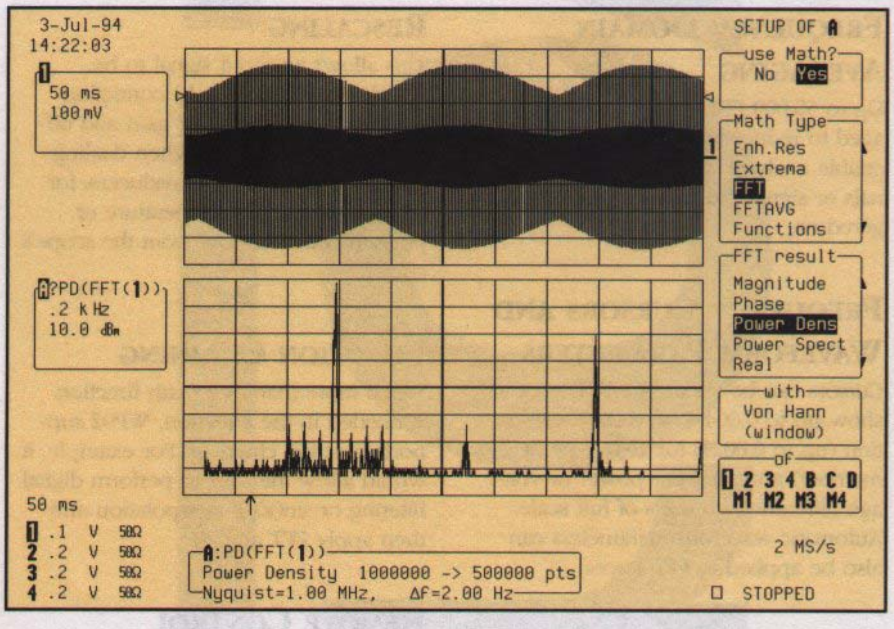
Spectrum Analysis Package



Main Features

- ***Frequency range from DC up to the instrument's full bandwidth***
- ***Simultaneous FFTs on up to 4 channels***
- ***Perform FFT on up to 4 million time domain samples***
- ***Frequency resolution down to 100 µHz***
- ***Frequency domain averaging***
- ***Wide selection of scaling formats and window functions***
- ***Full support of cursors and automatic waveform parameters***
- ***Full Pass/Fail testing support***

The Spectrum Analysis package provides LeCroy oscilloscopes with a powerful frequency-domain toolset that extends its processing capabilities, well beyond the realm of a standard instrument. In fact, all the processing is built-in to eliminate the need for external computers and controllers.

High-speed microprocessors and up to 64 MBytes of RAM are used to perform computations. Fast Fourier Transforms (FFTs) convert time domain waveforms into frequency domain records to reveal valuable spectral information such as phase, magnitude and power. The package is fully programmable over GPIB and RS-232-C interfaces, and hardcopies can be made directly on to a wide range of printers (including the optional internal printer), plotters or graphic formats. Data can also be saved to optional floppy disk or PCMCIA portable hard drive.

Features and Benefits

Why FFT in a scope?

The FFT package on a LeCroy DSO has at least four clear advantages over common swept spectrum analyzers:

- It can show the spectrum of a transient signal.
- Both time and frequency information can be monitored simultaneously.
- Phase information is available.
- The price is attractive.

It has two definite advantages over FFT analyzers:

- It can show higher-frequency components.
- Both time and frequency information can be monitored simultaneously.

Broad Spectrum Coverage

The frequency spectrum ranges from DC to the full bandwidth of the oscilloscope for repetitive signals and to one half of the maximum sampling frequency for transients.

Multi-Channel Analysis

All input channels can be analyzed simultaneously to look for common frequency-domain characteristics in independent signals.

Versatile Scaling Formats

Frequency-domain data may be presented as magnitude, phase, real, imaginary, complex, log-power and log-PSD (Power Spectral Density).

Standard Window Functions

Use rectangular for transient signals; von Hann (Hanning) and Hamming for continuous waveform data; Flattop for accurate amplitude measurements; Blackman-Harris for maximum frequency resolution.

See page 62 for Ordering Information.

Frequency Domain Averaging

Up to 50,000 FFT sweeps may be averaged to reduce base-line noise, or to enable analysis of phase-incoherent signals or signals which cannot be triggered on.

Frequency Cursors and Waveform Parameters

Cursors can be set on the FFT trace to show up to 0.004% frequency resolution (up to 0.002% for 10,000 point memory) and measure power or voltage differences to 0.2% of full scale. Automatic waveform parameters can also be applied to FFT traces.

Pass/Fail Testing on FFT Traces

Pass/Fail testing is fully supported on FFT traces. The instrument can be setup to test incoming spectra against tolerance masks. In case the signal "fails", the instrument can be programmed to perform a choice of actions (screen dump, waveform storage, pulse out, etc.)

