Open Loop Power-Control Time-Response Test
This product note will help you measure the “time response of open loop power control” for a CDMA mobile cellular telephone. The equipment and procedures in this document apply to CDMA mobile cellular telephones based on TIA/EIA/IS-95-A, or related industry standards.

Section 1—Introduction
The open loop power control time-response is defined as the amount of time (t) it takes the mobile phone to respond to and acquire equilibrium following a step increase in base station power, ΔP_in.

This test verifies that the mobile is capable of adjusting its transmit power throughout its dynamic range of transmission within a power versus time mask determined by applicable standards.

An example of this mask, with a ΔP_in = 20 dB and Δt = 100 ms, is shown in Figure 1. For TIA/EIA/IS-95-A, the upper and lower limits of this mask are determined by the equations shown on the following page.
Upper Limit Equations
For: $0 < t < 24 \text{ ms}$: Max $[1.2 \times |\Delta P_{in}| \times (t/24), |\Delta P_{in}| \times (t/24) + 2.0 \text{ dB}] + 1.5 \text{ dB}$

For: $t \geq 24 \text{ ms}$: Max $[1.2 \times |\Delta P_{in}|, |\Delta P_{in}| + 0.5 \text{ dB}] + 1.5 \text{ dB}$

Lower Limit Equation
For: $t \geq 0 \text{ ms}$: Max $[0.8 \times |\Delta P_{in}| \times [1 - e^{(1.25-t)/36} - 2.0 \text{ dB}, 0] - 1 \text{ dB}$

Where:
- $t$ is expressed in milliseconds,
- $\Delta P_{in}$ is expressed in units of dB
- Max $[x, y]$ is the maximum of the $x$ and $y$ components in the upper and lower limit equations.

Test Parameters
The following are general test parameters for the open loop power control time-response test (from industry standard IS-98-A, other standards should be similar).

- Test set power range into phone’s receiver: $-25 \text{ dBm to } -104 \text{ dBm}$
- Pilot channel level: $-7 \text{ dB}$
- Traffic channel level: $-7.4 \text{ dB}$

Base Station (Test Set) Power Transitions
1. The open loop power control time-response test is initiated at a power level of $-60 \text{ dBm}$ (base station). See Figure 2.

2. The test set power is increased by a step of $20 \text{ dB}$ to a power level of $-40 \text{ dBm}$.

3. The test set power is decreased by a step of $20 \text{ dB}$ to a power level of $-60 \text{ dBm}$.

4. The test set power is decreased by a step of $20 \text{ dB}$ to a power level of $-80 \text{ dBm}$.

5. The test set power is increased by a step of $20 \text{ dB}$ to a power level of $-60 \text{ dBm}$.

References
- Telecommunications Industry Association, Industry Standards TIA/EIA/IS-98-A (Section 10.4.2—Time Response of Open Loop Power Control), Sept. 10, 1997
- American National Standards Institute (ANSI). ANSI J-STD-018 Recommended Minimum Performance Requirements for 1.8 to 2.0 GHz Code Division Multiple Access (CDMA) Personal Stations (Section 4.4.2—Time Response of Open Loop Power Control)
- ARIB STD-T53 Ver. 1.0, CDMA Cellular System, Association of Radio Industries and Business, 1-4-1 Kasumigaseki, Chiyoda-ku, Tokyo 100, Japan, October 1997

