Spectrum Analyzer

H500 / SA2500 Datasheet

Features & Benefits

Scan

- Revolutionary DPX™ Live RF spectrum display technology with DPX Spectrum Mask provides intuitive understanding of live RF signals using colors based on frequency of occurrence, processing up to 10,000 spectrums/sec with a 100% Probability of Intercept (POI) to capture pulsed signals, radar emissions, hopping signals, and any other intermittent signals with a minimum duration as brief as 125 µs
- Benchtop spectrum analyzer performance in a ruggedized handheld battery-operated field unit offers better than 70 dB spurious free dynamic range (SFDR), guaranteed ≤ -95 dBc/Hz at 10 kHz offset phase noise specifications from 10 kHz to 6.2 GHz
- Excellent sensitivity for detecting very low-level signals with -153 dBm DANL at 10 Hz RBW (equivalent to -163 dBm/Hz) such as RF bugs and unauthorized transmitters
- LAN interface for remote control and unattended monitoring stations for spectrum awareness

Classify

- Built-in classification capability for WLAN, GSM, W-CDMA, CDMA, ATSC signals makes quick and simple identification of legitimate signals
- Flexibility to edit, upgrade, and share signal databases and signal classification database using CSV file formats
- Ability to export I/Q data into CSV, MATLAB®, and IQT format for additional post-analysis

Locate

- Rapid targeting of signals with field-proven signal hunting, mapping, and documentation tools
- Hunt outdoor signals with built-in GPS receiver by plotting measurements directly into GPS geo-referenced maps such as Pitney Bowes Mapinfo, Google™ Earth, Microsoft® MapPoint®, Bitmap, and many others
- Improved spectrum awareness with high-accuracy measurement synchronization and time stamping
- Hunt in-building signals with a single-touch Tap-and-Walk-and-Tap interface
- Backlit display, viewable in direct sunlight, and extended battery performance with hot-swappable dual batteries
- Rugged design per MIL-PRF-28800F

Applications

- Spectrum Management
- Spectrum Monitoring and Surveillance
- Interference Detection and Troubleshooting
- Signal Hunting
- Signal Identification
- Signals Intelligence (SIGINT)
- Homeland Security

Tektronix®

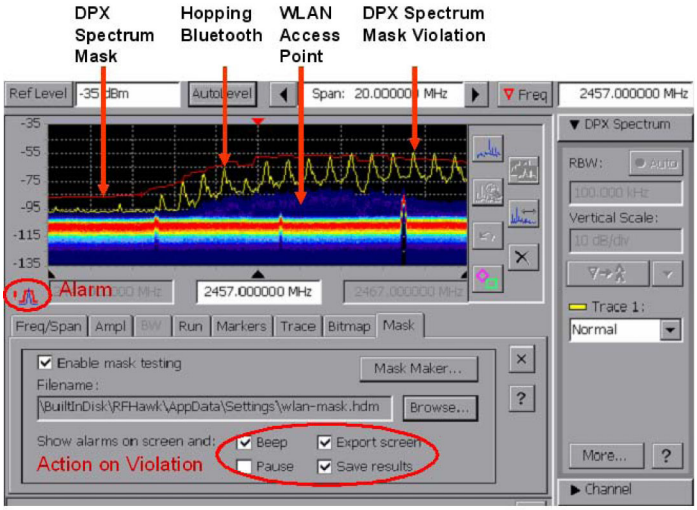
Interference Troubleshooting has Never Been so Easy

The H500 and SA2500 will quickly scan the RF environment, classify the known signals, and help you locate the unknown signals with their field-proven signal hunting tools. Featuring real-time DPX™ Live RF spectrum display technology, the H500 and SA2500 offer practical solutions for discovering transient events that slip past conventional spectrum analyzers. With field-ready, rugged hardware featuring outstanding displayed average noise level (DANL), spurious free dynamic range (SFDR), phase noise, and easy LAN networking capability in a handheld unit, the H500 and SA2500 are a great choice for general-purpose spectrum measurements and ideal signal-hunting tools.

