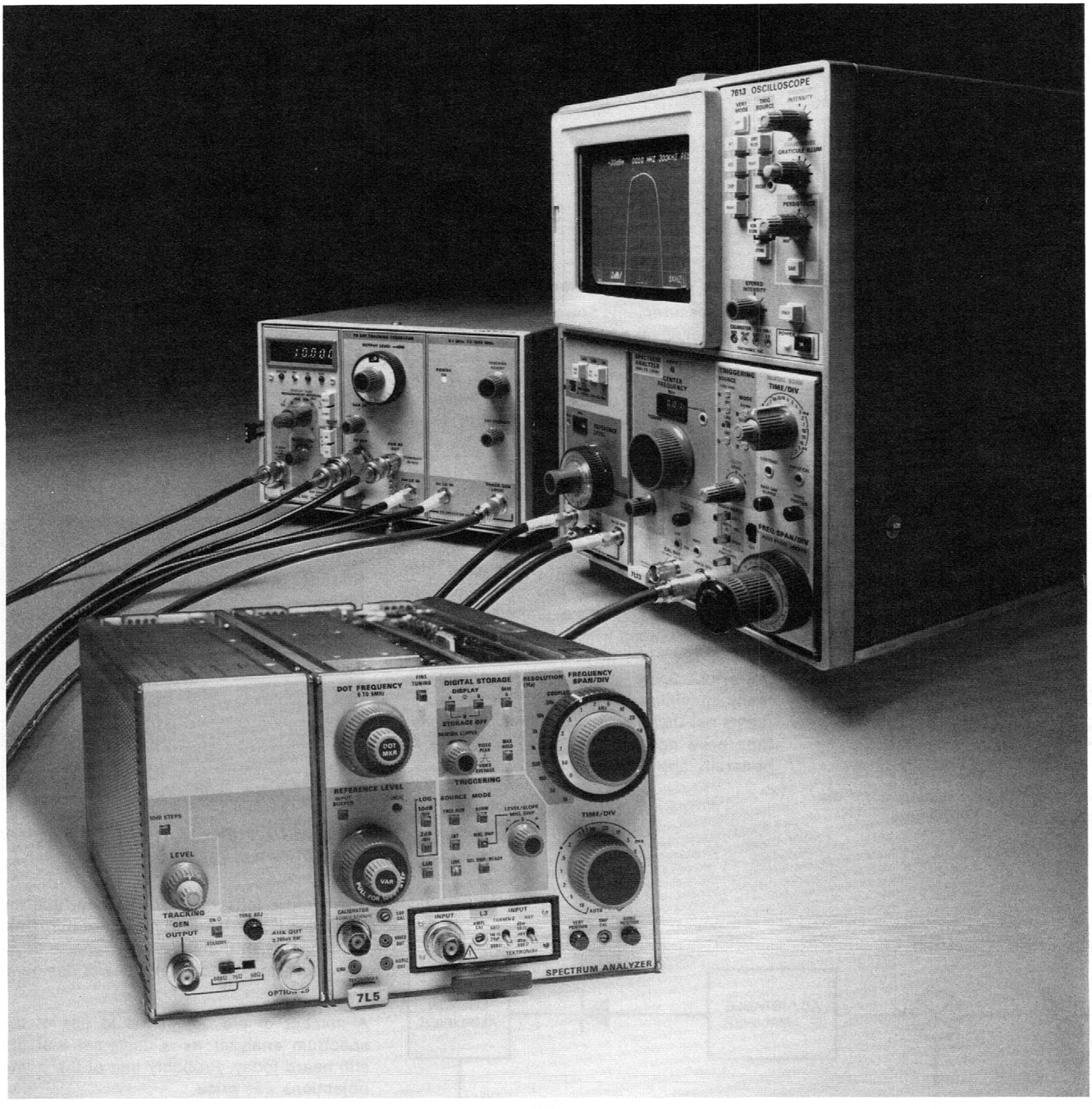
Spectrum Analyzers



7L5 with Option 25 Tracking Generator and 7L13 with TR 502 Tracking Generator are part of the high-performance spectrum analyzer family.

20 years ago the spectrum analyzer was a laboratory curiosity. Today the modern spectrum analyzer may well be one of the most powerful tools available to the electronics industry.

Early spectrum analyzers were nothing more than indicators, giving a representation of frequency and amplitude. Often called panoramic indicators, these early units were used with radio receivers to show other signals close to the one being received. The introduction of the amplitude-calibrated spectrum analyzer 10 years ago triggered the development of the instrument into the measurement tool it is today.

What Is A Spectrum Analyzer?

A spectrum analyzer draws a graph, theoretically little more. This graphic representation has 2 axes: frequency and amplitude, much as an oscilloscope graphs time and amplitude.

Various display modes are available such as log and linear amplitude, and various frequency spans can be selected.

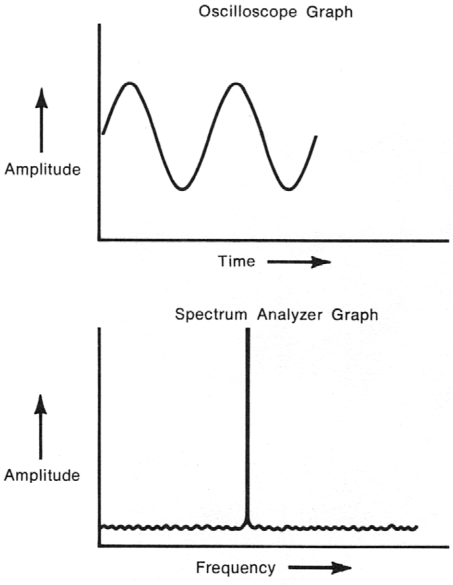


Fig. 1. Difference between oscilloscope display and spectrum analyzer display.

Basically a spectrum analyzer is a tuned receiver, with selectable frequency ranges and spans, selectable if bandwidths, and a linear or log detector — all coupled to a cathode ray type display.

Why Use A Spectrum Analyzer?

Many measurements now performed by more cumbersome and time-consuming means can be best performed with the spectrum analyzer. Measurements of waveforms, distortion, signal to noise, and amplitudes of complex components are easy with spectrum analysis.

The communications industry was first to take advantage of the spectrum display machines because there was just no other way to work with the higher frequencies involved.

In the past, spectrum analyzer cost and complexity encouraged use of the oscilloscope, not only for time domain measurement, but in areas where the spectrum analyzer is 10-, 100-, or even 1000-times more powerful. Some industries developed so many specialized instruments for measurements not then feasible by other means that they have not yet been able or willing to generally apply modern instrumentation.

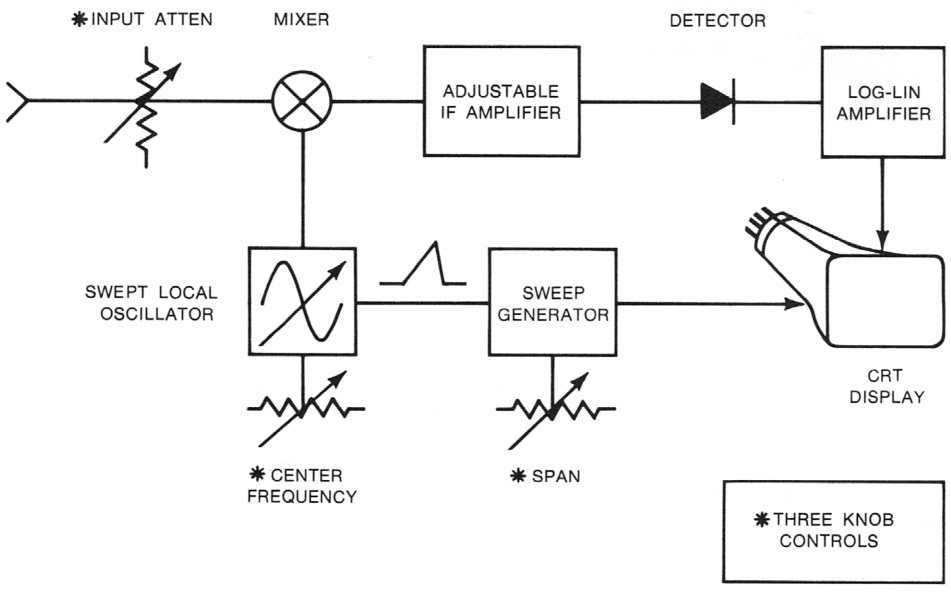


Fig. 2. Simplified block diagram of a modern swept front-end three knob spectrum analyzer.

Spectrum Analyzer Applications

The audio industry offers good examples. Many distortion measurements have been adopted over the past 25 years to analyze the performance of audio equipment. These distortions include harmonic distortion (thd), intermodulation distortion (CCIF, SMPTE, BELL, IHFM, etc), and crossover distortion, among the more common standards. Many specialized test sets have been built to measure each of the different distortions via the many standards. *Yet each distortion can be measured by studying the components of the waveforms.* The modern spectrum analyzer such as the 5L4N can analyze these components and measure any existing (or new) standard. In addition it can measure frequency response, signal-to-noise and virtually any other parameter used in the audio industry.* And the answers not only come out as numbers, but also as pictures.

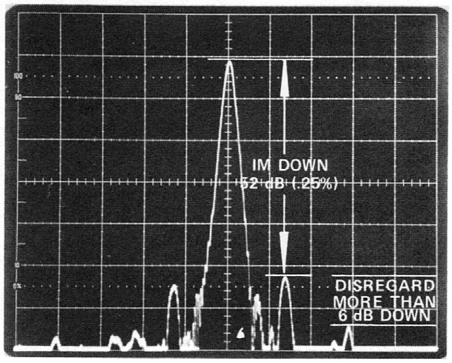


Fig. 3. 5L4N display of the SMPTE Standard Audio Distortion Test.

The picture tells you, for instance, that the harmonic distortion is due to third harmonic components, or that the signal to noise problem is due to 60 and 120 Hz power line components.

A number of old objections to use of the spectrum analyzer as a universal tool are still heard today. Probably one of the prime objections was price.

Through modern technology, the 5L4N audio spectrum analyzer can be purchased for much less than the other equipment normally found in an audio shop, such as two distortion analyzers (thd and im), an ac voltmeter, and an oscilloscope. An oscilloscope is normally part of a TEKTRONIX Spectrum Analyzer. The flexibility and time savings realized with the modern analyzer help make the analyzer less expensive than the crowd of older single-purpose instruments.

**Audio cookbook available*

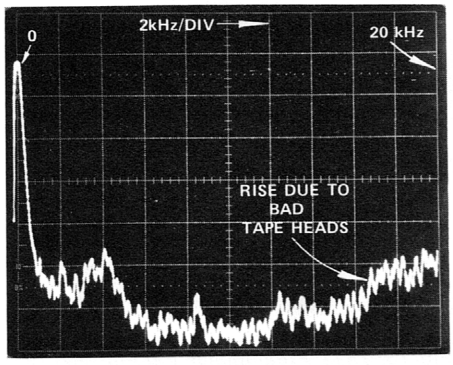


Fig. 4. An audio signal-to-noise measurement on a tape deck.

Another objection was complexity. (One expects a new device to be different.) Many of the complexities of the early spectrum analyzers have been eliminated. High school and college students first learning to make measurements often prefer the analyzer over any of the other instruments. And instruments like the 5L4N provide many real conveniences such as log sweep 20 Hz to 20 kHz, 600-ohm balanced input, automatic controls on some functions, and others.

The Field of Communications

The communications industry still includes the largest users of spectrum analysis. Vital measurements such as occupied bandwidth, frequency separation, percentage of modulation or frequency deviation, signal to noise, harmonics and im distortion are easily handled with the modern analyzer.

Prime users are: the microwave industry, the CATV industry (using analyzers for yearly proof of performance and day-to-day measurements), am and fm broadcasters, avionics shops, two way radio repair shops, radio common carrier services, and military services.

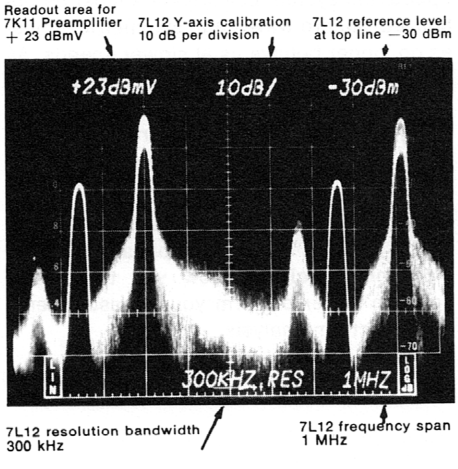


Fig. 5. Display of a standard NTSC color tv signal.

