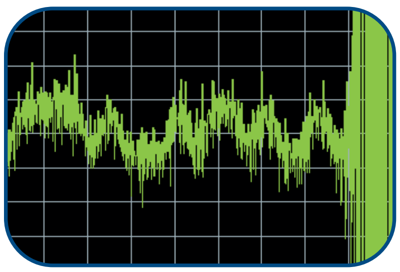
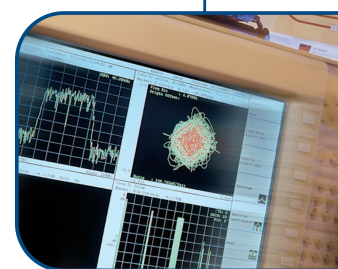
Wireless Communication Analyzer

Windows to the New World of Wireless Telecommunications





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Windows to the new world of wireless telecommunications

The world of wireless telecommunications is expanding and changing at an incredible rate—presenting significant technical challenges to system designers. Subscribers are demanding wider access to more services for voice and data communications, which has created the need for new generations of worldwide standards with higher connection speeds and increased capacity. Competition for spectrum allocations among the growing number and variety of wireless devices has driven up license costs and made the efficient use of bandwidth for multiple users and applications a top priority. Hundreds of millions of electronic devices will be outfitted for use in new wireless local area networks that must meet sophisticated new RF communication standards.

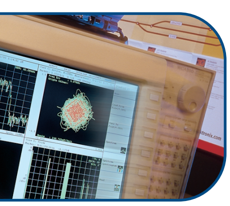
The stakes are high. The cost and complexity of implementing new systems will be substantial. Short time to market will be critical, as system operators compete to attract subscribers with new improved services. Sophisticated new technology must coexist in an already complicated landscape of previous generations—most of which must continue to be supported for many years. Above all, the new systems must perform reliably—in the face of fierce competition, the success or failure of any system will be the direct result of customer satisfaction.

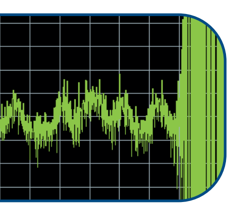
Leading edge measurement tools are essential to the design of reliable systems that will conform to the new standards, operate at peak performance and get to market in the shortest possible time. This brochure and the accompanying application inserts describe revolutionary new Wireless Communication Analyzers that provide clear and comprehensive insight into the complex new systems. These advanced real-time measurement tools capture all of the information faithfully and display it in formats that are easy to interpret and analyze—leading to optimum designs and shorter development cycles. They are the system designer's windows to the challenging new world of wireless telecommunications.

Complex challenges—advanced solutions

Measurement challenges in new wireless telecommunication systems

New wireless telecommunication systems employ a wide variety of complex analog and digital signals to improve performance, optimize bandwidth utilization and expand services. There is no longer a solid, continuous carrier from which to trigger, acquire and analyze over a period of time, so the traditional swept-frequency spectrum analyzer is as likely to miss an event of interest as to catch it. Many signals require the simultaneous acquisition of frequency and time transitions within narrow bands and very short frames, ruling out the use of broadband or single-domain analyzers. High transmission rates, new sources of distortion and interference and the need to view subtle characteristics simultaneously in the time, frequency, modulation and code domains are beyond the capability of conventional test equipment.



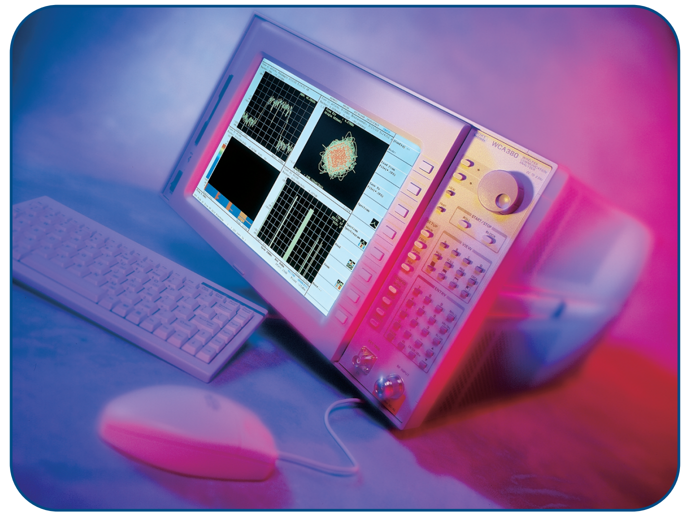


A common characteristic of the new generation of signals is their non-stationary nature. In order to share time and bandwidth, information is transmitted in short bursts, hopped between different frequencies and/or switched between system resources. Most of these signals are intermittent and unpredictable; some occur only once, others repeat, but occur at random. Time varying signals must be detected, accumulated and displayed in composite form to reveal changes over the period of interest. Intermittent interference must be detected in the presence of intermittent signals.