Evolving digital RF communication standards pose an unprecedented challenge to the surveillance and security community. Identification of unknown signals and determining their precise location has traditionally been accomplished using a combination of lab-grade spectrum analyzers, handheld spectrum analyzers, oscilloscopes, and offline analysis capabilities using PCs. When lab equipment is used in the field, several limitations appear. Such instruments are not meant for field use, can be easily damaged, are not portable, and require AC power. Signal classification using these systems often requires a lot of prior knowledge about these signals, particularly when they are digital. With such systems the unknown signals can be difficult or impossible to identify.

Scan

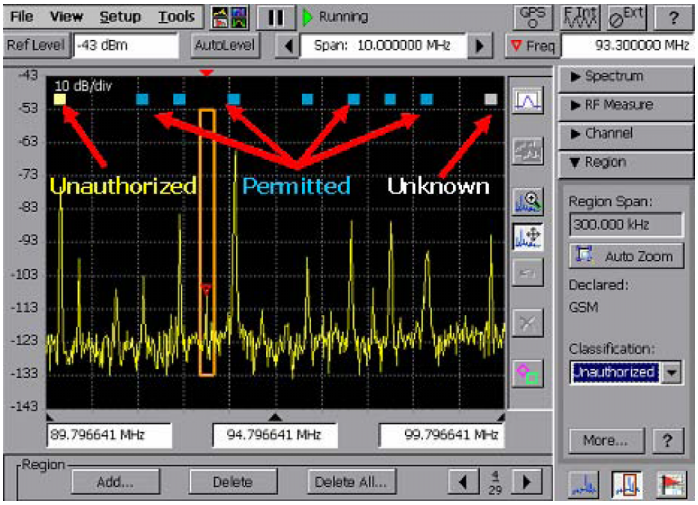
By scanning the RF spectrum users can spot which signal emitters are in the area. Signals with significant power are usually candidates for further analysis, as are signals that are present infrequently. By color-coding events based on the rate of occurrence, the DPX™ Live RF spectrum display provides unparalleled insight into the behavior of signals. Performing 10,000 spectrum updates per second, transients as brief as



DPX Spectrum Mask captures and logs spectrum violations with options of warning alarm, pausing test, export screen, and result save

125 µs can be "frozen" in the frequency domain. This offers tremendous improvement over swept analysis techniques.

Signals that are present in the spectrum today but were not there yesterday are of particular interest. Reference signals can be stored and deviations from this reference can be quickly identified using the trace math feature. The H500 and SA2500 make analysis easier by quickly logging signals that are weak, bursting, hopping, time multiplexed, or intentionally random. It takes advantage of the FFT-based spectrum analysis capability to allow users to see the true shape of the signal, even when it is bursting. Masks can be automatically created from traces captured earlier. You can compare this mask to the current trace and if a mask violation occurs, the trace is logged. Finally, when the spectrogram is paused, you can scroll through the spectrogram's time axis and view the results.

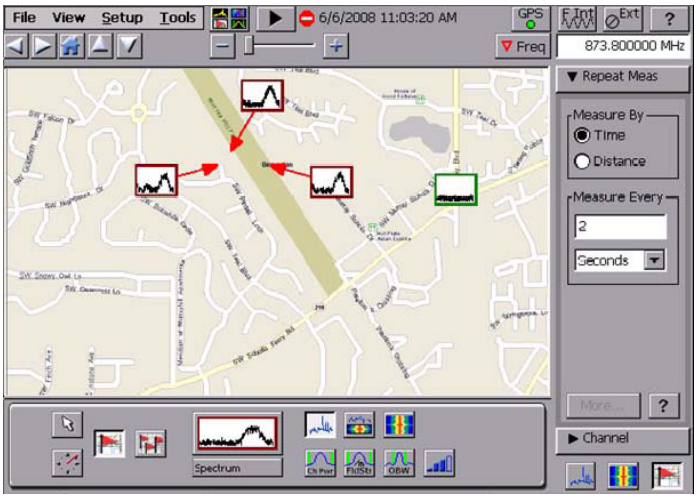


Color-coded signal classification database can be saved, recalled, imported, exported, and shared to keep track of spectrum activities at different locations