Most radio services have many things in common. Frequency ranges differ, but the transmitting and receiving systems are all characterized with the same requirements. The need to measure oscillator purity and stability, and to measure performance of multipliers, mixers, modulators, amplifiers, and filters, are requirements shared by the communications industry.

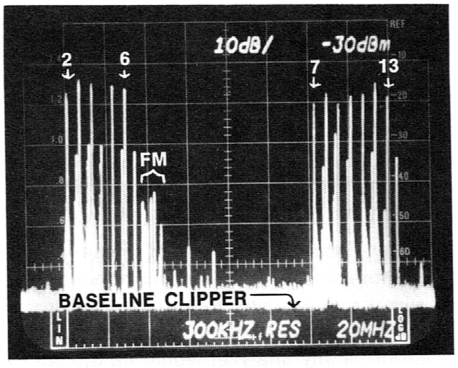


Fig. 6. Display of a 12 channel CATV system.

Even though most of these industries have specialized test sets, the spectrum analyzer is rapidly becoming the universal testing and troubleshooting tool.

Improved instruments mean more capability. As analyzers improve in stability and resolution, theoretical measurements of yesterday become day-to-day practice. Most engineers of today were taught Fourier analysis as a theoretical study of the frequency components of a wave. We believed, almost on faith, the actuality of the phenomenon. Today it is commonplace to check the purity of a square wave by looking at the components with a spectrum analyzer.

In the communication field it is now possible not only to detect carriers, but to analyze the modulation components for modulation percentage, distortion of the transmitted signal, and signal-to-noise ratio, to name a few.

A designer or technician with a modern high frequency spectrum analyzer such as the 7L12 or 7L13 is capable of testing or evaluating practically any radio device up to the 1.8 GHz frequency limit of the analyzer.

The Tracking Generator

The tracking generator is a signal source that follows the tuning of the spectrum analyzer. This instrument combination is ideal for making frequency response measurements. Because of the narrow bandwidth of the spectrum analyzer, the noise floor of an amplifier or system is reduced, allowing measurements with a dynamic range in excess of 120 dB. The tracking generator can also be used for precise frequency measurements, and is especially useful for measuring low-level signals in the presence of other higher level signals. The tracking generator derives its signal from the spectrum analyzer by mixing a local oscillator in the generator with the sweeping oscillators in the spectrum analyzer. A tracking generator is locked to the analyzer and can, by design, be no better than the analyzer in stability or drift.

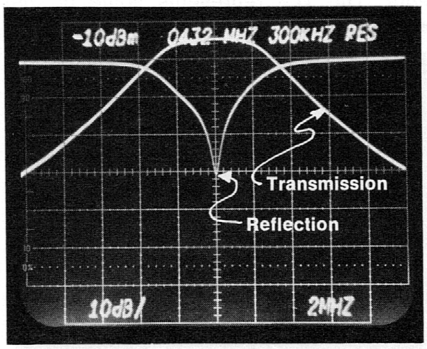


Fig. 8. Interdigital filter, passband response and return loss characteristics.

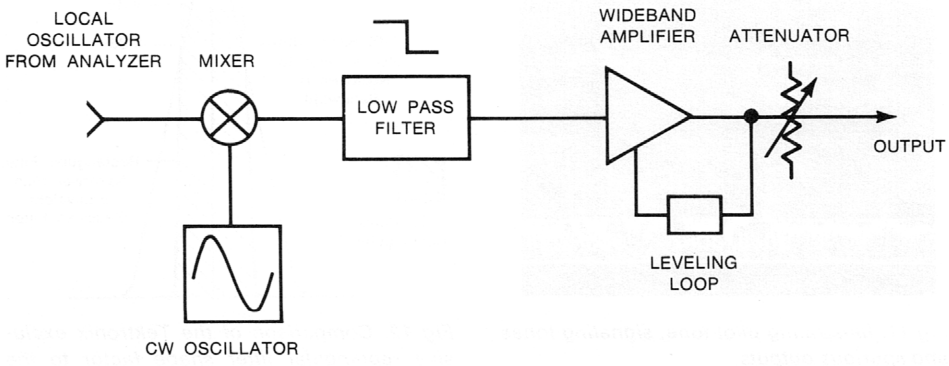


Fig. 7. Simplified block diagram of a tracking generator.

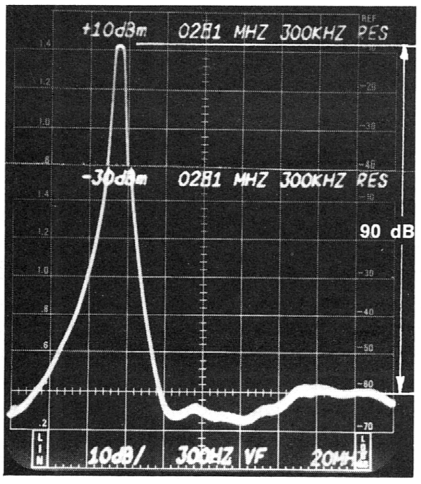


Fig. 9. Composite photo. High dynamic range, filter stop band attenuation measurement.

The New Generation

As spectrum analyzers are becoming more commonplace, they are becoming more useful as well. Many improvements are being made to increase the utility of the instrument. The 7L5 represents some of these improvements.

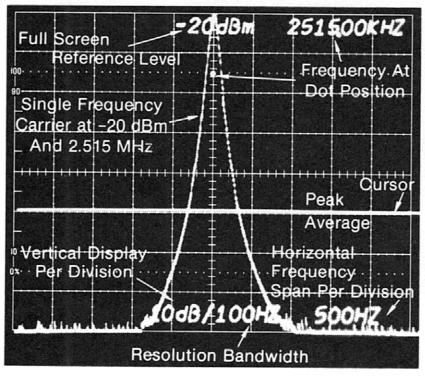


Fig 10. Spectrum analyzer display of unmodulated carrier.

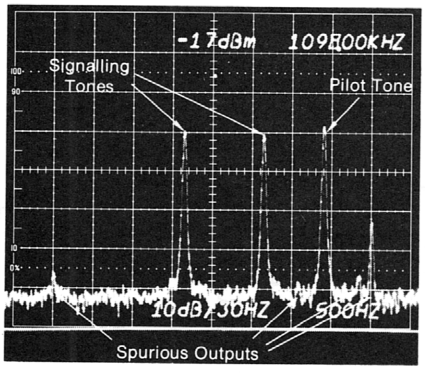


Fig 11. Illustrating pilot tone, signaling tones and spurious outputs.

Direct Frequency readout — the logical step in a truly calibrated instrument would be exact frequency selection. The 7L5 uses frequency synthesis to obtain center frequency readout with counter accuracy.

Digital storage — a true spectrum analyzer would display all frequencies at once without sweep effects such as flicker and distortion. The use of digital storage permits the closest approach yet to true theoretical spectrum displays of time and frequency.

Three-knob control — the true key to simple acceptance of spectrum analysis is simplicity and uncomplicated operation. The 7L5 offers true 3-knob control. Select the frequency, the span, and the input attenuation and the display is ready to view.

Stability — through the use of phase-locked oscillators and/or frequency synthesis, the analyzer can be used to measure the instability of the device under test. An important criterion of any analyzer would be the ability to turn on the unit and instantly, with no drift, be able to tune onto a signal. The 7L5 can be tuned almost immediately after turn-on and will remain tuned to the frequency selected indefinitely.

Choosing Your Analyzer

To be useful as a quantitative measuring tool, your analyzer must have these five major abilities:

1. Capable of calibrated amplitude measurements.

2. Capable of accurate frequency measurements.

3. Able to operate over a wide calibrated dynamic range.

4. Capable of adequate calibrated resolution.

5. Capable of sensitivity adequate for the measurements required.

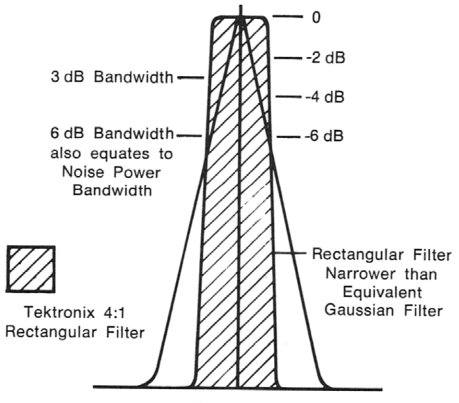


Fig 12. Comparison of the Tektronix exclusive rectangular filter shape factor to the widely used Gaussian filter.

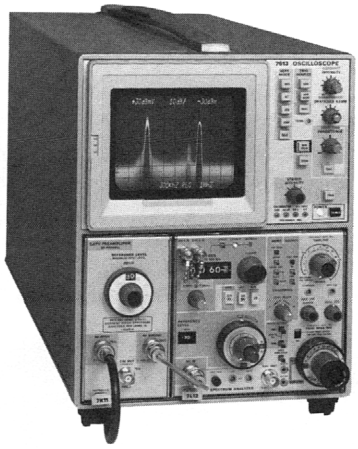


Fig 13. 7K11 Preamplifier Plug-in next to a 7L12 to increase the measurement sensitivity.

Additional important parameters include:
1. Portability
2. Flexibility
3. Method of display.

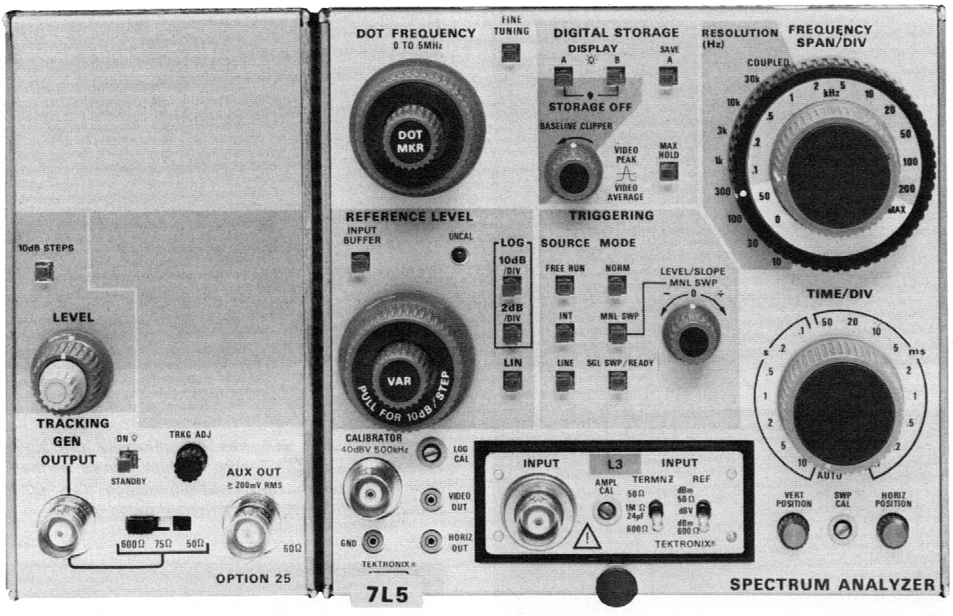
Closing

Spectrum analysis is still in its infancy—not because of present analyzer capability, but because of lack of acceptance as the powerful and universal measuring tool it is.

Tektronix has developed training programs and books to help speed this learning process, and we will continue. Application notes are available on a variety of subjects: Audio, Cable Television, Television, etc. A school lab program based around the spectrum analyzer with a demonstrative approach to Fourier analysis is available to schools to help train students to think in terms of frequency and amplitude.

Other industries are becoming aware of the need for spectrum analysis. One example is the computer industry, long thought of as a digital world. As the data rates increase in speed and system performance must be optimized, square waves and symmetrical pulses no longer behave as at slower speeds. As clocks jitter and transients become critical, a few far-looking pioneers are beginning to apply the long-overdue spectrum analyzers (with a great deal of success) to their problems.

Spectrum analysis is with us to stay, and the sky is the limit as far as applicability. Let a Tektronix specialist show you today how you can better perform your measurements with spectrum analysis.



7L5 with Option 25 Tracking Generator.

THREE-KNOB OPERATION makes the 7L5 the world's easiest-to-use spectrum analyzer.

SYNTHESIZER STABILITY for six-digit accuracy of center frequency setting with virtually no drift.

DIGITAL STORAGE & AVERAGING of display signals.

REFERENCE LEVEL SELECTION in 1 dB steps.

ABSOLUTE CALIBRATION in dBm, dBV or volts/div.

CHANGEABLE INPUT IMPEDANCE MODULES to accommodate any impedance requirement.

TRACKING GENERATOR for swept component measurements.

WIDE DYNAMIC RANGE and nanovolt sensitivity.

PRESET REFERENCE LEVEL for extra input protection.

CRT READOUT of all major parameters.

