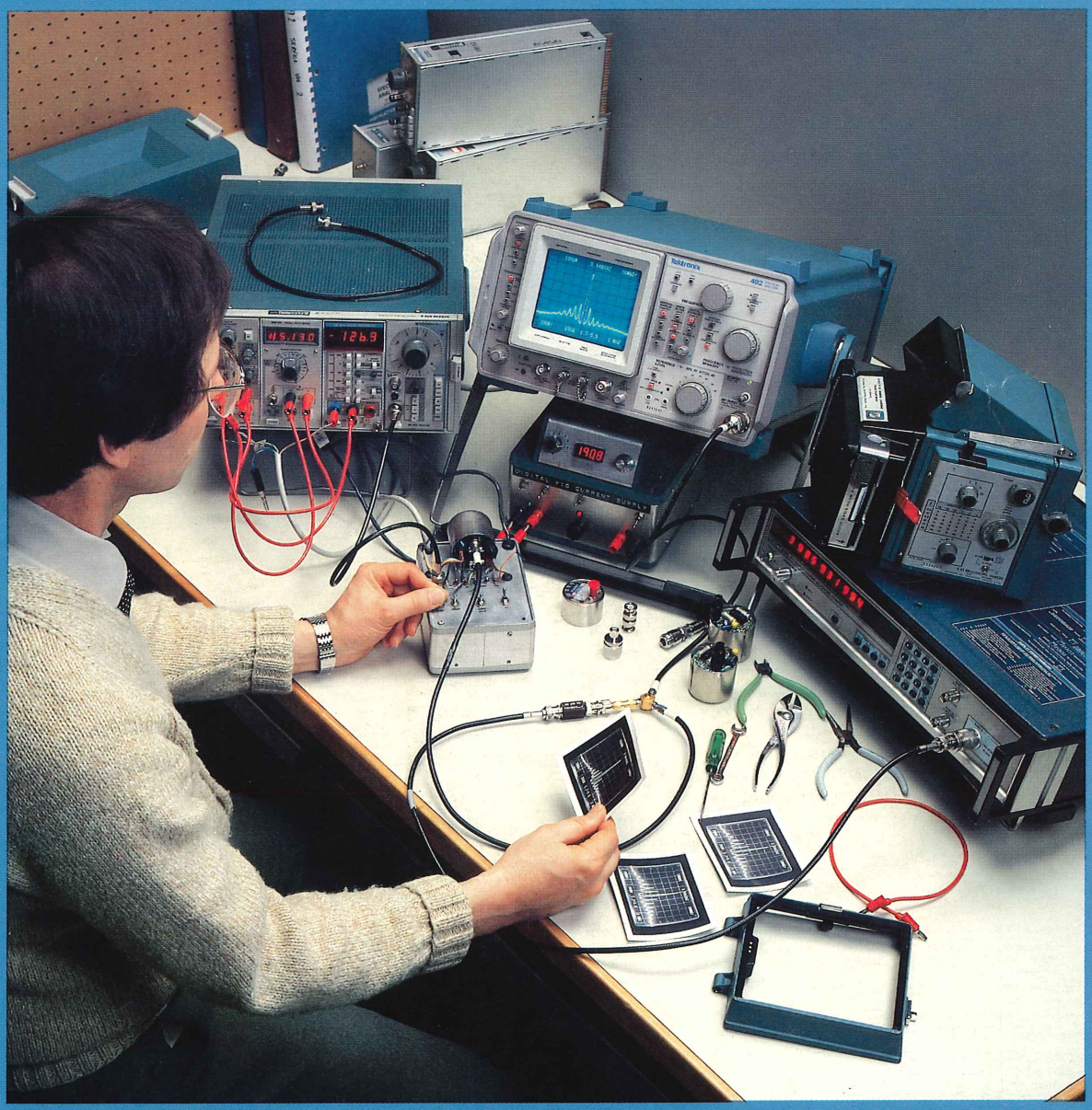
TEK 490 SERIES
SPECTRUM ANALYZERS

WE GO WHERE YOU GO WITH LAB QUALITY SPECTRUM ANALYSIS.



Tektronix®
COMMITTED TO EXCELLENCE

Lab quality you can get a handle on.

Fully calibrated in amplitude and frequency.

Crt readout of parameters. Reference level, center frequency, vertical scale factor, frequency span, frequency range, resolution bandwidth and *rf* attenuation are displayed right on the screen for easy reference and photographic documentation. Convenient bezel identification of crt parameters. Programmable control settings and signal display information are available via GPIB with the 492P and 496P.

80 dB dynamic range.

Low frequency-drift rate after just 30-minute warmup. 5 kHz/10 min. typical for the 492 and 492P; 2 kHz/10 min. typical for the 496 and 496P.

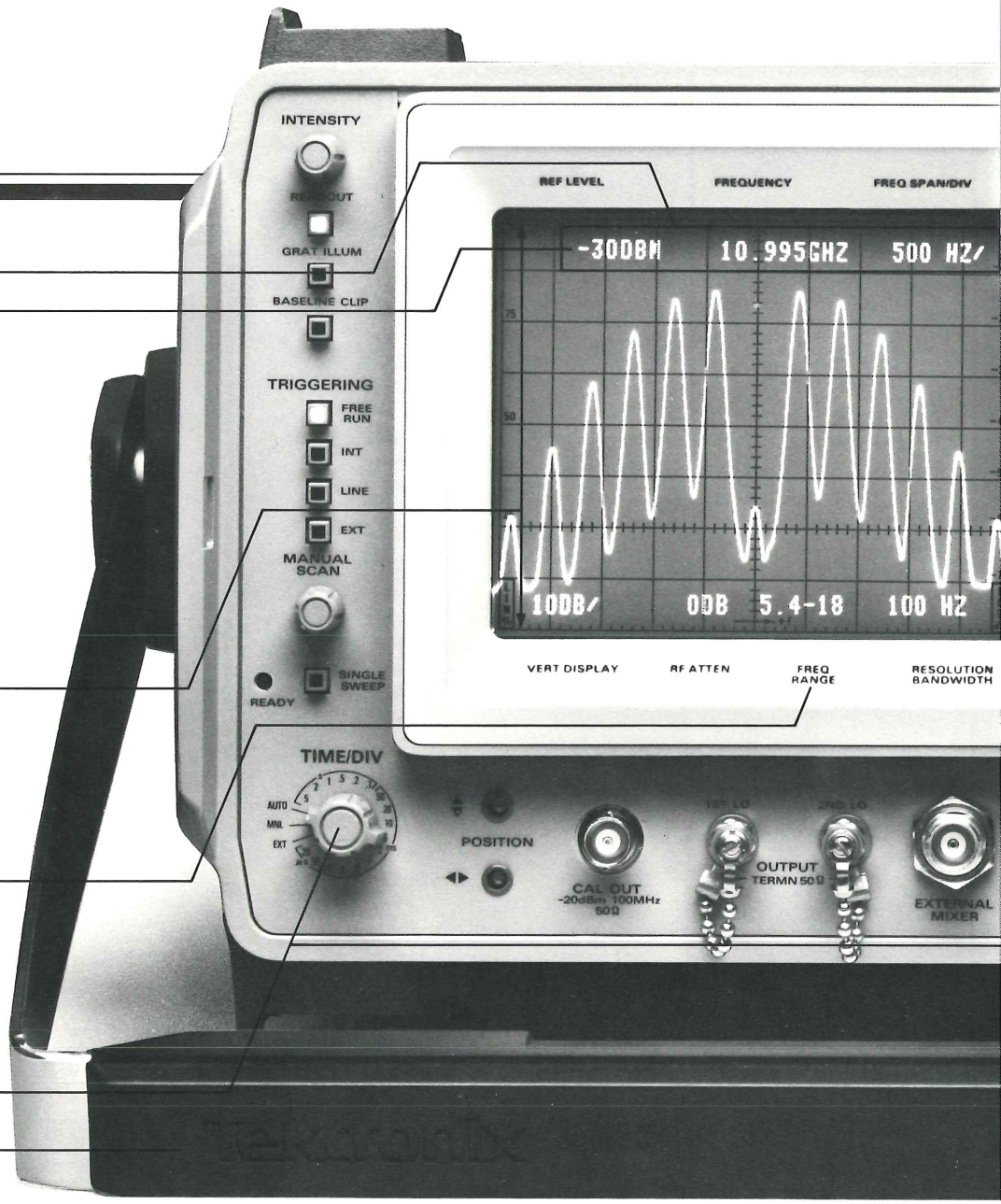
Wide frequency range. From 50 kHz to 220 GHz with the 492/492P—to 21 GHz in coax, from 18 to 220 GHz using Tektronix external waveguide mixers. The 496/496P covers from 1 kHz to 1.8 GHz.

Automatic Modes.

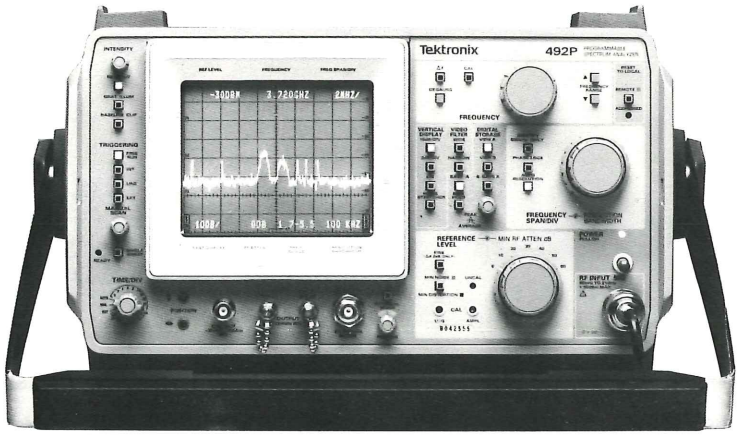
Lab quality plus portability. With their portable form factor and single-handle carry, 490 Series analyzers go where you go. Move easily around the lab or systems test area, fit under an airplane seat, or go with you on a field call.

Environmentalized per MIL-T-28800C type III, class 3, style C.

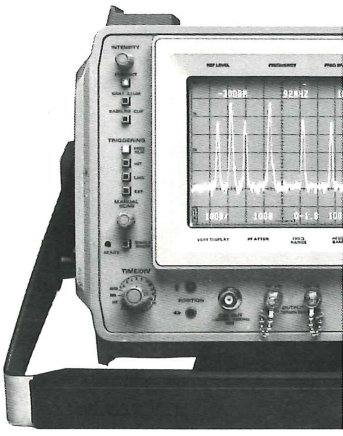
Full programmability. 492P and 496P models provide IEEE-488 compatibility via GPIB interface bus. For full programming of all signal-affecting front-panel control settings and processing of stored spectrum displays.



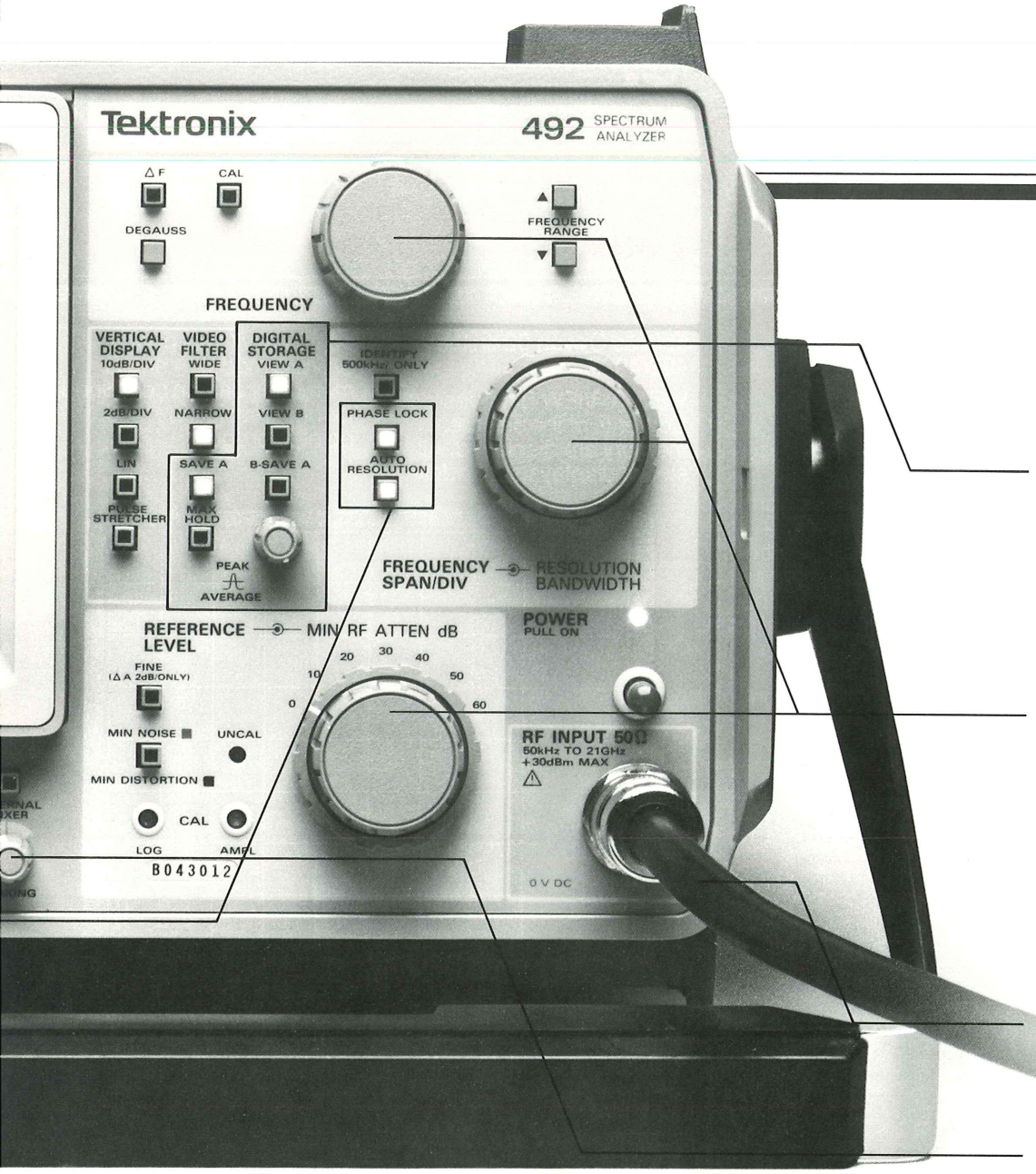
492 Spectrum Analyzer—50 kHz-220 GHz



492P Programmable Spectrum Analyzer—50 kHz-220 GHz



496 Spectrum Analyzer 1 kHz-1.8 GH



Manual to full programmability/GPIB conversion.
Buy now and convert later... if you're not sure about future programmability/GPIB requirements, you can postpone your decision and add capability at another time.