Rescaling

This allows an input signal to be rescaled using a (ax + b) correction factor to compensate for gain and offset. This is very useful when dealing with various types of transducers, for reading the correct temperature or pressure value directly from the scope's cursor.

Function Chaining

When more than one math function is needed in the equation, WP02 supports function chaining. For example, it would allow the user to perform digital filtering or sin(x)/x interpolation and then apply FFT analysis.

Remote Control

All of the waveform processing can be controlled via GPIB or RS-232-C remote control. The function traces do not even need to be called up on screen to be updated, an important feature that speeds up the computation.

General

Max. number data points: only limited by the available amount of system memory (indicated in the "memory used" status menu). Up to 6 million data points can be handled in scopes equipped with the 930X-64 RAM option of 64 MBytes of RAM.

Min. number data points: Data points can be reduced down to 50 in the processing function to improve update rate.

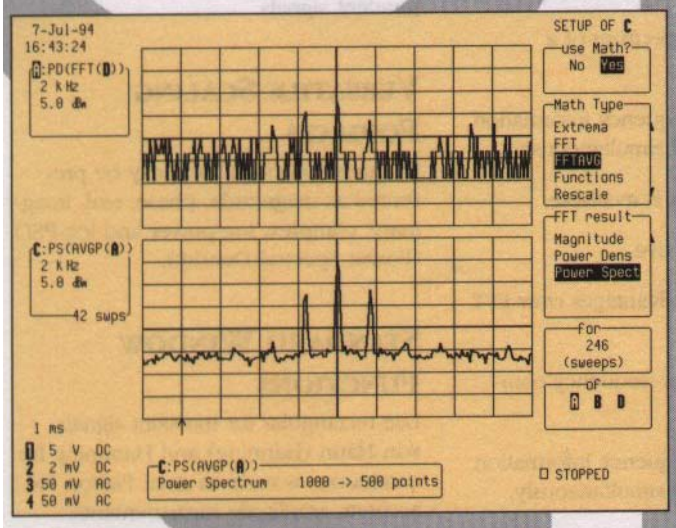
Vertical Zoom: x50 maximum.

Horizontal Zoom: maximum zooming to a point where 20 - 25 samples of the source trace occupy the full screen.

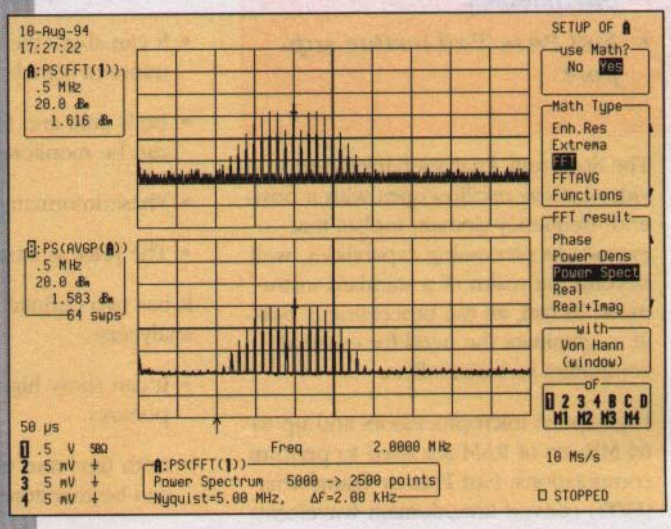
Maximum Sensitivity: 50 µV/div after vertical expansion.

Fourier Processing

Fourier processing is a mathematical technique which enables a time-domain waveform to be described in terms of either frequency-domain magnitude and phase or real and imaginary spectra. It is used, for example, in spectral analysis where a waveform is sampled and digitized, then transformed by a Discrete Fourier Transform (DFT). Fast Fourier Transforms (FFT) are a set of algorithms used to reduce the computation time (by better than a factor of 100 for a 1000 point FFT) needed to evaluate a DFT.



An FFT (top trace) with spectral components buried in noise. By applying the power averaging function (lower trace), all the baseline noise is removed, and the spectral components of an AM signal are clearly visible.



Frequency modulated signal, 2 MHz carrier with 99 kHz modulation frequency, 4:1 frequency deviation, FFT shows modulation sidebands, FFT power average used to improve s/n ratio.

Frequency Range:

Repetitive signals: DC to instrument bandwidth.

Transient signals: DC to 1/2 maximum single-shot sampling frequency.

Frequency Scale Factors: 0.05 Hz/div to 0.2 GHz/div in a 1-2-5 sequence.

Frequency Accuracy: 0.01%.

