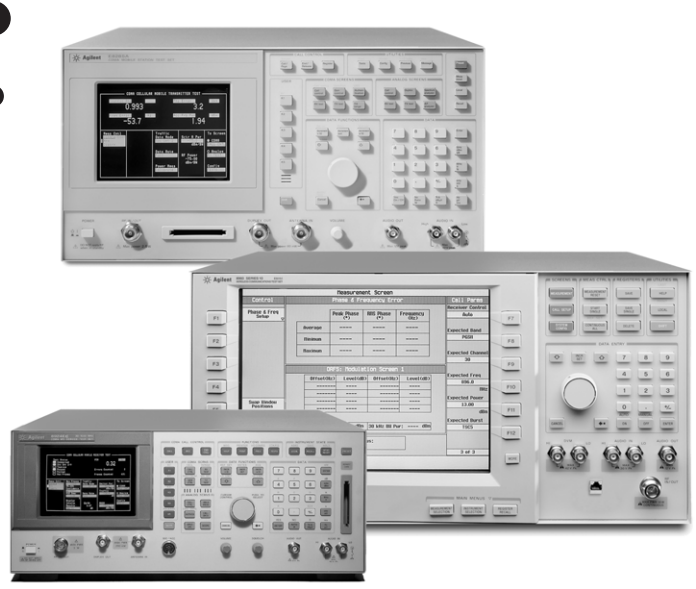
Agilent Comparison of Agilent Technologies IS-95/IS-2000 Test Sets

Product Note



Agilent Technologies

This document compares the features and performance of previously available CDMA test sets from Agilent Technologies and the new E5515C/E1962B test set. In general, the existing products cover the IS-95 CDMA standard with a wealth of features, while the E5515C/E1962B provides IS-2000 coverage with a more limited feature set combined with numerous performance enhancements. Items in *italics* indicate typical parameters for room temperature operation and do not include delta environmental effects or measurement uncertainty. Shaded boxes indicate that this is an advantage either in its functionality of performance.

Item	8924C	E8285A	E5515C
AMPS support	Yes	Yes	Summer 2001
IS-95 support	Yes	Yes	Summer 2001
IS-2000 RC1/RC2 support	No	No	Yes
IS-2000 RC3/4/5 support	No	No	Yes
Firmware upgradeable call processing hardware	No	No	Yes
Base originated SMS	Yes	Yes	No
Authentication	Yes	Yes	No
Query mobile capability function	No	No	Yes
Pilot, sync, paging, traffic, OCNS channels	Yes	Yes	Yes
F-FCH support	No	No	Yes
Quick paging channel	No	No	Yes
F-SCH support	No	No	Yes – test mode now, SO32 Summer 2001
Digitally generated AWGN	Yes	Yes	Yes
Second sector/ softer HO	Yes	Yes	No
Traffic/FCH service option support	1, 2, 3, 6, 9, 14, and 32768	1, 2, 3, 6, 9, 14, and 32768	1, 2, 3, 9, 17, 55, and 32768
Specified max cell Power at RF in/out port	–20 dBm/ 1.23 MHz	–20 dBm/ 1.23 MHz	–13 dBm/ 1.23 MHz
Specified RF level accuracy < 1000 MHz	±1.5 dB	±1.25 dB	±1.25 dB
Specified RF level accuracy > 1000 MHz	±2.0 dB with 83236B	±1.35 dB	±1.35 dB

Item	8924C	E8285A	E5515C
Typical RF level accuracy	*±1.0 dB*	*±1.0 dB*	*±0.62 dB*
Output VSWR < 2000 MHz	*<2.0:1*	*<1.5:1*	<1.2:1
Electronic attenuator	Yes < 1000 MHz	Yes	Yes
Duplex output port	Yes	Yes	Summer 2001
Code channel calibration required (PCB Cal)	Yes	No	No
Band class 0 support	Yes	Yes	Yes
Band class 1 support	Yes with 83236B	Yes	Yes
Band class 2 support	Yes	Yes	No
Band class 3 support	Yes	Yes	Yes
Band class 4 support	Yes with 83236B	Yes	Yes
Band class 5 support	No	No	Yes
Band class 6 support	No	No	Yes
Band class 9 support	No	No	Summer 2001
Hardware ready for new frequency bands	No	No	Yes
Independently tunable measurement receiver	No	No	Yes
Average power measurement accuracy at 800 MHz	±7.5%	±7.5%	±6.2%
Typical average power measurement accuracy	*±5.0%*	*±5.0 0%*	*±3.0%*
Average power measurement speed	500 ms	500 ms	<190 ms
Channel power specified measurement accuracy	N/A	N/A	±1 dB
Channel power typical measurement accuracy	*±1.5 dB*	*±1.2 dB*	*±0.5 dB*
Channel power minimum specified level	–50 dBm/ 1.23 MHz	–50 dBm/ 1.23 MHz	–61 dBm/ 1.23 MHz
Channel power typical noise floor	*–60 dBm/ 1.23 MHz*	*–62 dBm/ 1.23 MHz*	*–80 dBm/ 1.23 MHz*
10 ms channel power measurement speed	*200 ms*	*200 ms*	*67 ms*

