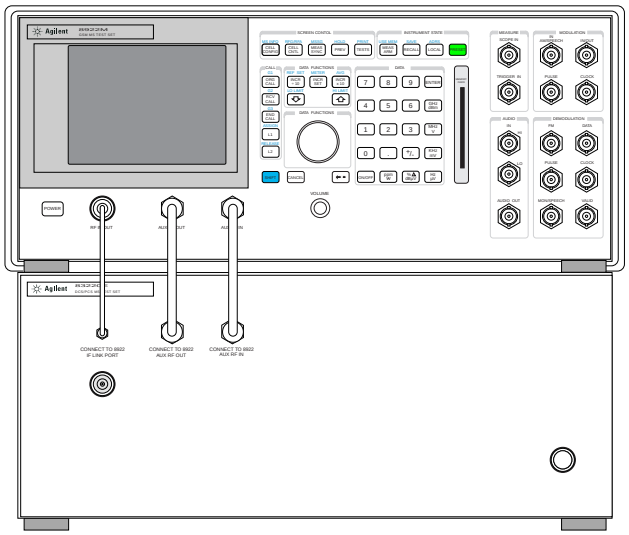
Agilent Technologies 8960 Series 10 Wireless Communications Test Set

Product Note

Converting Mobile-Phone Production Lines from the Agilent Technologies 8922 Test Set to the 8960 Series 10 Test Set

Agilent Technologies 8922M GSM MS Test Set with Agilent Technologies 83220E DCS/PCS MS Test Set



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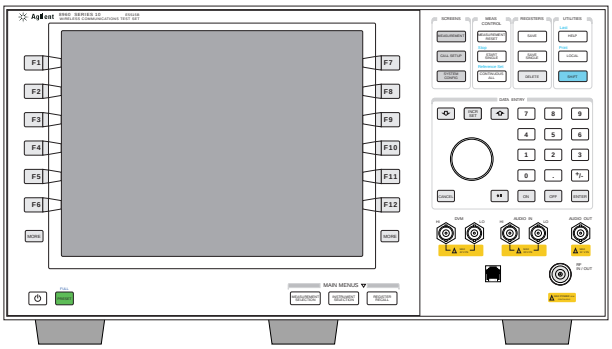

Introduction

This document is intended to provide information on migrating from the Agilent Technologies 8922 to the Agilent Technologies 8960 Series 10 wireless communications test set. It provides business analysis, programming and performance features of the 8922 and the 8960 test sets. The intended audience is mobile-phone test engineers and managers.

Because the 8960 increases throughput, has excellent measurement accuracy, and is easily upgradable to wireless formats, it is highly desirable to convert production lines from the 8922 test set to the 8960 test set.

The 8922 was the first GSM test set introduced to the mobile-phone market several years ago. Over the years, it has satisfied the needs of GSM customers around the world. The 8922 is still “the test set of choice” in the manufacture of state-of-the-art GSM phones.

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Innovating the HP Way

The 8960 Series 10 is one of the fastest test sets available today. The test set's speed is intrinsic to its architecture. Inside the 8960, there are three fast processors, multiple RF sources, and multiple RF and downlink analyzers (see Figure 1).

The flexible architecture of the 8960 uses Agilent Technologies' Reduced Instruction Parallel Processing (RIPP) technology. One of the key benefits of the RIPP architecture is measurement concurrency, that is, simultaneous processing of transmitter and receiver measurements, without additional time penalties. The 8960 makes each individual 8922 measurement faster by a factor of 10 to 30 times.

The 8960 is being introduced with the GSM test application, and is capable of running test applications in other phone formats. Shown in Figure 1 are generic block diagrams of the 8922 and the 8960.

