

Racal 3100M

## VXI Single/Dual Channel Arbitrary Waveform Generator



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# Astronics Test Systems

## 3100M

### VXI Single/Dual Channel Arbitrary Waveform Generator

The Astronics Test Systems 3100M Waveform Synthesizer Series combines 300 MS/s waveform generation performance, versatility, and compact size into a single-slot VXIbus format.

The 3100M is a greatly improved version of a field-proven instrument ideal for VXI test stimulus generation. It replaces one or two of the popular 3152A Precision PLL Waveform Synthesizers, which are standard on many military and commercial test platforms.

#### Key Features

- Phase locks to external analog signals: 500 Hz to 10 MHz, 100 mV to 30 V<sub>rms</sub>
- Sine and square waves up to 100 MHz at amplitudes up to 16 V<sub>pk-pk</sub> into 50 Ω
- Built-in functions: Trianglex, Sinex, Sinc, Square, Ramp, Pulse, DC, Exponential & Gaussian Pulse
- Linear/log sweep features (arbitrary and DDS) up to 100 MHz
- Ten high-performance modulation modes including AM, FM, PM, PWM, 3D, amplitude/frequency hopping
- VXI replacement for legacy pulse and function generators

#### Product Information

##### Compatibility Mode

The 3100M defaults to its highest performance operational mode, but also can be set to operate as though it were a 3151A+ or 3152A for all modes including (and not limited to) PLL, PM, sequenced mode, trigger delay, and multi-module synchronization. The 3100M provides a front panel interface that is different from that of the 3152A. For legacy designs, please refer to literature for the 3151B and 3152B models for more information.

##### Modulation Modes

The 3100M allows the modulation of a carrier waveform ranging up to 100 MHz with ten modulation types including AM, FM, PM, FSK, PSK, ASK, frequency hopping, amplitude hopping, 3D modulation (a combination of AM, FM, and PM), and Pulse Width Modulation (PWM).

Modulation sources are all internal except for PM (external or internal with 3D mode) and include sine, square, triangle, ramp, and arbitrary (in some cases). PWM is generated using the included waveform creation software and downloaded to the instrument.

##### Frequency Sweep

The 3100M sweeps sine (now using Direct Digital Synthesis or DDS), square, or triangle waveforms between any two frequencies up to 100 MHz. Sweep may be performed either up or down and linearly or logarithmically.

##### 11-Digit Frequency Resolution

The 3100M 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.

##### Phase-Lock Mode

The 3100M can phase-lock its output to external analog waveforms. In phase-lock mode, the output automatically locks its frequency to an external signal up to 10 MHz and voltage up to 30 V<sub>rms</sub>. Phase offset is programmable with 0.01° resolution, and the trigger threshold is programmable with 10 mV resolution.

##### Waveform Creation Software

The 3100M includes waveform creation software for instrument control and waveform creation that lets you interactively program the generator and import, edit, or create waveforms.

Creation tools are provided to help you design function generator or arbitrary waveforms, pulse waveforms, frequency modulated waveforms, 3D waveforms (user-defined combinations of amplitude, frequency and phase modulation), serial waveforms and more.

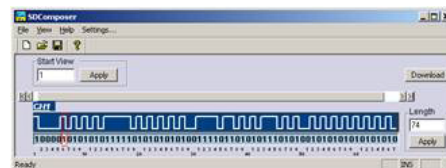


Figure 1: Serial Composer

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TEST SYSTEMS

## Product Information

continued

### Highly Configurable Design

The 3100M can be configured with one or two 3152-compatible channels. It can also be configured with a single- or dual-channel amplifier which can be used to increase the output voltage of the waveform generator to 40 V<sub>pk-pk</sub>\*

### LAN and USB Compatibility

The 3100M models only are fitted with a front panel LAN port and USB host port. The LAN port can be used as an alternate control port independent of a VXI controller and even in the absence of a VXI controller. The USB port can be used to connect with USB-compatible Flash drives.

### Arbitrary Waveform Creation

The Waveform Composer feature is useful for creating test stimuli for the 3100M. The Waveform Composer allows you to import wave-forms from a scope, .csv or text file, choose from a variety of pre-defined



Figure 2: LAN and USB Front Panel Connections

waveforms, or to enter an equation. Any waveform can then be manually edited with a variety of tools. The instrument drivers are capable of loading these waveforms into the instrument while running a test program.