Figure 1. Example Limits for the Open Loop Response

Figure 2. Base Station Power Transitions
**Section 2—Test Equipment**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8924C CDMA Mobile Station Test Set</td>
<td>The Test Set must be equipped with electronic attenuators. NOTE: To determine if the Agilent 8924C Test Set is equipped with an electronic attenuator, access the Test Set’s TESTS screen (this procedure will erase any other IBASIC program stored in the test set):</td>
</tr>
<tr>
<td></td>
<td>1. Press the TEST key.</td>
</tr>
<tr>
<td></td>
<td>2. Select <strong>Procedure Location: ROM</strong>.</td>
</tr>
<tr>
<td></td>
<td>3. Select <strong>Procedure Filename: ICONFIG3</strong>.</td>
</tr>
<tr>
<td></td>
<td>4. Press k1 (Run Test) and look for <strong>A5 Input with Electronic Attenuator</strong>.</td>
</tr>
<tr>
<td>83236B PCS Interface</td>
<td>This PCS interface is needed if performing PCS band tests</td>
</tr>
<tr>
<td></td>
<td>MINIMUM REQUIRED OPTIONS for 85725C open loop measurements:</td>
</tr>
<tr>
<td></td>
<td>• Option 004—Precision Frequency Reference (or equivalent external 10 MHz precision frequency reference)</td>
</tr>
<tr>
<td></td>
<td>• Option 101—Fast Time Domain Sweeps (if Option 151 is installed DO NOT INSTALL Option 101)</td>
</tr>
<tr>
<td></td>
<td>PREFERRED and RECOMMENDED OPTIONS for 85725C:</td>
</tr>
<tr>
<td></td>
<td>• Option 140—Narrow Resolution Bandwidth and Precision Frequency Reference (narrow bandwidth for ACPR measurements; includes precision reference same as Option 004)</td>
</tr>
<tr>
<td></td>
<td>• Option 053—Improved CDMA Amplitude Accuracy (for cellular and PCS bands)</td>
</tr>
<tr>
<td></td>
<td>• Option 151—DSP, Fast ADC, and Digital Demodulator (provides faster CDMA measurements)</td>
</tr>
<tr>
<td></td>
<td>• Option 160—CDMA firmware (for use with option 151)</td>
</tr>
<tr>
<td></td>
<td>OTHER SUGGESTED OPTIONS:</td>
</tr>
<tr>
<td></td>
<td>• Option 041—GPIB and Parallel Interface</td>
</tr>
<tr>
<td></td>
<td>• Option 105—Time-Gated Spectrum Analysis</td>
</tr>
<tr>
<td></td>
<td>To determine which spectrum analyzer option is installed in the spectrum analyzers:</td>
</tr>
<tr>
<td></td>
<td>1. Press CONFIG key.</td>
</tr>
<tr>
<td></td>
<td>2. Press <strong>More 1 of 3</strong> softkey.</td>
</tr>
<tr>
<td></td>
<td>3. Press <strong>SHOW OPTIONS</strong> softkey.</td>
</tr>
<tr>
<td>85725C CDMA Measurements Personality</td>
<td>This assembly is installed in the 859XE spectrum analyzer.</td>
</tr>
<tr>
<td>CDMA Mobile Phone</td>
<td>An appropriate antenna connector or cable is required for the phone.</td>
</tr>
<tr>
<td>Shielded RF Isolation Box</td>
<td>This item is optional but recommended.</td>
</tr>
<tr>
<td>Power Splitter</td>
<td>A resistive or transformer-coupled power splitter is acceptable. It must be able to handle the output power of the phone (approximately 25 dBm max). Example: Mini-Circuits resistive power splitter/combiner, p/n ZFRSC-2050 (dc to 2 GHz).</td>
</tr>
<tr>
<td>Trigger Cable</td>
<td>Use a 15-pin male D-connector to BNC male connector cable. This cable is used to send trigger signals to the 859XE Spectrum Analyzer from the 8924C Test Set. NOTE: See Appendix 5 in this document for instructions on how to build this cable.</td>
</tr>
<tr>
<td>RF Cable</td>
<td>Three low-loss shielded RF cables with type-N (male) connectors to mate with the power splitter, RF shielded box, and CDMA telephone.</td>
</tr>
</tbody>
</table>
Section 3—Connecting the Equipment
For CDMA cellular band mobile phones see Figure 3; for CDMA PCS band mobile phones see Figure 4.

1. Connect the CDMA phone to the power splitter. Ensure that the CDMA phone is properly shielded against external RF interference. An example of interference is an active base station transmitting on the same channel as the mobile unit under test.

2. Connect one output end of the power splitter to the 50 W input of the spectrum analyzer.

3. Connect the other output end of the power splitter to the RF IN/OUT port on the test set for cellular frequencies; or, to the RF IN/OUT port on the PCS interface for PCS frequencies.

