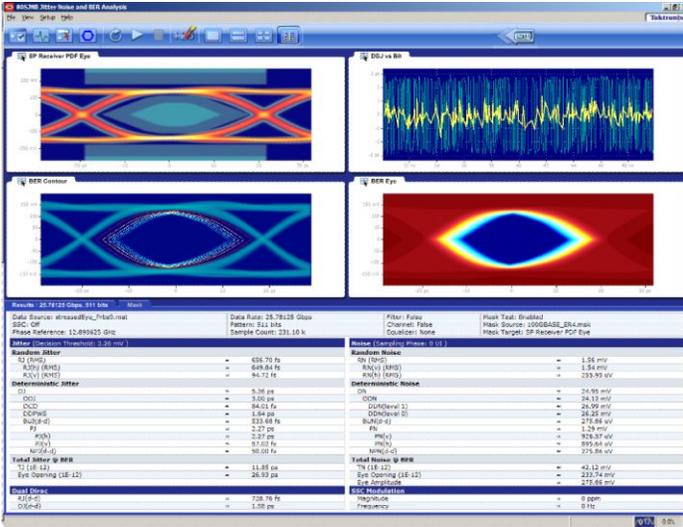


# 80SJARB and 80SJNB Jitter, Noise, and BER Analysis Software for DSA8300 Sampling Oscilloscopes Datasheet



## Jitter, Noise, BER, and Serial Data Link analysis software for Tektronix DSA8300 and 8000 series sampling oscilloscopes

The 80SJARB, 80SJNB Essentials, and 80SJNB Advanced (80SJNB01) software applications support high-speed serial data link measurements and analysis with the following capabilities:

Capability	80SJNB	80SJNB02 <sup>3</sup>	80SJARB
NRZ Data Supported	Repetitive pattern up to PRBS16	Repetitive pattern up to PRBS16	Any data, including PRBS31 or random traffic
J2 Jitter Result	Yes (on every edge; set the BER level to BER = $2.5e^{-3}$ )	Yes (on every edge; set the BER level to BER = $2.5e^{-3}$ )	Yes (on a histogram according to IEEE 802.3ba)
J9 Jitter Result	Yes (on every edge; set the BER level to BER = $2.5e^{-10}$ )	Yes (on every edge; set the BER level to BER = $2.5e^{-10}$ )	Yes (extrapolated from a histogram according to IEEE 802.3ba)
TJ Total Jitter Result	Yes (at settable BER; default BER = $1e^{-12}$ )	Yes (at settable BER; default BER = $1e^{-12}$ )	Yes (at BER = $1e^{-12}$ )
DJdd, RJdd <sup>1</sup>	Yes	Yes	Yes
Jitter and Noise Analysis (PJ, RJ, DDJ, PN, RN, DDN, etc.)	Yes	Yes	No
RIN, RINxOMA	Yes <sup>2</sup>	Yes <sup>2</sup>	No
BER Surface Graphs	Yes	Yes	No
SDLA Features (Channel emulation, fixture de-embedding, equalization)	No	Yes <sup>3</sup>	No
Additional features	Tektronix updates the software periodically. Please consult the latest data sheet from <a href="http://www.tek.com">www.tek.com</a> for up-to-date product feature information		

<sup>1</sup> Dual Dirac.

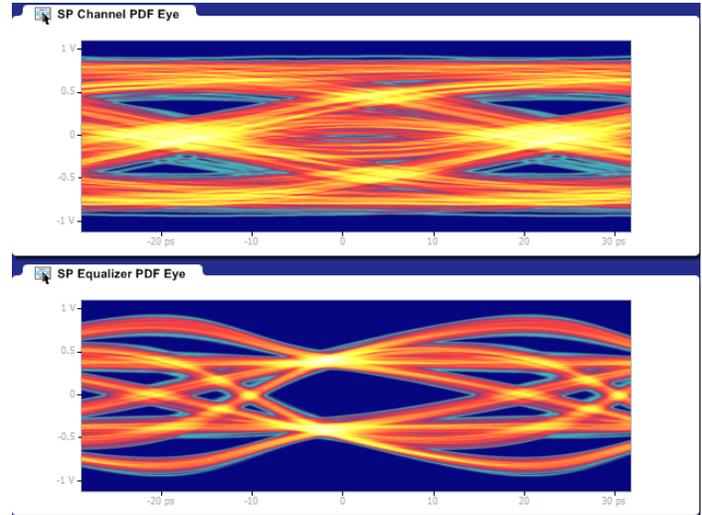
<sup>2</sup> Available from the TekExpress® RIN application which is distributed with the 80SJNB and 80SJNB01 applications

<sup>3</sup> JNB02 ships with SDLA Visualizer

<sup>4</sup> The tool for de-embedding filter creation is available free of charge from your Tektronix sales office.

