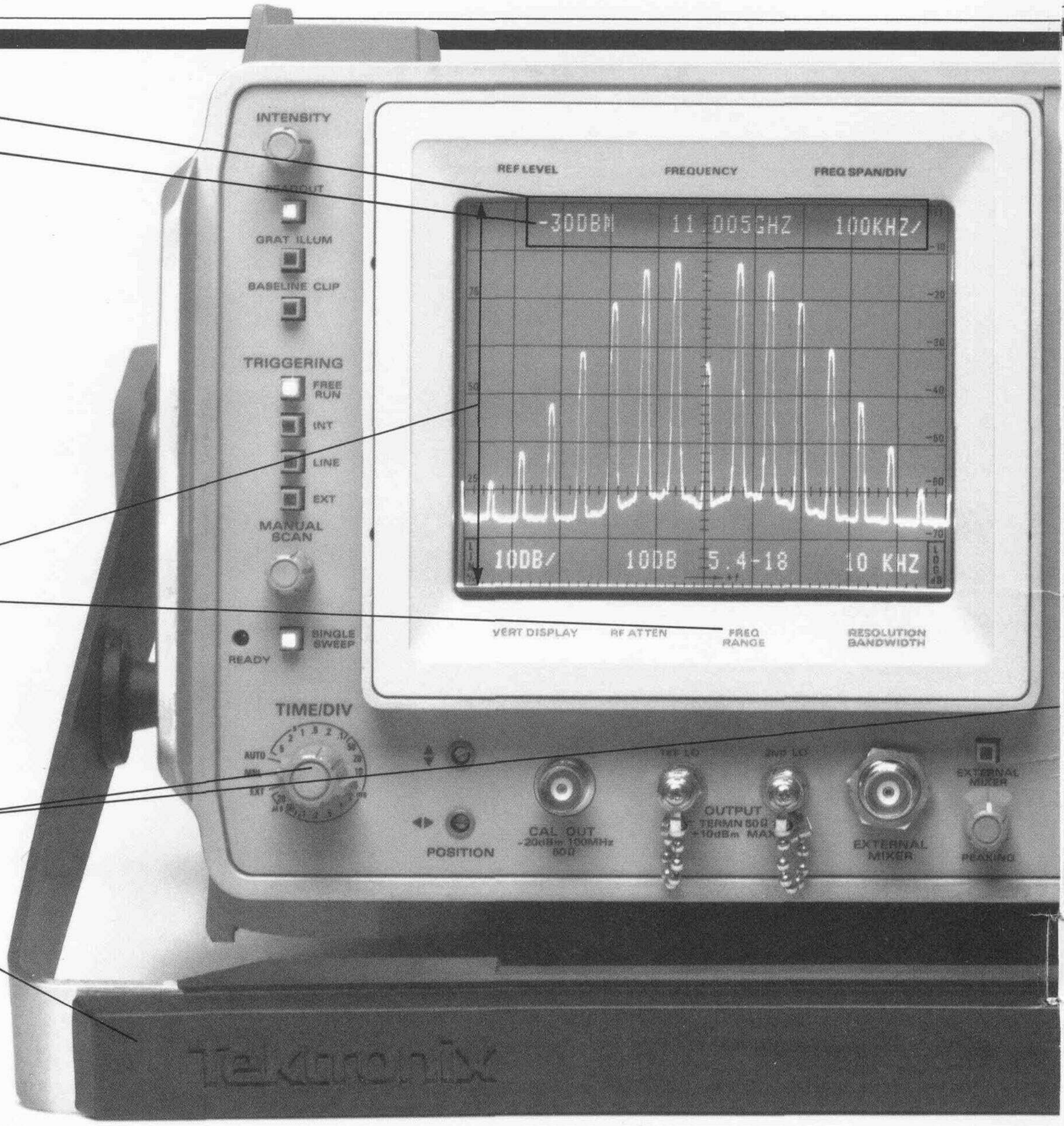
We go where **you** go with lab quality spectrum analysis.

Tektronix

492/492P Spectrum Analyzers

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 in the 492P.

80 dB dynamic range.

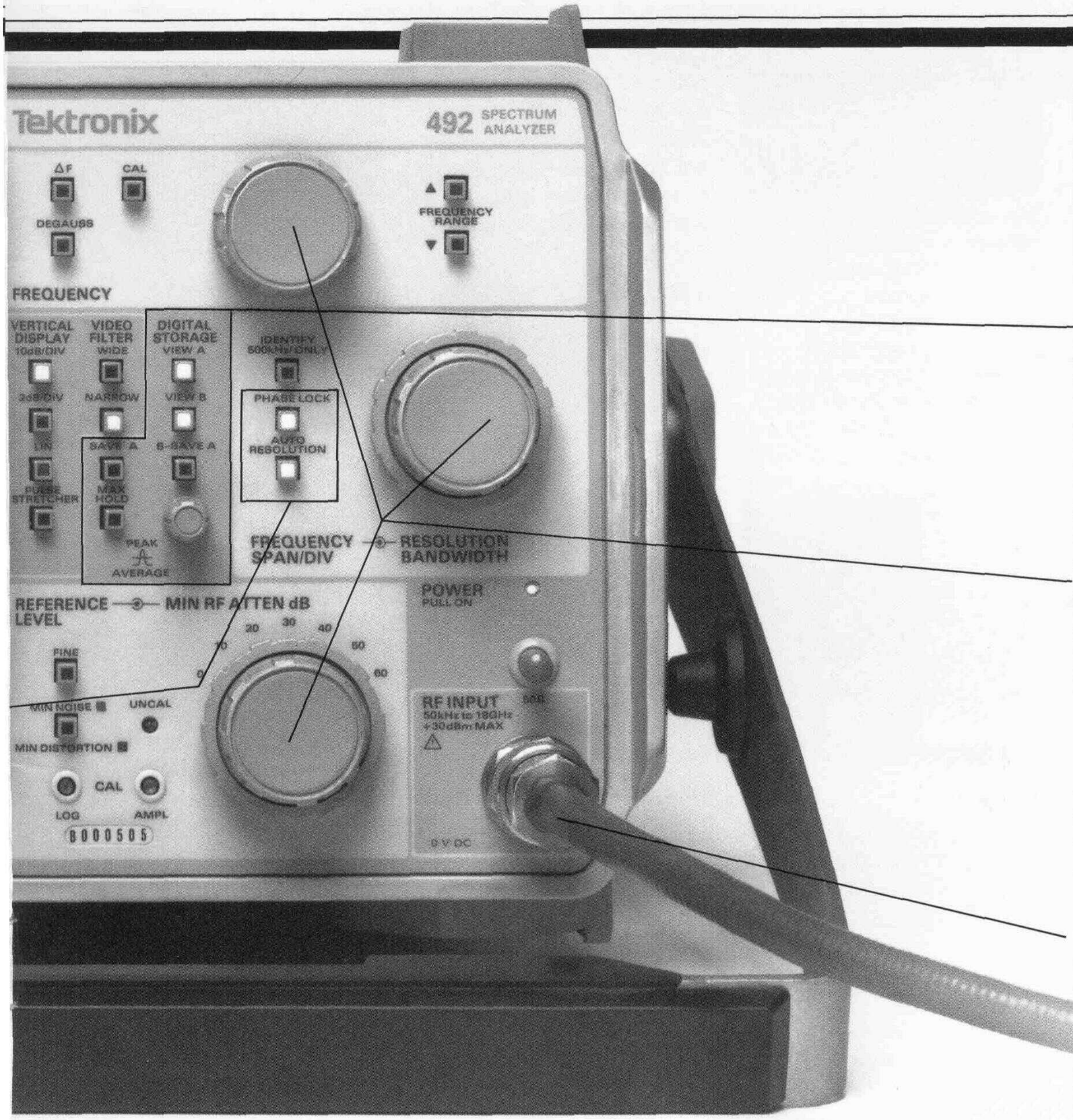
Wide frequency range. 50 kHz to 21 GHz internally and to 60 GHz with Tektronix calibrated external waveguide mixers. Operation to 220 GHz with commercially available external waveguide mixers.

