Characterizing RF Losses between CDMA Phones and Test Equipment

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Cell phone testing is designed to determine the performance of the phone at a point which is defined to be the phone's antenna. But the test equipment is generally connected to the phone either through an antenna coupler or a direct cable connection. In the case of a direction connection, losses will occur on the cable and there may be additional losses due to an impedance mismatch between the cable and test equipment. Of course, the losses will be even greater when an antenna or antenna coupler is used to provide the connection between the test equipment and phone. Test specifications require that a specific level of RF energy must be supplied to the phone's antenna during testing and that the phone's RF output be measured at the antenna. In order to accurately test the phone, the bidirectional losses between the RF port on the test equipment and the phone must be accurately measured.

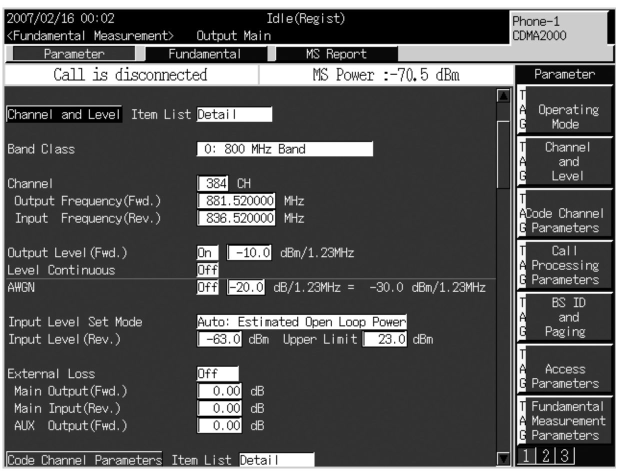
Challenge of determining RF losses on CDMA phones

It's particularly challenging to measure RF losses between test equipment and CDMA phones because CDMA phones are not capable of reporting received power. This means that a more complex method of measuring RF losses is required. One approach is to use a sophisticated set up involving several pieces of equipment such as signal generators, power meters, vector network analyzers, and spectrum analyzers. This type of setup can accurately measure RF losses but has the disadvantage that it requires expensive equipment that may not be available and would be expensive to purchase. Most RF go/no go testing is done with a one-box tester so the ideal approach would be to use the same instrument used to test the phones to characterize the RF losses. The rest of this application note will outline a method by which the Anritsu MT8815A one-box tester can be used to easily and accurately measure the RF losses between the tester and cell phone.

The method described here relies on indirectly measuring the received power by determining the power level at which the phone begins to experience frame errors. The power level, measured at the antenna, at which the phone begins to experience frame errors is provided in the specifications of every CDMA phone. Then this baseline power level can be subtracted from the power generated by the tester at the point where the phone begins to experience errors to determine the RF transmission losses. The phone can be characterized in the opposite direction by instructing the phone to transmit at its maximum rated power level and measuring the resulting signal received by the tester. Then subtract the signal received by the tester from the phone's maximum power specification to determine the losses on the transmit side. It's important to measure losses in both directions because CDMA phones transmit and receive on different frequencies so losses are often substantially different in uplink and downlink directions. Because this method involves approximation, it is also necessary to take an average of measurements performed on multiple phones.

Consistently setting up phone in tester

Obviously, the phone should be characterized using the same method, direct cable or antenna coupler, that will be used for testing. It's also important to identify a consistent method of setting up the phone that will be used both for characterization and for testing. If the RF connector snaps onto the phone this is relatively easy. If the connector will not snap into place, another way to ensure that the connection is consistent must be found. In the case of using an antenna or an antenna coupler, the phone antenna needs to be consistently positioned relative to the test antenna or antenna coupler. Many antenna couplers have a clamp or guide and strap method to assist in this placement. An RF shield box is recommended to avoid interference from local base stations.



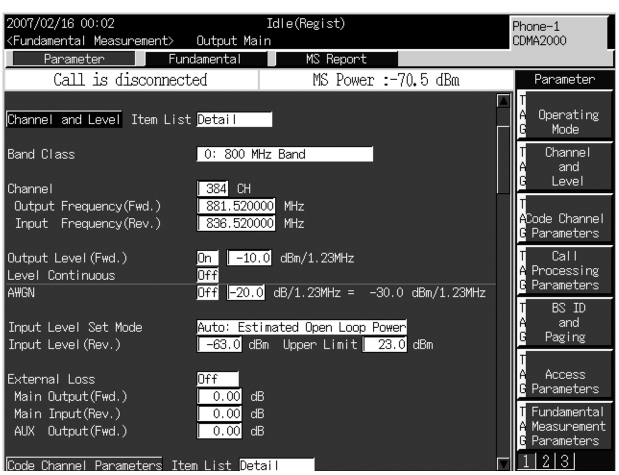


Figure 1: Communications Setup for CDMA

After a consistent phone connection is established, a call is placed from the tester to the phone. The tester's communications parameters must be set up so the phone registers on the control channel. Figure 1 shows the correct communications parameters on the MT8815A. Note that the External Loss value is set to off. This is necessary because if the External Loss value is set to on the tester will adjust the power level to compensate for various factors and this will reduce the accuracy with which the phone can be characterized. The phone will register onto the control channel. In the figure, the status shown at the top of the picture is "Idle(Regist)". This indicates that the phone has also registered on the system. At this point a call can be established by pressing the Start Call key on MT8815A. Because the testing in this example is being done in service option 2, which is a loopback service option, the phone will automatically answer and connect to the call. This service option is used because the frame error rate (FER) test requires that testing be done in the loopback mode. It's also important to note that the tester must be set up to a channel and SID combination that the phone will search for.