### Custom Pulse Waveform Creation

The Pulse Composer feature is used for the creation of arbitrary pulse trains. You

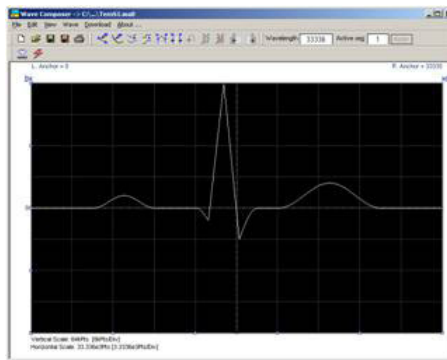


Figure 3: Cardiac Waveform in the Waveform Composer

can specify the characteristics of each pulse in terms of time, amplitude and repetitions.

The ArbConnection™ software then “programs” the instrument to create exactly the pulse that you need, saving you valuable time. In addition, pulses may be programmed by specifying timing parameters directly so that the firmware automatically can build single or double pulses with programmable rise/fall time, width, and delay.

### Creating Sequenced Waveforms

The Waveform Studio feature allows

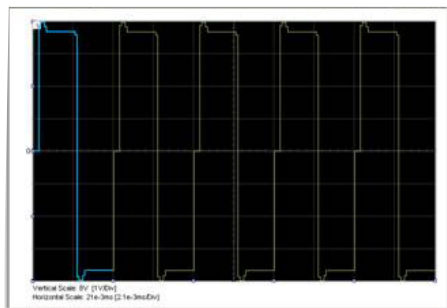


Figure 4: Custom Pulse Waveforms in the Pulse Composer

pre-defined waveforms to be “linked” and looped as one of 10 waveform sequences that may be stored in sequencer memory.

Sequences are useful when complex waveforms are required and portions of the waveform can repeat themselves. They can simplify waveform creation while they preserve waveform memory.

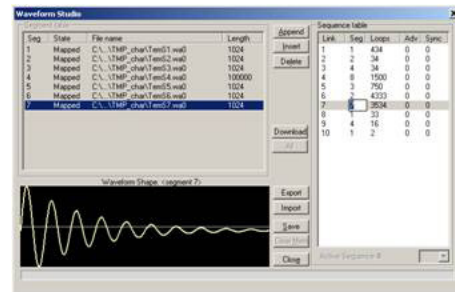


Figure 5: Sequence Definition in Waveform Studio

### Combining AM, FM, and PM

The 3D Waveform Composer feature allows you to define any combination of amplitude, frequency, and/or phase modulation into your signal. The composer then calculates the signal for loading into the instrument's 3D modulation memory.

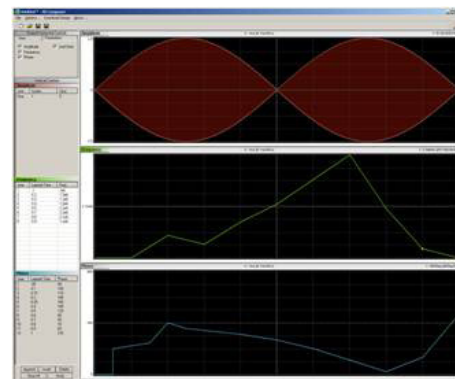


Figure 6: Combined AM, FM, and Phase Modulation in the 3D Composer

# 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 (direct)

- 20 mV to 32 V<sub>pk-pk</sub>, output open circuit
- 10 mV to 16 V<sub>pk-pk</sub>, into 50 Ω

### Amplitude (3201A/3202A in series)

- 32 mV to 40 V<sub>pk-pk</sub>, output open circuit
- 16 mV to 20 V<sub>pk-pk</sub>, into 50 Ω

### Resolution

- 4 digits

### Accuracy (at 1 kHz into 50 Ω)

- 1.6 V to 16 V<sub>pk-pk</sub>: ±(1% + 25 mV)
- 160 mV to 1.59 V<sub>pk-pk</sub>: ±(1% + 5 mV)
- 10 mV to 159.9 mV<sub>pk-pk</sub>: ±(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 <sub>pk-pk</sub> | <10 V <sub>pk-pk</sub> |
|-----------|-----------------------|------------------------|
| <100 MHz  | -35 dBc               | -30 dBc                |
| <10 MHz   | -50 dBc               | -35 dBc                |
| <1 MHz    | -50 dBc               | -40 dBc                |

