

## FEATURES/BENEFITS

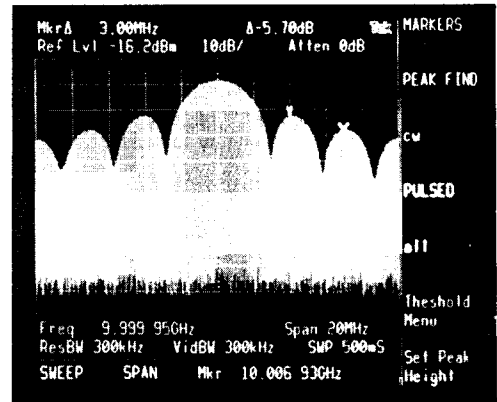
- 100 Hz to 33 GHz Coaxial Frequency Range and Wide Bandwidth Preselection for More Measurement Productivity
- External Waveguide Mixer Support to 325 GHz with Frequency Calibration to 1.2 THz
- Full-range Sweep from 0 Hz to 33 GHz
- Resolution Bandwidths from 3 Hz to 10 MHz in a 1, 3, 10 Sequence
- 100 dB Display Dynamic Range
- Unparalleled Phase Noise Performance as Low as  $-105$  dBc/Hz at 10 kHz Offset up to 21 GHz
- Mixer Input Level Decoupling from RF Attenuator by up to 30 dB Provides Higher SNR and Dynamic Range

## NEW STANDARD IN SPECTRUM ANALYZER PERFORMANCE

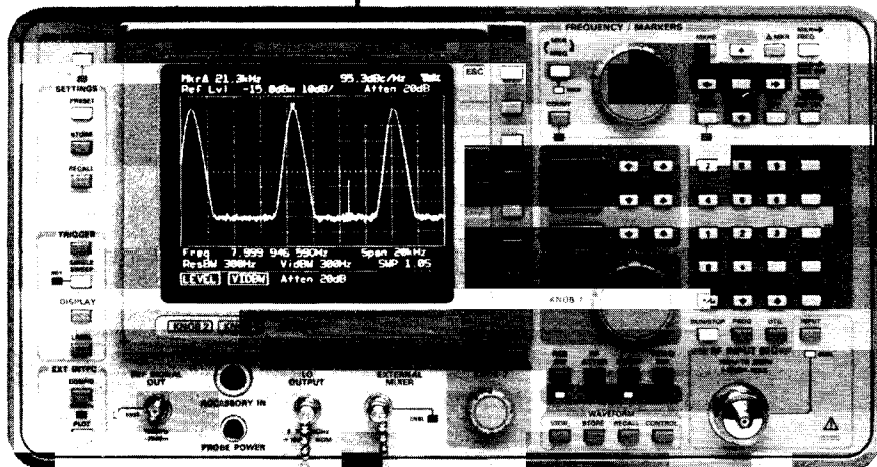
The Tektronix 2782 offers you leadership measurement performance, not just through minor enhancements, but by truly extending the state of the art. For example, the 33 GHz coaxial input gives you more frequency range without resorting to external mixers. And you can see it all with the full-range 0 Hz to 33 GHz sweep.

Whatever you need to measure, from close-in phase noise to demodulated pulsed RF, the 2782 provides the capabilities – capabilities such as substantially better phase noise, and resolution bandwidth selections from 3 Hz to 10 MHz. This is further backed with standard-setting dynamic range and improved sensitivity from direct fundamental mixing to 28 GHz, plus a host of other performance firsts. For example, a +15 dBm TOI, a 0 dBm 1-dB compression point, and the ability to uncouple the mixer input level from the RF attenuator by up to 30 dB means higher signal-to-noise ratio measurements.

When you need to go above 33 GHz and external mixers are used, the 2782 provides as much as 25 dB better measurement sensitivity than ever before possible. Set-up is simple as well. All you need is one cable and the new WM782 Waveguide Mixers and you are set; you do not even have to peak these new mixers.



efficiency. For example, the 2782 can communicate with the system host on one GPIB port and control a synthesizer on its other port. The host never has to deal with the synthesizer. The measurement host can be unburdened even further by downloading measurement-specific macros and key sequences to the 2782. And with its small size, the 2782 provides more performance in less rack space than any other spectrum analyzer on the market.



## SOFT KEY, MENU, AND MACRO CONVENIENCE

The 2782 is rich in measurement features that are quickly and easily accessible through softkeys and menus that rarely go three deep. Often, your most frequently used feature can be assigned to one of two soft knobs for immediate access and control. Additionally, you can store front-panel keystroke sequences to simplify complex measurements, or even create single-key executable macros for the most complex applications.

