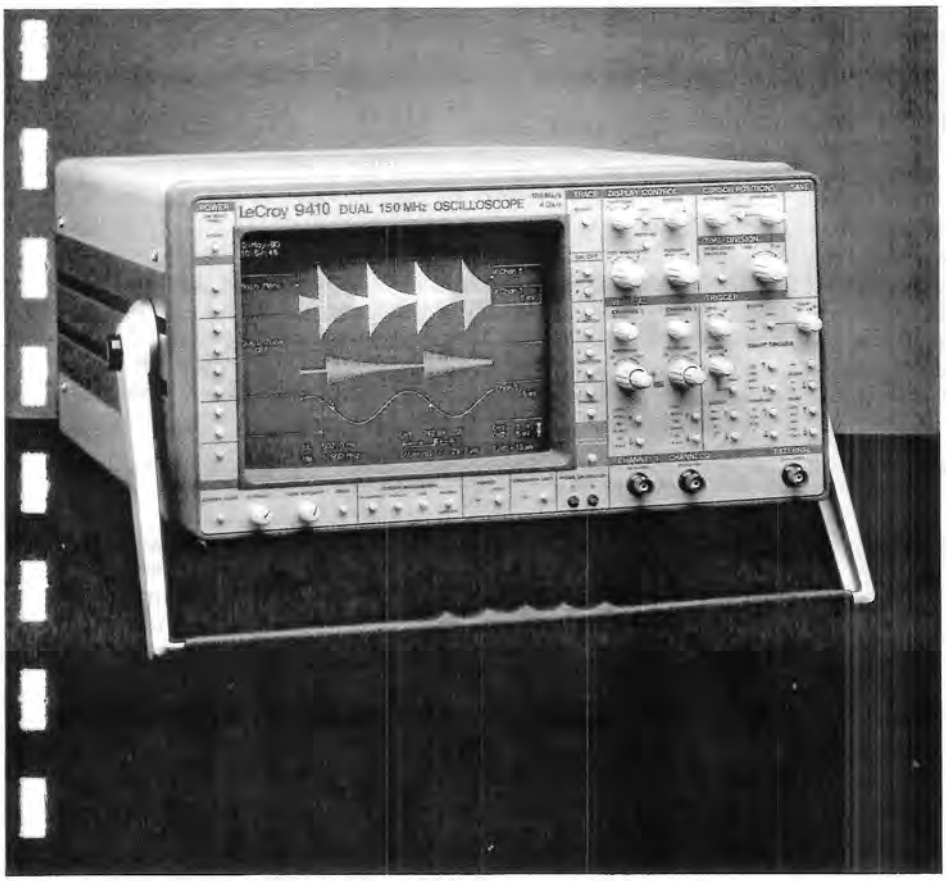
DIGITAL OSCILLOSCOPE
150 MHz BANDWIDTH, 100 Ms/s, 4 Gs/s

LeCroy

MODEL 9410 PORTABLE DUAL–CHANNEL OSCILLOSCOPE

9410



reveal fine signal details, often missed by conventional digital oscilloscopes, the 9410 uses ng 10K acquisition memories. Above, two different portions of the top trace are expanded (up to 200 times).

- **Advanced Triggering**
- **Sensitivity up to 100 μV/div**
- **Long 10K Memories per Channel**
- **Time and Frequency Domain Analysis**
- **High–speed GPIB for Plotters, Printers and PCs**
- **Optional 512K Credit Card Memory**

THE INTELLIGENT TEST INSTRUMENT

The 9410 Dual–channel Digital Oscilloscope delivers unrivaled capture and analysis capabilities for signals up to 150 MHz in frequency. Precision flash ADCs are used to digitize single–shot events at rates up to 100 megasamples/sec (4 gigasamples/sec for repetitive waveforms). The unit's long 10K acquisition memories ensure excellent timing resolution to reveal the finest signal details on any time–base setting. Live, stored or processed waveforms can be expanded up to 200 times for maximum timing accuracy.

Advanced triggering capabilities which detect glitches, timing violations or even logic patterns, make catching rare or complex events easy. Waveforms and measurements are presented instantly on the screen and can be transferred directly to a wide variety of plotters and printers, archived onto PCs, or stored on an optional credit card memory facility. Additional firmware packages are available to extend the oscilloscope's processing capabilities in both time and frequency domains.

FEATURES

High sensitivity – For detecting and monitoring small signal variations the 9410 offers continuously variable (and calibrated) sensitivity from 1 mV/div up to 2.5 V/div with 8–bit vertical resolution. Vertical expansion and signal processing can also be used to lower the sensitivity to an astounding 100 µV/division.

SMART triggering – For stable display and easy acquisition of complex signals, triggering capabilities include pre– and post–triggering, hold–off by time or event, delay by time or event, TV, logic (pattern of three inputs), state qualified, time/event qualified, glitch and time–interval modes.