Item	8924C	E8285A	E5515C
1.25 ms channel power measurement speed	*100 ms*	*100 ms*	*21 ms*
Channel power calibration time (all bands)	*660 seconds*	*240 seconds*	*120 seconds*
External cable required for channel power calibration	Yes	No	No
Access probe power measurements	Yes	Yes	Yes
Access probe power measurement range	–55 to +34 dBm	–55 to +34 dBm	–54 to +30 dBm
Modulation quality measurement input level	–20 to +34 dBm	–20 to +34 dBm	–25 to +30 dBm
Typical modulation quality minimum input level	*–25 dBm*	*–25 dBm*	*–50 dBm*
Modulation quality measurement speed	*666 ms*	*666 ms*	*261 ms*
Alias and image protected TX measurements	No	No	Yes
Graphical code domain power measurement	No	No	Yes
Code channel time and phase error measurement	No	No	Summer 2001
Graphical gated power measurement	Yes	Yes	Summer 2001
Graphical time response of open loop power	Yes	Yes	Summer 2001
One button min/max power measurement	Yes	Yes	No – uses power measurements
CDMA spectrum monitor	Yes	Yes	No
Independent demod and measurement receivers	No	No	Yes
FER test with confidence limits	Yes	Yes	Yes
Minimum specified level for FER measurements	*Typically –50 dBm*	*Typically –50 dBm*	–65 dBm
Residual FER at specified minimum level	No	No	Yes, $<1 \times 10^{-6}$

Item	8924C	E8285A	E5515C
Mobile reported FER	Yes	Yes	No
IBASIC controller	Yes	Yes	No
CDMA test software	83217A IBASIC	83217A IBASIC	E1990A PC
Color display	No	No	Yes
Multi-format	AMPS, IS-95	AMPS, IS-95	GSM, AMPS, IS-136, GPRS, IS-2000, IS-95 in Summer 2001
Firmware upgrade method	PCMCIA	PCMCIA	LAN
Old firmware stored in instrument	No	No	Yes, on internal hard drive

While the E5515C does not currently have all of the features of Agilent's earlier CDMA test sets, its performance and flexibility make it a clear choice for mobile manufacturing and R&D applications.

cdma2000 Support

The E5515C hardware platform, combined with the E1962B cdma2000 test application, provides the first commercially-available test solution for cdma2000 mobiles. Support for IS-95 and AMPS testing will be added to the E1962B in the summer of 2001 at minimal cost. While the first release of the E1962B does not directly support the old IS-95 protocols, it ***does*** support the Radio Configuration 1 (RC1) and Radio Configuration 2 (RC2) backwards compatibility modes. These RCs in the IS-2000 standard enable cdma2000 mobiles to use the exact same physical layer as IS-95. RC1 and RC2 support in the E1962B allows testing of cdma2000 phone operating in the IS-95 compatibility modes. The only difference is that in RC1 and RC2 the mobile is using the newer cdma2000 protocol messages rather than the older IS-95 messages. These protocol differences do not affect the physical performance of a mobile station. The E1962B test application supports frame-error-rate testing, average power, channel power, access probe power, and modulation quality measurements in RC1 and RC2.

Measurement accuracy

The E5515C/E1962B offers a number of measurement accuracy improvements over previous Agilent CDMA test sets. These improvements translate into increased yields on the manufacturing floor, reduced numbers of false failures, and longer battery life.

The average power measurement in the E5515C when using the thermal detector (reverse RC3 and RC4), is specified at ±6.2% accuracy versus ±7.5% for previous Agilent test sets (<1000 MHz). This improved accuracy lets you set the maximum TX power of your mobiles closer to the minimum allowed level with confidence, maximizing battery life (reducing power amplifier current drain) and giving you a competitive advantage. The typical performance of all average power measurements for the E5515C is < ±3.3% below 1000 MHz and < ±4.4% below 2000 MHz. A typical specification means that ***every*** unit shipped met the typical number at room temperature, not including measurement uncertainty. Agilent's typical specifications tell you what you can expect from your unit if it is operated in a well-controlled environmental condition.

Typical CDMA source level accuracy for the E5515C source is ±0.62 dB, a distinct improvement over previous test sets at ±1.0 dB. This reduced uncertainty translates into additional margin in your receiver measurements. The E5515C also fully specifies the channel power measurement to ±1 dB, with typical performance of ±0.5 dB. Previous CDMA tests from Agilent only provided typical specifications for channel power measurements of ±1.2 dB. You can be confident in the measurement results from the E5515C platform.