The 7L5 is a 5-MHz spectrum analyzer with exceptional frequency accuracy, achieved through a unique combination of synthesizer and digital technology.

Synthesizer stability and digital tuning let you set the center frequency with six-digit accuracy immediately after turn-on. There is no need to fine tune the displayed signal.

"Intelligence" makes the 7L5 easy to operate. Built-in processing decodes control settings, processes frequency and reference level information and optimizes sweep time and resolution for the chosen frequency span. At turn-on, the 7L5 is preset to a reference level of +17 dBm and a center frequency of zero. This provides input attenuation to protect the front end and a marker to verify correct operation.

The 7L5 has a full 80 dB spurious-free dynamic range for measuring wide relative amplitudes. Nanovolt sensitivity lets you measure very low-level signals and noise.

The front-panel input buffer control greatly increases front-end immunity to intermodulation, while maintaining a constant reference level.

The 7L5 is fully calibrated in dBm, dBV, or volts/div. The reference level can be set in 1 dB steps, eliminating the need to interpolate amplitude levels.

To accommodate a wide variety of input impedances, the 7L5 uses plug-in modules. Modules now available are the 50 Ω L1, 75 Ω L2, and 1 MΩ L3. The probe-compatible L3 offers selectable internal 50 Ω, 1 MΩ, or 600 Ω impedance. Special modules for any impedance can be provided.

Digital storage allows any 7000-Series Mainframe with crt readout to present clean, easy-to-photograph displays. The entire display is stored electronically and updated during each sweep. Two complete displays can be held in memory for comparison. Two display modes are available: a conventional peak display, or a digitally averaged display. For special measurements, such as signal-to-noise, these two modes can be used simultaneously by setting the continuously adjustable peak/average threshold, indicated with the crt cursor (see figure C). A maximum hold control lets you store maximum signal levels for checking long-term amplitude and frequency drifts.

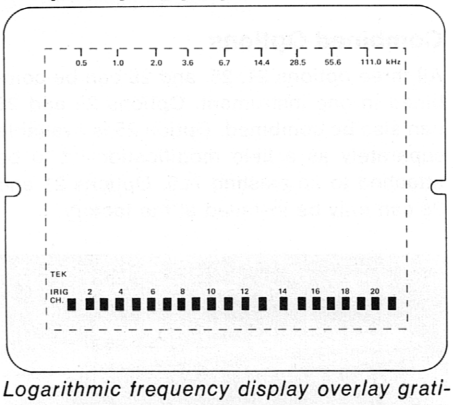
Crt readout displays center frequency, reference level, resolution bandwidth, dB per division, and frequency span.

The 7L5 has a triggerable time base for time-domain displays in zero-span modes.

7L5 Option 25 Tracking Generator

The 7L5 with Option 25 Tracking Generator, provides selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 10 Hz to 5.0 MHz. The output frequency can be adjusted so it tracks within 10 Hz of the spectrum analyzer frequency. The frequency span and rates are controlled with the spectrum analyzer. The output level is controlled from the tracking generator. Output level is calibrated and controlled in 10 dB and 1 dB steps over a 63 dB range. An Aux Output may be used to drive a frequency counter. The 7L5 with Option 25 is a three-wide unit for the 7000-Series mainframe.

7L5 Option 21 Logarithmic Frequency Display

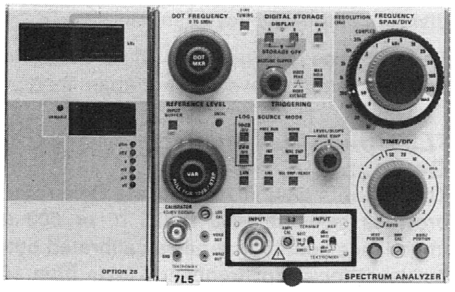


Logarithmic frequency display overlay graticule showing the position and assigned width of the 21 proportional bandwidth IRIG channels.

The 7L5 option 21 is a three-wide version of the normally two-wide 7L5 7000 Series plug-in spectrum analyzer. The additional compartment houses circuitry that generates a logarithmic frequency display covering all 21 proportional bandwidth IRIG telemetry channels. The nominal frequency range is 200 Hz to 200 kHz.

The logarithmic frequency display is generated in the digital storage memory by logarithmically compressing and combining the data from three separate linear sweeps each of which covers one decade of frequency. Consequently, the logarithmic frequency display requires the operation of digital storage. Resolution bandwidth and sweep time are automatically controlled to provide the fastest possible data acquisition consistent with amplitude calibration. A front panel control provides for normal operation of the 7L5.

7L5 Option 28 Front Panel Readout



The 7L5 Option 28 is a three-wide version of the normally two-wide 7L5 7000 Series plug-in spectrum analyzer. The additional compartment houses circuitry to provide LED front panel readout of center frequency and reference level. The front panel LED display is automatically disabled when operating in a mainframe that has CRT readout to avoid mutual interference. Option 28 is recommended for 7000 Series mainframes that have no provision for CRT readout such as 7603N11s.

Combined Options

All three options 21, 25, and 28 can be combined in one instrument. Options 25 and 28 can also be combined. Option 25 is available separately as a field modification kit to be attached to an existing 7L5. Options 21 and 28 can only be installed at the factory.

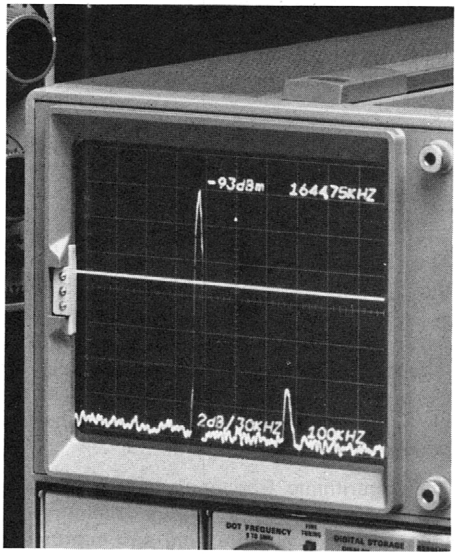


Figure A

Accuracy—The 1644.75-kHz center frequency is identified by crt readout and marked by a dot on crt. Tuning the center frequency to position a signal on the dot marker allows you to read the signal frequency with 6-digit resolution.

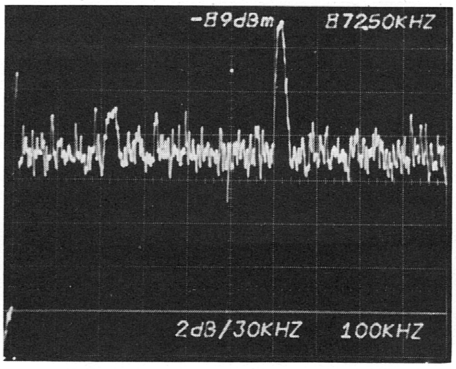


Figure B

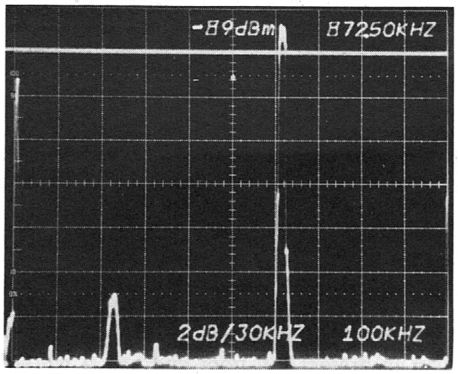


Figure C

Digital Averaging — Figures B and C show two small signals in the presence of noise. In Figure B, both signal and noise are peak detected (peak/average cursor is one division from the bottom of the crt). The smaller signal (which appears to be about —94 dBm) is almost completely obscured because the amplitude of the display is really the level of signal and noise combined. In Figure C the noise is digitally averaged (peak/average cursor is one division from the top of the crt). The noise level is reduced, showing the signals more clearly and giving a true indication of the small-signal amplitude at —102 dBm.

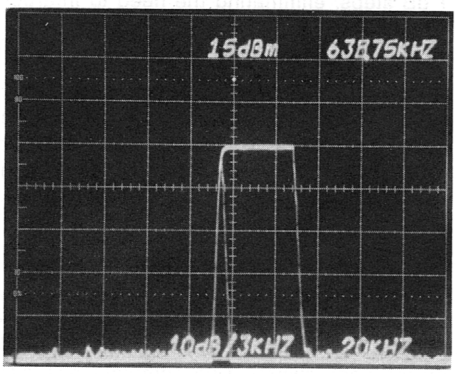


Figure D

Maximum Hold — The 7L5 maximum hold function lets you check for signal drift. It is also useful for detecting short-duration signals. In this mode, the maximum amplitude at any frequency is stored and displayed even if the signal is only there for an instant. Figure D shows a split memory display with MAX HOLD on. The flat top pedestal shows the frequency excursion of an oscillator as it shifted about one and one half divisions across the screen.

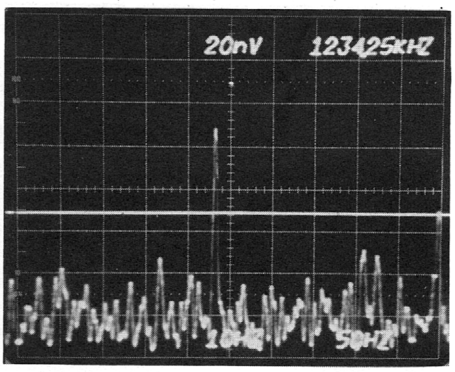


Figure E

Low Noise—The 7L5 has exceptionally low noise. This is illustrated in Figure E which shows the noise floor of the L3 at 1 MΩ input impedance. The 100 nV signal is well above the instrument noise level.

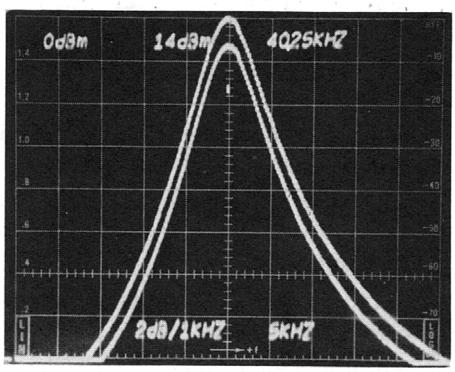
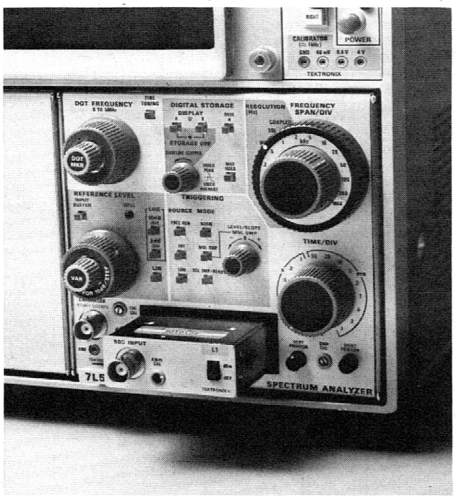


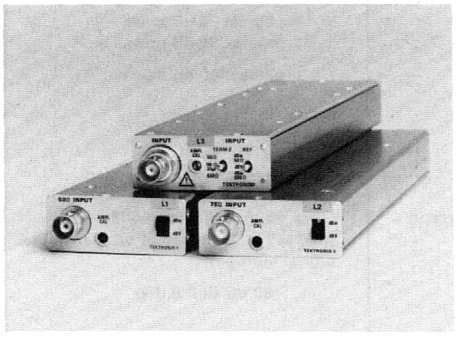
Figure F

Tracking Generator—Here the tracking generator (Option 25) is used in conjunction with split memory storage to align a narrow-band amplifier. A known-to-be-good sample (upper trace) is swept and stored in memory "A". The frequency response of the amplifier under test is displayed on memory "B" (lower trace). The amplifier under test can now be adjusted for the same response as the sample. This would be shown by merging of the two traces. Other data indicated is: tracking generator output level of 0 dBm, amplifier output level is +14 dBm (gain of 14 dB), center frequency is 40.25 kHz.



The 7L5 with L1 50 Ω input impedance plug-in module.

Changeable modules permit the 7L5 user to adapt to new measurement requirements. Modules now available are the 50 Ω L1, 75 Ω L2, and 1 MΩ L3. The probe-compatible L3 offers selectable internal 50 Ω, 1 MΩ, or 600 Ω impedance.



The module you select calibrates displays for the impedance in use.

7L5 CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer and its options. They are applicable over the environmental specification criteria for the 7000-Series mainframe.

FREQUENCY CHARACTERISTICS

Range — Input frequency range is 10 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz tuned in 250 Hz steps. Dot accuracy: 0°C to 50°C ±(20 Hz + 10^{-5} of dot frequency); 20°C to 30°C ±(5 Hz + 2X 10^{-6} of dot frequency).