Perhaps the single greatest measurement challenge is to identify specific problems or parameters from the vast amount of information that is needed to characterize the new signals. Signal quality is now evaluated in the frequency, time and modulation domains using methods such as EVM, spectrogram, waterfall, constellation and vector diagrams, as well as code domain power measurements. To provide these insights, instruments must be specifically designed to address wireless signals with appropriate trigger and acquisition options, display formats and analysis functions.

Advanced measurement solutions—the Wireless Communications Analyzer

The Wireless Communication Analyzer (WCA) directly addresses the challenges of the evolving wireless technologies such as GSM, IS-I 36, PDC, CDMA, Bluetooth and even the high chip rates of Wideband CDMA and cdma2OOO. Based on the real-time spectrum analyzer architecture that was pioneered a decade ago by Tektronix, the WCA is capable of capturing continuous, intermittent, and random signals with equal ease. Because the instrument acquires full frames constantly, the signal can come or go as it pleases and the WCA will catch all of the information—even for single short events (the RACH signal of a mobile station, for example).



The Wireless Communication Analyzer.

The WCA simultaneously captures blocks of both time and frequency information, storing them in digital memory for multi-domain and cross-functional analysis. In addition to conventional time/slope triggering, a frequency mask trigger allows capture of randomly occurring or infrequent signals. The WCA displays dynamic time-space signal detail with powerful 3-D modes that reveal far more signal information than the simple two-dimensional amplitude vs. frequency formats. Post-processing capabilities compute quality metrics such as Code Power vs. Time, EVM vs. Code, EVM vs. Time CCDF and Transient Spurious Signals.

The right tools to capture, store and see all of the results

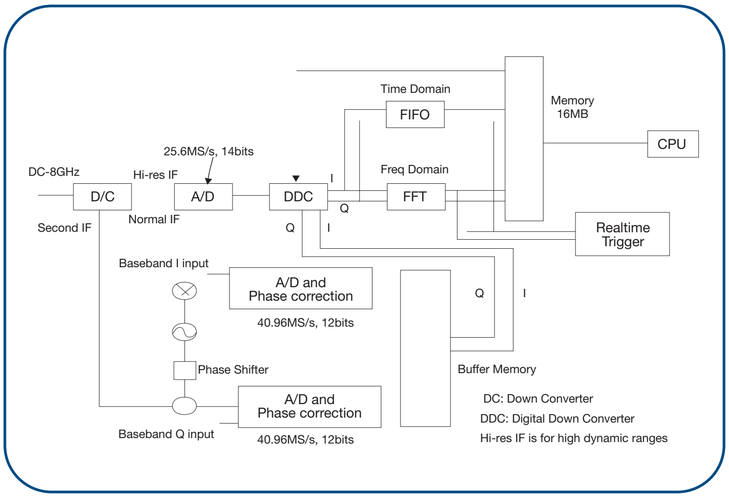


Figure 1. Simplified Block Diagram of the Wireless Communication Analyzer.

Acquisition

Traditional swept-frequency spectrum analyzers can not handle the new generation of signals. They have a single path from the input to the display that is tuned to only one frequency at any given time. They accumulate a spectrum display by tuning the path to successive frequency steps and detecting the amplitude at each step. The display represents the composite result of many single-frequency acquisitions performed serially, which requires a stationary uninterrupted signal to produce a meaningful measurement.

The WCA uses FFT techniques to produce in effect, hundreds of filters in parallel. All of the frequency components within the real-time bandwidth are filtered concurrently and detected simultaneously. The resulting display is a continuously updated representation of everything that happened within the full spectrum of the capture band during a particular frame. At any instant, a massive volume of signal information can be frozen in memory for post-acquisition analysis.

Figure 1 is a block diagram of a Tektronix WCA. Note that both the time and frequency domain data are stored in memory, so they can be extracted and processed or displayed in a variety of different ways. The time-continuity of a signal can also be post-processed in multiple domains after acquisition. For example, the difficult to capture frequency hopping Bluetooth signal is easily analyzed to determine behavior such as frequency set-on time, amplitude vs. frequency profile and modulation characteristics (see Figure 2).

The Zoom mode takes full advantage of the memory content, providing a microscopic view of events that occurred within an acquisition frame. The analyzer captures a contiguous block, and Zoom permits the user to expand any portion of the frame by a factor of up to 1,000. Because the full block is in memory, there is no need for re-acquisition.