4. Connect the trigger cable from the AUX CONTROL port (15-pin D-connector) on the back of the test set to the EXT TRIG INPUT (TTL) BNC-connector on the back of the spectrum analyzer. A trigger signal is required to activate the open loop test once it has undergone a step change in power. For instructions on making a trigger cable, see Appendix 5—Trigger Cable and Trigger Signal Description.

References
- Agilent Technologies E8285A CDMA Mobile Station Test Set Reference Guide, Chapter 2, Description of Connectors (SA TRIG OUTPUT), pub. number E8285-90018
- Agilent Technologies 859XE Users Guide, pub. number 08590-90301
- Agilent Technologies 85725X CDMA Measurements Personality User’s Guide, pub. number 85725-90010
Figure 4. Setup for PCS Band Phones
Section 4—Test Procedure

This section is a step-by-step measurement procedure. Some of the following steps will refer you to other sections in this document. After you complete the instructions in those sections, return to this section to continue the procedure.

1. Connect equipment as described in Section 3—Connecting the Equipment. Power-up the instruments but not the mobile phone.

2. Configure the test set as described in Section 5—Configuring the Test Set.

3. Set the RF power increment to 20 dB on the test set as described in Section 6—Setting Up a 20 dB Increment on the Test Set.

4. Calibrate channel power on the test set by accessing the CDMA TRANSMITTER POWER RANGE TEST screen (see Figure 5 item 6). For details refer to section 5, the subsection titled “Setting the CDMA Transmitter Mode.”

5. Measure the delay between the test set’s trigger signal and power transmission step using the spectrum analyzer as described in Section 7—Determining the Test Set’s Trigger Time Delay.

Record the trigger delay of the test set. Then convert the value from milliseconds to microseconds (milliseconds x 1000 = microseconds). It will be entered into the spectrum analyzer’s DELAY field.

Figure 5. CDMA TRANSMITTER POWER RANGE TEST Screen

Figure 6. Time Response and Open Setup Functions
6. Configure the spectrum analyzer and software as described in Section 8—Configuring the Spectrum Analyzer and Software. Enter the recorded delay time into the DELAY field of the Time Response/Open Setup function, see Figure 6.

7. Turn on the CDMA phone. On the test set’s CDMA TRANSMITTER POWER RANGE TEST screen, set the following:

7a. Set **Closed Loop Pwr Cntl** field to **Closed Loop** (see Figure 5, item 1).

7b. Set **Sctr A Pwr** field set –40 dBm (see Figure 5, item 7).

7c. Set **Output Atten Hold** field (see Figure 5, item 8) to **Off**.

7d. Set **Traffic Data Mode** to **Svc Opt 1** (see Figure 4, item 3, *this will be changed to Svc Opt 2 in step 9*), or to normal voice-call service option for the phone type.

8. Select the test set’s CDMA CALL CONTROL screen. After the phone indicates service, dial a number and place a call from the phone to the test set. Wait until the call is connected.

9. Press the test set’s END CALL key.

9a. Set the **Traffic Data Mode** to **Svc Opt 2**

9b. Press the test set’s CALL key to connect a call in data loopback mode at full rate. (The phone will usually display a message indicating LOOP MODE.)

10. Once a call is connected, go to the CDMA TRANSMITTER POWER RANGE TEST screen on the test set and:

10a. Change the **Closed Loop Pwr Cntl** field from **Close Loop** to **Open Loop** (see Figure 5, item 1).

10b. Change the **Output Atten Hold** field to **on** (see Figure 5, item 8).

10c. Change the **Sctr A Pwr** field to –60 dBm (see Figure 5, item 7). Remember to use up and down arrows.

11. On the spectrum analyzer, on the Time Response screen (see Figure 6), select the **OPEN LOOP** softkey. This will start the open loop time-response test. The message **Waiting for Ext Trig** appears on the screen (see Figure 7) after a short delay.

12. Press the **SET REF LVL** softkey (see Figure 7, item 2). Enter 15 dBm. Press the ENTER key. This adjusts the spectrum analyzer's input attenuator and reference level to allow viewing of the full range of power transitions.

13. Step increase **Sctr A Pwr** field to –40 dBm. The time response will be displayed on the spectrum analyzer.
14. A 20 dB step change of the test set's power will trigger the time response test. Figure 8 shows the results of a 20 dB decrease in the test set's transmitted power. Note that PASS or FAIL is displayed in the lower right corner.

