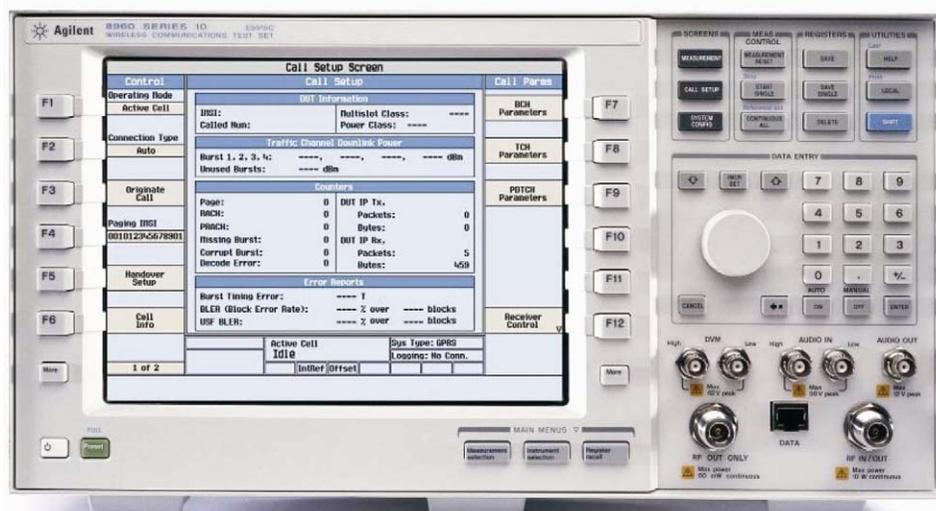
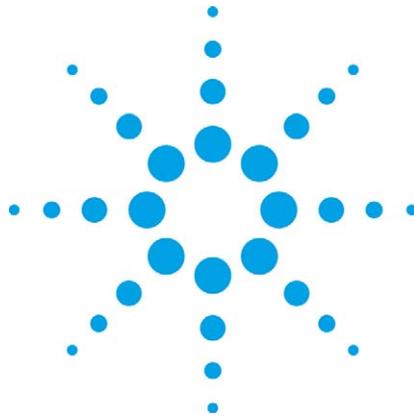


Fast Device Tune Measurement Solution for Calibrating W-CDMA Mobile Phones with the Agilent 8960 Series E5515C Wireless Communications Test Set

Application Note



Introduction

Continued consolidation and competition in the cell phone market has intensified manufacturing pressure to reduce cost of test. This has increased the need for test time improvements enabled by fast calibration techniques. These fast calibration techniques require unique chipset support capability and advanced test equipment. Such capability is realized in measurements like Agilent's Fast Device Tune, available in Agilent's 8960 and E6601A wireless communication test sets. Working together with chipset test mode software to synchronize with the mobile phone's test sequence, Fast Device Tune dramatically reduces test time for transmitter output power and receiver input level calibration. Measurement speed improvements are achieved with simultaneous calibration of transmitter and receiver performance across level and frequency in a single measurement sweep per frequency band.

This application note describes the Fast Device Tune measurement for calibrating W-CDMA mobile phones using the 8960, Agilent's full-featured test set optimized for wireless device design and manufacturing test. An overview of calibration, explanation of the measurement setup, tour of Fast Device Tune application features, and programming example are all included.

Table of Contents

Calibrating Mobile Phones	4
Why is calibration testing so time-consuming?	4
Agilent's contributions to fast calibration	5
Fast Device tune Measurement Overview	7
Mobile requirements	7
Test set requirements	7
Implementation	8
Measurement description	9
Initial conditions	10
Triggering	10
Operating considerations	10
Measurement parameters	10
Measurement results	11
Troubleshooting	12
Programming the Fast Device Tune Measurement	13
Program flow	13
Programming code	14
Programming Example Results	19
Conclusion	19

Calibrating Mobile Phones

Wireless device manufacturers are facing unprecedented pressures on operating margins. Commoditization of low priced phones, increased demand for features in mid-range phones, and aggressive global competition are all factors keeping downward pressure on wireless device pricing. As a result, test costs have become a higher percentage of the overall manufacturing cost of a mobile phone. Manufacturers are making serious efforts to reduce these test costs. Reducing test time is one of the most effective ways to cut test costs in manufacturing. Transmitter and receiver calibration testing, which requires a large number of measurements, is a key process focus for test time reduction. Faster calibration techniques are helping by dramatically improving throughput in manufacturing test.

Responding to the need to reduce manufacturing test time, mobile phone chipset providers have been implementing a fast calibration technique that allows their chipset transmitter output power and receiver input level to be calibrated across level and frequency in a single frequency band sweep. The Fast Device Tune measurement in Agilent's 8960 and E6601A wireless communication test sets supports this solution and is implemented in many of today's leading chipsets.

Agilent Fast Device Tune supports all the major wireless technologies such as W-CDMA, GSM/GPRS/EGPRS, cdma2000 and 1xEV-DO. This application note describes the benefits of Fast Device Tune in more detail and how it is used with the Agilent 8960 wireless communications test set for fast calibration of W-CDMA phones. (A similar paper on the Fast Device Tune measurement for the E6601A is available as part number 5989-6500EN.)

Why is calibration testing so time-consuming?

Calibrating a mobile phone requires a calibrated RF source and a calibrated RF measuring receiver with certain measurement capability. Call processing is not required, as calibration is a measurement-intensive, repetitive, and iterative process that requires test program control of the phone and the test set.

As a calibrated RF source, the test set provides a precise, known level to the phone, which the phone then measures. This measurement is known as the received signal strength indication (RSSI). As a calibrated RF receiver, the test set makes critical power measurements to verify the output level of the phone meets regulatory and standards requirements, along with other modulation and spectral measurement frequently included to verify other performance parameters of the phone's transmitter, such as phase and frequency or out-of-channel emissions.