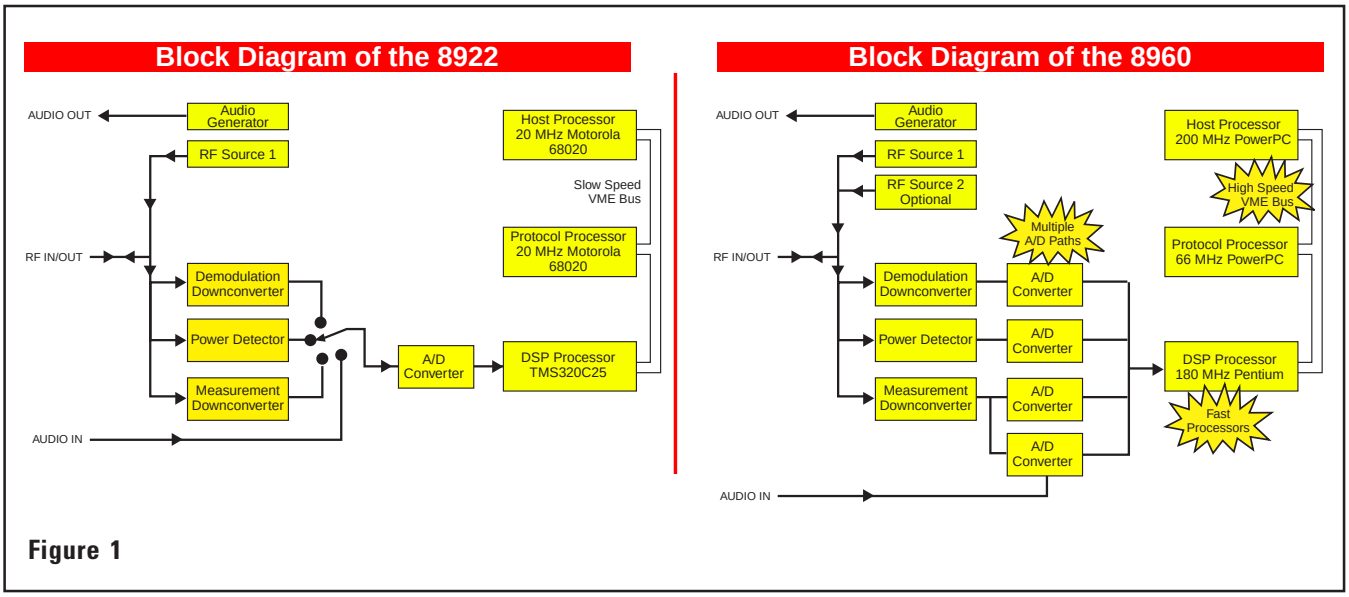

Figure 1

The 8922 has DSP (TMS320C25), and host and protocol processors (20 MHz Motorola 68020). The 8922 has switchable paths for making measurements (measurement downconverter) and maintaining the link (demodulation downconverter).

The 8960 has DSP (180 MHz Pentium®), host (200 MHz PowerPC), and protocol (66 MHz PowerPC) processors. The 8960 has separate paths for making measurements (using the measurement downcoverter and power detector) and maintaining the link (using demodulation downconverter). The separate paths allow fast measurement execution while simultaneously maintaining the link.

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Business Case

The Agilent 8960 Series 10 radio-test speed provides mobile-phone manufacturers with an opportunity to improve their financial performance. Let's consider two simplified scenarios:

A. A manufacturer who wants to increase current phone throughput

B. A manufacturer who wants to reduce the current test equipment on the production line, while maintaining current phone throughput

In scenario A, the manufacturer wants to increase the phone throughput in the same manufacturing space by re-engineering a line. If test time is a throughput limitation, replacing all existing 8922 test sets with 8960 test sets will at least double the phone production (at final test stations). This is because the production line with 8960 test sets removes any final test bottleneck experienced previously. Total phones manufactured will increase, and the costs associated with the operation of the entire line will be spread over more phones, ultimately lowering cost-per-phone and driving manufacturing profits up.

In scenario B, the manufacturer wants to free up a significant amount of manufacturing space. Replacing the current number of 8922 test sets with half as many 8960s will bring in at least 50% savings in equipment while still maintaining the current phone throughput experienced in the 8922 line. For example, applying this strategy to every phone line in a plant with 10 manufacturing lines may yield enough floor space to add an entire new line. The manufacturer has increased total production capacity by 10%, reduced the cost of maintaining each line with less test equipment, and increased revenue for the plant.