## HIGHLY EFFICIENT SYSTEMS COMPONENT

With full programmability and two GPIB ports, the 2782 offers a new level in systems convenience and

## CHARACTERISTICS

Except as noted, the following tables of electrical characteristics and features apply to the 2782 after a 30-minute warm-up.

### FREQUENCY-RELATED

**Frequency Range** – 100 Hz to 33 GHz in coax, 8 GHz to 1.2 THz externally.

**Frequency Readout Accuracy** –  $\pm [F(RE+10^{-10})] + D + M$

where: F = center frequency; RE = reference error; D = 2% of span or 20% of resolution bandwidth, whichever is greater; M > 2 MHz span = (100N) kHz; M < 2 MHz span = (10N) Hz.

**Counter (S/N  $\geq 20$  dB) –**

Range: 100 Hz to 1.2 THz

Resolution: Selectable from 1 Hz to 1 GHz

Accuracy:  $\pm [F(RE + 10^{-10})] + 5N$  Hz + 1 LSD

$\Delta$ Count:  $\pm [\Delta F(RE + 10^{-10})] + 10N$  Hz + 2 LSD

where: F = counter frequency; RE = reference error; N = L.O. harmonic; LSD = least significant digit.

**Frequency Reference Accuracy –**

Aging:  $< 1 \times 10^{-6}$ /year,  $< 7 \times 10^{-9}$ /day

Drift:  $< 5 \times 10^{-7}$  over instrument temperature range of  $-10^\circ\text{C}$  to  $+40^\circ\text{C}$ .

**Frequency Span –**

**Range** – 0, 10 Hz to 33 GHz in coax, to 600 GHz in external mixer bands.

Resolution: > 100 Hz, selectable in 1% increments

Accuracy:

> 2 MHz	$\pm 2\%$
100 Hz to 2 MHz	$\pm 1\%$
< 100 Hz	$\pm 7\%$

# HIGH-PERFORMANCE MICROWAVE SPECTRUM ANALYZER

2782

NEW

**Resolution Bandwidth (6 dB)** – 3 Hz to 10 MHz in 1, 3, 10 sequence.

Accuracy:

10 MHz, 3 MHz	± 20%
1 MHz to 100 Hz	± 15%
30 Hz, 10 Hz	± 20%
3 Hz	+50%, -10%

Selectivity (60 dB/6 dB): < 10:1

Shape: Synchronously-tuned, six-pole filters

**2782 Resolution Filter Bandwidths –**

(Specified) 6 dB	(Typical) Random 3 dB	(Typical) Noise	(Typical) Impulse
3 Hz	2.1 Hz	2.3 Hz	3 Hz
10 Hz	6.9 Hz	7.6 Hz	10 Hz
30 Hz	21 Hz	23 Hz	30 Hz
100 Hz	69 Hz	76 Hz	100 Hz
300 Hz	206 Hz	227 Hz	300 Hz
1000 Hz	686 Hz	758 Hz	1 kHz
3 kHz	2.1 kHz	2.3 kHz	3 kHz
10 kHz	6.9 kHz	7.6 kHz	9 kHz
30 kHz	21 kHz	23 kHz	30 kHz
100 kHz	69 kHz	76 kHz	100 kHz
300 kHz	206 kHz	227 kHz	270 kHz
1 MHz	686 kHz	758 kHz	720 kHz
3 MHz	2.1 MHz	2.3 MHz	2.5 MHz
10 MHz	6.9 MHz	7.6 MHz	4.5 MHz

**Video Bandwidth –**

Range: 0.03 Hz to 300 kHz in 1, 3, 10 sequence, and 10 MHz.

Accuracy (nominal): ±25%

**Stability –**

Residual: FM: < 2 MHz span 1N Hz P-P over one second.

> 2 MHz span 25N kHz P-P over 500 msec.

Drift (after one hour warm-up): < 2 MHz span 5N Hz/minute of sweep time. >2 MHz span) 5N kHz/minute of sweep time.

Notes: N = L.O. Harmonic. Errors due to drift are not cumulative from sweep to sweep.