Classify

Once signals of interest are found, it becomes necessary to identify and classify each of them. Are they authorized, legal signals, or are they illegitimate, malicious signals? Digital signal classification can be a particularly difficult part of the signal hunter's job requiring extensive knowledge of signal characteristics. The signal may be weak, subject to fading or intermittent conditions. In addition antenna position may be suboptimal. All of this makes classification of signals more challenging when using traditional signal identification tools.

The H500 and SA2500 with Option EP2 offer expert systems guidance to aid the user in classifying signals. It provides graphical tools that allow users to quickly create a spectral region of interest, enabling users to identify and sort signals efficiently. The spectral profile mask, when overlaid on top of a trace, provides signal shape guidance while frequency, bandwidth, channel number, and location are displayed allowing for quick checks.



Locate interference with integrated mapping solution

Locate

Once the signal has been identified as a threat, the H500 and SA2500 provide various field-proven signal hunting tools to locate the offending signals. For the easier-to-find signals, the signal strength meter produces tones that vary with pitch as a function of the strength of this signal. This allows the operator to look for signals while watching their surroundings, not the screen.

For signals that are harder to find, such as signals influenced by multipath, fading, low signal strength, etc, the H500 and SA2500 provide several signal mapping tools to facilitate hunting for these signals. Analyzing mapped signals is a quick way to find signals that can be difficult to find otherwise. The mapping capability is also a way to document what you have found. Traces can be recorded on a map either manually or automatically. Built-in GPS can be used to automatically record signal position and time data as the operator moves. For indoor use, a unique tap-and-walk interface provides signal mapping capability. Color-coded icons automatically record the relevant measurements based on preset thresholds for acceptability.

Performance You Can Count On

Depend on Tektronix to provide you with performance you can count on. In addition to industry-leading service and support, this product comes backed by a three-year warranty as standard.

Characteristics

General Performance Characteristics

Characteristic	Description
RF Input	
Operating Frequency Range	10 kHz - 6.2 GHz
Maximum Operating Input Level	+20 dBm peak envelope power This is the maximum input level at which the instrument will meet its performance specifications. For a signal without any amplitude variation, peak envelope power = rms.
Maximum Input Power without Damage	50 W_{rms} below 3.2 GHz 15 W_{rms} between 3.2 GHz and 6.2 GHz
IF Output	
Output Impedance	50 ohms
IF Center Frequency	140 MHz
IF 3 dB Bandwidth	24 MHz

IF Output Level (nominal performance at 0 dBm input)

	Input Frequency	IF Output Level
	1 GHz	-12 dBm
	1.6 GHz	-12 dBm
	3.6 GHz	-10 dBm
	4.35 GHz	-11 dBm
	5 GHz	-16 dBm
	5.75 GHz	-22 dBm

Internal Timebase	
Frequency Error (factory calibration corrected)	±0.5 PPM from 0 °C to 50 °C ±1.0 PPM aging/year Twenty-minute warm-up period required to meet accuracy specification
Frequency Error (GPS corrected)	±0.01 ppm (typical)
Frequency Error (after GPS Lock Loss)	±0.03 ppm, 10 minute interval after Lock Loss (unit operated for >20 minutes before Lock Loss and < 5 °C temperature change over interval) (typical)
External Reference Input	
Impedance	1500 ohm
Frequency Range	1 MHz up to 20 MHz ± 1 PPM in 1 MHz steps
Input Level Range	-15 dBm to +15 dBm, 1 MHz to 15 MHz -10 dBm to +15 dBm, 16 MHz to 20 MHz dBm levels assume 50 ohm source
Integrated GPS receiver	
Position Accuracy (typical)	Horizontal: R < 9 meters (P = 90%) Altitude: H < 18 meters (P = 90%)
Position Update Rate (nominal)	1 update/sec (Latitude/Longitude/Altitude)

