# MODELS WS8351/2

## 350MHz Single/Dual Channel Arbitrary Function Generators

- Single / Dual-channel Arbitrary / Pulse / Function Generator
- Differential outputs configured as separate or synchronized
- 350MHz sine and 250MHz square waves
- 14-Bit, 2GS/s, 512Kpoint arbitrary waveforms
- 4Vp-p into 50Ω (8Vp-p differential), double into open circuit
- 10 built-in waveforms: sine, square, pulse, triangle, ramp, sin(x)/x, gaussian, exponential, noise and DC
- AM, FM, FSK, PSK and Sweep modulations

- Continuous, triggered, gate and burst modes
- Powerful pulse/pattern composer for analog, digital and mixed signals, device tests
- User friendly 4" color LCD display
- Remote control through LAN, USB and GPIB
- Store/recall on memory stick or 1GB internal memory
- Free ArbConnection software, IVI and MATLAB drivers
- LXI Class C compliant

Tabor's WS8351/2 is a 350MHz single/dual channel generator with the functionality of a function, arbitrary, modulation and pulse/pattern generator, all in one easy to use, high performance, compact stand alone bench top, which enables engineers to test analog, digital and mixed signals devices with a single instrument.

### Standard Waveforms
The WS8351/2 has 11 built-in functions for quick and easy waveform generation. Front panel operations allows for easy selection and editing of all waveform parameters. All the standard waveforms can reach up to 125MHz with Sine and Square going as high as 350MHz and 250MHz respectively.

### User Defined Waveforms
For more advanced users the WS8351/2 with its 14-bit vertical resolution offers a standard 512Kpoint memory depth and a 2GS/s sample clock for designing waveforms. With the ability to control and edit the value of each and every point any wave is possible. The memory can be divided into segments for storing all of the user defined waveforms.

### Common or Separate Clocks
Need a dual channel unit, a single channel unit... why choose? With the new WS8352 you can have it both ways. The WS8352 has two differential output channels, which operate either independently, or synchronized. As two separate channels, one has the advantage of having two separate instruments in one box, each having the ability to be programmed to output different function shapes, frequencies, amplitude levels and even in different run modes. Alternatively, the advantage of having two synchronized channels with less than 10ps skew and skew control is very significant in applications that require an accurate and controlled phase between the two channels.

### Pulse / Pattern Creation
Generating complex pulse trains has never been easier. The Pulse Composer is a powerful built-in tool that converts the WS8351/2 to a very sophisticated Pulse/Pattern Generator, allowing to create literally any complex pulse train / pattern, whether it's a single pulse, multi-level, linear-points, initialization or preamble pattern definition, arbitrary bit design, user-defined or even standard random

patterns with programmable resolution, so it doesn't matter if your application is radar communications, nanotechnology or serial bus testing, the pulse/pattern composer is the right tool for your application. Moreover, all the WS8351/2 advanced trigger modes are applicable, hence one can choose to use the "step" mode to advance every bit independently or the "once" mode to advance a complete data block in one trigger event, enabling even more applications, such as trigger, clock and data protocols.

### Multi-Level and PAM(n) Signals
The WS8351/2's pulse composer enables up to 350Mbit/s data rate generation, utilizing either NRZ and RZ modes (minimum transition times) which is ideal especially for multi level and PAM(n) applications such as, LED (light-emitting diodes), CAN, QPHY, FlexRay or simulating and testing Ethernet environment, whether it's 100Mbit/s (100BASE-T), the later gigabit Ethernet (1000BASE-T) or even the latest 802.3an standard (10GBASE-T), which utilizes PAM-16.

### Smart Trigger

Until now, you've been forced to trigger on a specific event. Tabor's all-new SmarTrigger feature was designed to enhance the trigger capability and facilitate wider flexibility of a specific pulse event. It allows triggering on either a pulse having a larger pulse width than a programmed time value (<time), a pulse having a smaller pulse width than a programmed time value (>time), or even on a pulse having a pulse width between two limits (<>time). In addition, the SmarTrigger has a hold-off function, in which the output is held idle after the first trigger and starts a waveform cycle only with the first valid trigger after a hold-off interval has lapsed, allowing you to solve endless "negotiation" scenarios.

### Modulated Waveforms

Agility and modulation capabilities open the door to diverse applications. In addition to the capability of generating any shape and style of waveform with the arbitrary waveform generation power, the WS8351/2 can also do standard modulation schemes such as AM, FM, FSK, PSK, sweep and chirp without sacrificing the power of the instrument control and output run modes.