Drift — Frequency drift is ≤ 5 Hz/hour.

Residual Incidental Fm — Residual fm is ≤ 1 Hz (p-p) for frequency spans of 50 Hz/div to 2 kHz/div. Residual fm is ≤ 40 Hz (p-p) for frequency spans of 5 kHz/div to 500 kHz/div.

Resolution Bandwidth — 8 resolution bandwidths range from 30 kHz to 10 Hz. COUPLED switch position electronically couples resolution to span/div selection so that both are controlled by the same knob. Bandwidth accuracy @ 6 dB down is within 20% of selected resolution. Shape factor (60:6 dB ratio) is 10:1 or better for 10 Hz to 1 kHz and 5:1 or better from 3 kHz to 30 kHz. Amplitude change between resolution bandwidths is ≤ 0.5 dB for 30 kHz — 100 Hz and ≤ 2.0 dB for 30 kHz — 10 Hz.

SWEEP CHARACTERISTICS

Frequency Span—Provides calibrated frequency spans from 50 Hz/div to max (500 kHz/div) within 4% in 1-2-5 sequence.

Horizontal linearity is within 4% over the entire 10 div display.

A 0-Hz/div position is provided for time domain operation.

Sweep Rate — Time per div is selectable from 10 s/div to 0.1 ms/div in 1-2-5 sequence. An AUTO position permits automatic selection of optimum time/div depending on resolution and span/div settings.

Sweep rate accuracy is within 5% of the rate selected.

Triggering — Provides two triggering sources, INT (internal) and LINE, in addition to a FREE-RUN position.

When INT is selected, ac coupled signal components from the mainframe trigger source (left or right vertical amplifiers) are used.

When LINE is selected, ac coupled sample of mainframe ac line voltage is used.

Three triggering modes are NORM (normal), SGL SWP/READY (single sweep), and MNL SWEEP (manual sweep).

Trigger level is ≥1.0 div of internal signal for both NORM and SGL SWP modes over the approx frequency range of 30 Hz to 500 kHz.

OUTPUT CONNECTORS

Video Out — Front-panel pin jack connector supplies the video (vertical) output signal at an amplitude of 50 mV/div +5% (about the crt vertical center) with source impedance of 1 kΩ. (Analog signal prior to digitization for storage).

Horiz Out — A front-panel pin jack connector supplies horizontal output signal (negative-going sawtooth that varies from about 0 to about −6 V dc with a source impedance of 5 kΩ).

Calibrator — Front-panel BNC connector supplies a calibrated 500 kHz square wave output signal (derived from the analyzer's time base). Output amplitude is within ±0.15 dB of −40 dBV into the plug-in impedance.

OPTION 25 TRACKING GENERATOR CHARACTERISTICS

Frequency Range — 10 Hz to 5.0 MHz.

Output Impedance — 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

Amplitude — The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

Range —
50 Ω, 0 dBm to −63 dBm
75 Ω, −6 dBm to −69 dBm
600 Ω, −17 dBm to −80 dBm

Accuracy — (Max Output calibrated at 500 kHz.)
50 Ω, 0 dBm ±0.25 dBm
75 Ω, −6 dBm + 0.4, −0.2 dBm
600 Ω, −17 dBm + 0.5, −0.1 dBm

Attenuator —
Range: 0 to 63 dB in 10 dB or 1 dB steps.
Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

Flatness —
50 Ω and 75 Ω: Within 0.5 dB Peak to Peak.
600 Ω: Within 1.0 dB Peak to Peak.
Total System Flatness (7L5 with Option 25)
50 Ω and 75 Ω: Within 1.0 dB Peak to Peak.
600 Ω: Within 1.25 dB Peak to Peak.

Dynamic Range (7L5 with Option 25) — ≥110 dB.

Residual FM (peak-to-peak) —
Spans to 2 kHz/div: 2 Hz (7L5 with Option 25).
Spans 5 kHz/div or greater: 40 Hz (7L5 with Option 25).

Stability — Within 25 Hz over a one hour period after a 10 minute warmup.

Spurious Suppression, 10 Hz to 5.0 MHz (Harmonic and non-harmonic) — 40 dB or more with respect to the carrier.

Auxiliary Output — ≥200 mV rms into 50 Ω.

OPTION 21 LOG SWEEP (IRIG) CHARACTERISTICS

Logarithmic Display Frequency Range — 250 Hz to 222.25 kHz consisting of three combined linear sweeps.

Combined Linear Sweeps — 250 Hz to 2250 Hz, 2.25 kHz to 22.25 kHz, 22.25 kHz to 222.25 kHz, each displayed over one third the crt.

Nominal Resolution Bandwidth — 10 Hz @ 250 Hz input, increasing to 3 kHz @ 40 kHz to 222.25 kHz input.

Signal Acquisition Time for Full Screen Log Display — 2.5 sec max.

Stability — Drift and incidental fm same as ordinary 7L5 at each frequency.

Dot Frequency Display — Continually changing as linear sweep segments cycle through. The dot feature is not operational.

7L5 Controls — All except the vertical reference and MAX HOLD controls are disabled.

Option 21 Controls —
220 kHz IRIG (On-Off) — Normal 7L5 when "off", log frequency display when "on".

SWP INHIBIT —When "on", the instrument will finish the three linear sweeps to form a log display. Data will stay in memory to provide the equivalent of a single sweep function.

OPTION 28 FRONT PANEL READOUT CHARACTERISTICS

Provides front panel LED display of frequency and reference level when operating in a non-readout mainframe. LED display shuts off automatically when operating in a mainframe with crt readout.

CHARACTERISTICS WITH PLUG-IN INPUT IMPEDANCE MODULE

	L1	L2	L3
INPUT CHARACTERISTICS			
Input Impedance —	50 Ω	75 Ω	1 MΩ/28 pF (also 50 Ω and 600 Ω)
Input Power — Max input power for reference levels:			
above 0 dBm	+21 dBm		+21 dBm
below 0 dBm	+10 dBm		+21 dBm 100 V (peak ac + dc) @ 1 MΩ input z
AMPLITUDE CHARACTERISTICS			
Residual Response — Internally generated spurious signals (referred to input).	−130 dBm or less, −125 dBm for calibrator and harmonics		−143 dBV or less −138 dBV for calibrator and harmonics
Sensitivity — Equivalent input noise for each resolution bandwidth setting is measured in VIDEO AVERAGE mode with 10 s/div sweep rate and INPUT BUFFER control off. Equivalent input noise for resolution bandwidth of:	*(equal to or better than)		*(equal to or better than)
10 Hz	−135 dBm		−148 dBV
30 Hz	−133 dBm		−146 dBV
100 Hz	−130 dBm		−143 dBV
300 Hz	−125 dBm		−138 dBV
1 kHz	−120 dBm		−133 dBV
3 kHz	−115 dBm		−128 dBV
10 kHz	−110 dBm		−123 dBV
30 kHz	−105 dBm		−118 dBV
Sensitivity is further degraded 8 dB with INPUT BUFFER on. Noise level increases approx 10 dB operating in VIDEO PEAK mode.			
Intermodulation Distortion — Within any freuqency span, intermodulation products for two, on screen, signals			
of any input level: 3rd order products	at least 75 dB down		at least 75 dB down
2nd order products	at least 72 dB down		at least 72 dB down
of any input level up to −53 dBv/−40 dBm (50 Ω): 2nd and 3rd order products	at least 80 dB down		at least 80 dB down
of any input level with INPUT BUFFER on: 2nd and 3rd order products	at least 80 dB down		at least 80 dB down
Display Flatness — Peak-to-peak display variation over any frequency span.	0.5 dB max (Add 0.5% quantization error in digital storage)		0.5 dB max (25 Hz to 5 MHz) 0.75 dB max (20 Hz to 5 MHz) (Add 0.5% quantization error in digital storage)
On Screen Dynamic Range —	80 dB (full 8 div)		80 dB (full 8 div)
Reference Level** — In LOG mode, reference level refers to top horizontal graticule line. Calibrated in dB steps.	1-dB and 10-dB steps		1-dB and 10-dB steps
Range — LOG 2 dB/div mode	−128 dBm to +21 dBm		−141 dBV to +8 dBV
LOG 10 dB/div mode	−78 dBm to +21 dBm		−83 dBV to +8 dBV
LIN mode	20 nV/div to 200 mV/div within 5%, in 1-2-5 sequence		20 nV/div to 200 mV/div within 5%, in 1-2-5 sequence
Accuracy — When calibrated @ −40 dBV in LOG mode.	Within 0.2 dB/dB, to max of 0.25 db/10 dB change in reference level		Within 0.2 dB/dB, to max of 0.25 db/10 dB change in reference level

*Note: dBm = dBV −10 Log Z + 30 where Z = impedance
Example: dBV = [dBm (600 Ω) — 2.22]

**Note: A > sign is displayed by the reference level readout when the reference level is not calibrated and the UNCAL light is on. A < sign is displayed when the reference variable is out of its detent.

ORDERING INFORMATION

7L5 Spectrum Analyzer
(Spectrum Analyzer Requires L Plug-in Module.)

Option 21 with Logarithmic Frequency Display

Option 25 with Tracking Generator
For a separate tracking generator, (One-wide field modification to be attached to an existing 7L5) order 040-0810-00

Option 28 with Front-Panel Readout

Option 32 combines Options 25 and 28

Option 33 combines Options 21, 25 and 28

Included Accessories — Graticule, Spectrum Analyzer 337-1159-02 (7000 Series), Filter, light blue 378-0684-00.

L1 Plug-in Module (50 Ω)

L2 Plug-in Module (75 Ω)

L3 Plug-in Module (1 MΩ)

***7603 Oscilloscope**

***R7603 Oscilloscope (Rackmount)**

Option 06 Internal S A Graticule

Option 08 Protective Front Cover (Cabinet Only)

***7704A Oscilloscope**

***R7704 Oscilloscope**

Option 06 Internal S A Graticule

*Suggested Mainframe. See 7000 Series pages for oscilloscope specifications and options.

OPTIONAL ACCESSORIES

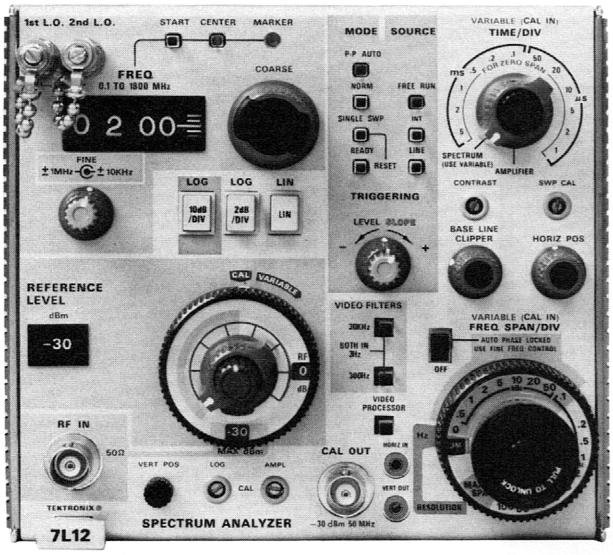
Tracking Generator, one wide field modification kit, to be attached to an existing 7L5 040-0810-00

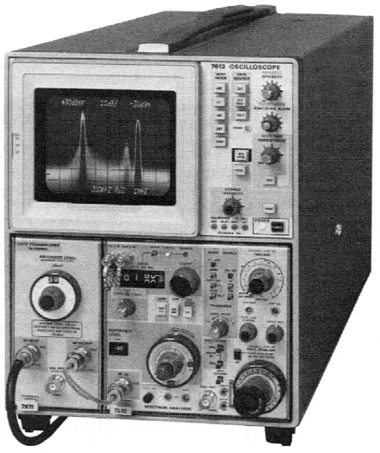
2701 50 Ω Step Attenuator

2703 75 Ω Step Attenuator

75 Ω to 50 Ω Min Loss Attenuator (Ac Coupled) 011-0112-00

P6105 10X Probe, (2m) 010-6105-03





The 7L12 is shown in a 7613 Variable Persistence Mainframe with 7K11 CATV Preamplifier for extra sensitivity.

100 kHz to 1800 MHz in One Display

Fully Calibrated Displays

300 Hz to 3 MHz Resolution

4:1 Resolution Bandwidth Shape Factor

70 dB On Screen Dynamic Range

IM Distortion 70 dB below Full Screen

Spurious Free Operation

Automatic Phase Lock

—115 dBm Sensitivity

The 7L12 Spectrum Analyzer is a modern, high-performance, swept front-end type of analyzer covering the frequency range up to 1.8 GHz. The unit employs phase lock stability and an ample selection of resolution bandwidths in an economical field or laboratory instrument.

