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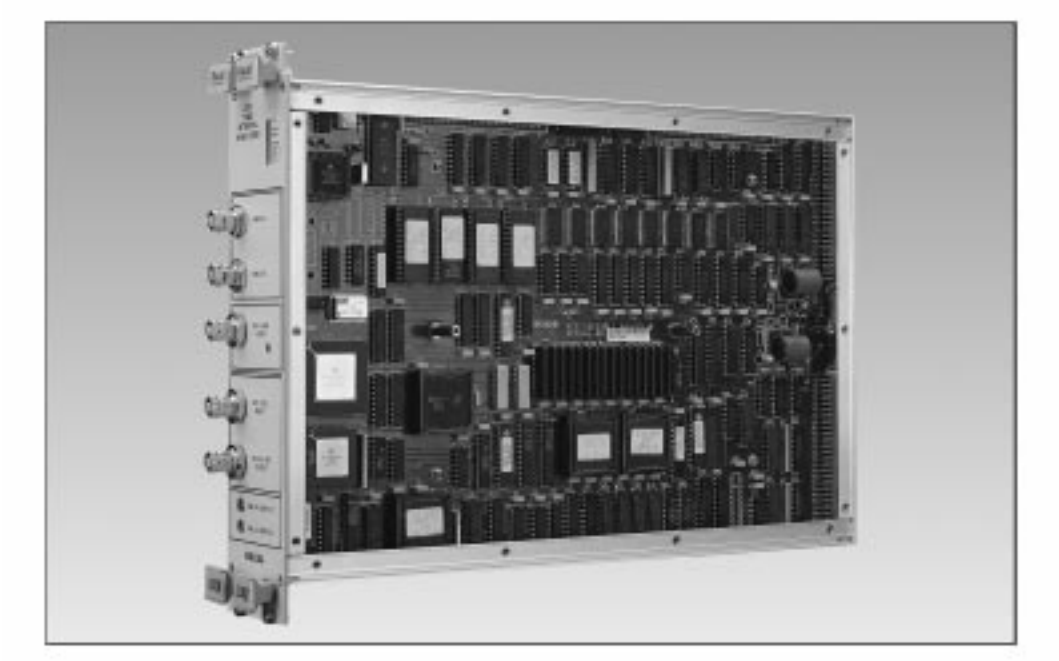
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8 Picosecond Time Interval Analyzer Model 2351/2351EMD



- **Time Interval, Period, Rise/Fall Time, Pulse Width, Duty Cycle, Slew Rate and Phase Measurements**
- **Oscillator Stability and Jitter Characterization**
- **Comprehensive Event Capture Capability**
- **8ps Resolution for Verification of Minute Timing Changes**
- **CIIL (Opt. 02) and Excess Modulation Detection (EMD) Optional**

High Resolution Time and Frequency Measurement
The advent of high-speed devices and sophisticated systems has increased the need to make very rapid measurements in real time. In addition, requirements for increased production throughput create the need for rapid results analysis as well as easy-to-read data output formats. The Racal Instruments Model 2351 meets these challenges by offering high-speed data capture performance, sophisticated analysis capability and a broad selection of formats for data output.

Continuous Precision Measurement
Fast output of high-speed measurement data has been one of the most difficult tasks for universal counter-timers to provide due to the instruments' dead time between measurements. Measurement cycles can be missed while the instrument is processing, formatting and loading each individual measurement for display.

Real-time characterizations can be made of swept or chirped radar signals, oscillator stability, and high-speed ECL pulses for verification of signal integrity in high-speed data transfers.

The 2351 can store 8k events per channel. Each data point is time-stamped, so real-time sequences of events are captured for analysis. If events occur at a rate greater than they can be stamped, the 2351 records the number of events and the amount of elapsed time between each measured edge.

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High Speed Measurement
The 2351 makes high speed measurements by capturing events at rates up to 5MHz on 250MHz signals. Measurements such as pulse width, duty cycle, and rise and fall times are set up automatically.

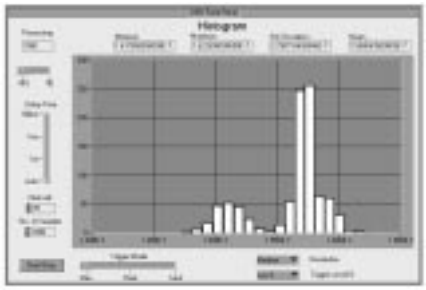
Built-in Analysis
In addition, the 2351 analyzes captured events and processes the results. Statistic results of samples, such as variance are computed automatically, reducing the processing time required by the host controller.

