

**Technology Backgrounder**  
**Tektronix 2782**  
**33-GHz Microwave Spectrum Analyzer**

**The New Standard of Performance  
for Spectrum Analysis**

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In the area of Microwave and RF Test Instrumentation, Tektronix offers microwave and RF spectrum analyzers, real-time digital spectrum analyzers, FFT analyzers, digitizers, digital sampling oscilloscopes, microwave probes, waveguide mixers, tracking generators, EMI software, and MMIC packaging.

Tektronix is a leading manufacturer of electronic products and systems in the areas of test and measurement, computer graphics, and communications. Sales in fiscal 1988 totalled \$1.4 billion. The company has approximately 16,000 employees worldwide.

## The New Standard of Performance in Microwave Spectrum Analysis

The new 2782 Microwave Spectrum Analyzer from Tektronix significantly extends coaxial microwave analysis performance and establishes numerous industry firsts. Some of the key features of the 2782 include -

- Wider coaxial frequency range - 100 Hz to 33 GHz with direct fundamental mixing to 28 GHz
- Frequency calibrated to 1.2 Terahertz
- Full-range sweep from 0 Hz to 33 GHz
- Widest available resolution bandwidth range - 3 Hz to 10 MHz
- Widest available dynamic range - 100 dB display dynamic range
- 20 dB sensitivity improvement for external waveguide mixer measurements
- Simultaneous digital and analog display
- Synthesizer frequency accuracy and built-in microwave frequency counter
- High-resolution, high-contrast color display (liquid-crystal color shutter)
- Two GPIB ports
- Revolutionary human interface

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These and many other features of the 2782 offer engineers extended measurement capabilities and ease of use for design, installation, manufacturing ATE, and service activities in pulsed RF and broadband communication applications.

The 2782 Spectrum Analyzer also represents a new level of technology supported measurements first introduced by Tektronix in 1980 with the first laboratory grade portable spectrum analyzer. As the high-performance leader in Tektronix' portable spectrum analyzer family, the 2782 sets the new standard for microwave spectrum analyzers. It is designed to complement Tektronix' family of high-performance portables in providing measurement solutions for current and future advanced radar, communications systems, navigation systems, and electronic counter measure systems.

## Precedent Setting Performance

While the 2782 is a portable spectrum analyzer similar in size and shape to other Tektronix portable spectrum analyzers, the resemblance ends there. The 2782 incorporate completely new technology in a completely new architecture. Extensive use of surface mount technology and multilayer boards has allowed unprecedented levels of performance, functionality, and ease-of-use to be compressed into a convenient, portable package. This and the performance features detailed in the following discussion offer a new level of high-end measurement capability for pulsed RF and broadband communication applications.

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## **100 Hz to 33 GHz Coaxial Frequency Range with Fundamental Mixing to 28 GHz**

No other spectrum analyzer comes close to these capabilities. Fundamental mixing means lower conversion loss in the mixer for improved sensitivity at higher frequencies. Fundamental mixing also improves basic stability (residual FM).

The wider coaxial range provides more measurement range without resorting to complex external mixer setups. Coaxial input also has the benefits of a wider dynamic range resulting from use of an internal attenuator and preselector convenience for eliminating internally generated spurious responses.

Competing spectrum analyzers fall short of this performance. A few medium-performance models do go to 26.5 GHz with options. However, most spectrum analyzers covering the coaxial microwave range only cover up to 22 GHz. Also, these competing spectrum analyzers only use "quasi-fundamental mixing" to 22 GHz. This quasi-fundamental mixing is achieved by multiplying a 2- to 6-GHz LO and filtering out the desired harmonic to obtain results similar to direct fundamental mixing. This does yield improved sensitivity, but it does not provide any gain in stability. The Tektronix 2782, on the other hand, uses direct fundamental mixing from an 8 to 18 GHz oscillator. This direct fundamental mixing provides advantages in both sensitivity and stability, especially at higher frequencies.

## **Fast 0 Hz to 33 GHz Full-Range Sweep**

The 2782's full-range sweep, combined with improved sensitivity and 1-dB compression point, allows large frequency ranges to be swept much faster than ever before. Other spectrum analyzers may have similar capabilities up to 22 GHz, but

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the 2782 provides full coverage to 33 GHz. And, at the same time, it does it with a higher attainable drive level.