The potential financial benefits of either action are clear. Since manufacturing space is costly to create and operate, manufacturers are always looking for ways to minimize the space needed to produce phones. Both scenarios highlight the 8960's ability to provide improvements in productivity to mobile-phone manufacturers.

Software Case

Because the 8960 Series 10 is a next generation design, software written for the 8922 is not forward compatible with the 8960. This is a blessing in disguise, as programming and maintaining the 8960 code is much easier and faster. Further, the 8960 has high-level measurement features which remove the burden of measurement complexity from the user. As a result, the 8960 programmer does not have to worry about all of the technical details of the measurements.

The Reduced Instruction Parallel Processing (RIPP) technology in the 8960 allows the previous 8922 programs to be reduced into a few lines (see the example programs on the following page). The traditional subroutines in programs for the 8922 are now single-line syntaxes for the 8960. In addition, the 8960 returns multiple results including various statistical parameters related to the measurement in response to a single query command.

Measurement concurrency will allow you to start and perform transmitter and receiver measurements simultaneously, and retrieve the results as measurements finish. This results in significant time savings. To include this feature, it is expedient to rewrite the software to fully exploit the power of the 8960. This may also involve modifying your factory software routines for archiving measurement results.

While measurement concurrency is very desirable, there may be a need to make measurements in a sequential fashion, like the 8922, using the 8960's sequential measurement feature. The sequential measurement feature of the 8960 can be utilized in quickly converting an 8922 production line to the 8960, and later adding measurement concurrency.

The following are guidelines for converting 8922 software to 8960 software:

1) Start development for a completely new software driver using measurement concurrency. This will give you the optimum speed advantage. This may involve modifying your current routines for archiving test results in your factory database.

2) While the optimum driver is being developed, replace your existing 8922 software, test by test, using the sequential measurement feature of the 8960. Each test will run 10 to 30 times faster. This is an interim solution until the software driver specified in (1) is ready.

Shown on page 5 are 8960 and 8922 example programs for making single-burst phase/frequency error and transmit power measurements. The program for the 8960 takes less than 5 milliseconds to run, and gives you results for transmit power and phase/frequency error measurements, while an equivalent program written for the 8922 takes about 1.35 seconds.

The 8960 provides a measurement integrity indicator (a value indicating conditions evaluated surrounding a measurement) and statistical results without any time penalty. The 8922 does not provide an integrity indicator, and it requires additional time and code for any statistical result. The 8960 code does not require any "wait" or "screen switching" statements, as the remote user interface of the 8960 is independent from the manual user interface.

8960 Code

```
10   OUTPUT 714;"SET:TXP:CONTINOUS OFF"                !TXP MEAS. SINGLE
20   OUTPUT 714;"SET:PFER:CONTINOUS OFF"               !PFER MEAS. SINGLE
30   Time1=TIMEDATE                                    !START TIMER
40   OUTPUT 714;"INIT:TXP;PFER"                        !START TXP AND PFER
50   OUTPUT 714;"FETCH:TXP?;PFER?"                     !FETCH THE RESULTS
60   ENTER 714;I1,Power,I2,Rms_ph_max,Peak_ph_max,Freq_worst
                                                       !LINE 60 ENTERS INTEGRITY FOR
                                                       TXP, AVG. POWER, INTEGRITY
                                                       FOR PFER, RMS PHASE, PEAK
                                                       PHASE AND WORST FREQ ERROR
70  PRINT "RESULTS=";I1,Power,I2,Rms_ph_max,Peak_ph_max,Freq_worst
                                                       !LINE 70 PRINTS ALL THE
                                                       RESULTS OBTAINED IN LINE 60
80   PRINT "TIME=";TIMEDATE-Time1                      !PRINT MEAS. TIME
90   END
```