Automatic modes.

Wide range of options.

Goes where you go. With its portable form factor and single-handle carry, the 492 moves easily around the lab or systems test area, fits under an airplane seat, or goes out with you on a field call.

Environmentalized per MIL-T-28800B.



Full programmability.

492P model provides IEEE 488 compatibility via GPIB interface bus. Allows full programming of all signal-affecting front-panel control settings and processing of stored spectrum displays.

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.

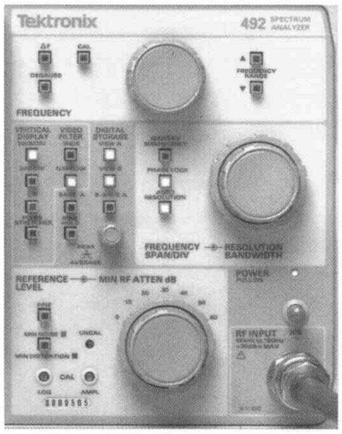
Freedom from spurious responses.

Internal calibrated YIG pre-selector available with Option 01. Eliminates harmonic mixing products and images, and increases dynamic range for harmonic measurements in the microwave range.

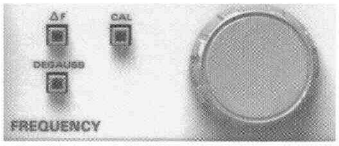
A spectrum analyzer with unmatched convenience and capability. In one compact package.

Simple to use.

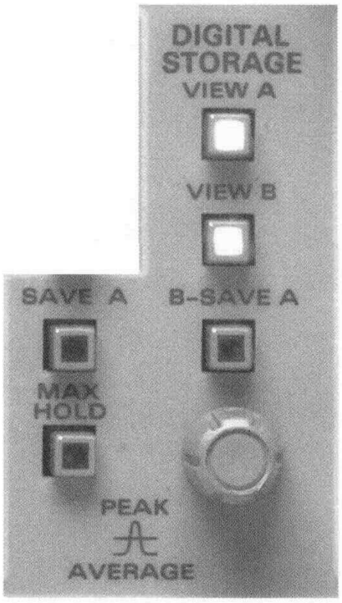
Operation of the 492 is as easy as 1 (set the input reference level), 2 (set the center frequency), and 3 (set the frequency span).



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.

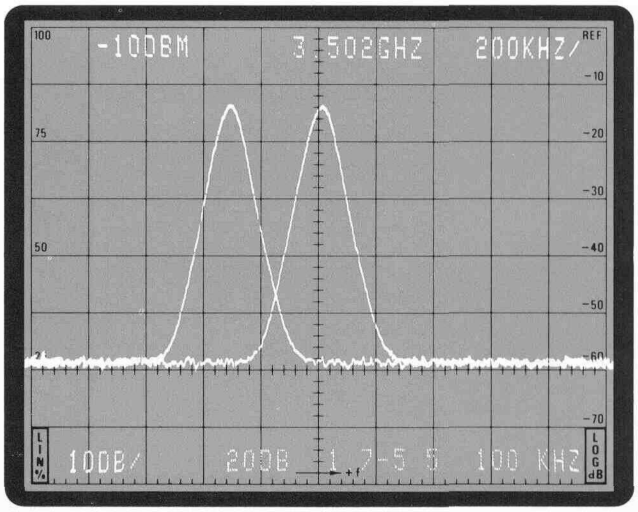


Digital storage and signal processing.

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

Available as Option 02, digital storage and signal processing enhance the 492's performance and ease of operation.

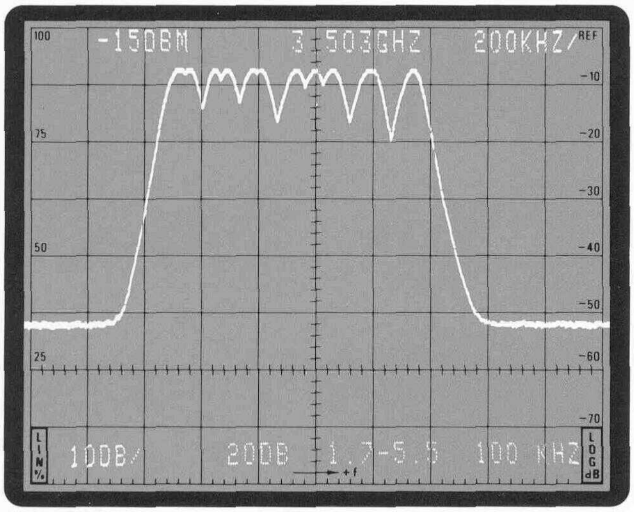
VIEW A, VIEW B modes — Contents of the selected memory are displayed. All stored displays are updated continually (except with SAVE A mode). A and B memories can be combined for high resolution (1000 point) storage.



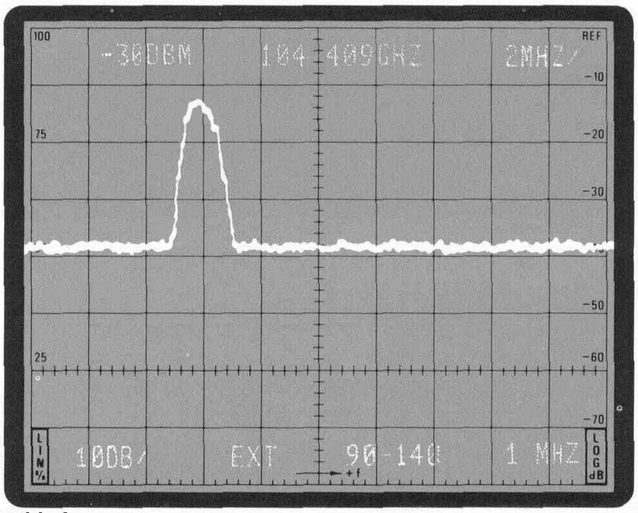
SAVE A mode.

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 light weight combine to offer unmatched portability in a laboratory quality analyzer. The 492 can easily be moved in the design lab or systems test area — or wherever else you need it. It even fits under an airplane seat.

Wide frequency range.

The 492 offers unequalled frequency coverage. From 50 kHz to 220 GHz, with amplitude calibrated waveguide mixers to 60 GHz available from Tektronix. A broader range than any laboratory analyzer and with the performance you need to handle tough laboratory measurements.