15. Step decrease Sctr A Pwr field to $-60 \text{ dBm}$. The new time response will be displayed on the spectrum analyzer.

16. Step decrease Sctr A Pwr field to $-80 \text{ dBm}$. The new time response will be displayed on the spectrum analyzer.

17. Step increase Sctr A Pwr field to $-60 \text{ dBm}$. The new time response will be displayed on the spectrum analyzer.

**NOTE:** The REPEAT MEAS softkey on the spectrum analyzer can be used to reinstate the open loop test (see Figure 8). However, the open loop test will automatically reset for another measurement, so this softkey does not have to be pressed.
Section 5—Configuring the Test Set
As an example, the following test set screens show the appropriate settings for testing a U.S. PCS phone. The screens presented are accurate with respect to firmware revision A.05.30. Future revisions will be similar but are not guaranteed to be the same.

Setting the RF Level Offset
Access the CONFIGURE screen, see Figure 9.

1. The RF Level Offset field must be On in order to activate the RF In/Out field (item 2).

2. The RF In/Out field should be set to the attenuation value determined by the methods described in Appendix 3—Determining Cable Connection Losses. This will compensate for losses encountered by the power splitter and cables. This value is entered as a negative offset (loss).

Setting the Pilot and Traffic Channels
Access the CDMA GENERATOR CONTROL screen, see Figure 10.

1. For sector A (the left column on the screen), the Pilot channel field (Walsh channel 0) must be set to –7.0 dB (for testing EIA/TIA/IS-98-A).

2. The Traffic channel (Walsh channel 8 through 31 or 33 through 63) must be set to –7.4 dB (for testing to EIA/TIA/IS-98-A).
Setting the Channel and Protocol
Access the CDMA CALL CONTROL screen, see Figure 11.

1. Set the RF Chan Std field (item 3) to the appropriate standard.

1a. For example, for U.S. PCS frequencies, set this field to US PCS.

1b. For U.S. cellular frequencies, set this field to MS AMPS.

1c. For CDMA phones for use in Japan, choose Japan CDMA. The RF Channel field is automatically updated with the starting channel within the given standard.

2. Enter the appropriate channel value in the RF Channel field (item 1). The manufacturer or service provider programs the phone to the appropriate RF channels. If the RF channel is not known or incorrectly entered into the test set, the phone will start to scan all the possible channels in the phone’s channel list. If an outside base station of higher power is received, the phone will lock onto it and discontinue its search. For some phones, this is a long process, therefore, it is recommended that the appropriate channel value is known and entered into the RF Channel field.

3. Enter the appropriate protocol for the selected channel standard into the Protocol field (item 2). For example:

3a. For U.S. CDMA PCS frequencies, select JSTD-008.

3b. For U.S. CDMA cellular frequencies, select IS-95A or TSB-74.

3c. For Japanese CDMA, select ARIB T53.

Figure 11. CDMA CALL CONTROL Screen
Setting the CDMA Transmitter Power Test Mode

Access the CDMA TRANSMITTER POWER RANGE TEST screen, see Figure 12.

1. Set the **Closed Loop Pwr Cntl** field (item 1) to **Closed Loop** to begin the test. This field controls the sequence of the “punctured” power control bits. In open loop mode the test set sends alternating 0 and 1 bits.

**NOTE:** In closed loop mode the test set sends the appropriate power control bits to control the transmitted power level of the phone. Closed loop mode should be active while a call is being connected. Open loop mode is activated after a call has been connected and throughout the remainder of the open loop power control time-response test. For more information, see Appendix 1—Background on Open and Closed Loop Power Control.

2. Set the **Drop Timer** field (item 2) to **Off**. This stops the test set from disconnecting the call even when it cannot detect the phone’s transmitted signal. This may occur when the test set is transmitting at the –40 dBm level.

3. Set the **Traffic Data Mode** field (item 3) to **Svc Opt 2** (9600 bps) or **Svc Opt 9** (18800 bps), depending on the standard.

4. Set the **Data Rate** field (item 4) to **Full**.

5. The power meter is able to operate as either a channel-power meter or an average-power meter. Select **Chan Power** (item 5). For this test the channel power meter is used because it gives a channel power reading specific to the reverse channel bandwidth that is occupied by the phone.