Digital storage and signal processing.
SAVE A, B MINUS SAVE A, MAX HOLD and AVERAGE modes. Lets you compare, subtract, save maximum values, or noise average (smooth) your spectrum displays.

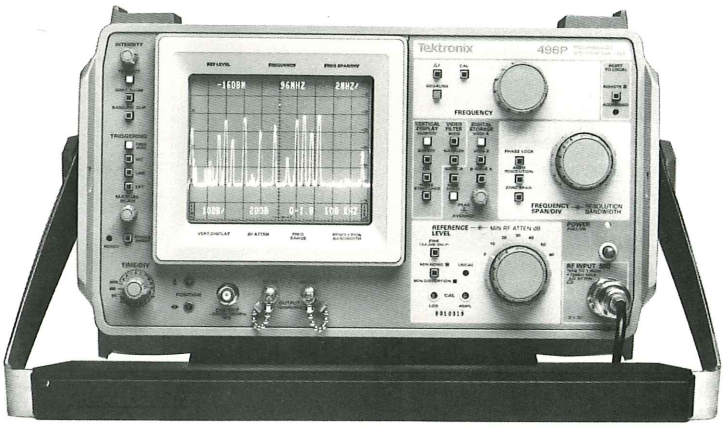
Microprocessor-aided ease of operation.
Simple three-knob operation performs your measurements quickly and easily:
1. Set center frequency.
2. Set span/div.
3. Set reference level.

Automatic control on most-often-used functions. Power-on initiates input protection and normal start-up settings.

Input protection.
1 watt (+30 dBm) at any attenuator setting including zero with 492 Option 1, and 496.

Preselector and external waveguide mixer peaking.

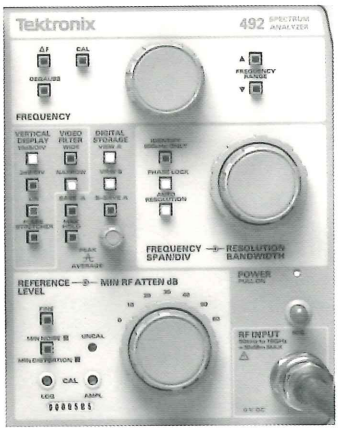
Freedom from spurious responses.
Internal calibrated YIG preselector plus low pass filter available as Option 01 with the 492/492P; low pass filter is standard with the 496/469P. Eliminates harmonic mixing products and images and increases dynamic range for harmonic measurements in the microwave range.



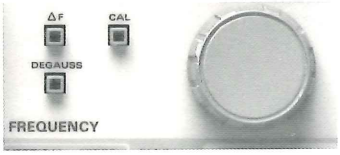
496P Programmable Spectrum Analyzer 1 kHz-1.8 GHz

490 Series Spectrum Analyzers. Unmatched convenience and capability. In a compact package.

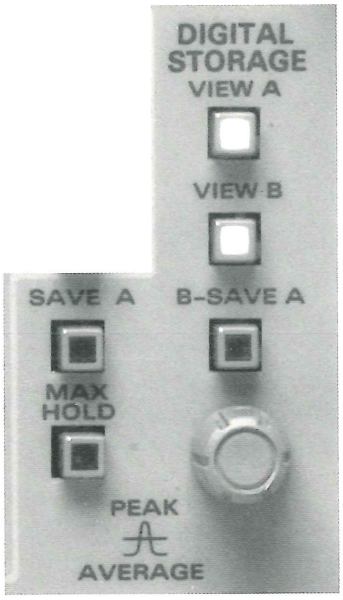
Simple to use.
Operation of 490 Series analyzers is as easy as 1 (set the input reference level), 2 (set the center frequency), and 3 (set the frequency span).



Most-used functions are automatically controlled. Setting the reference level automatically selects the proper *if* gain and *rf* attenuation. Setting the span/div automatically selects the proper resolution and scan time. These preprogrammed controls of interrelated functions save you time and simplify your measurement task.



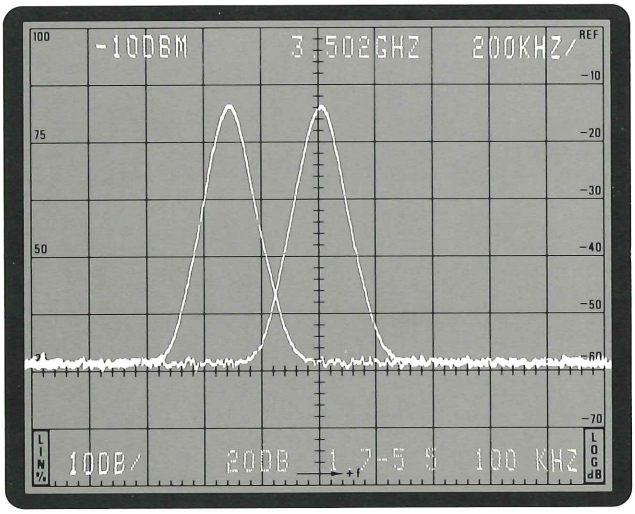
The center frequency control with constant tuning rate (CTR) provides smooth frequency adjustment with just one knob regardless of the span being used. CTR allows the operator to position a signal more quickly and more precisely than a conventional tuning system.



Digital storage and signal processing.
Digital storage allows for flicker-free, easy to interpret displays that may be held in memory as long as instrument power is on.

Digital storage and signal processing are standard on the 496/496P and available as Option 02 on the 492/492P.

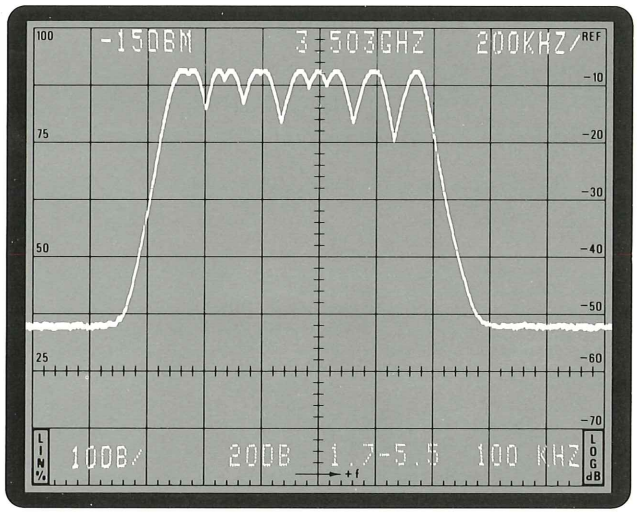
VIEW A, VIEW B modes—Contents of the selected memory are displayed. All stored displays are updated continually (except with SAVE A mode). A and B memories can be combined for high resolution (1000 point) storage.



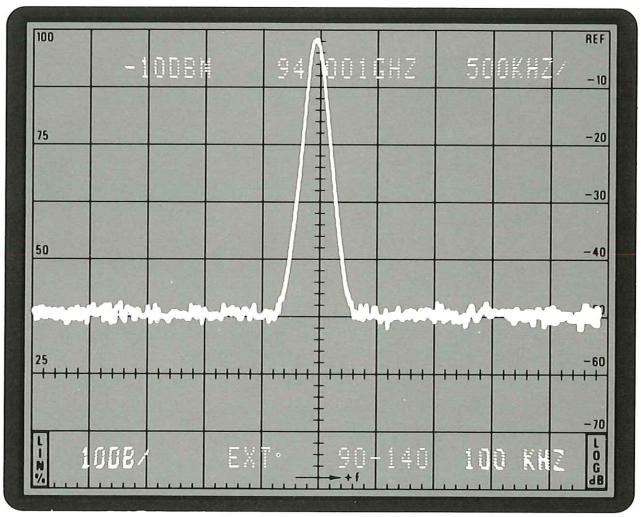
SAVE A mode.

SAVE A mode—The spectrum stored in memory A is displayed. If VIEW B mode is selected at the same time, memory A and B are both displayed simultaneously for comparison (data viewed in memory B is updated continuously).

B MINUS SAVE A mode—SAVE A is automatically activated and the algebraic difference of the continuously updated contents of memory B and the stored contents of memory A is displayed. Positive and negative differences are displayed above and below an internally selectable zero reference screen position.



MAX HOLD mode.



Wide frequency range.

MAX HOLD mode—The memory stores the highest amplitude signal detected for each frequency display, allowing you to maintain and monitor maximum values. This feature is especially useful in measuring signal drift and stability, in recording peak amplitudes, and in logging the presence of random signals.

AVERAGE mode—Moveable cursor sets the level of signal peak detection or averaging. All signals above the cursor are peak detected and then digitally stored; all signals below the cursor are averaged before storage.

Portable form factor.
Compact size and lightweight combine to offer unmatched portability among laboratory quality spectrum analyzers. You can easily move 490 Series analyzers in the design lab, systems test area, or wherever you're working. They even fit under an airplane seat.

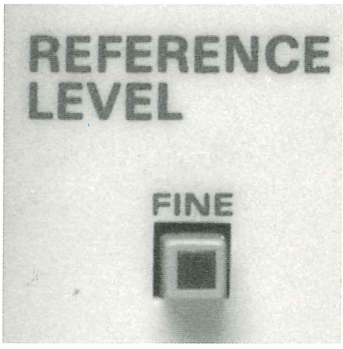
Wide frequency range.
The 492/492P has the widest calibrated amplitude vs. frequency range of any spectrum analyzer on the market, with the performance you need to handle tough laboratory measurements.

It covers from 50 kHz to 21 GHz in coax, 18 GHz to 220 GHz with amplitude calibrated waveguide mixers available from Tektronix. The VHF/UHF 496/496P covers from 1 kHz to 1.8 GHz.

Programmability/IEEE (GPIB) compatibility.
The programmability and interface bus capability available with the 492P and 496P provide added measurement versatility.

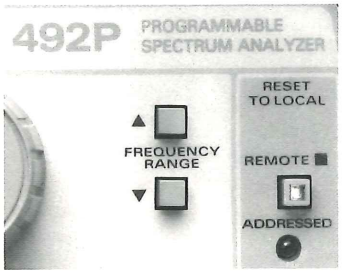
Repetitive or large quantity data collection with consistent and rapid results is made easy, as is recording of data in hard copy form. Automated testing and monitoring are also possible. The GPIB interface enables full program control of front panel settings and of special modes like 12 dB/div and "smart" functions. When an external controller is used, automated data correction and analysis can enhance results and make possible complex measurements such as total harmonic distortion and power spectral density. Manual 490 Series Spectrum Analyzers can be converted to include programmability/GPIB.

Amplitude resolution of 0.25 dB.
High amplitude accuracy is possible through 0.25 dB steps, an improvement over the well-known *if* substitution technique. Superfine 0.25 dB control increments provide 0.05 dB per 0.25 dB step accuracy. This performance increase is achieved without a separate vernier control.



The 492P and 496P make spectrum analysis automatic. And easy.

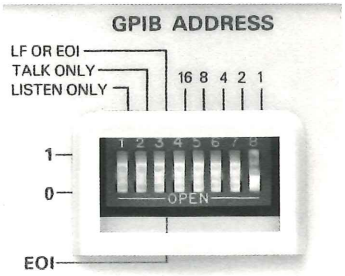
Two instruments in one.
The 492P and 496P are fully programmable versions of the 492 and 496. They incorporate all lab quality performance and ease of use features of each. Simply push the "Reset to Local" button and they become manual instruments—with operation from the front panel. Most important, they



open the way to automated spectrum analysis and documentation via IEEE-488 (GPIB) interface.

This versatility makes them useful in many applications in the lab, factory or field.

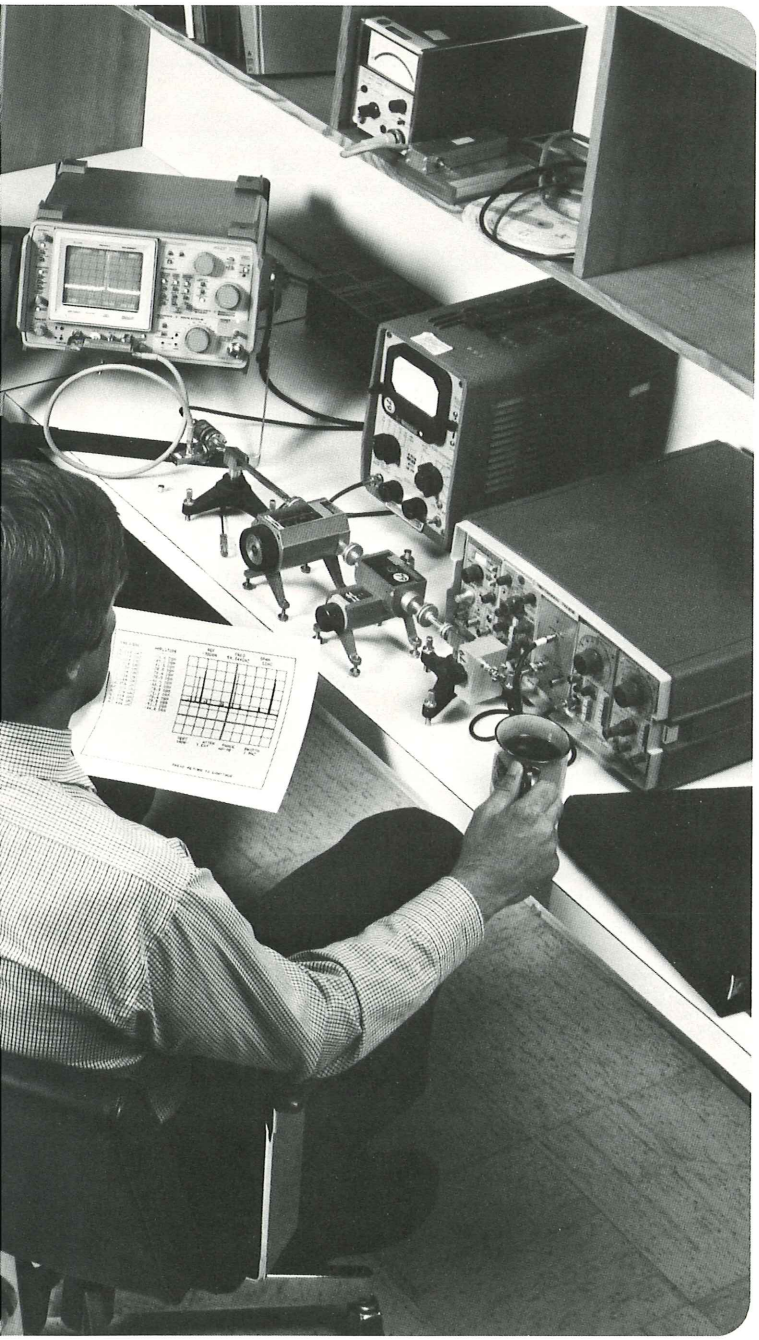
Programmability/GPIB features can be added to manual 492 Spectrum Analyzers, serial number B030000 and above, and to all 496 Spectrum Analyzers. This means: if you want to postpone a programmability/GPIB decision because of budgetary constraints, or for any other reason, you can convert your 490 Series Spectrum Analyzer later. Conversions are made by your nearest Tektronix Service Center. Ordering detail is on page 23.



