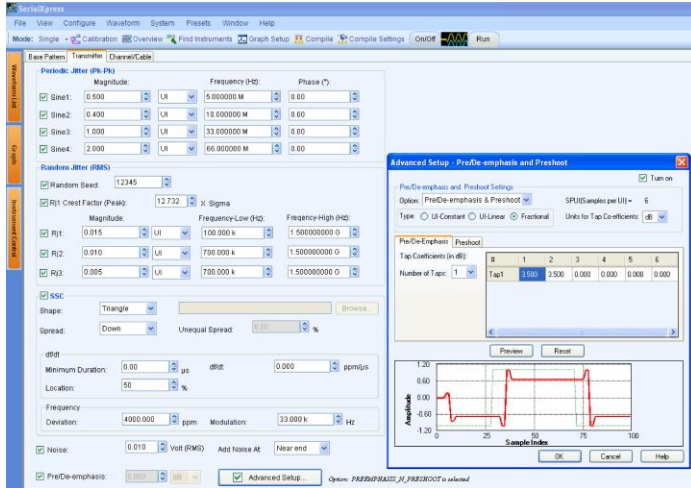


# SerialXpress<sup>®</sup> Advanced Jitter Generation for AWG

## SDX100, SDXUP Datasheet



SerialXpress is a powerful easy-to-use software package to synthesize high-speed serial data signals for Arbitrary Waveform Generators (AWG). It runs directly on the AWG5000/7000/70000 Series arbitrary waveform generators or from an external PC.

### Key features

- **Flexibility:** Jitter generation has become so flexible that the user now has the freedom to try various permutations and combinations of jitter parameters like  $P_j$ ,  $R_j$ , ISI, Noise, Delay, etc.
- **Replicate scenarios:** The signals are digitally synthesized. All AWG setups can be recalled and the scenarios can be replicated on any other AWG within seconds.
- **Analog nature of digital signals:** In reality all digital signals are analog in nature and hence SerialXpress exploits the capabilities of an AWG to generate real-world signals.
- **Ease of use:** It is easy to integrate a multitude of  $S_j$  tones into the waveforms at no additional cost. Band-limited  $R_j$  can be injected with ease.
- **Crest Factor Emulation (CFE):** Users can now apply any amount of peak pseudo-random jitter needed to their bit patterns which can reduce test times. Test cases can be repeated accurately enabling fast receiver debug cycles. SerialXpress can also create worst-case scenarios to stress receivers by accurately controlling the Crest Factor of the random jitter.
- **Programmable pre/de-emphasis and preshoot:** Most of the next-generation standards like PCIe, 10GbE, SAS, or USB 3.0 need more than one tap for pre/de-emphasis signal generation. The SerialXpress Advanced Pre/De-emphasis feature offers the ultimate in flexibility, giving users the ability to program the pre/de-emphasis and preshoot sample by sample.

- **Channel emulation through cascaded S-parameter filter:** Touchstone files can easily be inserted to simulate the exact behavior of cable emulators, which can be again controlled and modified by adding jitter and other parameters. You can also tweak the imported touchstone file data to adjust the ISI and see how the receiver responds to those variations. The effect of the channel can also be de-embedded by selecting the Inverse filtering option. Closed EYE can be opened up by adding the right amount of pre-emphasis or by varying the rise time. You can also cascade up to 6 touchstone files to emulate a cascaded channel that might include connectors, fixtures, and channel models.
- **ISI Direct Dial-in:** ISI can be directly dialed-in at ease. It is no longer necessary to use FR4 traces which are inflexible and need frequent calibration when switching from one to another.
- **Presets:** SerialXpress supports any emerging standard data rate from 500 Kb/s to 8 Gb/s when teamed with the appropriate Tektronix AWG. There are ready-to-use presets that allow you a head-start on your testing.
- **Offline mode:** SerialXpress applications can run on an external PC, thereby reducing the time taken to synthesize large waveforms and leaving the AWG free for continued testing.

### Applications

- Design, debug, characterization, and compliance testing of high-speed serial data receivers
- SATA, PCIe, SAS, DisplayPort, Fibre channel, HDMI, USB, MIPI, Receiver testing

### Jitter generation made easy

SerialXpress enables creation of exact waveforms required for thorough and repeatable design validation, margin/characterization, and conformance testing of high-speed serial data receivers. It considerably simplifies the signal creation and jitter simulations, thus reducing overall development and test time.

