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User Manual

Tektronix

SJ300E
SONET/SDH
Jitter and Wander Analyzer

070-9389-02

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Use Proper Voltage Setting. Before applying power, ensure that the line selector is in the proper position for the power source being used.

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth gruond. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

The common terminal is at ground potential. Do not connect the common terminal to elevated voltages (see Specification section for further details).

Safety Certification Compliance

Category	Description
Temperature (operating)	5 to +40°C
Altitude (maximim operating)	2000 meters
Equipment Type	Test and Measuring
Safety Class	Class I (as defined in IEC 1010-1, Annex H) - grounded product
	EN61010-1/A1 Safety requirements for electrical equipment for measurement, control, and laboratory use.
Overvoltage Category	Overvoltage Category II (as defined in IEC 1010-1, Annex J).
Pollution Degree	Pollution Degree 2 (as defined in IEC 1010-1). Note - Rated for indoor use only

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Safety Standards

Category	Standards
U.S. Nationally Recognized Testing Laboratory Listing (NRTL)	UL 1244 - Electrical and Electronic Measuring and Testing Equipment
Canadian Certification	CAN/CSA-22.2.No. 231 CSA Safety Requirements for Electronical and Electronic Measuring and Testing Equipment

Warning and Caution Labels

Paragraphs or sections in the SJ300E User's Guide that contain important safety information will be identified by either a CAUTION or a WARNING label in the left hand margin. These labels are explained below:

Icon	Label	Meaning
	**WARNING !**	Indicates a safety practice that must be followed to avoid **possible injury** to the user and possible damage to the instrument.
	**CAUTION!**	Indicates a safety practice that must be followed to prevent **possible damage** to the SJ300E or other instruments used with the SJ300E.

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About This Document

This Document is intended for telecommunications engineers and technicians with more than two years of experience using SONET/SDH Analyzers to measure jitter and wander.

The document covers the SJ300E SONET/SDH Jitter and Wander Analyzer.

Chapter 1—Introduction
Introduces the SJ300E SONET/SDH Jitter and Wander Analyzer and defines the scope of the SJ300E User's Guide. It also contains an overview of SJ300E applications and a list of references that contain supplemental applications and operation information.

Chapter 2—Getting Started
Presents important safety information that we strongly urge you to read before setting up and using your SJ300E. It also contains initial unpacking, setup, and check-out procedures, plus information on how to contact Tektronix Customer Service if you have any setup or service questions.

Chapter 3—Instrument Description and Configuration
First, this chapter provides a functional or “block diagram” description of the SJ300E. Second, it describes each connector, control, and indicator on the SJ300E front and rear panels. Third, it presents example configurations showing how the SJ300E may be connected to networks, network elements, and other test equipment to make SONET/SDH jitter and wander measurements.

Chapter 4—Setup and Operation—General
This chapter explains how to set up and perform manual jitter and wander measurements using SJ300E front panel controls.

Chapter 5—Setup and Operation Jitter Sequences
This chapter details how to set up and perform jitter transfer measurements using the automatic jitter sequence generation, calibration, and measurement features of the SJ300E.

Chapter 6—Using Printers and External Controllers
This chapter explains how to connect external devices to the instrument's RS-232, GPIB, and parallel ports, including port setup procedures.

Chapter 7—Remote Commands
This chapter explains the general syntax and defines the SJ300E remote command language. Definitions are grouped by function and listed alphabetical. It includes page references for individual commands.

Appendix A—This Appendix contains SJ300E specifications. All specifications apply to the SJ300 after a 20 minute warm-up period in it’s ambient operating environment. These specifications apply to SJ-300s with firmware revisions greater than 5.3 and to SJ300E test sets with serial numbers 9309000 and higher.

Software Revision

This manual supports software revision 6.1

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Manual Conventions

This manual users the following conventions:

Brackets ***[ ]*** indicate an optional software function.

The drive letter in the following statement may not be needed:

[<drive>:]

The drive letter and the path description may not be needed:

[<drive>:][<path>] **TDEVMTIE**

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Introduction

This chapter introduces the SJ300E SONET/SDH Jitter and Wander Analyzer and defines the scope of the SJ300E User's Guide. It also contains an overview of SJ300E applications and a list of references that contain supplemental applications and operation information.