In mobile phone manufacturing, accurate calibration is imperative to ensure product quality and interoperability in operators systems. Many channels (frequencies) and levels (power levels) are involved in the testing of today's multi-band and multi-format 2G/3G mobile phones. A typical W-CDMA calibration profile, for example, measures a mobile phone across two bands (800 to 1000 MHz and 1700 to 1990 MHz) with 15 channels in each band and 20 power levels at each channel. This adds up to 600 power measurements. Another 300 receiver measurements typically are made in each band. Thus 1200 measurements in total are needed to calibrate the phone.

The traditional "set and measure" process involves setting the mobile phone to each channel and level, and then setting the test set's measuring receiver to the same channel to make the power measurement. The process is repeated on each channel until all calibration channels and levels have been measured, and the calibration correction data is stored in the mobile phone. Next the same "set and measure" process is carried out using the test set's RF source to provide calibrated levels for the mobile phone receiver's RSSI calibration. This method of W-CDMA device calibration might take over 150 seconds to complete – a long time in manufacturing terms. A large portion of this calibration time is communications overhead.

For each channel and level the mobile phone must be set via a control interface and the test set must be set via GPIB, LAN, or USB interface, depending on the test set used. The measurement data then must be read, the calibration corrections calculated, and the data stored into the mobile phone.

Reducing the number of measurements to speed up the calibration process is not always an option, however. Calibration of the transmitter output power affects maximum power, minimum power, power control, modulation quality, adjacent channel leakage, spectrum emissions, and battery life. Calibration of the receiver input level removes sources of uncertainty over the receiver's dynamic range to ensure proper operation in the wireless network, quality of reception, and accuracy. Since eliminating measurements is not always advisable, new techniques that improve the speed of the measurement process and reduce the communications overhead are needed. Agilent's Fast Device Tune measurement can reduce calibration test time by an order of magnitude; for example, from 150 to 8 seconds (in 10 ms duration/step) or 15 seconds (in 20 ms duration/step) on the aforementioned W-CDMA calibration profile.

Typical W-CDMA calibration test plan

20 power levels per channel
15 channels per frequency band
2 frequency bands

With Fast Device Tune (10 ms duration/step)

20 power levels $\rightarrow 20 \times 10 \text{ ms} = 200 \text{ ms}$
Turns between 15 channels $\rightarrow (15-1) \times 10 = 140 \text{ ms}$
15 channels $\rightarrow 15 \times 200 + 140 \text{ ms} = 3.14 \text{ s}$
2 frequency bands $\rightarrow 2 \times 3.14 \text{ s} = 6.28 \text{ s}$
Self tests, VCO tuning, verification $\rightarrow 1-2 \text{ s}$

With Fast Device Tune (20 ms duration/step)

20 power levels $\rightarrow 20 \times 20 \text{ ms} = 400 \text{ ms}$
Tunes between 15 channels $\rightarrow (15-1) \times 20 = 280 \text{ ms}$
15 channels $\rightarrow 15 \times 400 + 280 \text{ ms} = 6.28 \text{ s}$
2 frequency bands $\rightarrow 2 \times 6.28 \text{ s} = 12.56 \text{ s}$
Self tests, VCO tuning, verification $\rightarrow 1-2 \text{ s}$

Typical W-CDMA Tx/RSSI calibration test times can be reduced **from 150 seconds to 8 or 15 seconds!**

Agilent's contributions to fast calibration

- 1998 – GMSK power measurement
- 1999 – Dynamic power measurement
- 2005 – PAVT measurement
- 2006 – Fast Device Tune
- 2008 – Enhanced Fast Device Tune

Agilent has been working with manufacturers for many years to provide faster calibration techniques. In 1998, Agilent introduced the fastest Gaussian minimum shift keying (GMSK) power measurement in the industry with the ability to measure transmitted power at close to the GSM burst rate – a factor of 10 improvement over previous test sets.

The dynamic power measurement, introduced in 1999, improved the GMSK power measurement by an additional 50 percent by enabling power ramp measurements at the GSM frame rate at a single channel. Continued enhancements to the dynamic power measurement have added support for EDGE, W-CDMA, and cdma2000® 1xRTT. The dynamic power measurement requires the mobile phone to provide a predefined test mode power ramp at each calibration channel, which helps reduce the communications overhead by measuring up to several hundred power levels in a single stepped sweep per channel.

Agilent's implementation of the phase and amplitude versus time (PAvT) measurement was introduced in 2005. With PAVT manufacturers can calibrate non-linear power amplifiers to effectively produce a varying phase component – for example, an EGPRS 8PSK signal – so that they also can be used with the GMSK signal. This eliminates the need for a second power amplifier for a GSM/GPRS phone. The PAVT measurement increases the flexibility of the power measurement ramping capability and adds new phase and frequency measurements. These highly optimized measurement algorithms are typically used with a pulsed amplitude CW signal in the mobile phone's test mode. If a different signal type is needed for calibration, then an alternative method can be used in which the waveform is sampled directly and the raw polar or IQ data received is used to calculate the data needed to create the calibration factors.

Fast Device Tune is the latest and fastest in this progression of calibration test improvements, allowing the test set to make simultaneous transmitter output power level and receiver input level measurements across level and frequency in a single frequency band sweep. For chipsets that support Fast Device Tune, Agilent recommends this measurement as the fastest way to characterize power and RSSI over frequency range.

At the first introduction on April 1, 2006, Fast Device Tune (E1999A-201) could measure 20 ms duration/step for W-CDMA, cdma2000 and 1xEV-DO formats, and 577us duration/step for GSM/GPRS/EGPRS format. To further shorten calibration time, the newly introduced Enhanced Fast Device Tune (E1999A-202) also supports 10 ms duration/step for W-CDMA, cdma2000 and 1xEV-DO formats. From the aforementioned example, you can see that a typical W-CDMA Tx/RSSI calibration test time can be reduced from 150 seconds to 8 seconds (in 10 ms duration/step) or 15 seconds (in 20 ms duration/step).