With or without a controller.
Switches on the rear panel select the mode of operation as GPIB instrument. In the normal TALKER/LISTENER mode, the 492P and 496P listen to and execute commands from a GPIB controller. All important front panel settings can be operated remotely. Some functions are controlled with more detail through the bus than possible from the front panel. For example, SPAN can be set with two digit precision anywhere within the range of the instrument, making possible special spans such as 4.8 kHz per div. Also, via the GPIB, the vertical scale may be set for 1 to 15 dB per division in 1 dB increments. When requested, the 492P and 496P will report instrument settings, internal status or data from their displays.

And for field use where a controller is not available, they can be set to the TALK ONLY or LISTEN ONLY modes. In the TALK ONLY mode, it outputs waveforms and front panel settings in a fixed format for data logging to a digital tape drive, such as the Tektronix 4924. In the LISTEN ONLY mode, the

When used with the Tektronix 4052 Graphic Computing System Controller or 4041 Controller and 4631 or 4611 Hard Copy Unit, the 492P or 496P can provide test results in both graphic and numeric form for the evaluation of signal sources.



analyzers become a display for waveform data sent on the bus and will respond to commands for measurement setup.

Easy to use.
The 492P and 496P are designed for ease of operation via the GPIB, just as the 492 and 496 are designed for front panel operational ease. Most commands for program control are simply abbreviations of the front panel nomenclature. For example, to set center frequency, send the ASCII characters "FREQ 5.2 GHz." To query the center frequency, send "FREQ?" The reponse is "FREQ 5.2 E + 09."

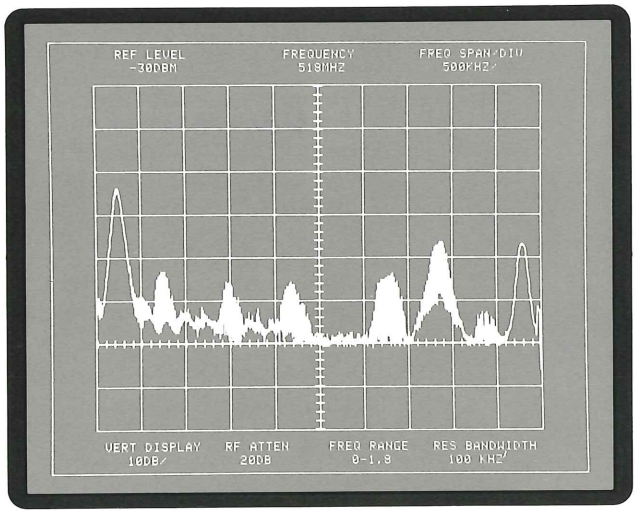
High level command language and the similarity of commands and responses simplify programming and make program listings easily readable for editing.

Automated setup.
The 492P and 496P are not only obedient servants under program control, but smart enough to do many things on their own. For example, they provide all settings with one command. Just send "SET?" You'll get back a block of characters listing all front panel and internal settings. Store this response in the controller or on a tape file. To return the analyzer to the original measurement condition, send the same characters back to it. To initialize its "power on" settings, send "INIT."

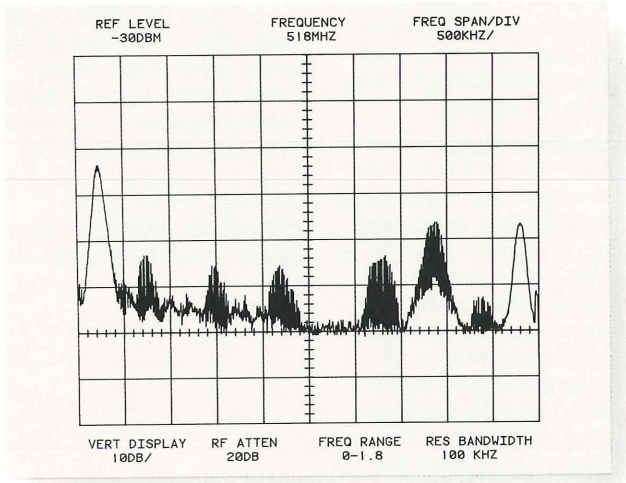
Internal processing simplifies programming.
The power of these programmable spectrum analyzers reduces processing time and eases the software development task. For example, they can identify all signal peaks above a specified amplitude threshold and the maximum and minimum points on the display waveform.

Having identified a point of interest in digital storage memory, they can then perform certain operations automatically. They can tune to center a signal on the display before narrowing the span. Send the command, "CENSIG" and it's done automatically. Another command, "TOPSIG" automatically changes the reference level so the signal peaks at the top of the screen reference level. This display now reads directly in dB below the signal peak and assures an on-screen display for precision amplitude measurements.

Programmability saves time and simplifies your job.



A UHF TV signal with a multiburst test pattern is acquired by the 496P Programmable Spectrum Analyzer sent via the GPIB in digital form and then displayed on the 4052 Graphic Computing System Controller.



The same spectrum displayed above is drawn by the 4052 using the Tektronix 4662 Interactive Digital Plotter for high resolution documentation.

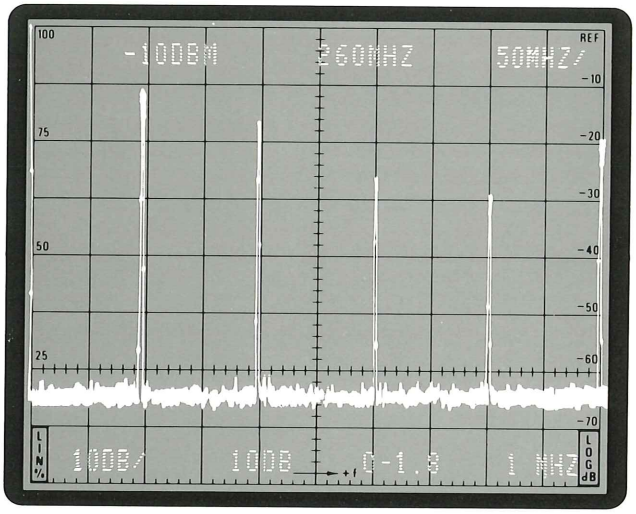
Automated signal tracking.
Keeping a drifting signal on screen in a narrow frequency span per division is no longer troublesome. With the internal processing functions and the ability to repetitively execute sequential instructions, the 492P and 496P can track drifting signals with virtually no help from the controller.

Auto peaking.
The 492P features automatic preselector peaking, which provides greatest accuracy when measuring at widely differing frequencies using the optional internal preselector filter (1.8-21 GHz). Send "PEAK AUTO" from the controller to the 492P and an internal routine automatically adjusts the preselector tracking or external mixer bias for maximum signal response.

Enhanced data presentation via GPIB.
Displayed waveforms can be output from digital storage to a calculator, computer, or data storage device such as a tape or disc file. The data may be graphed on a digital plotter, lower left, or displayed on the screen of a controller such as the BASIC-language programmable Tektronix 4052 Graphic Computing System, top left.

Mathematical operations such as calibration and correction of the original data can be performed in the controller. Data can be combined from several different frequency spans to make a composite plot. Raw data can be converted into different units such as micro-volts or dBc. The two-way communication ability of the 492P and 496P permits a real time comparison of a controller generated spectrum, or set of limits, and an incoming signal on the spectrum analyzer. The computational power of the controller can be used to solve complex analytical measurements such as total harmonic distortion, (photos at top of page 9 (facing)) or power spectral density.

Full programmability completes the task.
Complete automation of the entire measurement saves time and eliminates many operator errors or inconsistencies. Also, some programmed measurements may be made more precisely and thoroughly than by manual methods. For a total harmonic distortion measurement, for example, the analyzer can be controlled to tune each harmonic frequency separately, permitting an enlarged high resolution display of the signal peaks, lower left, page 9. After the peak amplitude is measured, the span can be widened and the analyzer tuned to find the next harmonic. Internal processing greatly simplifies the controlling program and speeds the measurement.



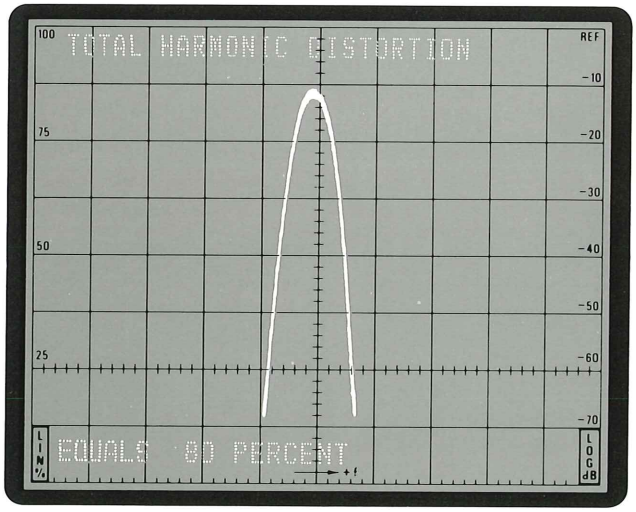
A 100 MHz signal and its harmonics is displayed on the 496P, with a full screen span of 500 MHz.

FREQUENCY	AMPLITUDE DBM	RELATIVE DB
1.0E+8	-20.8	0
2.0E+8	-25.64	-4.84
3.0E+8	-34.96	-14.16
4.0E+8	-38.16	-17.36
5.0E+8	-28.32	-7.52
6.0E+8	-37.64	-16.84
7.0E+8	-39.08	-18.28
8.0E+8	-35	-14.2
9.0E+8	-43.56	-22.76

TOTAL HARMONIC DISTORTION EQUALS 80 PERCENT

DO YOU WANT TO DO ANOTHER ANALYSIS (YES OR NO)?

Automated total harmonic distortion test results computed by the Tektronix 4052 and output on the Tektronix 4631 Hard Copy Unit.



Full programmability allows tuning to each harmonic frequency and measuring the signal peak with high amplitude resolution. Internal processing commands greatly simplify this measurement.

Put one to work.
With a programmable 492P or 496P on your measurement team, repetitive measurements can be done the same way every time. Your throughput will increase—and your confidence in results. And, the internal processing and high level programming language make software development faster. You get high power results with easy programming.

Look at their total performance capability and you'll recognize the value of the 492P and 496P. They offer ease of operation as both programmable and manual instruments. Plus wide frequency range and the versatility to go where you go—into the lab for automated testing and into the field for data collection.

Compare the 490 Series Spectrum Analyzers to each other. And all others.

You won't find anything to equal the portability, performance and operational ease of the Tektronix 490 Series Spectrum Analyzers. They meet the demands of a wide variety of proof-of-performance measurements, on site or on the bench. The 490 Series gives you a choice of analyzers so you can select from many capabilities.

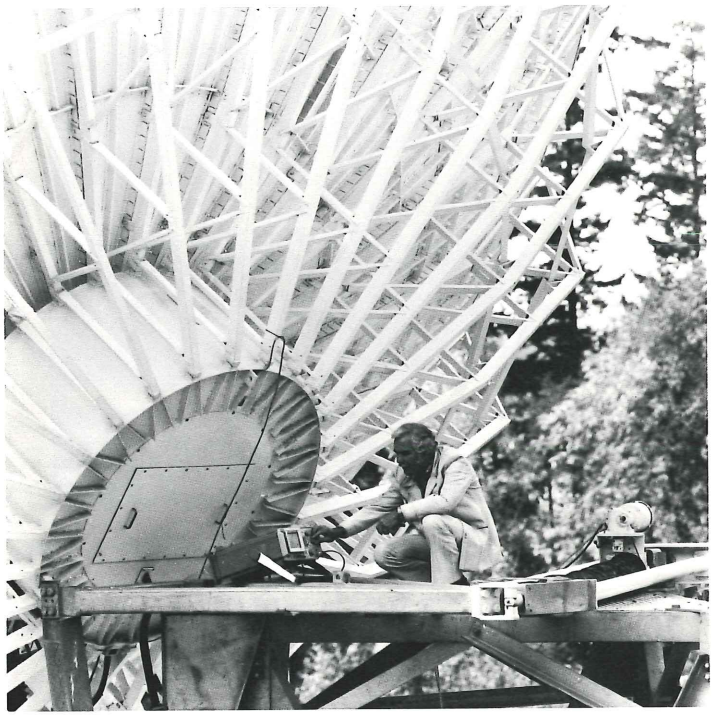
From baseband to microwave: The 492/492P has you covered.
With the 492/492P you get the widest amplitude calibrated frequency range of any spectrum analyzer on the market. It covers from 50 kHz to 21 GHz with internal mixer capability; to 220 GHz with calibrated external waveguide mixers from Tektronix.

The 492/492P offers you everything from millimeter wave capability to lower frequency coverage for IF and baseband measurements. All made easily with one versatile, portable instrument.