The unit has a 3 MHz resolution mode for accurate measurement of pulse phenomena; the zero-span mode may be used to present a demodulated display of a signal for time domain measurements. A 4:1 resolution bandwidth shape filter introduced by TEKTRONIX permits close-in measurements not possible with conventional filters. Noise measurements are also easily made due to the high sensitivity, video filters, and equivalent resolution and noise power bandwidth of the instrument.

The 7L12 fills two holes in any 3- or 4-hole 7000-Series Mainframe and features a complete time base so that other oscilloscope or time domain plug-ins may be used simultaneously. As with all 7000-Series Plug-ins, CRT READOUT will display the major parameters. For the 7L12, these include: reference level, dB/div, frequency span, and resolution.

7L12 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 100 kHz to 1.8 GHz. (Useable below 100 kHz with degraded performance.)

Resolution Bandwidth — Resolution bandwidth selections from 300 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 4:1 or better.

Stability — After 2 hour warm-up, within 50 kHz, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temperature.

Incidental Fm — 200 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from −100 dBm to +30 dBm, within ±2 dB.

Log 10 dB/div:
−70 dB dynamic range. Accuracy ±0.1 dB/dB to a max of 1.5 dB.

Log 2 dB/div:
−14 dB dynamic range. Accuracy ±0.4 dB/2 dB to a max of 1.0 dB.

Linear:
— Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode). −115 dBm at 300 Hz, −108 dBm at 3 kHz, −100 dBm at 30 kHz, −90 dBm at 0.3 MHz, −80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — ±1.5 dB over any frequency span.

Spurious Responses —

Residual — (No signal present at input) with input attenuation at 0 dB, ≤−100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals.

Mixed — All image, harmonic related, and out-of-band mixing responses are ≤70 dB down from a level of −30 dBm to the input mixer (0 dB input attenuation).

Dynamic Range — 70 dB. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

Impedance — 50 Ω, nominal.

SWEEP CHARACTERISTICS

Frequency Span — 500 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — 10 ms/div to 1 μs/div.

Triggering — Trigger signal source can be external, internal, or line voltage.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, −30 dBm at 50 Ω.

Vert Out — Approx 2 V full screen.

Horiz In — For use with chart recorder.

1st LO — For use with tracking generator or 1405 Sideband Analyzer.

2nd LO — For use with tracking generator.

ACCESSORIES

Included — Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings, 337-1439-01 for 7403N and 7603 Oscilloscopes and 337-1159-02 for other 7000-Series Oscilloscopes. Amber Light Filter: 378-0684-01; 50 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

ORDERING INFORMATION

7L12 Spectrum Analyzer

7603 Mainframe

Option 08 Protective Front Cover

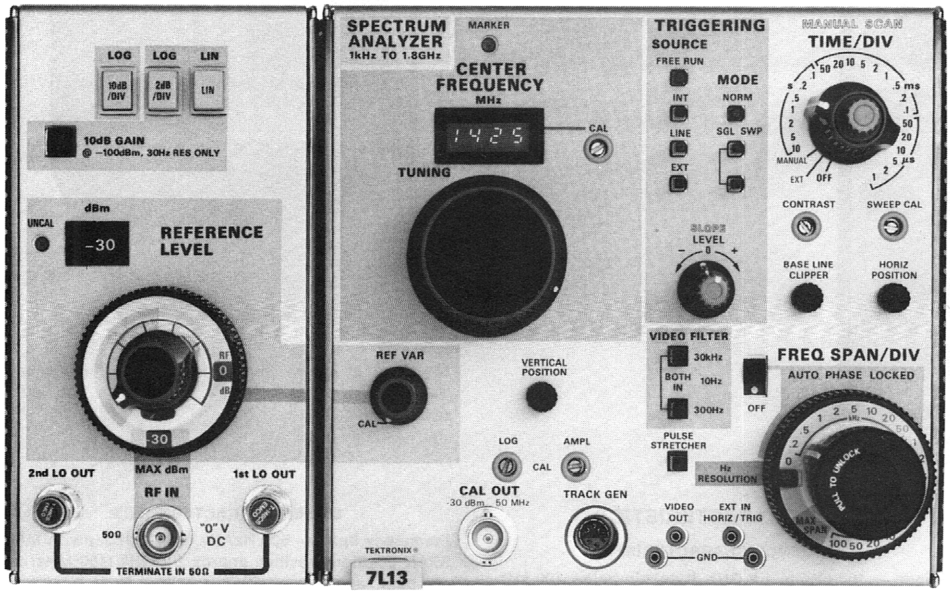
Option 77 P7 Phosphor and Internal S A Graticule

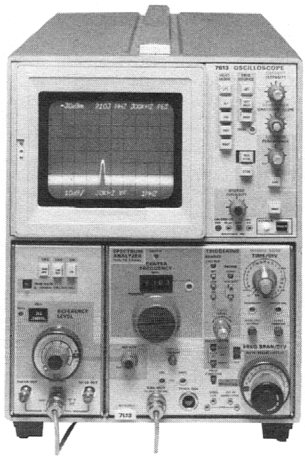
7613 Variable Persistence Mainframe

Option 06 Internal S A Graticule

Option 08 Protective Front Cover

Extended Frequency Range to 2.5 GHz. Ask about the modified 7L12.





The 2.5 GHz modified 7L13 in a 7613, a mainframe featuring variable persistence. Variable persistence is recommended for maximum utilization of the capabilities of the 7L13. Information is available upon request.

1 kHz to 1800 MHz in One Display

Fully Calibrated Displays

30 Hz to 3 MHz Resolution

4:1 Resolution Bandwidth Shape Factor

70 dB On Screen Dynamic Range

IM Distortion 70 dB below Full Screen

Spurious Free Operation

Automatic Phase Lock

−128 dBm Sensitivity

The 7L13 Spectrum Analyzer represents the highest performance possible today in an instrument of this frequency range and price. The fm stability is 10 Hz, making 30-Hz resolution possible across the entire frequency range.

This analyzer is a high quality laboratory instrument. In addition to incorporating the standard features of the 7L12, it has crt readout of the center frequency, and an UNCAL light to indicate incorrect settings of the sweep rate or resolution controls.

7L13 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 1 kHz to 1.8 GHz.

Resolution Bandwidth — Resolution bandwidth selections from 30 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 12:1 or better for 30 Hz resolution and 4:1 or better for 300 Hz to 3 MHz resolution.

Stability — After a 2 hour warm-up, within 2 kHz, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temperature.

Incidental Fm — −10 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from −110 dBm to +30 dBm, within ±2 dB. An UNCAL indicator shows when excessive sweep speeds are selected.

Log 10 dB/div:
−70 dB dynamic range. Accuracy ±0.1 dB/dB to a max of 1.5 dB.

Log 2 dB/div:
−14 dB dynamic range. Accuracy ±0.4 dB/2 dB to a max of 1.0 dB.

Linear:
— Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode) −128 dBm at 30 Hz, −115 dBm at 300 Hz, −108 dBm at 3 kHz, −100 dBm at 30 kHz, −90 dBm at 0.3 MHz, −80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — +1 dB, −2 dB over any frequency span.

Spurious Responses —
Residual — (No signal present at input) with input attenuation at 0 dB, ≤−100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals.

Mixed — All image, harmonic related, and out-of-band mixing responses are ≤70 dB down from a level of −30 dBm to the input mixer (0 dB input attenuation).

Dynamic Range — 80 dB when operating with 30 Hz resolution bandwidth. 70 dB with 300 Hz to 3 MHz resolution bandwidth. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

Impedance — 50 Ω, nominal.

SWEEP CHARACTERISTICS

Frequency Span — Calibrated steps in 1-2-5 sequence from 200 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — Selection of an external sweep source, manual sweep, or calibrated time base, 10 s/div to 1 μs/div.

Triggering — Trigger signal source can be external, internal, or line voltage.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, −30 dBm at 50 Ω.

Video Out — Approx 2 V full screen.

Horiz In — (and Trig) For use with chart recorder.

Tracking Gen (Logic) — For use with tracking generator (5 V TTL).

1st LO — For use with tracking generator or 1405 Sideband Analyzer.

2nd LO — For use with tracking generator.

ACCESSORIES

Included — Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings, 337-1439-01 for 7403N and 7603 Oscilloscopes and 337-1159-02 for other 7000-Series Oscilloscopes. Amber Light Filter: 378-0684-01; 50 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

ORDERING INFORMATION

7L13 Spectrum Analyzer

7603 Mainframe

Option 08 Protective Front Cover

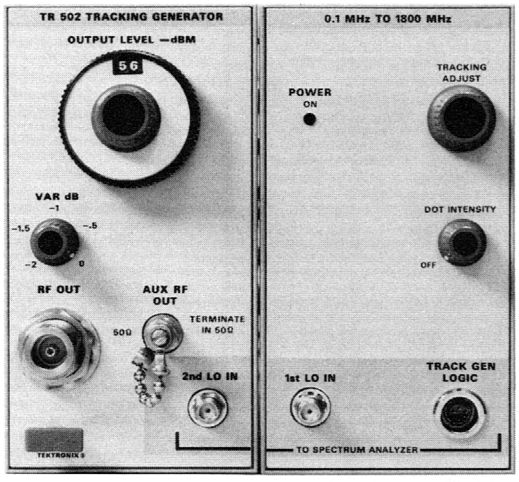
Option 77 P7 Phosphor and Internal S A Graticule

7613 Variable Persistence Mainframe

Option 06 Internal S A Graticule

Option 08 Protective Front Cover

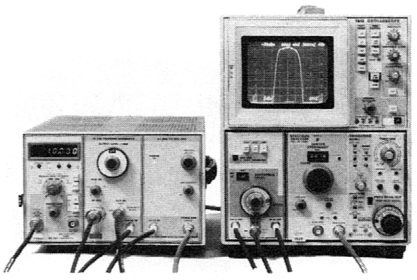
Extended Frequency Range to 2.5 GHz. Ask about the modified 7L13.



TR 502 Tracking Generator.

The TR 501 or TR 502 are capable of the same performance with either the 7L12 or 7L13 Spectrum Analyzer.

The TR 502 is recommended for use with the 7L13 because of the provisions for dot marker function with the 7L13 only. The TR 501 is recommended for use with the 7L12 for cost effectiveness.



The TR 502 Tracking Generator is used with the TEKTRONIX 7L13 Spectrum Analyzer to make swept frequency tests and precise frequency measurements.

Wide Frequency Range — 100 kHz to 1.8 GHz

System Stability
10 Hz (TR 502 w/7L13)
200 Hz (TR 501 w/7L12)

Flatness — ±0.5 dB
±2.0 dB (TR 502/7L13)
±3.0 dB (TR 501/7L12)

Resolution
30 Hz (TR 502 w/7L13)
300 Hz (TR 501 w/7L12)

Plus — TR 502 Has Automatic Counter Dot Marker When Used with DC 502 and 7L13

The TR 502 and TR 501 Tracking Generators work with either the 7L13 or 7L12 Spectrum Analyzers to provide constant level, calibrated rf sources for swept frequency tests to 1800 MHz.

When used as a cw source, with the analyzer in a zero span (nonswept) mode, the TR 502/7L13 system has 10 Hz stability. (The TR 501/7L12 system has 200 Hz stability.) This exceptional stability enhances the dynamic range capability of the analyzer/tracking generator combination.

The Tracking Generator Aux RF output may be used to drive a frequency counter. Frequencies up to 1800 MHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer. TR 502/7L13 sensitivity is −128 dBm at 30 Hz resolution bandwidth. (TR 501/7L12 sensitivity is −115 dBm at 300 Hz resolution bandwidth.) When the TR 502 is used with the 550 MHz DC 502 Frequency Counter the spectrum display center frequency, indicated by a bright dot, is automatically counted.

The Tracking Generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the Tracking Generator. The output frequency of the Tracking Generator is the same as the frequency of the analyzer at any instant of the sweep.

The Tracking Generator is a two-wide unit compatible with the TM 500 Modular Instrument Series. When powered by a TM 503, there is room for a 550 MHz DC 502 or other counter.

CHARACTERISTICS

apply to both the TR 502/7L13 and TR 501/7L12 except where noted.

FREQUENCY CHARACTERISTICS

Range — 0.1 MHz to 1800 MHz.

Resolution Bandwidth — 30 Hz to 3 MHz (TR 502/7L13). 300 Hz to 3 MHz (TR 501/7L12).

Stability — 10 Hz p-p (TR 502/7L13). 200 Hz p-p (TR 501/7L12).