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Scope of This Guide

This guide is the primary manual for local and remote operation of the SJ300E SONET/SDH Jitter Analyzer, including the Wander Test Option.

Specifically it explains or provides:

- Important safety information.
- How to unpack and set up the SJ300E for the first time.
- The functions of all inputs, outputs, controls, and indicators.
- How to operate the SJ300E locally using front panel controls.
- How to connect the SJ300E to external printers and controllers.
- How to connect the SJ300E to SONET/SDH networks and equipment in typical applications.
- A reference for the SJ300E remote command language.
- Specifications
- Hardware and software options available with the SJ300E.

For information on using the the TDEV (wander analysis) or FFT (jitter power spectrum) applications available with the SJ300E, or the SC100 data converter, please refer the appropriate document listed in the section titled “Where to Find More Information” on page 1-10.

Customer Support and Product Ordering

Customer Support:

Tektronix, Inc.
Measurement Business Division
Microwave Logic Products
285 Mill Road
Chelmsford, MA 01824
Tel: 800-643-2167 or 508-256-6800
Fax: 508-256-2038

Ordering Information:

To order Microwave Logic Products, call
Tektronix at 800-426-2200

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Repair Returns

If your SJ300E is not functioning, or if you believe it needs service or calibration, please contact our Customer Service department. There are no user-serviceable parts or assemblies in the SJ300E. If we cannot solve your problem over the phone, and you want to return your SJ300E to the factory for service or repair, please ship the instrument to Tektronix, Inc. as follows:

1. Ask our Customer Service department for a **Return Authorization Number (RAN)**.
2. Pack the instrument in its original packing material if available, or other suitable material if it is not. Always provide sufficient shipping protection by using a double-walled box and packing the instrument in shock-absorbing material such as foam or bubble-wrap. It is also a good idea to include a note inside the box with the appropriate contact name and phone number in your organization, the desired return shipping address, and a brief explanation of why the instrument is being returned. Then seal the box with strong tape and mark the outside of the box with the RAN.
3. Ship to:

   Tektronix,
   Microwave Logic Products
   285 Mill Road
   Chelmsford, MA 01824
   Attn. Customer Service

*NOTE: Please don't forget to print the **RAN** on the outside of the box. This will help us identify your package when it arrives at our factory.*

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SJ300E Product Description

The SJ300E is a portable, full-featured instrument that generates and measures Phase Jitter on SONET OC-1/3/12 or SDH STM-0/1/4 lines. With option 06, it also provides STM-n/OC-n and DS1/E1 wander generation and analysis. It is considered the only universally-accepted method to successfully complete jitter and wander testing and analysis. It analyzes line jitter and wander up to 622 Mb/s and diagnosis system synchronization problems.

TDEV MTIE software that runs on a PC, and is included with the Wander Test Option, provides fast MTIE and TDEV analysis and insures conformance to ANSI, Bellcore, and CCITT specifications.

With its expanded wander test capabilities the SJ300E is ideal in the field for test applications, and in the lab for component design and specification conformance testing.

NOTE: The SJ300E does both SDH and SONET jitter and wander testing. Conformance to the SDH specification is not 100% but the SJ300E provides functionality on par with competitive products. Call product line marketing for additional information.

SJ300E Options

Nomenclature	Description
Opt. 03	SONET OC-1/3, SDH STM-1 Optical
Opt. 04	OC-1/3/12, STM-1/4 Optical
Opt. 06	DS1, E1, 51-622 Mb Wander Test
Opt. 09	SC100A Line Code Converter
Opt. 1M	Rack Mount
Opt. 3C	Replace FC Connectors with SC
Opt. 4C	Replace FC Connectors with ST
Opt. 4S	FFT SW Application Diskette
Opt. 7C	Replace DS1 Connectors with E1 BNC
Opt. 1M	Rack Mount
Interface Cables	RS-232-C, GPIB, Centronics
Adapters	SMA

SONET OC-1/3, SDH STM-1 Optical (Opt. 03)

This option adds jitter test capabilities for the OC-1 52 Mb/s and the OC-3/STM-1 155Mb/s optical line rates. FC connectors and 310 nm optics are standard for this option.