Another specification improvement is the output VSWR of the E5515C. This reduction in VSWR translates directly into improved yields in manufacturing by significantly reducing output level uncertainty. This error has a profound effect on the yield of sensitivity tests. If the SWR of a mobile under test is 3:1, then the level uncertainty due to mismatch with the E5515C will be +0.28, –0.29 dB. Using the E8285A, the uncertainty due to mismatch will be +0.83, –0.9 dB. This represents an improvement of over 0.5 dB in test system uncertainty. This improvement can be directly applied to margin and thus improve yields and false failures significantly.

Performance improvements

Other areas of significant performance improvements include: increased source output power, greatly reduced receiver noise floor, completely independent measurement and demodulation receivers, alias and image protected measurement receiver, and simplified firmware upgrades.

Increased CDMA source output power

The CDMA source of the E5515C can output distortion-free waveforms at a level of –13 dBm/ 1.23 MHz over its entire operating frequency range. This level is 7 dB higher than the power available on previous Agilent CDMA test sets. This extra power makes it easy to accommodate external system losses in your test systems. IS-98 tests require RF output levels of up to –25 dBm/1.23 MHz. With the extra power available in the E5515C, you can accommodate system fixture losses of up to 12 dB without using external amplifiers.

Measurement receiver noise floor improvements

One area of concern in previous test sets was the noise floor of their measurement and demodulation receivers. The E5515C provides greatly reduced noise floor performance for both its measurement receiver and demodulation receiver. Because of this noise floor issue, previous Agilent test sets only specified their channel power measurement accuracy down to levels of –50 dBm/ 1.23 MHz. With the increased performance of the E5515C, channel power measurement accuracy is fully specified to –61 dBm/ 1.23 MHz and functions with slight degradation down to –69 dBm/ 1.23 MHz. The typical noise floor on the E5515C is –80 dBm/ 1.23 MHz. This greatly simplifies measuring the minimum power and standby power of CDMA mobiles and provides extra confidence in the measurement results. External losses, that directly degrade the minimum measurement level of any instrument, are now handled with this improved noise floor performance.

Another benefit of this reduced noise floor is that waveform quality measurements can be made at much lower levels. While the E5515C specifies the minimum input level for waveform quality measurements to be > –25 dBm/ 1.23 MHz (5dB lower than previous test sets), it works down to input levels of –50 dBm/1.23 MHz. Typical residual rho performance at –50 dBm/1.23 MHz is still better than 0.985.

Demodulation receiver noise floor improvements

The demodulation receiver has similar noise floor improvements relative to previous test sets. This extra performance shows up as a guaranteed minimum input level with low residual FER. For the E5515C, this minimum input level is –65 dBmn/1.23 MHz with residual FER of less that one part in ten to the minus sixth. Previous Agilent test sets were not specified in this manner, but had typical performance of –50 dBm/1.23 MHz for similar performance. With this improved capability, you can be confident in your measurement results for such tests as dynamic range FER (input levels of about –50 dBm/1.23 MHz) even when you have external fixture losses. External fixture losses directly reduce the level input to the test set. For example, a test fixture with 10 dB loss would result in an input level of –61.2 dBm/1.23 MHz for an RC3 full rate phone call. The E5515C can handle this situation without introducing frame errors into the test results.

Independent measurement and demodulation receivers

Another innovation of the E5515C platform is that it incorporates completely independent receivers for mobile station transmitter measurements and for mobile station demodulation. This allows the E5515C to maintain a phone call using its demodulation receiver while tuning its measurement receiver anywhere desired. The demodulation receiver maintains the phone call, decodes protocol messages sent by the mobile, and performs FER measurements. The demodulation receiver must stay tuned to the reverse link of the mobile station to perform these tasks. With an independent measurement receiver, the E5515C can optimize receiver performance for mobile transmitter measurement and can be independently tuned as required.

For example, by using this feature of the E5515C and the channel power measurement, you can measure alternate channel power (±1.98 MHz offsets from the carrier). The channel power measurement reports the total power in a 1.23 MHz bandwidth. Normally the measurement receiver is tuned to the reverse channel that the CDMA mobile station is using. To perform an alternate channel power measurement, simply select the channel power measurement and read the active channel power. Then tune the measurement receiver to the alternate channel (±2.5 MHz) and read the channel power. The ratio of the two readings is the alternate channel power ratio. Typically, the alternate channel measurements are reported in a 30 kHz measurement bandwidth. To correct for this difference, simply reduce the level of the alternate channel result by 16.1 dB [10*log(1,230,000/30,000)].

