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Racal Instruments™ 3151B

VXI Precision Waveform Synthesizer

The Racal Instruments™ 3151B Waveform Synthesizer combines 250 MS/s waveform generation performance, versatility, and compact size into a single-slot VXIbus format. The 3151B is a greatly improved version of a field-proven instrument ideal for VXI test stimulus generation. It replaces the 3151A+ and other similar units which were standard on many military and commercial test platforms.

Key Features

- **Front panel connector compatible with legacy 3151, 3151A, and 3151A+**
- **Sine and square waves up to 50 MHz at Amplitudes up to 16 V_{pk-pk} into 50 Ω**
- **Built-in functions: Triangle(x), Sine(X), Sinc, Square, Ramp, Pulse, DC, Exponential & Gaussian Pulse**
- **Linear/log sweep features (Arbitrary and DDS) up to 100 MHz**
- **High-performance frequency synthesis: 11-digit resolution and 1 ppm accuracy**
- **VXI replacement for legacy pulse and function generators**

Product Information

Compatibility Mode

The 3151B default operational mode is a compatibility mode which makes the 3151B accept and execute programming as though it were a 3151 or 3151A for all modes including (and not limited to) standard waveforms, arbitrary waveforms, sequenced mode, trigger delay, and multi-module synchronization.

The 3151B provides a front panel interface which is identical to that of the 3151, 3151A, and 3151A+ models. For new designs, please refer to literature for the 3100M and 3100R series of message-based VXI/LAN and register-based single and dual channel 3151B models.

Extended Performance Mode

The extended performance mode of the 3151B provides a synergistic combination of a swept function generator, pulse generator, programmable sequencer, and arbitrary waveform synthesizer into one instrument. In addition, the 3151B integrates a phase lock loop, modulation, sweep, hopping (amplitude and frequency) and a high-performance frequency counter into a single-slot VXI module, saving valuable space. Refer to the 3100M and 3100R product family literature for specifications on the 3151B extended performance modes because this document mainly describes 3151B's comparison with the traditional 3151 capabilities only.

Frequency Sweep

The 3151B sweeps sine (now using Direct Digital Synthesis or DDS), square or triangle waveforms between any two frequencies up to 100 MHz for sine or square, 16 MHz for triangle. Sweep may be performed either up or down and linearly or logarithmically.

11-Digit Frequency Resolution

The 3151B DDS frequency synthesizer (CW mode) provides high frequency resolution, high signal-to-noise ratio (70 dB, typical) and the low phase-noise and jitter needed for telecommunications test applications.

WaveCAD Compatible

The 3151B is compatible with WaveCAD 3.4 (Figure 1) for the 3151 and 3151A, so you can continue to use this program if desired. The 3151 and 3151A VXI*plug&play* drivers are also compatible with the 3151B.

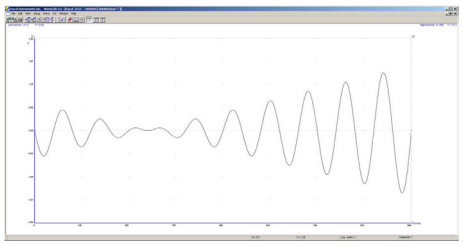


Figure 1: WaveCAD 3.4

ArbConnection™ Software

The 3151B is provided with ArbConnection™ software for control and waveform creation that lets you unlock the enhanced modes of the 3151B.

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Product Information
continued

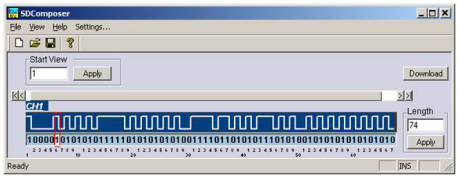


Figure 2: Serial Composer

The ArbConnection™ software includes composers to help you design arbitrary waveforms, pulse waveforms, frequency modulated waveforms, 3D waveforms (user-defined combinations of amplitude, frequency and phase modulation) and serial waveforms.