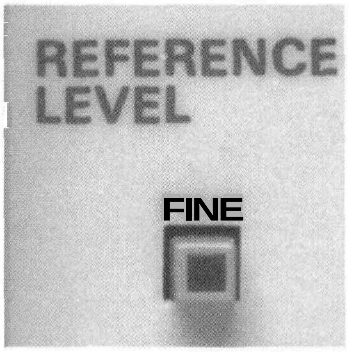
Programmability/IEEE (GPIB) compatibility.

The programmability and interface bus capability available with the 492P 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.

Amplitude resolution of 0.25 dB.

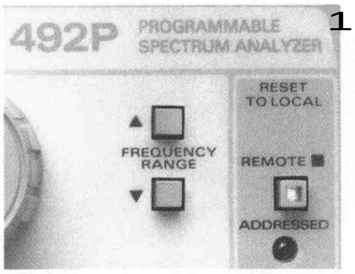
High amplitude accuracy is possible through 0.25 dB steps, an improvement over the well-known *if* substitution technique. Superfine 0.25 dB control increments provide 0.05 dB per 0.25 dB step accuracy. This performance increase is achieved without a separate vernier control.



492P makes spectrum analysis automatic. And easy.

Two instruments in one.

The 492P is a fully programmable version of the 492 Spectrum Analyzer. It incorporates all of the 492's lab quality performance and ease of use features when used as a manual instrument. Push the "Reset to Local"

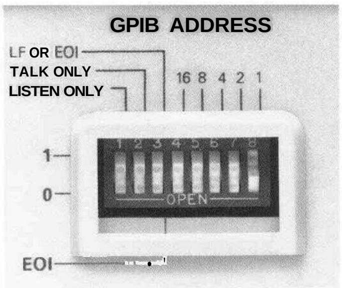


button and the 492P becomes a 492—with operation from the front panel. But, most important, the 492P opens the way to automated spectrum analysis and documentation via its IEEE-488 (GPIB) interface.

This versatility makes the 492P useful in many applications in the lab, factory or field.

With or without a controller.

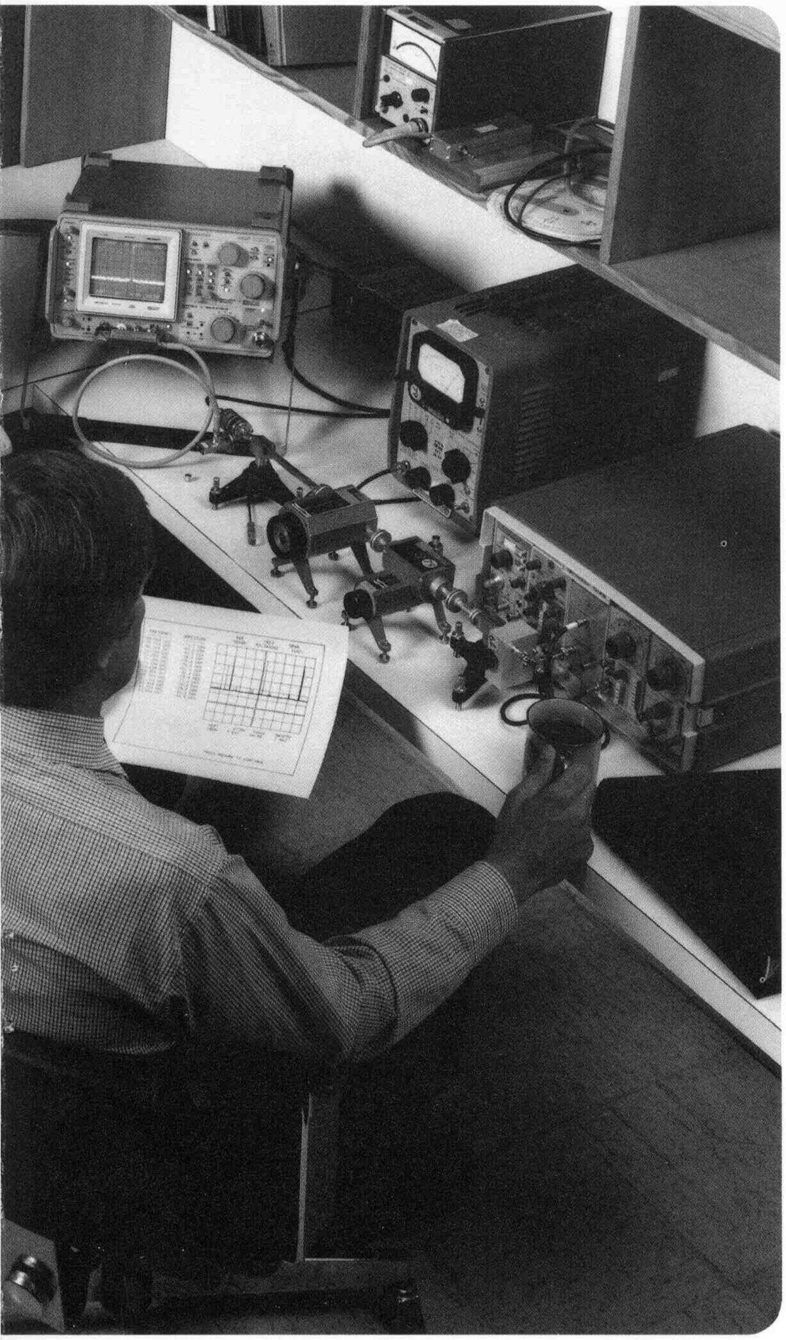
Switches on the rear panel select the mode of operation as a GPIB instrument. In the normal TALKER/LISTENER mode, the 492P listens to and executes commands from a GPIB controller. All important front panel settings can be



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 a 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 will report instrument settings, internal status or data from its display.

For field use where a controller is not available, the 492P 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, such as the Tektronix 4924. In the LISTEN ONLY mode, the 492P becomes a display for waveform data sent on the bus and will respond to commands for measurement setup.

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



Easy to use.

The 492P is designed for ease of operation via the GPIB, just as the 492 is 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 response is "FREQ 5.2 E + 09."

The 492P's high level command language and the similarity of commands and responses simplify programming and make program listings easily readable for editing.

Automated setup.

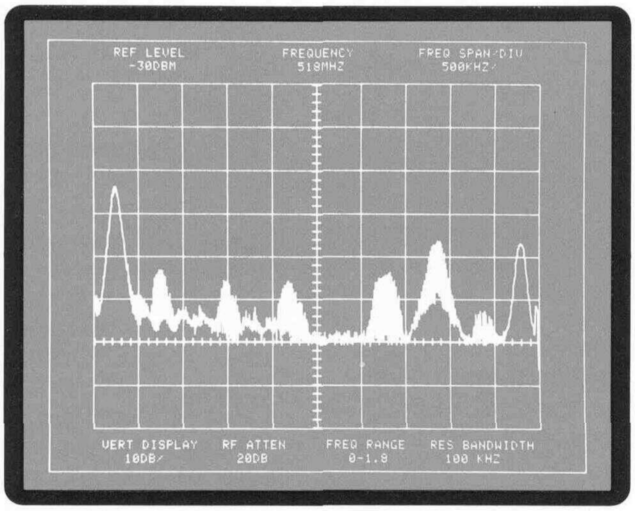
The 492P is not only an obedient servant under program control, but smart enough to do many things on its own. For example, it will provide all of its settings with one command. Just send "SET?" You'll get back a block of characters listing all of the front panel and internal settings. Store this response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

Internal processing simplifies programming.

