

# Agilent Technologies 8924C Mobile Station Test Set

## Measuring Idle and Soft Handoff Performance

8924C Solutions for CDMA Cellular and PCS Mobile Stations

### Product Note

With the release of firmware revision A.06.15, the Agilent Technologies 8924C Mobile Station Test Set, which will be referred to as the test set in this document, has the ability to simulate two base stations synchronized to the same system time clock. This feature allows testing of a mobile station's demodulation performance during idle and soft handoffs.

The following procedure describes how to connect and configure two 8924C's for tests that require two base stations. After the two 8924C test sets are synchronized, the following tests, described in industry standards TIA/EIA-98, ARIB T-53, and ANSI J-STD-008 can be performed:

- 9.2.3 Idle Handoff in Slotted Mode
- 9.2.4 Neighbor Set Pilot Detection and Incorrect Detection in Soft Handoff
- 9.2.5 Candidate Set Pilot Detection and Incorrect Detection in Soft Handoff
- 9.2.6 Active Set Pilot Loss Detection in Soft Handoff
- 9.3.5 Demodulation of Forward Traffic Channel During Soft Handoff
- 9.3.6 Decision of Power Control Bit for Channels Belonging to Different Power Control Sets During Soft Handoff
- 9.3.7 Decision of Power Control Bit for Channels Belonging to the Same Power Control Set
- 3.2.3 Idle Handoff
- 3.3.5 Demodulation of Traffic Channel During Soft Handoff

In addition, the following soft handoff tests can be performed with a single 8924C:

- 9.3.8 Demodulation of Power Control Subchannel During Soft Handoff

### Equipment List

- Two test sets (Test Set 1 and Test Set 2) with firmware 6.15 or above
- Combiner (Mini-Circuits ZFRSC-2050 or similar)
- BNC cables
- RF cables
- Spectrum analyzer

NOTE: This document does not provide procedures for performing the tests listed at left. However, Appendix A provides a few examples of how this test setup can be used to perform various tasks required for some of these tests.

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## Step 1. Connect the two test sets.

Connect the two test sets as follows:

- Remove the jumper that connects the 10 MHz OVEN OUT to the REF INPUT on the rear panel of Test Set 2; see Figure 1.
- If Test Set 1 is not configured with a PCS Interface, connect a cable between the 10 MHz REF OUTPUT of Test Set 1 and the REF INPUT of Test Set 2. Otherwise go to “c.”
- If Test Set 1 is configured with a PCS Interface, connect a cable between the 10 MHz REF OUT of the PCS Interface and the REF INPUT of Test Set 2; see Figure 2.
- Connect the EVEN SEC INPUT of Test Set 2 to the CDMA (frame) CLOCK MUX OUTPUT from Test Set 1. When the test sets are powered up, Test Set 2 will sense the presence of an Even Second clock on the EVEN SEC INPUT connector and align its CDMA clocks accordingly.