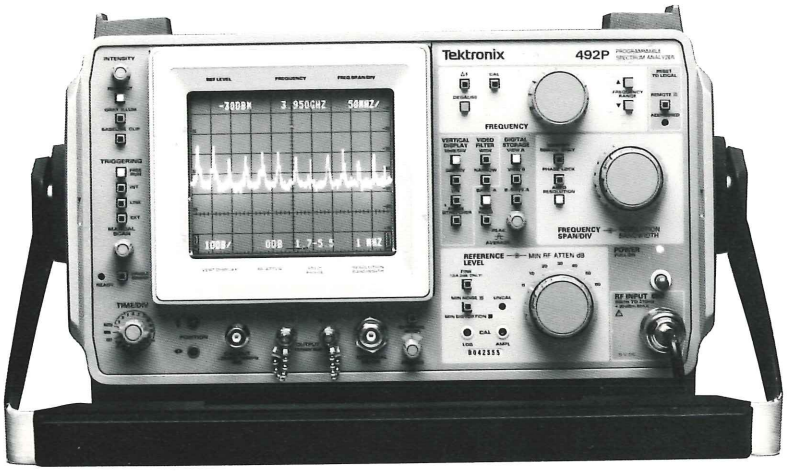
The 492/492P has 80 dB dynamic range on-screen and excellent sensitivity, with an average noise level of −123 dBm at 100 Hz resolution bandwidth.

Residual FM is no more than 50 Hz peak-to-peak, giving high stability for single source spectral purity analysis.

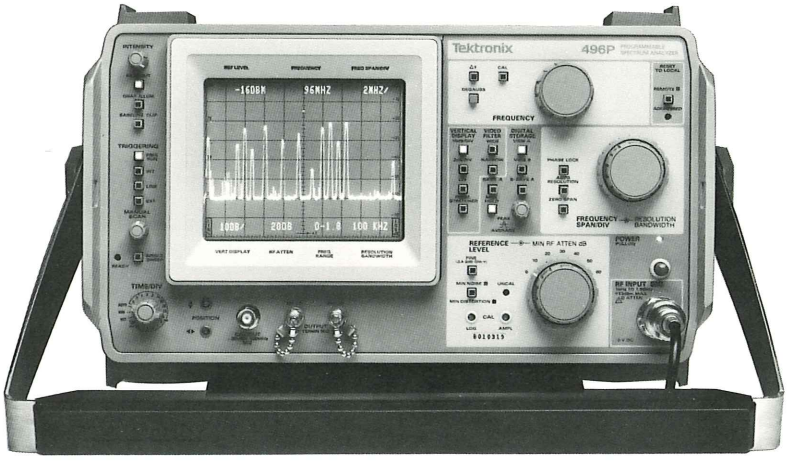
With its capability and convenience, the 492/492P might be the only spectrum analyzer you'll ever need. Options include digital storage, phaselock stabilization and front-end preselection. You can tailor the 492/492P to your own measurement requirements easily, exactly.



Measure millimeter wave to baseband frequency signals with the 492/492P . . . on the bench or at a remote site such as the antenna platform shown above.



The money saving 496/496P covers 1 kHz to 1.8 GHz with 80 dB dynamic range, 30 Hz resolution and high stability... and it's ideally configured for the lab or for rigorous field use.



If you work in just LF to UHF bands, work with the 496/496P.

If you make VHF/UHF measurements, you can get additional performance features without paying for more frequency coverage than you need.

The 496/496P gives you spectrum analysis capability from 1 kHz to 1.8 GHz. All features have been optimized for use in LF or baseband, VHF and UHF measurements. The 496/496P can meet your higher performance requirements, easily and with some savings.

The 496/496P offers the same portability and ease of use features as the 492/492P. It fits easily under an airplane seat—and into the tightest telecommunications service situation. Most-used functions are automatically controlled, plus digital storage and phaselock are standard.

You get 80 dB dynamic range on-screen, as with the 492/492P. And excellent sensitivity, with an average noise level of −127 dBm at 30 Hz resolution bandwidth. Residual FM is no more than 10 Hz peak-to-peak. And the 496/496P provides 1 kHz frequency resolution in Δ F mode. There's all this and more in a compact package that goes where you go, with the capability you need.

Check the specs and see.

492/492P

492/492P Characteristics

The following characteristics and features apply to the 492/492P Spectrum Analyzer after a 30-minute warm up period unless otherwise noted.

Frequency Related

Center Frequency Range—50 kHz to 21 GHz standard; amplitude specified coverage to 220 GHz with optional Tektronix waveguide mixers.

Frequency Accuracy—±0.2% or 5 MHz, whichever is greater, +20% of span/div.

Frequency Readout Resolution—Within 1 MHz. 492P TUNE Command accuracy (±7% or ±150 kHz)N, whichever is greater.

Frequency Span per Division—10 kHz to 200 MHz plus zero and full band max span, down to 500 Hz with Option 03 in 1-2-5 sequence.

Frequency Span Accuracy—±5% of span/div, measured over center eight divisions.

Resolution Bandwidth (–6 dB) Points—1 MHz to 1 kHz (100 Hz for Option 03) in decade steps, plus an AUTO position. Resolution is within 20% of selected bandwidth.

Resolution Shape Factor (60/6 dB)—7.5:1 or less.

Residual FM—1 kHz peak-to-peak for 2 ms time duration, improves to (50 Hz) for 20 ms with phaselock Option 03.

Long Term Drift (at constant temperature and fixed center frequency)—3 kHz/10 minutes after one hour warm-up with Opt. 03 for fundamental mixing.

Noise Sidebands—At least −75 dBc @ 30X resolution offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth).

Spurious Responses

Residual (no input signal referenced to mixer input)—−100 dBm or less.

Harmonic Distortion (CW signal, MIN distortion mode)—At least −60 dBc for full screen signal in the MIN Distortion mode to 21 GHz. At least −100 dBc for preselected Option 01. 1.7 to 21 GHz.

Third-Order Intermodulation Distortion (MIN distortion mode)—At least 70 dB down from two full screen signals within any frequency span. At least 100 dB down for two signals spaced more than 100 MHz apart from 1.7 to 21 GHz for preselected Option 01.

LO Emissions (referenced to input mixer)—−10 dBm maximum; −70 dBm maximum for Option 01.

Amplitude Related

Reference Level Range—Full screen, top of graticule −123 dBm to +40 dBm (+40 dBm, includes maximum safe input of +30 dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 20 nV/div to 2 V/div (1 W maximum safe input) in the linear mode.

Reference Level Steps—10 dB, 1 dB, and 0.25 dB for relative level (△) measurements in log mode. 1-2-5 sequence and 1 dB equivalent increments in LIN mode.

Reference Level Accuracy—Accuracy is a function of changes in RF Attenuation, Resolution Bandwidth, Display Mode and Reference Level. See amplitude accuracies of these functions. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when Min Noise is active) unless Min RF Attenuation is greater than normal. The IF gain increases 10 dB for each 10 dB Reference Level change below −30 dBm (−20 dBm when Min Noise is active).

Display Dynamic Range—80 dB @ 10 dB/div, 16 dB @ 2 dB/div and 8 divisions in linear mode.

Display Amplitude Accuracy—±1 dB/10 dB to maximum of ±2 dB/80 dB; ±0.4 dB/2 dB to maximum of ±1 dB/16 dB; ±5% of full screen in LIN mode.

Resolution Bandwidth Gain Variation—±0.5 dB.

Input Signal Characteristics

RF Input—Type N female connector.

Input Impedance—50 ohms.

Maximum VSWR* with ≥10 dB Attenuation—

Frequency Range	Typical	Specified Maximum
Dc to 2.5 GHz	1.2:1	1.3:1
2.5 GHz to 6.0 GHz	1.5:1	1.7:1
6.0 GHz to 18 GHz	1.9:1	2.3:1
18 GHz to 21 GHz	2.7:1	3.5:1

*At Type N female connector to internal mixer, with 10 dB attenuation.

Input Level (Optimum Level for Linear Operation)—−30 dBm referenced to input mixer. Full screen not exceeded and MIN Distortion control settings.

1 dB Compression Point—−10 dBm except −28 dBm at 1.7 to 2 GHz for Opt. 01 only.

Maximum Safe Input Level (RF attenuation at zero dB)—+13 dBm without Option 01. +30 dBm (1W) with Option 01.

Maximum Input Level (with 20 dB or more RF attenuation)—+30 dBm (1W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor (attenuation limit). DC must never be applied to RF input.

SENSITIVITY AND FREQUENCY RESPONSE

Frequency Range	Mixing Number (n)	Average Noise Level for 1 kHz Resolution: No Preselection	Average Noise Level for 1 kHz Resolution: Preselected Option 01	Frequency Response with 10 dB Attenuation: No Preselection	Frequency Response with 10 dB Attenuation: Preselected Option 01
50 kHz-1.8 GHz*	1	−115 dBm	−110 dBm		±1.5 dB
50 kHz-4.2 GHz*	1	−115 dBm	−110 dBm	±2.5 dB	
1.7-5.5 GHz	1	−115 dBm	−110 dBm	±1.5 dB	±2.5 dB
3.0-7.1 GHz	1	−115 dBm	−110 dBm	±1.5 dB	±2.5 dB
5.4-18 GHz	3	−100 dBm	−95 dBm (12 GHz) −90dBm (18 GHz)	±2.5 dB	±3.5 dB
15-21 GHz	3	−95 dBm	−85 dBm	±3.5 dB	±5.0 dB
100 MHz-18 GHz***				±3.5 dB	±4.5 dB
With Tektronix optional high performance waveguide mixers					
18-26 GHz	6	−100 dBm		±3.0 dB	
26-40 GHz	10	−95 dBm		±3.0 dB	
40-60 GHz	10	−95 dBm		±3.0 dB	
60-90 GHz	15	−95 dBm @60 GHz†		±3.0 dB**†	
		−85 dBm @90 GHz†		±3.0 dB**†	
90-140 GHz	23	−85 dBm @90 GHz†		±3.0 dB**†	
		−75 dBm @140 GHz†		±3.0 dB**†	
140-220 GHz	37	−65 dBm @220 GHz†		±3.0 dB**†	

* Low frequency and performance does not include effects due to zero Hz feedthrough.
** Over any 5 GHz bandwidth.
*** Includes frequency band switching error of 1 dB maximum.
† Typical

Output Characteristics

Calibrator (Cal Out)—−20 dBm ±0.3 dB at 100 MHz ±1.7 kHz.

1st and 2nd LO—Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm, 2nd LO −16 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 ohms at all times.

Vertical Out—Provides 0.5 V ±5% of signal per division of video above and below the centerline.

Horizontal Out—Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

Pen Lift—TTL, 5 V nominal to lift pen.

IF Out—Output of the 10 MHz IF. Level is approximately −16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 ohms.

492P Only: IEEE Std. 488-1978 Port (GPIB)—In accordance with IEEE 488 Standard.

General Characteristics

Sweep Time—20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

CRT Readout—Displays: Reference level, center frequency, frequency range, vertical display mode, frequency span/div, resolution bandwidth, and RF attenuation.

CRT—8 x 10 cm, P31 Phosphor.

Power—210 W max with all options, at 115 V and 60 Hz.

Input Voltage—90 to 132 VAC or 180 to 250 VAC, 48 to 440 Hz.

Configuration—Portable, 20 kg (44 lb) (all options), 17.5 x 32.7 x 49.9 cm (6.9 x 12.9 x 19.7 in) without handle or cover.

Environmental Characteristics

Per MIL-T-28800C type III, class 3, style C.

Temperature—−15°C to +55°C operating; −62°C to +75°C non-operating storage.

Humidity—95% operating; 120 hours per MIL-std 810 non-operating.

Rain Resistance—Drip proof at 16 liters/hour/square foot.

Altitude—15,000 feet operating; 40,000 feet non-operating.

Vibration—15 Hz to 55 Hz @ 0.025 inch excursion.

Shock—30 g of half sine 11 ms duration.

Drop—12 inches.

Electromagnetic Compatibility—490 Series Spectrum Analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources, with the exceptions shown below.

Conducted Emissions—CE01—15 dB relaxation for first 10 harmonics of power line frequency. CE03 (Narrowband)—Full limits. CE03 (Broadband)—15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility—CS01—Full limits. CS02—Full limits. CS06—Full limits.

Radiated Emissions—RE01—10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz. RE02—Full limits.

Radiated Susceptibility—RS01—Full limits. RS02-1—Full limits. RS02-2—To 5 amps only. RS03—Up to 1 GHz only.

496/496P

496/496P Characteristics

The following characteristics and features apply to the 496/496P Spectrum Analyzer after a 30-minute warm up period unless otherwise noted.

Frequency Related

Center Frequency Range—1 kHz to 1800 MHz.

Frequency Accuracy—±5 MHz + 20% of span/div.

***Frequency Readout Resolution**—1 MHz. 496P TUNE Command Accuracy (SPAN/Div≤50 kHz)—±7% or ±100 Hz, whichever is greater.

***Delta Frequency Readout Accuracy (Span/Div≤50 kHz)**—±5% of the Delta Frequency Readout.

Residual FM (short term), Phaselock ON—≤10 Hz p-p over 20 ms.

Residual FM (short term), Phaselock OFF—≤1 kHz p-p over 20 ms.

Long Term Drift (at constant temperature and fixed center frequency)—330 Hz/10 minutes after 1 hour warmup Phaselocked.

Resolution Bandwidth (6 dB)—30 Hz, then 100 Hz to 1 MHz in decade steps, plus an AUTO position. Resolution bandwidth is within 20% of selected bandwidth.

Resolution Shape Factor (60 dB/6 dB)—7.5:1 or less. 15:1 or less for 30 Hz Resolution Bandwidth.

Noise Sidebands—At least −75 dBc at 30 times the Resolution Bandwidth offset from the Center Frequency (−70 dBc for 100 Hz Resolution Bandwidth or less).

Frequency Span/Div Range—From 50 Hz/div to 100 MHz/div in a 1-2-5 sequence.

MAX Span—When selected, the entire effective frequency range is scanned and displayed.

Zero Span—When selected, the horizontal axis of the CRT is calibrated in time (instead of frequency). The SPAN/div readout is changed to Time/div.

Frequency Span/Div Accuracy—Within 5% of the selected Span/div over the center eight divisions of the ten-division CRT display.

*△f mode provides measurements to the nearest kHz plus direct center frequency readout to the nearest kHz between 1 kHz and 500 kHz.