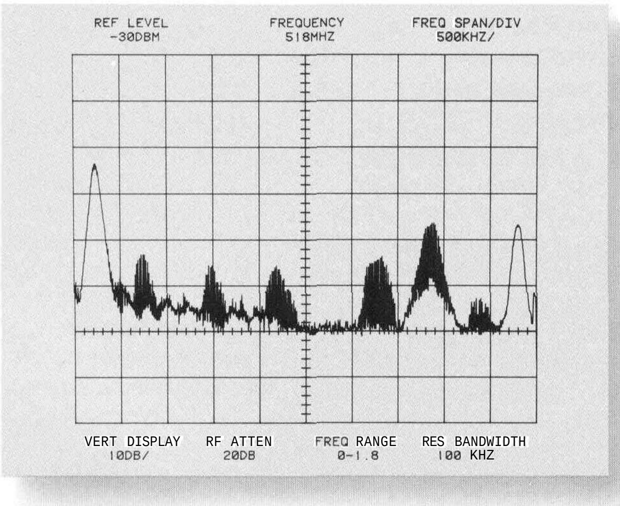
The 492P's power reduces processing time and eases the software development task. For example, the 492P can identify all signal peaks above a specified amplitude threshold and the maximum and minimum points on the display waveform.

Having identified a point of interest in its digital storage memory, the 492P can then perform certain operations automatically. It 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 sensitivity so the signal peaks at the top of the screen reference level. The display now reads directly in dB below the signal peak and assures an on screen display for precision amplitude measurements.

Programmable 492P saves time and simplifies your job



A UHF TV signal with multiburst test pattern is acquired by the 492P Programmable Spectrum Analyzer, sent via the GPIB in digital form and then displayed on the 4052 Graphic System.



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

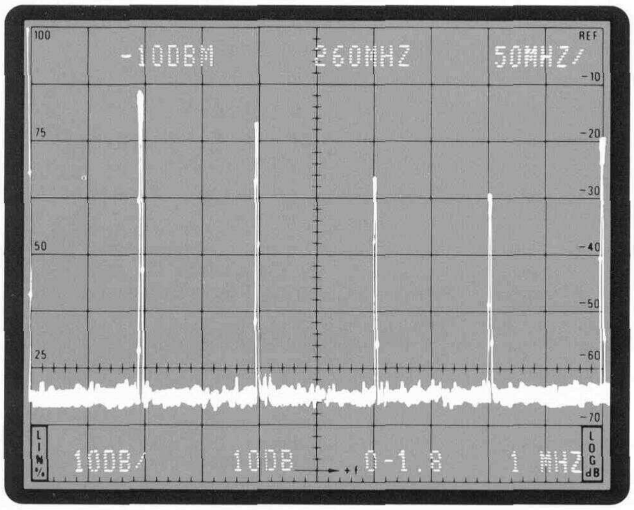
Automated signal tracking.
Keeping a drifting signal on screen in a narrow frequency span per division is no longer troublesome. With the internal processing functions and the ability to repetitively execute instructions in its input buffer, the 492P can track drifting signals with virtually no help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

Auto peaking.
Automatic peaking 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 for maximum signal response.

Enhanced data presentation via GPIB.
Displayed waveforms can be outputted 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 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 permits a real time comparison of a controller-generated spectrum, or set of limits, and an incoming signal on the 492R 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.



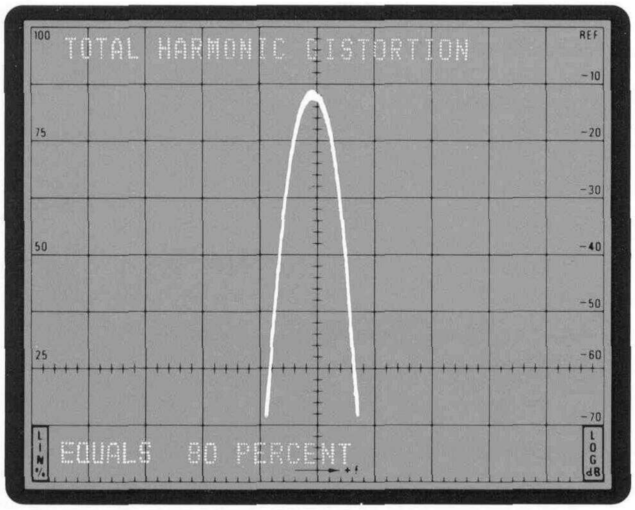
A 100 MHz signal and its harmonics displayed on the 492P with a full screen span of 500 MHz.

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 outputted 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 in the 492P greatly simplify this measurement.

Put it to work.

With the programmable 492P 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.

When you look at the total performance capability of the 492R you'll recognize its value: Ease of operation both as a programmable and manual instrument. Wide frequency range. The versatility to go where you go. Into the lab for automated testing; into the field for data collection.

Check the specs and see.

Frequency Related

Frequency Range — 50 kHz to 21 GHz with internal mixer, to 220 GHz with external mixers. Option 08 deletes coverage above 21 GHz (calibrated mixers to 60 GHz available from Tektronix).

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

Frequency Readout Resolution — Within 1 MHz.

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 within ±20%, manually or automatically selected.

Resolution Shape Factor (60/6 dB) — 7.5; maximum.

Spurious Responses

Residual (no input signal) — -100 dBm or less referenced to input mixer for fundamental conversion.

Harmonics — 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.

Intermodulation — 3rd order products at least -70 dB down from two full screen signals within any frequency span in the Min Distortion mode. At least -100 dB down for two signals spaced more than 100 MHz apart from 1.7 to 21 GHz for preselected Option 01.

L.O. Emissions (referenced to input mixer) — 10 dBm maximum; -70 dBm maximum for Option 01.

Stability (after 2 hour warm-up)

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: 200 kHz/hour unphaselocked, 25 kHz/hour phaselocked for fundamental mixing.

Noise Sidebands — At least 75 dBc @ 30X resolution offset (70 dBc for 100 Hz resolution) for fundamental mixing.

Amplitude Related

Reference Level Range— -123 dBm to +40 dBm (+30 dBm maximum safe input) 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 (A) measurements in log mode. 1-2-5 sequence and 1 dB equivalent increments in LIN mode.

Reference Level Accuracy — Amplitude change of 0.25 dB ±0.05 dB, 1 dB ±0.2 dB, 10 dB ±0.5 dB; to a maximum of ±1.4 dB for 60 dB and ±2 dB for 90 dB reference level change when gain change and attenuation do not offset each other.

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

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.

SENSITIVITY AND FREQUENCY RESPONSE

		Average Noise Level for 1 kHz Resolution		Frequency Response With 10 dB Attenuation	
Frequency Range	Mixing Number (n)	No Preselection	Preselected Option 01	No Preselection	Preselected Option 01
50 kHz-1.8 GHz*	1	-115dBm	-110dBm		±1.5 dB
50 kHz-4.2 GHz*	1	−115 dBm	-110dBm	±2.5dB	
1.7-5.5 GHz	1	−115 dBm	-110dBm	±1.5dB	±2.5 dB
3.0-7.1 GHz	1	-115dBm	-110dBm	±1.5dB	±2.5 dB
5.4-18 GHz	3	−100 dBm	-95 dBm (12GHz) -90 dBm (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 5dB
With Tektronix optional high performance waveguide mixers					
18-26 GHz	6	-100dBm		±3 dB	
26-40 GHz	10	-95 dBm		±3dB	
40-60 GHz	10	-95 dBm		±3dB	

*Low frequency end performance does not include effects due to zero Hz feedthrough.