### Flatness

| Frequency | <5 V <sub>pk-pk</sub> | <10 V <sub>pk-pk</sub> |
|-----------|-----------------------|------------------------|
| <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 waveform software allows instrument control and creation of custom waveforms and sequences using freehand mode, equations, and built-in functions; or they can be 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

# Specifications

continued

## Sweep Waveforms

### Sweep Range

- 10 Hz to 100 MHz

### Swept Waveform

- Sine, square or triangle

### Spacing

- Linear or logarithmic

### Direction

- Up or Down

### Sweep Duration

- 1.4  $\mu$ s to 40 s

### Marker Output

- Selectable frequency

## Modulated Waveforms

### Carrier Frequency Range

- 10 Hz to 100 MHz

### Baseline (pre-trigger state)

- DC or Carrier Frequency, selectable

### Modulated Waveform

- AM, FM: Sine, triangle, square, or ramp

### Arbitrary FM: Arbitrary Waveform

- Others: Sine

### Run Modes

- Continuous, Triggered, Burst and Gated

### Run Mode Advance Source

- Software commands, Front panel TRIG IN, Backplane TTLTrg0-7

### Trigger Delay Range

- 0, 100 ns to 20 s

### Re-trigger Delay Range

- Range: 100 ns to 20 s
- Resolution: 20 ns

### Trigger Jitter

- $\pm 1$  sample clock period

## FM

### Modulating Frequency Range

- 10 MHz to 350 kHz

### Peak Deviation

- Up to 50 MHz

### Modulating Waveform Sampling Clock (Arbitrary FM Mode)

- 1 S/s to 5 MS/s

### Frequency Array Size (Arbitrary FM Mode)

- 4 to 20 k frequencies

### Marker Output

- Programmable at selected frequencies

## AM

### Modulated Waveform

- Sine, triangle, square, or ramp

### Envelope Frequency

- 10 mHz to 1 MHz

### AM Depth

- 0% to 100%

## FSK, PSK, ASK

### Baud Rate Range

- FSK, PSK: 1 bit/sec to 10 Mbits/sec
- ASK: 1 bit/sec to 2.5 Mbits/sec

### Internal Data Bits

- 1 to 4000

### Marker Output

- Programmable at selected bits

## Frequency, Amplitude Hopping

### Hopping Function

- Frequency or amplitude

### Hop Table Size

- 1 to 5000

### Advance Source

- External, internal, backplane

### Dwell Time Range

- 200 ns to 20 s

### Dwell Time Resolution

- 20 ns

### Dwell Time Mode

- Fixed or variable

### Hop Frequency Range

- 10 Hz to 100 MHz

### Amplitude Hopping Range

- 10 mV to 16 V<sub>pk-pk</sub>

### Amplitude Hopping Resolution

- $\text{Ampl}_{\text{max}}/4096$

### Marker Position

- Programmable on a selected hop table index

## 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 25° C)

- Continuous Mode: 300 MS/s
- Other Modes: 240 MS/s

## Resolution

- 11 digits

## Accuracy and Stability

- Same as reference

## Reference Clock

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

## 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

- Delays any trigger by up to 2 million waveform points

### 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.

### 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.

### Phase Lock Mode

- Phase locks a standard or arbitrary waveform to an external signal to 30 V<sub>rms</sub>

### Modulation Mode

- CW or AM, FM, FSK, PSK, ASK, Sweep, Frequency or Amplitude Hopping

### Phase Modulation (external)

- PM Modulation Rate: 0 to 10 kHz

### Counter/Timer

- Measures frequency, period, period averaged, pulse width and events

## Triggering Characteristics

### Sources

- Internal: 1  $\mu$ s to 20 s, programmable
- External
- Input Impedance: 10 k $\Omega$

# Specifications

continued

Damage Level: 30 V<sub>rms</sub>  
 Level (Programmable):  $\pm 10$  V  
 Resolution: 10 mV  
 Sensitivity: 100 mV<sub>rms</sub>

- 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: 150 ns + 6 clock period

## Re-trigger Delay (Waveform end to re-start)

- Resolution: 20 ns
- Accuracy: 20 ns + 3 clock periods

## 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,  $\frac{1}{2}$  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

- $\pm 180^\circ$

### Fine Phase Offset Control

- Range:  $\pm 36^\circ$
- Resolution: 0.01°

### Phase Control Accuracy

- 2%  $\pm$  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:  $\pm 10$  V
- Sensitivity: 500 mV<sub>pk-pk</sub>
- Damage Level:  $\pm 12$  V
- Slope: Positive or negative
- Minimum Pulse Width: 10 ns

### Frequency, Period Averaged

- Frequency: 10 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  $10^{12}$ -1

### Gate Time

- Frequency: 100  $\mu$ s to 1 s

### Reading Modes

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

## PM Characteristics

### Operation

- External signal offsets phase. The PM input is operational in PLL mode.