Amplitude and Phase

Amplitude Accuracy: Better than 2%. Amplitude accuracy may be modified by the window function (see the window functions table).

Signal Overflow: A warning is provided at the top of the display when the input signal exceeds the ADC range.

Number of Traces:

Time domain and frequency domain data can be displayed simultaneously (up to 4 waveforms).

Phase Range: -180° to +180° .

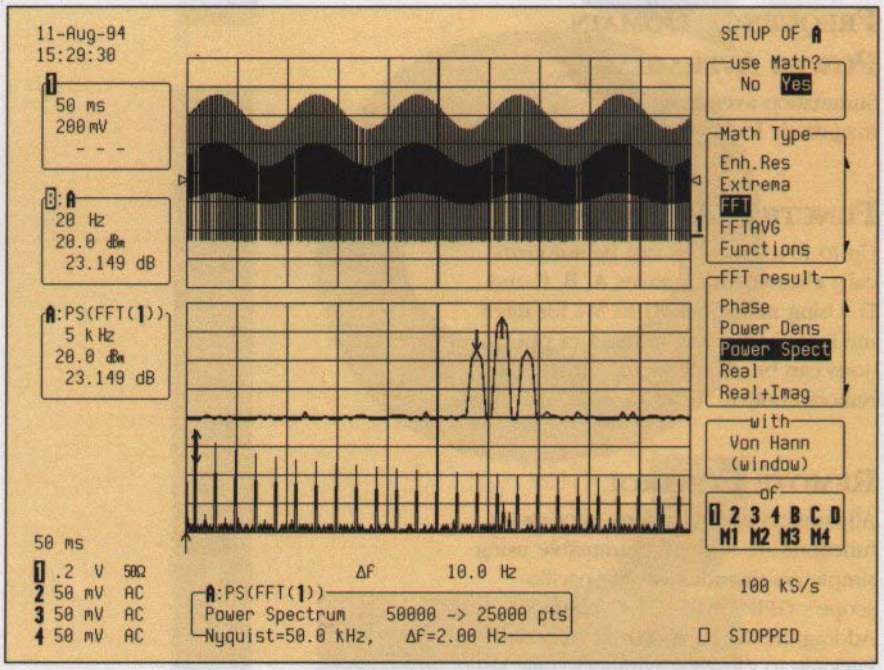
Phase Accuracy: ±5° (for amplitudes > 1.4 div).

Phase Scale Factor: 50° /division.

Spectrum Scaling Formats

Horizontal Scale: Linear, in Hz.

Vertical Scales: Power Spectrum in dBm (1 mW into 50 W).



FFT analysis of a 1 kHz square wave with 25% pulse amplitude modulation at 10 Hz. Long memory and 50 kpoint FFT show up to 51st harmonic, while expansion shows 10 Hz modulation sidebands.

Power Spectral Density (PSD) in dBm.

Magnitude, Real, Imaginary: Linear, in V/div.

Phase Display: Linear, in degrees.

Window Functions

Rectangular, von Hann (Hanning), Hamming, Flattop and Blackman-Harris (see table below).

FFT Execution Times*

100 points in less than 0.03 s.
1000 points in less than 0.3 s.
10000 points in less than 3 s.

* Valid for 9350, 9360, 9370, 9384 and 9304/10/14 with MWP option. Other 9300 models, add 50%.

FFT execution in LC series scopes is typically a factor of 15 faster.

Filter Pass Band and Resolution

Window Type:	Filter bandwidth at 6dB [freq. bins]	Highest side lobe [dB]	Scallop loss [dB]	Noise bandwidth [freq. bins]
Rectangular	1.21	-13	3.92	1
von Hann	2	-32	1.42	1.5
Hamming	1.81	-43	1.78	1.36
Flattop	1.78	-44	0.01	2.96
Blackman-Harris	1.81	-67	1.13	1.71

Filter Bandwidth at -6dB characterizes the frequency resolution of the filter.
Highest Side Lobe indicates the reduction in leakage of signal components into neighboring frequency bins.
Scallop Loss is the loss associated with picket fence effect.

Frequency Domain Power Averaging

Summation averaging of power, PSD or magnitude for up to 50,000 sweeps.

Function Averaging

Up to four functions can be automatically chained using traces A, B, C and D. Using memories M1 to M4 for intermediate results, any number of operations can be chained manually or via remote control.

Remote Control

All controls and waveform processing functions are fully programmable using simple commands over the oscilloscope's GPIB or RS-232-C interfaces. Adding the WP02 Spectrum Analysis Package to the 9300 family of digital oscilloscopes provides a fast and economical solution to frequency domain applications.

Ordering Information

Software Options:	Product Code	Price
Spectrum Analysis	93XX-WP02	$ 1,250

Included as standard in LCXXX Series Oscilloscopes.