### Accuracy and Stability

As standard, the WS8351/2 is equipped with an internal frequency reference that has 1ppm accuracy and stability over a period of 1 year. An external frequency reference is provided on the rear panel for applications requiring greater accuracy or stability, supported by the instrument's 8 digits resolution.

### Easy to Use

Large and user-friendly 4" backlit color LCD display facilitates browsing through menus, updating parameters and displaying detailed and critical information for your waveform output. Combined with numeric keypad, cursor position control and a dial, the front panel controls simplify the often complex operation of an arbitrary function generator.

### Remote Control

Model WS8351/2 comes standard with a variety of interfaces: Ethernet, USB and GPIB allowing the user to freely select the interface best suited to his individual requirements. The included ArbConnection software is a powerful editorial tool for designing waveforms and provides the user with full control of instrument functions, modes and features.

### Multiple Environments to Write Your Code

In addition to the included ArbConnection software, the WS8351/2 comes with a complete set of drivers, allowing you to write your application in various environments such as: Labview, CVI, C++, VB, and MATLAB. You may also link the supplied dll to other Windows based API's or, use low level SCPI commands (Standard Commands for Programmable Instruments) to program the instrument, regardless if your application is written for Windows, Linux or Macintosh operating systems.

### Automated External Calibration

Leading-edge technology is implemented to allow calibration from any interface, USB, GPIB or LAN and calibration factors are stored in a flash memory thus eliminating the need to open instrument covers.

### ArbConnection

The ArbConnection software provides you with full control of instrument functions, modes and features. ArbConnection is a powerful editorial tool that allows you to easily design any type of waveform. Whether it is the built in wave, pulse or serial data composers, or the built in equation editor with which you can create your own exotic functions, ArbConnection makes virtually any application possible.

## Specification

### CONFIGURATION

| | |
|---|---|
| **Output Channels** | 1/2, Synchronized/fully separated |

### STANDARD WAVEFORMS

| | |
|---|---|
| **Type:** | Sine, triangle, square, ramp, pulse, sin(x)/x, exponential rise, exponential decay, gaussian, noise and DC. |
| **Frequency Range:** | |
| Sine | 10kHz to 350MHz |
| Square, Pulse | 10kHz to 250MHz |
| All others | 10kHz to 125MHz |

### SINE

| | |
|---|---|
| **Start Phase:** | 0 to 360° |
| **Harmonics Distortion (typ.):** | |
| 5MHz to 200MHz[1] | <-40dBc[1] |
| 200MHz to 350MHz[1] | <-50dBc[1] |

[1] Measured with 500MHz lowpass filter

| | |
|---|---|
| **Non-Harmonics Distortion (typ.):** | |
| 1MHz to 100MHz | <-80dBc |
| 100MHz to 250MHz | <-75dBc |
| 250MHz to 350MHz | <-70dBc |
| **SSB Phase Noise (10kHz offset):** | |
| 1MHz Carrier | <-120dBc/Hz |
| 10MHz Carrier | <-118dBc/Hz |
| 100MHz Carrier | <-115dBc/Hz |
| 250MHz Carrier | <-108dBc/Hz |
| 350MHz Carrier | <-100dBc/Hz |

### TRIANGLE / RAMP (SAW-TOOTH)

| | |
|---|---|
| **Start Phase:** | 0 to 360° |
| **Phase Resolution:** | 0.1° |
| **Timing Range:** | 1.0% to 99.9% |

### SQUARE

| | |
|---|---|
| **Duty cycle Range:** | 1.0% to 99.9% |
| **Rise/Fall time:** | 1ns (typically <900ps) |
| **Overshoot:** | <5%, typ. |
| **Jitter (rms):** | <10ps |

### SINC (Sine(x)/x)

| | |
|---|---|
| **"0 Crossings"** | 4 to 100 cycles |

### GAUSSIAN

| | |
|---|---|
| **Time Constant** | 10 to 200 |

### EXPONENTIAL PULSE

| | |
|---|---|
| **Type:** | Rise or Decay, selectable |
| **Time Constant:** | -100 to 100 |