Spectrum Analyzer Characteristics

Characteristic	Description
Frequency	
Span	10 kHz to 6.2 GHz preamp off 10 MHz to 6.2 GHz preamp on
Center Frequency Setting Resolution	1 Hz
Swept Spans (wide scanning)	
Span Range	20 MHz to 6.2 GHz
Spectrums per second	61 (typical)
Scan Speed	1240 MHz per second (Typical)

Characteristic	Description
Resolution Bandwidth (RBW)	
RBW Range	10 Hz to 3 MHz (Manual) 10 Hz to 1 MHz (Auto)
RBW Setting Resolution	1 Hz
Spectral Purity	
Displayed Average Noise Level, Preamp On	-153 dBm, 10 MHz to 2 GHz, 10 Hz RBW -152 dBm, 2 GHz to 4 GHz, 10 Hz RBW -151 dBm, 4 to 5 GHz, 10 Hz RBW -145 dBm, 5 to 6.2 GHz, 10 Hz RBW
Phase Noise (entire operating frequency range)	≤ -95 dBc/Hz at 10 kHz offset ≤ -95 dBc/Hz at 20 kHz offset ≤ -95 dBc/Hz at 30 kHz offset ≤ -97 dBc/Hz at 100 kHz offset ≤ -110 dBc/Hz at 1 MHz offset
Residual Spurious, Preamp Off	≤ -90 dBm, 0 dBm attenuator setting
	Exception Frequencies: 9 MHz to 19 MHz center frequency 3464 MHz center frequency 4592 MHz center frequency 5374 MHz to 5378 MHz center frequency 6160 MHz center frequency
Residual Spurious, Preamp On	≤ -105 dBm, 0 dBm attenuator setting
	Exception Frequencies: 9 MHz to 19 MHz center frequency 5374 MHz to 5378 MHz center frequency
Third Order IMD	≤ -70 dBc for two tones at or below the reference level, preamp off, all gain settings Auto-coupled
Second Harmonic	≤ -60 dBc for a single tone at or below the reference level, preamp off, all gain settings Auto-coupled
Input-related Spurious	≤ -70 dBc except for F_{in}= 2.282 GHz ± 20 MHz The dBc reference for this specification is the total power of all signals at the input of the instrument regardless of the current span
Input-related Spurious, exception frequencies, typical	≤ -55 dBc at F_{in}= 2.282 GHz ± 20 MHz The dBc reference for this specification is the total power of all signals at the input of the instrument regardless of the current span
Third Order Intercept	≥ +7 dBm, 0 dB Input Attenuation, Preamp Off
Spectral Display Amplitude	
Reference Level Range	+20 dBm to -160 dBm
Marker Power Accuracy	±1.75 dB, -50 dBm ≤ input ≤ +20 dBm, preamp off ±3.0 dB, -80 dBm ≤ input < -50 dBm, preamp on, above 10 MHz ±3.75 dB, -120 dBm ≤ input < -80 dBm, preamp on, above 10 MHz Use peak detector for CW-like signals; use average detector for wideband (signal >> RBW) Accuracy guaranteed for CW signals and span set to 20 MHz or less
Display	
Display Modes	Normal – Updates display with each new result Max Hold – Updates displayed point only if new point > old Min Hold – Updates displayed point only if new point < old Max/Min Hold – Displays a vertical bar between Max Hold and Min Hold Average – Displays average of N (specified by user) acquisitions Average is calculated as follows: Last N values are saved in memory; when a new result is available, the earliest result of the N stored values is discarded, the new result is added to the stored values, and a new average is calculated from the stored values If the number of results is less than N, then all of the results are averaged together
Number of Averages	1 ≤ N ≤ 200