Triggering

Triggering capabilities are vitally important. Conventional spectrum analyzers contain only time-domain triggering—when the signal crosses an amplitude threshold, the instrument begins its capture sequence. The WCA includes both an amplitude time-domain trigger (see Figure 3) and a frequency-mask trigger that enable acquisition even when signal events are erratic or infrequent. The triggers can be used to capture signals arising from intermittent spurious or spectral re-growth events such as phase lock loop jitter and oscillator phase hits.

The frequency-mask trigger uses a frequency window as a condition of triggering. The user graphically defines the mask to trigger on a specific event in the frequency domain irrespective of other activity within the span. The window can be set to watch for the disappearance or attenuation of a pre-existing signal. The frequency-domain portion of main memory keeps a running record of acquisition frames (time) as they accumulate—discarding the oldest information as new data enters the memory. When a trigger occurs, memory continues to acquire for a prescribed number of frames (set by the user), then stops recording. At that instant, the content of the memory reflects all the activity that led up to the triggering event, as well as the activity that followed it.

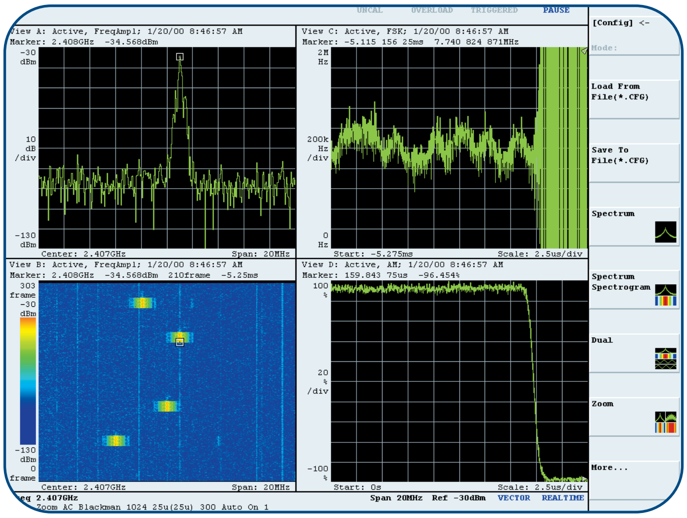


Figure 2. Spectrogram of the frequency hopping Bluetooth signal (lower left) with spectrum display of the selected burst (upper left). Frequency and amplitude versus time profiles are shown in upper and lower right displays.

The frequency mask trigger has a second major benefit; it can be used to capture widely spaced events more efficiently. The instrument triggers only when the signal appears within the programmed window to allow the capture of “burst-on” periods and ignore the dead time intervals. The frequency mask trigger and the frequency domain memory work together to maximize the number of bursts that can be captured for subsequent spectral, time or modulation analysis, providing rich detail about the continuity of the signal.

Display modes reveal every dimension

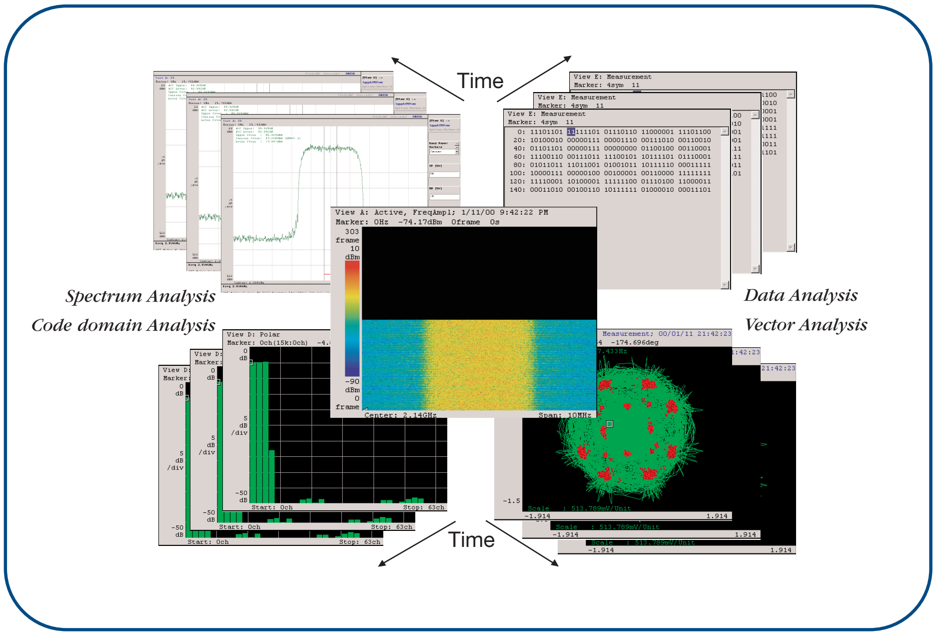


Figure 3. Examples of space-time displays available in the WCA.