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

*** Includes frequency band switching error of 1 dB maximum.

Input Characteristics

Internal Mixer— Type N female connector, VSWR 1.45 to 18 GHz, and 3.5 to 21 GHz, with 10 dB or more attenuation.

Optimum Level for Linear Operation — -30 dBm referenced to mixer.

1 dB Compression Point — -28 dBm from 1.7 to 2 GHz for Option 01; otherwise -10 dBm.

Maximum Safe Input Level — +13 dBm without Option 01, +30 dBm (1 W) with Option 01, zero *rf* attenuation.

Attenuator Power Limit — +30 dBm (1 W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor.

Output Characteristics

Calibrator— −20 dBm ±0.3 dB, 100 MHz ±0.01%.

1st **L.O.—** +7.5 dBm @ 50ft nominal.

2nd L.O.— −16 dBm @ 50ft nominal.

Vertical Out— 0.5V ±5%/div, 1 kΩ nominal.

Horizontal Out— 0.5 V ± 10%/div, 1 kΩ nominal.

Pen Lift — TTL, 5 V nominal.

IF Out — -15 dBm nominal for full screen, -30 dBm display; 10 MHz, 50 Ω.

GPIB Control — IEEE 488 input/output control for 492 P

Miscellaneous

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

Crt Readout— 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 — 90 to 132 VAC, 180 to 250 VAC, 48 to 440 Hz, 210 W max with all options.

Environmental Characteristics — Per MIL-T-28800B type III, class 3, style C.

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.

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

Interpreting the specifications

Low-End Frequency Performance.

Typical low-end frequency performance for the 492 is shown opposite in figure 1.

Unlike many spectrum analyzers with microwave measurement capability, the 492 is specified for measurements down to 50 kHz.

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

Performance below 50 kHz is affected by local oscillator phase noise, input coupling and the zero hertz feedthrough. Practical performance is limited to approximately 5 kHz.

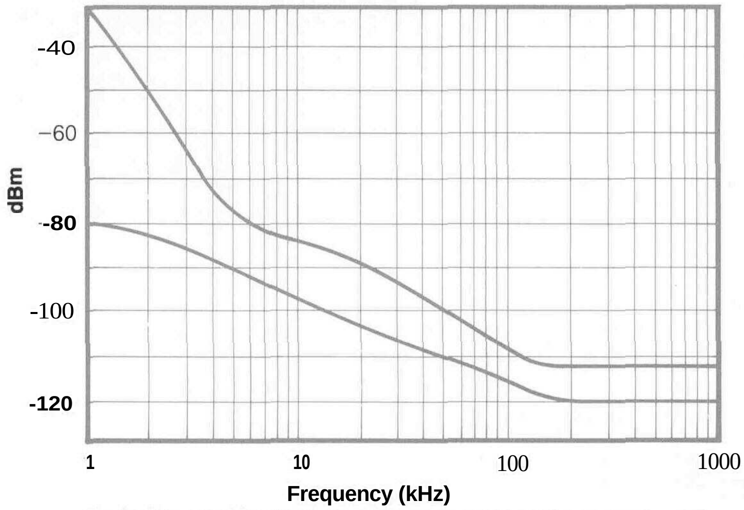
Note that, at 50 kHz, the noise level is degraded to approximately −90 dBm for a 1 kHz resolution bandwidth due to noise sidebands around the zero Hz feedthrough.

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 A amplitude mode.

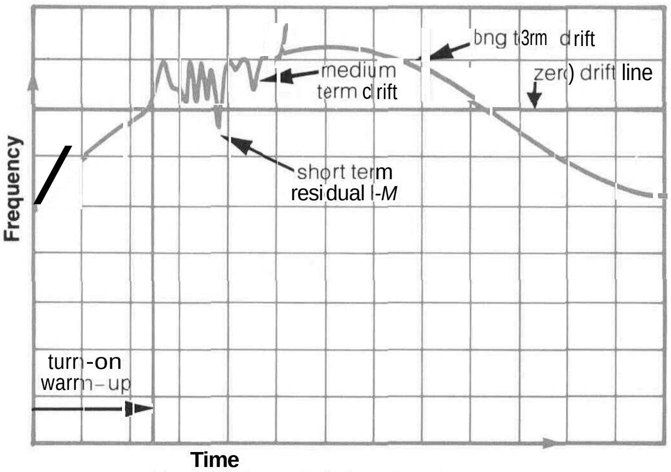
Frequency Drift.

The relationship between long-term, medium-term, and short-term frequency drift for the 492 is illustrated in figure 2.

Spectrum analyzer frequency drift is primarily caused by changes in temperature and manifests itself as a shift in signal display frequency even though input signal frequency remains constant. The apparent change in frequency depends on several factors, including instrument temperature at turn-on, environmental temperature, time since turn-on, whether or not the 492 is phase-locked, the mixing harmonic number, and the period of time over which the measurement is made.

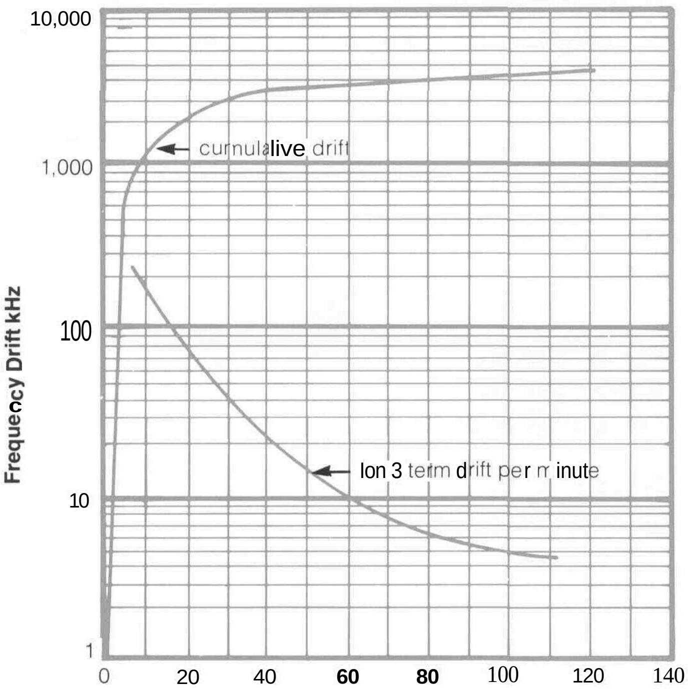


Typicaf low end frequency performance for the 492 with Option 01 (see text for explanation.)
Figure 1



Representative drift characteristics of modern spectrum analyzers.
Figure 2

Interpreting the specifications



Typical long term turn-on drift characteristics for an unphase-locked 492 starting at room temperature (fundamental mixing. Multiply by mixing N number for higher mixing products).

Figure 3

Frequency Drift During Specified Warm-Up Time.
Because of the thermal nature of frequency drift, the 492's behavior depends to a great extent on external temperature conditions as they affect the internal temperature of the instrument. A 492 that has been out in the cold before warm-up may drift more than one that has been in the laboratory.