Alias and image protected measurement receiver

Another improvement in the E5515C platform is the inclusion of alias and image protection of the measurement receiver for signals within the selected frequency band. The 8924C and E8285A used under-sampling techniques to allow the use of cost effective analog-to-digital converters at the time of their design. However, this resulted in alias and image problems when multiple phones were being tested near each other if adequate RF shielding was not used. The E5515C uses a multiple down-conversion architecture combined with a high rejection SAW filter to eliminate images for signals within the selected frequency band.

Additionally, modern high sample rate analog-to-digital converters are used to ensure alias-free performance. Because of the E5515C's measurement receiver design, it retains its excellent performance even in the presence of a demanding RF environment.

Simpler firmware upgrades

Previous Agilent CDMA test sets required the use of PCMCIA cards to perform firmware upgrades. With the E5515C, upgrades require only a CD-ROM and a Windows® computer connected to the test set via a LAN connection. CD-ROM upgrades reduce cost and the hassle of getting PCMCIA cards. As an added benefit, firmware upgrades are stored internal to the E5515C on its hard drive. Previous versions remain on the hard drive and can be accessed at any time. This provides an instant "go-back" feature if required.

Measurement speed

One of the key benefits of the E5515C platform is its extremely fast measurement capability. In addition to fast measurements, the E5515C provides an unparalleled level of simultaneous measurement functionality.

The E5515C is optimized for fast measurement throughput. For example, channel power measurements are used extensively for calibrating and verifying the wide TX output power range of CDMA mobile stations. Previous CDMA test sets from Agilent could complete a channel power measurement in as little as 100 ms (using a measurement interval of 1.25 ms). The E5515C can make a channel power measurement in 21 ms, including the time required to send the measurement command and receive the results. Similar improvements in measurement speed are also achieved for average power and waveform quality measurements. Combined with fast source switching, the E5515C's measurement speed can have a drastic effect on overall test time for common procedures such as calibrating the open loop power control performance of a CDMA mobile station. Since the E5515C is optimized to extremely fast GPIB performance, overall measurement times are heavily dependent on controller performance. For the best results, a high performance controller is required.

Another benefit of the E5515C is that for cdma2000 phone operating in the new radio configurations, the waveform quality measurement also returns code domain power results. This Agilent-exclusive feature saves time by providing the key code domain results without incurring additional measurement time. Since cdma2000 mobiles transmit multiple Walsh-coded channels, similar to the method found in IS-95 base stations, the code domain power measurement is essential in determining if a cdma2000 mobile is functioning properly. Multiple channel transmission places an extra burden on the linearity of a mobile's transmitter. If the mobile does not have sufficient phase and amplitude through its entire transmitter chain, then these Walsh-coded channels will distort causing errors that can ***only*** be detected using a code domain power analyzer. The IS-98-D test specification sets limits on these code domain errors. Experience has already shown that cdma2000 mobile stations that easily meet the IS-95 waveform quality requirements can ***fail*** the code domain requirements. With the E5515C, you get high-accuracy waveform quality measurements and code domain power results in as little as 261 ms.

With independent measurement and demodulation receivers, the E5515C can perform TX and RX measurements simultaneously. Since these receiver are both independently settable for both frequency and level, RX FER measurements can be made while making TX measurements. For example, while measuring sensitivity, maximum power, waveform quality, and code domain power measurements can be performed simultaneously.

Flexibility and futures

Unlike previous test sets from Agilent Technologies, the E5515C is ***software*** re-programmable to accommodate new radio systems, new measurements, and features. Currently, the following software Test Applications are available for the E5515C platform: GSM (E1960A), GPRS (E1964A), AMPS/IS-136, TDMA (E1961A), IS-2000 (E1962B), and GSM+ IS-126/AMPS (E1985A). Option 003 provides flexibility for CDMA-type formats, while the base platform includes flexibility for analog and TDMA formats. In the near future IS-95 and AMPS will be added to the E1962B test application and the W-CDMA test application will also be available. All of these applications can reside in the same instrument simultaneously and once selected, will be active in 120 seconds. These test applications reside on the internal hard drive and as such are non-volatile.

In the case of the E1985A test application, switching between the GSM and IS-136 modes requires less than two (2) seconds. In the future, additional "fast-switching' test applications will be available as required by the development of phones that support more than one standard. This level of flexibility reduces your cost by using the same hardware to support multiple radio formats. Production lines can be quickly changed to support customer orders for different types of phone. You can react to changing market conditions without costly development of new test lines.

The E5515C platform also supports a wide range of frequencies to make your investment go farther. For example, the E1962B test application supports two new frequency bands: the 450 MHz band and the IMT-2000 frequency band. These bands were added by simply performing a few new tests in the factory and did not require any hardware modifications. The E5515C provides the frequency coverage you need today and in the future.

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