Instrument Architecture Overview

PROCESSORS

The Waverunner central processing unit (CPU), a PowerPC™ microprocessor, performs the oscilloscope's computations, and controls its operation. A range of peripheral interfaces allow you to control remotely, store waveforms and other data, and make hard copies. A support processor constantly monitors the front panel controls. The Waverunner transfers data to display memory for direct waveform display, or stores it to reference memories for fast data processing.

ADCs

Each Waverunner channel has an 8-bit Analog-to-Digital Converter (ADC). The instrument's ADC architecture is designed to give excellent amplitude and phase correlation, maximum analog-to-digital conversion performance, large record lengths, and superior time resolution.

MEMORIES

Waverunner acquisition memories simplify signal acquisition by producing waveform records that allow detailed analysis over large time intervals. There are four memories for temporary storage, and four more for waveform zooming and processing.

RIS

The Waverunner oscilloscope captures and stores repetitive signals at a maximum Random Interleaved Sampling (RIS) rate of 25 GS/s. This advanced digitizing technique enables measurement of repetitive signals with an effective sampling interval of 100 ps, and a measurement resolution of up to 10 ps.

TRIGGER SYSTEM

You can control Waverunner triggering to a highly specialized degree in accordance with waveform characteristics and chosen trigger conditions. The trigger source can be any of the input channels, line (synchronized to scope's main input supply) or external. The coupling is selected from AC, LF REJect, HF REJect, HF, and DC; the slope from positive and negative. Waverunner SMART Trigger offers a wide range of sophisticated trigger modes matched to special trigger conditions and sets of conditions.

AUTOMATIC CALIBRATION

The Waverunner's automatic calibration ensures an overall vertical accuracy of typically 1% of full scale. Vertical gain and offset calibration, and horizontal (time) resolution take place each time you change the volts per division setting. Periodic and temperature dependent auto-calibration ensures long-term stability at the current setting.

DISPLAY SYSTEM

You control the display's interactive, user-friendly interface using push buttons and knobs. Display as many as eight different waveforms at once on eight separate grids. The parameters controlling signal capture are simultaneously reported. The Waverunner displays internal status and measurement results, as well as operational, measurement, and waveform analysis menus.

The 8.4-inch color flat panel TFT LCD screen displays waveforms and data by means of advanced color management. Overlap mixing and contrast enhancement functions ensure that overlapping waveforms remain distinct at all times. Preset and personal color schemes are available.

