal propagation conditions for proper results.

The test configuration used for this evaluation is shown in Figure 5. An unequal loss combining network is inserted in the coaxial IF input path to the digital terminal receiver for the hop and channel under test. The normal IF input signal is connected through the low-loss path of the combining network, and an adjustable level 74-MHz interference tone is injected into the IF input signal by the high-loss path. For evaluation, a specified S/I ratio is established by independent power measurements of the "S" and "I" components at the output of the combining network corresponding to the digital receiver IF input.

With the connections established, the BER is then determined under this S/I condition by observing the ERR RATE display on the digital terminal CHAN CONTR unit. The ERR rate must not exceed 5×10^{-8} to be acceptable.

This procedure applies to regular or protection channels.

Caution: THIS PROCEDURE IS SERVICE-AFFECTING UNLESS THE PROPER SWITCHING OPERATION HAS BEEN PERFORMED.

TEST EQUIPMENT

- Refer to Figure 3.

For recommendations and specifications of equivalent test equipment, see TEST EQUIPMENT AND ACCESSORIES tab.

PROCEDURE

1. Prepare channel for testing.

   (a) If testing a regular channel, protect service by performing a manual line switch (even if an automatic line switch exists).

   OR

   If testing the protection channel, prevent access by performing a protection channel lockout.

   (b) Remove the right front side cover of the terminal bay to be tested.

Measure the"S" (IF Signal) Power Level

Note: Determine the "S" and "I" test cables to establish the setup shown in Figure 5; then keep the same cables for all tests in this procedure.

2. On the terminal shelf patch panel, remove the IF input cable from the RCV IF IN jack for the digital receiver to be evaluated and establish the setup in Figure 3.

3. Measure the power at the end of the 5-foot cable, and record the reading as "S."

   Requirement:

   Standard IF interconnect cable (equal to or less than 50 feet), –8 to –10 dBm.

   Long IF interconnect cable (greater than 50 feet), –11.3 to –13.7 dBm.

   If the requirement is met, go to Step 4.

   If the requirement is not met, check the test connections and equipment setup. If it still is not met, go to Step 14.

Set the "I" (Interference) Power Level

4. Condition the 74-MHz "I" source to send 74 MHz at about +10.0 dBm.

   Note: If a microwave system analyzer is used as the 74-MHz "I" source, ensure that all transmitter sweep and deviation signals are off.

5. Make the test connections as Figure 4 shows.

6. Measure the "I" power level at the end of the 5-foot test cable, and adjust the "I" power level to 40 dB below the "S" power level recorded in Step 3. To do this, set the "I" power level to 10 dB below the "S" power recorded in Step 3 and then decrease the IF level by 30 dB in the "I" path.

Establish the IF "S+I" Test Connections (Figure 5)

7. Make test connections as shown in Figure 5.

8. To verify the connections, momentarily remove the "S" connection and verify that the associated bar graph on the CHAN CONTR unit lights.

Measure S/I Performance

9. Observe the ERR RATE (bar graph) display on the associated CHAN CONTR unit. Wait 10 seconds before determining if the requirement is met.

   Requirement: The bar graph display shall not be lighted above the line between the 8 and 7 segments. (The BER shall be less than or equal to 5×10^{-8}.)

   Note: Some early production CHAN CONTR units have the line between the 7 and the 6 segments on the bar graph. The requirement is still between the 8 and 7 segments.

   If the requirement is met, go to Step 10.

   If the requirement is not met, go to Step 14.

Restore the Equipment for Normal Operation

10. Disconnect all test connections at the terminal bay.

11. Reinstall the normal IF input cable to the RCV IF IN jack of the digital receiver.

12. If no further access to the terminal IF jacks is required, reinstall the side cover.

13. This completes the Over-the-Air S/I Stress Check. If this procedure was referenced from another flowchart or test, return to the instruction that referenced this procedure.

14. Evaluate a failure to meet requirements.

    (a) If the requirement was not met and this procedure was referenced from another procedure, return to that procedure to see if there are instructions about a failure to meet requirements. If there are no instructions or the given instructions are inadequate or this procedure was not referenced from another, proceed to the next step.