Automated measurements – Up to ten signal characteristics (risetime, falltime, RMS voltage, etc.) can be automatically calculated on displayed, stored, expanded and processed waveforms. High–speed processing is used to instantly update results with each new acquisition. Auto–setup can be used to identify and display repetitive waveforms in under a second.

Signal processing – The 9410's built–in processing includes mathematics (add, subtract and invert), XY display with ratio and multiplication cursor readout, and summation averaging (up to 1000 sweeps). Additional firmware can be installed in the 9410 to allow filtering, EXTREMA, complex mathematics and FFT spectral analysis.

Remote control – All front–panel controls (including cursor positions) are fully programmable over GPIB and RS–232–C interfaces. Waveform data and measurements can be transferred to computers in binary or ASCII formats or output directly to digital plotters and printers.

Mass storage – A credit card memory system can be added to the 9410 for applications requiring high–speed data logging and non–volatile waveform storage. Waveform data can be stored at rates unmatched in the industry onto 128– or 512–Kbyte cards.

FUNCTIONAL DESCRIPTION

The 9410 Dual–channel Digital Oscilloscope is a general purpose instrument which brings precision waveform acquisition and measurement within the reach of engineers working in all areas of electronics. Featuring a design that optimizes performance but keeps cost to a minimum, the 9410 can be used in almost any application where signal frequencies of up to 150 MHz are monitored.

LOW COST WITHOUT COMPROMISE

Seeing fine signal details with accuracy and precision is a difficult task for most of today's analog and digital oscilloscopes. In an attempt to catch transient signals, analog oscilloscopes use storage techniques that are costly and cumbersome. The results are poor and the waveform display is of a very low quality. In contrast, digital oscilloscopes offer much better measurement precision, easy transient capture and the possibility of automation. These benefits, however, are usually obtained at a much higher price. In order to compete with analog oscilloscopes, low–cost digital instruments sacrifice performance by compromising on features (sampling rate, vertical resolution, record length, DC accuracy, sensitivity etc.) that are crucial to good waveform acquisition and all–round usability. The Model 9410 is the first digital oscilloscope to offer a low entry price without compromising on performance.

PRECISION ACQUISITION

The 9410 combines all the key elements (low–noise amplification, quality ADCs, long memories, precision time base, high sensitivity and outstanding display) required for accurate waveform acquisition. Each channel contains a high–resolution flash ADC which digitizes transient events at up to 100 megasamples/sec and repetitive signals at up to 4 gigasamples/sec. To ensure maximum timing accuracy (even for measurements between channels), the ADCs are driven simultaneously with a high–precision time base. Vertical resolution is 8 bits (0.4% of full scale) and can be extended as high as 12 bits (0.025%) using averaging and filtering techniques. These features are combined with genuine 1 and 2 millivolt sensitivity settings and a big, crisp display to let you see the finest signal structure.

LONG MEMORIES

Only long memories give you high–fidelity recording over extended periods of time. In fact, on equal time–base settings, the 9410, with 10K of memory per channel, will sample waveforms up to 10 times faster than an oscilloscope with only 1K of memory. With improved timing resolution on slower time–base settings, users can analyze waveforms by expanding them up to 200 times!

CATCH THE EVENTS YOU WANT

Two levels of triggering make catching difficult signals an easy task for the 9410. The standard trigger functions such as pre– and post–triggering, level, slope, mode and coupling are all accessed directly from the front panel with rotary knobs that make adjustment a pleasure. Icon trigger graphics show the current setup at a glance. And just a touch of a button accesses the SMARTest trigger in any portable scope.

SMART trigger modes are designed to help track and monitor complex and rare phenomena. Trigger techniques include FASTGLITCH mode for triggering on glitches down to 5 nsec in width, TV mode for NTSC, PAL and SECAM signals, PATTERN mode for fast logic testing, and TIME/EVENT QUALIFIED mode for ranging

Standard Trigger

Sources: CHAN1, CHAN2, EXT, EXT/10, LINE. CHAN1, CHAN2 and EXT have independent trigger circuits allowing slope, coupling and level to be set individually for each source.

Slope: Positive, negative.

Coupling: AC, LF REJ, HF REJ, DC.

Modes:

Auto: Automatically re–arms after each sweep. If no trigger occurs, one is generated at an appropriate rate.

Normal: Re–arms after each sweep. If no trigger occurs after a reasonable length of time, the warning message "No or Slow Trigger" is displayed.

Single (hold): Holds display after a trigger occurs. Re–arms only when the "single" button is pressed again.

Sequence: Stores multiple events in segmented acquisition memories.

SMART Trigger

Single–source trigger operational modes:

Hold–off by time: 25 nsec to 20 sec.
Hold–off by events: 0 to 10^9 events.

Width–based trigger modes:

Pulse width < (FASTGLITCH): Triggers on opposite slopes of pulses narrower than a value in the range 5 nsec to 20 sec.
Pulse width >: Triggers on opposite slopes of pulses wider than a value in the range 5 nsec to 20 sec.
Interval width <: Triggers on similar slopes of signals narrower than a value in the range 10 nsec to 20 sec.
Interval width >: Triggers on similar slopes of signals wider than a value in the range 25 nsec to 20 sec.