The Analog Persistence function offers display attributes of an analog instrument with all the advantages of digital technology. The Full Screen function expands waveform grids to fill the entire screen.
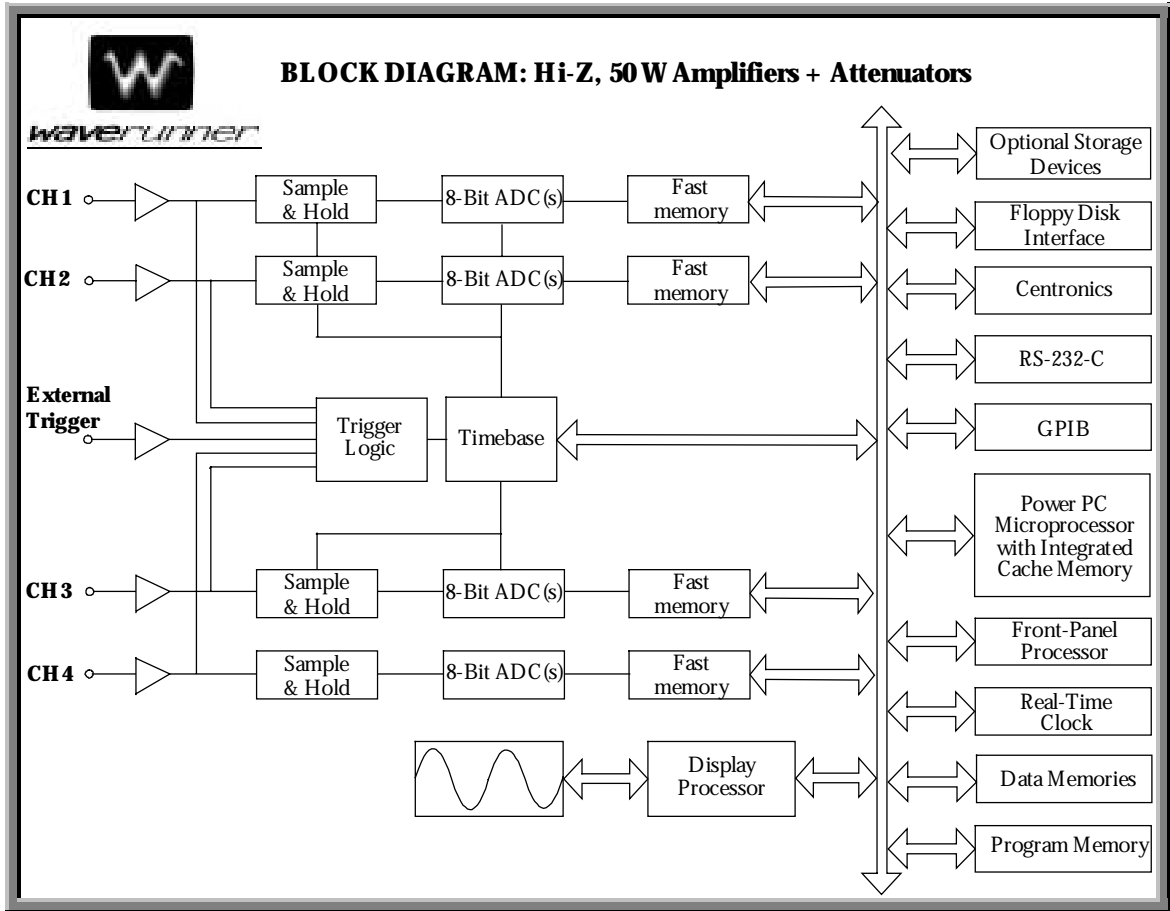
A hard copy of the screen can be easily produced by pressing the front panel PRINT SCREEN button.

INTERFACE AND PANEL SETUPS

Although the Waverunner is a truly digital instrument, the front panel layout and controls are similar to those of an analog oscilloscope. Rapid response and instant representation of waveforms on the high resolution screen add to this similarity. Four front panel setups can be stored internally, and recalled directly or by remote control, thus ensuring rapid front panel configuration. When power is switched off, the front panel settings are automatically stored for recall when the scope is next powered on.

REMOTE CONTROL

The Waverunner has also been designed for remote control operation in automated testing and computer aided measurement applications. You control the entire measurement process — cursor and pulse-parameter settings, dynamic modification of front panel settings, and display organization — through the rear panel industry standard GPIB (IEEE-488) and standard RS-232-C ports. See Chapter 12, "Use Waverunner with PC," of this manual and the *Remote Control Manual*.

BLOCK DIAGRAM: Hi-Z, 50 W Amplifiers + Attenuators

*wave**runner***

CH 1	Sample & Hold → 8-Bit ADC(s) → Fast memory
CH 2	Sample & Hold → 8-Bit ADC(s) → Fast memory
External Trigger	Trigger Logic → Timebase
CH 3	Sample & Hold → 8-Bit ADC(s) → Fast memory
CH 4	Sample & Hold → 8-Bit ADC(s) → Fast memory

Display Processor

- Optional Storage Devices
- Floppy Disk Interface
- Centronics
- RS-232-C
- GPIB
- Power PC Microprocessor with Integrated Cache Memory
- Front-Panel Processor
- Real-Time Clock
- Data Memories
- Program Memory

LT22X, LT32X, and LT34X models

Specifications

MODELS

Waverunner LT342/LT322 Series: Two channels

Waverunner LT344/LT244/LT364 Series: Four channels

NOTE: Specifications are subject to change without notice. For the most up-to-date information, consult the latest data sheets, available from LeCroy offices.

⚠ ACQUISITION SYSTEM

Bandwidth (–3dB): LT342/LT344/LT322/LT364: 500 MHz; **LT224:** 200 MHz. Bandwidth @ 50 Ω and at probe tip with PP006. Bandwidth Limiter at 25 MHz (LT224), and 25 MHz or 200 MHz (other models) can be selected for each channel.