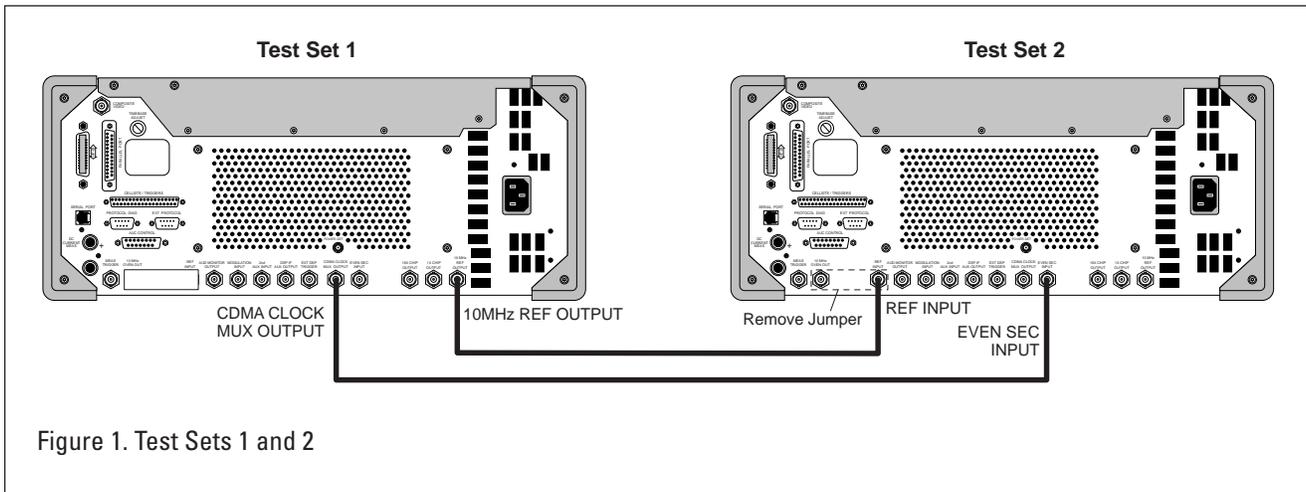


Figure 1. Test Sets 1 and 2

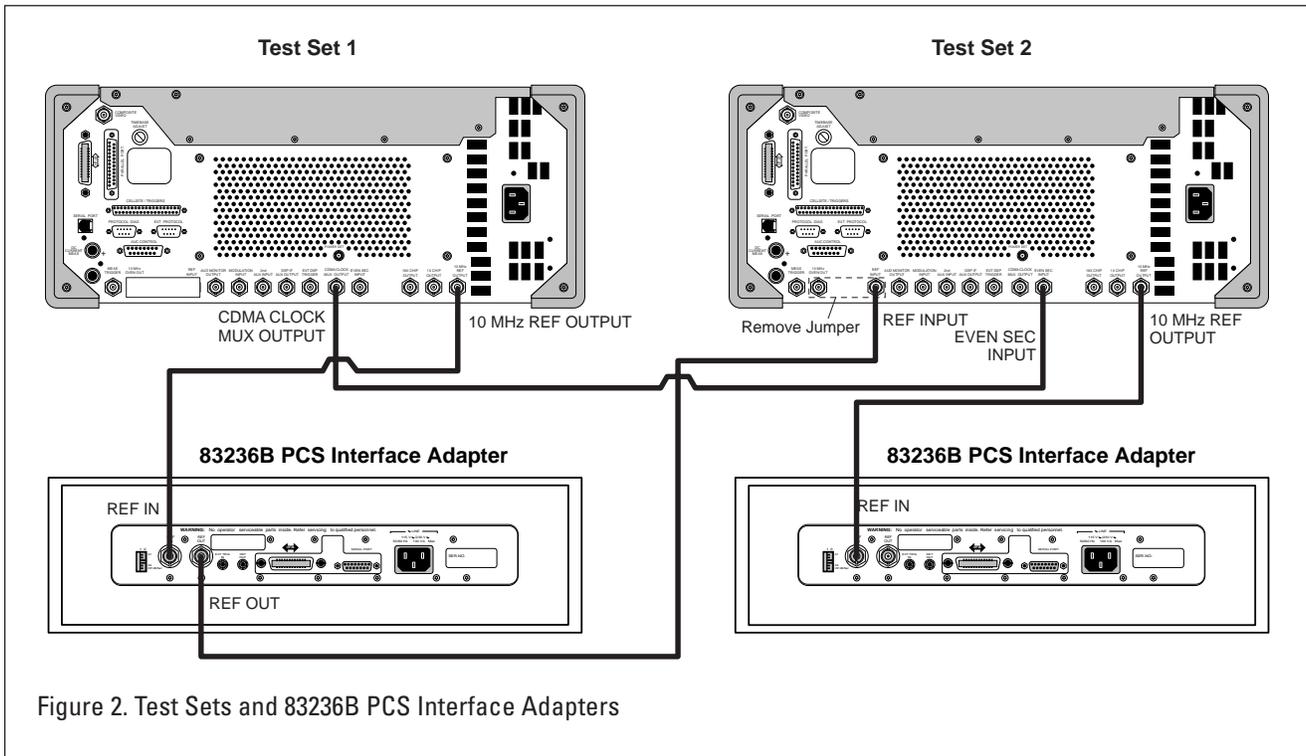


Figure 2. Test Sets and 83236B PCS Interface Adapters

## Step 2. Power-up the test sets.

Power-up Test Set 1 first.

- a. Press the POWER button on Test Set 1.
- b. Wait for the CDMA CALL CONTROL screen to be displayed.
- c. After the CDMA CALL CONTROL screen on Test Set 1 appears, press the POWER button on Test Set 2.

## Step 3. Connect the Mobile Station to Test Set 1 and 2.

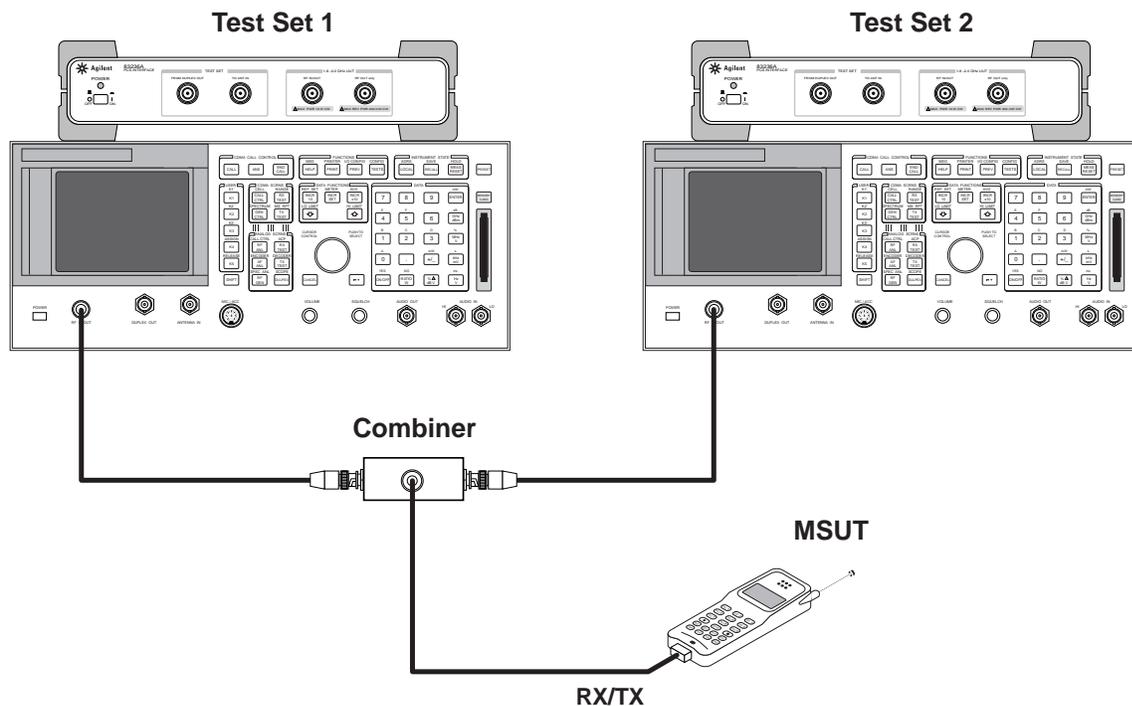


Figure 3. Mobile Station to Test Sets 1 and 2

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### Operating Considerations

It is highly recommended that the mobile station be isolated from interfering RF signals from other equipment or actual base stations.

If a "car kit" is used to make the RF connection, be sure to enter an accurate value in the **RF Level Offset** field (see Step 4). Enter the path loss from the Mobile Station to the Test Set). Path loss includes the loss through the combiner.

This step becomes more critical in higher path-loss setups.

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## Step 4. Enter the path loss from each test set to mobile station.

- On both test sets, press and release the SHIFT key and then press the TESTS key to display the CONFIGURE screen (see Figure 4).
- Position the cursor in front of the appropriate field or fields below the **RF Level Offset** field and enter a value for RF path loss.
- Set the **RF Level Offset** field to On.