☐ = Comparison Code

8922 Code

```
10   OUTPUT 714;"MEAS:DSP:PHASE:MBURST 'ON'"           !PFER MEAS SETUP
20   OUTPUT 714;"MEAS:DSP:PHASE:MBURST:COUNT 1"        !PFER MEAS SETUP
30   OUTPUT 714;"TRIG:MODE 'Single'"                   !MEAS. MODE SINGLE
40   Start_time=TIMEDATE                               !START TIMER
50   OUTPUT 714;"DISP:DSP:VIEW 'PHASEMAIN'"            !DISPLAY DSP SCREEN WITH PFER
     MEAS.
60   OUTPUT 714;"TRIG:AST 'ARM'"                       !START THE MEAS.
70   OUTPUT 714;"MEAS:DSP:AMPL:PTCP?"                  !QUERY POWER MEAS.
80   ENTER 714;Power                                   !ENTER POWER MEAS.
90   OUTPUT 714;"MEAS:DSP:PHASE:PEAK:MBUR:MAX?"        !QUERY PEAK PHASE
100  ENTER 714;Pk_ph_max                               !ENTER PEAK PHASE
110  OUTPUT 714;"MEAS:DSP:PHASE:RMS:MBUR:MAX?"         !QUERY RMS PHASE
120  ENTER 714;Rms_ph_max                              !ENTER RMS PHASE
130  OUTPUT 714;"MEAS:DSP:PHASE:FREQ:MBUR:MAX?"        !QUERY FREQ. ERROR
140  ENTER 714;Freq_err_max  !ENTER FREQ. ERROR
150  PRINT Power,Pk_ph_max,Rms_ph_max,Freq_max         !PRINT RESULTS
160  PRINT TIMEDATE-Start_time                         !PRINT MEAS. TIME
170  END
```

☐ = Comparison Code

Conclusion

It is easy to convert the production line from the 8922 to the 8960 Series 10. The 8960 is fast and allows measurement concurrency. As a result, it provides an increase in phone production, throughput, and floor space savings. In addition, it provides easy and fast programming that requires less code to make measurements.

Performance Case

The performance of 8960 and 8922 are compared in the following tables.

Call Control Capabilities and GSM Functionality

FUNCTION NAME	8960	8922	COMMENT
MS origination	Yes	Yes	The 8960 uses immediate channel assignment, which is a fast way to bring up a call. 8922 can use immediate assignment, if the right BCH configuration is used.
BS origination	Yes	Yes	The 8960 uses immediate channel assignment, which is a fast way to bring up a call. 8922 can use immediate assignment, if the right BCH configuration is used.
MS camp-on	Yes	Yes	
MS release	Yes	Yes	
BS release	Yes	Yes	
Channel assignment	Yes	Yes	
Interband channel assignment	Yes (0.5 s)	Yes (3.7 s)	The interband channel assignment is significantly faster in the 8960 because of its hardware.
Handover	Yes	Yes	In the 8960 interband channel assignment is used instead of interband handover.
Interband handover	No	Yes	In the 8960 handover channel assignment is used instead of interband handover.
SAACH reports	Yes, for 1 cell	Yes, for 6 cells	
Power level change	Yes, on FACCH (default)	Yes, on SACCH (default)	In the 8960 power level change is very fast as it happens over FACCH, and not SACCH.
Timing advance change	Yes, on FACCH (default)	Yes, on SACCH (default)	In the 8960 timing advance change is very fast as it happens over FACCH, and not SACCH.
Frequency bands support	P-GSM (GSM900), E-GSM, DCS, PCS	GSM900, E-GSM, DCS, PCS	
MS power output level control	0-19 P-GSM 0-31 E-GSM 0-31 DCS 0-31 PCS	0-19 GSM900 1-19 E-GSM 2-15 DCS 0-15, 30, 31 PCS	
BCH configuration	BCCH + CCCH+ SDCCH/4	BCCH + CCCH+ SDCCH/4; BCCH + CCCH	
Traffic channel	TCH/FS	TCH/FS	
Hopping traffic channel	No	Yes	
Flexible control of ARFCN and burst type	Yes	Yes	
Flexible control of time slot	3, 4, 5	2, 3, 4, 5, 6	
Audio speech echo	1 second fixed delay	User settable 0 to 5 seconds delay	
Speech CODEC	No	Yes, full rate speech	