Input Impedance: 50 Ω ± 1.0%; 1 MΩ ± 1.0% // 12 pF typical (using PP006 probe)

Input Coupling: 1 MΩ: AC, DC, GND; 50 Ω: DC, GND

⚠ **Max Input:** 50 Ω: 5 V rms; 1 MΩ: 400 V max (peak AC ≤ 5 kHz + DC)

Single Shot Sampling Rate: LT342/LT344/LT364: 500 MS/s; **LT224/LT322:** 200 MS/s

Acquisition Memory (4 channel): LT342L/LT344/LT364L: 1 M; **LT342/LT344/LT364:** 250k points per channel; **LT224/LT322:** 100k points per channel; 1 M points per channel on L models

Acquisition Memory (2 channel): LT364: 500k; **LT364L:** 2 M

Vertical Resolution: 8 bits

Sensitivity: 2 mV to 5 V/div fully variable; 10 V/div

DC Accuracy: ± 1.5% (0.5% of full scale)

Offset Range:

    2 mV to 50 mV/div: ± 1 V

    100 mV to 500 mV/div: ± 10 V

    1 V to 10 V/div: ± 100 V

Interleaved Channels: LT364 Series: 2

ACQUISITION MODES			
MODE	**TIMEBASE SETTING**	**MAXIMUM RATE**	**DESCRIPTION**
Single Shot	5 ns to 1000 s/div (LT364)	1 GS/s (LT364)	One ADC per channel
	10 ns to 1000 s/div (LT342/LT344)	500 MS/s	
	20 ns to 1000 s/div (LT224/LT322)	200 MS/s (LT224)	
Repetitive	1 ns to 5 µsec/div (LT342/LT344/LT364)	25 GS/s	Random Interleaved Sampling (RIS)
	5 ns to 5 µsec/div (LT224/LT322)	10 GS/s	
Sequence			
LT342/LT344/ LT364	2–1000 segments	500 MS/s	Stores Multiple Events with time stamp in segmented acquisition memories
LT224/LT322	2–400 segments	500 MS/s 200 MS/s (LT224)	Stores Multiple Events with time stamp in segmented acquisition memories
LT342L/LT344L /LT364L	2–4000 segments	500 MS/s	Stores Multiple Events with time stamp in segmented acquisition memories
Roll	≤500 kpts: 500 ms to 1000s/div	100 kS/s	Waveform slowly rolls across display when used with slow time bases.
	≥500 kpts: 1 s to 1000 s/div		

TIMEBASE SYSTEM

Timebases: Main and up to four zoom traces simultaneously

Time/Div Range: 1 ns/div to 1000 s/div

Clock Accuracy: ≤ 10 ppm

Interpolator Resolution: 5 ps

External Clock: LT342/LT344/LT322: ≤ 500 MHz; **LT224:** ≤ 200 MHz; 50 Ω, or 1 MΩ impedance

TRIGGERING SYSTEM

Modes: NORMAL, AUTO, SINGLE and STOP

Sources: Any input channel, External, EXT 10 or line; slope, level, coupling unique to each except line.

Coupling Modes: DC, AC, HF, HFREJ, LFREJ (reject frequency 50 kHz typical)

Pre-Trigger Recording: 0–100% of horizontal time scale

Post Trigger Delay: 0–10 000 divisions

Holdoff by Time or Events: Up to 20 s or from 1 to 99 999 999 events

Internal Trigger Range: ± 5 div

Maximum Trigger Frequency: Up to 500 MHz with HF coupling

External Trigger Input: ± 0.5 V, ± 5 V with Ext 10; max input same as input channels

SMART TRIGGER TYPES (ALL MODELS)

Signal or pulse width: Triggers on glitches down to 2 ns. Pulse widths are selectable between < 2.5 ns to 20 s.

Signal interval: Triggers on intervals selectable between 10 ns and 20 s.

TV: Triggers on line (up to 1500) and field 1 or 2 (odd or even) for PAL (SECAM), NTSC, or non-standard video (**LT364 Series:** a choice of 1, 2, 4, or 8 fields is offered).

State/Edge qualified: Triggers on any input source only if a given state (or transition) has occurred on another source. Delay between sources is selectable by time or number of events.