For example: If the path loss is 5 dB, and you are using the RF IN/OUT port, enter -5 dB in the **RF In/Out** field.

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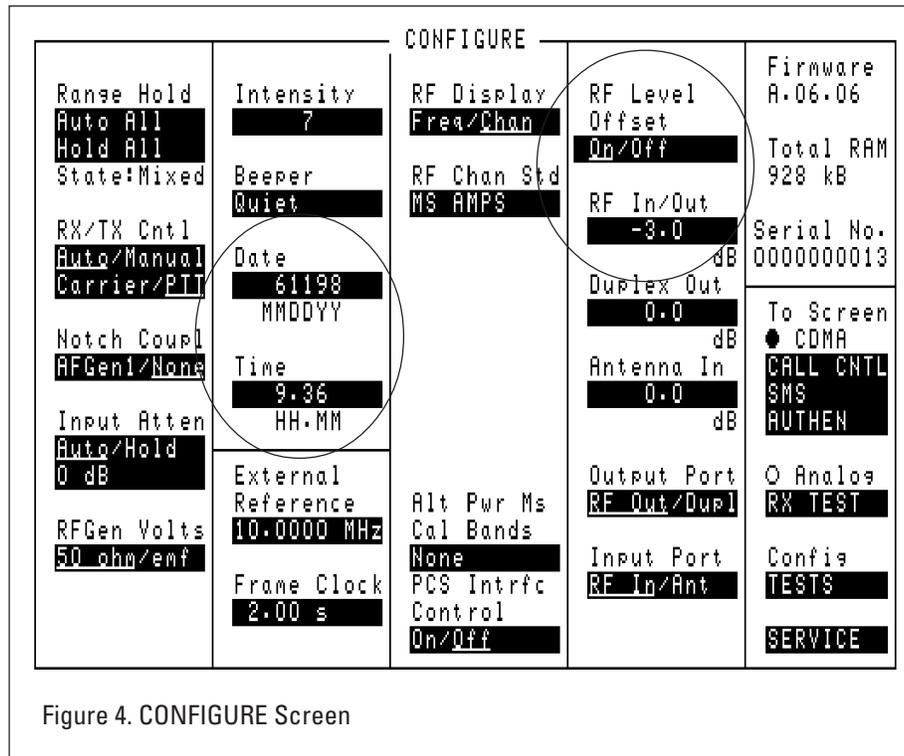
### Operating Considerations

Entering the path loss values provide the test sets with the information needed to set up internal analyzer path attenuators correctly for expected power levels from the mobile station.

---

## Step 5. Set the date of Test Set 2 to match Test Set 1.

Refer to Figure 3 to set the date of Test Set 2 to match Test Set 1.



## Step 6. Synchronize the test sets' time-of-day clocks.

- a. Enter the identical time in the **Time** fields on Test Set 1 and Test Set 2 (see Figure 4). DO NOT PRESS THE ENTER KEY OR KNOB YET. (The fields should both be highlighted.)

**IMPORTANT:** You must enter a value in each **Time** field even if the correct time is already set.

- b. SIMULTANEOUSLY press the ENTER key on Test Set 1 and Test Set 2 to synchronize their time-of-day clocks. Both fields should remain highlighted momentarily, then become un-highlighted at the same time.

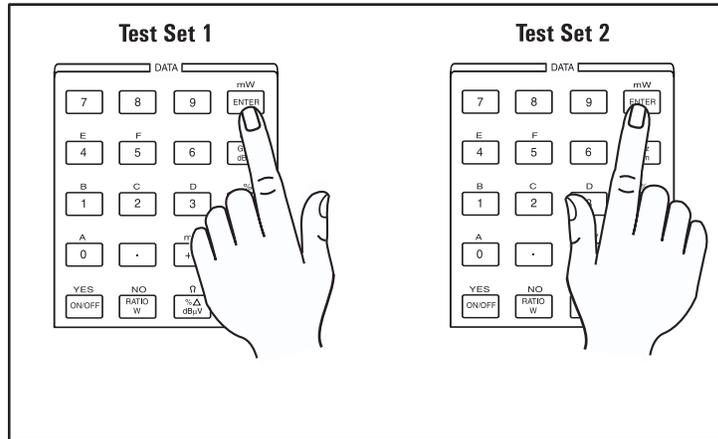


Figure 5. Press Enter buttons SIMULTANEOUSLY.

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### Operating Considerations

When the ENTER keys are pressed, the time-of-day for both test sets is set to the next even-second clock boundary.

**NOTE:** If after pressing the ENTER keys one field remains highlighted longer than the other, it is likely that a race condition caused one test set to accept the new time setting before an Even Second clock boundary, and the other test set to accept the new time setting after the same boundary. If this appears to be the case, repeat this step.

---

## Step 7. Configure Test Set 1 and Test Set 2 cell sectors.

- Press the GEN CTRL key on both test sets to display the CDMA GENERATOR CONTROL screens.
- Raise the power level of Sector A Traffic on both test sets to  $-7.4$  dB.

**IMPORTANT:** Steps c and d must be completed in the order listed.

- Enter the same **PN Offset** displayed in Sector A (**Sctr A Pwr**) on Test Set 1 into the Sector B **PN offset** field on Test Set 2 (see Figure 6).
- Enter the same **PN Offset** displayed in Sector B (**Sctr B Pwr**) on Test Set 1 into the Sector A **PN offset** field on Test Set 2 (see Figure 7).