General Purpose RF Measurements Characteristics

Characteristic	Description
General Purpose RF Channel Power Measurement	
Bandwidth Range	1 kHz - 20 MHz
Accuracy	≤1.2 dB; +20 dBm to -60 dBm; 1 MHz to 3.2 GHz, preamp off, Ref Level > -35 dBm ≤2.4 dB; -40 dBm to -75 dBm; 10 MHz to 3.2 GHz, preamp on, Ref Level ≤ -35 dBm ≤1.8 dB; +20 dBm to -50 dBm; 3.2 GHz to 6.2 GHz, preamp off, Ref Level > -35 dBm ≤3 dB; -40 dBm to -75 dBm; Resolution BW < 100 kHz; -40 dBm to -55 dBm; Resolution BW ≥ 100 kHz 3.2 GHz to 6.2 GHz, preamp on, Ref Level ≤ -35 dBm Specifications apply for default control settings (Auto RBW, Auto Level)
Occupied Bandwidth Measurement	
Percent Power Inclusion Range	50-100%
RF Field Strength	
Channel Bandwidth Range	Same as Channel Power
Accuracy	Same as Channel Power

Scan, Classify, Locate Characteristics

Feature	Description
DPX™ Live RF Spectrum Display	
Spectrum Processing Rate, nominal	10,000 spectrums per second, span independent (H500 standard and SA2500 with Option EP1) 2,500 spectrums per second (SA2500 standard)
Minimum Signal Duration for 100% Probability of Intercept (POI), typical	125 µs (H500 standard and SA2500 with Option EP1) 500 µs (SA2500 standard)
Span Range	5 kHz to 20 MHz
Spectrogram (Rising Raster)	
Spectrum Processing Rate, nominal	20 spectrums per second
Minimum Signal Duration for Time Measurement	20 milliseconds (Typical)
Span Range	5 kHz to 20 MHz
Trigger	
Modes	Single or Continuous, Free Run or Triggered
Event Source	IF Level, External Input, or Internal Timebase
Types	Rising Edge, Falling Edge, Level Above Threshold, Level Below Threshold
Delay	0 to 60 s with 1 µs resolution
Position	Settable from 0-100%
IF Level Trigger	
Threshold Range	-160 dBm to +20 dBm
Bandwidth Range	5 kHz to 20 MHz
External Trigger	
Maximum Input Level without Damage	±5 V_{peak} continuous
Minimum High Threshold	2.0 V
Maximum Low Threshold	0.8 V
Minimum High/Low Time	10 ns
Impedance	10 kΩ
Coupling	DC
Internal Timebase Trigger	
Mode	Single trigger on time, Repeat trigger at interval or both
Resolution	1 µs
Measurement Result Time Stamps	
Resolution (nominal)	1 ms before GPS lock obtained; 1 ns after GPS lock obtained.

Feature	Description
Accuracy - Relative (typical)	±500 ns time-stamp error between multiple measurement results. Internal GPS reference lock required.
Accuracy - GPS Reference (typical)	±1 µs, all measurements except DPX Spectrum; ±1 ms DPX Spectrum. Time-stamp error relative to GPS system absolute time reference. Internal GPS reference lock required, identical acquisition bandwidth setting required.

IQ Acquisition Time (available in Amplitude vs. Time)

	Span	Sample Rate	Max Acquisition Length
	20 MHz	28 Msps	36 ms
	10 MHz	14 Msps	73 ms
	5 MHz	7 Msps	146 ms
	2 MHz	2.8 Msps	365 ms
	1 MHz	1.4 Msps	731 ms
	500 kHz	700 ksps	1.4 sec
	200 kHz	280 ksps	3.6 sec
	100 kHz	140 ksps	7.3 sec
	50 kHz	72.9 ksps	14 sec
	20 kHz	27.3 ksps	37 sec
	10 kHz	13.7 ksps	74 sec
	5 kHz	6.8 ksps	149 sec