SONET OC-1/3/12, STM-1/4 Optical (Opt. 04)

This option adds jitter test capabilities for the OC-1 52 Mb/s, OC-3/STM-1 155Mb/s, and the OC-12/STM-4 622 Mb/s optical line rates. FC connectors and 310 nm optics are standard for this option.

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Wander Test Option (Opt. 06)

The Wander Test Option provides additional hardware, firmware, and software. It includes the Wander Test Card that can measure wander amplitude on SONET/SDH line or BITS/SETS synchronization signals. The Wander Test Card can also generate a BITS/SETS synchronization signal output with added wander or noise jitter. This option includes MS-DOS compatible software to upload (TIE) data from the SJ300E and calculate TDEV and MTIE based on wander.

FFT Jitter Analysis Software (Opt. 4S)

The FFT Option is an MS-DOS compatible software application that can calculate a jitter power spectrum—jitter power as a function of frequency—based on jitter data uploaded from the SJ300E.

Line Code Converter (Opt. 09)

This option is the stand alone SC100A unit that has three primary functions:

- It converts received STS-1 (STM-0) AMI signals or STS-3 (STM-1) CMI signals into clock and data signals compatible with the SJ300E's electrical (ECL) clock and data inputs. This allows the SJ300E to make jitter and wander measurements from STSX-1 or STSX-3 cross-connect locations.
- It converts SJ300E clock and data ECL outputs into STSX-1 or STSX-3 signals. This allows the SJ300E to generate jitter and wander on STSX-1 or STSX-3 format signals.

Rack Mount Kit (Opt. 1M)

This option provides a pair of rack-mounting ears and associated hardware to mount the SJ300E in a 19-inch equipment bay.

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Interface Cables, RS-232-C, GPIB, Centronics

RS-232-C

012-0911-00	10 ft. DB25 male – DB25 female, straight through
012-1285-00	9 ft. DB25 male – DB25 female, null modem
012-1298-00	9 ft. DB25 male – DB9 female, null modem
131-4923-00	DB25 male – DB25 male gender changer
174-1453-00	For 222/224
012-1241-00	9-pin female to 25-pin male
012-1379-00	9-pin female to 9-pin male
012-1380-00	9-pin female to 25-pin male
012-1398-00	9 in. RS-232-C to plotter/printer

GPIB

012-0991-00	2m, double-shielded
012-0991-01	1m, double-shielded
012-0991-02	4m, double-shielded
012-1282-00	0.5 m, GPIB

Centronics

012-1233-00	3 m, 4693 to Terminal
012-1214-00	8 ft. Male Centronics to PC 25-Pin D
012-1284-00	9 ft. male to male

Adapters, SMA

015-0369-00	SMA male to N
015-0572-00	SMA male to BNC male
015-0554-00	SMA male to BNC female
015-1009-00	SMA male to N female
015-0553-00	Threaded female to male slip-on connector
015-0549-00	Male to female connector (Used permanently installed to prolong life of instrument connector.)
020-1693-00	SMA Kit

Bellcore CLEI and CPR Product Codes

The SJ300E has been assigned the following Bellcore COMMON LANGUAGE Product Codes:

CLEI: SNTQABR6AA

CPR: 674505

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Applications Overview

Jitter and wander are important timing characteristics of digital networks. In an idealized digital network, all signals appearing at network interface points would have no phase variation when compared with a jitter- and wander-free reference signal. In real networks, however, all signals contain some phase variation. Digital signal phase variation is classified as either jitter or wander, depending on its frequency. Specifically, phase variation composed of frequencies above 10 Hz is defined as **jitter** while phase variation composed of frequencies below 10 Hz is defined as **wander**. It is important to note that wander is defined to include any frequency difference or "offset" that may exist between the signal under test and the reference signal. Frequency offsets result in a "phase ramp"—a phase difference that grows at a constant rate as a function of time. The frequency ranges of wander and jitter are illustrated in Figure 1-1.