Single-shot resolution of each measurement is selectable at 200ps, 50ps or 8 ps. This allows precise characterization of signal jitter as well as phase shift on RF signals. An external arm input provides a versatile tool for arming complex measurements. This permits selection of pulses of interest, eliminating the need to fill memory space with unwanted data.

Jitter Characterization
The flexible arming capabilities of the 2351 enhance testing of magnetic media. Signal components may be selected to maximize read rates without compromising the integrity of the test setup. Time intervals up to 250MHz can be captured and measured. High resolution data such as read/write media and head noise can be statistically analyzed for peak, mean and variance by selecting signals of interest and arming the analyzer to start and stop on specific data points.

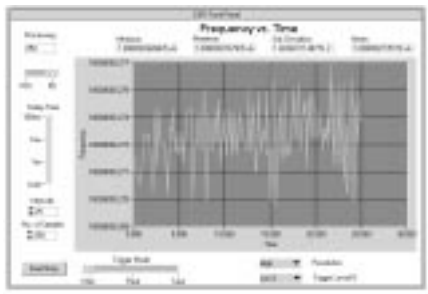
The Block and Sample techniques of the 2351 permit this data to be compared over several runs of a test. In this case, running totals are kept, and repeated arrays plotted over time. This data can then be manipulated to extract the read and write noise independent of the other system noise sources.

Oscillator Stability
To quantify frequency variation such as phase noise or random modulation on frequency sources, results from consecutive measurements can be summed. By removing the dead time between measurements, the 2351 allows analysis of the complete waveform. The 2351 also permits single-shot frequency changes to be correlated with unwanted aberrations such as overshoot, ringing and settling time. Systematic and continuous changes such as drift rate, as well as unwanted phenomena caused by frequency shifting, can be observed.



Symmetry of distribution can be displayed to permit extraction of timing patterns, jitter and noise in magnetic media and digital communications systems.

Agile Radio Testing
The 2351 also provides a number of benefits for agile radio testing. A time stamp and event stamp are provided for each signal in the measurement train, allowing correlation of the signal characterization to real time. This permits extraction of modulation on the hopping carrier for analysis and verification. The histogram display of the distribution can also be analyzed for flatness.



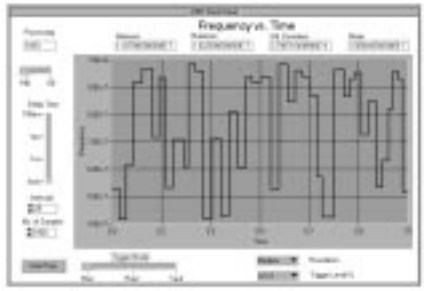
Frequency drift of 1MHz source over 25 seconds. Both long-term drift & short-term stability can be extracted.

Optional EMD Algrorithm
The Model 2351/EMD couples the continuous measurement, high-resolution performance of a the 2351 with a patented, built-in, digital signal processing algorithm, providing rapid, accurate characterizations of swept, pulsed or CW signals.

The following paragraphs highlight features of the 2351/EMD which includes the following features:

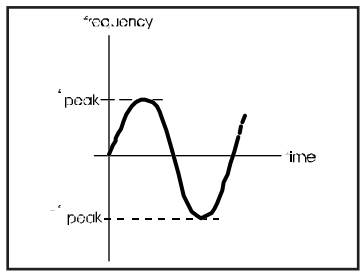
- Built-in Algorithm for Excess Modulation
- Automates Production of Swept Oscillators
- Measures VC, Rubidium Vapor Oscillator and DDS Non-linearities
- Measures Short-term Stability of CW Signals
- Calculates: Sweep Rates, Actual Carrier, Peak-to-Peak Non-linearities, Carrier Drift Rates (Short-term),Non-linearities as a Function of Time

Discrimination EMD Mode
In the Discrimination (or CW) Mode, the signal under test is digitally discriminated and filtered. The resultant output can be graphed as a linear representation of the frequency modulation (as a function of time) of the input signal. In addition, the algorithm automatically calculates the carrier frequency to be used by the algorithm as a reference. This is useful when analyzing FM drift or offset.



Frequency profile of an agile radio over time. Absolute frequencies at each time can be recovered, as well as dwell time and switching speed.

Swept Analysis EMD Mode
In the Swept Analysis or Ramp Mode, the algorithm digitally models and analyzes the swept portion of the signal. This is accomplished by dividing the signal under test into four parts: pre-sweep carrier, sweep, retrace and post-sweep carrier. Each of these parts is then analyzed to provide the user with the required data, which includes the short term drift rate of the carrier, the calculated sweep rate, the peak-to peak non-linearity and absolute carrier frequency.



Typical display of sinusoidally modulated carrier with the carrier removed.