Dropout: Triggers if the input signal drops out for longer than a selected time-out between 25 ns and 20 s.

Window: Triggers when the signal crosses the window boundaries, which extend above and below the selected trigger level. A trigger event will occur when the signal leaves this window region in either direction and passes into the upper or lower region. The next trigger will occur when the signal again passes into the window region.

SMART TRIGGER TYPES (LT364 SERIES ONLY)

Pattern (5 inputs): Enables triggering on a logical combination of the five inputs CH 1, CH 2, CH 3, CH 4 and EXT. This combination, called a pattern, is defined as the logical AND of trigger states.

AUTOSETUP

Automatically sets timebase, trigger, and sensitivity to display a wide range of repetitive signals.

Vertical Find: Automatically sets sensitivity for the selected input signal

PROBES

Model PP006: PP006 with auto-detect: 10:1, 10 MΩ; one probe per channel

Probe System: ProBus Intelligent Probe System supports active, high voltage, current, and differential probes, and differential amplifiers

COLOR WAVEFORM DISPLAY

Type: Color 8.4-inch flat panel TFT LCD with VGA, 640 x 480 resolution

Screen Saver: Display blanks after 10 minutes

Real Time Clock: Date, hours, minutes, and seconds displayed with waveform

Number of Traces: Maximum eight on LT344, LT224 Series, six on LT342, LT322 Series; simultaneously display channel, zoom, memory, and math traces

Grid Styles: Single, Dual, Quad, Octal, XY, Single+XY, Dual+XY; Full Screen gives enlarged view of each style

Waveform Display Styles: Sample dots joined or dots only — regular or bold

ANALOG PERSISTENCE DISPLAY

Analog Persistence and Color Graded Persistence: Variable saturation levels; stores each trace's persistence data in memory

Trace Display: Opaque or transparent overlap

ZOOM EXPANSION TRACES

Style: Display up to four zoom traces

Vertical Zoom: Up to 5x expansion, 50x with averaging

Horizontal Zoom: Expand to 2 pts/div, magnify to 50 000x

Autoscroll: Automatically scan and display a captured signal

RAPID SIGNAL PROCESSING

Processor: 96 MHz Power PC

LT 342/LT 322	LT 364/LT 344/LT 224	LT 342L	LT 364/LT 344L
16 MBYTES	16 MBYTES	32 MBYTES	32 MBYTES
64 MBYTE SYSTEM MEMORY OPTIONAL FOR ALL MODELS			

INTERNAL WAVEFORM MEMORY

Waveform: M1, M2, M3, M4; memory length equal to acquisition memory

Zoom and Math: A, B, C, D; memory length equal to acquisition memory

Memories M1–4 and A–D store full-length waveforms with 16 bits/data point

SETUP STORAGE

For front panel and instrument status: Four non-volatile memories and floppy drive are standard; hard drive and memory card are optional

MATH TOOLS

Simultaneously perform up to four math processing functions; traces can be chained together to perform math on math. Standard functions: add, subtract, multiply, divide, negate, identity, summation, averaging to 1000 sweeps, ERES low-pass digital filters for 11-bit vertical resolution, FFT of 50 kpoint waveforms, Extrema for displaying envelope roof and floor, physical units, rescale (with units), sin x/x, resample (deskew).

MEASURE TOOLS

Cursor Measurements:

> **Relative Time:** Two arrow cursors measure time and voltage differences relative to each other with a resolution of ± 0.05% full scale.

> **Relative Amplitude (Voltage):** Two horizontal bars measure voltage differences at ± 0.2% fs resolution.

> **Absolute Time:** Cross-hair marker measures time relative to trigger and voltage with respect to ground.

> **Absolute Amplitude (Voltage):** A horizontal reference line cursor measures voltage with respect to ground.

Automated Measurements: Display any five parameters together with their average, high, low and standard deviations.

Pass/Fail: Test any five parameters against selectable thresholds. Limit testing is performed using masks created on the scope or on a PC. Setup a pass or fail condition to initiate actions such as hardcopy output, save waveform to memory, GPIB SRQ, or pulse out.

EXTENDED MATH AND MEASUREMENTS OPTION

Adds math and advanced measurements for general purpose applications. Math Tools is expanded to include all standard math plus integration, derivative, log and exponential (base e and base 10), square, square root, absolute value, plus data log when using the trend function.