    (b) Failure to meet the requirements of this performance check is probably because of a defective terminal or radio receiver. Use the loopback check in the Terminal procedures to isolate the trouble to the radio or the terminal. When the trouble is isolated, use the terminal or radio receiver procedures to clear the trouble, and then repeat this procedure.

END OF PROCEDURE

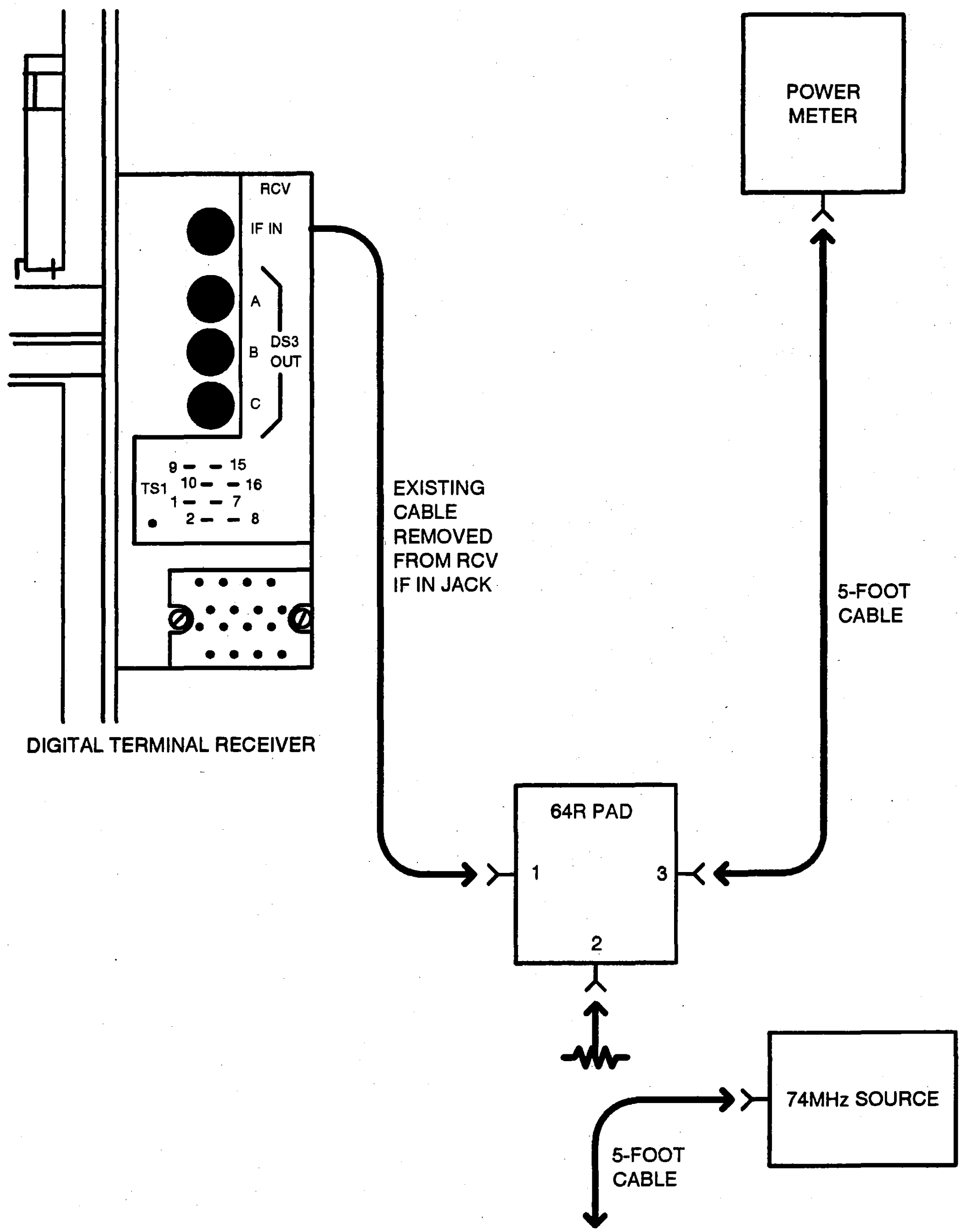

Figure 3–IF Input Signal Level Measurement Test Connections

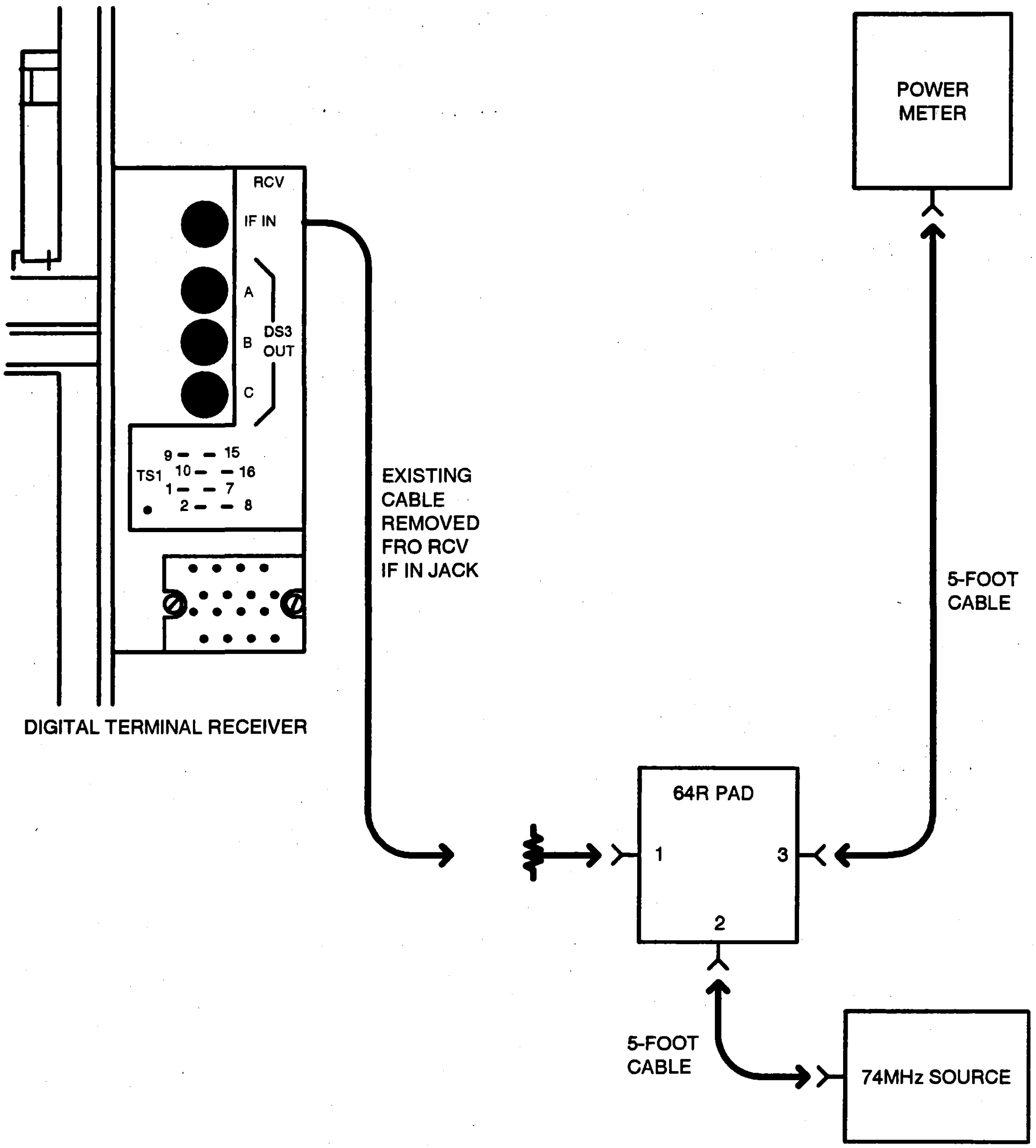

Figure 4 – Interference Signal Level Measurement Test Connections

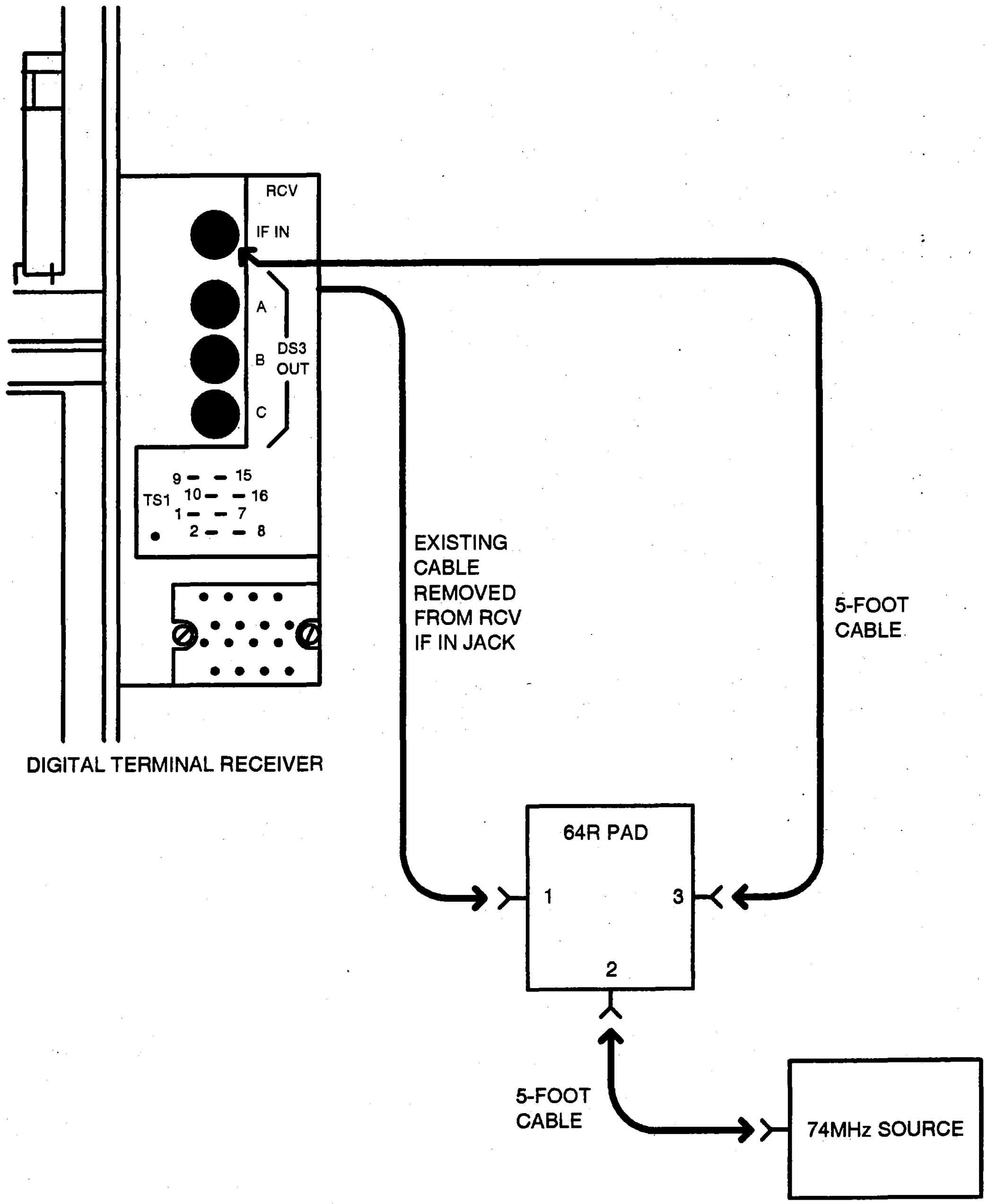

Figure 5– Terminal Over-the-Air S/I Stress Check Test Connections

4. OVER-THE-AIR ERROR CORRECTOR STRESS CHECK

OVERVIEW

This procedure checks the performance of the error correcting circuits in the digital terminal receiver associated with a single hop under normal propagation conditions. Performance quality is determined by comparing an uncorrected cyclic redundancy check (CRC) error rate with the output DS3 parity error rate following error correction.