### **Widest Available Dynamic Range**

The 2782's exceptional dynamic range comes from significant contributions in several major areas. These include -

**100 dB Display Dynamic Range** - The 2782 is the first microwave analyzer with this capability for frequencies above 5 GHz.

Display dynamic range is the range over which the largest and smallest signals can be simultaneously viewed (the log amplifier's range). In the past, the best range available was 90 dB. Now, with the 2782, it's 100 dB.

**3 Hz to 10 MHz Resolution Bandwidth (6 dB) in a 1-3-10 Sequence** - There are two industry firsts here - both the widest and narrowest bandwidth available in any microwave spectrum analyzer.

The 3 Hz resolution bandwidth is usable to 28 GHz. It provides enhanced close-in dynamic range for phase noise, spurious, and sideband measurements.

The 10 MHz resolution bandwidth improves dynamic range for signals with wide occupied bandwidths, such as pulsed RF and broadband communications. It also allows signal modulation characteristics to be passed with higher fidelity. This means more signals can be measured directly in zero span with the 10-MHz bandwidth.

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**0-dBm, 1-dB Compression Point** - Historically, the 1-dB compression point has been the primary limitation to the allowable IF gain to RF attenuation ratio. This ratio determines how hard the mixer can be overdriven.

The 0-dBm, 1-dB compression point of the 2782 mixer allows it to be overdriven by as much as 30 dB. This is a 10 dB higher drive level than possible in the past. It provides more dynamic range for measurements such as phase noise and broadband spur searching in the presence of high-level signals. It also provides more dynamic range for pulsed RF measurements, allowing higher drive levels before pulse compression is seen.

**+ 15-dBm Third-Order Intercept Point (TOI)** - A TOI of + 15 dBm for less than 6.5 GHz and + 10 dBm above 6.5 GHz means that the distortion products on two signals at -30 dBm will be -90 dBc and -80 dBc, respectively. By comparison, current microwave analyzers have sideband levels of -75 and -70 dBc, respectively. In other words, for TOI distortion measurements, the 2782 provides 10 to 15 dB more dynamic range than previously available.

**Single-Sideband Phase Noise** - This is an area of significant achievement for the 2782. At higher frequencies (e.g., 18 or 20 GHz), the 2782 excels by as much as 20 to 30 dB. As a result, phase noise measurements can be done directly and simply, without the very costly and slow phase noise test systems required previously. For any phase noise measurement application, the 2782 means direct savings in both time and money.

**Improved Sensitivity** - This is still another area of major significance for the 2782. Due to the 2782's fundamental mixing to 28 GHz, higher sensitivities are gained as compared to analyzers using harmonic mixing. The higher the frequency,

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the larger the advantage in sensitivity. This advantage can be as much as 20 dB in the external mixing ranges.

### **Synthesizer Frequency Accuracy and Built-In Microwave Frequency Counter**

The frequency accuracy of the 2782 is approximately equal to the state-of-the-art, which is a function of the internal reference oscillator. The 2782's greatest advantage is in its built-in microwave frequency counter. Accurate frequency measurements can be made much faster with the built-in counter. This is because it is no longer necessary to manually center the signal and span down to the narrowest span to obtain measurement accuracy. With the 2782's counter, you simply place the marker on the signal to be counted and activate the count. The signal's frequency is accurately measured, even on wide spans.

### **High-Resolution, High-Contrast Color Display**

The 2782's color display provides clearer, easier viewing of signals and readout information. Spectrum traces can be displayed in either red or green. Where two traces overlap, color mixing highlights the overlap with yellow. This use of color heightens the user's ability to quickly interpret complex multi-waveform displays. Additionally, the polarizing effect of the liquid-crystal color shutter used for the display, provides very high-contrast viewing, making the 2782's displays easy to see, even in direct sunlight.

### **Simultaneous Digital and Analog Spectrum Display**

With the digitizers currently being used in spectrum analyzers, it is not possible to see all of the spectral detail on some complex waveforms (e.g., TV and

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pulsed RF waveforms). Typically, detail such as gray-scale information must be viewed on an analog display.

Tektronix has always given customers the choice of viewing either an analog or digital display. Now, the 2782 takes that another step further with simultaneous viewing of digital and analog displays.

Other important issues in this area include digital resolution and number of displayable traces. With the 2782, all traces have 1000 by 1000-bit resolution. And up to four traces can be displayed simultaneously. Digital averaging has also been enhanced. With the Peak Average Cursor, you can selectively average noise while leaving the signal unaveraged.