### NOISE

| | |
|---|---|
| **Bandwidth:** | 125MHz |

### DC

| | |
|---|---|
| **Range:** | -2V to +2V |

### PULSE

| | |
|---|---|
| **Pulse Mode:** | Single or double, programmable |
| **Polarity:** | Normal, inverted or complement |
| **Period:** | 4ns to 1.6s |
| **Resolution:** | 1ns |
| **Pulse Width:** | 2ns to 1.6s |
| **Rise/Fall Time:** | |
| Fast | 1ns (typical < 900ps) |
| Linear | 1ns to 1.6s |
| **Delay & Double** | |
| **Pulse Delay:** | 1ns to 1.6s |
| **Amplitude Window:** | 100mVp-p to 4Vp-p into 50Ω |
| **Levels** | |
| Low Level | -2V to +1.95V |
| High Level | -1.95V to +2V |

**NOTES:**

1. All pulse parameters, except rise and fall times, may be freely programmed within the selected pulse period provided that the ratio between the period and the smallest incremental unit does not exceed the ratio of 512,000 to 1.
2. Rise and fall times, may be freely programmed provided that the ratio between the rise/fall time and the smallest incremental unit does not exceed the ratio of 1,000,000 to 1.
3. The sum of all pulse parameters must not exceed the pulse period setting.

### PULSE / PATTERN COMPOSER

| | |
|---|---|
| **Modes:** | Multi-level, linear-points, arbitrary bit design, PAM |

### MULTI-LEVEL

| | |
|---|---|
| **Number of Levels:** | 1 to 1000 |
| **Dwell Time:** | 1ns to 10s |
| **Amp. Resolution:** | 4 digits |
| **Time Resolution:** | 1ns |

### LINEAR-POINTS

| | |
|---|---|
| **Number of Points:** | 1 to 1000 |
| **Memory:** | 100k |
| **Amp. Resolution:** | 4 digits |
| **Time Resolution:** | 1ns |

### ARBITRARY BIT DESIGN

| | |
|---|---|
| **Data Rate:** | TBD |
| **Pattern Memory:** | 16Mbit |
| **Resolution:** | TBD |
| **Pattern Source:** | PRBS or user-defined |
| **Trigger Mode:** | Auto, step, once |
| **Modulation:** | TBD |

### PAM (PULSE AMPLITUDE MODULATION)

| | |
|---|---|
| **Data Rate:** | 10Mbit/s to 1Gbit/s |
| **PAM Range:** | 2 to 1000 |
| **Pattern Memory:** | 512k |
| **Resolution:** | 1 bit (TBD) |

### ARBITRARY WAVEFORMS

| | |
|---|---|
| **Sample Rate:** | 10MS/s to 2GS/s |
| **Vertical Resolution:** | 14 bits |
| **Waveform Memory:** | 512k points standard |
| **Min. Segment Size:** | 384 points |
| **Resolution:** | 16 points |
| **No. of Segments:** | 1 to 16k |
| **Waveform Granularity:** | 1 point |

### MODULATION

#### COMMON CHARACTERISTICS

| | |
|---|---|
| **Carrier Waveform:** | Sine |
| **Carrier Frequency:** | 10kHz to 350MHz |
| **Modulation Source:** | Internal |

#### AM

| | |
|---|---|
| **Modulation Shape:** | Sine, square, triangle, ramp |
| **Modulation Freq.:** | $(CW/9) > (M.F) > (CW/50e^3)$ |
| **Modulation Depth:** | 0.1 to 100% |

#### ASK

| | |
|---|---|
| **Hop Type:** | Fast or Linear |
| **Dwell Time Mode:** | Fixed or programmable per step |
| **Dwell Time:** | 4ns to 10s |
| **Dwell Time Res.:** | 4ns |

#### FM

| | |
|---|---|
| **Modulation Shape:** | Sine, square, triangle, ramp |
| **Modulation Freq.:** | $(CW/6) > (M.F) > (30e^{-6} x CW)$ |
| **Deviation Range:** | CW/2 |

#### FSK

| | |
|---|---|
| **Hop Type:** | Fast or Linear |
| **Dwell Time Mode:** | Fixed or programmable per step |
| **Dwell Time:** | 4ns to 10s |
| **Dwell Time Res.:** | 4ns |

#### SWEEP / CHIRP

| | |
|---|---|
| **Sweep Type:** | Linear or log |
| **Sweep Direction:** | Up or down |
| **Sweep Time:** | $(9/High Freq.) > (S.T) > (50e^3/High Freq.)$ |
| **Modulation Shape:** | Pulse |
| **Pulse Repetition:** | |
| Range | 100ns to 2s |
| Resolution | 3 digits |
| Accuracy | 100ppm |