6. The **Power Meas** field (item 6) is used to calibrate the channel power meter. Set this field to **Calibrate**, *but*, before the calibration can proceed, the RF IN/OUT and RF OUT Only ports on the PCS interface, or the RF IN/OUT and DUPLEX OUT ports on the test set, must be connected together with a short RF cable. Refer to the Agilent 8924C Applications Guide, chapter 1, pub. number 08924-90021, for assistance in calibration.

7. The sector-A power, **Sctr A Pwr**, field (item 7) is used to change the transmitted power level of the test set in steps of ±20 dB. The power level steps must be entered in whole values and not incremented by turning the knob. Use the up-and down-arrow keys to increment values in 20 dB steps. See Section 6—Setting Up a 20 dB Increment on the Test Set.

8. The **Output Attn Hold** field (item 8) is set to **On** only for PCS phones. This field is used to hold the setting of the mechanical relay attenuator in the PCS interface. (For more information see Appendix 4—Holding the PCS Interface’s RF Attenuator.)

9. The **Chan Power** reading can be compared to the **Ideal Mobile Power** reading (item 9) to obtain a measure of how effectively the phone operates under the open loop power control.

![Figure 12. CDMA TRANSMITTER POWER RANGE TEST Screen](image-url)
Section 6—Setting Up a 20 dB Increment on the Test Set

You can increase or decrease the Sctr A Pwr by 20 dB with a press of one button. Listed below are the steps to set up a 20 dB increment adjustment:

1. Go to the CDMA TRANSMITTER POWER RANGE TEST screen, see Figure 13.

2. Move the cursor to the Sctr A Pwr field (item 7).

3. Press the Incr Set key on the front panel of the test set.

4. Typically I = 1.00 will appear in the Sctr A Pwr field. Using the DATA KEYS, enter the value 20 and then press the knob.

5. By using the up- and down-arrow keys (or turning the knob) on the front panel of the test set, the power will increase or decrease in increments of 20 dB each time an arrow key is pressed (or the knob is turned).

Section 7—Determining the Test Set’s Trigger Time Delay

In order to perform an accurate open loop power control time-response test, it is important to accurately determine the delay between the trigger signal and the actual power step at the test set’s output. Inaccurate delay times will cause the test to start before the power level from the test set has a chance to change. This will often cause the test results to indicate a failure. For details, see Appendix 5—Trigger Cable and Trigger Signal Description.

1. Turn off the phone.

2. On the spectrum analyzer:
   2a. Press the PRESET key on the front panel.
   2b. Press the Spectrum Analyzer softkey.

3. On the test set, set the Sctr A Pwr field in the CDMA TRANSMITTER POWER RANGE TEST screen to –40 dBm (see Figure 13, item 7).

4. For testing PCS phones only, on the test set, set the Output Atten Hold field to on (see Figure 13, item 8).

5. On the spectrum analyzer:
   5a. Press the FREQUENCY key.
   5b. Enter the center frequency that the test set (forward channel) is operating on. For example: RF Chan Std = US PCS; RF Channel = 500; forward channel frequency = 1955 MHz.
   5c. Press the ENTER key (same as Hz/µv/µs key).
   5d. On the spectrum analyzer, press the SPAN key.
5e. Enter 0 Hz, and press the ENTER key.
5f. Press the BW Band Width key.
5g. Enter 3 MHz, press the ENTER key.
5h. Press the AMPLITUDE key.
5i. Press the REF LEVEL softkey and enter –25 dBm. Press the ENTER key.
5j. Press the ATTEN softkey and ensure it is set to manual, MAN. Enter an attenuation of 0 dB and press the ENTER key.
6. Change the test set’s Sctr A Pwr field from –40 to –60 dBm to ensure that the setup is correct. The spectrum analyzer display should show a 20 dB drop.

7. On the spectrum analyzer press the SWEEP key.
7a. Enter 20 ms.
7b. Press the ENTER key
8. Set the test set’s Sctr A Pwr field from –60 to –40 dBm.

9. On the spectrum analyzer press the TRIG key.
9a. Press the SWEEP softkey (next to the display) and set it to single, SGL.
9b. Press the EXTERNAL softkey.