Fast Device tune Measurement Overview

The Fast Device Tune measurement in the Agilent 8960 and E6601A wireless communications test sets allows the simultaneous calibration of a mobile phone's transmitter output power and receiver input level across level and frequency in a single sweep per frequency band. Fast Device Tune is a combination of the dynamic power measurement with simultaneous output level steps and frequency hopping.

The measurement is performed with the phone in a test mode. No call is established between the phone and the test set, and call processing capability in the test set is not required. The test mode, however, requires chipset support and software to cause the phone to output and receive at a series of frequencies and levels. A pre-defined series of power steps at various uplink frequencies (channels) is used to set up the test set in advance to track the power-step sequence when it is transmitted by the phone. The phone transmits this predefined series of power steps and simultaneously tunes its receiver to perform measurements (such as RSSI) of the test set's signal at various downlink frequencies and power levels.

Mobile requirements

This type of calibration must be designed into the chipset software by the chipset provider and then implemented by the phone manufacturer during the phone calibration stage. A special set of mobile phone commands and a test-mode process are required to use Fast Device Tune.

Test set requirements

Fast Device Tune is an optional feature of the Agilent 8960 Series 10 (E5515C) Wireless Communications Test Set – the test set used to test more wireless devices in production than all other wireless test sets combined. Fast Device Tune is commercially available for W-CDMA/HSPA, GSM/GPRS/EGPRS, cdma2000, and 1xEV-DO calibration testing.

The E1999A-202 Enhanced Fast Device Tune Measurement license¹ enables Fast Device Tune in all 8960 test applications that support this feature, including the E1962B cdma2000 Test Application, E1963A W-CDMA Test Application, E1966A 1xEV-DO Test Application and E1968A GSM/GPRS/EGPRS Test Application.

Lab applications for the 8960 that support Fast Device Tune do not require the E1999A-202 license; the measurement is included as part of the standard product.

The remainder of this application note focuses on the Fast Device Tune measurement for W-CDMA/HSDPA calibration testing with the 8960 series test set. Note that the solution and test techniques for cdma2000 and 1xEV-DO are similar.

¹ The E1999A-202 is a superset of the previously-released E1999A-201. It not only offers the equivalent capabilities of E1999A-201, but is also further enhanced to reduce the calibration test times for W-CDMA, cdma2000 and 1xEV-DO wireless devices with smaller step size support (10 ms step size versus 20 ms step size). There is no change for the GSM/GPRS/EGPRS calibration.

Implementation

To implement the Fast Device Tune measurement solution, a connection is made between the RF output of the mobile phone and the RF IN/OUT port of the test set. An intermediary controller (PC) running chipset calibration software is required to set up and control the Fast Device Tune measurement parameters and to control the mobile phone in transmitting its test signal waveform. Figure 2 illustrates a typical hardware configuration.

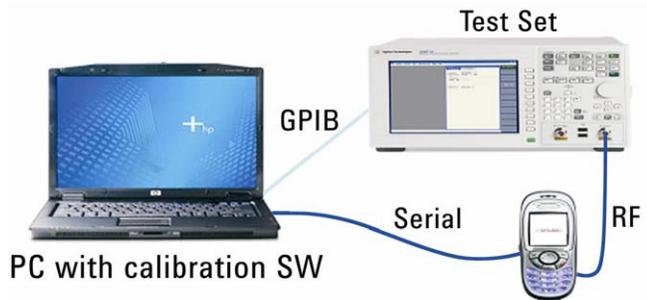


Figure 2: Diagram shows the 8960 Series 10 Wireless Communications Test Set, mobile phone, and PC controller interconnections.

Measurement description

The W-CDMA mobile phone's transmitter power sequence may include up to 400 steps, of 20 ms or 10 ms duration per step. The power step level can span the entire range of the measurement's input (from -61 to +28 dBm). The levels can step up or down, but the power level change between any two adjacent power steps should be no more than 20 dB (for 20 ms duration) and no more than 10 dB (for 10 ms duration). Note that the first step in the sequence should provide at least a 20 dB rise to trigger the measurement. The mobile phone may transmit the same power sequence at up to 20 frequencies in a single sweep with one sweep per band. The measurement allows a maximum of 400 steps (up to 20 power steps x frequency \leq 400).

Once triggered, the Fast Device Tune measurement follows the pre-defined test mode sequence of the mobile as the mobile amplitude and frequency-hops. While following the transmitted signal sequence from the mobile (MS Tx), the test set can also synchronously transmit a W-CDMA modulated downlink over a different pre-defined frequency/amplitude calibration combination, which may be used to simultaneously calibrate the mobile phone's receiver (MS Rx).

The MS Tx and MS Rx frequency/amplitude profiles are set by the user and allow up to 400 total steps each. The power measurement that is reported on each MS Tx step is compliant with the Mean Power measurement as defined in the 3GPP standard.

Putting the mobile phone into test mode allows it to transmit the predefined series of power steps at various frequencies (MS Tx frequency/power series), and, if necessary, to simultaneously tune its receiver to perform measurements of the test set's signal at various frequencies and power levels (MS Rx frequency/power series) – to determine RSSI, for example. Note that the MS Rx frequency/power series must include the same number of power steps as the MS Tx frequency/power series (maximum 20 level steps x frequencies = 400). These steps can be at any power level in the test set's RF output range (the range of -109 to -15 dBm (RF IN/OUT) or -109 to -7 dBm (RF OUT ONLY)) is specified).