AMPLITUDE CHARACTERISTICS

Rf Output Amplitude — 0 dBm to −59 dBm in 10 and 1 dB steps plus 2 dB vernier (TR 502). 0 dBm to −11 dBm in 1 dB steps plus 2 dB vernier (TR 501).

Auxiliary Output Level — 0.1 rms in 50 Ω.

Flatness — ±0.5 dB (Tracking Generator only). ±2.0 dB (TR 502/7L13). ±3.0 dB (TR 501/7L12).

Spurious Output —
Harmonic: >20 dB below carrier.
Nonharmonic: >40 dB below carrier.

Dynamic Range — >110 dB (TR 502/7L13). >100 dB (TR 501/7L12).

SWEEP CHARACTERISTICS

Frequency Span — 200 Hz/div to 180 MHz/div (TR 502/7L13). 500 Hz/div to 180 MHz/div (TR 501/7L12).

OUTPUT CONNECTORS

Rf Out — 50 Ω nominal impedance, vswr 2:1 or less.

Aux Rf Out — For use with frequency counter.

Note about Mainframes, Phosphors, and Graticules — 7000-Series Mainframes, except storage versions, are normally shipped with P31 phosphor. Slow swept displays sometimes are more easily viewed with P7 phosphor (an option with most mainframes). External spectrum analyzer graticules for 7000-Series Mainframes come with the units (see included accessories). See mainframe specification for availability of crt option with internal spectrum analyzer graticules. Storage mainframe is recommended for high resolution displays or variable persistence.

Included Accessories — Two 50 Ω coaxial cables 012-0649-00, logic interface cable (TR 502 only) 012-0648-00, adapter N male to BNC female 103-0045-00, retainer plug-in 343-0604-00 fixed 10 dB attenuator with 3 mm fittings 307-0553-00 (TR 501 only).

ORDERING INFORMATION

TR 502 Tracking Generator

Suggested Complementary Items

TM 503 Option 07 Power Module

DC 502 Option 07 (Includes Option 01 High Stability) Digital Counter
or
016-0195-01 Blank Panel

TR 501 Tracking Generator

Suggested Complementary Items

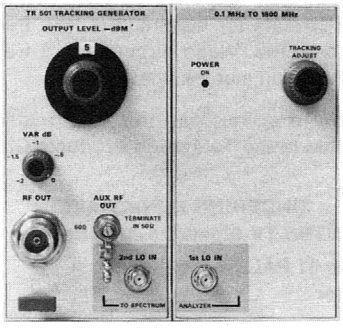
TM 503 Power Module

DC 502 Digital Counter

Blank Panel 016-0195-01

14 dB, 3 mm attenuator 015-1002-00
(used in the 2nd L.O. input line to improve TR 501/7L12 isolation)

Note: Existing 7L12 Spectrum Analyzers, if not already factory equipped for use with the TR 501, may be modified. Further information may be obtained from your local Tektronix office or representative.



TR 501 Tracking Generator.

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

1405/7L12 Sideband Analyzer

To analyze the sideband response of a television transmitter, the 1405 is used with a spectrum analyzer, such as the 7L12 or 7L13. The 1405 generates a composite video signal, the "picture" portion of which is a constant-amplitude sinusoidal signal that sweeps 15-0-15 MHz. This signal is applied as modulation to a television transmitter; the output is then displayed on the spectrum analyzer, and appears as the response curve of the transmitter under test. 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.

Complete specifications and prices are available in the Television Products Catalog.

ORDERING INFORMATION

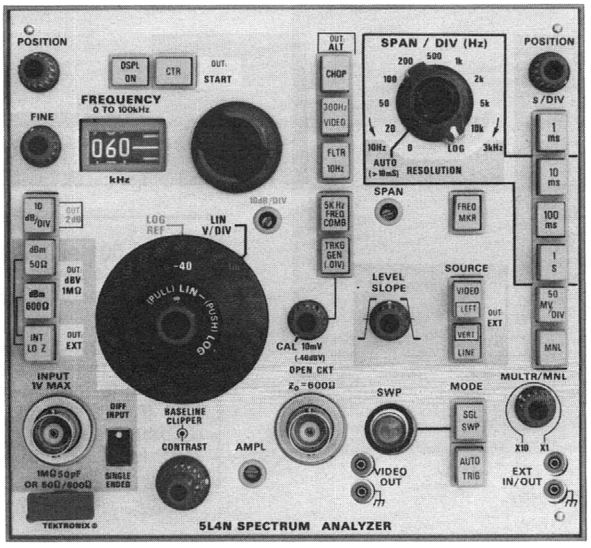
1405 NTSC TV Sideband Adapter

Option 01 PAL TV Sideband Adapter

OPTIONAL ACCESSORIES

Rackmount-conversion kit for mounting 1405 or 1405 Option 01 in std. 19 inch rack. 016-0489-00

5L4N | 0 to 100 kHz Spectrum Analyzer



0 to 100 kHz

Selectable Impedance

Calibrated Appropriate to Impedance Selected

Single-Ended Input

Differential (Balanced) Input

On Screen Dynamic Range 80 dB (Full 8 div)

Intermod >70 dB Down

Resolution Bandwidth 10 Hz to 3 kHz

Auto Resolution

Built-in Tracking Generator

20 Hz to 20 kHz Log Sweep*

The 5L4N is a 0- to 100-kHz spectrum analyzer that offers both high performance and economy. The analyzer features selectable input impedances, 80 dB of dynamic range, and a built-in tracking generator.

This analyzer is especially suited for noise and distortion studies in the audio range and comes equipped for 20 Hz to 20 kHz log sweeps.

Many educators prefer this economical analyzer to teach frequency-related theory and demonstrate practical application in the areas of speech, sound, music, vibration, audio, broadcasting, and many others.

The 5L4N can be used with any 5000-Series Oscilloscope Mainframe. Only two compartments are occupied by the analyzer so that, with the addition of a vertical plug-in, basic oscilloscope functions may be obtained. We recommend the use of a 5111 Storage Oscilloscope for maximum utilization of the analyzer.

**100 Hz to 100 kHz also available.*

FREQUENCY CHARACTERISTICS

Range — 0 to 100 kHz. Accuracy ±3 kHz (fine tune control midrange and span/div calibrated for 10 kHz).

Resolution Bandwidth — The resolution bandwidth is continuously variable from 3 kHz to 10 Hz. An AUTO mode provides the best resolution for the frequency scan and sweep rate selected. Signal level change over the resolution bandwidth range is 2 dB or less. Line frequency modulation of 50 Hz or more can be resolved up to 70 dB below the signal level. In the log sweep mode the resolution bandwidth changes with frequency giving an effect similar to octave bandwidth sweeps.

Stability — Within 30 Hz over a 10 min period, at a fixed ambient temperature.

Incidental Fm — 2 Hz (p-p) or less.

AMPLITUDE CHARACTERISTICS

Reference Level Range —

Log 10 dB/div:
from −10 dBm/dBV to −70 dBm/dBV, within 0.4 dB/10 dB to max of 1 dB at −70 dBm/dBV.

Log 2 dB/div:
from −10 dBm/dBV to −130 dBm/dBV within 0.4 dB/10 dBV to max. 1.0 dB at −70 dBm/dBV and 2 dB at −130 dBm/dBV.

Linear:
from 50 mV/div to 20 nV/div within 5% decade.

Cw Sensitivity (Signal Level + Noise = 2X Noise) — The following characteristics are applicable with the input internally terminated, or with a 600 Ω or less source impedance.

	Resolution Bandwidth	
Display Mode	**3 kHz**	**10 Hz**
dBV	−123 dBV	−147 dBV
dBm 50 Ω	−110 dBm	−134 dBm
dBm 600 Ω	−121 dBm	−145 dBm
LINEAR	680 nV	45 nV

Flatness (20 Hz-100 kHz) — Flatness remains within ±0.2 dB, over any selected frequency span, with respect to the level of −40 dBV signal at 5 kHz. Intermodulation Distortion — with two signals, within any frequency span, that are less than or equal to the reference level:

−10 dBm/dBV	≥70 dB down
≤ −20 dBm/dBV	≥75 dB down

Internal Spurious Signals — Equal to or less than −130 dBm/dBV referred to the input. Line related spurii less than −120 dBm/dBV.

Dynamic Range — 80 dB (8 div).

INPUT CHARACTERISTICS

Selectable Impedance — 1 MΩ/47 pF or 600 Ω or 50 Ω (single-ended or differential).

Differential Input Characteristics — Full screen limit is approx 300 mV to 400 mV. Common-mode rejection ratio is 70 dB or more.

Single Ended Input Characteristics — Max single input for linear operation: −10 dBm/dBV or 0.316 V rms.

SWEEP CHARACTERISTICS

Linear Frequency Span — 20 Hz/div to 10 kHz/div, 10-5-2 sequence. 4% accuracy.

Log Frequency Span — 100 Hz to 100 kHz internally reprogrammable from 20 Hz to 20 kHz.

Zero Frequency Span — Analyzer operates as a fixed tuned receiver for time-domain displays.

Internal Sweep Sources — Time base 1 s/div to 1 ms/div (increased up to X10 with multiplier).

Triggering — Internal at least 0.1 div, External at least 250 mV. Slope and level selection are provided. Auto Trigger provides a sweep baseline when a trigger signal is absent. Single sweep provided.

Manual Sweep — Provided.

External Sweep — Requires 0 V to 500 mV ±50 mV; from a 1 kΩ or less source to sweep the full span.

OUTPUT CONNECTIONS

Tracking Generator — 600 Ω source. Calibrated output level is −40 dBV ±0.2 dB (10 mV) open circuit, or −46 dBV when terminated into 600 Ω. Output level can be varied from approximately 0.001 V to 0.1 V open circuit.

5 kHz Freq Comb — 600 Ω source of 5 kHz ±0.005% markers for span calibration.

Video Out — Provides 250 mV ±5% of video signal per display div (0 V to 2 V). Source impedance is about 1.0 kΩ.

Ext In/Out — Provides 500 mV ±25 mV, per div of span, from 0 to 5 V, when using internal or manual sweep.

INCLUDED ACCESSORIES

013-0156-00 Adapter, Floating BNC to Dual BNC. 175-1178-00 BNC to Pin Jack Adapter Cable. 331-0429-00 Log Graticule (20 Hz-20 kHz).

ORDERING INFORMATION

5L4N Spectrum Analyzer

We recommend that the Plug-in 5L4N be ordered with a storage mainframe.

5111 Storage Oscilloscope (Cabinet)

Option 02 Protective Front Cover

R5111 Storage Oscilloscope (Rackmount)

OPTIONAL PLUG-INS FOR TIME DOMAIN USE

5A15N Single Trace Amplifier

5B10N Time Base Amplifier

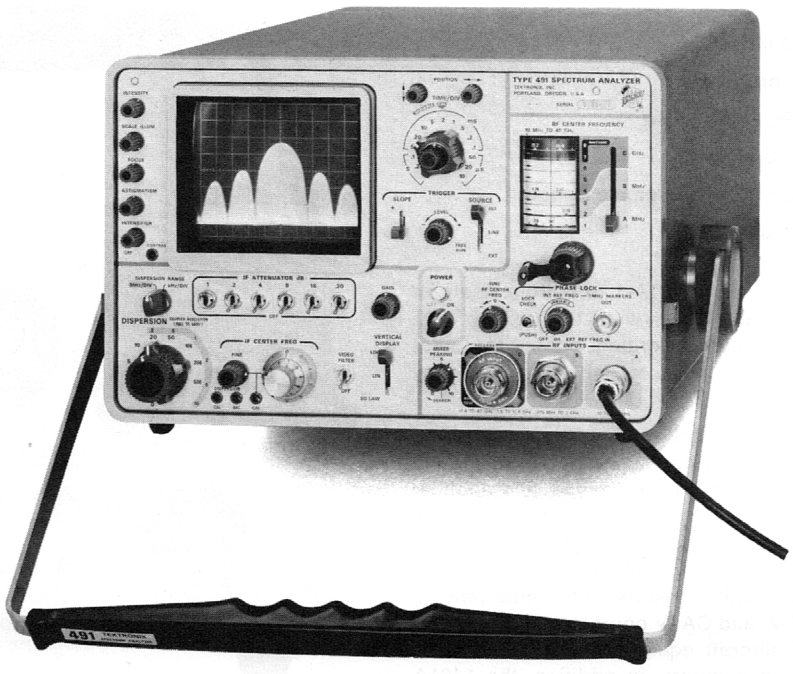
OPTIONAL ACCESSORIES

010-0160-00 10 x Probe P6006 (6 ft.)