SerialXpress supports generation of jitter (Random, Periodic (Sinusoidal), Inter Symbol Interference (ISI), and Duty Cycle Distortion (DCD)), and also supports Spread Spectrum Clocking (SSC), pre-emphasis, and noise addition. This allows the user to create a combination of various impairments simultaneously to stress the receiver. SerialXpress also allows the waveforms to be captured from Tektronix oscilloscopes and to be replayed using arbitrary waveform generators.

A programmatic interface enables easy integration of SerialXpress into test automation systems.

### Scrambling, PWM, 4-PAM, and 8B/10B encoding

The input data pattern can be scrambled by defining a polynomial. The user could enable the 8b/10b encoding option if the input pattern is in 8-bit word format before applying other impairments like jitter, SSC, and ISI. Users can also define the pattern duty cycle using the Pulse Width Modulation (PWM) feature, which allows for alternatively encoding the bit stream to 4-PAM.

### Jitter addition

Up to 4 different sinusoidal jitters with different amplitudes, frequencies, and phases can be added to the base pattern. Three independent band-limited random jitters can also be added to the base pattern.

### SSC modulation

SSC can be added with precisely controlled profile, spread, deviation, modulation, and  $df/dt$ . It supports Triangular, Sinusoidal, and Custom SSC profiles, where the custom SSC profile allows you to import your own user-defined profile by literally allowing any kind of shape to be added as SSC to the base pattern. You can also define the exact location and duration of  $df/dt$  on the SSC slope.

### Advanced emphasis

Many standards such as PCIe require the output waveform to be pre/de-emphasized. SerialXpress allows easy addition of pre/de-emphasis, including preshoot, with all other jitter parameters. Vertical noise can also be added at both near and far end of the channel.

### ISI creation

SerialXpress allows creation of ISI in two ways. First, the ISI value can be directly dialed-in. Second, an S-parameter file generated from a Tektronix sampling oscilloscope or a vector network analyzer can be directly convolved with the base pattern to recreate the channel characteristics. By applying inverse filtering the effects of the channel can be de-embedded from the system. Also, ISI within the S-parameter can be scaled upward or downward, which will change the characteristics of the channel.

### Delay

SerialXpress allows users to introduce delay to the waveform, and this feature can also generate skew between channels or patterns.

### Base pattern

SerialXpress is bundled with several sample patterns for various standards like SATA, Display Port, SAS, PCIe, HDMI, USB, MIPI, and Fibre Channel. Patterns can also be directly entered in a Binary, Symbol, or Hex editor or loaded as a file.

### Idle state

Standards like SATA call for OOB signaling which requires idle state<sup>1</sup> followed by a burst. Now the user can directly create this idle state without the need of using additional power dividers. Noise and offset can also be added to these idle state waveforms. Idle state can also be defined as a part of pattern definition.

### Calibration

SerialXpress has a built-in calibration routine which controls a Tektronix oscilloscope and calibrates the output of the AWG for periodic jitter and random jitter, reducing the need for time-consuming manual calibration.

### Bandwidth expansion filter

Rise time of the AWG can be expanded further by applying the bandwidth expansion filter. For example, when used with AWG7122C and Option 06, this compensates for the DAC roll-off at higher frequencies and extends the bandwidth up to 9 GHz.

### Marker outputs

Marker outputs can be configured to be the same as the input base pattern or to generate clocks at a user-defined frequency including subdata rates.

### Batch processing

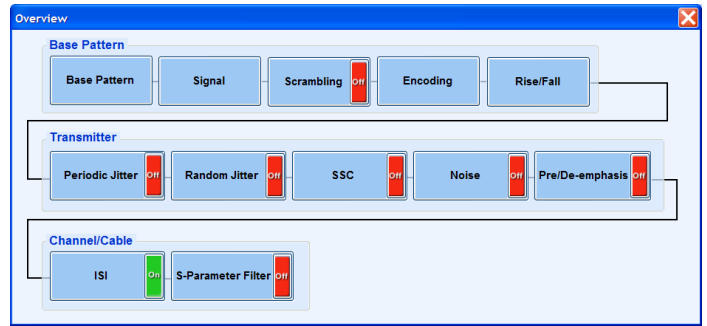
When more than one pattern needs to be synthesized, you can use batch processing that enables creation of multiple waveforms with a combination of random jitter and sinusoidal jitter with a maximum of 4 different frequencies.