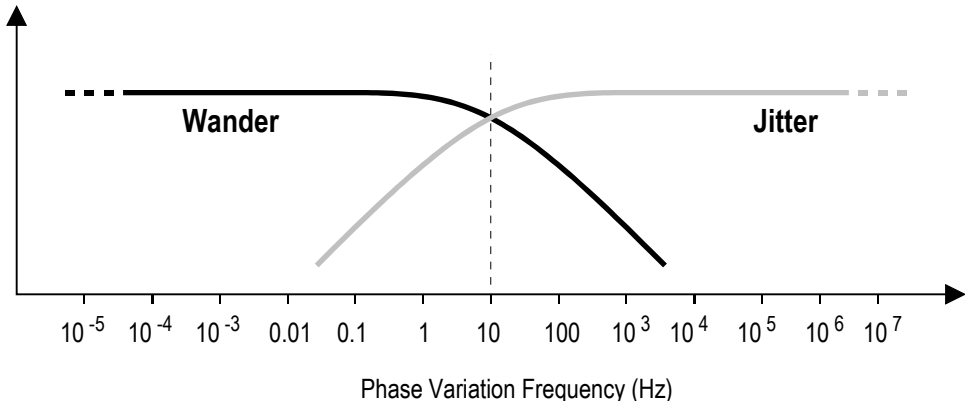


Figure 1-1 Wander is composed of phase variation components below 10 Hz. Jitter is composed of components above 10 Hz.

In SONET or SDH synchronous networks both jitter and wander are of interest. As in traditional asynchronous networks, synchronous network elements have clock recovery phase-locked loops that are sensitive to jitter. In addition, they are equipped with FIFO buffers that operate "open loop", depending on the inherent synchronization of the network to keep from overflowing or underflowing. Therefore, synchronous networks are also sensitive to phase variation at wander frequencies, including frequency offsets.

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Jitter Causes and Specifications

The jitter transfer characteristics of regenerators, loop-timed network elements, or through-timed network elements can amplify the nominal jitter present in all SONET/SDH networks to unacceptable levels. In the example shown in Figure 1-2, an Add-Drop Multiplex (ADM) originates an OC-n or STM-n line signal with a small amount of jitter generated by noise and inter-symbol interference. As the jitter passes through each regenerator, it can experience jitter transfer gain. At any interface point, for example at optical signal cross-connects, the question is whether the terminating network element can tolerate the jitter on its input.

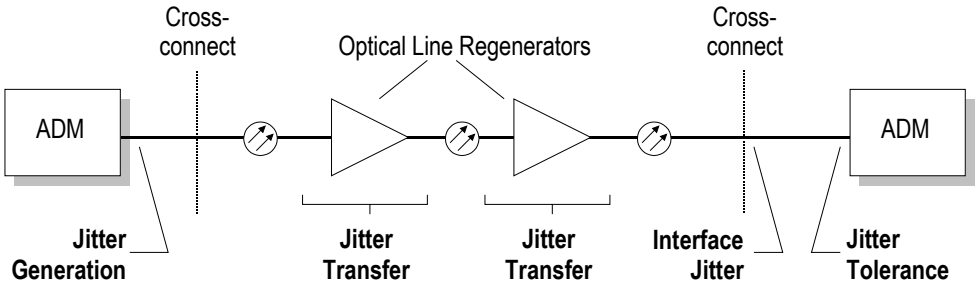


Figure 1-2 Jitter accumulation in a SONET or SDH network.

To control jitter accumulation in SONET and SDH networks, standards organizations including ANSI (T1.105.03-1994), Bellcore (GR-253-CORE), and the ICU/CCITT (G.82j and G.958) have specified limits on the following jitter characteristics:

- **Jitter Generation:** The jitter on a line output of a SONET or SDH netork element that is synchronized to a jitter-free, wander-free reference signal.
- **Jitter Tolerance:** The jitter on a line input to a SONET or SDH network element that causes a specified performance degradation.
- **Jitter Transfer:** The ratio of the jitter on a line output of a network element to the single-frequency jitter applied to the corresponding line input. Jitter transfer is specified only for regenerators, or ADMs in loop- or through-timed configurations.
- **Interface Jitter:** The jitter on output signals at a network interface, for example an OC-n or STMn signal cross-connect.

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Wander Causes and Specifications

Network elements in SONET or SDH systems may depend on the synchronization between two incoming OC-n or STM-n line signals, or between incoming line signal and a BITS or SETS synchronization clock signal. For example, in the SONET network illustrated in Figure 1-3, the ADM on the left depends on the synchronization between the incoming OC-n line signal and an applied BITS synchronization signal which is used to time the outgoing line signal (indicated by dashed line).