016-0195-00 Blank Plug-in Panel

2701 Step Attenuator (50 Ω)

011-0093-00 Step Attenuator (600 Ω)



10 MHz to 40 GHz **491**
10 MHz to 2 GHz . . . . . **491 Option 01**
1.5 GHz to 40 GHz . . . . . **491 Option 02**

The 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is easy to carry, weighing less than 40 pounds complete with accessories. The R491 is electrically identical and requires only 7 inches of rack height.

FREQUENCY CHARACTERISTICS

Range

10 MHz to 40 GHz

Option 01
10 MHz to 2 GHz

Option 02
1.5 GHz to 40 GHz

Resolution — 1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

Frequency Stability — ±200 kHz after 1 minute.

Incidental Fm — Less than 300 Hz at fundamental, with Phase Lock.

AMPLITUDE CHARACTERISTICS

Display Flatness — Max amplitude variation over 100 MHz dispersions up to 12.4 GHz is 3 dB or less, except over 50 MHz dispersion in Band 1. Above 12.4 GHz the max amplitude variation (100 MHz dispersion) is 6 dB or less.

Max Input Power — −30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

Vertical Display (8 Div) — Log — ≥ 40 dB dynamic range. Linear. Square Law — ≥ 13 dB dynamic range.

If Attenuator — 51 dB in 1 dB steps, ±0.1 dB/dB.

If Gain Control — > 50 dB range.

Sensitivity — Greater than — 100 dBm to 8.2 GHz
Greater than — 90 dBm to 18 GHz
Greater than — 70 dBm to 40 GHz

INPUT CHARACTERISTICS

50 Ω Input

SWEEP CHARACTERISTICS

Sweep Range — The 491 uses a complete triggered oscilloscope type time base with 15 calibrated steps from 10 μs/div to 0.55/div.

Calibrated Dispersion — 1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div and MHz/div).

CRT AND DISPLAY FEATURES

Crt — 8 x 10 div display area (each div = 0.8 cm); P7 phosphor.

ENVIRONMENTAL CAPABILITIES

The 491 meets MIL-I-6181D specs for EMI, operates up to 15,000 ft with temperatures from −15°C to +55°C and can stand a 30 g shock.

Weight —	Rackmount	41 lb	18.6 kg
	Portable	30 lb	13.6 kg

ORDERING INFORMATION

491 Spectrum Analyzer

R491 Spectrum Analyzer (Rackmount)

Option 01 (10 MHz to 2 GHz)

Option 02 (1.5 GHz to 40 GHz)

1105 Battery Power Supply

Additional specifications are available through your local Tektronix Field Office.

1401A
1401A-1

1 MHz to 500 MHz Spectrum Analyzers

50 or 75 Ω Input

1 to 500 MHz

Ac, Dc, or Battery

Portable, Lightweight

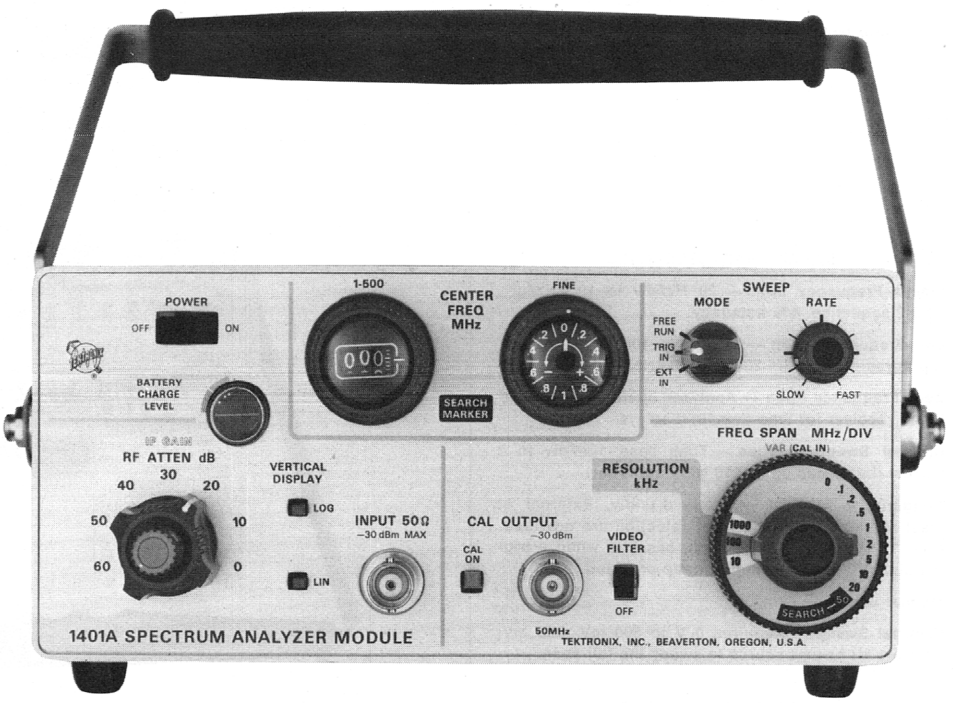
Built-in Calibrator

60 dB On Screen Dynamic Range

Gated Mode

The 1401A and 1401A-1 Spectrum Analyzer Modules are used with the SONY/TEKTRONIX battery-operated scope for measurements in the 1 to 500 MHz frequency range.

Because of its battery operation, the 1401A is popular with persons engaged in remote site studies, field maintenance, and applications where power is not convenient. The unit may be used for surveillance measurements by law enforcement officials and for displays and measurements important to radio, TV, and CATV operators, medical personnel, aircraft equipment personnel, shop owners, and others. In addition, the 1401A Module may be connected to any inexpensive scope to form an economical 500 MHz analyzer.



1401A Spectrum Analyzer Module

FREQUENCY CHARACTERISTICS

Range — Continuously selectable with 10-turn digital frequency readout control, 1 to 500 MHz. Absolute accuracy within ±5 MHz (+5% of dial reading). Fine control provides a calibrated variation of up to ±1 MHz, within 10%.

Resolution — 10, 100, 1000 kHz Gaussian-shaped Filter.

Frequency Stability — Within 100 kHz over any 5 minute interval after 25 minute warm-up and measurement at +20°C to +30°C ambient. Temperature coefficient = 0.5 MHz/°C or less.

Incidental Fm — 20 kHz or less.

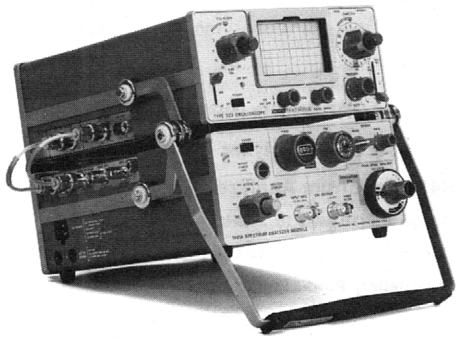
AMPLITUDE CHARACTERISTICS

Rf Attenuator — 0 to 60 dB in 10 dB steps (accurate within +0.2 dB + 1% of dB reading).

If Gain Control — At least 30 dB range.

Vertical Display — Linear and log.

Cw Sensitivity	1401A	1401A-1
10 kHz Resolution	≥ −95 dBm	≥ −40 dBmV
100 kHz Resolution	≥ −85 dBm	≥ −30 dBmV
1000 kHz Resolution	≥ −78 dBm	≥ −23 dBmV



1401A-1/323 Spectrum Analyzer System

Display Flatness — Measured with respect to the level at 50 MHz, ±0.75 dB to 200 MHz and within +0 dB to −3 dB from 200 MHz to 500 MHz.

Intermodulation Distortion — 1401A at least 55 dB down with two signals at −30 dBm (+25 dBmV 1401A-1), 1 MHz apart; 60 dB down with signals at −40 dBm (+15 dBmV 1401A-1).

Dynamic Range — At least 60 dB in log mode at 10 dB/div.

INPUT CHARACTERISTICS

Impedance — 1401A 50 Ω nominally. 1401A-1 75 Ω nominally.

SWEEP CHARACTERISTICS

Sweep Rate — Continuously variable from one sweep per second or less to at least 100 sweeps per second.

Frequency Span (Dispersion) — 50 MHz/div to 100 kHz/div in 9 steps (1-2-5 sequence), accurate within 10% over a 10 div display, plus 0-Hz span. Frequency span can be continuously varied (uncalibrated) from any calibrated value toward zero.

OTHER CHARACTERISTICS

Calibrator — −30 dBm 1401A. +25 dBmV 1401A-1. Accuracy 0.3 dB at 25°C

Power Source — 6 size C NiCd cells for 3½ hours of operation. External dc source: operates from an external dc source of 6 V to 16 V, requires 4.8 W. External ac source: operates from an external ac source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 14 W max 115 V ac.

Weight — 1401A or 1401A-1 and 323 Oscilloscope
15 lb 6.8 kg

ORDERING INFORMATION

1401A Included Accessories — 8 ft power cable assembly (161-0043-02); panel cover (200-0812-00); blue filter (378-0670-01); amber filter (378-0670-02); three 5½ inch, 50 Ω BNC to BNC cable assemblies (012-0113-00); screwdriver (003-0672-00); strap assembly (346-0051-00).

1401A

1401A-1 Included Accessories — Same as for 1401A except: two BNC to F adapters (013-0126-00); change 6 ft, 50 Ω BNC to BNC cable assembly to 6 ft 75 Ω BNC to BNC cable assembly (012-0113-01).

1401A-1

1401A/323 (P7 Phosphor) Included Accessories — Includes accessories for both the 1401A, 323, and a two-instrument handle conversion kit (040-0563-00).

1401A/323P7, Order 1401A-3

1401A-1/323P7, Order 1401A-1-3

OPTIONAL ACCESSORIES

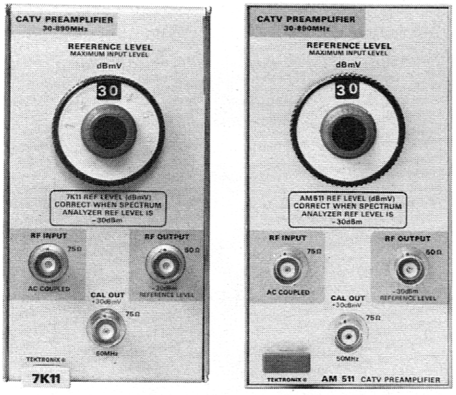
Protective Cover — Waterproof blue vinyl, **016-0112-00**

Handle Conversion Kit (for Two Instruments) — For combining an existing 323 Oscilloscope with 1401A or 1401A-1, for a system as shown, **040-0563-00**

Power Pack — Extra power pack, in addition to the one supplied with the 1401A or 1401A-1, allows one power pack to charge while the other is powering the analyzer. An identical power pack is used in the 323. **016-0119-02**

Adapter — BNC 75 Ω to 50 Ω impedance matching network. **011-0112-00**

Battery Set — Set of 6 NiCd cells **146-0012-01**



These plug-in preamplifiers are designed for spectrum analyzer applications where extra sensitivity is required. The 7K11 is a 7000-Series Plug-in while the AM 511 fits into the TM 500 Modular Series power supplies.

The amplifiers are tailored to the CATV and field intensity measurement markets providing a 75 Ω input impedance and calibration in dBmV. The low noise figure makes the preamplifiers well-suited for signal-to-noise and low-level radiation measurements.

CHARACTERISTICS
(with 7L12 and 7L13)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in LIN mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is no greater than 5 dB.

Intermodulation Distortion (with 7L12 or 7L13) — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for: 1) third order intermodulation with two signals at the reference level (full screen), 2) second order intermodulation and harmonics with two signals 10 dB below the reference level.

Reference Level — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

Input Impedance — 75 Ω.

Calibrator — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

Accessories — BNC to BNC 50 Ω Cable, 5½ inch: 012-0057-01; BNC to F Adapter: 013-0126-00; BNC to BNC 75 Ω Cable, 42 inch: 012-0074-00.

7K11 CATV Preamplifier

AM 511 CATV Preamplifier

TM 501 Power Module for AM 511

The 2701 and 2703 Step Attenuators are laboratory quality, bench top instruments for attenuation of large value radio frequency signals. The 2701 50 Ω Attenuator is particularly useful in making receiver sensitivity and distortion measurements. The range of attenuation is 0 to 79 dB, selected in 1 dB steps with tens and units cam switches. A front-panel switch selects DC, AC, or DC TERM (a 50 Ω precision termination).

The 2703 75 Ω Step Attenuator is tailored for television, CATV, telephone, and radio applications. A front-panel switch extends the range to 109 dB, making the attenuator an ideal accessory for wide-range measurements such as cross modulation, signal-to-noise and receiver sensitivity. A dc block has been incorporated for both rear-panel ports to protect the attenuator against accidental burnout from high dc offsets or ac power on center conductors.