Frequency Drift During Warm-Up For An Unphaselocked 492.
Turn-on drift as a function of time is caused by environmental changes. Because the 492 is designed to operate in a wide variety of environments, drift is a more important consideration for the 492 than for a spectrum analyzer designed for lab use only.

For a typical unphaselocked 492 starting out at room temperature, frequency drift during the first half hour of warm-up is about 4 MHz, as shown in figure 3.

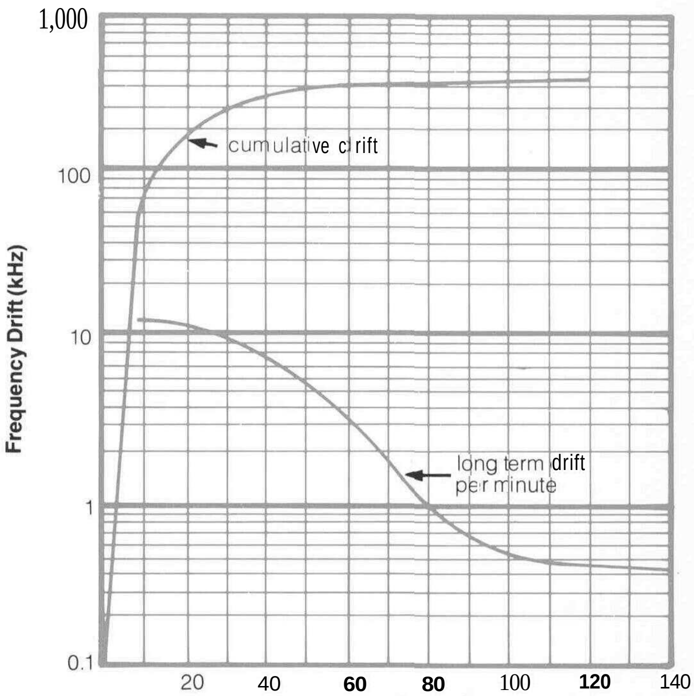
The cumulative drift specifications shown in figure 3 represent a slope of several hundred kHz/min at turn-on, down to a few kHz after the specified two-hour warm-up period.

Total cumulative drift after the two-hour warm-up is about 5 MHz. At this point, the 492 has reached the long-term drift specification of 200 kHz/hr. The instrument should be recalibrated after warm-up to maintain accuracy.

Frequency Drift During Warm-Up for a Phaselocked 492 (Option 03).
Adding phaselock (Option 03) to a 492 helps minimize drift. The first local oscillator is stabilized (automatic at 50 kHz/div at fundamental conversion unless manually overridden), leaving only drift caused by the second local oscillator. The second oscillator is not affected by higher mixing product multiplication, and so drift is independent of input frequency.

Furthermore, 492 phaselock stabilization offers the equivalent of infinite hold-in range, so that the first local oscillator will not break lock as it drifts. When phase error voltage reaches a predetermined maximum, the tune voltage is reset to maintain lock.

A phaselocked 492 (Option 03) starting at room temperature changes frequency by no more than 500 kHz in the



Typical long term turn-on drift characteristics for a phaselocked 492 (with Option 03) starting at room temperature.

Figure 4

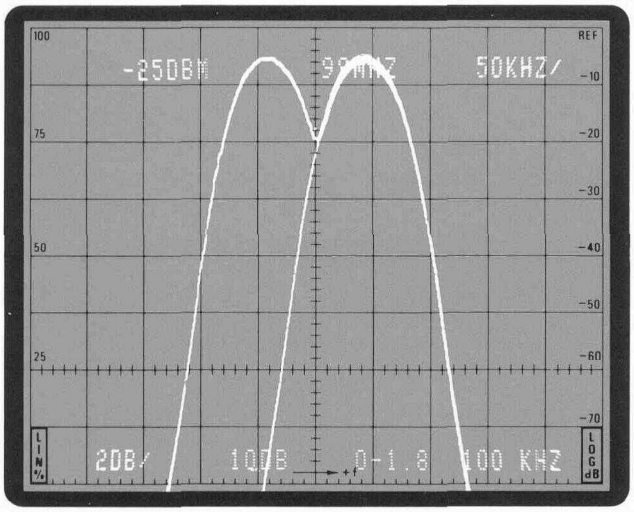


Figure 5

Specified 6 dB Resolution Bandwidth ±20%	Typical 3 dB Bandwidth	Typical Impulse Bandwidth	Typical Random Noise Bandwidth
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
100kHz	75 kHz	100kHz	100 kHz
1 MHz	750 kHz	800 kHz*	1 MHz*

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

Table 1.

first two hours. After the two-hour warm-up, the instrument drifts a maximum of 25 kHz/hr — a specification that is almost ten times better than without phaselock. These specifications represent an approximate drift of 10 kHz/min at turn-on and 400 Hz/min after two hours, as shown in figure 4.

Medium-Term Drift. A phaselocked 492 (with Option 03) exhibits excellent medium-term drift at 100 Hz/sec. An unphaselocked 492 will exhibit medium-term drift of about 2 kHz/sec. Medium-term drift is random back and forth movement of the displayed signal after the instrument has warmed up.

Incidental FM (Short-Term Drift), A phaselocked 492 exhibits 50 Hz incidental fm, and a basic 492 exhibits 1 kHz peak-to-peak. Incidental fm (caused by short-term drift) takes place in a very short time — often in milliseconds, at the most in seconds — and it must be measured in a very short time as well.

Resolution Bandwidth.

492 resolution bandwidths are specified at the 6 dB down points. This specification represents the spacing of two equal amplitude signals that can be well resolved, as illustrated in figure 5.

Depending on the application, other bandwidths may be of interest: for example, 3 dB, random noise, and impulse bandwidths. For most measurements, 492 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.

Harmonics and Intermodulation.

The 492 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

Third-Order Intermodulation — −70 dBc

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

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

I = Intercept point in dBm.
A = Distortion level relative to input carriers in dB.
N = Distortion order numbers.
S = Input signal level to the mixer in 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 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

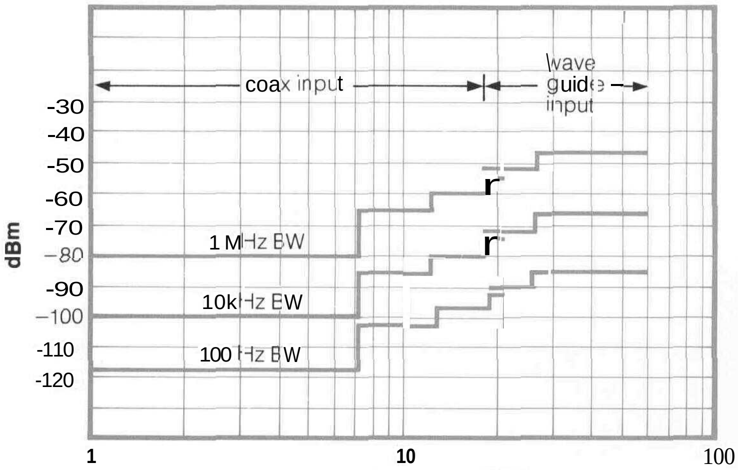
$$\Delta_o = \frac{(N-1)\ (I-n)}{N}$$

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

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.

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

Interpreting the specifications



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

Figure 6

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.)