Multi–source trigger operational modes:

Pattern: Triggers on the logic AND of CHAN1, CHAN2 and EXT, where each source can be defined as high (H), low (L) or don't care (X). The trigger can be selected at the beginning (entered) or at the end (exited) of the specified pattern.

Bi–level: This is a special condition of pattern trigger which allows the 9410 to trigger on any signal that exceeds a certain pre–set high or low trigger level. The signal must be connected simultaneously to two inputs. The third input must be set to don't care (X).
State qualified: Allows the 9410 to trigger on any source (CHAN1, CHAN2 or EXT), while requiring that a certain pattern of the other two inputs is present or absent. In addition, a delay by time or by number of events can be selected from the moment the pattern is valid.

Time/Event qualified: Allows the 9410 to trigger on any source (CHAN1, CHAN2 or EXT), as soon as a certain pattern of the three inputs is entered or exited. From the moment of validity, a delay can be defined in terms of time or number of events.

TV: Allows stable triggering on TV signals that comply with PAL, SECAM or NTSC standards. Selection on both line (up to 1500) and field number (up to 8) is possible. Active on EXT only.

DISPLAY

CRT: 12.5 ×17.5 cm (5 × 7 inches); magnetic deflection; vector type.

Resolution: 4096 × 4096 points.

Real–time clock: Date, hours, minutes, seconds.

Grid: Internally generated; separate intensity control for grid and waveforms. Single, dual and pulse parameter measurement grid mode.

XY mode: Plots any two sources (CHAN1, CHAN2, MEMORY C or D, FUNCTION E or F and EXPAND A or B) against one another. Operates on live waveforms with cursor readout.

Hard copy: Single– or multi–pen digital plotters as well as IBM, HP QuietJet, HP ThinkJet, HP LaserJet and EPSON printers can be used to make hard copies of the display. Screen dumps are activated by a front–panel button or via remote control. Supported plotters include: the HP 7400 and 7500 series, Philips PM 8151, Graphtek FP 5301, and compatible models. Plotting is done in parallel with normal 9410 operation.

Graphics: All waveforms and display information are presented using vector (linear) graphics. Expanded waveforms use LeCroy's DOT–LINEAR graphics that highlight actual data points and interpolate linearly between them.

Menus: Waveform storage; acquisition parameters; memory status; save/recall front–panel configurations; SMART trigger; waveform parameters; XY mode; RS–232–C configuration; hardcopy setup and real–time clock setup; averaging and arithmetic.

Cursors

Relative time: Two cursors provide time measurements with a resolution of ± 0.05% of full scale for unexpanded traces; up to 10% of the sampling interval for expanded traces. The corresponding frequency information is also provided.

Relative voltage: Two horizontal bars measure voltage differences to ± 0.2% of full scale.

Absolute time: A cross–hair marker measures absolute voltage versus signal ground, as well as the time relative to the trigger.

Absolute voltage: A reference bar measures absolute voltage with respect to ground.

Pulse parameters: Two cross–hair cursors are used to define a region of interest for which pulse parameters will be calculated automatically.

AUTO–SETUP

Pressing the auto–setup button automatically scales the time–base, trigger and sensitivity settings to display a wide range of repetitive input signals.

Type of signals detected: Repetitive signals with amplitudes between 2 mV and 8 V, frequency above 50 Hz and a duty cycle greater than 0.1%.

Auto–setup time: Approximately 1 sec.

WAVEFORM PROCESSING

Waveform processing routines are called and set up via menus. These include arithmetic functions (add, subtract and invert), and summation averaging (up to 1000 signals).

Pulse parameters: Based on ANSI/IEEE Std 181–1977 "Standard on Pulse Measurement and Analysis by Objective Techniques". The terminology is derived from IEEE Std 194–1977 "Standard Pulse Terms and Definitions".

Automatic measurements determine:

Maximum	Period
Minimum	Pulse width
Mean	Risetime
Standard deviation	Falltime
RMS	Delay

Sources: CHAN1, CHAN2, MEMORY C or D, FUNCTION E or F, EXPAND A or B. Cursors define the measurement zone. When more than one pulse is present in the measurement zone, averaged results for period, width, risetime and falltime are presented.

REMOTE CONTROL

Front–panel controls, including variable gain, offset, position controls and cursors, as well as all internal functions are programmable.

RS–232–C port: For computer/terminal control or plotter connection. Asynchronous up to 19200 baud.

GPIB port: (IEEE–488). Configured as talker/listener for computer control and fast data transfer (up to 380 kbytes/sec). Address switches on rear panel. Command syntax and data formats follow IEEE–488.2 standards.

Local/remote: Remote control can be interrupted for local (manual) control at any time (except when in remote control with the lock–out state selected) by pushing a button on the front panel.

PROBES

Model: Two 94XX–P01 (×10,10 MΩ // 15 pF) probes supplied.