AM Demodulation	
Measurement Frequency	As previously selected
Minimum Input Signal Level, typical	-100 dBm
Audio Measurement Bandwidth	8 kHz
FM Demodulation	
Measurement Frequency	As previously selected
Minimum Input Signal Level, typical	-100 dBm
Maximum Signal Deviation	Up to 100 kHz
Audio Measurement Bandwidth	8 kHz, 15 kHz, 75 kHz, or 200 kHz
Maximum Audio Output Bandwidth	15 kHz
Signal Strength Indicator	
Input Signal Level	-120 dBm, minimum
Measurement Frequency	As previously selected
Measurement Bandwidth	Up to 20 MHz, dependant upon span and RBW setting
Tone Type	Variable beep rate or variable frequency
Update Rate, Typical	10 per second
Mapping	
Native Map Type	Graticule (.gsf)
Map Types Directly Supported	Pitney Bowes MapInfo (*.mif), Bitmap (*.bmp)
Other Map Types Accepted Using PC Application iMap Converter	Google™ Earth Microsoft® MapPoint® USGS DLG (*.opt) ESRI ArcInfo Shape (*.shp) Other raster formats (*.gif, *.jpg, *.png, *.tif)

General Characteristics

Characteristic	Description
Environmental	
Temperature	Operating: 0 °C to +50 °C specified performance, -10 °C to +50 °C, typical Nonoperating: -40 °C to +60 °C
	The temperature specs above are modified with the following options installed: Li-Ion Batteries: Charge 0 °C to +45 °C, Storage -20 °C to +60 °C
Humidity	Operating and Nonoperating: 5% to 95% relative humidity (RH) at up to +30 °C, 5% to 45% RH above +30 °C up to +50 °C, noncondensing
Altitude	Operating: Up to 4,600 meters (15,092 feet) Nonoperating: Up to 12,192 meters (40,000 feet)
Electromagnetic Compatibility (EMC) Compliance	
EN61326-1:2006 and EN61326-2:2006 Product Family Standard for Electrical Equipment for Measurement, Control, and Laboratory Use – EMC Requirements.	
European Union	
Emissions	CISPR11, Group 1, Class A EN 61000-3-2 EN 61000-3-3
Immunity	IEC 61000-4-2 IEC 61000-4-3 IEC 61000-4-4 IEC 61000-4-5 IEC 61000-4-6 IEC 61000-4-11
Australia/New Zealand	EMC compliance in accordance with the ACMA
USA	FCC, CFR Title 47, Part 15, Subpart B, Class A.
Safety Compliance	
Safety Compliance	ANSI/UL610101:2004 Electrical Equipment for Measurement, Control, and Laboratory Use CSA C22.2 No. 61010.1:2004 Electrical Equipment for Measurement, Control, and Laboratory Use EN 610101:2001 Safety Compliance Electrical Equipment for Measurement, Control, and Laboratory Use IEC610101:2001 Electrical Equipment for Measurement, Control, and Laboratory Use ISA 82.02.01 Electrical Equipment for Measurement, Control, and Laboratory Use
Physical	
Dimensions	Height: 25.5 cm. (10.0 in.) Width: 33 cm. (13 in.) Depth: 12.5 cm. (4.8 in.)
Weight	5.56 kg (12.27 lb.)
Display	
Color Display	10.4 in. (diagonal), transflective LCD Resolution: 640×480 (VGA)
Power	
Battery Life	5 hours of continuous Spectrum Mode (with optional second battery). Actual life can be higher depending on usage.
Warranty and Calibration	
Warranty	1 year on parts and labor
Recommended Instrument Calibration Interval	2 years