Dynamic Range.

On-screen dynamic range of the 492 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 the same signal with a 1 kHz resolution bandwidth filter.

Note that the phase noise sideband pedestal breaks out at 70 dB down, dropping to 75 dB down at 20 kHz offset from the carrier. This allows easy observation of close-in sidebands 10 kHz out and 70 dB down.

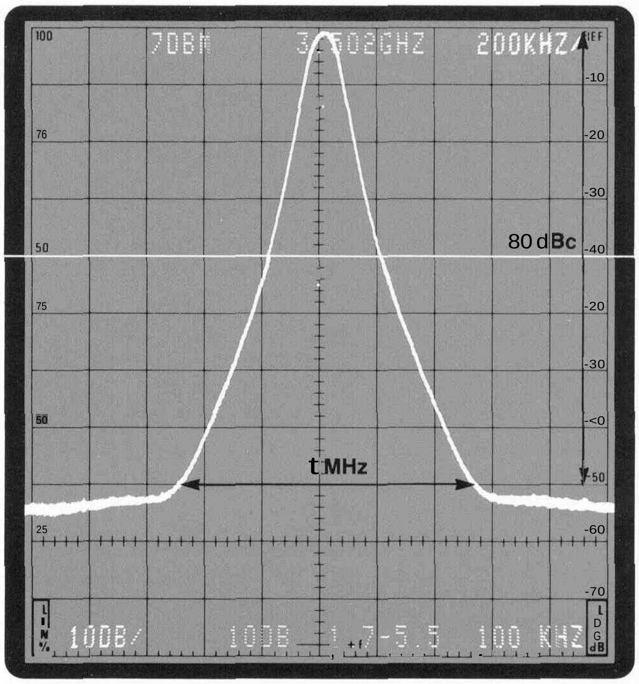


Figure 7

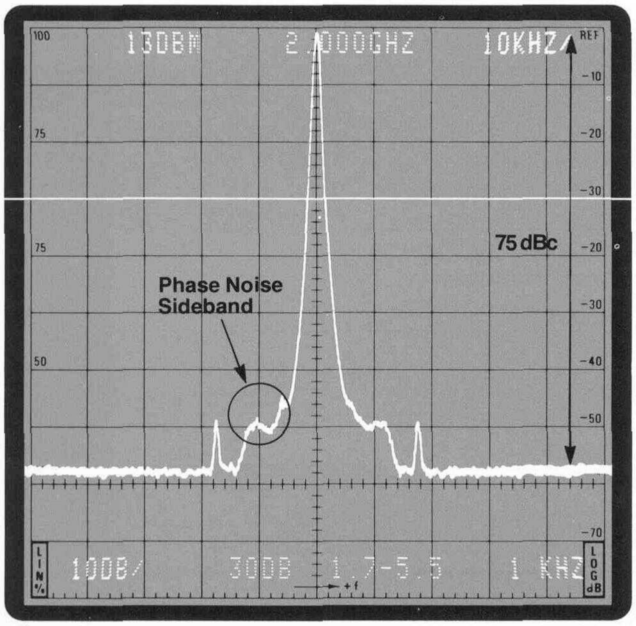
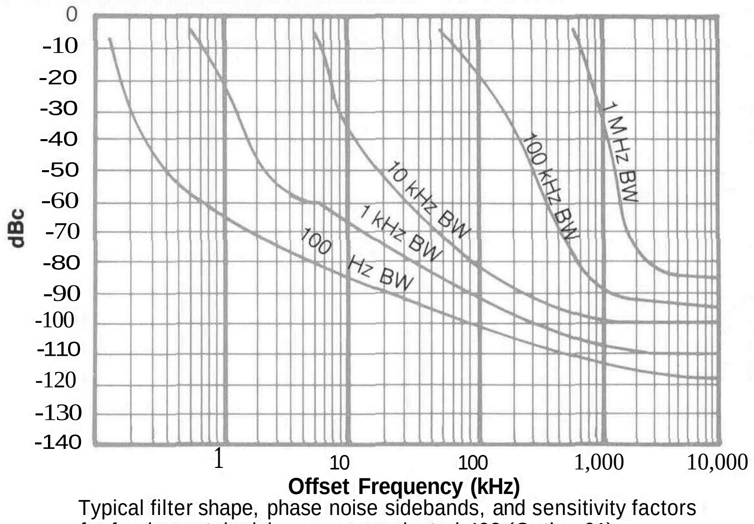


Figure 8



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

Figure 9

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

Amplitude Accuracy.

The amplitude reference for the 492 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 first band 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 instrument is operating outside the first band.

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/10dB, 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.

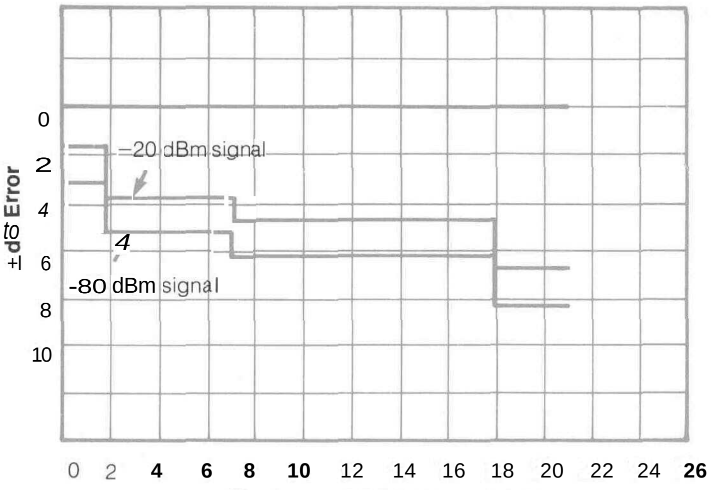
Reference level change errors are ±0.2 dB/1 dB, ±0.5 dB/10 dB accumulating to ±1.4 dB/60 dB, and ±2 dB/90 dB. This error analysis is worst case, providing gain and attenuation are not switched in simultaneously. This is normally prevented by the 492's automatic reference level mode.

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.

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

Interpreting the specifications



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

Frequency Range	Frequency Response ±dB Max.	IF Gain* Variation ±dB Max.	Calibrator Output ±dB Max.	Total ±dB Max.
50 kHz-1.8 GHz	1.5	0.5	0.3	2.3
1.7 GHz-5.5 GHz	2.5	0.5	0.3	3.3
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	0.5	0.3	3.8
26.5 GHz-40.0 GHz	3	0.5	0.3	3.8
40.0 GHz-60.0 GHz	3	0.5	0.3	3.8

*10 dB steps over a 70 dB range.
**Using optional accessory high performance mixers.

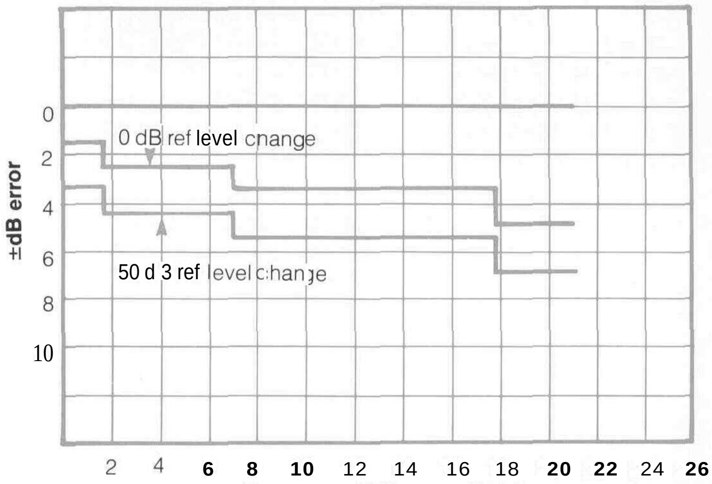
Achievable amplitude accuracy for a preselected 492 is shown above.