### **A New and Revolutionary Human Interface**

The 2782's human interface integrates the best of existing designs and enhances that with many unique innovations.

Current instruments lean either toward menu-driven or dedicated function controls. The 2782 provides an optimum mix of these two popular approaches. It has a menu system that rarely goes to three levels deep. Additionally, menu depth and menu path are always shown so that you never get lost or confused. This clarity is provided by means of an overlapping menu page structure.

Menu selections are made via soft keys on the right side of the display. At the same time, the most commonly used functions have been maintained as dedicated functions. Functions such as Frequency, Span, and Reference Level can all be controlled without ever using a menu. Most of the common marker functions also have dedicated buttons.

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Another major innovation is in the way the control knobs operate. While one knob is dedicated to frequency control, the other two knobs are user assignable. A wide range of functions - Sweep Speed, Res BW, Span, etc. - can be assigned to these knobs. This allows users to "customize" front-panel control for different applications. Knob assignments are also retained in nonvolatile memory for user convenience.

### **Two Interface Ports**

The 2782 is the first spectrum analyzer to implement two interface ports. This is of great potential benefit for ATE systems. With two GPIB ports, the 2782 can use internally stored macros (downloaded programs stored in the 2782's nonvolatile memory) to control another piece of equipment on one port while the ATE system controller accepts data from the 2782 on the other port. This two-port capability opens the door to higher system speeds through distributed processing.

### **Unheard of Performance in a Portable**

Portable no longer means performance compromises for the sake of mobility. The new architecture of the 2782--along with high-density ICs, multi-layer boards, and surface mount technology - allows more capability to be packed into a smaller package. With the new 2782 Microwave Spectrum Analyzer, portability means -

- unprecedented performance without compromise
- rugged packaging
- wide environmental operating range
- small size

- greater flexibility for lab, system, or field use
- MIL 461C EMI performance

## Continuing a Long List of Industry Firsts

The new capabilities of the 2782 Spectrum Analyzer add to a long list of industry firsts set by the Microwave & RF Instruments (MRI) Division of Tektronix. These industry firsts establish an impressive record of technological leadership for Tektronix. They include -

- The first portable general-purpose microwave spectrum analyzer - 491, introduced in 1970
- The first high-performance portable microwave spectrum analyzer with MIL T 28800 Type 3 Class 3 environmental specifications - 492, introduced in 1979
- The first high-performance microwave spectrum analyzer offering 30 Hz resolution bandwidth - 7L18, introduced in 1977
- The first spectrum analyzer offering 3 MHz resolution bandwidth for pulsed RF measurements - 7L12, introduced in 1973
- The first spectrum analyzer with a synthesized local oscillator - 7L5, introduced in 1975
- The first microwave spectrum analyzer with a built-in frequency counter - 494, introduced in 1984
- The first spectrum analyzer offering 5 MHz resolution bandwidth for TV measurements - 2710, introduced in 1988

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- The first spectrum analyzer offering frequency coverage to 325 GHz - the 494, introduced in 1984
- The first calibrated waveguide mixers for spectrum analyzers to 140 GHz - WM490 Series, introduced in 1982
- The first portable general microwave spectrum analyzer to offer GPIB interfacing and full programmability - 492P, introduced in 1981
- The first microwave spectrum analyzer to offer 3 Hz resolution bandwidth to 28 GHz - 2782, introduced in 1989
- The first microwave spectrum analyzer to offer 10 MHz resolution bandwidth for pulsed RF applications - 2782, introduced in 1989
- The first microwave spectrum analyzer to offer simultaneous viewing of digitized and analog displays - 2782, introduced in 1989
- The first microwave spectrum analyzer to offer a third-order intercept of +15 dBm to 6.5 GHz - 2782, introduced in 1989
- The first microwave spectrum analyzer to offer two interface ports for ATE applications - 2782, introduced in 1989
- The first microwave spectrum analyzer to offer a 1 dB compression level of 0 dBm input - 2782, introduced in 1989
- The first full-range microwave spectrum analyzer with a displayed dynamic range of 100 dB - 2782, introduced in 1989
- The first spectrum analyzer to offer frequency coverage to 1.2 Terahertz - 2782, introduced in 1989

As can be seen from this list, the 2782 not only continues a tradition of Tektronix firsts in spectrum analysis, it substantially adds to it with numerous industry firsts in a single instrument.

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