## Modern serial data link designs

Acceleration of signaling speeds creates a number of challenges for design and test. The designs are evolving to address these challenges with equalization techniques in the receiver, pre-emphasis, or de-emphasis in the transmitter; with dedicated fixtures for capturing the signal at test point; and with complex compliance verification procedures.



## 80SJNB analysis tools

The advanced techniques employed by the designs call for advanced tools in the measurement solutions. The concerns begin with acquisition: capturing the data signal through physical fixture distorts signal shape; 80SJNB provides you with a fixture de-embedding feature<sup>4</sup> which allows you to remove the effects of the fixture from the measurement. The accuracy improvement might well mean the difference between a passing design and a failing one, because the impact of the fixtures on the signal fidelity today is large.

And what is the transmitter signal shape you are capturing? The signal from the transmitter is no longer a simple NRZ square-wave pattern. Transmitter designers alleviate high-frequency loss in the media with transmitter equalization features, for example with preemphasis or de-emphasis of the transmitter waveform. Correspondingly, transmitter signals today need to be evaluated for this transmitter equalization; your 80SJNB quickly provides equalizing tap weight results to give you insight into the quality of your transmitter for both single- and multi-tap transmitter equalization designs.

## Measure jitter and noise

80SJNB revolutionized jitter analysis by adding noise analysis, critical to noise- and eye-closure-limited high-speed designs. Complete characterization of both jitter and noise allows 80SJNB to offer capability new for oscilloscopes – BER contours, found on BERT instruments like the Tektronix BERTScope Series.

The latest version of 80SJNB offers another new feature: analysis that is aware of bounded uncorrelated disturbers (BUJ etc.). Bounded uncorrelated disturbers are a growing problem in fast, densely packed designs at 8 Gb/s and above, where they arise mostly from increased crosstalk. In older jitter and noise analysis tools they are typically mistaken for random, unbound components; classifying these components as unbound leads to inappropriate increase in random component breakdown (RJ) and total (TJ, TN) result. 80SJNB answers the challenge with a jitter and noise breakdown extended to properly classify the bounded uncorrelated disturbers in their own category, increasing the accuracy of the jitter/noise result.

Unique among jitter tools, 80SJNB breaks down the contribution of noise to jitter with RJ(v) and PJ(v). The breakdown quickly pinpoints the cause of jitter problems.

## Beyond measurements at the transmitter

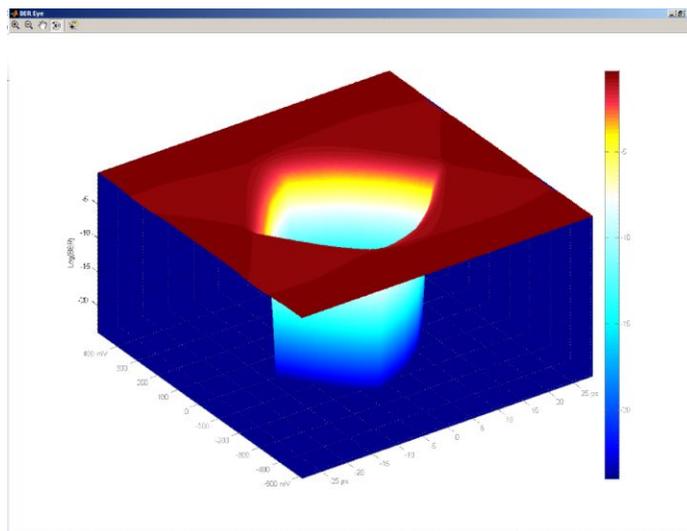
An important part of today's evaluation of serial data links is the complicated interaction between the shape of the measured waveform and the complex behavior of the interconnect channel. It is no longer possible to assume that if transmitter output meets the eye diagram mask it will work against all channels up to a given loss. Instead, advanced link test methods acquire the true transmitter waveform shape, and test against several corner-case channels.