Because the Fast Device Tune measurement is performed in test mode and not in a call, the MS Rx power sequence does not have to be in the same frequency band as the MS Tx power sequence. However, the number of frequencies in the MS Rx frequency sequence must match the number of frequency steps in the MS Tx frequency sequence.

Although the RF generator cannot be formally turned off during the test, the transmitter can be effectively isolated from the receiver if necessary by setting the source to the lowest power and a single frequency for all steps in the profile. The technique effectively "turns off" the RF generator.

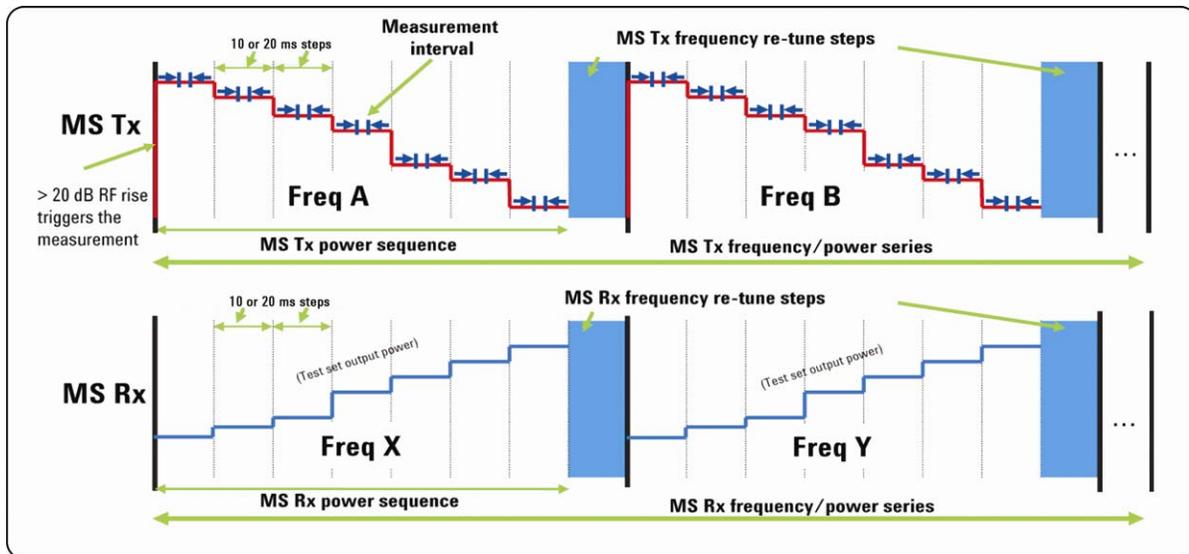


Figure 3: Example of the MS Tx and MS Rx frequency and power series for a Fast Device Tune measurement (step width = 20 or 10 ms).

Initial conditions

For the Fast Device Tune measurement, the operating mode of the 8960 test set is set to FDD and the channel type to one of the symmetrical RMCs. Power control, measurement frequency, and RF generator frequency control must all be in manual mode, and AWGN power must be off. The measurement is not supported on a faded channel.

The user must configure the MS Tx frequency/power series to match the pattern of power levels that the mobile phone will transmit, and configure the MS Rx frequency/power series to match the pattern of power levels that the mobile phone will measure.

Triggering

Recall that the mobile phone triggers the Fast Device Tune measurement with a positive change in power of at least 20 dB – that is, the mobile phone’s power must rise from 20 dB below the level of the first step in the MS Tx power sequence to within 9 dB of the level of the first step.

The test set tunes its receiver for each step according to the power levels specified by the user for the MS Tx power sequence. The mobile phone must step its power according to the MS Tx power sequence and be within ± 9 dB of the expected power level for each step. This power must be held constant for the duration of the measurement interval. After completing a measurement at each step of the MS Tx frequency/power series, the measurement returns power results for all of the measured steps.

Operating considerations

It’s important to be aware that the Fast Device Tune measurement must re-range and re-trigger for every step in the MS Tx power sequence. To ensure that this process is not interrupted by other operations, Agilent recommends that no other commands be sent to the test set or any front panel keys be pressed until the measurement has completed. No additional measurements can be run at the same time as Fast Device Tune.

Not also that Fast Device Tune supports single mode only and does not support measurement averaging. It also does not perform auto-ranging, and it supports RF rise triggering only.

Measurement parameters

The following parameters are configured during the Fast Device Tune setup process:

- Measurement timeout
- MS Tx power step start index
- MS Tx frequency step start index
- MS Rx power step start index
- MS Rx frequency start index
- Number of power steps
- Number of frequency steps
- Power step length

Fast Device Tune MS Tx and Rx parameters include the following:

- MS Tx power step levels
- MS Tx frequency step values
- MS Rx power step levels
- MS Rx frequency step values

Measurement results

Measurement results are obtained via GPIB and can be viewed on the external controller. Graphical and numerical results can also be viewed on the front panel display.

Note that the test set does not report the mobile phone's receiver measurement results. The user must capture these results for comparison with the test set's actual transmission level.

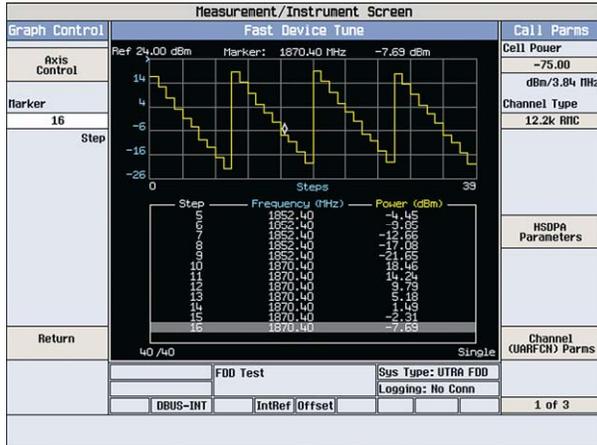


Figure 4: 8960 front panel displays graphical and numeric results.