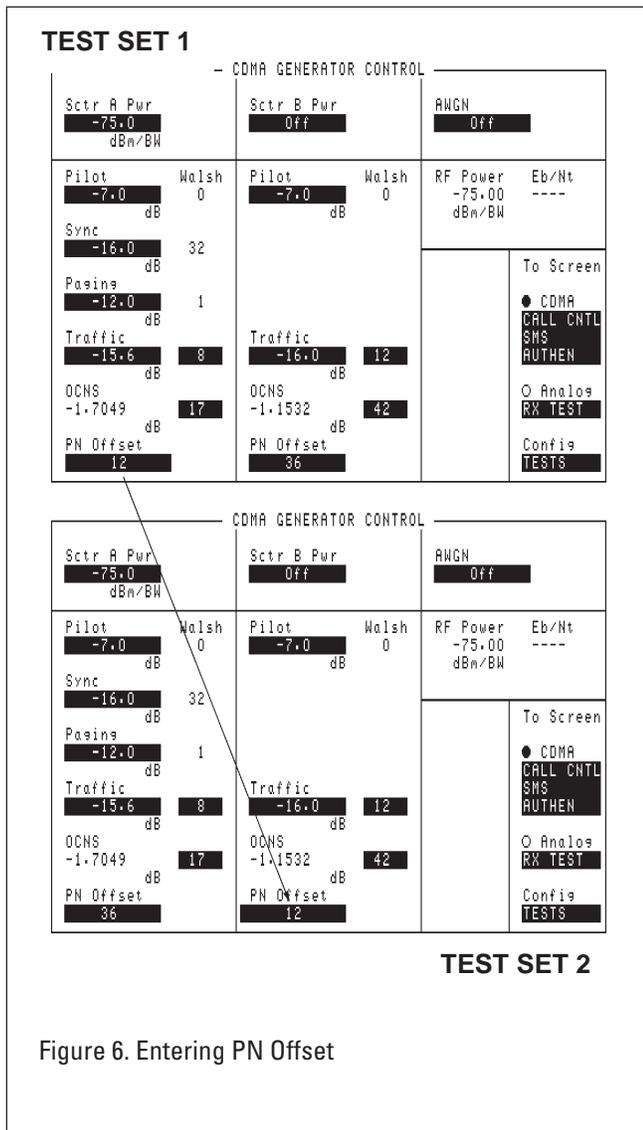


Figure 6. Entering PN Offset

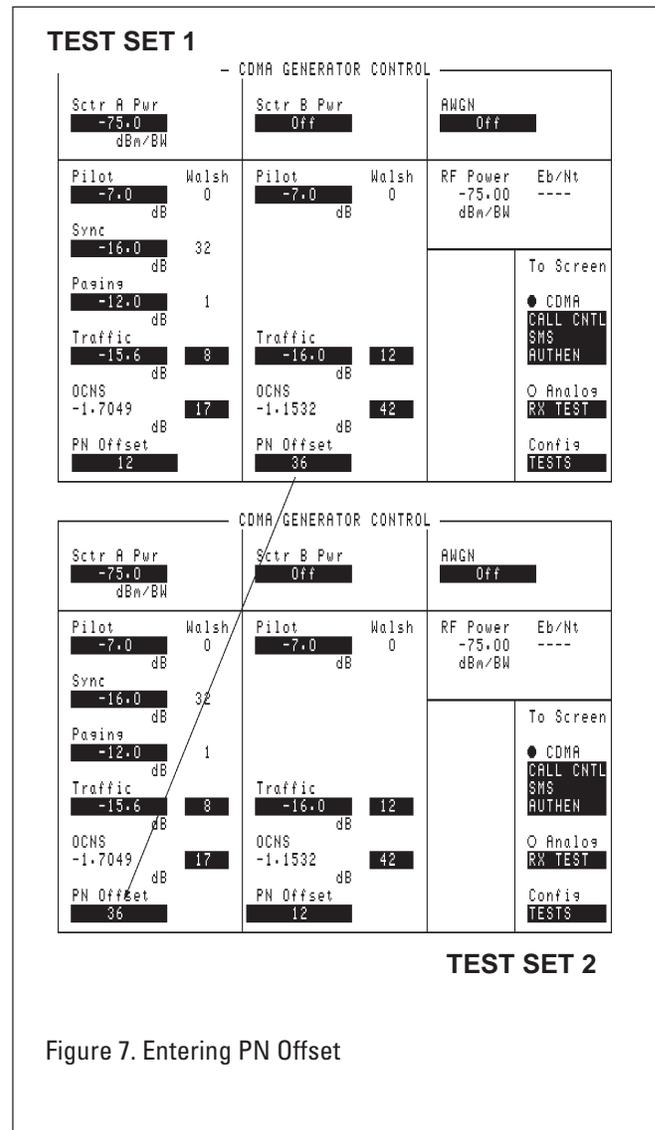


Figure 7. Entering PN Offset

- e. On both test sets, set Sector A and Sector B Traffic Walsh codes to the same value (this is a total of four fields). See Figure 8.
- f. On Test Set 1, turn Sector B power (**Sctr B Pwr**) on and then off.
- g. On Test Set 2, turn Sector B power on and then off.

**Operating Considerations**

This setup causes Sector A of Test Set 2 to be included in the Neighbor List Message transmitted from Test Set 1. Setting the Walsh code for Sector A of Test Set 2 to the same value as Sector B of Test Set 1 is necessary because Test Set 1 “thinks” it is setting up a soft handoff between Sector A and Sector B of Test Set 1. However, since Sector B of Test Set 1 is turned off, the soft handoff “points” to Sector A of Test Set 2.

Making all four Walsh codes the same also allows for soft handoff initiation from Test Set 2, should this prove to be more convenient.