Amplitude Related

Reference Level Range (full screen, top of graticule)—−123 dBm to +40 dBm (+40 dBm includes maximum safe input of +30 dBm and 10 dB of IF gain reduction) for 10 dB/div and 2 dB/div Log modes. 20 nV/div to 2 V/div (1 W maximum safe input) in LIN mode.

Reference Level Steps—10 dB, 1 dB, and 0.25 dB for differential (△) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in LIN mode.

Reference Level Accuracy—Accuracy is a function of changes in RF Attenuation, Resolution Bandwidth, Display Mode and Reference Level. See amplitude accuracies of these functions. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when Min Noise is active) unless Min RF Attenuation is greater than normal. The IF gain increases 10 dB for each 10 dB Reference Level change below −30 dBm (−20 dBm when Min Noise is active).

Display Dynamic Range—80 dB at 10 dB/div, 16 dB at 2 dB/div, and 8 divisions in LIN mode.

Display Amplitude Accuracy—±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. LIN mode is 5% of full scale.

Differential Amplitude—Delta A mode provides differential measurement in 0.25 dB increments.

Display Flatness—±1.5 dB, 1 kHz to 1800 MHz measured with ≥10 dB RF attenuation.

Sensitivity—

Resolution Bandwidth	Average Noise Level
30 Hz	−127 dBm
100 Hz	−123 dBm
1 kHz	−115 dBm
10 kHz	−105 dBm
100 kHz	−95 dBm
1 MHz	−85 dBm

Spurious Response

Residual (no input signal, referenced to mixer input)—−100 dBm or less.

Third-Order Intermodulation Distortion (Min Distortion mode)—At least 70 dBc below any two on-screen signals within any frequency span.

Harmonic Distortion (cw signal, Min Distortion mode)—At least −60 dBc for a full-screen signal.

Zero Frequency Spur (referenced to input mixer)—−20 dBm or less.

LO Emissions (referenced to input mixer)—−70 dBm, maximum.

Input Signal Characteristics

RF Input—Type N female connector.

Input Impedance—50 ohms.

Maximum VSWR* with ≥ 10 dB attenuation—1.3:1 maximum (1.2:1 typical).

Input Level (optimum level for linear operation)—−30 dBm referred to input mixer. Full screen not exceeded and MIN Distortion control setting.

1 dB Compression Point—−18 dBm, no RF attenuation.

Maximum Input Level (RF attenuation at 0 dB)—+30 dBm.

Maximum Input Level (with 20 dB or more RF attenuation)—+30 dBm (1W) continuous 75 W peak, pulse width 1 μs or less with a maximum duty factor of 0.001 (attenuation limit). DC must never be applied to RF input.

Output Signal Characteristics

Calibrator (Cal Out)—−20 dBm ±0.3 dB at 100 MHz ±1.7 kHz.

1st and 2nd LO—Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm, 2nd LO −16 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 ohms at all times.

Vertical—Provides 0.5 V ±5% of signal per division of video above and below the centerline.

Horizontal Out—Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

Pen Lift—TTL compatible, nominal +5 V to lift pen.

IF OUT—Output of the 10 MHz IF Level is approximately −16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 ohms.

496P Only: IEEE Std. 488-1978 Port (GPIB)—In accordance with IEEE 488 Standard.

Probe Power—Provides operating voltages (+5 V, +15 V, −15 V, and Ground) for active probes.

General Characteristics

Sweep Time—20 μs to 5 s/div in 1-2-5 sequence (10 s/div in Auto).

CRT Readout—Displays: Reference Level, Frequency, Frequency Span/div, Vertical Display, RF Attenuation, and Resolution Bandwidth.

*At Type N female connector to internal mixer, with 10 dB attenuation.

CRT—8 x 10 cm, P31 Phosphor.

Configuration—Portable, 20 kg (44 lb), 17.5 x 32.7 x 49.9 cm (6.9 x 12.9 x 19.7 in) without handle or cover.

Input Voltage—90 to 132 VAC or 180 to 250 VAC, 48 to 440 Hz.

Power—210 Watts maximum, 3.2 amperes, at 115 V and 60 Hz.

Environmental Characteristics

Per MIL-T-28800C, type III, class 3, style C.

Temperature—−15°C to +55°C operating; −62°C to +75°C non-operating storage.

Humidity—95% operating; 120 hours per MIL-std 810 non-operating.

Rain Resistance—Drip proof at 16 liters/hour/square foot.

Altitude—15,000 feet operating; 40,000 feet non-operating.

Vibration—15 Hz to 55 Hz @ 0.025 inch excursion.

Shock—30 g of half sine 11 ms duration.

Drop—12 inches.

Electromagnetic Compatibility—490 Series Spectrum Analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources, with the exceptions shown below.

Conducted Emissions—CE01—15 dB relaxation for first 10 harmonics of power line frequency. CE03 (Narrowband)—Full limits. CE03 (Broadband)—15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility—CS01—Full limits. CS02—Full limits. CS06—Full limits.

Radiated Emissions—RE01—10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz. RE02—Full limits.

Radiated Susceptibility—RS01—Full limits. RS02-1—Full limits. RS02-2—To 5 amps only. RS03—Up to 1 GHz only.

Interpreting the Specifications

Low-end Frequency Performance.
Typical low-end frequency performance for the 492 and 496 is shown opposite in Figure 1.

Resolution filter shape, phase noise sideband performance, input mixer coupling, and zero hertz local oscillator feedthrough can all contribute to limiting low-end frequency performance.

The 492 low-end frequency specification is 50 kHz. This is based on the fact that, for a basic 492, 50 kHz corresponds to center screen at the narrowest available frequency span of 10 kHz/div.

By comparison, a phase-locked 492 (with Option 03), set at 100 Hz resolution, has a center frequency capability of 2.5 kHz (500 Hz/div).

Practical low frequency usefulness is limited by instrument drift, zero hertz feedthrough, and resolution. These factors limit the low end of the 492 and 492P with Option 03 to approximately 800 Hz for −70 dBm sensitivity. Amplitude response remains accurate to the limit of resolution (3 dB notch between two signals), however on screen dynamic range, sensitivity, and intermodulation performance are degraded between 50 kHz and the limit of resolution.

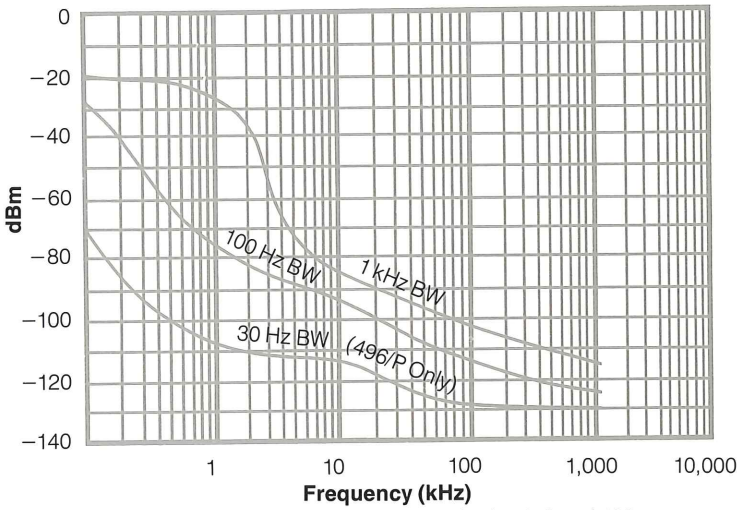
Note that, at 50 kHz, the noise level is degraded to approximately −90 dBm for a 1 kHz resolution bandwidth due to noise sidebands around the zero Hz feedthrough.

The zero Hz signal also limits the ability to set a small signal (e.g. −80 dBm) to full screen in 2 dB/div. These effects are not significant at frequencies above 1 MHz, and they can be circumvented by using the △ amplitude mode.

The 496 low-end specification is 1 kHz where sensitivity at 30 Hz resolution bandwidth is typically −110 dBm, shown in figure 1. This degradation of nearly 20 dB, compared to the −127dBm sensitivity above 100 kHz is due to noise sidebands about the zero hertz feedthrough. Note that −70 dBm measurements can be made at an input frequency of only 100 Hz.

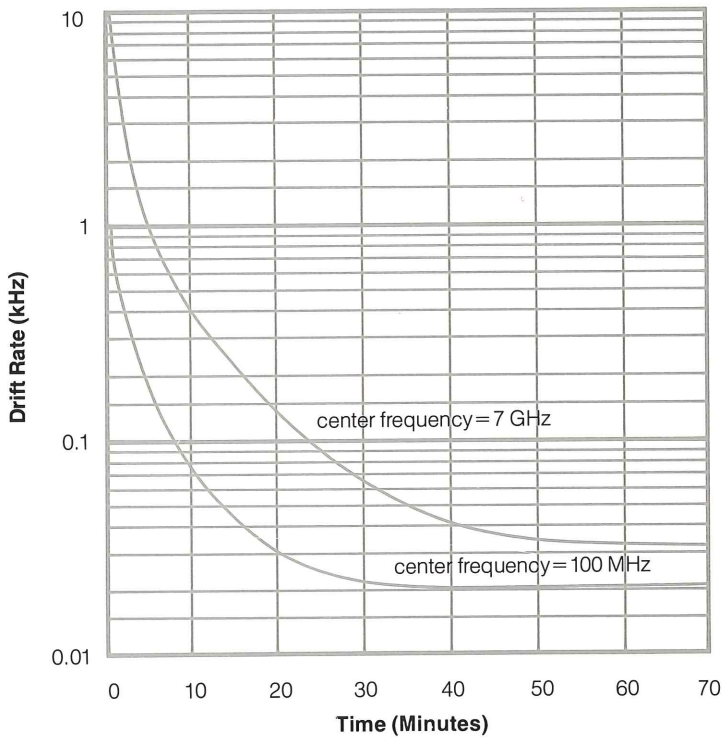
Frequency Drift.
Drift specifications give some indication of the analyzer's usefulness shortly after turn-on. For the 492 the center frequency drift is specified to be no more than 15kHz/10 minutes after 30 minutes of warm-up in the lower three bands. For the 496, the specification is 3.3 kHz/10 minutes after 30 minutes of warm up. Actual performance may be considerably better than the specified limits, which are worst-case estimates. The specifications, of course, do not fully describe instrument behavior, especially under extreme or transient environmental conditions.

Results of some simple tests help to illustrate the actual behavior of a typical instrument, shortly after turn-on. Figure 2 is a plot of frequency drift vs. warm-up time for a phaselocked 492



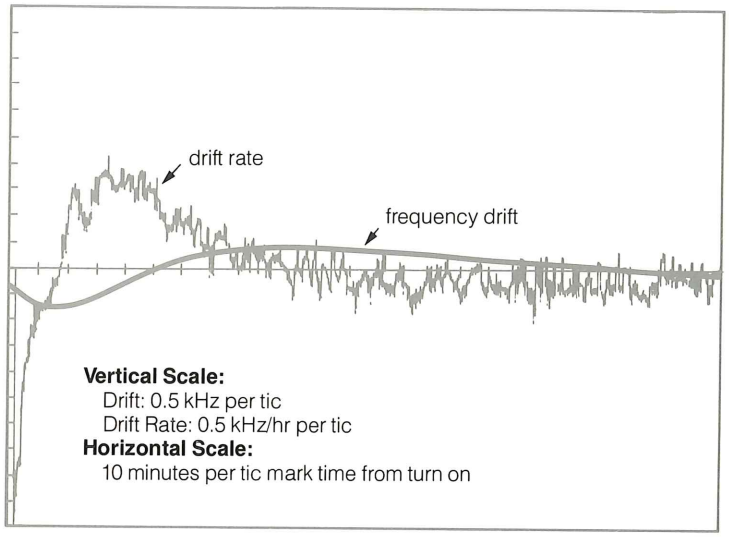
Typical low-end frequency performance for the 492 and 496.

Figure 1



Turn-on drift per minute for a phaselocked 492 at fundamental mixing.

Figure 2



Drift of center frequency of 496 at 100 MHz and −15°C.

Figure 3

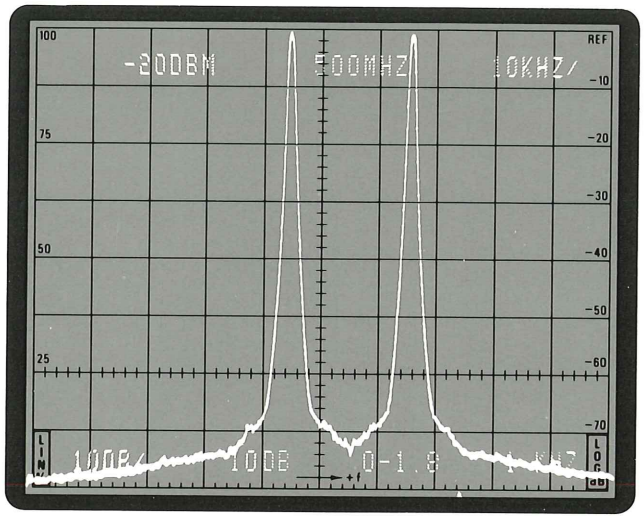


Figure 4

operating at room temperature. Even at 7 GHz the initial drift rate is less than 500 Hz/minute after only 10 minutes. Many measurements could be made at a 1 kHz/division setting without additional waiting.

Portable instruments are often used immediately after they have been transported from/to a hot or cold environment. To simulate such conditions, a 492 was first heated in an oven to +50°C, then placed in a +20° environment. Total drift during the first half hour of operation was less than 1.5 kHz at 500 MHz.

Next, the analyzer was cooled to −25°C, then moved to a +20° ambient and turned on. Ten minutes of thawing were required before critical functions, such as the center frequency control would operate properly. Total drift over the next 10 minutes was about 4 kHz at 500 MHz. Drift after half an hour of operation at room temperature was roughly 350 Hz/minute.

Good drift behavior of the 496 is evident in Figure 3, a computer plot of data from a 496P operating at 100 MHz at −15°C. For the first 10 to 60 minutes after turn-on, the drift rate does not exceed 2 kHz/hour. After a one-hour warmup, the drift rate remains below 1 kHz/hour.

Harmonics and Intermodulation.

The specifications for harmonics and intermodulation are based on a −30 dBm RF signal level at the first mixer. The following worst-case specifications relate to the level referenced to the RF signal (in dBc):

Harmonic Products—−60 dBc

The third-order intermodulation specification for the 492 and 496 Spectrum Analyzers is −70 dBc for two on-screen signals within any frequency span. Figure 4 shows intermodulation just visible at −75 dBc, typical of these instruments.