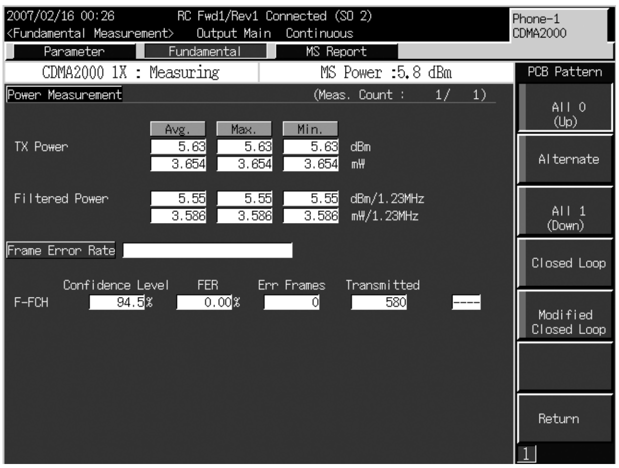
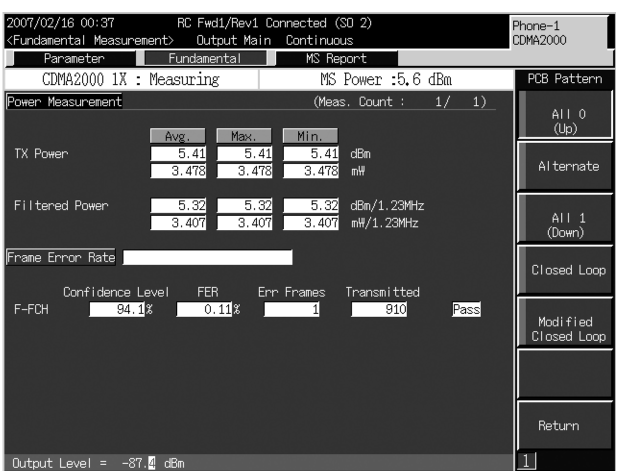


Figure 2: Measuring Power and FER

Reducing the power output of the tester

After the call has been established, change the input mode from Automatic to Manual and the Input Level to 10 DB. Press the Next hard key to access page 2 of the menu, then press the MS Power Control soft key to access the MS Power Control Menu. Press the All 0 (UP) soft key to drive the phone to its maximum power, the only known power it can be set to. Then press the Continuous key on the front panel of the MT8815A. Press the Focus key on the front panel until the Fundamental tab is highlighted as shown in Figure 2 to view the measurement results. Then reduce the power output of the tester to identify the point at which the phone fails the FER test.



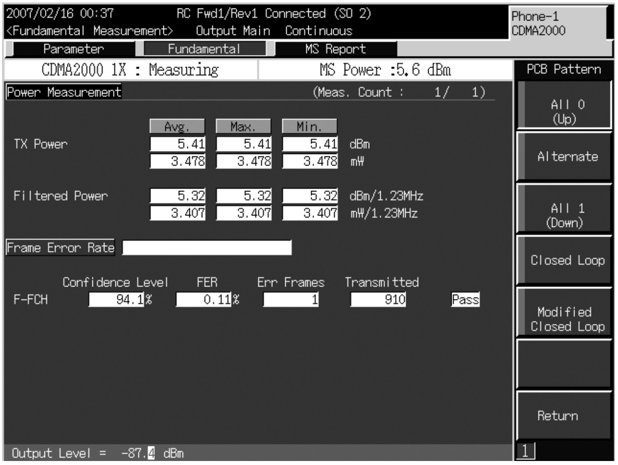


Figure 3: Measurements – Passing and Failing FER

Figure 3 shows that at an Output Level of -87.4 dBm the FER test passes but that at an output level of -87.5 dBM the FER test fails. Therefore -87.4 dBm is the minimum power at which the phone passes the FER test. We know that a good phone passes the FER test at -104 dBm, measured at its antenna, and often will pass at -104.5 dBm. So the loss at the mobile receive path can be calculated as -87.4 – (-104.5) = 17.1 dB loss. Figure 3 also shows that the maximum output power level of the phone is about 5.4 dBm. According to the testing specifications, the maximum output level for the phone used in the example should be 23 dBm. So the loss over the mobile transmit path is 23 – 5.4 = 17.6 dB loss.