Creating Arbitrary Waveforms

The ArbConnection™ software provides a Waveform Composer application which is useful for creating test stimuli for the 3151B. The Waveform Composer allows you to import waveforms from a scope, .csv or text file, choose from a variety of pre-defined waveforms, or to enter an equation. Any waveform can then be manually edited with a variety of tools.

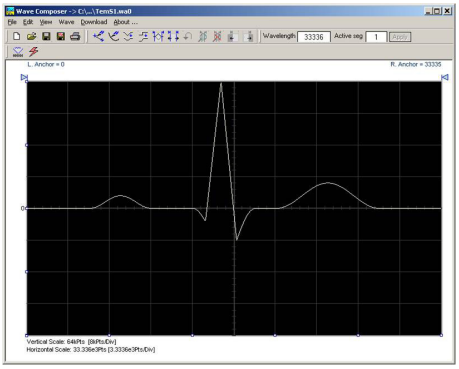


Figure 3: Cardiac Waveform in the Waveform Composer

Creating Pulse Waveforms

The ArbConnection™ software also provides a Pulse Composer for the creation of arbitrary pulse trains. You can specify the characteristics of each pulse in terms of time, amplitude and repetitions. The ArbConnection™ software then "programs" the 3151B to create exactly the pulse that you need, saving you valuable time.

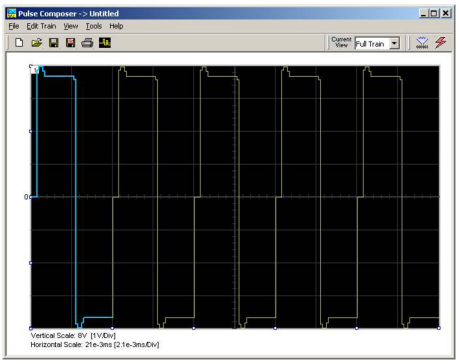


Figure 4: Custom Pulse Waveforms in the Pulse Composer

Creating Modulated Waveforms

The 3D waveform composer allows you to selectively combine three types of modulation profiles, amplitude, frequency and phase, into one signal.

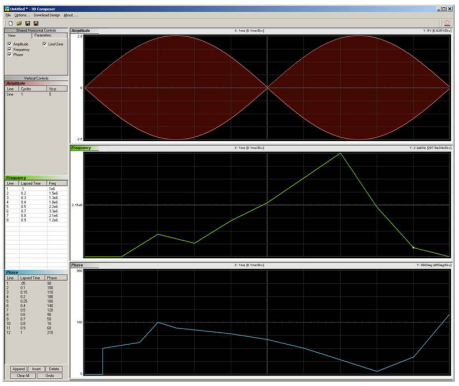


Figure 5: Combined AM, FM and Phase Modulation in 3D Composer

Specifications

Note: The Astronics Test Systems policy is one of continuous development and improvement. Consequently, the equipment may vary in detail from the description and specifications in this publication.

Amplitude Characteristics

Amplitude
- 20 mV to 32 V_{pk-pk}, output open circuit
- 10 mV to 16 V_{pk-pk}, into 50 Ω

Resolution
- 4 digits

Accuracy (at 1 kHz into 50 Ω)
- 1.6 V to 16 V_{pk-pk}: ±(1% + 25 mV)
- 160 mV to 1.59 V_{pk-pk}: ±(1% + 5 mV)
- 10 mV to 159.9 mV_{pk-pk}: ±(1% + 2 mV)

DC Offset
- Range: 0 to ±7.995 V
- Resolution: 1 mV
- Accuracy: ±(1% ±1% of Amp. ±5 mV)

Output Impedance
- 50 Ω ±1%

Low-Pass Filters (selectable)
- 25 MHz: Bessel
- 50 MHz: Bessel
- 60 MHz: Elliptic
- 120 MHz: Elliptic

Standby (Output disconnected)
- Output On or Off

Output Protection
- Short circuit to case (10 s max)

Standard Waveforms
(Sine, Triangle, Square, Pulse, Ramp, Noise, DC.)