Probe calibration: 1 kHz square wave, 1 V p–p.

Probe power: Two rear–panel power outlets for use with active probes provide ± 15 V, + 5 V DC.

SELF TESTS

Auto–calibration ensures specified DC and time accuracy.

GENERAL

Temperature: 5 to 40° C (41 to 104° F) rated; 0 to 50° C (32 to 122° F) operating.

Humidity: < 80%.

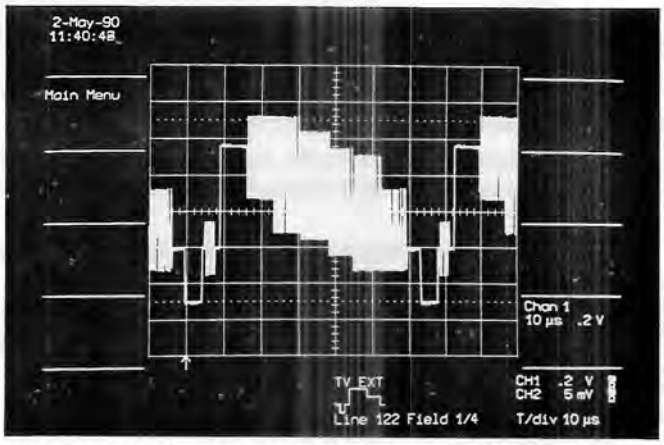
Power Required: 110 or 220 V AC, 45 to 440 Hz, 150 W.

Battery Backup: Lithium batteries maintain front–panel settings for 2 years.

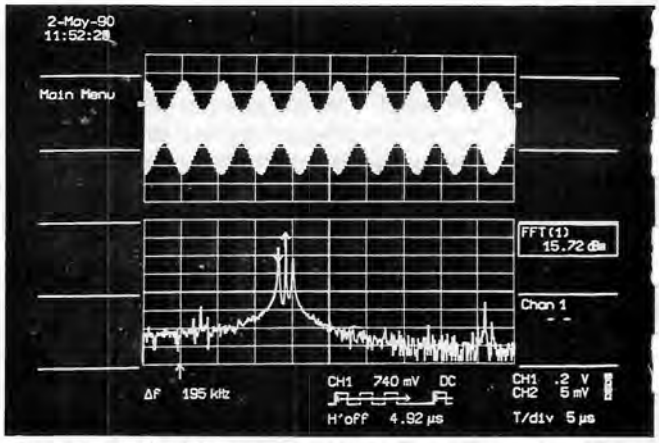
Dimensions: (HWD) 19.2 × 37 × 49.5 cm, (7 1/2 × 14 1/2 ×19 1/2 inches).

Weight: 13.5 kg (30 lb) net, 19 kg (42 lb) shipping.

Warranty: 2 years



The TV trigger allows selection of both line and field number on PAL, SECAM or NTSC signals.



The optional WP02 Spectrum Analysis Firmware allows the 9410 to compute a 1000–point FFT in less than a second. The picture above shows a modulated signal (top trace) analyzed in frequency domain. Side lobes 195 KHz from the fundamental frequency are clearly visible on the bottom trace.

applications or tracking timing violations. Other trigger features include HOLD–OFF by time or number of events, BI–LEVEL and INTERVAL modes of operation.

REMOTE CONTROL AND MASS STORAGE

High–speed GPIB, on–board processing and credit card storage facilities all add up to make the 9410 an ideal instrument for automated testing applications. For remote control, the 9410 offers both RS–232–C and GPIB interfaces. All front–panel controls and internal processing functions can be controlled. For applications where throughput is critical, the 9410's GPIB interface can be used to transfer hundreds of waveforms per second. Acquisition rates that most digital oscilloscopes cannot even match internally! The optional credit card system is ideal for applications requiring non–volatile storage or for field work. Up to 512K of information (waveforms or panel settings) can be stored on a single card.

SPECIFICATIONS

VERTICAL ANALOG SECTION

Bandwidth (– 3 dB):
@ 50 Ω: DC to 150 MHz for 5 mV/div to 2.5 V/div
DC to 125 MHz for 1 mV/div to 5 mV/div
@ 1 MΩ: DC to 125 MHz at probe (94XX–P01) tip.

Input impedance: 1 MΩ // 25 pF and 50 Ω ± 1%.

Channels: Two independent channels; standard BNC connector inputs.

Sensitivity range: 1 mV/div to 2.5 V/div; continuously variable up to 2.5 times the fixed setting. Fixed settings range from 1 mV/div to 2 V/div (in a 1, 2, 5 sequence). Sensitivity can be extended to 25 V/div using a D9010 High Impedance divider connected to the input BNLs.

Vertical expansion: Up to 5 times (with averaging, up to 10 times or 100 μV/div sensitivity).

Scale factors: Probe attenuation factors of ×1, ×10, ×100, ×1000 and ×10000 may be selected and are remotely programmable.