Table 2.

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.



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

Figure 11

Option Configurations

Two basic models of spectrum analyzer are available, the 492 Spectrum Analyzer and the 492P Programmable Spectrum Analyzer. You can order either model with any combination of the available performance options and optional accessories to configure the instrument for your requirements.

The 492P is fully compatible with the IEEE-488 interface bus (GPIB) and can be operated through any controller capable of interfacing through the bus, especially the Tektronix 4050 Series systems. All important front panel controls function digitally and can be operated by the controller. Thus, the 492P not only transmits data to the controller, but may be programmed by that controller. A remote/local switch on the 492P front panel provides for local, manual control of the analyzer, overriding program control.

The front panel may also be locked out by the controller for testing situations in which the possibility of local control might invalidate measurement results.

For general use spectrum analysis, optimum performance may be obtained with the inclusion of Options 01, 02, and 03.

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.

Ordering Information

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, phase-locked local oscillator stabilization provides exceptional display stability and low noise sidebands, and results in less frequency drift and less residual fm. Thus, the 492 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 special purity of clean oscillators may thus be measured directly at microwave frequencies. The 492 retains its one knob center frequency control with Constant Tuning Rate (CTR) even with phaselock.

Option 03 is recommended when the 492 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.

Option 20 — General Purpose 12.5 GHz to 40 GHz Waveguide Mixer Set.

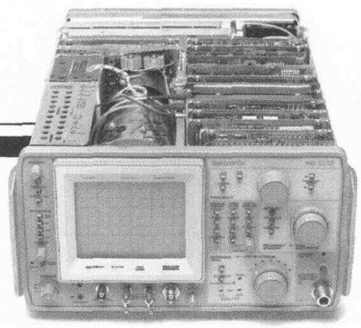
This option extends the operational upper frequency of the 492 or 492P to 40 GHz. The actual waveguide range is 12.5 to 40 GHz. This option package, designed to provide economical use of the analyzer at frequencies above 21 GHz, consists of three waveguide mixers and a connecting coaxial cable.

Option 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 or 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 or 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.



Combined options.

The basic 492 Spectrum Analyzer or the basic 492P Programmable Spectrum Analyzer may be ordered with many combinations of options and optional accessories. The prices are additive (except for one delete option, Option 08, which deletes external mixer capability). Note that the standard accessories are listed only once (with the basic 492), but that one set is included with either spectrum analyzer.

Also listed with the 492P are the companion 4052 Graphic Computing System Controller, 4631 Hard Copy Unit, 4662 Interactive Digital Plotter and 4924 Digital Cartridge Tape Drive.

492 Spectrum Analyzer **$18,500.00**

Including the following listed standard accessories: Diplexer Assembly (015-0385-00); 50 Ω Coaxial Cable, N to N Connectors, 6 foot (1) (012-0114-00); 50 Ω 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, Fast 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) (378-0115-00); 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 (2).

492P Programmable Spectrum Analyzer **$22,500.00**

Including Programmers Manual and the listed standard 492 accessories.

4052 Graphic Computing System Controller **$10,950.00**
4631 Hard Copy Unit .. **$ 4,850.00**
4662 Interactive Digital Plotter .... **$ 4,495.00**
4924 Digital Cartridge Tape Drive .... **$ 2,695.00**

Option Ordering Information.

Option 01—Internal Preselection .... **Add $3,800.00**

Provides calibrated preselected filtering of input to first mixer for each frequency band.

Option 02—Digital Storage **Add $1,700.00**

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 .... **Add $3,250.00**

Provides first local oscillator stabilization by phaselocking the oscillator to an internal reference. Also provides 100 Hz resolution.

Option 08—Delete External Mixer Capability .... **Subtract $1,250.00**

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** **Add $520.00**

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** **Add 1,970.00**

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 **Add $3,220.00**

Includes three mixers (18 to 26.5 GHz, 26.5 to GHz, and 40 to 60 GHz) and attaching hardware to extend the 492 upper frequency.

Optional Accessories

The following listed accessories are optional with all models and configurations of the 492 system, and may be ordered in any combination.

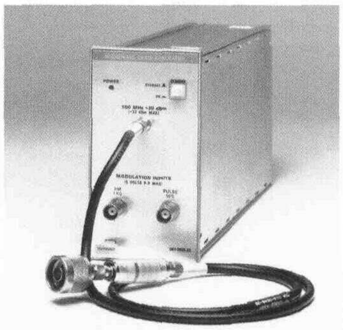
General Purpose 12.5 to 40 GHz Waveguide Set
(016-0656-00) .... $ 550.00
12.4 to 18 GHz Mixer
(119-0097-00) 150.00
18.0 to 26.5 GHz Mixer
(119-0098-00) 190.00
26.5 to 40 GHz Mixer
(119-0099-00) 220.00
Cable (012-0748-00) . . . 20.00
Case (004-1651-00) 35.00

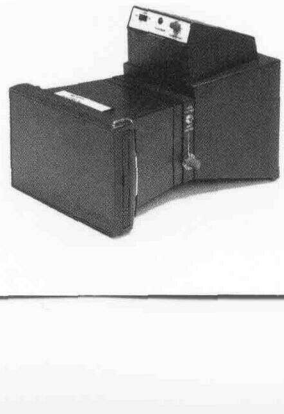
High Performance 18 to 40 GHz Waveguide Mixer Set
(016-0662-00) $2,005.00
18 to 26.5 GHz Mixer
(016-0631-01) 975.00
26.5 to 40 GHz Mixer
(016-0632-01) 975.00
Cable (012-0649-00) . . . 25.00
Case (004-1651-00) 35.00

High Performance 18 to 60 GHz Waveguide Mixer Set
(016-0657-00) $3,255.00
18 to 26.5 GHz Mixer
(016-0631-00) 925.00
26.5 to 40 GHz Mixer
(016-0632-00) 925.00
40 to 60 GHz Mixer
(016-0634-01) 1,250.00
Cable (012-0649-00) . . . 25.00
Case (004-1651-00) 35.00

Microwave Comb Generator
(067-0885-00) $1,800.00
C-5C Camera 425.00
TV Trigger Synchronizer
(015-0261-00) 360.00
Hard Case (transit)
(016-0658-00) 495.00
Soft Case (016-0659-00) 125.00

Note: The 492 Spectrum Analyzer system is compatible with all Tektronix C50 Series cameras.





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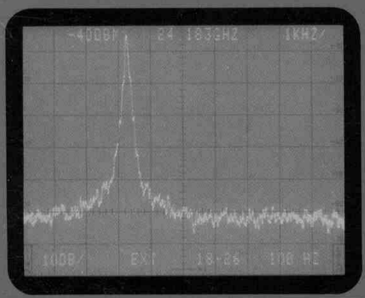

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