The distortion-free dynamic range for any input level can be computed from the intercept point equation:

$$I = \frac{\triangle}{N-1} + S, \text{ where:}$$

I = Intercept point in dBm

$\triangle$ = Distortion level relative to input carriers in dB.

N = Distortion order numbers.

S = Input signal level to the mixer in dBm*.

*Input level to the mixer is spectrum analyzer input level less rf attenuator level. Thus, a +10 dBm input with 30 dB or rf attenuation is a mixer input level of +10 −30 = −20 dBm.

For second-harmonic distortion,

$$I = \frac{60}{2-1} + (-30) = +30 \text{ dBm}$$

For third-order distortion.

$$I = \frac{70}{3-1} + (-30) = +5 \text{ dBm}$$

Optimal distortion-free dynamic range occurs when the distortion products equal the sensitivity noise level (n) in dBm.

For example, for the 492 with preselector at 100 Hz resolution, n = −118 dBm for fundamental conversion. Thus,

$$S_o = \frac{(N-1)\,I + n}{N}$$

$$= \frac{(2)5 + (-118)}{3} = -36 \text{ dBm},$$

and

$$\triangle_o = \frac{(N-1)\,(I-n)}{N}$$

$$= \frac{(2)\,(123)}{3} = 82 \text{ dBc}$$

Interpreting the specifications.

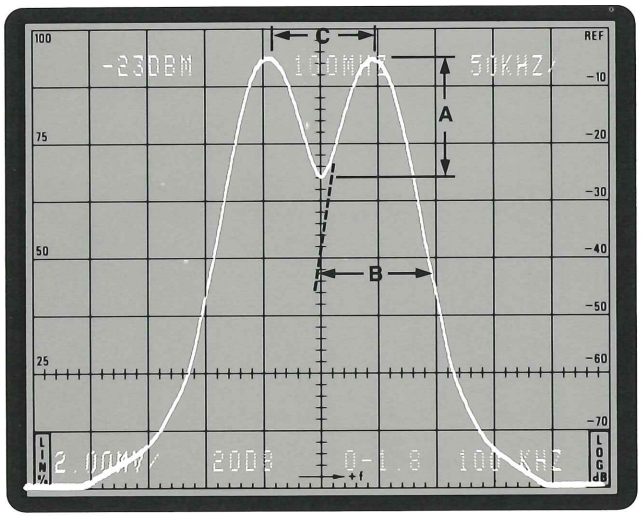


Figure 5

Best distortion-free dynamic range for closely spaced signals is 82 dB. Intermodulation dynamic range reaches 100 dB for signal spacings greater than 100 MHz for the 1.7 to 21 GHz frequency range.

Resolution Bandwidth.
Resolution Bandwidths are specified at the 6 dB down points. This represents the spacing of two equal amplitude signals that can be well resolved (≥3 dB notch). Figure 5 is a LINEAR MODE display with amplitude shown in mV. Dimension A is equal to a 3 dB notch. Figure 5 shows that at the 3 dB-equivalent notch point, the 6 dB down-equivalent resolution bandwidth is at 2 x 50 kHz/div or approximately 100 kHz (Dimension B). Note also that the signal peaks are separated by a frequency span approximately equal to the resolution bandwidth (Dimension C).

Depending on the application, other bandwidths may be of interest: for example, 3 dB, random noise, and impulse bandwidths. For most measurements, the random noise and impulse bandwidths are approximately equal to the 6 dB bandwidth, and the 3 dB bandwidth is approximately 0.75 of the 6 dB bandwidth. Typical approximations are given in Table 1.

Sensitivity.
Sensitivity for a preselected 492 (Option 01) is shown in Figure 6.

Note that, although a non-preselected 492 has 5 dB lower input loss, and therefore 5 dB better sensitivity, the spurious-free dynamic range of the preselected instrument is superior.

Sensitivity is specified in terms of the smallest observable signal, and is therefore determined by spectrum analyzer internal noise level. Noise level depends on resolution bandwidth and local oscillator mixing multiplication number (Refer to Figure 6).

Specified 6 dB Resolution Bandwidth ±20%	Typical 3 dB Bandwidth	Typical Impulse Bandwidth	Typical Random Noise Bandwidth
* 30 Hz	22 Hz	30 Hz	30 Hz
100 Hz	75 Hz	100 Hz	100 Hz
1 kHz	750 Hz	1 kHz	1 kHz
10 kHz	7.5 kHz	9.5 kHz	9.5 kHz
100 kHz	75 kHz	100 kHz	100 kHz
1 MHz	750 kHz	800 kHz**	1 MHz

*496/496P only
**The pulse stretcher must be activated to achieve full impulse bandwidth at 1 MHz resolution setting.

Table 1

Sensitivity for the 496 is independent of frequency above ≃ 100 kHz. Refer to Figure 1, p. 14.

Dynamic Range.
On-screen dynamic range is 80 dB at a vertical display scale factor of 10 dB/div.

Intermodulation distortion dynamic range for signals spaced closer than 100 MHz is consistent with on-screen dynamic range at 80 dB.

For small signals or modulation components next to a large carrier, the dynamic range can be considerably greater. Limiting factors are resolution bandwidth filter shape, phase noise sideband characteristics, and input overload capability.

For resolution bandwidths wider than 10 kHz, filter shape is the limiting factor. Figure 7 shows a 100 kHz resolution bandwidth filter that exhibits 1.1 MHz bandwidth at 80 dB down. Phase noise sidebands are the limiting factor closer in. Figure 8 shows a signal with a 1 kHz resolution bandwidth filter.

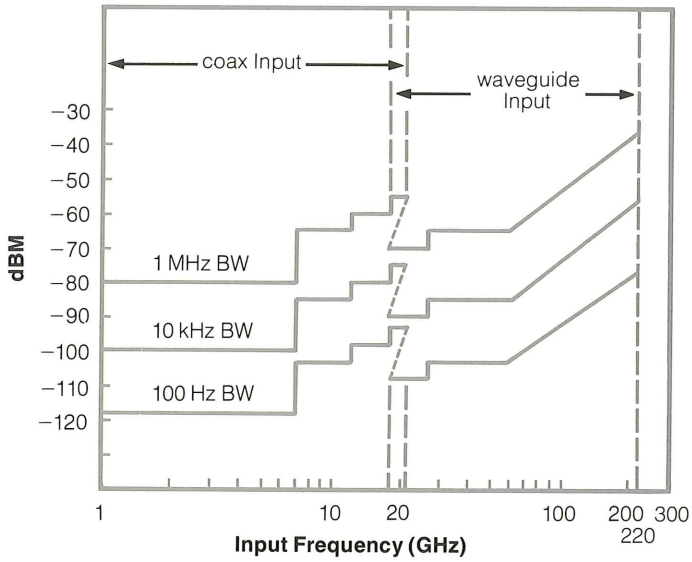
Note that the phase noise sideband pedestal breaks out at 10 kHz offset from the carrier, dropping to better than −75 dBc at 20 kHz offset. This allows easy observation of close-in modulation sidebands.

Figure 9 shows typical filter shape, phase noise sidebands, and sensitivity factors for fundamental mixing on a preselected 492 (Option 01) and for the 496.

Amplitude Accuracy.
The amplitude reference is a −20 dBm, 100 MHz calibrator. The amplitude accuracy of this signal is ±0.3 dB. Factors affecting measurement accuracy depend on input signal frequency and amplitude as follows:

Frequency response per band.
The frequency response for the 496 or the first band of the 492 is referenced to the 100 MHz calibration point.

A band-to-band reference error of 1 dB must be added to the per-band frequency response specifications when the 492 is operating outside the first band.



Sensitivity showing average noise level for a preselected 492 (Option 01).

Figure 6

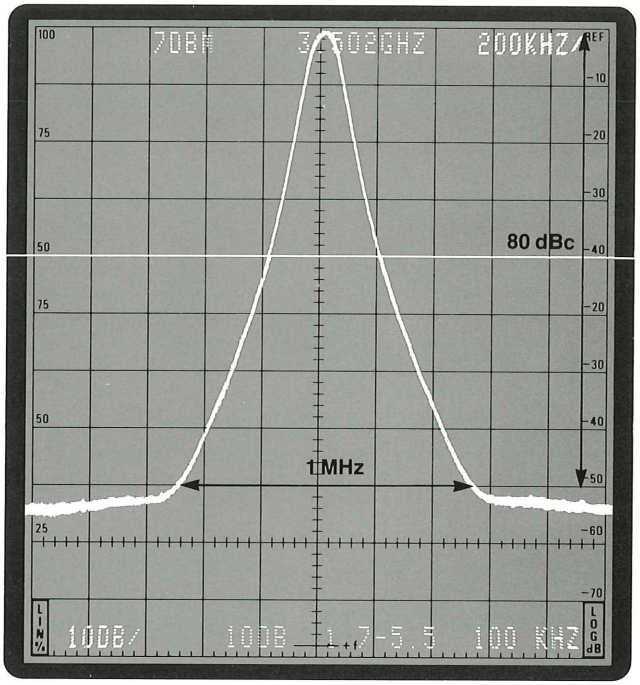


Figure 7

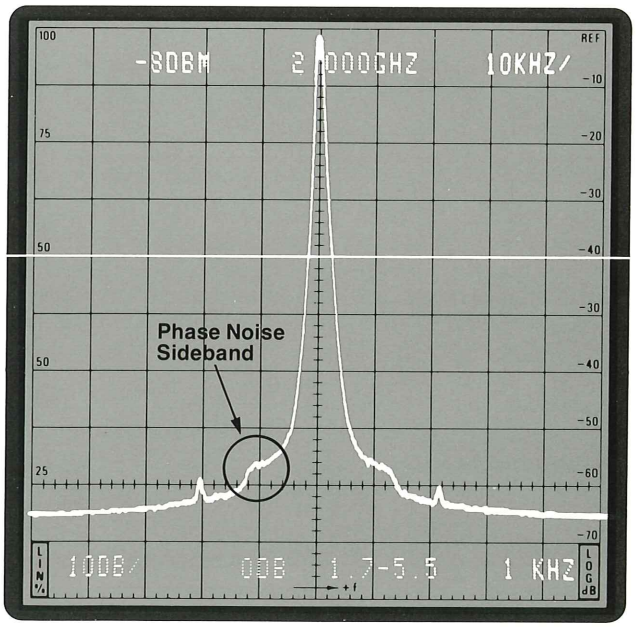
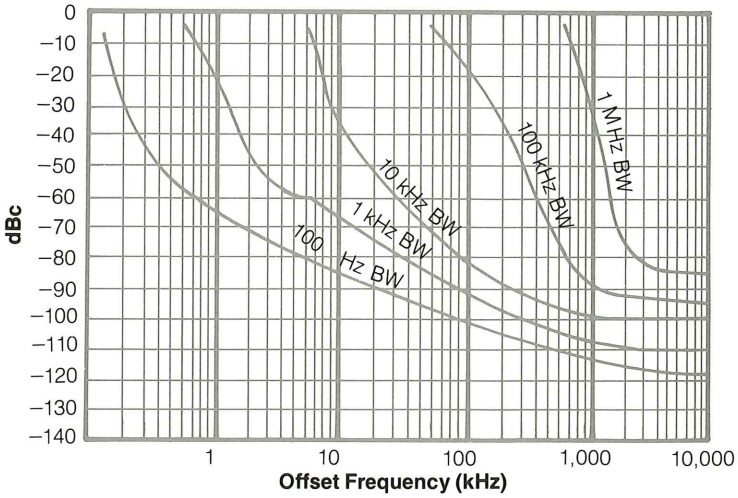


Figure 8



Typical filter shape, phase noise sidebands, and sensitivity factors for fundamental mixing on a preselected 492 (Option 01) and 496.

Figure 9

Interpreting the specifications.

	Frequency Range	Frequency Response ±dB Max	IF Gain* Variation ±dB Max.	Calibrator Output ±dB Max.	Total ±dB Max.
496	1 kHz-1.8 GHz	1.5	0.5	0.3	2.3
Pre-	50 kHz-1.8 GHz	1.5	0.5	0.3	2.3
selected	1.7 GHz-5.5 GHz	2.5	0.5	0.3	3.3
492	3.0 GHz-7.1 GHz	2.5	0.5	0.3	3.3
	5.4 GHz-18.0 GHz	3.5	0.5	0.3	4.3
	15.0 GHz-21.0 GHz	5.0	0.5	0.3	5.8
	18.0 GHz-26.5 GHz**	3.0	0.5	0.3	3.8
	26.5 GHz-40.0 GHz**	3.0	0.5	0.3	3.8
	40.0 GHz-60.0 GHz**	3.0	0.5	0.3	3.8
	60.0 GHz-90.0 GHz**#	3.0	0.5	0.3	3.8
	90.0 GHz-140.0 GHz**#	3.0	0.5	0.3	3.8
	140 GHz-220 GHz**#	3.0	0.5	0.3	3.8

* 10 dB steps over a 70 dB range.
** Using optional accessory high performance mixers.
# Typical, over any 5 GHz bandwidth.

Achievable amplitude accuracy for a preselected 492 and 496 is shown above.

Table 2

Amplitude measurement error resulting from frequency response depends on the frequency of the incoming signal.** Approximately ±1 dB is contributed by the preselector (Option 01), and the remainder is contributed by other input circuits.

A nonpreselected 492 has almost 1 dB better amplitude accuracy.

Amplitude Display
An amplitude display error of 0.4 dB/2 dB, 1 dB/10 dB, and 2 dB/80 dB occurs when signal display amplitude is not at the full screen reference level.

Reference Level.
Gain/attenuation errors are introduced when the reference level is changed from the −20 dBm calibrator level.

Absolute reference level in dBm can be changed in 1 dB and 10 dB steps.

Reference level change errors are ±0.2 dB/1 dB, ±0.5 dB/10 dB accumulating to ±1.4 dB/60 dB, and ±2 dB/90 dB.

This error analysis is worst case, providing gain and attenuation are not switched in simultaneously. This is normally prevented by the 492's and 496's automatic reference level mode.