Offset: ±12 times the fixed sensitivity setting in 0.02 division increments up to ±12 V max.; ±24 div @ 5mV/div; ± 60 div @ 2 mV/div; ± 120 div @ 1 mV/div.

DC accuracy: ± 2% full scale for ≥ 5 mV/div;
± 3% for < 5 mV/div.

Bandwidth limiter: 15 MHz (– 3 dB) typical.

Max Input voltage: 250 V (DC + peak AC ≤ 10 kHz) at 1 MΩ, ± 5 V DC (500 mW) or 5 V RMS at 50 Ω.

VERTICAL DIGITAL SECTION

ADCs: One per channel, 8–bit flash.

Conversion rate: Up to 100 megasamples/sec for transients, up to 4 gigasamples/sec for repetitive signals, simultaneously on both channels.

Aperture uncertainty: ±10 psec.

Acquisition memories, Channels 1 and 2: Memories of 10 kilowords per channel can be segmented into 2, 5, 10, 20 or 50 blocks.

Reference memories, C and D: 10K, 16–bit word memories which store one acquired or processed waveform, or up to 50 segmented waveforms.

Function memories, E and F: Two 10K, 16–bit word memories for waveform processing.

Peak and glitch detection

Minimum and maximum peaks, as fast as 0.01% of the record length (minimum 10 nsec), are captured and displayed with 100% probability.

Using LeCroy's new FASTGLITCH trigger technique (see trigger section below), glitches faster than 5 nsec can be detected on all time–base settings.

HORIZONTAL SECTION

Time Base

Range: 2 nsec/div to 1000 sec/div.
Clock accuracy: ≤ ± 0.01%.
Interpolator resolution: 5 psec.
Trigger–time accuracy: 20 psec RMS.

Acquisition Modes

Random Interleaved Sampling (RIS) for repetitive signals from 2 nsec/div to 5 μsec/div.

Single shot for transient signals and repetitive signals from 50 nsec/div to 200 msec/div.

Roll for slowly–changing signals from 500 msec/div to 1000 sec/div.

Sequence mode divides the acquisition memory into 2, 5, 10, 20 or 50 segments.

Horizontal expansion: DUAL ZOOM mode allows two different signals or two different sections of the same signal to be expanded up to 200 times.

Trigger

Pre–trigger recording: Adjustable in 0.2% increments to 100% of full scale (grid width).

Post–trigger delay: Adjustable in 0.02 division increments up to 10,000 divisions.

External trigger input: 1 MΩ, < 25 pF, 250 V max. (DC + peak AC ≤ 10 kHz).

External trigger range: ± 20 V.

Rate: Up to 200 MHz.

Timing: Trigger timing (date and time) is listed in the memory status menu. The timing of subsequent triggers in sequence mode is measured with 0.1 sec absolute resolution, or nanosecond resolution relative to the time of the first trigger.

ORDERING INFORMATION

Oscilloscope and Options

Code	Description
9410	Digital Oscilloscope
9410WP01	Waveform Processing
9410WP02	FFT Processing

Oscilloscope Accessories

OM9410	Operator's Manual
9410–FC	Front Cover
9410–MC01	Card Reader + 128K Memory Card
9410–MC02	128K Memory Card
9410–MC04	512K Memory Card
CA9001	Camera (using Polaroid film) and Hood.
CA9002	Camera Adapter (35 mm) with Hood

Oscilloscope Accessories (cont'd)

DC/GPIB–2	2–meter GPIB Cable
DP9001	Digital Plotter, 8–pen A4 size
DP9003	Epson Printer
SG9001	High Voltage Protector
OC9001	Oscilloscope Cart
94XX–P01	10:1 Oscilloscope Probe
P9011	10:1/1:1 Oscilloscope Probe
P9100	100:1 Oscilloscope Probe
RM9400	Rackmount
TC9001	Transit Case
TC9002	Carrying Bag

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Finland: Labtronic OY, (80) 847 144
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New Zealand: E.C. Gough Ltd., (03) 798–740
Norway: Avantec AS (02) 630520
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Sweden: MSS AB, (0764) 68100
Taiwan: Topward El.Inst., Ltd., (02) 601 8801
Thailand: Measuretronix Ltd., (02) 374 2516
United Kingdom: LeCroy Ltd.,(0235) 533 114

LeCroy
Innovators in Instrumentation

LeCROY CORPORATE HEADQUARTERS

700 Chestnut Ridge Road
Chestnut Ridge, NY 10977–6499
Phone: (914) 425–2000
TWX: (710) 577–2832
Fax: (914) 425–8967

LeCROY EUROPEAN HEADQUARTERS

2, rue du Pré–de–la–Fontaine
P.O.Box 341
1217 Meyrin 1 – Geneva, Switzerland
Telephone: (022) 719–21–11
Telex: 41 90 58
Fax: (022) 782–39–15