Averaging measurements for multiple phones

Because of the indirect nature of these measurements, five different phones should be tested and the losses, band, channel and whether the measurement is uplink or downlink should be recorded as shown in Figure 4. After testing is completed, check the test results for each phone to look for unrepresentative results. For instance, assume that the downlink losses found for five phones at channel 600 in the PCS band are 23.9, 23.6, 24.5, 24.2, and 30. The value 30 is an outlier that is not representative of the rest of the data. Therefore the data for that phone should be considered suspect, and only the data from the other 4 phones should be used. In this case, the average loss is 24.1 dB. The average should be calculated for the uplink and the downlink for each channel that the phone will be tested on. The data should then verified by testing each phone at -104.5 dBm less the average RF losses on the receive path. All phones should pass and if they do not it may be necessary to tweak the loss data to ensure each of the phones passes. The easiest way to set up the loss table and test phones for go/no go status is to use the CRCA program shown in Figure 5. Using the CRCA program is outside the scope of this document.

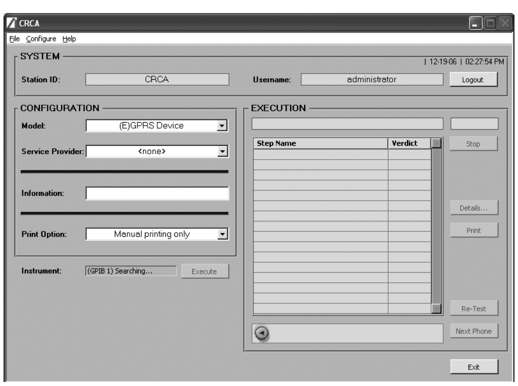


Figure 5: CRCA

When testing mobile phones, many of the measurements depend on knowing the power received and transmitted at the phone's antenna. However test equipment can only be manufactured and calibrated to the RF port of the device. Therefore the differences in the power levels between the RF port and the mobile phone antenna must be determined and compensated. This document discussed how to use the one box tester to determine and compensate for those loses.

About Related Anritsu Company Offerings

Anritsu offers a line of equipment designed for cellular phone testing.

RF Shielding Encloser with Antenna Coupler

Anritsu offers the MA8120E Shield Box for Mobile Phone Testing. This RF enclosure has a built in antenna coupler as well the capability to connect a coax cable to the phone. Some of the features of the MA8120E include:

- Frequency: 800 to 2500 MHz
- Shield characteristics: More than 60 dB
- Dimensions: 330(W) x 181(H) x 393(D) mm
- Operating Temperature: +10° to +50 °C

Cellular Phone Testers

Anritsu offers three different cellular phone testers – the MT8510B, the MT8815A, and the MT8820A.

MT8510B

The MT8510B is a low cost Go/No Go tester for testing WCDMA and GSM phones. It can use a separate control PC to update the test software, control the tester, or install test parameters. Otherwise, the MT8510B runs standalone with no external PC needed. Some of the features of the MT8510B include:

- Supports W-CDMA/UMTS and GSM
- Voice codec for W-CDMA
- Multi-band support
- 10-line color TFT LCD
- Front panel USB connector for simple software upgrade using USB memories
- Remote software upgrade via Ethernet 10/100 Mbps link

MT8815A

The MT8815A is a full featured tester. It runs faster than the MT8510A, and includes a more complete test suite. It also supports more protocols than the MT8510B does. It supports WCDMA, GSM/GPRS/EGPRS, cdma2000 1xRTT, cdma2000 1xEV-DO, AMPS voice channel, and PHS. Some of the features of the MT8815A include:

- W-CDMA Measurement Function including transmitter, receiver, and performance tests
- GSM/GPRS/EGPRS Measurement Function with GSM and EGPRS Measurement Software and TDMA Measurement Hardware
- cdma2000 1X Measurement Function with cdma2000 Measurement Software and Hardware
- cdma2000 1xEV-DO Measurement Function with 1xEV-DO Measurement Software and Hardware
- AMPS Audio Board with cdma2000 Measurement Software
- PDC Measurement Function with PDC Measurement Software and TDMA Measurement Hardware
- PHS Measurement Function with PHS Measurement Software and TDMA Measurement Hardware
- Real-Time Voice Encoding and Decoding

- Test Function for Packet Communication Data Transfer
- cdma2000 1X/1xEV-DO Synchronous Function
- Call Processing Function
- High-speed, Easy-to-Use GPIB Control

MT8820A

The MT8820A is identical to the MT8815A with one major exception – the MT8820A has an option for a second RF unit, and when used in combination with the Parallel Phone measurement option, allows the testing of two phones at the same time. This gives the customer the testing power of two testers while only taking the space of a single tester. The protocols supported and the features are the same as the MT8815A.

CRCA

Then MX880150B - Computer-Aided Radio Communication Analysis (CRCA) Software option provides external control of the MT8801C, MT8815A and MT8820A Radio Communication Analyzers. Together, an analyzer and this software form a single, effective, and easy-to-use test solution for fast, automated testing of most of the world's wireless phones. This test system supports IS-136, GSM, GPRS/EDGE, IS-95, cdma2000 1x, 1xEV-DO, and W-CDMA.

Specifications are subject to change without notice.

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