The test configuration used for this evaluation is shown in Figure 7. The normal receive IF signal "S" is connected to the low-loss input of the unequal loss combining network (Figure 6). The "S" power level is then measured at the output of the combining network. The 74-MHz interference "I" level is established by direct power measurement. The "I" component is then connected to the high-loss input of the combining network. The resulting "S+I" signal from the combining network is connected to the digital receiver IF input.

An S/I ratio is established by adjusting the "I" level to achieve a specified pre-error-correction CRC error rate. The DS3 parity error rate is then measured to evaluate the performance of the error correction circuits.

This procedure applies to any channel, regular or protection.

Caution: THIS PROCEDURE IS SERVICE-AFFECTING UNLESS THE PROPER SWITCHING OPERATION HAS BEEN PERFORMED.

Warning: A SPAN SWITCH is required. This procedure is service-affecting on regular channels due to the SPAN SWITCH. The procedure should only be performed on a trouble basis when there is a strong possibility that there is a problem in the error correction circuits.

TEST EQUIPMENT

- Refer to Figure 7.

For recommendations and specifications of equivalent test equipment, see TEST EQUIPMENT AND ACCESSORIES tab.

PROCEDURE

1. Prepare channel for testing.
   - (a) If testing a ***regular*** channel, protect service by performing a manual receive ***span*** switch for the channel to be tested (even if an automatic ***span*** switch already exists for that channel).

     OR

     If testing the protection channel, prevent access by performing a protection lockout.
   - (b) Remove the right front side cover of the terminal bay to be tested.

Measure the "S" (IF Signal) Power Level

Note: Determine the "S" and "I" test cables to establish the setup in Figure 7; then keep the same cables for all tests in this procedure.

2. On the terminal shelf patch panel, remove the IF input cable from the RCV IF IN jack for the digital receiver to be evaluated and establish the setup in Figure 6.
3. Measure the power at the end of the 5-foot "S" cable.

   Requirement:

   Standard IF interconnect cable (equal to or less than 50 feet), –8 to –10 dBm.

   Long IF interconnect cable (greater than 50 feet), –11.3 to –13.7 dBm.

   If the requirement is met, go to Step 4.

   If the requirement is not met, check the test connections and equipment setup. If it still is not met, go to Step 14.
4. Set the "I" (interference) power level. Condition the 74-MHz "I" source to send 74 MHz at about 0.0 dBm.

   Note: If a microwave system analyzer is used as the 74-MHz "I" source, ensure that all transmitter sweep and deviation signals are off.

Establish the "S+I" test connections

5. Establish test connections per Figure 7.

Perform the Error Corrector Stress Check

6. Condition the counter to measure DC-TTL type signals at ***1-second*** intervals.
7. Connect the counter to the SECT CRC ERRS jack on the TERM FRMR unit, and reduce the "I" level to achieve about 675 counts per second (5×10^{-6}).
8. With the "I" level properly adjusted, condition the counter to measure at ***10-second*** intervals.
9. Disconnect the counter from the SEC CRC ERRS jack, connect it to the DS3 PTY jack on the VMR & CODER unit (beginning with TRIB A), and measure the DS3 parity errors.

   Requirement: 23 counts or less (5×10^{-8})

   Repeat this measurement for the TRIB B and TRIB C VMR & CODER units, as equipped.

   If the requirement is met for each equipped VMR & CODER unit, go to Step 10; otherwise, return to Step 6.

Restore the Equipment for Normal Operation

10. Disconnect all test connections at the terminal bay.
11. Reconnect the normal IF input cable to the RCV IF IN jack of the digital receiver.
12. If no further access to the terminal IF jacks is required, reinstall the side cover.
13. This completes the Over-the-Air Error Corrector Stress Check. If this procedure was referenced from another flowchart or test, return to the instruction that referenced this procedure.

(a) If the requirement was not met and this procedure was referenced from another procedure, return to that procedure to see if there are instructions about a failure to meet requirements. If there are no instructions or the given instructions are inadequate or this procedure was not referenced from another, proceed to the next step.