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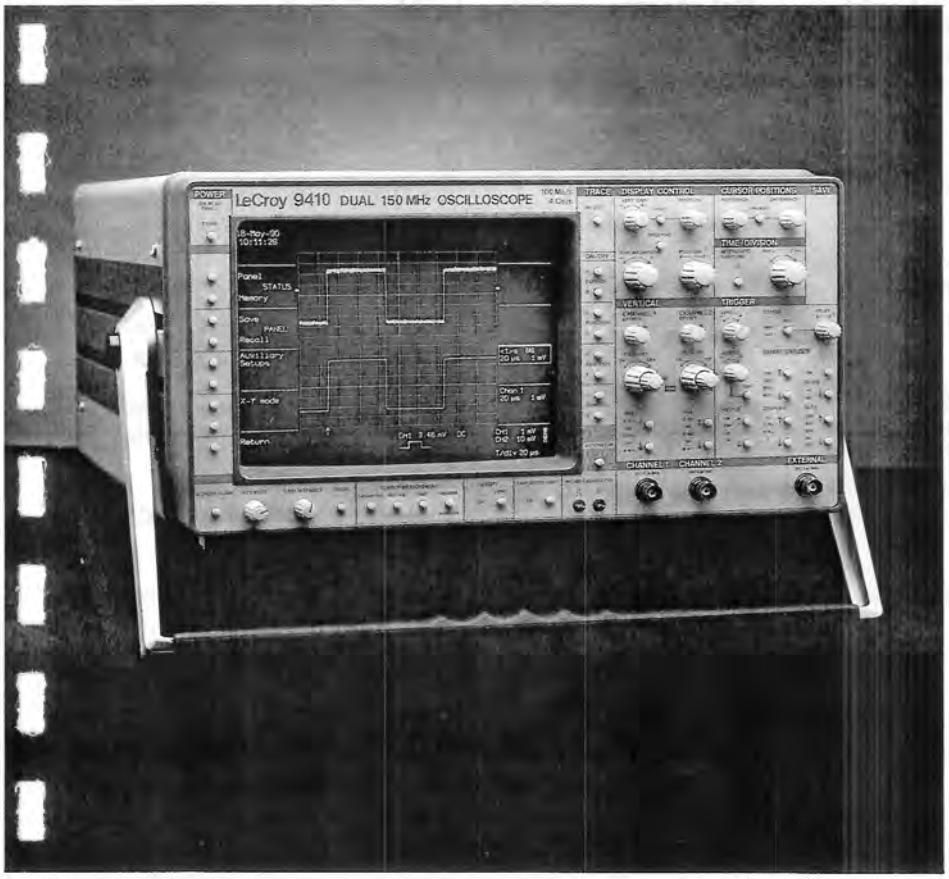
TDS 050/005

WAVEFORM PROCESSING PACKAGE
AVERAGING, MATHEMATICS, HIGH RESOLUTION

LeCroy

WP01 WAVEFORM PROCESSING FIRMWARE FOR MODEL 9410 DIGITAL OSCILLOSCOPE

9410 WP01



:dded as a factory option or retrofitted in the field, the WP01 Waveform Processing Package adds gh–speed averaging, filtering and mathematical capabilities to the Model 9410 digital oscilloscope.

- **Averaging – Summation and Continuous**
- **Arithmetic – incl. Addition, Subtraction, Ratio and Multiplication**
- **Functions – including Integration, Differentiation, Log, Exp, ABS and Square Root**
- **Extrema Mode – Storage of Extreme Positive and Negative Values**
- **Enhanced–Resolution Mode for 11–bit Performance**

FOR SIGNAL CHARACTERIZATION AND ANALYSIS

The LeCroy WP01 Waveform Processing package offers powerful routines that extend the processing capabilities of the Model 9410 Digital Oscilloscope. All processing is built in to eliminate the need for external computers and controllers. High–speed microprocessors are used to ensure that computed waveforms are displayed instantly on the screen. The package is fully programmable over the GPIB or RS–232–C interface and hard copies can be directly made on a wide range of digital plotters or printers.

FEATURES

Extensive Signal Averaging – Two operation modes:

- Summation averaging up to 1,000,000 waveforms.
- Continuous averaging with weighting factors up to 127.

Average speed up to 300,000 points/sec in summation averaging mode.

Offset Dithering – Improves the vertical resolution for low–noise measurements by several bits in summation averaging mode. Reduces the effect of ADC differential non–linearities.

Artifact Rejection – Rejects waveforms that exceed the dynamic range of the ADC to ensure statistical validity of summed average results.

Extrema Mode – Keeps track of time and amplitude drift by storing extreme positive and negative values, such as glitches, over a programmable number of sweeps.

Powerful Arithmetic – Processes identity, negation and reciprocal on single waveforms as well as addition, subtraction, multiplication or division on pairs of waveforms stored in the 9410's memory location CH1, CH2, A, B, C, D, E and F. Waveform data can be normalized by additive or multiplicative constants.

Mathematical Functions – Computes integration, differentiation, square, square root, absolute value, exponential and log on single waveforms stored in the 9410 memory locations CH1, CH2, A, B, C, D, E and F. Waveform data can be normalized by additive or multiplicative constants.