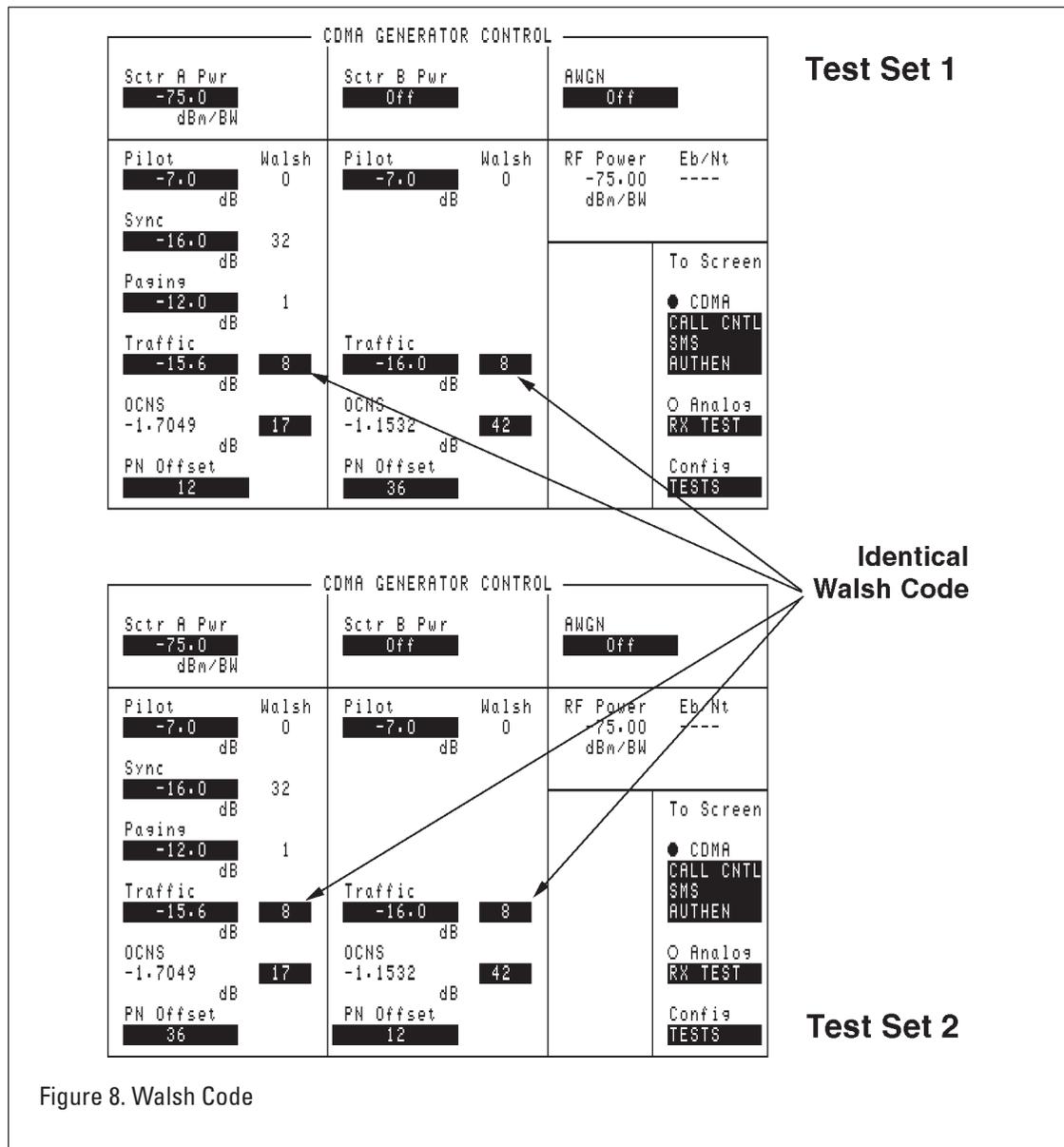


Figure 8. Walsh Code

## Step 8. Set the Sector-A power value for Test Set 1 and 2.

- a. On Test Set 1, set the **Sctr A Pwr** field and change the value to **-50 dBm/BW**.
- b. On Test Set 2, set the **Sctr A Pwr** field and change the value to **-75 dBm/BW**.

## Step 9. Turn off the call drop timers on Test Set 1 and Test Set 2.

- a. Press and release the SHIFT key and then press the RX TEST key to display the CDMA TRANSMITTER POWER RANGE TEST screen.
- b. Select **Off** in the **Drop Timer** field.

---

### Operating Considerations

When the **Call Drop Timer** field is **Off**, the Test Set will stay on a Traffic channel (Connected state) if the mobile station stops transmitting (mobile station power level is undetectable for greater than 5 seconds). This setting is necessary because during the rest of this procedure you will:

1. Establish a call on Test Set 2
2. Cause the mobile station to drop the call on Test Set 2
3. Establish a call on Test Set 1

After this sequence of calls is completed both Test Sets will be on the same Traffic Channel with the mobile station because only the mobile station will drop the call with Test Set 2.

---

## Step 10. Configure Test Set 1 and 2 to make a call.

On Test Sets 1 and 2:

- a. Press the CALL CTRL key to access the CDMA CALL CONTROL screen.
- b. Enter the mobile station's protocol in the **Protocol** field.
- c. Enter the mobile station's channel standard in the **RF Chan Std** field.
- d. Enter the mobile station's primary RF channel in the **RF Channel** field.
- e. Optional: If the mobile station is programmed to "Home Only" (no roaming), it may be necessary to enter the mobile station's home System Identification (SID) in both test sets. The **System ID** field is located on the CDMA CELL SITE CONFIGURATION screen.

---

### Operating Considerations

Refer to "Setting Up a Call" in the Agilent Technologies 8924C Application Guide for a more detailed explanation of call setup requirements and troubleshooting information.

Also, located on the CDMA CELL SITE CONFIGURATION screen is the **Base ID** (Base Identification) field. This field can be used to further distinguish one test set's forward channel from the other. However, during the development and testing of this procedure it did not prove to be necessary to enter differing values in the **Base ID** field.

---

## Step 11. Register the mobile station on Test Set 1.

Turn on power to the mobile station and wait for power-up registration on Test Set 1; see Figure 9. The mobile station will perform power-up registration on Test Set 1 after it has found digital service (this should take no longer than 30 seconds).