**NOTE:** The spectrum analyzer is now ready to measure the time delay between the E8285A trigger signal going high and the E8285A RF output level changing 20 dB.

10. Change the test set’s Sctr A Pwr field from –40 to –60 dBm. It typically falls within 15 to 20 ms. Each major graticule line from left to right is 2 milliseconds (typically set trigger delay is between 15 and 20 ms).

11. On the spectrum analyzer measure the time delay that appears on the display.

12. Record this delay time, it will be used later in the test procedure.

13. To reset the spectrum analyzer for another trigger delay measurement:
12a. Press the FREE RUN softkey.
12b. Press the EXTERNAL softkey.

14. Change the test set’s Sctr A Pwr field by a step of 20 dB. Try it from –40 dBm to –80 dBm. The time delays should be almost identical.

15. When the trigger delay measurements are complete:
15a. Press the AMPLITUDE key.
15b. Press the ATTEN softkey.
15c. Choose AUTO.
Section 8—Configuring the Spectrum Analyzer and Software

First install the Agilent 89725C software following the instructions in the 85725C user’s guide, *Chapter 1—Getting Started*, step 1 “Load the CDMA Measurement Personality.” For best accuracy, you should also perform step 2, the spectrum analyzer’s calibration routines. When the 85725C CDMA Measurements Personality software is installed in the spectrum analyzer, the CDMA ANALYZER menu options (see Figure 14) are available.

Setting “CDMA Config” Options

1. Press the MODE key.

   1a. Press the **CDMA ANALYZER** softkey.

   1b. Press the **CDMA Config** softkey of the CDMA ANALYZER main menu 1 of 3 (see Figure 11). The CDMA Config options sub-menu 1 of 3 appears.

2. Press the **BASE MOBILE** softkey until **MOBILE** is underlined. This tunes the spectrum analyzer to the reverse link of the selected channel.

3. Press the **MS EXT ATTEN** softkey (on sub-menu 1 of 3) enter the value for the attenuation measured from the power splitter and the cables connecting the test set to the spectrum analyzer. This is a positive number since the field is assuming it is an attenuation loss.

   For example:
   3a. 6 dB of attenuation is measured (see *Appendix 3—Determining Cable Connection Losses*).

   3b. Enter 6 dB in the **MS EXT ATTEN** return field.

   3c. Press the ENTER key on the spectrum analyzer.

4. Press **More 1 of 3** field to obtain CDMA Config sub-menu 2 of 3 (see Figure 12).

5. The **TRIG** field must be set to **EXT** (external). This enables the trigger from the test set.

6. Press **More 2 of 3** softkey to obtain CDMA Config sub-menu 3 of 3 (see Figure 12).

7. Press the **Std/Band** softkey. Then press the softkey that matches the standard you are using. For example, **JSTD-008** for U.S. PCS frequencies.

8. Press the **More 3 of 3** softkey to return to CDMA Config sub-menu 1 of 3 and press the **Main Menu** softkey.

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*Figure 14. CDMA ANALYZER Main Menu and CDMA Config Menu Options*
Setting the RF Channel Function
1. Select the **RF Channel** softkey on the CDMA ANALYZER main menu 1 of 3, the RF Channel options will appear (see Figure 15).

2. Press the **CHANNEL NUMBER** softkey and enter in the correct channel operation number for the phone in this field, then press the **ENTER** key. The **CENTER FREQ** field will automatically update with the center frequency of the entered channel.

3. Press the **Main Menu** softkey to return to the CDMA ANALYZER main menu screen.

Setting the Time Response Function
1. Press the **More 1 of 3** softkey on the CDMA ANALYZER main menu to go to menu 2 of 3 (see Figure 16).

2. Press the **Time Response** softkey to access the time response test functions (see Figure 16).

3. Press the **Open Setup** softkey of the Time Response functions to configure the open loop test setup functions (see Figure 16):

   3a. Press the **SWP TIME** softkey. Set the sweep time to 100 ms and then press the **ENTER** key. (100 ms is the measurement time specified by IS-98-A.)