Integrity indicator – The test set can evaluate its own performance and gauge the validity of each measurement result. A result of “Normal” indicates that the measurement suite completed successfully without error and the result is accurate.

Power – The test set performs a channel power measurement near the center of each step (6.33 ms after the start of each 20 ms step or 3.16 ms after the start of each 10 ms step), with a measurement interval of 666.7 μ s (1 timeslot) and the root raised cosine (RRC) filter off. Power, in dBm/5 MHz, is returned for each step in the MS Tx frequency/power series except for the frequency re-tune steps.

Note: Frequency re-tune steps do not show up in results, either graphically or numerically.

The total number of results returned by the measurement is always 400; first the power results for the first frequency in the MS Tx frequency sequence, then the power results for the second frequency, and so on, followed by NANs if fewer than 400 points were measured.

Troubleshooting

Problems with the Fast Device Tune measurement often are caused by setup errors. Triggering issues, over-range or under-range conditions, and certain integrity indicators are most common.

Check that the following steps have been taken to ensure proper setup:

- Mobile phone is in test mode.
- Measurement has been initiated by pressing the "start single" key if using front panel operation.
- Input signal requirements (frequency within 800 to 1000 MHz, 1400 to 1500 MHz, 1700 to 1990 MHz or 2480 to 2580 MHz range; power within -70 to +30 dBm range) are met.
- Test set has been properly calibrated for measurement.
- Number of MS Tx and MS Rx power sequence steps match; number of MS Tx and MS Rx frequency sequence frequencies match.
- Power change is at least 20 dB to trigger the measurement.
- Required initial conditions are met.
- Measurement timeout value is great enough to allow the mobile phone to transmit the MS Tx frequency/power series and for the test set to measure it.
- MS Tx power step start index plus the number of power steps and MS Rx power step start index plus the number of power steps do not exceed 40.
- Frequencies indicated by MS Tx frequency step start index and number of frequency steps are within one frequency band range; frequencies indicated by MS Rx frequency step start index and number of frequency steps are within one frequency band range.

Note that the following limitations apply to the Fast Device Tune measurement when used in the W-CDMA/HSPA application:

- Power levels are measured only in the range of -70 to +30 dBm; measurement is specified only in the range of -61 to +28 dBm.
- Frequencies are tested only within a single W-CDMA/ HSPA frequency band range, regardless of frequencies entered for MS Tx or Rx frequency step values.
- The test set transmits test power levels in the range of -115 to -13 dBm (RF IN/OUT) or -115 to -5 dBm (RF OUT ONLY); specifications are given in the range of -109 to -15 dBm (RF IN/OUT) or -109 to -7 dBm (RF OUT ONLY); amplitude offset of 0 is assumed.

Other items to verify:

- To ensure that the process of re-ranging and re-triggering is not interrupted, do not send any GPIB commands or press any front panel keys until the measurement has been completed.
- Do not run any other measurements at the same time that Fast Device Tune is running.
- Check the RF IN/OUT amplitude offsets entered, as they affect measurement results.
- Obtain measurement results via GPIB command.

Programming the Fast Device Tune Measurement

The following programming example illustrates a typical automated procedure using the command interface provided in the Fast Device Tune measurement solution.

Program flow

A procedure that can be used to make a Fast Device Tune measurement is described below and illustrated in Figure 5. Prior to executing the measurement, connect the mobile phone to the test set and put the mobile phone into a suitable test mode. Also connect the mobile phone's digital control port to a PC controller to facilitate starting the test mode.

Set up the Fast Device Tune measurement

- Set the test set's initial conditions: operating mode to FDD test; measurement frequency, power control, and RF generator frequency control all to manual mode.
- Set the MS Rx frequency/power series (3 power step levels plus 7 dummy power levels at 4 frequency points) on the test set to match the mobile phone configuration.
- Set the MS Tx frequency power series (10 power step levels at 4 frequency points) on the test set to match the mobile phone configuration.
- Set the MS power step length on the test set (20 or 10 ms. this example uses 20 ms default value) to match the mobile phone configuration.
- Verify that the mobile phone is in the proper test mode and configured to match the MS Tx/Rx frequency power series specified in the test set.
- Order the mobile phone to transmit continuously at > 20 dB below the power level of the first step in the MS Tx power series.

Initiate and fetch the Fast Device Tune measurement

- Use the INITiate:<measurement mnemonic>[:ON] command to start the measurement.
- Use the INITiate:CFDTune:ARMed? Query to determine if the measurement is armed and ready to be triggered.
- Order the mobile phone to start transmitting its MS Tx frequency/power series (the MS should then increase its output power by at least 20 dB to reach the first step in the series, which triggers the measurement with an RF rise).
- Use the FETCh:CFDTune? Commands to obtain the measurement results.

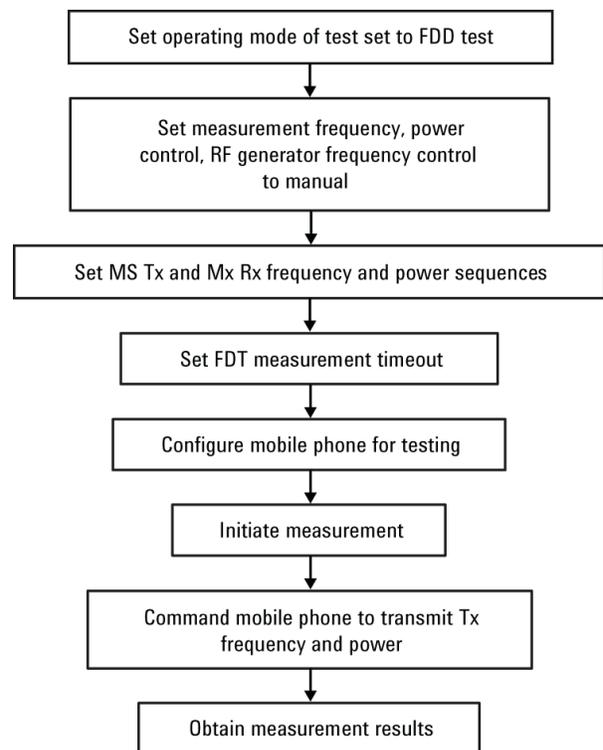


Figure 5: Example of a procedure used to make W-CDMA Fast Device Tune measurement.