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<sup>1</sup> When idle state (z) is included in the pattern definition, no jitter is applied.

## Overview window

All the jitter parameters can be switched ON/OFF from the Overview window.



Overview window

# Specifications

## General

<b>User interface</b>	Can reside and run on Windows 7.
<b>Compatibility for import of waveform/pattern files</b>	Tektronix TDS6000, DSA/DPO70000, MSO70000, and DSA/DPO7000 Series oscilloscopes. Tektronix Data Timing Generators DTG5000 Series.

## Instrument control

<b>Tektronix Arbitrary Waveform Generator controls</b>	SerialXpress® runs on an external PC or on AWG5000/7000/70000 Series arbitrary waveform generators; waveform transfer and control of the AWG5000/7000/70000 Series can be performed directly from SerialXpress
<b>Analog</b>	Interleave and zeroing on/off, DAC resolution, sampling frequency, amplitude, offset, run, stop, and channel output on/off
<b>Digital markers</b>	Amplitude high, low, and delay
<b>Tektronix oscilloscope controls</b>	Remote control Tektronix oscilloscope parameters from SerialXpress
<b>General settings</b>	Run, stop, single, and autoset
<b>Vertical settings</b>	Channel, scale
<b>Horizontal settings</b>	Scale, record length, sampling rate

## SerialXpress for jitter creation

<b>Mode</b>	Single, sequence
<b>Base data standard patterns</b>	
<b>SATA</b>	Idle state, LFTP, MFTP, HFTP, SFPCAlignR12, SFPCAlignR12-badbit, Gen1R12FCP4A, Gen1R25FCP4A, Gen1R10FCP2AnewLBP, Gen1R10FCP2AnewLBPErr, Gen2R8FCP2AnewLBP, Gen2R8FCP2AnewLBPErr, LTDP RD-, LTDP RD+, HTDP RD-, HTDP RD+, LFSCP RD-, LFSCP RD+, SSOP RD-, SSOP RD+, LBP, COMP RD-, COMP RD+
<b>PCIe</b>	Compliance pattern
<b>SAS</b>	CJTPAT, JTPAT RD+, JTPAT RD-
<b>Display port</b>	PRBS7, D24.3, D10.2, frequency lock, and symbol lock
<b>HDMI</b>	480P Gray RGB, 720P Gray RGB, 1080P 8-bit Gray RGB, 1080P 10-bit Gray RGB, 1080P 12-bit Gray RGB
<b>Fibre channel</b>	JTPAT, CJTPAT, SPAT, CSPAT
<b>USB</b>	minadd1N, minadd1P, TSEQ, CPO, CP1, CP2, CP3, CP4, CP6, CP8, BEREC, BRST
<b>MIPI</b>	CJTPAT_FC, Clock
<b>General</b>	Clock, PRBS (7, 9, 15, 16, user defined)
<b>File input</b>	Annotated .txt - Binary (1, 0, z) and Symbol (D, K, z words) <sup>2</sup>
<b>Pattern editor</b>	Binary, hex, symbol
<b>Data rate</b>	500 Kb/s to 8 Gb/s (direct synthesis with ×3 oversampling) and 12 Gb/s (binary data with ×2 oversampling)
<b>Encoding</b>	NRZ, NRZI, 4-PAM <sup>3</sup> , 8B/10B with starting disparity RD+, RD-

<sup>2</sup> "z" represents the idle state in a pattern definition.

<sup>3</sup> 4-PAM and PWM are mutually exclusive.