   3b. The **DELTA PWR** field determines the step value at which the mask limits change with respect to each trigger signal. 20 dB is the default value of this field (20 dB is the step specified by IS-98-A).
3c. Press the **DELAY** softkey. Enter the trigger delay time measured in *Section 8—Determining Trigger Time Delay*. The delay time is entered in microseconds, for example: 17 ms delay time = 17,000 µs. Press the ENTER key twice. It is important to enter an accurate delay time in order to obtain accurate test results. The test may fail frequently if the trigger does not occur at the time of power transitions.

3d. Press the **Previous Menu** softkey to return to the Time Response menu screen.

**References**


- For Agilent Technologies 859XE setup and configuration refer to the *User’s Guide*, pub. number 08590-90301.
Appendix 1—Background on Open and Closed Loop Power Control

The effectiveness of CDMA as a method to increase call capacity is partially determined by how effective the transmitted power of each mobile can be accurately controlled and minimized. The goal of the mobile is to transmit its signal with the least amount of power capable of producing a detectable signal at the base station; any more power will simply be added noise to the system. In order to accurately control the mobile’s power (reverse link), two methods are used: open loop power control and closed loop power control.

Open Loop

The open loop power control process is performed when the phone is in an idle state (not on a call). Open loop power control assumes that the path loss is the same on the reverse path as it is on the forward path. The mobile can determine the correct transmit power (reverse link) by monitoring the base station’s transmit power (forward link) and subtracting a constant. The open loop power control response for cellular and PCS frequencies are described by the following equations:

**Cellular Equation**

\[
\text{Receive Power (Forward Link)} + \text{Transmit Power (Reverse Link)} + \text{Nominal Power} + \text{Initial Power} = -73 \text{ dBm}
\]

**PCS Equation**

\[
\text{Receive Power (Forward Link)} + \text{Transmit Power (Reverse Link)} + \text{Nominal Power} + \text{Initial Power} = -76 \text{ dBm}
\]

Closed Loop

Closed loop power control accompanies the open loop power control process. The base station monitors the received signal from the mobile and determines if the signal is “just good enough to maintain a link.” Every 1.25 milliseconds or 800 times a second the base station commands the mobile to raise or lower its transmit power by a step of 1 dB based on the signal it received from the mobile. Therefore, the power transmitted from the mobile is never constant for more than 1.25 ms.

The base station sends the closed loop power control instruction to the mobile by replacing a bit of voice data with a power control bit. For instance, if a one bit is received the mobile knows to reduce its power by 1 dB, and if a zero bit is received the mobile knows to increase its power by 1 dB. This process is called “puncturing.”
Appendix 2—The Effect of Closed Loop Control on the Open Loop Test

Since this test is only concerned with the open loop response it would be ideal to eliminate the effects of the closed loop power control on the reverse power transmission. This is not entirely possible. Due to the various design limitations that phone manufacturers have in their products, the test set is unable to tell the phone to turn off the closed loop control.

The open loop test that is described in this paper is not exclusively open loop controlled, the closed loop control is still present because the phone is on a call. The test set has the capability of going into a “virtual open loop mode” by alternating the power control bits (between digital 0 and 1). This gives the appearance of being exclusively in open loop power control mode, but with an error of ±1 dB at best.

This can cause a problem when the base station is transmitting near the noise floor. Since there is no form of error correction associated with the “punctured” power control bits, they are easily received in error. Once the forward link approaches the noise floor, the Frame Error Rate (FER) increases, which will increase the probability of receiving consecutive similar power-control bits. At such low signal levels this error could be enough to cause a dropped call or failure of the open loop time-response test.

Simply by monitoring the FER you can tell when the noise floor is compromising your measurements. The noise floor is not standard, it can vary from time to time and location to location. Just because your phone passes the tests in one location doesn’t mean that the phone will pass in a different location or at a different time. Therefore, it is very important to have your phone properly shielded from outside noise and interference during testing.
Appendix 3—Determining Cable Connection Losses

In order to obtain accurate power measurements a few steps need to be taken. First, always calibrate the channel power on the test set when you have powered down the test set or if significant changes have been made to the configuration of the test set (channel changes, cellular to PCS operation, and so forth).