RF Measurements

IMPORTANT MEASUREMENTS	8960	8922	COMMENT
Transmit power (peak and CW)	Yes, approx. 11 ms per burst No “Power zero” calibration required	Yes, 30 to 500 ms per burst “Power zero” calibration required	The 8960 returns integrity indicator and statistical results without any time penalties.
Tx phase and frequency error	Yes, approx. 35 ms per burst No graphics available	Yes, 500 ms per burst Phase error graphics available	The 8960 returns integrity indicator and statistical results without any time penalties.
Output RF spectrum (ORFS) due to modulation	Yes, approx. 215 ms (2 modulation offsets and 4 switching offsets) 5-pole filter No reference measurement required	Yes, 1000 ms/burst/offset 3-pole filter Reference measurement required	The 8960 returns integrity indicator and statistical results without any time penalties. The 8960 provides two measurements per burst (patent pending).
ORFS (Tx RF spectrum) due to switching	Yes, approx. 215 ms (2 modulation offsets and 4 switching offsets) No reference measurement required	Yes, 1000 ms/burst/offset Reference measurement required	The 8960 returns integrity indicator and statistical results without any time penalties.
Power vs. time (Tx amplitude envelope)	Yes, approx. 55 ms per burst PVT graphics not available No “Power zero” calibration required A “Pass result is returned if the entire burst falls within the ETSI mask, otherwise a “Fail” result is returned. Mask limits are preprogrammed, and the limits are for phase II phones only.	Yes, 500 ms per burst. “Power zero” calibration required. A “Pass result is returned if the 12 user-specified offsets for the burst fall within the user programmed mask limits at the user specified offsets, otherwise a “Fail” result is returned. Mask limits are NOT preprogrammed. Mask limits can be specified for phase 1 and phase II phones.	The 8960 returns integrity indicator and statistical results without any time penalties. The dynamic range for this measurement is >74 dB for the 8960 vs 30 dB for the 8922.
Burst timing	Yes, returned every 500 ms	Yes, 500 ms per burst	
Normal BER	Yes	Yes	In the 8960 measurement setup time and functionality is smaller, and user must set loopback type.
Fast BER (burst by burst)	Yes Measurement setup time: 200 ms Measurement time: 1000 to 999,000 bits	Yes Measurement setup time: 1000 ms Measurement time: 10,000 to 50,000 bits (fixed)	Fast BER is 5 times faster than normal BER.
IQ tuning	Yes	Yes with spectrum analyzer option	

Audio Measurements

AUDIO MEASUREMENT SPECIFICATIONS	8960	8922	COMMENT
Baseband audio source	Yes	Yes	
Downlink speech (digital audio) source	Yes	Yes (more flexible)	
Analog audio voltage measurement	Yes, 10 mV to 20 V rms (0.2 to 8 kHz)	Yes, 0 V to 30 V rms (20 Hz to 15 kHz)	The 8960 returns integrity indicator and statistical results without any time penalties.
Uplink speech (digital audio) level measurement	Yes (0.2 to 3.6 kHz, calibrated)	No	The 8960 returns integrity indicator and statistical results without any time penalties.
Frequency measurement	No	Yes, 20 Hz to 400 kHz	
DC voltage measurement	No	Yes, 100 mV to 42 V	
Distortion measurement	No	Yes, 0.1% to 100%	

Test Mode Functionality

FUNCTION/MEASUREMENT	8960	8922
Test modes	BCH, BCH + TCH, CW	BCH, BCH, + TCH, CW
Tunable frequency/channel	On-channel (downlink); on-channel and between channels (uplink)	On-channel (downlink); on-channel and between channels (uplink)
Available trigger types	Amplitude (RF) rise, immediate, protocol	Amplitude (RF) rise, immediate, protocol, external trigger
Available measurements	All available measurements	All available measurements
Manual user interface	Yes	Yes
Remote user interface	Yes	Yes
RACH measurements	Yes	Yes