Is the solution of emulating the channels based on their network description, for example, S-parameters? Such compliance tests are becoming a part of new standards. Now the measurement suite on your transmitter under test simply involves acquisition of the transmitter signal. Then you connect the captured signal to all required channels, one channel at a time – in emulation, rather than physically. 80SJNB supports this methodology; you can view the candidate channels without the need to reacquire the transmitter waveform. And unlike bare-bones evaluation scripts often used for pass/fail decisions the 80SJNB offers a rich set of views of the signal, starting with complete waveform, oversampled for high signal fidelity.

And of course the complete set of 80SJNB jitter and noise measurements is available to support your analysis of what problems, if any, your device might have. At the same time the BER eye offers a view of the link performance that matters most to the end user – in terms of BER performance and its margins. At the end of the test, save the waveform description data set for evidence or for future experiments; then recall and reanalyze whenever is needed without the need to reacquire.

## 80SJNB BER

Perhaps the single most important result of serial data link test is the BER; uniquely, the 80SJNB brings you the BER eye plot. While measurements on narrow parts of the signal are now common (jitter at the crossing, noise at the cursor), 80SJNB captures the whole signal, and then truthfully presents the accumulation of all impairments. Measurement results at a different decision threshold or timing point are just a click away, as the 80SJNB always keeps the whole 3-D shape and all waveforms behind it.



## Correlation

80SJNB Advanced offers a jitter-only analysis for compatibility with tools that measure jitter without considering the noise effect on bathtub closure.

## Mask testing

The communication industry (e.g. IEEE 802.3 100GBASE-LR4) has evolved mask testing from a basic test done on acquired data to a statistical-based methodology. In the past, testing was done by measuring the hit-ratio on the acquired eye and thus was done at a shallow BER. Statistical-based methods improve the repeatability and efficiency of the mask test on a larger population of data and as a direct result improve the ability to separate good and bad transmitters.

80SJNB Essentials adds support for the hit-ratio mask test and includes masks for common standards. Mask testing can be done on the waveform data or after de-embedding, channel emulation or equalization (requires 80SJNB02).

The 80SJNB Mask test goes beyond the standards' methodology and adds two new concepts:

First, you are not limited to measuring the eye diagram at the probability given by the acquired data, but can also measure at other probabilities calculated in the PDF space. For example, the hit ratio for a standard mask test may be one hit in 20,000 samples. This is supportable by the traditional mask testing available in an oscilloscope. However, for a hit ratio of one hit in 10 million samples, traditional mask testing would require an excessively long acquisition time; 80SJNB quickly calculates both of these hit ratios.

Second, since 80SJNB also calculates the BER eye surface, you can apply the mask test to a target Bit Error Ratio (such as the BER contour space). In other words, you can find the Bit Error Ratio for a given mask (a BER mask test). This approach provides a different insight into the overall system quality.

The PDF mask test is the traditional industry approach to assess the quality of a transmitter. The BER Mask test provides a test of the BER that the signal supports for the given mask. When a custom mask shape is needed, for example, based on a change in requirements, the shape can be easily modified in an ASCII file and used in either of the PDF or BER space.

## De-embed, embed, and equalize

### SDLA Visualizer and JNB Signal Path

JNB's Signal Path is now complemented with the advanced features of SDLA Visualizer. SDLA Visualizer extends the de-embedding and channel emulation capabilities of JNB signal path by offering a complete 4-port de-embed that models not only the effects of insertion loss, but also models the effects of return loss and cross-coupling. SDLA Visualizer also complements the DFE/FFE receiver equalization support in JNB and adds the ability to model CTLE equalization.

SDLA Visualizer works with the Signal Path function built into JNB Advanced. After configuring SDLA Visualizer, selecting the desired test point, and applying the model, the filter for the selected test point will automatically be loaded into the Signal Path filter block.

If DFE or FFE equalization are required, those parameters can be quickly entered in the JNB Signal Path and then the final measurements can be done.

These are just a few examples of the many features available from SDLA Visualizer, for more details see the SDLA Visualizer datasheet available on [www.tektronix.com](http://www.tektronix.com).

### Transmitter equalization measurements

Serial data transmitters employing pre-emphasis/de-emphasis can be evaluated and measured using the FFE equalization feature. The package can autoselect the tap values on the received PRBS pattern, enabling evaluation of the value of taps that counter-equalize the transmitter pre-emphasis/de-emphasis.