Ordering Information

Product	Description
H500	
Real-time spectrum analyzer with DPX™ Live RF spectrum display of 125 µs minimum signal duration for 100% Probability of Intercept (POI) and signal classification capability.	
Includes	User Manual (in PDF format), Installation Software, AC Power Adapter, Lithium-ion Battery, GPS Antenna, Flexible monopole antenna, Type-N (m) to BNC (f) adapter, USB A-B cable, Tilt Stand, Soft Carry Case, Audio Jack Mute Plug (mute all audio output from the instrument speaker), Three-year Warranty
SA2500	
Real-time spectrum analyzer with DPX™ Live RF spectrum display of 500 µs minimum signal duration for 100% Probability of Intercept (POI).	
Includes	User Manual (in PDF format), Installation Software, AC Power Adapter, Lithium-ion Battery, GPS Antenna, Flexible monopole antenna, Type-N (m) to BNC (f) adapter, USB A-B cable, Tilt Stand, Soft Carry Case, Audio Jack Mute Plug (mute all audio output from the instrument speaker), Three-year Warranty
Option EP1	Enhances SA2500 DPX™ Live RF spectrum display to 10,000 spectrums/sec and 125 µs minimum signal duration for 100% Probability of Intercept (POI)
Option EP2	Enhances SA2500 by adding signal classification to the Spectrum Notes capability. Provides capability to notate regions of RF spectrum. Provides capability to compare bandwidth, channel frequency, etc., to internal tables of standards. Can save a mask (stored display) of user-generated mask to enable spectrum violation measurement. Provides database to store these notation results, along with GPS location and time.

Language Options

Option	Description
L0	English manual
L99	No manual

Power Options

Option	Description
A0	North America
A1	Universal EURO
A2	United Kingdom
A3	Australia
A5	Switzerland
A6	Japan
A10	China
A11	India
A12	Brazil
A99	No Power Cord or AC Adapter

Service Options

Option	Description
G3	Complete Care 3 Years (includes loaner, scheduled calibration and more). H500 only
G5	Complete Care 5 Years (includes loaner, scheduled calibration and more). H500 only.
R3	Repair Service 3 Years
R5	Repair Service 5 Years
C3	Calibration Service 3 Years
C5	Calibration Service 5 Years
D1	Calibration Data Report
D3	Calibration Data Report 3 Years (with Option C3)
D5	Calibration Data Report 5 Years (with Option C5)

Recommended Accessories

Accessory	Description
119-6594-xx	Beam Antenna, 824 to 896 MHz
119-6595-xx	Beam Antenna, 896 to 960 MHz
119-6596-xx	Beam Antenna, 1710 to 1880 MHz
119-6597-xx	Beam Antenna, 1850 to 1990 MHz
119-6970-xx	Magnetic Mount Antenna, 824 to 2170 MHz (requires adapter 103-0449-00)
119-7246-xx	Pre-filter, General Purpose, 824 to 2500 MHz, Type-N (f) Connector
119-7426-xx	Pre-filter, General Purpose, 2400 to 6200 MHz, Type-N (f) Connector
012-0482-xx	Cable, 50 Ω, BNC (m) 3 foot (91 cm)
174-4977-xx	Cable, 50 Ω, Straight Type-N (m) and angled Type-N (m) connector, 1.6 foot (50 cm)
174-5002-xx	Cable, 50 Ω, Type-N (m) to Type-N (m) connector, 3 foot (91 cm)
119-6030-xx	External Battery Charger (2-slot, external)
119-7755-xx	AC Power Supply
146-0151-xx	Lithium-ion Battery
016-1882-xx	Display Protector Sheets

Instrument Upgrades

Upgrade	Description
To upgrade your SA2500, order options as noted:	
SA2500F Option EP1	Field Upgrade Kit for Enhanced Performance. Increases the SA2500 DPX™ live RF spectrum rate to 10,000 spectrums/s and 125 µs minimum signal duration for 100% probability of Intercept (POI), typical.
SA2500F Option EP2	Field upgrade for Enhanced Performance. Adds signal classification capability to notable regions of RF spectrum. Provides capability to compare bandwidth, channel frequency, etc., to internal tables of standards. Can save mask (stored display) of user-generated masks to enable spectrum violation measurements. Provides database to store these notation results, along with GPS location and time.

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

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For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

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