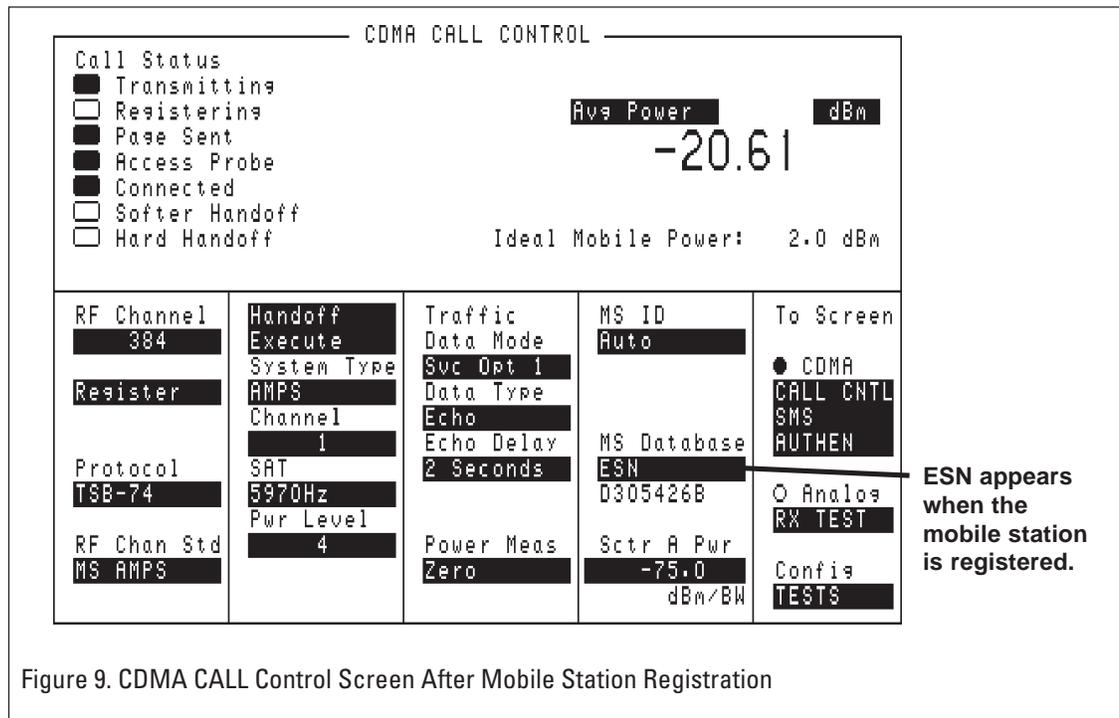


Figure 9. CDMA CALL Control Screen After Mobile Station Registration

### Operating Considerations

The display on the mobile station will indicate when the mobile station has found a service. If the mobile station does not find a service within a few seconds, check mobile station system settings, paying particular attention to the following configurations:

- HOME ONLY vs. ROAM
- A (side service) vs. B (side service) in the cellular band,
- PREFER DIGITAL vs. PREFER ANALOG, and
- Preferred Roaming List in the PCS band.

If the mobile station is programmed to HOME ONLY, the **System ID** field (CDMA CELL SITE CONFIGURATION screen) must match the mobile station's home system identification.

If a PCS mobile station is programmed to allow roaming, the **System ID** field entry (CDMA CELL SITE CONFIGURATION screen) must be included in the mobile station's Preferred Roaming List.

The test set also has a **Pwr Up Reg** field that determines whether the mobile station will perform a power-up registration. The default setting is **On**. If the mobile station finds service but does not perform a power-up registration, check the **Pwr Up Reg** setting.

## Step 12. Register the mobile station on Test Set 2.

- a. Turn off power to the mobile station.
- b. Set the **Sctr A Pwr** values for Test Set 1 and 2 as follows:
  - On Test Set 1, set the **Sctr A Pwr** field to **-75 dBm/BW**.
  - On Test Set 2, set the **Sctr A Pwr** field to **-50 dBm/BW**.
- c. Turn on power to the mobile station.
- d. The phone will perform power-up registration on Test Set 2 after it has found digital service (this should take no longer than 30 seconds); see Figure 9.

---

### Operating Considerations

See "Operation Considerations" of Step 11.

---

## Step 13. Make a call on Test Set 2.

- a. Select Service Option 2 or 9; Service Option 2 for rate set 1, Service Option 9 for rate set 2.
- b. Press the CALL key on Test Set 2. The **Connected** annunciator is lit.

---

### Operating Considerations

Service Option 2 or 9 is required to perform FER testing, as described in EIA/TIA IS-98A Demodulation of Forward Traffic Channel During Soft Handoff. The test sets, after being synchronized as described in this procedure transmit identical, synchronized pseudorandom bits when Service Option 2 or 9 is used.

---

## Step 14. Make a call on Test Set 1.

- a. On Test Set 1, select the same Service Option entered in the **Traffic Data Mode** field on Test Set 2.
- b. Set the **Sctr A Pwr** value for Base Station 1 and 2 simulators as follows:
  - On Test Set 1, set the **Sctr A Pwr** field to **-50 dBm/BW**.
  - On Test Set 2, set the **Sctr A Pwr** field to **-75 dBm/BW**.

Lowering the power on Test Set 2 will cause the mobile station to drop the call after about 5 seconds. Since the (call) **Drop Timer** field is off, the **Connected** annunciator will remain lit on Test Set 2, while the mobile station finds service on Test Set 1.

- c. After the mobile station has registered on Test Set 1, press the CALL key on Test Set 1. The **Connected** annunciator is lit.