Enhanced Resolution – Allows filtering of the digitized signals, whether they are single–shot or repetitive, in order to increase the resolution of the displayed trace from 8 bits to 11 bits in steps of 0.5 bits.

Vertical Expansion – Provides vertical scale expansion by a factor of up to 10.

Chaining of Operations – Automatically chains two operations:
Example: F(E) = Average (CH1–CH2).

An indefinite number of operations can be performed sequentially, either manually or via remote control.

Remote Control – Controls remotely all front–panel settings, as well as all waveform processing options via either GPIB or RS–232–C interfaces.

Color Archiving – Copies screen in color using a wide range of digital plotters or printers.

FUNCTIONAL DESCRIPTION

The WP01 waveform processing package for the Model 9410 Digital Oscilloscope is optimized for processing signals in real time. A powerful 68020 microprocessor and a 68881 co–processor enable very rapid representation of results such as averages, integrations, exponentials and multiplications.

Waveform operations can be performed on live, stored, processed or expanded waveforms. They are selected through simple menus that allow functions to be chained together allowing more complex computations. For example, it is possible to perform the integration of an averaged waveform or the multiplication of a differentiated waveform.

All processing occurs in function memories E and F which may be displayed on the screen by simply pressing the appropriate function button. Processing is fully automatic and is simultaneous whenever more than one function has been selected.

SIGNAL AVERAGING

WP01 offers two powerful, high–speed averaging modes that can be used to reduce noise and improve the signal–to–noise ratio. Vertical resolution can be extended by several bits to improve dynamic range and increase the overall input sensitivity to as much as 100 μV/division.

Summed Averaging consists of the repeated addition (with equal weight) of recurrences of the selected source waveform. The number of acquisitions averaged can be selected between 2 and 1,000,000 sweeps with the accumulation automatically stopping when the number is reached. Signals exceeding the range of the oscilloscope's ADC can be automatically rejected to ensure valid summed averaging results.

The user may choose to "dither" the programmable offset of the input amplifier after each acquisition. Dithering uses slightly different portions of the ADC for successive waveforms so that the differential non–linearities are also averaged. As a result, in low–noise applications, the measurement precision and dynamic range are improved.

Continuous Averaging, sometimes called exponential averaging, is the repeated weighted average of the source waveform with the previous average. Averaging goes on indefinitely with each new acquisition and the effect of previous waveforms gradually tends to zero. Relative weighting factors can be chosen from 1:1 to 1:127. The method is particularly useful for monitoring noisy signals which may change slowly over a period of time.

ENHANCED RESOLUTION

The WP01 package provides a selective filtering technique that improves vertical resolution for reduced bandwidth applications. By effectively removing high–frequency noise, with digital smoothing functions, waveforms can be analyzed with resolution from 8 to 11 bits. The technique can be used with both single–shot and repetitive signals and provides an ideal method for smoothing transient phenomena.

EXTREMA MODE

Tracking rare glitches or monitoring signals drifting in time and amplitude is made easy with EXTREMA mode. EXTREMA waveforms are produced by repeatedly comparing acquisitions of a source waveform with a stored waveform that contains previous maximum and/or minimum excursions. Whenever a given data point of a new acquisition exceeds the existing data point of the stored waveform, the old data point is replaced by the new. In this way the envelope of all waveforms is accumulated for up to a maximum of 1,000,000 sweeps.

ARITHMETIC

WP01 offers basic arithmetic operations such as addition, subtraction, division and multiplication. These arithmetic functions can be performed on any source waveform on a point by point basis. Different vertical gains and offsets of the source waveforms are automatically taken into account in the computed result.

MATHEMATICAL FUNCTIONS

Functions including differentiation, integration, square, square root, logarithm (base 10 and e), exponential and absolute value may be performed on any source waveform. The waveforms may be multiplied by a constant factor or offset by a constant. Arithmetical and mathematical functions can also be chained together to construct more complex processing routines.

SPECIFICATIONS

SUMMATION AVERAGING

Number of sweeps: 1 to 1,000,000.
Number of input points: 50 to 10,000.
Offset dithering: only on acquisition channels; ON /OFF.
Artifact rejection: ON/OFF.
Vertical expansion: 10 × maximum.
Maximum sensitivity: 500 μV/div after vertical expansion.
Speed: up to 200,000 points/sec.

CONTINUOUS AVERAGING

Possible weighting factors: 1:1, 1:3, 1:7, 1:15, 1:31 and 1:127.
Number of input points: 50 to 10,000.
Vertical expansion: 10 × maximum.
Maximum sensitivity: 100 μV/div after vertical expansion.

ARITHMETIC

Identity, negation and reciprocal of any waveform. Addition, subtraction, multiplication, and ratio on any two waveforms.
Number of input points: 50 to 10,000.
Multiplicative constant on first input: from 0.001×10^{-33} to 999.999×10^{33}.
Additive constant on first input: from -999.999×10^{33} to 999.999×10^{33}.
Vertical expansion: 5 × maximum.