### Fixture removal, arbitrary filter

At high speeds the test fixture often significantly distorts the acquired signal. The Advanced package supports a filter block which can be used for the fixture removal. But the processing block is flexible, not dedicated; it can perform as an arbitrary filter instead, for example for simulation of pre-emphasis/de-emphasis schemes or for the use of filters created with SDLA Visualizer.

## Channel emulation

The interaction between the true transmitter signal shape and the channel (interconnect) parameters is complex and not easily predictable from separate measurements. A reliable way to observe the performance of the whole serial link is by connecting the true transmitter waveform to the channel. The channel doesn't have to be physically present: the Advanced 80SJNB package offers channel emulation based on network measurements of the channel. In this situation a transmitter signal with or without pre-emphasis/de-emphasis can be captured; the channel can be emulated through its S-parameters or time-domain network description, such as the TDR/TDT traces, and the signal at the end of the emulated channel can be measured.

## Equalize, then equalize again

The equalization in the transmitter is one tool in the arsenal of tricks for fighting the loss and dispersion in the interconnect: another one is the equalization at the receiver. Receiver equalization in most modern NRZ systems falls under either FFE (Feed Forward Equalization; also known as LFE – Linear Feedback Equalization), or DFE – Decision Feedback Equalization. A receiver equipped with equalization can decode signals that, when viewed as an eye diagram, are completely closed.

How to measure such signals? The 80SJNB equalization tools can open a completely closed eye, with your own equalizer tap values, or, at the push of a button, find equalization tap values on a PRBS pattern for you, for either a FFE or DFE equalizer. The speed of recalculation and the ease of use allows you to easily modify system parameters, such as the number and weight of taps, or the amount of pre or de-emphasis; you can verify the optimization of the design, or develop “what-if” scenarios.

For those cases where CTLE (Continuous Time Linear Equalization) is required SDLA Visualizer can quickly create the necessary filter and load it directly in JNB.

If you design or measure devices intended for the high-volume PC market you will appreciate the addition of operation on the SSC (Spread Spectrum Clocking) – another first in the sampling oscilloscope measurements. Using the DSA8300 or DSA/TDS/CSA8200 mainframes plus the 82A04 Phase Reference module, the 80SJNB not only measures your signals under the presence of SSC, it also measures the SSC parameters.

Beyond just analysis, 80SJNB presents the unmatched utility of separating the jitter caused by noise impairments versus its jitter-based component.

## The platform

The 80SJNB Jitter, Noise, BER, and Serial Data Link Analysis runs on the Tektronix 8000 Series Sampling Oscilloscopes. This combination of state-of-the-art analysis software with the advantages of the Tektronix sampling oscilloscope mainframe, such as modular flexibility, uncompromised performance, and unmatched signal fidelity provide you with the ideal solution for next-generation high-speed serial data design validation and compliance testing.

## Network description tool

The 80SJNB Jitter, Noise, BER, and Data Link Analysis software in some cases uses network description information, such as S-parameters in the Touchstone format. We recommend Tektronix TDR hardware and Tektronix IConnect application software for high-quality Touchstone network description data. Amongst the advantages of using Tektronix TDR hardware and IConnect is the preservation of the DC values in the Touchstone matrix, which is typically lost with other measurement methods. 80SJNB will work with network description based on other measurement methods, such as VNA data; the DC measurement results will then typically have to be extrapolated in the 80SJNB.

## Prerequisites

The software package is designed for use on 8000 Series Sampling Oscilloscopes, including the DSA8300 Digital Serial Analyzer Sampling Oscilloscopes and the older DSA/TDS/CSA8200, TDS/CSA8000B, and 8000 Digital Sampling Oscilloscopes and Communications Signal Analyzers<sup>5</sup>.

The SSC (Spread Spectrum Clocking) support requires the use of a 82A04 Phase Reference module, which can only be used on the 8300 and 8200 Series instruments.

When clock recovery of a SSC (Spread Spectrum Clocking) signal is needed the CR125A or higher or 80A07 Clock Recovery Unit is recommended; the 80A05 Clock Recovery unit does not support SSC.