Frequency Resolution
- 11 digits

Accuracy & Stability
- Same as frequency standard

Sine

Frequency Range
- 100 µHz to 100 MHz

Phase Adjustment
- Range: 0 to 359.95°
- Resolution: 0.05°

Power Range (sine raised to a power)
- 1 to 9

Total Harmonic Distortion
- <0.1% to 100 kHz, STD & CW

Harmonics & Spurious

Frequency	<5 V_{pk-pk}	<10 V_{pk-pk}
<100 MHz	-35 dBc	-30 dBc
<10 MHz	-50 dBc	-35 dBc
<1 MHz	-50 dBc	-40 dBc

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Specifications
continued

Frequency	<5 V_{pk-pk}	<10 V_{pk-pk}
<50 MHz	10%	15%
<10 MHz	5%	5%
<1 MHz	1%	-

Square

Frequency Range
- 100 µHz to 100 MHz

Duty Cycle Range
- 0% to 99.99%

Rise/Fall Time (10%-90%)
- <5 ns

Aberration
- <6%

Triangle

Frequency Range
- 100 µHz to 16 MHz

Phase Adjustment
- Range: 0 to 359.95°
- Resolution: 0.05°

Power Range (triangle raised to a power)
- 1 to 9

Pulse and Ramp Functions

Frequency Range
- 100 µHz to 16 MHz

Delay, Rise/Fall Time, High Time Ranges
- 0% to 99.99% of period (each independently)

Gaussian Pulse Time Constant Range
- 1 to 200

Sinc Pulse "Zero Crossings" Range
- 4 to 100

Exponential Pulse Time Constant Range
- -200 to 200

DC Output Function

Range
- -100% to 100% of amplitude

Arbitrary Waveforms

Waveform Creation Software
- Included ArbConnection™ software allows instrument control and creation of custom waveforms and sequences using freehand mode, equations, built-in functions or imported from a spreadsheet, scope or text file

Waveform Memory
- Legacy Mode: 512 k points
- Modern Mode: 1 Meg points

Vertical Resolution
- Legacy Mode: 12-bits
- Enhanced Mode: 16-bits

Number of Memory Segments
- 1 to 16 k

Minimum Segment Size
- Legacy Mode: 10 points
- Enhanced Mode: 16 points

Sequenced Waveforms

Operation
- Segments may be linked and repeated in a user-selectable fashion to generate extremely long waveforms. Segments are advanced using either a command or a trigger.

Advance Modes
- Automatic Sequence Advance
- No trigger required to step from one segment to the next. Sequence is repeated continuously per a pre-programmed sequence table.

Stepped Sequence Advance
- Current segment is sampled continuously until a trigger advances the sequence to the next programmed segment and sample clock rate.

Single Sequence Advance
- Current segment is sampled the specified number of repetitions and then idles at the end of the segment. Next trigger samples the next segment the specified repeat count, and so on.

Sequencer Steps
- 1 to 4096

Segment Loops
- 1 to 1 Meg

Minimum Segment Duration
- 500 ns

Minimum Segment Size in a Sequence
- 10 points

Sweep Waveforms

Sweep Range
- Sine, square: 10 Hz to 100 MHz
- Triangle: 10 Hz to 16 MHz

Swept Waveform
- Sine, square or triangle

Spacing
- Linear or logarithmic

Direction
- Up or Down

Sweep Duration
- 1.4 µs to 40 s

Sampling Clock

Internal Source Range (worst case)
- Continuous Mode: 100 mS/S to 250 MS/s
- Other Modes: 100 mS/s to 225 MS/s

Internal Source Range (typical 25º C)
- Continuous Mode: 300 MS/s
- Other Modes: 240 MS/s

Resolution
- 11 digits

Accuracy and Stability
- Same as reference

Reference Clock

Internal Reference
- 10 MHz ±50 ppm

External Reference
- Impedance: 10 kΩ
- Threshold: TTL or 0 dBm sine, selectable

Reference Clock
- CLK10: 100 ppm (typical)
- Internal TCXO: 1 ppm, 19° to 29° C
- Drift: 1 ppm/yr

Operating Modes

Normal Mode
- Continuous output of a single waveform segment

Sequenced Mode
- Continuous or triggered output of a sequence of waveform segments (see Sequenced Waveforms)

Sweep Mode
- Continuous output of a swept waveform

Triggered Mode
- One waveform cycle or sequence or sweep is output

Delayed Triggered Mode
- Legacy: Delays any trigger by up to 2 million waveform points
- Modern: Delays any trigger by up to 20 seconds in 20 ns increments

Gated Mode
- Generator is enabled when an external gate signal is active. The first gated output cycle is synchronous with the active slope of the gate signal. The last output cycle is always completed.