The board assemblies and thick-film hybrid attenuation chips used in both instruments are mounted in a sturdy metal housing; solid top and bottom plates provide excellent mechanical and electrical stability. The two cam switches which select individual chips operate through gold-plated switch contacts. Held on a four-layer circuit board with spring clips, the chip substrates can be replaced easily in the field.

The attenuators may be used for frequencies up to 2 GHz, with slight degradation of the attenuation accuracy and vswr characteristics specified at 1 GHz.

CHARACTERISTICS	2701	2703
Attenuation	0 to 79 dB in 1 dB steps	0 to 109 dB in dB steps (Including extra 30 dB range)
Impedance	50 ohms nominal	75 ohms nominal
Frequency	Dc to 1 GHz	3 kHz to 1 GHz*
Accuracy	Units Error +0.1 dB to −0.5 dB Max Error +1.0 dB to −0.7 dB	Units Error 500 MHz +0.1 −0.5 dB; 1000 MHz +0.1 −0.8 dB 79dB +0.9 −0.8 dB; 79 dB +1.4 −1.1 dB 109 dB +1.3 −1.0 dB; 109 dB +1.9 −1.3 dB
Insertion Loss @ 0 dB Setting	−(0.5 dB + 0.14 dB/100 MHz) or better	−(0.2 dB + 0.08 dB/100 MHz) or better
Return Loss	20 dB 10 −300 MHz (1.22 vswr) 17 dB >300 −600 MHz (1.32 vswr) 17 dB @ 1 GHz (1.32 vswr)	20.5 dB 10 −300 MHz (1.22 vswr) 15.5 dB >300 −600 MHz (1.48 vswr) 11.5 dB @ 1 GHz (1.78 vswr)
Max Average Input Power	1.5 W to 65°C	1.5 W to 65°C
Signal Coupling	Dc, ac, and dc terminated at one port only	Ac only both PORTS*
Size	7½ in lg x 4½ in w x 2½ in h	7½ in lg x 4½ in w x 2½ in h
Connector	Type BNC Female 50 ohm	Type BNC Female 75 ohm

**Blocking capacitors may be removed for specialized applications.*

ORDERING INFORMATION

2701 50 Ω Step Attenuator

2703 75 Ω Step Attenuator

600 Ω Attenuator. 51 dB in 1 dB steps
011-0093-00

Pads and Adapters

75 Ω to 50 Ω Minimum Loss Attenuator with dc block **011-0112-00**

75 Ω to 50 Ω Minimum Loss Attenuator with 11.25 dB conversion factor from dBm to dBmV **011-0118-00**

Fixed 10 dB attenuator with 3 mm fittings for use with TR 501/TR 502 with 7L12 **307-0553-00**

Dc Block BNC to BNC max dc potential 50 volts **015-0221-00**

"F" Female to BNC Male Adapter 013-0126-00

BNC Female to "F" Male 103-0158-00

Calibrator Jumper 50 Ω BNC to BNC 5½ in **012-0214-00**

Jumper Cable BNC to BNC 50 Ω, 42 in **012-0057-01**

Jumper Cable BNC to BNC 75 Ω, 42 in **012-0074-00**

"N" Female to BNC Male 103-0058-00

Protective Vinyl Covers

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe or instruments.

7000-Series 3 Hole Mainframe Cover 016-0192-01

7000-Series 4 Hole Mainframe Cover 016-0531-00

5000-Series Mainframe Cover 016-0544-00

491 Analyzer Cover 016-0074-01

1401A-323 Protective Cover 016-0112-00

Rigid Front Covers

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613, or the Option 02 Protective Front Cover for 5100 Series Mainframes.

491 Spectrum Analyzer — cover supplied, no charge with instrument.

1401A and 323 Analyzer Combination (2 required) **200-0812-00**

Graticules, Filters

Plastic Implosion Shield and S A Graticule 7613 and 7623 Mainframes **378-0625-07**

Plastic Implosion Shield and S A Graticule 7403 and 7603 Mainframes **337-1439-01**

Plastic Implosion Shield and S A Graticule All other 7000-Series Mainframes **337-1159-02**

(Internal graticules are available with most 7000-Series Mainframes)

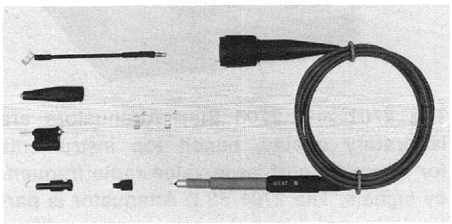
EMI Metal Screen Mesh Filter for 7500-, 7700-Series instruments **378-0603-00**

EMI Metal Screen Mesh Filter for 7400-Series instruments **378-0696-00**

Audio 20-20 kHz Log Graticule for 5000-Series instruments — **331-0429-00**

IRIG Log Graticule for 7L5 331-0421-00

Complete selection of colored filters is available in the accessories section.



Probes

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L12, 7L13, and 1401A Spectrum Analyzers:

FET Probe P6201 to 900 MHz 010-6201-01

FET Probe P6202 to 500 MHz 010-6202-01

Conventional Probe P6056 Dc to 3.5 GHz 6 ft. 010-6056-03

Conventional Probe P6057 Dc to 1.4 GHz with Adapter **010-6057-03**

Current Probe P6022 to 150 MHz 015-0135-00

Complete specifications are available in the probes and accessories section.

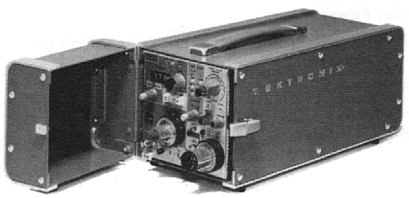
Cameras

A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available however, the most popular units for the 5000- and 7000-Series instruments are:

Polaroid Film Back C-59P

Polaroid Film Back C-5A

Complete specifications on all cameras are available in the cameras, probes, and accessories section.



Carrying Cases and Mounts

Specialized carrying cases are available in 2 forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L12 or 7L13 Plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

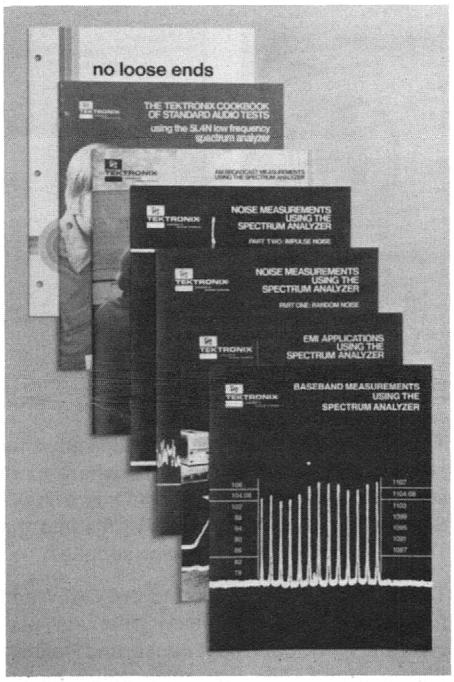
A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

3-wide Carrying Case for 7L13, 7L5 Option 25, etc. 016-0626-00

2-wide Carrying Case for 7L12, 7L5, etc. 016-0625-00

Luggage-type Carrying Case for 7603 Opt 08, 7613 Opt 08 016-0628-00

Your local field office can quote prices and availability on any of these accessories.



Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMI, am, fm, and television measurements, cable television proof of performance, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Field Office.

Semiconductor Device Test Systems

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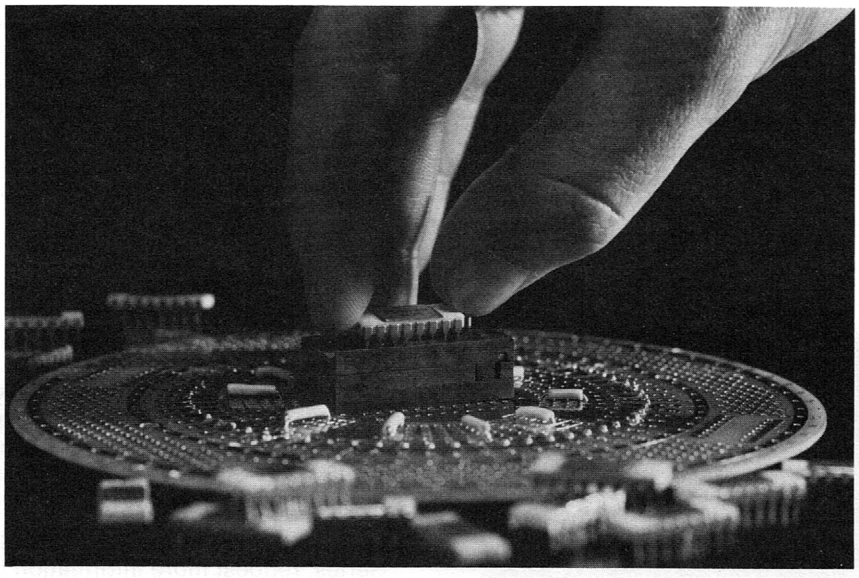
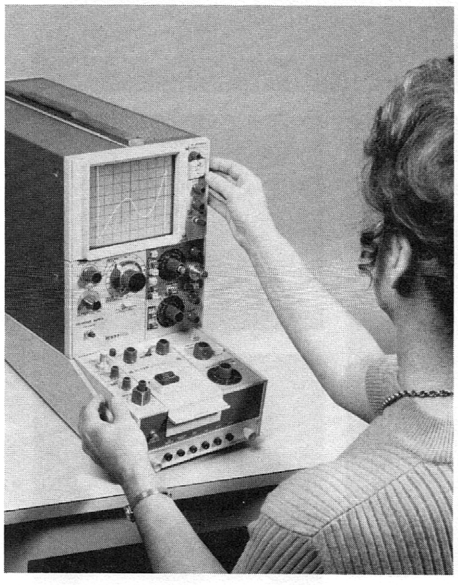
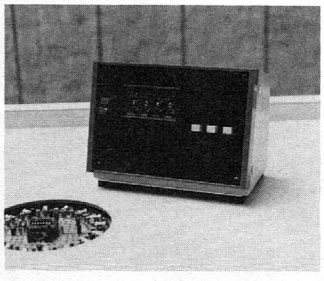
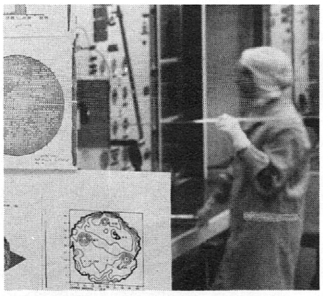


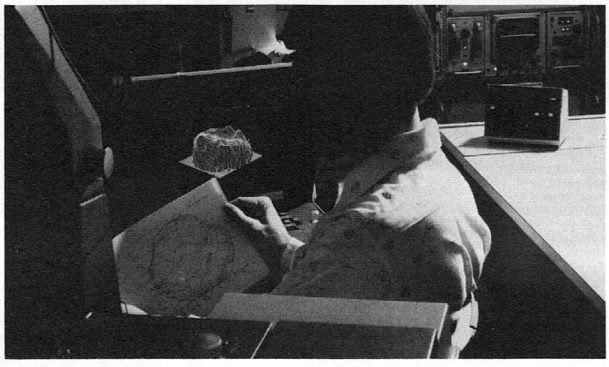


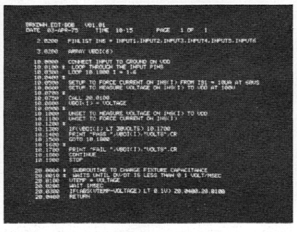


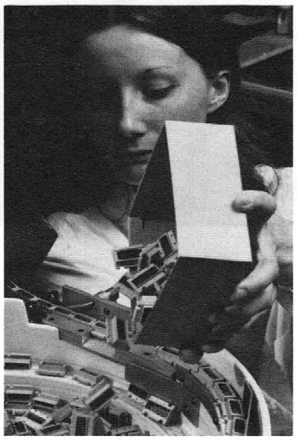
S-3260 Series

Respected around the world as the comprehensive LSI testing solution









When LSI devices graduate from the lab, they are characterized with an S-3260; when samples are received by device users, they are evaluated with an S-3260. When an LSI device goes into production, the production testing is often performed with an S-3260.

Over the last few years, we have seen the IC grow from a collection of gates into general purpose controllers. Now on the horizon are intelligent general-purpose interfaces. Throughout this explosion of IC technology, the TEKTRONIX S-3260 Series has always offered testing capability a step ahead of the testing requirements. That's why the S-3260 Series continues today as the comprehensive LSI testing solution.

For the complete story on the S-3260 Series, request more information by using the reply card inside the back cover; or, for faster action, contact your Tektronix Field Office, Distributor, or Representative.