## Jitter analysis of arbitrary data



The 80SJARB jitter measurement application software for the DSA8300 and older 8000 Series addresses IEEE 802.3ba applications requiring the J2 and J9 jitter measurements. It also enables basic jitter measurements for NRZ data signals including PRBS31, random traffic, and scrambled data. This provides an entry-level jitter analysis capability with simple Dual Dirac model jitter analysis and no hardware module requirements. 80SJARB can acquire continuously in “free run” mode, delivering acquisitions and updates beyond the IEEE minimum requirement of 10,000 data points. Plots include jitter bathtub curves for both measured and extrapolated data and a histogram of the acquired data.

## Supported 80SJNB, 80SJARB measurements

### 80SJNB, 80SJNB01 Advanced Jitter Analysis

Measurement	Description
TJ at BER	Total jitter at specified BER
J2	Total jitter for BER = $2.5e^{-3}$
J9	Total jitter for BER = $2.5e^{-10}$
RJ	Random jitter
RJ(v)	Vertical component of random jitter
RJ(h)	Horizontal component of random jitter
RJ(d-d)	Random jitter according to the Dual Dirac model
DJ	Deterministic jitter
DDJ	Data-dependent jitter
DDPWS	data-dependent pulse width shrinkage
DCD	Duty cycle distortion
DJ(d-d)	Deterministic jitter computed in the Dual Dirac model
PJ	Periodic jitter
PJ(v)	Vertical component of periodic jitter
PJ(h)	Horizontal component of periodic jitter
EO at BER	Horizontal eye opening at specified BER
BUJ	Bounded uncorrelated jitter
NPJ	Non-periodic jitter (uncorrelated and bounded)
SSCMagnitude	Magnitude of SSC modulation in ppm
SSCFrequency	Frequency of SSC modulation in ppm
<b>Noise analysis measurements</b>	
RN	Random noise
RN(v)	Vertical component of random noise
RN(h)	Horizontal component of random noise
DN	Deterministic noise
DDN1	Data-dependent noise on logical level 1
DDN0	Data-dependent noise on logical level 0

<sup>5</sup> DSA8200 recommended, min. 0.5 GB DRAM recommended. Consult release notes for performance limitations on older systems. SDLA Visualizer support for DSA8300 only.

Measurement	Description
PN	Periodic noise
PN(v)	Vertical component of periodic noise
PN(h)	Horizontal component of periodic noise
EO at BER	Vertical eye opening at specified BER
BUN	Bounded uncorrelated noise
NPN	Non-periodic noise
RIN	Relative Intensity Noise of the logic 1 level of a signal
RINxOMA	Relative Intensity Noise of a modulated signal

- Plots:** Jitter and Noise Components Probability Distributions, Spectral Distributions, Data Dependent Jitter and Noise and DDPWS vs. Bit, Data Pattern Waveform, Bathtub Curves for Jitter and Noise, BER Probability Map, BER Contour Diagrams, Q-Eye, Probability Distribution Eye Diagrams (Data pattern can be plotted after every Signal Path (SP) processing step), SSC (Spread Spectrum Clocking) Profile.
- Data Logging:** Query and Export of all Numeric Results. Export of Waveforms: Raw Acquired Pattern Waveform, Correlated Pattern

Waveform, Correlated Pattern Waveform after Every Signal Path Processing Step, Probability Distribution Eye Diagrams, and Bathtub Curves.

- Mask Testing:** Statistical mask testing in PDF or BER space.

## 80SJARB basic jitter analysis of arbitrary data

Measurement	Description
J2	Total jitter for BER = $2.5e^{-3}$
J9	Total jitter for BER = $2.5e^{-10}$
Tj	Total jitter for BER = $2.5e^{-12}$
DJdd	Deterministic jitter (Dual Dirac model)
RJdd	Random jitter (Dual Dirac model)

- Plots:** Jitter/Eye Opening Bathtub, Histogram of Acquired Data.
- Free Run Mode:** For continuous acquisitions and update beyond the IEEE minimum requirement of 10,000 data points.

## Specifications

All specifications apply to all models unless noted otherwise.