### COMMON CHARACTERISTICS

#### FREQUENCY

| | |
|---|---|
| **Resolution:** | 8 digits |
| **Accuracy/Stability:** | Same as reference |

## Specification

### ACCURACY REFERENCE CLOCK:

| | |
|---|---|
| Internal | 1 ppm from 19°C to 29°C; 1ppm/°C below 19°C or above 29°C; 1 ppm/year aging rate |
| External | -5dBm to 5dBm, 50Ω |

### AMPLITUDE

**Range:**

| | |
|---|---|
| Single-ended | 50mVp-p to 4Vp-p * |
| Differential | 100mVp-p to 8Vp-p * |

\* Double into high impedance

**Resolution:** 4 digits
**Accuracy:** ±(3% +5mV)
**Rise/Fall Time:** 1ns (<900ps typ.)
**Overshoot:** 5%, typ.

### OFFSET

**Offset Range:** -1.5V to + 1.5V into 50Ω
**Offset Resolution:** 4 digits
**Offset Accuracy:** ±(5% +5mV)

### OUTPUTS

#### MAIN OUTPUTS

**Coupling:** DC-coupled
**Type:** Single ended or differential
**Connectors:** Front panel SMAs
**Impedance:** 50Ω ±1%
**Protection:** Protected against temporary short to case ground

#### SYNC OUTPUT

**Connector:** Front panel SMA
**Source:** Channel 1 or channel 2
**Type:** Single ended
**Waveform Type:**

| | |
|---|---|
| Pulse | 16 points width |
| WCOM | Waveform complete |

**Impedance:** 50Ω
**Amplitude:** 1V; doubles into high impedance
**Variable Position Control:**

| | |
|---|---|
| Range | 0 to segment length |
| Resolution | 16 points |

**Rise/Fall Time:** 2ns, typical
**Variable Width control:**

| | |
|---|---|
| Range | 16 points to segment length |
| Resolution | 16 points |

### INPUTS

#### TRIGGER INPUT

**Connector:** Rear panel SMA
**Input Impedance:** 10kΩ
**Polarity:** Positive, negative, or both
**Damage Level:** ±20Vdc
**Frequency Range:** 0 to 15MHz

**Trigger Level Control:**

| | |
|---|---|
| Range | -5V to 5V |
| Resolution | 12 bit (2.5mV) |
| Accuracy | ±(5% of setting + 2.5mV) |
| Sensitivity | 0.2Vp-p |

**Min. Pulse Width:** 10 ns

### EVENT INPUT

**Connector:** Rear panel BNC
**Input Impedance:** 10kΩ
**Polarity:** Positive, negative or either
**Damage Level:** ±20Vdc
**Frequency Range:** 0 to 15MHz
**Trigger Level Control:**

| | |
|---|---|
| Range | -5V to 5V |
| Resolution | 12 bit (2.5mV) |
| Accuracy | ±(5% of setting + 2.5mV) |
| Sensitivity | 0.2Vp-p minimum |

**Min. Pulse Width:** 10ns

### EXTERNAL REFERENCE INPUT

**Connector:** Rear panel BNC
**Input Frequency:** 10MHz to 100MHz
**Input Impedance:** 50Ω
**Voltage Swing:** -5dBm to 5dBm
**Damage Level:** 10dBm

### EXTERNAL SAMPLE CLOCK INPUT

**Connector:** Rear panel SMA
**Input Impedance:** 50Ω
**Voltage Swing:** 0dBm to 10dBm
**Input Frequency:** 1GHz to 4GHz (Double the internal clock)
**Clock Divider:** 1/1, 1/2, 1/4, 1/256, separate for each channel
**Damage Level:** 15dBm

### RUN MODES

**Continuous:** A selected output function shape is output continuously.
**Self Armed:** No start commands are required to generate waveforms.
**Armed:** The output dwells on a DC level and waits for an enable command and then the output waveform is output continuously; An abort command turns off the waveform.
**Triggered:** A trigger signal activates a single-shot or counted burst of output waveforms and then the instrument waits for the next trigger signal.
**Normal Mode:** The first trigger signal activates the output; consecutive triggers are ignored for the duration of the output waveform.

**Override Mode:** The first trigger signal activates the output; consecutive triggers restart the output waveform regardless if the current waveform has been completed or not.
**Gated:** A waveform is output when a gate signal is asserted. The waveform is repeated until the gate signal is de-asserted. Last period is always completed.
**Burst:** Upon trigger, outputs a Dual or multiple pre-programmed number of waveform cycles from 1 through 1M.