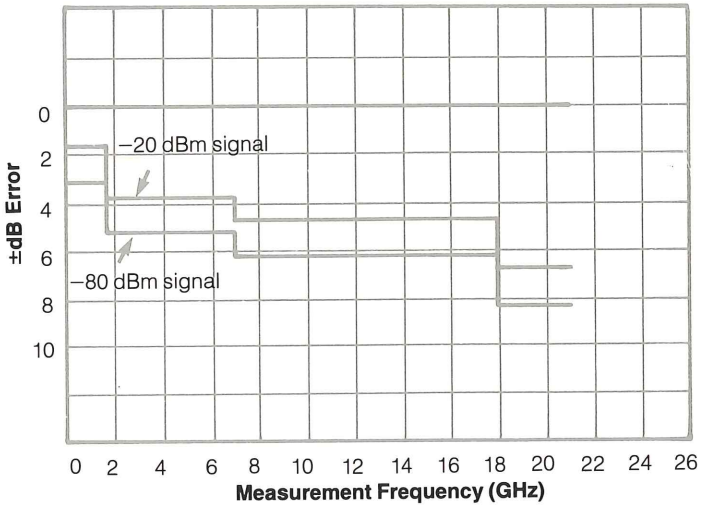
A −20 dBm calibration level should preclude having to switch gain and attenuation together.

A 10 dB minimum rf input attenuation setting during calibration allows for small signals that require some attenuation to provide good impedance match. The user also has the option of calibrating at −20 dB and zero dB attenuation by activating the MIN NOISE control.

Relative Reference Level Steps.
The 0.25 dB steps are enabled in the 2 dB/div vertical mode when FINE steps are selected. These steps are used for accurate relative amplitude difference measurements. The total measurement range is 50 dB, with an accuracy of 0.05 dB/0.25 dB, 0.4 dB/2 dB, 1 dB/10 dB, and 2 dB/50 dB.

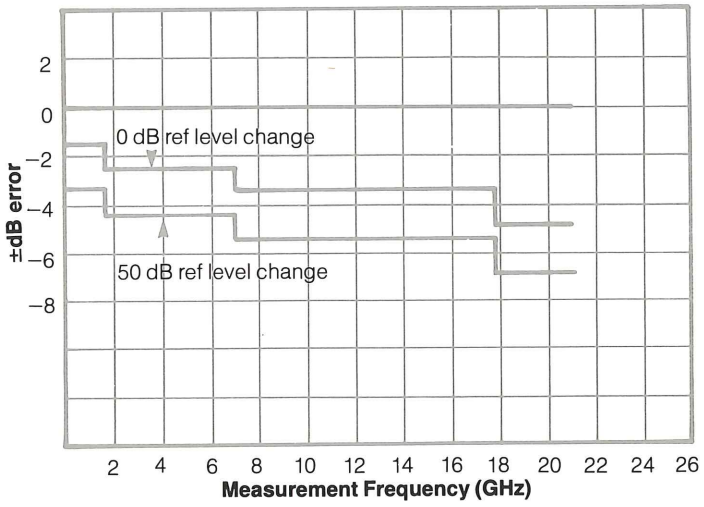
Typical accuracy limits in each band for a preselected 492 are summarized in Table 2. Worst case accuracy limits including band-to-band error of 1 dB are illustrated in Figures 10 and 11.

**Flatness and accuracy specifications do not apply to the 30, 40, 50, and 60 dB rf attenuator positions between 19 and 20 GHz.



Cumulative maximum *absolute* amplitude measurement error as a function of signal amplitude and frequency for a preselected 492 (Option 01) assuming calibration using the internal −20 dBm 100 MHz reference.

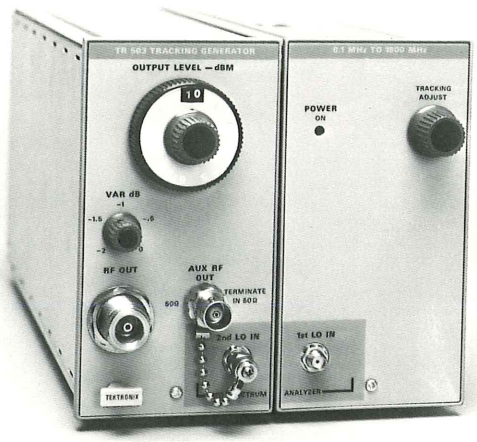
Figure 10



Cumulative maximum error in measurement of relative amplitude of two signals as a function of reference level change and frequency separation, for a preselected 492 (Option 01).

Figure 11

Ancillary Products



TR 503 Tracking Generator.

Characterize frequency response of active/passive devices with the companion TR503 Tracking Generator.

The Tektronix TR503 Tracking Generator is operated in combination with the 490 Series Spectrum Analyzers to provide a swept frequency test system. Since the instantaneous output frequency of the TR503 matches the instantaneous input frequency of the Spectrum Analyzer, the swept frequency test system exhibits the characteristics of a very sensitive synchronous detector. Harmonics of the signal are not displayed because the tracking generator output is always at the spectrum analyzer input frequency.

Check the features. A swept frequency test system using the TR503 and a 490 Series Spectrum Analyzer offers:

- Wide frequency range of 100 kHz to 1.8 GHz
- System fm'ing of 10 Hz maximum with the 496/496P, 50 Hz maximum with the 492/492P Option 03
- Output amplitude steps of 1 dB and 10 dB to −59 dBm
- System flatness typically ±1.5 dB 100 kHz to 1.8 GHz

The system offers high performance for measurements such as passband characteristics, return loss and SWR measurements (with external bridge such as Wiltron 60N50).

It is well suited to measure the frequency response of active and passive devices such as amplifiers, mixers, couplers, filters, attenuators, transmission lines and antennas (with external bridge).

With a Tek DP501 Prescaler and DC509 Counter, accurate frequency measurements of complex modulated signals and low level signals can be made with ease.

The 490 Series Spectrum Analyzer B MINUS SAVE A feature reduces frequency response measurement uncertainty by subtracting out system response variation caused by cables, connectors and residual system flatness.

Additional information about swept frequency test systems is documented in applications bulletin, The Tracking Generator/Spectrum Analyzer System, Tektronix part number AX-3281.

Electrical Characteristics

The following electrical characteristics apply to the TR 503 and 496/496P, or 492/492P with Option 03 interconnected as a Swept Frequency Test System except where specified separately.

Frequency Characteristics
Range: 100 kHz to 1800 MHz
Stability (Residual fm): 1 Hz p-p max (TR 503); 50 Hz p-p max (TR 503 and 496/496P, or 492/492P with Option 03)

Amplitude Characteristics
RF Output Level: 0 dBm ±0.5 dB max, adjustable to −59 dBm in 10 and 1 dB steps plus 2 dB vernier; attenuator error is ±0.25 dB for each 1 dB change; total error, 0 to −59 dBm = ±2.5 dB
Flatness: ±0.75 dB or less over frequency range (TR 503)
System Flatness: ±2.25 dB max 100 kHz to 1.8 GHz (Typically ±1.5 dB, TR503 w/490 Series Spectrum Analyzer.)
Spurious Output, Harmonic: 20 dB or more below fundamental
Spurious Output, Nonharmonic: 40 dB or more below fundamental
Dynamic Range: 110 dB minimum (TR 503/490 Series Spectrum Analyzer.)

Other Characteristics
Sweep Width (TR 503/492/492P (Option 03) or 496/496P): 500 Hz/div to 200 MHz/div plus max span (determined by spectrum analyzer frequency span)
Output Impedance: 50 ohms nominal; VSWR = 2:1 or less; type N connector

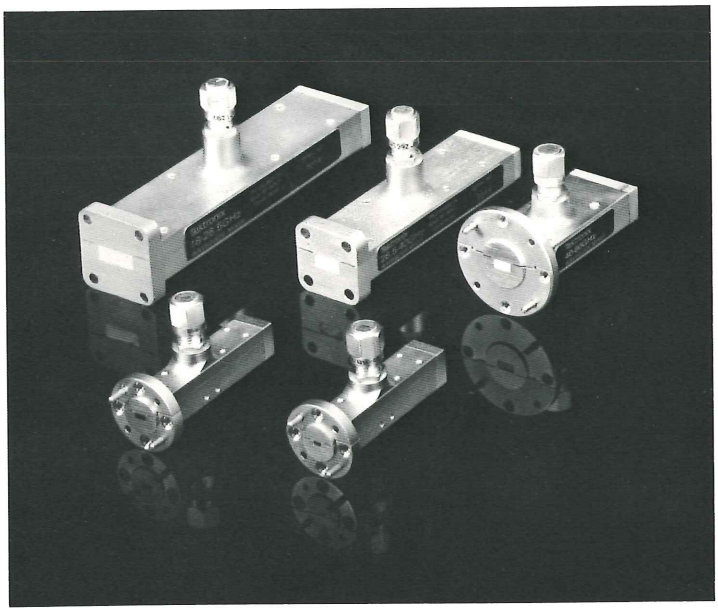
Interfacing Connections
Aux RF Out: 0.1 Vrms into 50 ohm load; type SMA connector
1st LO In: Connects to spectrum analyzer 1st LO out; type SMA connector
2nd LO In: Connects to spectrum analyzer 2nd LO out; type SMA connector

Characterize TV transmitter response with the 1405 TV Sideband Adapter.

- Response of transmitter under test within ±0.2 dB
- Frequency response of rf and if circuits for transmitters with frequency to 1 GHz
- Video circuits can be swept
- For in-service testing, use of external blanking allows either full-field or single-line operation
- Check aural fm deviation with built-in Bessel Null technique
- Flexible marker system will accept standard crystals

The 1405/Spectrum Analyzer combination will display the frequency response characteristics of rf and if circuits for transmitters with frequencies to 1 GHz. Video circuits (zero frequency offset) can also be analyzed.

Tektronix amplitude calibrated waveguide mixers increase frequency coverage to 220 GHz.



The Tektronix 490 Series Waveguide Mixers are designed for use with the 492/492P Spectrum Analyzer. They cover from 18 to 220 GHz with at least −65 dBm sensitivity.

The two microwave mixers cover ranges 18-26.5 GHz and 26.8-40 GHz. They have field replaceable diodes and frequency response of ±3 dB when used with the spectrum analyzers indicated above.

The three millimeter-wave mixers cover ranges 40-60 GHz (also specified at ±3 dB frequency response), 60-90 GHz and 90-140 GHz. Coverage to 220 GHz is achieved by using a 140-220 GHz tapered transition (part #119-1729-00) with the WM 490F, 90-140 GHz mixer.

The units are all gold-plated, conforming to MIL-G-45204 type I, class 1 specifications and will withstand harsh environments. Each set comes complete with a container for spare diodes, a 28″ cable, a 32-page instruction manual and a wood storage box with foam cutout storage locations for all five mixers.

Performance Characteristics

For all waveguide mixers:
Maximum CW RF input level: +10 dBm (10 mW)
Maximum PULSED RF input level: 1 W peak with 0.001 maximum duty factor and 1 μs maximum pulse width
L.O. requirement: +7 dBm min., +15 dBm max., +10 dBm typical
Bias requirement: −2.0 to +0.5 V with respect to the mixer body through a current limiting resistor, to provide 0-20 mA of bias current

For the 18-60 GHz waveguide mixers:
3 dB compression point (saturation): −10 dBm (typical)
Conversion loss: 30 dB typical (when used in the proper spectrum analyzer frequency band)

Electrical Characteristics

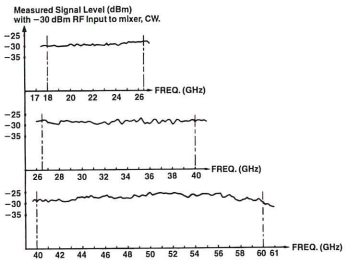
Mixer	Frequency Range	Sensitivity[a] (dBm)	Frequency[b] Response	Amplitude[c] Accuracy
WM490K	18-26.5 GHz	−100	±3 dB	±6 dB
WM490A	26.5-40 GHz	−95	±3 dB	±6 dB
WM490U	40-60 GHz	−95	±3 dB	±6 dB

[a]Equivalent average noise level at 1 kHz bandwidth.
[b]Maximum amplitude variation across each waveguide mixer band (with peaking control optimized) in response to a −30 dBm CW input signal to the waveguide mixer.
[c]Maximum reference level error with respect to the internal calibrator. Amplitude accuracy can be improved 3 dB by measuring amplitude response in each band with respect to a known external waveguide signal source level.

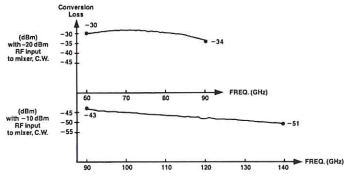
Mixer	Frequency Range	Typical[d] Sensitivity (dBm)	Typical[e] Frequency Response	3 dB Compression Point (Saturation)
WM490E	60-90 GHz	−95 @ 60 GHz −85 @ 90 GHz	±3 dB	−15 dBm @ 60 GHz −5 dBm @ 90 GHz
WM490F	90-140 GHz	−85 @ 90 GHz −75 @ 140 GHz	±3 dB	−5 dBm @ 90 GHz 0 dBm @ 140 GHz
WM490F[f]	140-220 GHz	−65 @ 220 GHz	±3 dB	+10 dBm @ 220 GHz

[d]Equivalent average noise level at 1 kHz bandwidth.
[e]Over any 5 GHz bandwidth.
[f]Used with 119-1729-00 tapered transition.

Typical Frequency Response for 18-60 GHz Waveguide Mixers.



Typical Frequency Response for 60-140 GHz Waveguide Mixers.



Physical Characteristics

Frequency Range	Length	Width	Height	Weight	Flange
18-26.5 GHz	8.97cm (3.53in)	2.22cm (.875)	3.68cm (1.45)	180g (6.5oz)	UG-595/U
26.5-40 GHz	6.93cm (2.73in)	1.90cm (.750in)	3.35cm (1.32in)	100g (3.7oz)	UG-599/U
40-60 GHz	4.52cm (1.78in)	1.84cm[f] (.725)[f]	2.45cm[f] (.980in)[f]	80g (2.9oz)	UG-383/U-M
60-90 GHz	4.31cm (1.70in)	0.89cm[f] (.350in)[f]	2.29cm[f] (.900in)[f]	40g (1.5oz)	UG-387/U
90-140 GHz	4.31cm (1.70in)	0.89cm[f] (.350in)[f]	2.29cm[f] (.900in)[f]	40g (1.5oz)	UG-387/U-M
140-220 GHz	Coverage provided via standard length WR-08 to WR-05 adapter and 90-140 GHz mixer.				