Linearity Verification Speeds Chirped Radar Testing
The continuous measurement capabilities of the 2351 enhance the analysis of radar signals. The linearity of the ramp in a swept radar system can be analyzed, and events inside a chirp can be captured for verification. The EMD option manipulates the data points inside the 2351 in order to analyze modulation patterns, and detect anomalies of specific types of radar.

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Automated Performance
The EMD algorithm uses the high resolution time stamped data captured by the 2351 for each edge of the signal under test. In Swept Analysis Mode, the system processes data by finding the beginning and ending of a sweep, if it is present, and calculating a mathematical model of the ideal waveform. The peak-to-peak modulation about that signal is extracted using the mathematical model computed by the system and referencing it to the actual captured signal. The non-linearity of the excess modulation can also be measured.

Compact Performance with EMD Option
By embedding a powerful algorithm into the compact, high performance model 2351 Time Interval Analyzer, an easy to use instrument is created that provides complex information about signal modulation and drift. This instrument provides all of the capability that previously required several rack-and-stack instruments and a computer by providing data which is quickly and easily captured, manipulated and displayed.

2351/2351EMD Specifications

AUTOMATIC MEASUREMENTS

(Actual measurement resolution for the following automatic functions depends on the signal, the resolution mode (8ps, 50ps or 200ps), the number of measurements averaged, internal jitter and trigger errors. Please refer to the 2351 Instruction Manual to determine resolution for your exact application. For accuracy considerations, RES is the actual measurement resolution, TBE is the Timebase Error which depends on the frequency reference used, TE is trigger level timing error and SE is the error due to internal time delays.)

Frequency (FREQ)
Range: 0 to 250MHz
Accuracy: ±(3 x RES + TBE x FREQ)

Period (PER)
Range: 4ns to 8s
Accuracy: ±(3 x RES + TBE x PER)

Time Interval (TI)
Range: 2ns to 8s
(T1 Mode): 0 to 8ns (±T1 Mode)
Accuracy: ±(3 x RES + TBE x TI + TE + SE)

Rise/Fall Time (RFT)
Range: 2ns to 1ms
Accuracy: ±(3 x RES + TBE x RFT + TE + SE)

Pulse Width (PW)
Range (autotrig): 2ns to 1ms
Range (man. trig): 2ns to 8s
Accuracy: ±(3 x RES + TBE x PW +TE + SE)

Duty Cycle (DC)
Range: 0% to 100%
Repetition Rate (autotrig): 1kHz to 100MHz
Repetition Rate (man. trig): 0kHz to 250MHz
Accuracy: ±(3 x RES + [1+PW/PER]/PER x 100% x [TE + SE])

Slew Rate (SR)
Range: 200V/s to 1GV/s
Transition Time Range: 2ns to 1ms
Signal Height (max.): 300mV$_{p-p}$ x Atten.
Accuracy: ±(3 x RES + [TBE x TT+ TE + SE]/TT x SR + TLA/TT)
where TT is Signal Transition Time and TLA is Trigger Level Accuracy

Phase
Range: 0° to 360°
Repetition Rate (auto trig): 1kHz to 100MHz
Repetition Rate (man. trig): 0 to 250MHz
Accuracy: ±(3 x RES + [1+TI/PER]/PER x 360 x [TE + SE])

Totalize
Frequency Range: 1Hz to 250MHz
Gate Source: A by B, B by A, A or B by Time
Resolution and Accuracy: ±1 count

Peak Signal
Frequency Range: 1kHz to 100MHz
Amplitude Range: 1mV$_{p-p}$ to 4V$_{p-p}$
Resolution: 2mV
Accuracy: 15% of Amplitude$_{pk-pk}$

Signal Analysis
Mean, Max, Min, RMS, Variance, Standard Deviation

Signal Math
Scale, Offset, Normalize, Invert, Add (A+B), Subtract (A-B, B-A), Divide (A/B, B/A)

Go/No Go Testing
High and Low Limits are programmable for all measurements

Programmable Timeouts
Arm Not Received and Measurement Not Complete

INPUT CHARACTERISTICS

Frequency Range
0 to 250MHz

Resolution Modes vs. Max. Sample Rate, Meas. Time
200ps: 5.5MHz, 6.9 hours
50ps: 1.5MHz, 100min.
8ps: 240kHz, 16.6min.

Selectable Input Features
Impedance: 50Ω or 1MΩ
Attenuation (Atten.): x1 or x2.5
Low Pass Filter: In x2.5, 1MΩ mode only
Bias: Ground or -2V (ECL) in x1 mode only
Triggering: Manual or Automatic

Amplitude Range
-2V x Atten. to +2V x Atten.