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Specifications
continued

Burst Mode
- A segment is repeated up to 1 million times. In External Burst Mode, each burst begins with a trigger. In Internal Burst Mode, an internal timer is used to repeat the burst at a programmed interval.

Counter/Timer
- Measures frequency, period, period averaged, pulse width and events

Amplitude Modulation (internal)
- AM Carrier Range: 10 Hz to 100 MHz
- AM Rate: 10 mHz to 100 kHz
- AM Depth: 0% to 200%

Triggering Characteristics

Sources
- Internal: 1 µs to 20 s, programmable

External
- Input Impedance: 10 kΩ
- Damage Level: 30 V_{rms}
- Level (Programmable): ±10 V
- Resolution: 10 mV
- Sensitivity: 100 mV_{rms}
- VXI Backplane: TTLTRG0-7

Maximum Trigger Frequency
- Internal Timer: 50 mHz to 1 MHz
- External: DC to 5 MHz

External Trigger Pulse Width
- 10 ns, minimum

Trigger Slope
- Positive or negative

System Delay (Trig I/P to Waveform O/P)
- 150 ns +6 clock periods

Trigger Delay (Trig I/P to Waveform O/P)
- Legacy Mode: 10 to 2 Meg points
- Modern Mode: 100 ns to 20 s + system delay
- Resolution: 20 ns
- Accuracy: 5% of setting + system delay

Re-trigger Delay (Waveform end to re-start)
- Resolution: 20 ns
- Accuracy: 20 ns + 3 clock periods + 5% of setting

Sync Output
- Front Panel BNC: TTL
- VXI Backplane: TTLTRG0-7

Sync Pulse
- Width Range: 4 to n-8 clock periods
- Position Range: 0 to n (Where n is the number of points in the selected memory segment.)
- Resolution: 4 points

Sync Sources
- Any point, sequence complete, ½ clock period

PLL Characteristics

Operation
- Automatically locks to external signal

PLL Input Characteristics
- Same as TRIG IN

External Lock Frequency Range
- STD Waveforms: 500 Hz to 10 MHz
- ARB Waveforms: 500 Hz to 100 MHz divided by # of points in segment

Coarse Phase Offset Range
- ±180°

Fine Phase Offset Control
- Range: ±36°
- Resolution: 0.01°

Phase Control Accuracy
- 2% ± sample clock period

Counter Characteristics

Operation
- Counter/timer mode, when enabled, disables waveform generation

Measurement Functions
- Frequency, period, period averaged, pulse width and totalize

Input Characteristics
- Input BNC: Front panel TRIG/PLL IN
- Trigger Level Range: ±10 V
- Sensitivity: 500 mV_{pk-pk}
- Damage Level: ±12 V
- Slope: Positive or negative
- Minimum Pulse Width: 10 ns

Frequency, Period Averaged
- Frequency: 20 Hz to 100 MHz
- Period: 10 ns to 50 ms
- Resolution: 7 digits/s

Period, Pulse Width
- Range: 500 ns to 50 ms
- Resolution: 100 ns

Totalize
- Frequency: 20 Hz to 100 MHz
- Event Counting Range: 1 to 1012-1

Gate Time
- Frequency: 100 µs to 1 s

Reading Modes
- Repetitive: Continuous measurements when signal is present.
- Hold: Single measurement on command
- Gated: Active in Gated Totalize mode

Multiple-Module Synchronization

(Multiple modules can be daisy-chained and synchronized to provide multi-channel systems. Master/slave phase is programmable.)