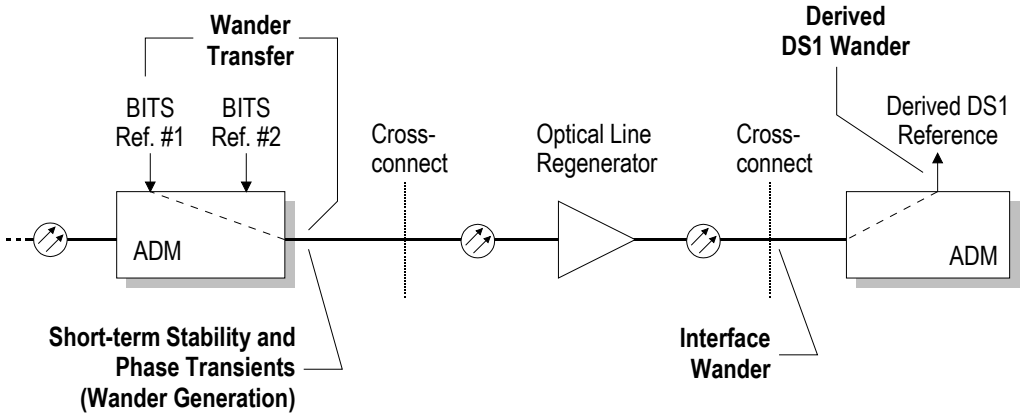


Figure 1-3 Wander in a SONET or SDH Network.

Every SONET and SDH ADM is equipped with a FIFO buffer that can accommodate some wander between the incoming line signal and the synchronization signal. However, if the wander between these two signals exceeds a threshold payload pointer, adjustments are necessary to keep the FIFO from overflowing. Excessive pointer adjustments can result in excessive payload jitter and payload errors. Thus, video, data, and even voice service can be degraded by excessive wander in a SONET or SDH network.

All wander measurements are based on the change in relative phase between two signals as a function of time. Relative phase vs. time is also known as time interval error or TIE. SONET/SDH wander requirements are not, however, specified in terms of TIE directly. Rather, they are expressed in terms of maximum time interval error (MTIE) and time deviation (TDEV), both of which are based on TIE. MTIE characterizes both short-term “phase hits” and long-term “frequency offset”, the two main components of wander. TDEV characterizes the spectral content of wander.

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To insure that payload jitter stays within acceptable limits in large SONET networks, Bellcore (GR-253-CORE) and ANSI (T1.101-1994) have specified limits on the wander generated by network elements, and the maximum wander amplitude that may appear on output signals at network interface points:

- **Wander Generation:** Limits the MTIE and TDEV on output line signals generated by a network element that is timed by a wander-free reference that contains a specified level of "noise-jitter" in the 10 to150 Hz jitter frequency band.
- **Wander Transfer:** Limits the TDEV on output line signals generated by a network element that is timed by a wandered line signal that has a specified TDEV vs. Integration Time mask.
- **Phase Transients:** Limits the MTIE on output line signals generated by a network element during "synchronization rearrangements", such as an internal switch from one reference signal to another.
- **Derived DS1 Wander:** Limits the TDEV on DS1 output timing signals generated by a network element that is timed to an OC-n line signal.
- **Interface Wander:** Limits the MTIE and TDEV on all output signals appearing at SONET optical and electrical signal interface points—for example OC-n or STSX-n cross-connects.

Documentation Reference (Where to Find More Information)

The following documents contain additional information on SJ300E applications, software options and the SC100 data converter. Depending on the options ordered with your SJ300E, some or all of these documents will be included in the back of the binder containing the SJ300E User's Guide. You may also obtain a copy of any document listed below by contacting Tektronix Customer Service.

[1] "SONET Jitter and Wander—Their Origin, Effects, and Measurement—A Guide to Bellcore and ANSI Specifications"

[2] "BITS Wander Option for the SJ300E Including OP-TDEV" (Addendum Manual).

[3] "PROGRAM FFT: Data Collection and Analysis Program for Jitter Raw Sample Data from the SJ300E" (Operations Manual).

[4] "SC100A Line Code Converter" (Operations Manual) .

[5] "OC-n/STM-n Wander Measurement" (Application Note).

[6] "BITS Wander Measurement Option" (Application Note).