Minimum Pulse Width
2ns

Sensitivity (Sine Wave)
57mV$_{p-p}$ x Atten. (20mV$_{rms}$ x Atten.)

Sensitivity (Pulse, at 2ns)
57mV$_{p-p}$ x Atten.

Coupling
DC

Front End Noise
1mV$_{rms}$ (typ., not guaranteed to be Gaussian)

Differential Error
1ns

10MHz TIMEBASE CHARACTERISTICS

Internal Reference (Default Timebase)
Short Term Stability: 0.25ppb (1s gate time, typ.)
Aging: 1ppm/month
Temperature Stability: 10ppm, 0°C to 60°C

Backplane Reference Input
VXIbus CLK10: 100ppm, typ.

Front Panel Standard Input
Connector: BNC, 1kΩ
Minimum Amplitude: 500mV$_{rms}$
Maximum Amplitude: 5V$_{rms}$

Front Panel Reference Output
Connector: BNC, 50Ω
Frequency: 10MHz
Amplitude: 200mV$_{rms}$

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2351/2351EMD Specifications Continued

TRIGGERING CHARACTERISTICS

Manual Trigger

Frequency Range: 0 to 250MHz
Resolution: 2mV x Atten.
Level Accuracy (TLA): 5mV x Atten. + 2% of setting

Autotrigger

Frequency Range: 1kHz to 100MHz (usable to 250MHz)
Resolution: 2mV x Atten.
Minimum Amplitude: 100mV_{p-p} x Atten.
Level Accuracy (TLA): ±15% of Amplitude$_{pk-pk}$

ARMING CHARACTERISTICS

Sources

Event 1, Event 2, Ext. Arm Input, TTLTRG0-7

External Arm Rate

5MHz

Arm to Measurement Delay

TTL Mode: 90ns
Zero Crossing Mode: 110ns

Minimum Arm Pulse Width

80ns

FRONT PANEL I/O

Inputs

Channel A: BNC, 50Ω or 1MΩ
Channel B: BNC, 50Ω or 1MΩ
External Arm: BNC, 10kΩ
External Standard: BNC, 1kΩ, 1MHz-10MHz

Outputs

10MHz Ref. Output: BNC, 50Ω, 10MHz
Cal. A Output: SMB, ECL, 250MHz
Cal. B Output: SMB, ECL, 250MHz

OPTIONAL FEATURES

Option 02: CIIL Command Set

Option EMD: Excess Modulation Detection

(PFD is Peak Frequency Deviation)

Frequency Error (in Coarse Mode): ±(3% PFD+.5Hz+TUE+QE)
Trigger Uncertainty Error (TUE) in Fine Mode: TE x IF
Quantization Error (QE) in Fine Mode: LSD x IF^2

VXIbus INTERFACE DATA

(Dual-slot, message-based, VXIbus 1.4 compliant)

Software Compliance

IEEE 488.2, CIIL (Opt. 02)

Backplane Signal Support

TTLTRG0-7: External Arm and Delay
CLK10: Timebase (selectable)

Setup Storage

10 Setups

Self-Test

90% coverage

Status Lights

Red: Self-Test Fail
Green: Channel A Trigger
Green: Channel B Trigger
Green: Instrument Armed
Green: Channel A Gate
Green: Channel B Gate
Green: Measurement Complete

Cooling (10° C Rise)

6l/s @ 0.22mm H_2O

Peak Current & Power Consumption

	+24	12	+5	-2	-5.2	-12
I_{Pm}(A)	0.21	0.334	5.11	3.66	2.85	0.334
I_{Dm}(A)	0.007	0.005	0.005	0.026	0.005	0.005

Total Power: 60 Watts

ENVIRONMENTAL

Temperature

Operating: 0°C to 55°C

Weight

6 lb (2.73 kg)

EMC (Council Directive 89/336/EEC)

EN55011, Group 1, Class A, EN50082-1, IEC 801-2,3,4

Safety (Low Voltage Directive 73/23/EEC)

EN61010-1, IEC1010-1, UL3111-1, CSA 22.2 #1010

CE The CE Mark indicates that the product has completed and passed rigorous testing in the area of RF Emissions, Immunity to Electromagnetic Disturbances and complies with European electrical safety standards.

ORDERING INFORMATION

Model	Description	Part Number
2351	8ps Time Interval Analyzer	404948
2351/EMD	EMD (Excess Modulation Detection) Added	OPT-407034
2351-02M	8ps Time Interval Analyzer w/ CIIL Command Set	404948-02M
2351/EMD-02M	EMD Option and CIIL Command Set Added	OPT-407034-02M

WORLDWIDE SUPPORT

http://www.racalinst.com

LLOYD'S REGISTER QUALITY ASSURANCE ISO9001

VXI bus

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