Programming code

This programming example is written in Visual Basic®, which is a common choice for automating wireless test systems. Other languages, such as Visual C++ and Agilent VEE, can also be used based on the same programming principles. The example makes use of the communication capability provided by the VISA COM

drivers that are part of the Agilent IO Libraries Suite. The VISA COM library supports a wide variety of hardware and operating systems. For more information, see the IO Libraries Web page at www.agilent.com/find/iolib.

```
10 !=====
20 !
30 ! Fast Device Tune Programming Example for W-CDMA/HSDPA
40 !
50 !=====
60 !
70 !*** Initialize Program Variables ***
80 !
90 OPTION BASE 0
100 Testset=714
110 CLEAR SCREEN
120 CLEAR 7
130 CLEAR Testset
140 PRINT "**** Fast Device Tune Programming Example for W-CDMA/HSDPA****"
150 PRINT
160 !
170 !
180 !***Set up GPIB timeout***
190 ON TIMEOUT 7,32 CALL Timeout
200 ! Call "Timeout" routine after 32 seconds of GP-IB hang-up
210 !
220 !
230 !*** Variable declarations ***
240 DIM Mstx_pow$(8000)
250 ALLOCATE REAL Mstx_pow_res(0:399)
260 Sz=16*(20+19) !ASCII Arrays = 16*(20+19) elements
270 ALLOCATE Freq_rx$(Sz),Pow_rx$(Sz),Freq_tx$(Sz),Pow_tx$(Sz)
280 !
290 Op_mode$="FDDTest" !Operating mode.
300 Meas_timeout=15 !Measurement timeout.
310 !
320 Num_freq_steps=4 !Number of Rx and Tx Frequency Steps
330 Num_pow_steps=10 !Number of Rx and Tx Power Steps
340 !
350 Str_ind_freq_rx=0 !Start Index of Rx Frequency
360 Str_ind_pow_rx=0 !Start Index of Rx Power
370 !
380 Freq_rx$="1932.4E6, 1950.4E6, 1966.4E6, 1982.4E6"
390 ! MS RX Frequencies
400 Pow_rx$="-80, -60, -40, -60, -60, -60, -60, -60, -60"
410 ! MS RX Powers (last 7 values are "dummy" values)
420 !
430 Str_ind_freq_tx=0 !Start Index of Tx Frequency
440 Str_ind_pow_tx=0 !Start Index of Tx Power
450 !
460 Freq_tx$="1852.4E6, 1870.4E6, 1866.4E6, 1902.4E6"
470 ! MS TX Frequencies
480 Pow_tx$="16, 12, 8, 4, 0, -4, -8, -12, -16, -20"
490 ! MS TX Powers
500 !
510 Loss_frequency$="800E6"!Set frequencies for path loss
520 Expected_loss$="-1.5"!Set path loss at frequencies specified
530 !
540 !*****
550 !***Simple Test Executive
560 !*****
570 !
580 GOSUB Preset_test_set
590 !End any current connection and present test set
600 GOSUB Set_path_loss
610 !Set the path loss required for your test
620 GOSUB Set_init_cond
630 !Set initial conditions required for the FDT test
```

```

640 GOSUB Set_msr_x_series
650 !Set up the MS Rx Freq/Power Series
660 GOSUB Set_mst_x_series
670 !Set up the MS Tx Freq/Power Series
680 GOSUB Check_ms_config
690 !Check UE settings match what you've set on the test set
700 GOSUB Fdt_meas
710 !Make the Fast Device Tune measurement
720 GOTO End_program
730 !
740 !
750 !*****
760 ! BEGINNING OF SUBROUTINES
770 !*****
780 !
790 !
800 Preset_test_set: !
810 !*****
820 ! Subroutine: Preset the test set (Step 1: Set Up the Test Set)
830 !*****
840 !
850 OUTPUT Testset;"RST"
860 ! Full preset test set
870 RETURN
880 !
890 Set_path_loss: !
900 !*****
910 ! Subroutine: Set path loss values
920 !*****
930 !
940 OUTPUT Testset;"SYST:CORR:FREQ ";Loss_frequency$
950 ! Set the frequencies for amplitude offset
960 OUTPUT Testset;"SYST:CORR ";Expected_loss$
970 ! Set the amplitude offsets for above frequencies
980 RETURN
990 !
1000 Set_init_cond: !
1010 !*****
1020 ! Subroutine: Set initial conditions required for the FDT Test
1030 !*****
1040 !
1050 OUTPUT Testset;"CALL:OPER:MODE ";Op_mode$
1060 !Set Operating Mode
1070 OUTPUT Testset;"SET:CFDT:TIM "&VALS(Meas_timeout)
1080 !Set measurement timeout.
1090 OUTPUT Testset;"CALL:CONT:DOWN:FREQ:AUTO OFF"
1100 !Set RF generator frequency control to manual mode.
1110 OUTPUT Testset;"RFAN:CONT:MEAS:FREQ:AUTO OFF"
1120 !Set receiver measurement frequency control to manual mode.
1130 OUTPUT Testset;"RFAN:CONT:POW:AUTO OFF"
1140 !Set receiver power control to manual mode.
1150 RETURN
1160 !
1170 Set_msr_x_series: !
1180 !*****
1190 ! Subroutine: Set up the MS Rx Freq/Power Series
1200 !*****
1210 !
1220 PRINT """"Set the number of Tx/Rx Frequency and Power Steps """"
1230 OUTPUT Testset;"SET:CFDT:FREQ:STEP:COUN ";Num_freq_steps
1240 OUTPUT Testset;"SET:CFDT:POW:STEP:COUN ";Num_pow_steps
1250 PRINT "Number of Tx/Rx Frequency Steps = ";Num_freq_steps
1260 PRINT "Number of Tx/Rx Power Steps = ";Num_pow_steps
1270 PRINT
1280 PRINT """" Set MS Rx Freq/Power Series """"
1290 Stp_ind_freq_rx=Str_ind_freq_rx+Num_freq_steps
1300 ! Compute Stop Index of Frequency Steps
1310 Stp_ind_pow_rx=Str_ind_pow_rx+Num_pow_steps
1320 ! Compute Stop Index of Power Steps
1330 !