### TRIGGER CHARACTERISTICS

#### EXTERNAL

**Source:** Channel 1, channel 2, or both
**Connector:** SMA
**Input Impedance:** 10kΩ
**Polarity:** Positive, negative, or both
**Damage Level:** ±20VDC
**Frequency Range:** 0 to 15MHz
**Trigger Level Control:**

| | |
|---|---|
| Range | -5V to 5V |
| Resolution | 12 bit (2.5mV) |
| Accuracy | ±(5% of setting + 2.5mV) |
| Sensitivity | 0.2Vp-p |

**Pulse Width:** 10 ns, minimum
**System Delay:** 200 SCLK periods + 50ns
**Trigger Delay:** Separate for each channel

| | |
|---|---|
| Range | 0 to 8,000,000 SCLK periods |
| Resolution | 4 points |
| Accuracy | Same as SCLK accuracy |

**Smart Trigger:** Detects a unique pulse width
**Conditioned Trigger:** < pulse width, > pulse width or <>pulse width

| | |
|---|---|
| Pulse Width Range | 50ns to 2s |
| Resolution | 2ns |
| Accuracy | ±(5% of setting +20ns) |

**Trigger Hold-off:** Ignores triggers for a hold-off

| | |
|---|---|
| Hold-off range | 100ns to 2s |
| Resolution | 2ns |
| Accuracy | ±(5% of setting +20ns) |

**Trigger jitter:** 2ns at max. SCLK (4 SCLK)

#### INTERNAL

**Source:** Common or separate
**Modes:**

| | |
|---|---|
| Timer | Waveform start to waveform start |
| Delayed | Waveform stop to waveform start |

**Timer:**

| | |
|---|---|
| Range | 400ns to 2s |
| Resolution | 3 digits |
| Accuracy | 100ppm |

## Specification

### Delay
| | |
|---|---|
| Range | 152 to 8,000,000 SCLK periods |
| Resolution | Even numbers, divisible by 4 |

### MANUAL
| | |
|---|---|
| Source: | Soft trigger command from the front panel or remote |

### INTER-CHANNEL SKEW CONTROL

#### COURSE TUNING
| | |
|---|---|
| Initial skew: | 200ps |
| Control: | |
| Range | 0 to waveform-length points |
| Resolution | 4 points |
| Accuracy: | Same as SCLK accuracy |

#### FINE TUNING
| | |
|---|---|
| Initial skew: | 200ps |
| Control: | |
| Range | -3ns to +3ns |
| Resolution | 10ps |
| Accuracy: | (10% of setting + 20ps) |

### GENERAL
| | |
|---|---|
| **Voltage Range:** | 100VAC to 240VAC |
| **Frequency Range:** | 50Hz to 60Hz |
| **Power Consumption:** | 150VA |
| **Display Type:** | TFT LCD, back-lit |
| Size | 4 " |
| Resolution | 320 x 240 pixels |
| **Interfaces:** | |
| USB 2.0 | |
| Host | 1 x front, USB host, (A type); |
| Device | 1 x rear, USB device, (B type) |
| LAN | 1000/100/10 BASE-T |
| GPIB | IEEE 488.2 standard interface |
| **Dimensions:** | |
| With Feet | 315 x 102 x 395 mm (WxHxD) |
| Without Feet | 315 x 88 x 395 mm (WxHxD) |
| **Weight:** | |
| Without Package | 4.5kg |
| Shipping Weight | 6kg |
| **Temperature:** | |
| Operating | 0°C to 40°C |
| Storage | -40°C to 70°C |
| **Humidity:** | 85% RH, non condensing |
| **Safety:** | CE Marked, IEC61010-1 |
| **EMC:** | IEC 61326-1:2006 |
| **Calibration:** | 2 years |
| **Warranty** [1]**:** | 3 years standard |

### ORDERING INFORMATION
| MODEL | DESCRIPTION |
|---|---|
| **WS8351** | 350MHz Single Channel Arbitrary Function Generator |
| **WS8352** | 350MHz Dual Channel Arbitrary Function Generator |

### ACCESSORIES
| | |
|---|---|
| **Sync Cable:** | Multi-instrument synchronization |
| **S-Rack Mount:** | 19" Single Rack Mounting Kit |
| **Case Kit:** | Professional Carrying Bag |
| **Note:** | Options and Accessories must be specified at the time of your purchase. |

[1] Standard warranty in India is 1 year.