[f]Excludes contribution to dimension due to the diameter of the round waveguide flange. Overall length contribution of flange is included.

Option Configurations

Combined performance options and optional accessories configure the 492/492P to a wide variety of measurement tasks, depending on your requirements. For general use spectrum analysis, optimum performance may be obtained with the inclusion of Options 01, Internal Preselection, Option 02, Digital Storage, and Option 03, Frequency Stabilization/100 Hz resolution.

Digital storage, phaselock stabilization and 100 Hz resolution are standard features on the 496.

Options 30, 31 and 32 offer a choice of mechanical configurations for all 490 Series Spectrum Analyzers.

Option 01—Internal Preselection.
With this option, internally generated image and harmonic mixing spurious responses are effectively eliminated. This results in a display that is much easier to interpret. In the frequency range of 50 kHz to 1.7 GHz, a low-pass filter is used to limit spurious responses. In the range of 1.7 GHz to 21 GHz, a tracking YIG preselector is used. Internal calibrated preselection reduces the requirement to examine each signal to verify authenticity.

Measurement capability is enhanced with Option 01 by an increase in dynamic range from 80 dB in the basic analyzer to 100 dB (for signals separated by 100 MHz). This is because the automatic tracking preselector rejects signals outside its bandwidth by 70 dB or more.

Option 01 also includes a limiter to provide +30 dBm input protection to the first mixer up to 1.7 GHz. Above 1.7 GHz the input mixer is protected by the preselector.

Option 02—Digital Storage.
Spectra may be digitized with 500 point resolution and held in one of two memories, A or B—or in a 1000 point memory created by combining A and B. Once in memory, spectra may be displayed with a bright flicker free trace, making prolonged viewing or photography easy—especially for single sweep or slow sweep speeds. Digital storage also adds several internal data processing features: Digital averaging—Data at each frequency point in memory is summed and divided by the number of samples at that frequency. Peak Detection—Data at each frequency point is continuously updated with peak-detected values. Digital cursor—An adjustable cursor allows the operator to obtain a combined peak/average display—data above the cursor is shown peak-detected, data below the cursor is averaged.

With MAX HOLD mode, the highest amplitude attained at each of the 1000 points during successive sweeps is stored and displayed. This mode is useful for measuring peak-to-peak drift over a time interval or in making swept response measurements of filters without a tracking source.

With SAVE A mode, one signal is stored in the A memory for later examination. This information is not updated and is useful in instances of later comparison with other signal information. In the B MINUS SAVE A mode, the A signal is stored and not updated, then arithmetically subtracted from the B signal, which may be continually updated. This mode is most useful for comparing signals such as in production test comparison of a signal with a standard, or for calibrating frequency response uncertainty out of a measurement.

With the AVERAGE mode, the display is divided by a horizontal cursor. Above the moveable cursor, signals are peak detected and displayed. Below the cursor, signals are averaged. Averaging is useful for applications in which signals must be analyzed in the presence of high noise levels. The trace smoothing that occurs through averaging simplifies the process.

Digital averaging and video filtering may be used jointly or independently depending on the nature of the signal.

In addition, with digital storage, slowly swept signals are easy to observe and photograph, and do not require intensity or other display readjustments.

Option 03—Frequency Stabilization/100 Hz Resolution.
With this option, phaselocked local oscillator stabilization provides exceptional display stability and low noise sidebands, and results in less frequency drift and less residual fm. Thus, the 492/492P user can observe and measure characteristics of lower modulation frequencies. As part of Option 03, improved resolution (100 Hz) and narrow span of 500 Hz/div provide increased measurement capability for close in sideband analysis. The spectral purity of clean oscillators may thus be measured directly at microwave frequencies. The 492/492P retains its one knob center frequency control with Constant Tuning Rate (CTR) even with phaselock.

Option 03 is recommended when the 492/492P will be used at spans less than 50 kHz per division, and is required for spans of less than 10 kHz per division. Phaselock occurs automatically and is a function of the setting of the span/div control. For convenience in operating the analyzer in fixed tuned receiver (zero span) mode, phaselock may be deactivated by a front panel control.

Option 08—Delete External Mixer Capability.
Option 08 deletes external mixer capability for extending frequency range above 21 GHz, with a cost savings as a result.

Option 20—General Purpose 12.5 GHz to 40 GHz Waveguide Mixer Set.
This option extends the operational upper frequency of the 492/492P to 40 GHz. The actual waveguide range is 12.5 to 40 GHz. This option package, designed to provide economical use of the analyzer at frequencies above 21 GHz, consists of three waveguide mixers and a connecting coaxial cable.

Option configurations

Option 21—High Performance 18 GHz to 40 GHz Waveguide Mixer Set. This option consists of two waveguide mixers and a coaxial cable, and extends the operational upper frequency of the 492/492P to 40 GHz. The actual waveguide range is 18 to 40 GHz, and the mixers are designed so that, in operation with the analyzer, the system is calibrated in amplitude, flatness, and sensitivity.

Option 22—High Performance 18 GHz to 60 GHz Waveguide Mixer Set. This option consists of three waveguide mixers and a connecting coaxial cable, and extends the operational upper frequency of the 492/492P to 60 GHz. The actual waveguide range is 18 to 60 GHz, and the mixers are designed so that, in operation with the analyzer, the system is calibrated in amplitude, flatness, and sensitivity.

Options 30, 31 and 32—Rackmount/Benchmount. These options offer a choice of mechanical configurations for the 492/492P and 496/496P.

Option 30 is a rackmount configuration with standard front panel input/outputs. Option 31 is a rackmount configuration with rear panel input/output capability. Option 32 adds side covers and trim to an Option 31, making it into a stackable bench top configuration.

The Option 30 and 31 Rackmount is a standard 19-inch width and comes with standard rackmount fittings. A spectrum analyzer accessories storage drawer is also included. Dimensions are 22.23 x 42.9 x 63.5 cm (8.75 x 16.89 x 25.00 inches). Weight is 24.5 kg (54 pounds).

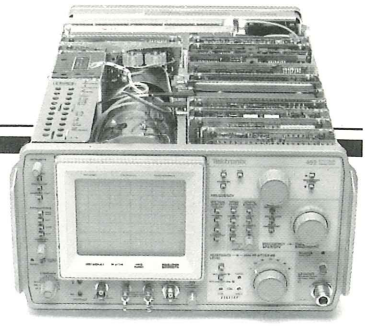
The Option 32 Benchmount is approximately the same size as the Rackmount but is dressed with side and top panels and carrying handles and feet. The Benchmount provides a convenient surface for stacking other instruments. Dimensions are 23.5 x 45.7 x 63.5 cm (9.25 x 17.9 x 25.00 inches). Weight is 25.9 kg (57 pounds).

Rackmounted 490 Series Spectrum Analyzer

Manual to Programmable/GPIB Conversion
492 Spectrum Analyzers, serial number B030000 and above, and all 496 Spectrum Analyzers can be converted to fully programmable/GPIB instruments. Conversions are made by your nearest Tektronix Service Center.

Specify 040-1037-00 for all 492 Spectrum Analyzers except those that include Option 08, (external waveguide mixer capability deleted). Specify 040-1038-00 for 492's including Option 08. For all 496 Spectrum Analyzers, specify 040-1046-00.

Ordering Information



Combined options.
The 492/492P may be ordered with any combination of options and optional accessories. Except for one delete option, Option 08, all options and optional accessories are additive.

Options 30, 31, and 32, the Rackmount/Benchmount Options, also apply to the 496/496P.

492 Spectrum Analyzer

496 Spectrum Analyzer

492/496 Spectrum Analyzer Standard Accessories
50Ω Coaxial Cable, N to N Connectors, 6 foot (1) (012-0114-00)
50Ω Coaxial Cable, BNC to BNC Connectors, 18 inch (1) (012-0076-00)
Adapter, N Male to BNC Female (1) (103-0045-00)
CRT Mesh Filter (1) (378-0726-01)
Fuse 2 A, Slow Blow (1) (159-0021-00)
Fuse 4 A Fast Blow (2) (159-0017-00)
Power Cord, 115-V (1) (161-0118-00)
Cord Clamp (1) (343-0170-00)
CRT Light Filter, Blue (1) (378-0115-00)
CRT Light Filter, Amber (1) (378-0115-01)
CRT Light Filter, Gray (1) (378-0115-02)
CRT Visor (1) (016-0653-00)
Operator's Manual (1); Operator's Handbook (1); Service Manual, Volume 1 (1); and Service Manual, Volume 2 (1).

For all 492 configurations except Option 08, include: Diplexer Assembly (015-0385-00)

492P Programmable Spectrum Analyzer

496P Programmable Spectrum Analyzer
Includes Programmer's Manual, listed 496 standard accessories, and GPIB cable, 2 meter, double shield (1) (012-0630-03)

Manual to Programmable/GPIB Conversion
Conversions are made by your nearest Tektronix Service Center.

Specify for:
492 Spectrum Analyzer excluding Option 08 (040-1037-00)
492 Spectrum Analyzer including Option 08 (040-1038-00)
496 Spectrum Analyzer—(040-1046-00)

Programmable Spectrum Analyzer Companion Products
4052A Graphic Computing System Controller
4041 Computer/Controller
4631 Hard Copy Unit
4662 Interactive Digital Plotter
4924 Digital Cartridge Tape Drive

492/492P Option Ordering Information

Option 01—Internal Preselection
Provides calibrated preselected filtering of input to first mixer for each frequency band.

Option 02—Digital Storage
Provides multiple memory display storage with SAVE A, MAX HOLD, B MINUS SAVE A, display average, and storage bypass.

Option 03—Frequency Stabilization/100 Hz Resolution
Provides first local oscillator stabilization by phaselocking the oscillator to an internal reference. Also provides 100 Hz resolution.

Option 08—Delete External Mixer Capability
Deletes internal switching front panel connector and external diplexer to connect and use external waveguide mixers.

Option 20—General-Purpose 12.5 to 40 GHz Waveguide Mixer Set
Includes three mixers (12.4 to 18 GHz, 18 to 26.5 GHz, and 26.5 to 40 GHz) and attaching hardware to extend the 492 upper frequency.

Option 21—High Performance 18 to 40 GHz Waveguide Mixer Set
Includes two mixers (18 to 26.5 GHz and 26.5 to 40 GHz) and attaching hardware to extend the 492 upper frequency.

Option 22—High Performance 18 to 60 GHz Waveguide Mixer Set
Includes three mixers (18 to 26.5 GHz, 26.5 to 40 GHz and 40 to 60 GHz) and attaching hardware to extend the 492 upper frequency.

490 Series Options

Option 30—Rackmount
19" rack width with front panel input/outputs.

Option 31—Rackmount
19" rack width with rear panel input/output capability.

Option 32—Benchmount
Adds side and top panels, carrying handles and feet for a stackable bench top configuration.

492/492P Optional Accessories

The following listed accessories may be ordered in any combination.

General Purpose 12.5 to 40 GHz Waveguide Set (016-0640-00)
12.4 to 18 GHz Mixer (119-0097-01)
18.0 to 26.5 GHz Mixer (119-0098-01)
26.5 to 40 GHz Mixer (119-0099-01)
Cable (012-0748-00)
Case (016-0465-01)

High Performance 18 to 40 GHz Waveguide Mixer Set (WM 4902)
18 to 26.5 GHz Mixer (WM 490K)
26.5 to 40 GHz Mixer (WM 490A)
Cable (012-0649-00)
Case (016-0465-01)

High Performance 18 to 60 GHz Waveguide Mixer Set (WM 4903)
18 to 26.5 GHz Mixer (WM 490K)
26.5 to 40 GHz Mixer (WM 490A)
40 to 60 GHz Mixer (WM 490U)
Cable (012-0649-00)
Case (016-0465-01)

High Performance 18 to 90 GHz Waveguide Mixer Set (WM 4904)
18 to 26.5 GHz Mixer (WM 490K)
26.5 to 40 GHz Mixer (WM 490A)
40 to 60 GHz Mixer (WM 490U)
60 to 90 GHz Mixer (WM 490E)
Cable (012-0649-00)
Case (016-0465-01)

High Performance 18 to 140 GHz Waveguide Mixer Set (WM 4905)
18 to 26.5 GHz Mixer (WM 490K)
26.5 to 40 GHz Mixer (WM 490A)
40 to 60 GHz Mixer (WM 490U)
60 to 90 GHz Mixer (WM 490E)
90 to 140 GHz Mixer (WM 490F)
Cable (012-0649-00)
Case (016-0465-01)

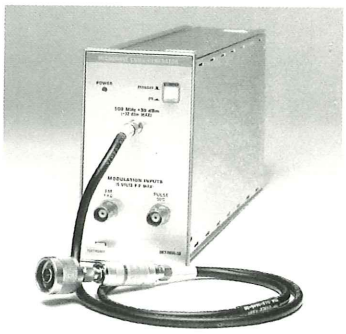
140 to 220 GHz tapered transition (119-1729-00 used with WM 490F waveguide mixer)

Microwave Comb Generator, TM 500 Series compatible (067-0885-00)

490 Series Spectrum Analyzer Optional Accessories

75Ω to 50Ω Minimum Loss Pad (011-0112-00)
Dc Block BNC to BNC (015-0221-00)
FET Probe P6201 to 900 MHz (010-6201-01)
1405 TV Sideband Adapter (525/60 Markers)
C-5C Camera
TV Trigger Synchronizer (015-0261-00)
Hard Case (transit) (016-0658-00)
Soft Case (016-0659-00)
Lab Cart Model 3

Note: 490 Series Spectrum Analyzers are compatible with all Tektronix C50 Series cameras.



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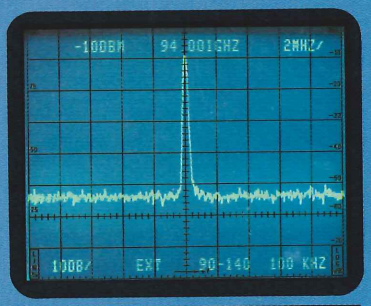

Spectral purity of 94 GHz signal using Tektronix external waveguide mixers.

Performance worth the name

Tektronix®
COMMITTED TO EXCELLENCE

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26W-4817-1