### PM Input

- Impedance: 100 k $\Omega$ ,  $\pm 5\%$
- Phase Range:  $\pm 130^\circ$
- Input Bandwidth: 100 Hz to 10 kHz
- External Lock Range: Same as PLL
- Sensitivity: 20°/V
- Accuracy:  $\pm 10\%$

## Multiple-Module Synchronization

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

### Initial Skew

- $< \pm 75$  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 & 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)

### Front Panel I/O

#### Outputs (1 per 3152B)

- MAIN (BNC): 50  $\Omega$ , 5.7 V<sub>rms</sub> (28 dBm)
- SYNC (BNC): TTL

#### Inputs (1 per 3152B)

- TRIG/PLL IN (BNC): 10 k $\Omega$ ,  $\pm 10$  V
  - SCLK IN (SMB): NECL, 50  $\Omega$ ,  $\pm 5\%$
  - Lower SMB Options:
    - W1/W4: 10 MHz IN, 100 k $\Omega$ , LVTTTL
    - W3/W5: PM IN, 50 $\Omega$  (3152x-compatible)
- Also available: 0 dBm sine

### I/O Ports

- LAN: RJ45
- USB 2.0: Type A jack

### General

#### Status Lights

- Red: Fail
- Amber: Link
- Amber: Module accessed on VXIbus
- Amber: PLL Locked
- Green: Output on



Lower  
SMB  
Options



# Specifications

continued

## Peak Current & Power Consumption

- Total Power: <25 W

|      | $I_{Pm}$ (A) | $I_{Dm}$ (A) |
|------|--------------|--------------|
| +24  | 0.116        | 0.03         |
| +12  | 0.07         | 0.011        |
| +5   | 1.74         | 0.014        |
| -2   | 0            | 0            |
| -5.2 | 1.8          | 0.15         |
| -12  | 0.06         | 0.01         |
| -24  | 0.112        | 0.01         |

## Software

### Native Language

- SCPI 1993.0, IEEE 488.2

### Firmware Upgrades

- Stored in Flash using VXI utility

### Drivers

- LabVIEW™, LabWindows™/CVI, VXIplug&play support for frameworks based on Microsoft Win32® application programming interface

### Waveform & Control Software

- ArbConnection™ 4.2

### Shared Waveform Memory

- D16/A24/A32 block transfer

## 3201A/3202A Amplifiers

### Input Characteristics

- Channels: 3201A (1), 3202A (2)
- Channel 1: Input SMB, BNC
- Channel 2: Input SMB (2)
- Input Impedance: 50  $\Omega$
- Coupling: DC
- Frequency Range: DC to 15 MHz
- Damage Level: 12 V<sub>pk-pk</sub> (6 V<sub>pk</sub>)

### Output Characteristics

- Channel 1: Output BNC
- Channel 2: Output SMB
- Coupling: DC
- Protection: Short Circuit, 10 seconds
- Gain: 10 (other values available)
- Polarity: Non-inverting
- Output Impedance: 50  $\Omega$  (75  $\Omega$  and 600  $\Omega$  are also available)

### Pulse Characteristics

- Transition Time: <22 ns
- Aberration: <7%

### Sine Characteristics

- Bandwidth: 15 MHz @ 20 V<sub>pk-pk</sub>
- Accuracy:  $\pm(3\%$  of full-scale amplitude range + 25 mV), Square wave at 1 kHz
- THD: 0.2%, 10 Hz to 100 kHz

### Harmonics

| Frequency | <10 V <sub>pk-pk</sub> |
|-----------|------------------------|
| <15 MHz   | -30 dBc                |
| <10 MHz   | -38 dBc                |
| <1 MHz    | -47 dBc                |

### Flatness

| Frequency | <10 V <sub>pk-pk</sub> |
|-----------|------------------------|
| <15 MHz   | 25%                    |
| <7.5 MHz  | 10%                    |
| <1 MHz    | 5%                     |