Second, you must account for losses that have occurred through the transmission medium between the connected devices. Since you are using a power splitter and two cables, these losses need to be taken out of the power transmission process. The test set allows you to enter an RF level offset. The test set transmits its signal at a level above or below the entered sector power, depending on the sign (+ or –) of the attenuation entered into the RF Level Offset field. (Refer to Section 6—Setting Up a 20 dB Increment on the Test Set; and Section 7—Determining Test Set Trigger Time Delay.)

External Power Meter Method

In order to determine the attenuation of the power splitter and the two cables, an external power meter can be used. Listed below are the steps you need to take to find your RF power compensation:

1. Zero the power meter.

2. Connect the power meter directly to the test set’s DUPLEX OUT port; or, the PCS interface’s RF OUT Only port.

3. On the CONFIGURE screen:

   3a. Set RF Level Offset field to Off.

   3b. Set the Output Port field to Duplex for cellular band, or only for PCS.

4. Go to the CDMA CALL CONTROL screen:

   4a. If no PCS interface is used, set Sctr A Pwr field to dBm.

   4b. If a PCS interface is used, set to –11 dBm.

5. With the power meter, measure the power out of the test set.

6. Connect the cables and splitter to the DUPLEX port, or RF OUT Only for the PCS interface. Include every connection from the test set up to but not including the cellular phone. This includes a car kit or break out box if used.

7. With the power meter, measure the power at the end of the cables and splitter.

8. Subtract the second measurement from the first to obtain your RF level offset.

Using the Agilent 8924C Test Set

To determine the attenuation of the power splitter and the cables, the test set can be used. Refer to “Determining RF Path Loss” in Chapter 1 of the Agilent Technologies 8924C Application Guide, pub. number 08924-90021.
Appendix 4—Holding the PCS Interface’s RF Attenuator

This appendix applies only if an Agilent 83236B PCS Interface is used.

A mechanical attenuator is used in the PCS interface. Mechanical attenuators when switched in and out of operation can produce transient responses as they are relays that open and close. While a relay is in an open state, the open loop power control of the mobile notices a loss of power from the base station and starts transmitting the reverse signal at a higher power level.

When the mechanical attenuator completes its transition (typically 10 ms to 50 ms) the forward power returns to a higher value and the mobile’s open loop power control notices that it is transmitting the reverse signal at too high a power and starts to lower its signal strength. This variation is undesirable for the open loop timing measurement.

To correct this problem, the mechanical attenuator in the PCS interface is set in a fixed state, and the RF output level is varied using the transit-free electronic attenuator in the test set. (The fixed state is selected when the Output Atten Hold field in the CDMA TRANSMITTER POWER RANGE TEST screen is set to on.)

The maximum power that the test set and the PCS interface will be transmitting in this test will be –40 dBm so that is the attenuator hold level. Once held, RF output levels down to approximately 50 dB lower than the “hold” level are accurate. However, output levels higher than the “hold” level are inaccurate.
Appendix 5—Trigger Cable and Trigger Signal Description

Making a Trigger Cable

Components
- Shielded coaxial cable approximately 3 ft (1 m) long
- Male BNC connector with solder pot terminal and ground lug
- 15-pin male subminiature D-connector with solder pot terminals
- 15-pin subminiature D-connector hood
- Heat shrink tubing or insulator

Procedure
1. Solder the cable’s center-conductor to pin 6 of the D-connector (see Figure 18).
2. Solder the other end of the center conductor to the BNC center pin.
3. Solder the cable shield to the BNC ground lug.
4. Shrink wrap the D-connector so it will not contact any pins.
5. Shrink wrap the conductor and soldered pins, and install the hood on the D-connector.

Trigger Signal Description
Approximately 15 to 20 milliseconds (ms) before the RF output power changes on the test set, the trigger signal on the AUX CONTROL connector pin 6 goes high, see Figure 17. The rise time for the trigger transition from low to high is negligible, approximately 600 nanoseconds (ns).

Reference
For more information on the auxiliary control port refer to: Agilent 8924C Reference Guide, publication number 08924-90053.

1. To measure the precise delay time for your test set, refer to Section 7—Determining the Test Set’s Trigger Time Delay in this product note.
By internet, phone, or fax, get assistance with all your test and measurement needs.

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