**Spectral Purity –**

**NOISE SIDEBANDS**

dBc/Hz	Center Frequency Range			
	Frequency 100 Hz to 6.5 GHz to Offset	6.5 GHz to 12 GHz	12 GHz to 21 GHz	21 GHz to 33 GHz
100 Hz	-85	-80	-75	-70
1 kHz	-97	-95	-90	-86
10 kHz	-105	-105	-105	-97
100 kHz	-105	-105	-105	-97
1 MHz	-112	-112	-112	-102

**AMPLITUDE-RELATED**

**Maximum Amplitude Range** – 135 dBm to +30 dBm

**Displayed Average Noise Level** – (10 Hz RBW, 0 dB attenuation)

Frequency	Level
100 Hz to 50 kHz	- 85 dBm
50 kHz to 5 MHz	-105 dBm
5 MHz to 2.5 GHz	-135 dBm
2.5 GHz to 6.5 GHz	-132 dBm
6.5 GHz to 21.25 GHz	-125 dBm
21.25 GHz to 28 GHz	-120 dBm
28 GHz to 33 GHz	-107 dBm

**Using WM782 Waveguide Mixer Series**

(typical) – (1 kHz RBW)

Band	Frequency	Sensitivity
Q	33 GHz to 50 GHz	-115 dBm
U	40 GHz to 60 GHz	-115 dBm
V	50 GHz to 75 GHz	-115 dBm
E	60 GHz to 90 GHz	-115 dBm
W	75 GHz to 110 GHz	-105 dBm
F	90 GHz to 140 GHz	-95 dBm
D	110 GHz to 170 GHz	-90 dBm
G	140 GHz to 220 GHz	-85 dBm
J	220 GHz to 325 GHz	-75 dBm

**Display Range** – Log amplifier, 100 dB.

Display Law Range:	
Log	1 dB/div to 15 dB/div
Linear	5 nV/div to 50 V/div
Square Law	1x10 <sup>-18</sup> W/div to 1 kW/div
Reference Level:	
Range	-140 dBm to +30 dBm
Resolution	0.1 dB

\*1: Measurements 0.5 dB/10 dB incremental.

**Frequency Response** – (for ≥ 10 dB RF attenuation and 20°C - 30°C temperature range)

100 Hz to 6.5 GHz: ±1.0 dB

6.5 GHz to 28 GHz: ±2.5 dB

28 GHz to 33 GHz: ±3.0 dB

(Attenuator accuracy over frequency included in frequency response.)

**Attenuator** – Range: 0 to 70 dB, 10 dB steps

Accuracy: ±0.5 dB @ 100 MHz

IF Gain: Range: 0 - 140 dB

Resolution: 0.1 dB

Accuracy: ±0.5 dB/10 dB, ±1.0 dB/50 dB, to a maximum of 1.5 dB cumulative over a 100 dB range

**RF Gain Uncertainty** – ±1.5 dB

**FEATURES/BENEFITS (cont.)**

- **Intelligent Markers and Signal Processing:** Search, Sort, and Mark CW, Pulse, or All Signals. Exclusive Occupied Bandwidth Mode. Signal Tracking.
- **Built-in 100 Hz to 1.2 THz Frequency Counter**
- **Up to 7x10<sup>-9</sup>/day Center Frequency Accuracy**
- **Fully Programmable with Two GPIB Interfaces**
- **Built-in Automation** Macro Downloading to 40k of NVRAM. Store up to 20 Front-Panel Key Sequences. Store up to 20 Waveforms with Readout Information. Store up to 20 Instrument States.
- **View Analog and Digitally-Stored Waveforms Simultaneously**
- **High-Resolution Color Display**
- **Space Saving Portable Package**

**SPURIOUS RESPONSES**

**Spurious Responses** – < -90 dBc except as noted below:

Residual Signals	< -100 dBm, 100 Hz to 6.5 GHz
	< -92 dBm, 6.5 GHz to 21 GHz
	< -82 dBm, 21 GHz to 28 GHz
	< -80 dBm, 28 GHz to 33 GHz

**1-dB Gain Compression –**

100 Hz to 21 GHz: 0 dBm.  
21 GHz to 28 GHz: -3 dBm.  
28 GHz to 33 GHz: -6 dBm.

**Intermodulation Rejection –**

Second Order Intercept: > +28 dBm, 1 MHz to 6.5 GHz.  
Third Order Intercept (with signal separation < 150 MHz):  
> +15 dBm, 1 MHz to 6.5 GHz.  
> +10 dBm, 6.5 GHz to 28 GHz.

**Second Harmonic Distortion –** (at -30 dBm signal)

< -60 dBc, 50 MHz to 6.5 GHz.  
< -100 dBc, 6.5 GHz to 33 GHz.