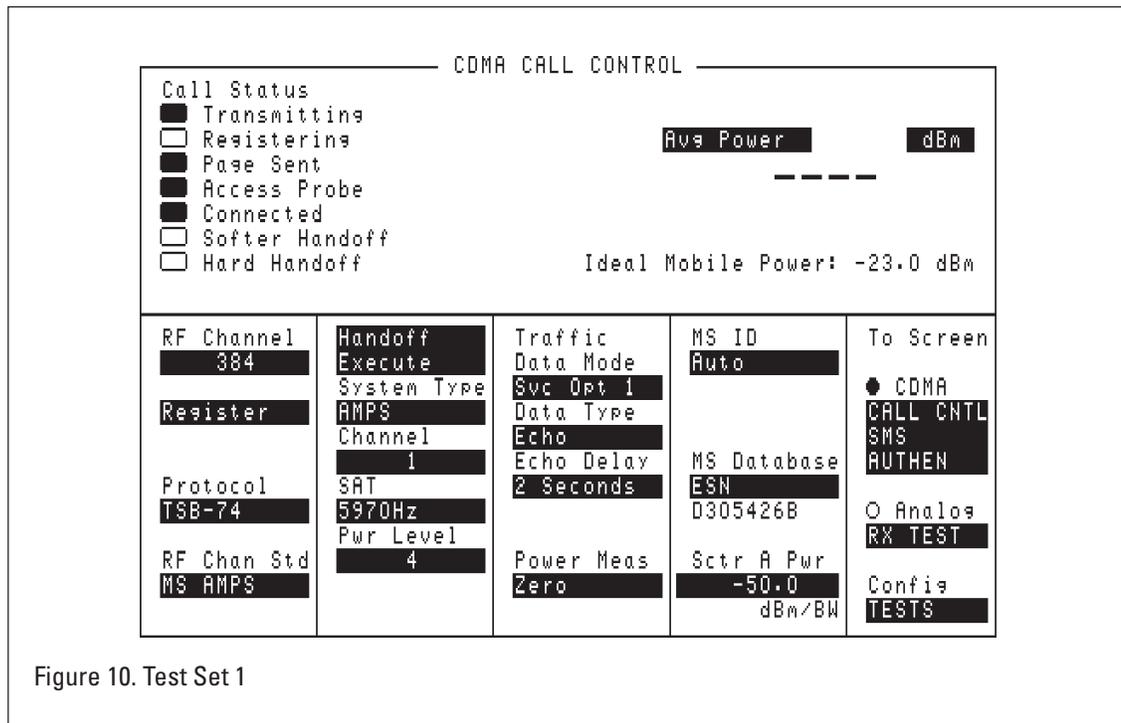


Figure 10. Test Set 1

### Operating Considerations

OPTIONAL (replaces steps 11 through 14):

To speed up the process of setting up a soft handoff, you can simply key in at least 3 digits on the mobile station's handset and press the SEND key as soon as the mobile station has found service. This shortcut assumes that the mobile station will make Service Option 2 or Service Option 9 mobile station originated calls. You may need to experiment with your model of mobile station to make this determination.

It is important that you make the calls in the order described, first on Test Set 2, then on Test Set 1.

## Step 15. Perform a soft handoff from Test Set 1.

- a. On Test Set 1, press and release the SHIFT key followed by the TX TEST key to display the CDMA MOBILE REPORTING screen.
- b. In the lower subfield of the **Soft Handoff** field, select **Soft** or **Softer**.
- c. In the upper subfield of the **Soft Handoff** field, select **On**.
- d. Ignore the beep and the message “**Warning, sector B off**” if it appears.

---

### Operating Considerations

Selecting **Soft** causes the PWR\_COMB\_IND bit in the Extended Handoff Direction Message to be set to a 0. This bit tells the mobile station that it will be receiving different power control bits from Test Set 1 and Test Set 2. The mobile station is expected to perform a logical OR'ing of “down” power control bits received from both test sets, which means the mobile station will increase its power level if and only if both power control bits are “up.”

---

## Step 16. Verify the soft handoff.

- a. On Test Set 1, press the CALL CTRL key to display the CDMA CALL CONTROL screen. The **Soft Handoff** annunciator should be lit.
- b. On Test Set 2, increase **Sctr A Pwr** to **-50 dBm/BW**.
- c. On Test Set 1, lower the **Sctr A Pwr** to **-80 dBm/BW**.

*If the soft handoff was not successful, Test Set 2 will interfere with the call that was set up on Test Set 1 and the call will drop within 5 seconds.*

If the call has not dropped within 5 seconds, the mobile station is combining the two signals to maintain the link. Sector power levels will need to be adjusted to perform various soft handoff tests.

## APPENDIX A: Implementing IS-98 Tests

After synchronizing the two test sets, several IS-98A tests can be performed. The following sections in this appendix refer to industry standard publication TIA/EIA/IS-98A, B, or C, and list the tests (in italics) and guidelines (as Operating Considerations notes) for performing some of the steps.

### IS-98A/B, 9.3.5 Demodulation of Forward Traffic Channel During Soft Handoff

1. *Connect two base stations and an AWGN generator to the mobile station antenna connector as shown in Figure 12.5.1-2, with both channel simulators set to configuration 2...*

---

#### Operating Considerations

Use the same setup as described in Step 10, with the addition of a channel simulator (fader) in each path from the test set to the mobile station.

---

3. *Set the test parameters for Test 1.*

---

#### Operating Considerations

Set **Sctr A Pwr** to **-55** and **AWGN** to **-65**. This will result in an  $I_{or}/I_{oc}$  ratio of 10.

---

4. *Send an Extended Handoff Direction Message to the mobile station...*

---

#### Operating Considerations

When the **Soft Handoff** field is turned on, this message is sent.

---

5. *Count, at the base station, the number of frames transmitted and the number of good frames received at the mobile station.*

---

#### Operating Considerations

Press the RX TEST key on Test Set 1 to display the CDMA CELLULAR MOBILE RECEIVER TEST screen. Arm a single FER test on Test Set 1. The pseudorandom bit sequences transmitted from both test sets are synchronized when the soft handoff is turned on, so either test set can be used to measure FER.

---

### IS-98A/B, 9.3.6 Decision of Power Control Bit for Channels Belonging to Different Power Control Sets During Soft Handoff

5. *After waiting a minimum of 160 ms, on both Channel 1 and Channel 2 synchronously send a periodic pattern of twenty '0' power control bits followed by twenty '1' power control bits.*

---

#### Operating Considerations

This part of the test should be performed with a single test set using the soft handoff. Connect the mobile station directly to the RF IN/OUT port, and make a Service Option 2 or 9 call. On the **CDMA MOBILE REPORTING** field turn Sector B on and adjust its level as indicated for Channel 2. Select **Soft** in the **Soft Handoff** field and select **On**. On the CDMA TRANSMITTER POWER RANGE TEST screen, select ramp in the **Change** field, and enter **16**<sup>†</sup> in the **Steps** field. Select **Execute** to transmit the sequence of synchronized power control bits.