## Temperature

- Operating: 0° C to 55° C
- Storage: -40° C to 71° C

## Humidity (non-condensing)

- 11° C to 30° C: 95%  $\pm 5\%$
- 31° C to 40° C: 75%  $\pm 5\%$
- 41° C to 50° C: 45%  $\pm 5\%$

## 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 25C, GB, GC)

- 3100M-3152B: 76,104 hrs
- 3100M-3152B-3152B: 43,088 hrs

## Vibration (non-operating)

- 2 g at 55 Hz

## Shock (non-operating)

- 30 g, 11 ms, half sine pulse

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- 3100M-3152B: 76,104 hrs
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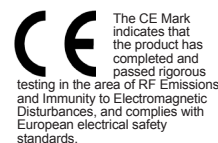
## Mechanical

### Weight

- 3 lbs 1 oz (1.40 kg)

### Cooling (10° C Rise)

- 3.7 l/s @ 0.5 mm H<sub>2</sub>O



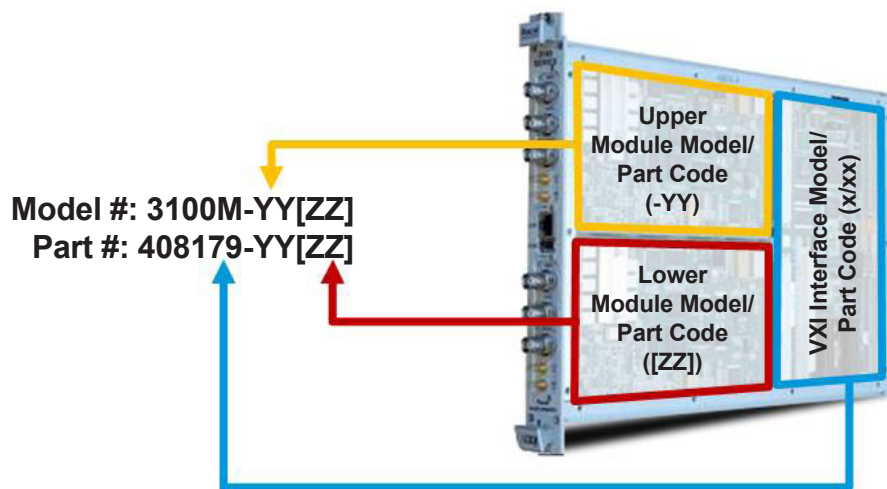
## Ordering Information

**408179-YY[ZZ] : Racal Instruments™ 3100M-YY[ZZ]**

VXI Single/Dual Channel Arbitrary Waveform Generator

### Model/Part # Configurator:

Substitute “YY” with the upper internal module code chosen, and substitute “[ZZ]” with the optional lower internal module code.

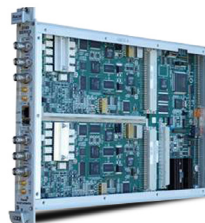


To create the optional sections of the model/part #, substitute the “-YY” and “[ZZ]” in the part # configurator with the correct Internal Module Code from the table below.

| Internal Module Model Code (-YY), ([ZZ]) | Internal Module P/N Code (-YY), ([ZZ]) | Internal Module Description                   |
|------------------------------------------|----------------------------------------|-----------------------------------------------|
| W1                                       | W1                                     | 1 MB, External Reference Input Port           |
| W3                                       | W3                                     | 1 MB, 3152-compatible pinout module           |
| W4                                       | W4                                     | 4 MB, External Reference Input Port           |
| W5                                       | W5                                     | 4 MB, 3152-compatible pinout module           |
| A1                                       | A1                                     | Amplifier, 20 MHz, 20 V <sub>pk-pk</sub>      |
| A2                                       | A2                                     | Dual Amplifier, 20 MHz, 20 V <sub>pk-pk</sub> |



3100M-W3



3100M-W3W3



3100M-W3A2

### Part Number Ordering Examples:

|                    |                                                                                                                                                        |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>408179-W3W3</b> | 3100M-W3W3: 3100M AWG with a 1 MB 3152B-compatible pinout module (W3) in the upper module position and the same unit in the lower module position (W3) |
| <b>408179-W4A1</b> | 3100M-W4A1: 3100M AWG with a 4 MB 3152B Ext Ref module (W4) in the upper module position and an amplifier (A1) in the lower module position            |

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