FUNCTIONS

Integration, differentiation, square, square root, logarithm and exponential (base e and 10).

Number of input points: 50 to 10,000.
Multiplicative constant on input: from 0.001×10^{-33} to 999.999×10^{33}.
Additive constant on input: from -999.999×10^{33} to 999.999×10^{33}.
Vertical expansion: 5 × maximum.

ENHANCED RESOLUTION

Choice of four low–pass filters for vertical resolution improvement from 8 to 11 bits at reduced bandwidth.

Vertical expansion: 10 × maximum.
Maximum sensitivity: 100 μV/div after vertical expansion.
Maximum bandwidth (for 11 bit resolution):
RIS mode: 32 MHz.
Single–shot mode: 800 kHz
Speed: from 50,000 points/sec up to 200,000 points/sec.

EXTREMA

Logs all extreme values of a waveform over a programmable number of sweeps. Maxima and minima can be displayed together, or separately by choosing ROOF or FLOOR traces.
Number of sweeps: 1 to 1,000,000.
Number of input points: 50 to 10,000.
Glitches as short as 0.01% of the time base down to 10 nsec are displayed.
Vertical expansion: 5 × maximum.

CHAINING OF OPERATIONS

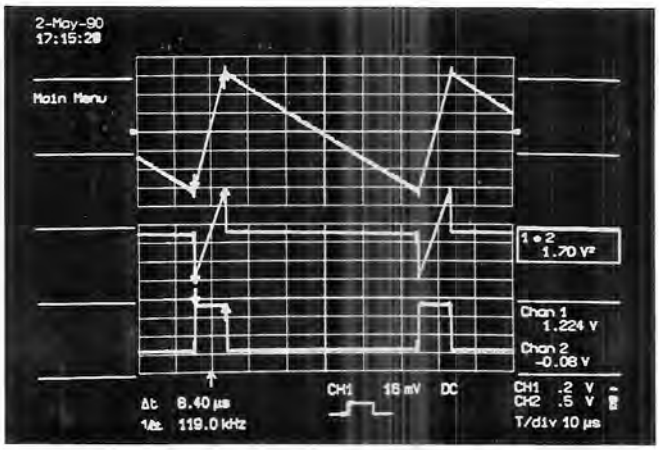
Two functions can be automatically chained using Functions E and F. Using memory C and D for intermediate results, any number of operations can be chained manually or via remote control.

REMOTE CONTROL

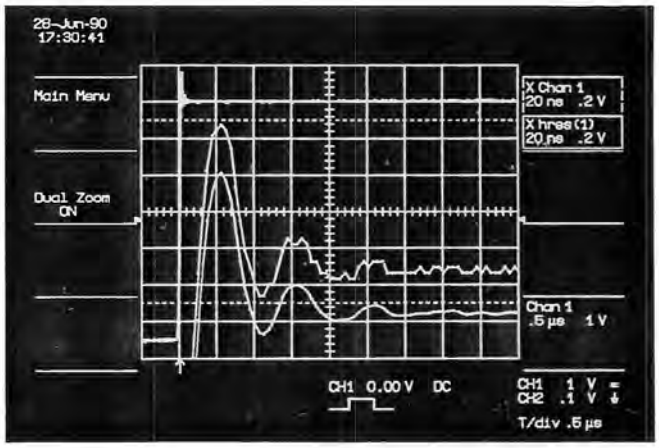
All controls and waveform processing functions are fully programmable using the oscilloscope's GPIB or RS–232–C interfaces. Simple English–like commands are used.

STORED FRONT PANELS

Up to 7 front–panel setups, including WP01 settings, can be stored in non–volatile memory and recalled using the menu buttons at the left side of the screen or via remote control.



Whether it's sophisticated functions (like integration, differentiation or logarithm) or simple mathematics (like addition, subtaction and multiplication), the WP01 package can calculate the results with just a touch of a button. Above, a ramp (top trace) and a square wave (lower trace) are multiplied together. The result is shown in the middle trace complete with cursor readout.



The WP01 package performs digital filtering techniques that allow improved vertical resolution and sensitivity. The above example shows the ringing on a step response (top trace) expanded 5 times vertically and 25 times horizontally (middle trace). The lower trace shows the same expansion but with 9–bit resolution. The second and third oscillations are now clearly visible.

LeCroy

Innovators in Instrumentation

LeCROY CORPORATE HEADQUARTERS
700 Chestnut Ridge Road
Chestnut Ridge, NY 10977–6499
Telephone: (914) 425 2000
TWX:(710) 577–2832
Fax: (914) 425–8967

LeCROY EUROPEAN HEADQUARTERS
2, rue du Pré–de–la–Fontaine
P.O. Box 341
1217 Meyrin 1–Geneva, Switzerland
Telephone: (022) 719–21–11
Telex: 41 90 58
Fax: (022) 782–39–15

Other sales and service representatives throughout the world.

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