```

```

1340 ! Check for MS Rx Test Freq/Power Indices Out of Range
1350 IF (Stp_ind_freq_rx<40 AND Stp_ind_pow_rx<40) THEN
1360 ! Set MS Rx Frequency and Power Start Indices
1370 OUTPUT Testset;"SET:CFDT:MS:RX:FREQ:STEP:STAR:IND ";Str_ind_freq_rx
1380 OUTPUT Testset;"SET:CFDT:MS:RX:POW:STEP:STAR:IND ";Str_ind_pow_rx
1390 PRINT "MS Rx Test Start Freq Index = ";Str_ind_freq_rx
1400 PRINT "MS Rx Test Start Power Index = ";Str_ind_pow_rx
1410 ELSE
1420 PRINT
1430 PRINT "Error-The number of freq steps or power steps Out of Range (>40)"
1440 PRINT
1450 PRINT "Program Stopped"
1460 STOP
1470 END IF
1480 !
1490 !** Set MS Rx Freq/Power Values **
1500 OUTPUT Testset;"SET:CFDT:MS:RX:FREQ:STEP ";Freq_rx$
1510 PRINT "MS Rx Test Freq Series = ";Freq_rx$
1520 OUTPUT Testset;"SET:CFDT:MS:RX:POW:STEP ";Pow_rx$
1530 PRINT "MS Rx Test Power Series = ";Pow_rx$
1540 PRINT
1550 !
1560 RETURN
1570 !
1580 Set_mstx_series: !
1590 !*****
1600 ! Subroutine: Set up the MS Tx Freq/Power Series
1610 !*****
1620 PRINT "**** Set MS Tx Freq/Power Series ****"
1630 Stp_ind_freq_tx=Str_ind_freq_tx+Num_freq_steps
1640 ! Compute Stop Index of Frequency Steps
1650 Stp_ind_pow_tx=Str_ind_pow_tx+Num_pow_steps
1660 ! Compute Stop Index of Power Steps
1670 !
1680 ! Check for MS Tx Test Freq/Power Indices Out of Range
1690 IF (Stp_ind_freq_tx<40 AND Stp_ind_pow_tx<40) THEN
1700 ! Set MS Tx Frequency and Power Start Indices
1710 OUTPUT Testset;"SET:CFDT:MS:TX:FREQ:STEP:STAR:IND ";Str_ind_freq_tx
1720 OUTPUT Testset;"SET:CFDT:MS:TX:POW:STEP:STAR:IND ";Str_ind_pow_tx
1730 PRINT "MS Tx Test Start Freq Index =";Str_ind_freq_tx
1740 PRINT "MS Tx Test Start Power Index =";Str_ind_pow_tx
1750 ELSE
1760 PRINT
1770 PRINT "Error-The number of freq steps or power steps Out of Range (>40)"
1780 PRINT
1790 PRINT "Program Stopped"
1800 STOP
1810 END IF
1820 !
1830 !** Set MS Tx Freq/Power Values **
1840 !
1850 OUTPUT Testset;"SET:CFDT:MS:TX:FREQ:STEP ";Freq_tx$
1860 PRINT "MS Tx Test Freq Series =";Freq_tx$
1870 OUTPUT Testset;"SET:CFDT:MS:TX:POW:STEP ";Pow_tx$
1880 PRINT "MS Tx Test Power Series =";Pow_tx$
1890 PRINT
1900 !
1910 RETURN
1920 !
1930 Check_ms_config: !
1940 !*****
1950 ! Subroutine: Check UE's Configuration Matches Test Set's
1960 !*****
1970 PRINT "***** NOTE *****"
1980 PRINT "Make sure that your UE is placed into test mode, and is properly"
1990 PRINT "configured to measure the MS RX Freq/Power series and transmit"
2000 PRINT "the MS Tx Freq/Power series you've set in the test set."
2010 PRINT
2020 PRINT "Order your UE to transmit continuously at >20 dB below the power level"
2030 PRINT "of the first step in MS Tx Power Series"
2040 PRINT "*****"
2050 PRINT
2060 LINPUT "Press ENTER when finished",Keyboard$