**Out of Band Responses –**

	Center Frequency Ranges	
	100 Hz to 28 GHz	28 GHz to 33 GHz
Image Response	< -65 dBc	< -65 dBc
Harmonic Conversions	< -65 dBc	< -55 dBc
Signals at external Input with coax selected:	< -90 dBc	< -90 dB GHz

**DISPLAY-RELATED**

**Display Type** – Liquid crystal color shutter, 10 x 10 div. graticule.

**Digital Storage** – Maximum Sweep Rate: 10 ms with 10-bit resolution, 2 ms with reduced horizontal resolution. Vertical Digitizer Uncertainty:  $\pm 0.4\%$ .

**Nonvolatile Memory** – CMOS battery backed-up RAM, memory retention guaranteed to  $-10^\circ\text{C}$ .  
Battery Type: Lithium cells.

Battery Life: 1.8 years @  $20^\circ\text{C}$ , 1 year @  $50^\circ\text{C}$  (batteries are not used while in standby mode).

Waveforms: 20 waveforms with screen readouts and labels or date/time stamp.

Front-Panel Setups: 20 complete front-panel setups.

Front-Panel Sequences: 20 sequences.

Macros: 40k of RAM.

Instrument Calibration Data: Separate EEPROM.

**Sweep Generator and Triggering –**

Sweep Generator:	
Sweep Speed Range	200 s to 2 $\mu\text{s}$ in 1, 2, 5 sequence
Accuracy	5%, 50 $\mu\text{s}$ and slower; 10%, 20 $\mu\text{s}$ and faster

**Triggering: Adjustable trigger level and slope**

Internal	ac coupled; 10 Hz to 1 MHz; no more than two divisions of signal required to trigger
External	dc coupled; 0 Hz to 5 MHz or 0 Hz to 1.5 kHz; 0.3 V P-P required to trigger
Line	Copy of ac line

**INPUTS AND OUTPUTS**

**RF Input** – Frequency Range: 100 Hz to 33 GHz.

Coupling: dc.

Connector: Planar crown system connector with K compatible and N-type adapters as standard accessories.  
Impedance: 50  $\Omega$ .

**VSWR –**

RF Atten	Center Frequency Ranges		
	100 Hz to 6.5 GHz	6.5 GHz to 28 GHz	28 GHz to 33 GHz
10 dB	< 1.4:1	< 2.0:1	< 2.0:1
0 dB	< 2.0:1	< 3.0:1	< 3.0:1

**Maximum Safe Input Power –**

AC Average Power: +30 dBm with  $\geq 10$  dB attenuation.  
Pulse Power: 50 W peak, 1  $\mu\text{s}$  and 0.005 duty factor with  $\geq 50$  dB attenuation.  
DC: 0 volts.

**Local Oscillator Emission** – (at 0-dB RF attenuation)  $\leq -75$  dBm: 100 Hz to 6.5 GHz.  $\leq -65$  dBm: 6.5 GHz to 33 GHz.

**External Mixer Input** – (diplexer built-in)

Impedance: 50  $\Omega$ ; VSWR < 1.9:1 at 525 MHz and < 2.2:1 at 3.525 GHz.

LO Output Power:

$\geq 13$  dBm at 8 - 10 GHz  
 $\geq 15$  dBm at 10 - 16.5 GHz  
 $\geq 13$  dBm at 16.5 - 18 GHz

**LO Output** – Provides access to output of 1st LO at +5 dBm minimum.

**Probe Power** – Provides operating voltage for active probes; output voltages are:

pin 1: +5 V  $\pm 5\%$  @ 100 mA max

pin 2: ground

pin 3: -15 V  $\pm 5\%$  @ 100 mA max

pin 4: +15 V  $\pm 5\%$  @ 100 mA max

**Reference Signal Out –**

Amplitude: -20 dBm.

Amplitude Accuracy:  $\pm 0.3$  dB.

Frequency: 100 MHz (derived from reference oscillator).

**Ref In/Out –**

Impedance: 50  $\Omega$  nominal.

Input Frequency: 10 MHz  $\pm 5$  Hz.

Input Signal Amplitude Range: 0 dBm minimum to +15 dBm maximum.

Output Signal (when selected): Nominally 0 dBm at 100 MHz.

Allowable Phase Noise:  $\leq 100$  dBc/Hz at 1 Hz offset.

(without degrading instrument phase noise performance).