### Measurement characteristics

**Jitter Floor (DSA8300)**      With 82A04B:  $\leq 100 \text{ fs}_{\text{RMS}}$ <sup>6</sup>  
 Without 82A04B:  $\leq 400 \text{ fs}_{\text{RMS}}$

**Noise Measurement Accuracy**      Matches underlying hardware capability, see sampling module data sheet for specifications. Acquired waveform must be live. Acquired waveform must be a fixed repetitive pattern of maximum pattern length: 100k UI Network description in either Touchstone S-parameters (one-, two-, or four-port supported; single-ended and differential entry supported) or in time-domain 'reference, waveform' format (time-domain format \*.wfm of 8000 Series supported; time-domain format \*.wfm of IConnect<sup>®</sup> supported)

**Export Waveforms**      Raw (acquired) waveform, correlated filtered waveform after every step of the Signal Path

**Equalization Autoselection Patterns**      PRBS3 through PRBS16 (any pattern that can be analyzed can be also equalized)

**Maximum SSC (spread spectrum clocking)**<sup>7</sup>      >5000 ppm equalization schemes supported

**Maximum Number of Taps, FFE/DFE**      100/40; 1, 2, or 10 FFE taps / UI

**Arbitrary Filter Description**      Finite Impulse response Arbitrary Filter Description. Contact your Tektronix Technical Support Center (<http://www.tek.com/service/>) for other formats / format converters.

<sup>6</sup> See 82A04B data sheet for details; 82A04B only supported in the DSA8300 and DSA8200 Series mainframes. See DSA8300 data sheet for details on jitter floor performance.

<sup>7</sup> SSC is currently supported to 12 Gb/s. Controlled length cables are required for SSC acquisition; contact your application engineer for an application note.

**System requirements**

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<b>80SJARB</b>	Windows 7 or Windows XP equipped 8000 Series mainframe
<b>80SJNB</b>	<p>DSA8300 Series mainframe configured with Option ADTRIG and with software release V5.*. MS Windows 7 (please contact the Tektronix field office for information on upgrading your mainframe if necessary)</p> <p>DSA8200 or older series mainframe with 80A06 Pattern Sync Module (plugged into the oscilloscope, or on a SlotSaver cable)</p> <p>Contact your local Tektronix sales office for details on configuring your existing TDS/CSA8200, TDS/CSA8000B, or TDS/CSA8000 to be compatible with 80SJNB</p>

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## Ordering information

### Models

<b>80SJNB</b>	Jitter, noise, BER, and RIN/RINxOMA <sup>8</sup> measurement and analysis
<b>80SJNB02</b>	Adds the following features to the 80SJNB package for SDLA support: Fixture de-embedding/arbitrary linear filter support Channel emulation (based on channel time- or frequency-domain measurements) FFE/DFE Equalizer support
<b>80SJARB</b>	Basic jitter measurements

### DSA8300 preinstall options

Order one of the following options to preinstall 80SJARB, 80SJNB, or 80SJNB01 in a DSA8300 instrument:

<b>Option JARB</b>	Add 80SJARB to DSA8300
<b>Option JNB</b>	Add 80SJNB Essentials to DSA8300
<b>Option JNB02</b>	Add 80SJNB Advanced to DSA8300

- For users of the original (80SJNB V1.\*) package, the 80SJNB Essentials (V2.\*) is a free update. Download the free update from [www.tek.com](http://www.tek.com).
- You do not need to order 80SJARB when ordering 80SJNB or 80SJNB02; it is included at no additional charge.
- 80SJARB is available to all licensed users of 80SJNB and 80SJNB02 at no charge. Simply download 80SJARB from the Tektronix Web site.

### Instrument upgrade options

Order one of the following to upgrade an existing instrument with 80SJARB, 80SJNB, or 80SJNB02 software:

Instrument	Upgrade	Option	
DSA8300	DSA83UP	JNB	Add 80SJNB Essentials to DSA8300
		JNB02	Add 80SJNB Advanced to DSA8300
		JNBTOJNB02	Upgrade from JNB <sup>9</sup> to JNB Advanced
		JNB01TOJNB02	Upgrade JNB01 to JNB02 (Adds SDLA Visualizer)
DSA8200	DSA82UP	JNB	Add 80SJNB Essentials to DSA8200
		JNB01	Add 80SJNB Advanced to DSA8200
		JNBADD01	Upgrade from JNB <sup>9</sup> to JNB Advanced



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.

<sup>8</sup> RIN and RINxOMA measurements are taken using the TekExpress RIN application which is distributed with the 80SJNB and 80SJNB01 software.

<sup>9</sup> The upgrade path from JNB to JNB Advanced also applies to JNB Essentials to JNB Advanced.



## 80SJARB and 80SJNB Jitter, Noise, and BER Analysis

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\* European toll-free number. If not accessible, call: +41 52 675 3777

**For Further Information.** Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit [www.tektronix.com](http://www.tektronix.com).

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