Initial Skew
- <±75 ns + 4 sample periods

Synchronization Modes
- Waveform: STD, ARB, SEQ (auto advance only)
- Run: Continuous, triggered, gated, burst

Inter-Module Phase Offsets
- Availability: Continuous run mode only
- Resolution: 20 ns
- Accuracy: 20 ns
- Range: <100 ns to 20 s

Synchronization Mechanism
- VXI Local Bus

Frequency Range for Operation
- STD Waveforms: 1.5 kHz to 100 MHz
- ARB/SEQ Waveforms: 2.5 MS/s to
- 150 MS/s (subject to backplane limits)

Interface

(Single slot, Message Based, VXIbus 3.0 Compliant)

Status Lights
- Red: Fail
- Amber: Module accessed on VXIbus
- Green: Output on

Peak Current & Power Consumption
- Total Power: <25 W

	I_{PM} (A)	I_{DM} (A)
+24 V	0.116	0.03
+12 V	0.07	0.011
+5 V	1.74	0.014
-2 V	0	0
-5.2 V	1.8	0.15
-12 V	0.06	0.01
-24 V	0.112	0.01

Front Panel I/O

(Accessed with BNC connectors)

Inputs
- TRIG IN: 10 kΩ, ±10 V
- CLOCK IN: NECL, 50 Ω, ±5%
- REF IN: 10 kΩ, TTL or 0 dBm sine, selectable

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Specifications
continued

Outputs
- OUTPUT: 50 Ω, 5.7 V_{rms} (28 dBm)
- SYNC OUT: TTL

Software

Native Language
- SCPI 1993.0, IEEE 488.2

Firmware Upgrades
- Stored in Flash using VXI utility

Firmware Emulation
- 3151, 3151A, 3151A+

Drivers
- LabVIEW™, LabWindows™/CVI, VXI*plug&play* support for frameworks based on Microsoft Win32® application programming interface, IVI

Waveform & Control Software
- WaveCAD 3.4, ArbConnection 4.2

Shared Waveform Memory
- D16/A24/A32 block transfer

Environmental

Temperature
- Operating: 0° C to 55° C
- Storage: -40° C to 70° C

Humidity (non-condensing)
- 11° C to 30° C: 95% ±5%
- 31° C to 40° C: 75% ±5%
- 41° C to 50° C: 45% ±5%

Altitude
- Operating: 10,000 ft
- Storage: 15,000 ft

Vibration (non-operating)
- 2 g at 55 Hz

Shock (non-operating)
- 30 g, 11 ms, half sine pulse

MTBF (MIL-HDBK-217F, GB, GC)
- 76,104 hrs

Mechanical

Weight
- 2 lbs 9 oz. (1.16 kg)

Cooling (10° C Rise)
- 3.7 l/s @ 0.5 mm H_2O

Ordering Information

408166-001 : Racal Instruments™ 3151B
250 MS/s Waveform Generator with 1 M RAM & 1 ppm TCXO

408166-011 : Racal Instruments™ 3151B
250 MS/s Waveform Generator with 1 M RAM & 1 ppm TCXO (Identify as 3151/3151A)

408166-021 : Racal Instruments™ 3151B
250 MS/s Waveform Generator with 1 M RAM & 1 ppm TCXO (Identify as 3151A+)

3151/3151A/3151A+ Cross-Reference Guide

Old Model	Old P/N	New Model	New P/N	Enhancements
3151 w/64 k	407382-001	"3151B w/1 M, 1 ppm, 3151/3151A ID codes"	408166-011	Sample Rate/BW/ memory are ≥2x Full legacy command emulation New modulation/sweep capabilities New waveform generation software
3151 w/ 512 k	407382-002			
3151 w/64 k, 1 ppm	407382-011			
3151 w/ 512 k, 1 ppm	407382-012			
3151A w/512 k	407824-011			
3151 w/ 512 k, 1ppm	407824-012			
3151A+ w/64 k	407824-001	"3151B w/1 M, 1 ppm, 3151A+ ID codes"	408166-021	
3151A+ w/ 512 k	407824-002			
3151A+ w/64 k, 1 ppm	407824-011			
3151A+ w/ 512 k, 1 ppm	407824-012			

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