**Ext Trig/ Horiz** – External trigger input, or external sweep input.

**Accessory Connector** – 15-pin connector for external inputs and outputs.

Ext. In Display Blanking: Provides external access to crt beam blanking.

Ext. In Display Horiz and Vert: Provides external access to real-time channel of the instrument; dc coupled; 10 MHz bandwidth.

Sweep Output: Provides copy of analog sweep.

Ext. In Video: Provides external access to instrument's video processing system; 7.5 MHz bandwidth.

# HIGH-PERFORMANCE MICROWAVE SPECTRUM ANALYZER

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NEW

Penlift: TTL-level output to lift plotter pen.  
YIG Coil Tune Voltage and Return: Provides external output of the YTO coil-tuning voltage and a return path.

**Ext V Out** - External display signal output; jumper-selectable between full deflection amplifier signal or the real-time signal.

**Ext H Out** - External display horizontal signal output; jumper-selectable between full deflection amplifier signal or the real-time signal.

**Ext Z Out** - External display blanking signal output; jumper-selectable between Z-axis signal or sweep gate.

**IF Output** -  
Amplitude: +10 dBm  $\pm$  1 dB for a full-screen signal  
Impedance: 50  $\Omega$ ; VSWR  $\leq$  1.5:1  
Frequency: 25 MHz for 3 MHz or 10 MHz resolution bandwidth filter; 4 MHz for 1 MHz or less resolution bandwidth filter.

## EXTERNAL INTERFACE PORTS

**GPIB** - Two GPIB ports (IEEE Std. 488-1978) are standard. Interface Functions: Port 1: SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, C0.  
Port 2: SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, C1, C2, C3, C4, C25. (C0 selectable).

## POWER REQUIREMENTS

**Input Voltage** - 90 to 132 V ac, 47 to 440 Hz; 180 to 250 V ac, 47 to 63 Hz.

**Power** - 250 W maximum, 2.8 amperes @ 115 V ac, 60 Hz

**Leakage Current** - 3.5 mA maximum current.

## ENVIRONMENTAL CHARACTERISTICS MIL-T-28800C, TYPE III, CLASS 3, STYLE C

**Temperature** - Operating: -10°C to +55°C.  
Non-operating: -62°C to +85°C.

**Humidity** - 5 cycles per MIL STD 810D Procedure III (modified).

**Altitude** - Operating: 15,000 ft. Non-Operating: 40,000 ft.

**Vibration** - Operating: Tested to MIL STD 810D Procedure I (modified); resonant search in all axes from 5-15 Hz with displacements up to 0.060 inches, 15-25 Hz with displacements up to 0.040 inches, and 25-55 Hz with displacements up to 0.020 inches.

**Shock** - Operating and Non-operating: Tested to withstand three shocks of 30 g, one-half sine, 11 ms duration each direction along each major axis.

**Transit Drop** - Tested to withstand eight-inch drops, one per each of six faces and eight corners.

## ELECTROMAGNETIC INTERFERENCE

### MIL STD 461C Part 4 -

#### Conducted Emissions -

CE01-60 Hz to 15 kHz, 15 dB relaxation below 2 kHz.  
CE03-15 kHz to 50 MHz power leads; narrowband and broadband full limits (Navy).

#### Conducted Susceptibility -

CS01-30 Hz to 50 kHz power leads, full limits.  
CS02-50 kHz to 400 MHz power leads, full limits.  
CS06-spike power leads, full limits.

#### Radiated Emissions -

RE01-30 Hz to 50 kHz magnetic field, 5 dB relaxation below 1 kHz and 10 dB relaxation from 1 kHz to 50 kHz.  
RE02-14 kHz to 1 GHz; meets MIL STD 461C Part 7 to full limits.

#### Radiated Susceptibility -

RS01-30 Hz to 50 kHz magnetic field, full limits.  
RS02-magnetic induction, 30 dB relaxation.  
RS03-14 kHz to 1 GHz; front-end responses, full limits at 1 V/m, relaxed 15 dB at 10 V/m; IF frequencies, full limits at 1 V/m, relaxed 20 dB at 10 V/m. 1 GHz to 10 GHz; front-end responses, full limits at 1 V/m, relaxed 20 dB at 10 V/m; IF frequencies, relaxed 15 dB at 1 V/m, relaxed 35 dB at 10 V/m.