## SerialXpress for jitter creation

<b>Pulse width modulation</b>	On/Off				
<b>T_Minor</b>	0 to 0.5 UI				
<b>Rise time</b>	10/90, 20/80 1/sampling rate to 1/data rate				
<b>DCD</b>	0 to 1 UI				
<b>Periodic jitter</b>	Up to a maximum of 4 sinusoidal jitter				
<b>Amplitude</b>	0 to 50 UI				
<b>Frequency</b>	10 kHz to data rate/2				
<b>Phase</b>	0 to 360 degrees				
<b>Random jitter</b>	Up to max of 3 (Rj1, Rj2, and Rj3) with random seed on/off				
<b>Amplitude</b>	0 to 0.5 UI				
<b>Frequency</b>	1 Hz to data rate/2				
<b>Crest factor</b>	1 to 20				
<b>Idle state</b>	53 nS to 100 $\mu$ S				
<b>Offset</b>	-0.5 V to +0.5 V				
<b>SSC</b>					
<b>Shape</b>	Triangle, sinusoidal, custom				
<b>Spread</b>	Up, down, center, unequal (0 to 100%)				
<b>df/dt</b>	0 to 5000 ppm/ $\mu$ s				
	<table border="1"> <thead> <tr> <th>Minimum duration</th> <th>Location</th> </tr> </thead> <tbody> <tr> <td>0 to 5 <math>\mu</math>s</td> <td>20% to 80%</td> </tr> </tbody> </table>	Minimum duration	Location	0 to 5 $\mu$ s	20% to 80%
Minimum duration	Location				
0 to 5 $\mu$ s	20% to 80%				
<b>Frequency deviation</b>	0 to 200,000 ppm				
<b>Frequency modulation</b>	0 to 500 kHz				
<b>Noise</b>	0 to 100 ppm				
<b>Vertical noise</b>	0 to 0.5 $V_{RMS}$ with far end or near end				
<b>Pre/De-emphasis</b>	0 to 20 dB				
<b>Advanced pre/de-emphasis</b>	On/Off				
<b>Options</b>	Pre/de-emphasis, preshoot, pre/de-emphasis and preshoot				
<b>Type</b>	UI-constant, UI-linear, fractional				
<b>Units for tap co-efficients</b>	dB, Volts				
<b>Delay</b>	0 to 50 ps				
<b>ISI direct dial-in</b>	0 to 1 UI				
<b>S-parameter</b>					
<b>Mode</b>	Noncascading, cascading (6 max)				
<b>Filter bandwidth</b>	None, auto, and custom				
<b>Plot frequency response</b>	On/Off				
<b>File formats</b>	s1p, s2p, s4p, and s8p (single-ended and differential)				

**SerialXpress for jitter creation**

ISI scaling 0 to 10  
 Inverse filter (de-embed) On/Off

Aggressor	Signal	Amplitude scale	Data rate	Direction	Swap aggressor and victim
Enabled when s8p touchstone file is selected	Pattern from file, clock, same as victim	0 to 5	500 Kb/s to 12 Gb/s	Same as victim, opposite to victim	On/Off

**Presets**  
 SATA Gen1, Gen2, Gen3  
 USB 3.0  
 Display port HBR, RBR  
 HDMI 27 MHz, 222 MHz, 74.25 MHz, and 148.5 MHz at 60 Hz

**Batch processing**  
 Random jitter 0 to 0.5 UI with 0.01 increments  
 Sinusoidal jitter 0 to 50 UI with 0.01 increments  
 Sinusoidal frequency 10 kHz to data rate/2 (max of 4 frequencies)

**Bandwidth enhancement filter** On/Off

**Calibration** Periodic jitter, random jitter

**Marker setting base pattern**  
 Clock frequency Data rate, data rate/2, data rate/4, data rate/8, user defined (in Hz)

**Graphs**  
 DPO EYE  
 Normal EYE  
 Rise/fall time  
 Simulated data  
 Random, periodic, and total jitter  
 Jitter summary  
 TIE spectrum

**System requirements**

The following PC configuration is required to install the offline version:

**Note:** The hardware requirements detailed here are the minimum required. Additional processing power and memory will increase the performance of the generation software.

**PC** Genuine Intel Pentium class >1.2 GHz processor recommended  
**Motherboard chip set** Intel or 100% compatible  
**Operating system** Windows 7  
**RAM** 1 Gigabytes (GB)  
**Hard disk space** 2 GB of available space for the applications and documentation  
**Display** XVGA 1024×768 with 120 dpi font size recommended  
**Media drive** CD-ROM or DVD  
**Accessories** Keyboard and Microsoft mouse or compatible pointing device

## System requirements

# Ordering information

## Models

**SerialXpress®** Jitter Generation Software Package for Tektronix AWG5000/7000/70000 Series.  
**Includes:** USB dongle

## Software packages and options

**SDX100** Jitter Generation Software Package for the AWG5000/7000/70000 Series (includes USB dongle)  
**Option ISI** Include S-parameter and ISI creation (requires SDX100 as prerequisite)  
**Option SSC** Include Spread Spectrum Clock (requires SDX100 as prerequisite)

## Upgrade options

**SDXUP** Base software upgrade for SDX100  
**Option ISI** Upgrade to include S-parameter and ISI creation option for SDX100  
**Option SSC** Upgrade to include Spread Spectrum Clock option for SDX100



Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.



Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

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