<sup>†</sup> **NOTE:** It is highly recommended that multiples of 16 (the number of power control bits in each 20 ms frame) are entered in the **Steps** field. If a number that is not a multiple of 16 is entered and a ramping sequence is executed, a nonlinear ramp will result. For example, if 20 is entered in the steps field, the first 16 bits will be transmitted during one traffic channel frame as "up" bits. During the next traffic channel frame, the remaining 4 "up" bits will be transmitted. To "pad" the rest of the frame, 12 alternating "up" then "down" bits are transmitted. The next frame would then begin transmitting the sequence of 20 down bits in the same fashion. Always enter multiples of 16 in the **Steps** field to produce a linear ramp.

---

7. *Send a periodic pattern of twenty '0' power control bits followed by twenty '1' power control bits on channel 1. Send continuously '0' power control bits on Channel 2.*

---

**Operating Considerations**

On Test Set 2, select **Always Up** in the **Closed Loop Pwr Cntl** field. On Test Set 1, select ramp in the **Change** field and enter **16**<sup>†</sup> in the **Steps** field. Select the **Execute** field on Test Set 1. In this mode, the mobile station will go up in power when Test Set 1 sends an up bit, and down in power when Test Set 1 sends a down bit. After the ramping, Test Set 1 controls the mobile station to the power level indicated by the open loop law.

<sup>†</sup> **NOTE:** It is highly recommended that multiples of 16 (the number of power control bits in each 20 ms frame) are entered in the **Steps** field. If a number that is not a multiple of 16 is entered and a ramping sequence is executed, a nonlinear ramp will result. For example, if 20 is entered in the steps field, the first 16 bits will be transmitted during one traffic channel frame as "up" bits. During the next traffic channel frame, the remaining 4 "up" bits will be transmitted. To "pad" the rest of the frame, 12 alternating "up" then "down" bits are transmitted. The next frame would then begin transmitting the sequence of 20 down bits in the same fashion. Always enter multiples of 16 in the **Steps** field to produce a linear ramp.

---

### IS-98A/B, 9.3.7 Decision of Power Control Bit for Channels Belonging to the Same Power Control Set...

3. *Set the test parameters as specified in Table...*

---

**Operating Considerations**

For Channel 2, set Ior 4 dB lower in power than Channel 1. This will give additional margin for the mobile station to ensure that the weaker "down" power control bits do not cause loss of signal power from the mobile station. The Power Control  $E_c/I_{or}$  is not directly settable. (The test set transmits the power control subchannel at full rate power.)

---

4. *Send an Extended Handoff Direction Message to the mobile station, specifying...*

---

**Operating Considerations**

The table referred to in this step specifies that the PWR\_COMB\_IND bit be set to 1. This is accomplished by selecting **Softer** in the **Soft Handoff** field (instead of **Soft**) and then selecting **On**.

---

5. *After waiting a minimum of 160 ms, begin sending a periodic pattern of one '0' power control bit followed by one '1' power control bit on Channel 1 and only '1' power control bits on Channel 2.*

---

**Operating Considerations**

On Test Set 1, which is transmitting at a higher power level, select the CDMA TRANSMITTER POWER RANGE TEST screen. Select **Open Loop** in the **Closed Loop Pwr Cntl** field.

Select the CDMA REVERSE CHANNEL SPECTRUM screen and adjust the **Ref Level** field to display the mobile station's signal.

On Test Set 2, select the CDMA TRANSMITTER POWER RANGE TEST screen. Select **Always Down** in the **Closed Loop Pwr Cntl** field. The mobile station power should remain at the initial power control setpoint.

---

6. *Measure the output power at the mobile station antenna connector for at least 40 power control groups (50 ms).*

---

**Operating Considerations**

On Test Set 2, gradually raise the power level, observing the mobile station power on Test Set 1, until Test Set 2 is 2 dB lower than Test Set 1. The mobile station power level should remain at the initial power control setpoint.

---

## IS-98 A/B, 9.3.8 Demodulation of Power Control Subchannel During Soft Handoff...

3. *Set the test parameters as specified for both base stations.*

---

**Operating Considerations**

This test should be performed with a single test set. Select the CDMA GENERATOR CONTROL SCREEN. Adjust Sector A and Sector B power levels to -55 (Min for Channel 1 and Max for Channel 2). Adjust Sector A and Sector B Traffic Channels to the values shown in the table for Traffic  $E_c/I_{or}$ .

---

4. *Send an Extended Handoff Direction Message to the mobile station, specifying the following pilots in the Active Set:*

---

**Operating Considerations**

Select the CDMA MOBILE REPORTING screen field. Select **Soft** in the **Soft Handoff** field and then select **On**. This sets the **PWR\_COMB\_IND** bit to **0**.

---

5. *After waiting a minimum of 160 ms, on both Channel 1 and Channel 2 synchronously send a periodic pattern of one '0' power control bit followed by one '1' power control bit.*

---

**Operating Considerations**

On the CDMA TRANSMITTER POWER RANGE TEST screen, select **Open Loop** in the **Closed Loop Pwr Cntl** field.

---

6. *Measure the mobile station output power at the mobile station antenna connector for at least 22 seconds.*

---

**Operating Considerations**

Select the CDMA GENERATOR CONTROL screen. Assign a global user key to the **Sctr B Pwr** field. Select the CDMA CELLULAR MOBILE TRANSMITTER TEST screen. Display the **Sctr B Pwr** field by pressing the SHIFT key, then the assigned USER key. Select **Chan Power**. Alternately lower then raise the power of Sector B at 1 second intervals, observing the Channel Power measurement.

**NOTE:** The standard specifies that Sector A power also be varied at 1 second intervals. This is practical only through remote operation. Refer to the *Agilent Technologies 8924C Condensed Programming Reference Guide* for GPIB commands.

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Printed in U.S.A. 8/00  
5968-0944E

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