WAVEANALYZER OPTION

Adds math processing to include FFTs of 1 Mpoint waveforms, power spectrum density, spectrum averaging, waveform averaging to one million sweeps, continuous averaging, waveform histograms, and histogram parameters. Includes the Extended Math and Measurement option.

SPECIAL APPLICATION SOLUTIONS

Jitter and Timing Analysis (JTA): Precision cycle-to-cycle timing measurements with enhanced accuracy, histograms on persistence traces, persistence to waveform tracing and full statistical analysis.

PowerMeasure™: A complete solution for the power conversion engineer. Includes timing deskew of voltage and current, and rescale to electrical units.

INTERFACE

Remote Control: Full control via GPIB and RS-232-C*

Floppy Drive: Internal, DOS format, 3.5" high density

PC Card Slot: Supports memory and hard drive cards

External Monitor Port: 15-pin D-Type VGA compatible*

Centronics Port: Parallel printer interface*

Internal graphics printer (optional): 25 mm/s max, 112 mm paper width; provides hardcopy output in < 10 seconds

Ethernet (optional): 10BASE-T

⚠ * Shielded cables of less than 3 m length are required to conform with EMC Directive 89/336/EEC.

OUTPUTS

Calibrator signal: 500 Hz–1 MHz square wave, −1.0 to + 1.0, test point, and ground lug on front panel

Control signals: Choice of trigger ready, trigger out, or Pass/Fail status; TTL levels into 1 MΩ at rear panel BNC (output resistance 300 Ω ± 10%)

⚠ **GENERAL**

Operating Conditions: Temperature 5–40° C; Humidity 80% RH max (non-condensing) at 40° C; Altitude ≤ 2000 m

Shock and Vibration: Conforms to selected sections of MIL-PRF-28800F, Class 3

Power Requirements: 90–132 V AC and 180–250 V AC; 45–66 Hz; automatic AC voltage selection; Power dissipation: 230 VA max

Dimensions (HWD): 210 mm x 350 mm x 300 mm (8.3" x 13.8" x 11.8"); height excludes scope feet

Weight: 8 kg (18 lbs)

Warranty and Calibration: Three years; calibration recommended yearly

Certifications: CE, UL and cUL

CE Declaration of Conformity: The oscilloscope meets requirements of the EMC Directive 89/336/EEC for Electromagnetic Compatibility and Low Voltage Directive 73/23/EEC for Product Safety.

EMC Directive	EN61326-1: 1997
	EMC requirements for electrical equipment for measurement, control, and laboratory use.

Electromagnetic Emissions:	EN 55011: 1991, Class A	Radiated and conducted emissions
	EN 61000-3-2: 1995	Harmonic Current Emissions
	EN 61000-3-3: 1995	Voltage Fluctuations and Flickers

Warning: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Electromagnetic Immunity:	ENV 50204: 1995	900 MHz Keyed Carrier RF Field
	EN 61000-4-2: 1995	Electrostatic Discharge
	EN 61000-4-3: 1996*	RF Radiated Electromagnetic Field
	EN 61000-4-4: 1995*	Electrical Fast Transient/Burst
	EN 61000-4-5: 1995*	Surges
	EN 61000-4-6: 1996*	RF Conducted Electromagnetic Field
	EN 61000-4-8: 1994	Power Frequency Magnetic Field
	EN 61000-4-11: 1994**	Mains Dips and Interruptions

* Meets Performance Criteria "B" limits — at certain test levels, during the disturbance, product undergoes a temporary degradation or loss of function of performance which is self recoverable.

** Meets Performance Criteria "C" limits — at certain test levels, during the disturbance, product undergoes a temporary degradation or loss of function of performance which requires operator intervention or system reset.

Low Voltage Directive:	EN 61010-1: 1993 + Amd.2: 1995
	Safety requirements for electrical equipment for measurement, control, and laboratory use.
	The oscilloscope has been qualified to the following EN 61010-1 category: Installation (Overvoltage) Category II.
	Pollution Degree 2

UL and cUL Certifcations:	UL Standard: UL 3111-1
	Canadian Standard: CSA-C22.2 No. 1010.1-92

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