The WCA's large color screen presents clear multiple display windows of signal characteristics. For in-depth analysis of digitally modulated signals, constellation and vector diagrams are displayed, as are frequency, phase, magnitude, I and Q versus time. In the code domain, signals with high symbol rates such as W-CDMA, may be viewed during and after capture. Figure 3 illustrates some of the space-time displays that are available in the WCA. All of the display windows are correlated—when the viewer scrolls or sets a marker to a certain point on the spectrogram, for example, the other windows follow to the same point in the signal (Figure 4).

"Waterfall" displays add a third axis to the spectrum display. The time (Z) axis is the accumulation of many 2-D traces overlaid front-to-back in time sequence. By elevating the perspective slightly, changes that occur in these traces over time become clearly visible. This makes it easy to detect transients and amplitude variations that might not appear on isolated 2-D displays. The waterfall display is especially useful for observing W-CDMA spread-spectrum, EDGE bursts and other non-stationary signals.

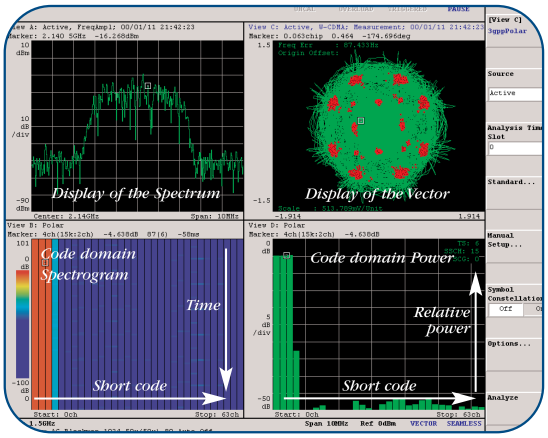
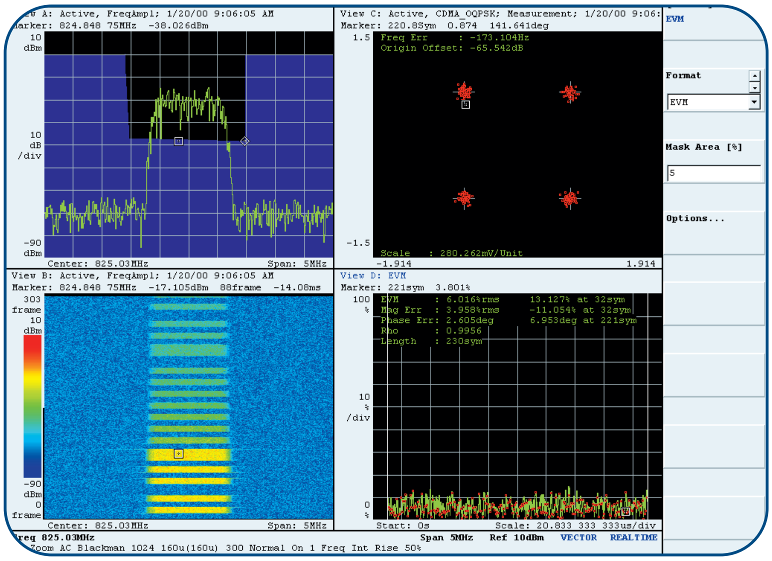


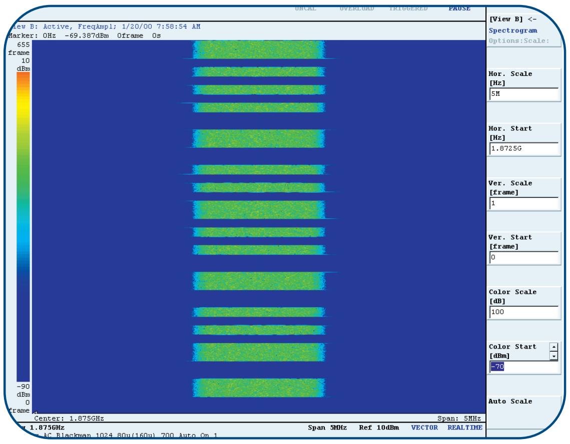
Figure 4. Multiple display windows of a code domain power conformance test (note correlated marker in each window).