(b) Failure to meet the error corrector stress requirement is probably because of a defective error correction circuit. Use the Error Corrector Loopback Check under the TERMINAL PROCEDURES tab to isolate the trouble.

END OF PROCEDURE

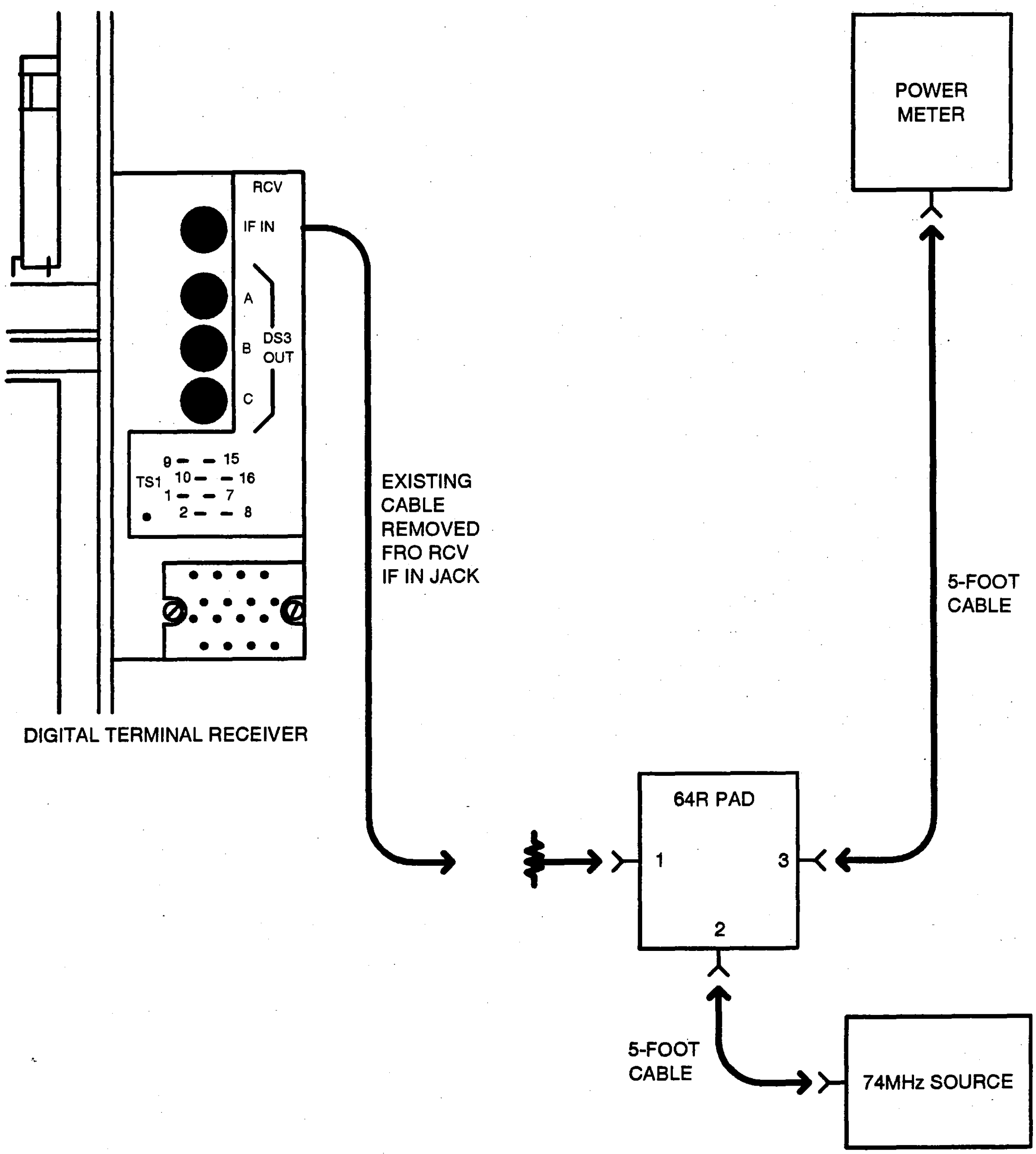

Figure 6– IF Input Signal Level Measurement Test Connections

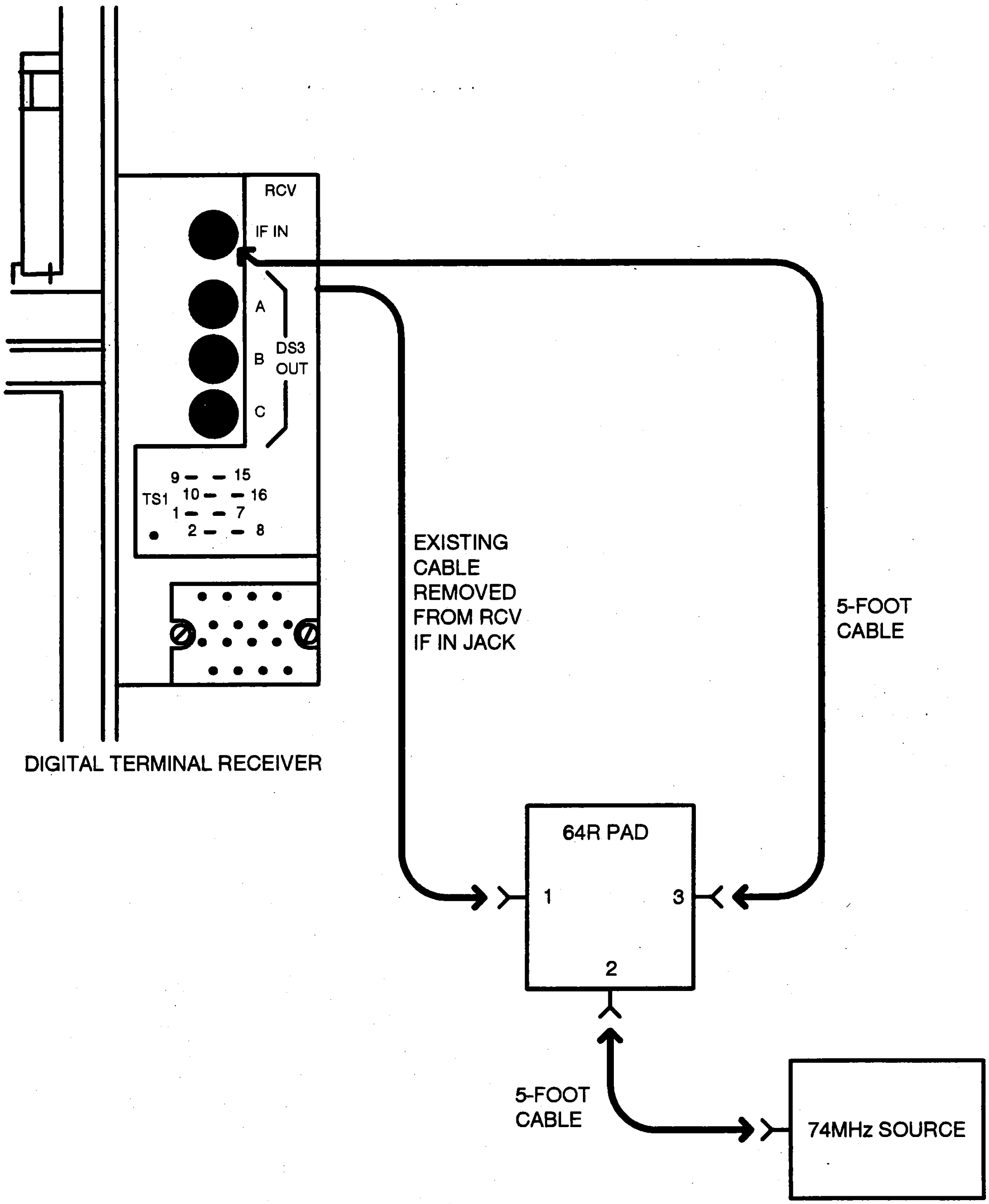

Figure 7–Terminal Over-the-Air Error Corrector Stress Check Test Connections