**VDE** - Meets VDE 0871 Class B-Regulations for RFI Suppression of High Frequency Apparatus and Installations.

**FCC** - Meets FCC Part 15 Subpart J Class A-EMI Compatibility.

**German R6V** - Meets German R6V, X-Ray Decree, Section 5, March 1973.

**Safety** - Meets the following industry safety standards: CSA Electrical Bulletin 556B; ISO/ANSI DS82, Safety Requirements for Electronic Measuring and Controlling Instrumentation; IEC 348, 2nd Edition, Safety Requirements for Electronic Measuring Apparatus; FM-Electrical Utilization Standard Class 3810.

## OPTICAL TO ELECTRICAL CONVERTER

### SA-42

- Adapts Microwave Spectrum Analyzers to measure optical components and systems.
- DC to 6.5 GHz (-3dB), 15 GHz (-25dB).
- 35 mV into 50  $\Omega$  per 1 mW of optical power.
- Ultra low noise.

## APPLICATIONS

- Measure RF spectral content of analog or digital

## PHYSICAL CHARACTERISTICS

Dimensions	Without Front Cover, Feet or Handle		With Front Cover, Feet and Handle	
	mm	in	mm	in
Width	330	13	407* <sup>1</sup>	16* <sup>1</sup>
Height	203	8	407* <sup>2</sup>	16* <sup>2</sup>
Depth	473	18.6	559* <sup>1</sup>	22* <sup>1</sup>
Weight	kg	lb	kg	lb
	-	-	20	44

\*<sup>1</sup> Handle folded back

\*<sup>2</sup> Handle extended

## ORDERING INFORMATION

2782 Microwave Spectrum Analyzer **\$65,000**  
Includes: N-male to BNC-female adapter (103-0045-00); N to Planar Crown adapter (131-4329-00); Cable, 50-ohm SMA (012-0649-00); Line fuses: 4 A, 125 V ac (159-0319-00); 4 A, 250; V ac (159-0320-00); Power cord (161-0104-00); Operator's Manual (070-6794-00); Operator's Reference Guide (070-6795-00); Programmer's Manual (070-6796-00); Programmer's Reference Guide (070-6798-00).

### OPTIONS

- Opt. B1** - Two Service Manuals (Volumes 1 and 2) prepared to the component-level. **+\$250**
- Opt. B2** - Complete set of manuals, including two-volume, component-level Service Manual set. **+\$350**
- Opt. 18** - WM782 Bands A, U, E, F, and G Waveguide Mixer Set (frequency coverage from 26 to 220 GHz). **+\$9,340**
- Opt. 19** - WM782 Bands Q, V, W, and D (frequency coverage from 33 to 170 GHz). **+\$15,040**
- Opt. 20** - Utility Software for PC, includes PC GPIB card. **+\$1,530**
- Opt. 21** - Compaq Portable II Computer with utility software. **+\$5,650**
- Opt. 25** - Tektronix PEP 301 System Controller with utility software. **+\$9,065**
- Opt. 29** - Epson LX-850 Printer. **+\$550**
- Opt. 30** - CradleMount for 19-inch rackmounting. **+\$750**
- Opt. 39** - Silver battery. **+\$50**

### WARRANTY INFORMATION

The standard one-year Tektronix warranty can be extended with the **Warranty-Plus** Service Plans listed below. For more information, contact your Tektronix Sales Engineer or local Tektronix Service Center or refer to the Service Section in this catalog.

- Opt. M1** - 2 calibrations **+\$3,175**
- Opt. M2** - + 2 years service. **+\$2,880**
- Opt. M3** - + 2 years service and 4 calibrations **+\$6,350**
- Opt. M4** - 5 calibrations **+\$5,675**
- Opt. M5** - + 2 years service and 9 calibrations **+\$10,480**
- Opt. M7** - + 2 calibrations **+\$1,835**

### INTERNATIONAL POWER PLUG OPTIONS

- Opt. A1** - Universal European 220 V 6 A, 50 Hz. **NC**
- Opt. A2** - United Kingdom 240 V/5 A, 50 Hz. **NC**
- Opt. A3** - Australian 240 V/12 A, 60 Hz. **NC**
- Opt. A4** - North American 240 V/12 A, 60 Hz. **NC**
- Opt. A5** - Switzerland 220V/6A, 50 Hz. **NC**

### OPTIONAL ACCESSORIES

- Module Level Service Manual** - Order 070-6799-00. **"**
- Service Kit** - Contact your local field office.
- SA-42** - Optical to Electrical Converter **\$3,250**

\*<sup>1</sup> Contact your local sales representative.