Important RF Specifications

SPECIFICATION	8960	8922
RF IN/OUT frequency	810 to 960, 1700 to 1990 MHz	880 to 960, 1710 to 1990 MHz NOTE: 8922 RF sig. gen. does not cover the DCS 1800 uplink frequency band (1710 to 1785 MHz) when Agilent 83220 is connected.
RF output level	–13 to –110 dBm	–14 to –127 dBm (880-960 MHz) –19 to –127 dBm (1805-1990 MHz)
Typical SWR	1.2:1 (810 to 960 MHz) 1.22:1 (1.7 to 1.99 GHz)	1.5:1 (old 8922, without the 83220) 1.25:1 (8922 with 83220 GSM/EGSM) 1.3:1 (8922 with 83220 DCS/PCS)
GSM signal phase error	<±4° peak, <1° rms	<±4° peak, <1° rms
GSM signal frequency error	<±0.02 ppm + timebase ref.	<0.02 ppm + timebase ref. (880 to 960 MHz) <0.01 ppm + timebase ref. (1880 to 1990 MHz)
GSM signal amplitude flatness	<±0.3 dB across useful part of burst	±0.25 dB peak
Power measurement accuracy	<±0.36 dB (810 to 960 MHz, ≥+4 to +43 dBm) <±0.44 dB (810 to 960 MHz, –20 to <+4 dBm) <±0.48 dB (1.7 to 1.99 GHz, –20 to +43 dBm)	±0.7 dB ± noise (880 to 960 MHz) ±0.6 dB ± noise (1710 to 1880 MHz)
Sensitivity for specified accuracy, for power measurement	≥–20 dBm	+4 to +41 dBm (880 to 960 MHz) 0 to +32 dBm (1710 to 1880 MHz)

Programming Features, Remote User Interface (RUI)

FEATURE	8960	8922	COMMENT
Synchronization commands	Yes, many types of commands are available to synchronize the mobile phone, external controller, and the 8960.	No	No “hard” wait statements required when programming the 8960.
RUI/MUI linkage	No, MUI and RUI are independent of each other, so programming the 8960 is very easy.	Yes, RUI and MUI are tightly coupled, so the 8922 programming is not as easy.	No “display screen” statements required when programming the 8960.
GPIB syntax debugger	Yes, the 8960 has a very intuitive syntax message describing the error and pointing to the error at the exact place in the command. Error messages are accessible over the RUI.	No, a general error message appears on the screen. Error messages are NOT accessible over the RUI.	
GPIB syntax software tool	Yes on the CD-ROM manual	No	The syntax tool is handy in viewing GPIB commands of the 8960.

Features of the 8960 and 8922

FEATURE	8960	8922	COMMENT
Display	Color flat panel display (26 cm diagonally)	Monochrome picture tube (15 cm diagonally)	You will love the large display size of the 8960.
Built-in software controller, and automatic test software.	No	IBASIC micro-controller, and the Agilent 83212C as GSM automatic test software	
Spectrum analyzer	No	Yes, available as an option	
Printer port	No	Yes, RS-232, parallel, and GPIB	
Oscilloscope	No	Yes, low frequency oscilloscope	
Weight	27 kg	48.8 kg including the 83220	
Remote programming	Yes, GPIB (IEEE 488.2)	Yes, GPIB (IEEE 488.2)	The 8922 and the 8960 have different GPIB command sets.
Video output	Yes, VGA port on the rear panel	Yes, PAL CVBS port on the rear panel	The VGA port of the 8969 is very handy for connecting PC monitors and video projectors.
Multi-band system configuration	Yes, completely integrated	Yes, but a separate 83220 adapter is required	
Rack mountable (and approximate size)	Yes, 70H x 405W x 600D mm	Yes, 310H x 426W x 574D mm for the 8922 and the 83220	
RF IN/OUT connector	Yes, N-type	Yes, N-type	
Auxiliary RF OUT and RF IN connectors	No	Yes, on some models	The 8922 is connected to the 83220 using this connector.
Autoranging	No	No	The 8960 always returns a measurement value even when the input signal is outside the specified range. The 8960's accuracy is better than the 8922's inside and outside the specified range.
Documentation	Yes, CD-ROM and Web (paper printed manual available as an option)	Yes, paper printed manual	
Programming classroom training (optional)	Yes, pay per class or student	No	

For more product information visit our web site at:
http://www.agilent.com/find/8960support/

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