```

```

2070 RETURN
2080 !
2090 Fdt_meas: !
2100 !*****
2110 ! Subroutine: Perform FDT Measurement
2120 !*****
2130 !
2140 OUTPUT Testset;"INIT:CFDT:
2150 !Arm the FDT measurement and start to build the MS Tx and Rx Freq/Power Series.
2160 OUTPUT Testset;"INIT:CFDT:ARMed?"
2170 !Queries that the MS Tx and Rx Freq/Power Series is successfully built
2180 !and the test set is ready for test.
2190 ENTER Testset;Meas_arm
2200 IF Mesa_arm THEN
2210 PRINT "Command the UE to trigger the measurement (20 dB RF rise)..."
2220 PRINT
2230 !
2240 !**Obtain measurement results**
2250 OUTPUT Testset;"FETC:CFDT?"
2260 ENTER Testset;Integrity,Freq_step_cnt,Pow_step_cnt,Num_meas,Mstx_pow$
2270 !
2280 ELSE
2290 PRINT "The test set is not properly armed. Please check the MS Tx and"
2300 PRINT "Rx Freq/Power Series Setups."
2310 GOTO End_program
2320 END IF
2330 !
2340 PRINT "**** Print MS Tx Measurement Results ****"
2350 PRINT
2360 PRINT "Integrity = ";Integrity
2370 PRINT "Number of Freq Steps = ";Freq_step_cnt
2380 PRINT "Number of Power Steps = ";Pow_step_cnt
2390 PRINT "total Number of Meas Results = ";Num_meas
2400 PRINT
2410 !
2420 !Convert ASCII Array to Real Array
2430 FOR N=1 TO Num_meas
2440 Dynamic_mkr=((N-1)*17)
2450 !Set up a marker that will jump to each comma in the ascii string
2460 Mstx_pow_res(N)=VAL(Mstx_pow$(Dynamic_mkr+1,Dynamic_mkr+16))
2470 !Convert ascii to a numeric value
2480 NEXT N
2490 !
2500 ! PRINT "MS Tx Power Results:"
2510 PRINT "Freq Step # Power Step # Meas Power [dBm/5 MHz]"
2520 PRINT
2530 FOR N_freq=0 TO Freq_step_cnt-1
2540 FOR N_pow=0 TO Pow_step_cnt-1
2550 PRINT N_freq+1," ",N_pow+1," ",Mstx_pow_res(N_freq*Pow_step_cnt+N_pow+1)
2560 NEXT N_pow
2570 PRINT
2580 PRINT N_freq
2590 !
2600 RETURN
2610 !
2620 End_program: !
2630 !*****
2640 ! Subroutine: End of all testing clean up
2650 !*****
2660 !
2670 OUTPUT Testset;"RST"
2680 !Full preset test set
2690 DEALLOCATE Mstx_pow_res(*),Freq_rx$,Pow_rx$,Freq_tx$,Pow_tx$
2700 PRINT
2710 PRINT "End of Program"
2720 END
2730 !

```

```
2740 !*****
2750 ! SUB-PROGRAM SECTION
2760 !*****
2770 !
2780 Timeout: SUB Timeout ! Global timeout handler
2790 PRINT
2800 PRINT "Program timed out, check setup"
2810 CLEAR 7
2820 CLEAR Testset
2830 STOP
2840 SUBEND
2850 !
2860 !
```

Programming Example Results

This program returns the following results:

- Fast Device Tune integrity indicator
- Number of frequency steps
- Number of power steps at each frequency
- Number of MS Tx power steps measured
- MS Tx power results

Figure 6 shows a sample output generated by the programming example.

```
*** Fast Device Tune Programming Example for W-CDMA/HSDPA***

*** Set the number of Tx/Rx Frequency and Power Steps ***
Number of Tx/Rx Frequency Steps = 4
Number of Tx/Rx Power Steps = 10

*** Set HS Rx Freq/Power Series ***
HS Rx Test Start Freq Index = 0
HS Rx Test Start Power Index = 0
HS Rx Test Freq Series = 1932.4E6, 1950.4E6, 1966.4E6, 1982.4E6
HS Rx Test Power Series = -80, -60, -40, -60, -60, -60, -60, -60, -60, -60

*** Set HS Tx Freq/Power Series ***
HS Tx Test Start Freq Index = 0
HS Tx Test Start Power Index = 0
HS Tx Test Freq Series = 1852.4E6, 1870.4E6, 1886.4E6, 1902.4E6
HS Tx Test Power Series = 16, 12, 8, 4, 0, -4, -8, -12, -16, -20

***** NOTE *****
Make sure that your UE is placed into a test mode, and is properly
configured to measure the HS RX Freq/Power series and transmit
the HS TX Freq/Power series you've set in the test set.

Order your UE to transmit continuously at >20 dB below the power level
of the first step in HS Tx Power Series
*****

Command the UE to trigger the measurement (20 dB RF rise)...

*** Print HS Tx Measurement Results ***

Integrity = 0
Number of Freq Steps = 4
Number of Power Steps = 10
Total Number of Meas Results = 40

3          1          18.24912
3          2          14.11261
3          3          9.657504
3          4          5.039826
3          5          1.382568
3          6          -2.420129
3          7          -7.774743
3          8          -10.6108
3          9          -15.0158
3         10          -19.58286

4          1          17.55658
4          2          13.47682
4          3          9.099032
4          4          4.505765
4          5          .9050926
4          6          -2.883015
4          7          -8.155545
4          8          -10.97964
4          9          -15.38637
4         10          -19.96578
```

Figure 6: Sample output of W-CDMA Fast Device Tune measurement.

Conclusion

Compared to “traditional” calibration measurement techniques, the Fast Device Tune measurement (E1999A-202 option¹) on the Agilent 8960 improves Tx power and Rx RSSI test time during the calibration of a mobile phone by up to an order of magnitude. Agilent has been working with chipset manufacturers to ensure test mode support of Fast Device Tune for all leading chipsets so that more users can take advantage of this major improvement to wireless test.

¹ The E1999A-202 is a superset of the previously-released E1999A-201. It not only offers the equivalent capabilities of E1999A-201, but is also further enhanced to reduce the calibration test times for W-CDMA, cdma2000 and 1xEV-DO wireless devices with smaller step size support (10 ms step size versus 20 ms step size). There is no change for the GSM/GPRS/EGPRS calibration.

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