The spectrogram is an even more insightful display. In effect, the spectrogram raises the waterfall perspective to the point where the viewer is directly "above" the frequency-time plane. More than any other display format, the spectrogram reveals the effects of CDMA partial rates and similar phenomena. In Figure 5, fifteen bursts of a CDMA signal are displayed. The spectrogram clearly shows at-a-glance that there is no signal present between the bursts—a steady carrier, if there were one, would appear as a narrow line connecting the bursts. Figure 6 illustrates another CDMA partial rate analysis with the spectrogram shown in the lower left screen. The frequency (X) axis runs from left to right; time (Y) runs from top to bottom and color denotes the amplitude (Z) axis. The highest peaks are shown in yellow.



▶ **Figure 6.** CDMA partial rate-bursts are captured as the varying signal strength exceeds the trigger mask (upper left). Spectrogram of the varying signal is shown in lower left. Marker on spectrogram defines which frame is used for modulation analysis in top right.

The WCA also has the ability to display time-domain information, plotting amplitude, phase and other quantities on an oscilloscope-like time axis. The time domain data are also the basis of vector, constellation, eye diagram, and other modulation displays.



▶ **Figure 5.** Spectrogram of CDMA mobile phone in partial rate speech mode.

Flexibility and growth to protect your investment

The Wireless Communication Analyzer is as flexible as it is powerful. The basic instrument contains in a single standard package all of the hardware functionality needed for the full range of new generation telecommunication signals—no options, add-ins or variations are required. Multiple units can also be connected in synchronism to provide even broader spectrum coverage.

The WCA is configured with built-in scripts and software routines suited to each of the existing standard test requirements. A script writing program is also provided for users to develop their own custom measurement scenarios. As new standards are released and new systems evolve, the WCA can grow with them by simply adding new software. Table 1 lists some of the functions, displays and measurements that are available in the Wireless Communication Analyzer as of this printing.

Table 1: Partial List of WCA Functions, Displays and Measurements

	Modulation Formats	BPSK, QPSK, DQPSK, 8PSK, OQPSK, 16QAM, 64QAM, 256QAM, GMSK
	Standard Setups	PDC, PHS, NADC, TETRA, GSM, CDPD, IS-95, T53
Displays	Vector Diagram	Symbol, Locus Display, Frequency Error Measurement, Origin Offset Measurement
	Constellation Diagram	Symbol Display, Frequency Error Measurement, Origin Offset Measurement
	Eye Diagram	IQ Trellis Display
	Error Vector Diagram	EVM, Magnitude Error, Phase Error, Waveform Quality Measurement
	Symbol Table	Binary, Octal, Hexadecimal
	Amplitude vs. Frequency	2-D Spectrum
	Amplitude vs. Time	2-D Time
	Waterfall	3-D Time-Space
	Spectrogram	3-D Time-Space
Measurements	Spectrum	ACPR, ACLR, Spurious and Transients, CCDF, Amplitude vs. Time
	Frequency Domain	ACPR, Occupied Band width (99% OBW), Transmitted Power, Frequency Response, IM Distortion, Purity of Carrier (C/N), Spurious
	Time Domain	Rise and Fall Time, CCDF, Power of Bursted Signal, Power Changing, Crest Factor Difference Due to Code Multiplexing
	Modulation and Code Domains	Vector Constellation Display, Modulation Accuracy (EVM) and Waveform Quality (Rho), Analysis of De-Spread Data, Multi Symbol Rate, Code Domain Power Spectrogram, Code Power vs. Time, Code vs. Power vs. Time slot, Symbol Table, EVM on Individual Short Codes, De-Spreading Data Bits, Verification of BTS Operation

Conclusion

As wireless telecommunications systems have grown to include analog, digital and now broadband multi-domain, Tektronix has kept pace with the oscilloscope, the spectrum analyzer and now the real-time Wireless Communication Analyzer. This first release of the WCA brochure and application inserts offers information for the designer and test engineer who are searching for measurement solutions for the new world of wireless telecommunications. Updates will follow in the near future, as the technology and standards continue to evolve. The documents are also available at our web site (www.tektronix/commtest.com), along with updates and related documents (including a new series of Application Notes on the protocol testing of UMTS interfaces).

Tektronix is committed to the most advanced test solutions for telecommunication networks. As mobile networks continue to evolve through GPRS, UMTS and cdma2000 to IMT 2000 and revolutionary new wireless LAN's are standardized, we will keep you in the forefront with the latest measurement products and methods. We welcome your comments and suggestions for improving these documents and your ideas for developing other tools to help you meet the measurement challenges of new wireless systems. Contact us at the locations listed below, or through our web site.

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