[7] "Why the Need for Jitter Transfer Measurement" (Application Note).

[8] "Derived BITS Clock Accuracy" (Application Note).

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Getting Started

This chapter presents important safety information that we strongly urge you to read before setting up and using your SJ300E. It also contains initial unpacking, setup, and check-out procedures, plus information on how to contact Tektronix, Inc. Customer Service if you have any setup or service questions.

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Safety Information

This section contains information and instructions that are critical to the safe operation of the SJ300E SONET/SDH Jitter Analyzer. **READ THIS SECTION BEFORE SETTING UP AND USING YOUR SJ300E**.

Key Safety Practices



WARNING! When operating your SJ300E, always follow the safety practices listed below. Failure to do so can cause injury to the user and damage the instrument.

AC Power

The SJ300E is designed to sense and switch line voltages between 115 VAC (90 to 132 VAC) and 230 VAC (180 to 250 VAC) and to operate at a line frequency of either 50 Hz or 60 Hz (47 to 63 Hz range). Never connect the SJ300E to a line voltage that falls outside this voltage or frequency range.

Ground the Instrument

The SJ300E is grounded through its AC LINE connector. Always power the SJ300E using a three-conductor power cord that is plugged into a grounded, three-conductor outlet. If you operate the SJ300E without a proper ground then all metal surfaces of the instrument become potential shock hazards.

Use the Proper Fuse

Always replace the SJ300E AC LINE fuse using the procedure and fuse rating specified in the section titled “Fuse Replacement” on page 2-5. Operating the instrument with an improper fuse will create a fire hazard.

Do Not Look Into the OPTICAL Output

The SJ300E OPTICAL output is equipped with a high-powered laser. ***Never look directly into this output or into an unterminated optical patch cord connected to this output.*** If you do not follow these precautions, permanent eye injury can result.

Do Not Operate in Explosive Atmospheres

The SJ300E does not provide protection from static discharges or arcing components and therefore must not be operated in an explosive atmosphere.

Do Not Remove Instrument Covers

To avoid a shock hazard and to maintain proper air flow, never operate the SJ300E with any of its outside covers removed.

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Unpacking and Inspection

Unpack your SJ300E and note any exterior or interior damage to the shipping container. Inspect the SJ300E itself for exterior physical damage such as dents or paint scratches. Carefully tilt the instrument up and down a few times to make sure there are no loose components rolling around inside. DO NOT however remove any instrument covers. If damage is found, or damage to the instrument during shipment is suspected, keep the container and contact Tektronix, Inc. Customer Service for instructions.



WARNING! If you live in a cold weather area, let the SJ300E shipping container warm up to room temperature before opening the container. A recommended minimum container warm-up time is two hours. If you expose a cold instrument to warm air, damaging condensation can occur inside the instrument. If you suspect that condensation has occurred, let the instrument dry completely at room temperature before plugging it into an AC power outlet.

Initial Setup Procedures

Procedures for setting up your SJ300E hardware for bench-top or rack-mount applications are given next.

Bench-Top Setup

When the SJ300E is operated from a bench-top, shelf, or other flat surface, you can raise the instrument's front panel to a convenient viewing angle by rotating the carrying handle down and to the front. Or you can operate the SJ300E with all four feet "on the ground" by adjusting the carrying handle to a position above the top cover. To rotate the handle, press and hold the two black buttons on either side of the handle; then move the handle to the desired position. When you release the buttons the handle will lock in place.

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Rack Mount Setup

The SJ300E can be mounted in a 19-inch equipment bay using optional rack-mounting adapters (see Appendix C). If you order these adapters with your unit, they will be installed at the factory. However, if you order the rack mount adapters separately, use the following procedure to install them on your SJ300E. If you have any questions, please call Tektronix, Inc. Customer Service.

1. Remove the handle:
   a. Pry off the two detent buttons on either end of the handle using a small, flat screwdriver.
   b. Remove the screws that were hidden by the buttons.
   c. Carefully bend the two ends of the handle outward and remove it from the instrument.
2. Remove the instrument's front and rear bezels. Note there are two metric screws holding each bezel in place.
3. Slide out the trim strip located in each side rail.
4. Add the square nut and plastic retainer from your adapter kit to each side rail.
5. Using the metric screws provided, *loosely* attach the T-shaped panel bracket to the middle two square nuts in each side rail (DO NOT TIGHTEN YET!).
6. Attach a rack-mount panel bracket to each side rail (two 8-32 nuts each). Slide the rack-mount panel and bracket in each rail as necessary.
7. Replace the front bezel (two metric screws), sliding the rack mount panel and brackets for alignment.
8. Tighten the two screws holding each bracket its side rail.
9. Replace the rear bezel (two metric screws) keeping the top and bottom covers in place.

Connecting to AC Power

The SJ300E is designed to sense and switch line voltages between 115 VAC (90 to 132 VAC) and 230 VAC (180 to 250 VAC) and to operate at a line frequency of either 50 Hz or 60 Hz (47 to 63 Hz range). Never connect the SJ300E to a line voltage that falls outside this voltage or frequency range. Therefore you may power the SJ300E from either 115 VAC or 230 VAC without adjustment.

Cooling Requirements

SJ300E cooling fans are mounted on the rear-panel. Therefore you must provide *at least* a 2-inch (5 cm) clearance behind the rear-panel.



CAUTION! Failure to provide proper clearance behind the SJ300E can affect its performance or cause permanent damage to the instrument.

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Fuse Replacement

The SJ300E power fuse is located next to the AC LINE connector on the rear panel. **Always equip the SJ300E with a 5-A slo-blo fuse (LittleFuse 3AG or equivalent).** .

▶ **To replace the SJ300E power fuse:**

1. Unplug the power cord from the AC outlet.
2. Disconnect the power cord from the SJ300E AC LINE connector.
3. Slide the fuse cover (located on the rear-panel next to the AC LINE connector) upwards; then remove the old fuse.
4. Install the new fuse and slide the fuse cover back into place.
5. Re-install the power cord into the AC LINE connector.
6. Plug the power cord back into an AC outlet

Your SJ300E is now ready for use.

Check-Out Procedure

To verify the basic operation of your SJ300E, refer to Appendix B for a functional verification procedure. This procedure is also a useful introduction to basic SJ300E features and operation.

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Instrument Description and Configurations

This chapter has three objectives. First, it provides a functional or “block diagram” description of the SJ300E. Second, it describes each connector, control, and indicator on the SJ300E front and rear panels. Third, it presents example configurations showing how the SJ300E may be connected to networks, network elements, and other test equipment to make SONET/SDH jitter and wander measurements.

- ❑ Functional Description 3-2
- ❑ Front Panel Overview 3-8
- ❑ Menu Overview 3-13
- ❑ Rear-Panel 3-17
- ❑ Inputs and Outputs 3-18

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Block Diagram Description

This section explains the measurement capabilities of the SJ300E. To do this, the instrument will be described from a functional point of view, referring to the block diagram shown on the next page.

Overview

The objective of the SJ300E block diagram (Figure 3-1) is to show *what* the instrument can do rather than *how*. Thus, for the sake of clarity, the actual architecture of the SJ300E differs somewhat from that shown in the diagram. However the block diagram accurately depicts the measurement capabilities of the SJ300E and the functions of its inputs and outputs.

Inputs and Outputs Shown in the Diagram

Several general points can be made about the inputs and outputs shown in Figure 3-1. First, all instrument inputs are shown on the left of the diagram while all outputs are shown on the right. Moreover, all rear-panel inputs and outputs are marked with an asterisk (*) while all front panel inputs and outputs are not marked.

Second, inputs and outputs labeled REF CLOCK are used to sink or source *reference* clock signals. These are clock signals that are assumed or designed to be “jitter- and wander-free.” REF CLOCK inputs may be used as reference signals when measuring jitter or wander. They may also be used as reference clock signals to which jitter or wander may be added. REF CLOCK outputs will not contain added jitter or wander.

Third, all REF CLOCK inputs and outputs are marked either “Line” or “Sync.” REF CLOCK *line* ports are inputs or outputs for line rate clock references, which are clock signals that have a frequency of 52 MHz, 155 MHz, or 622 MHz. The Receiver REF CLOCK *sync*. port, on the other hand, is an input for a sychronization clock reference, which may be a 1.544 Mb/s BITS or 2.048 Mb/s SETS framed all-ones signal. Note that the BITS IN and BITS OUT ports are also a synchronization clock input and output respectively.

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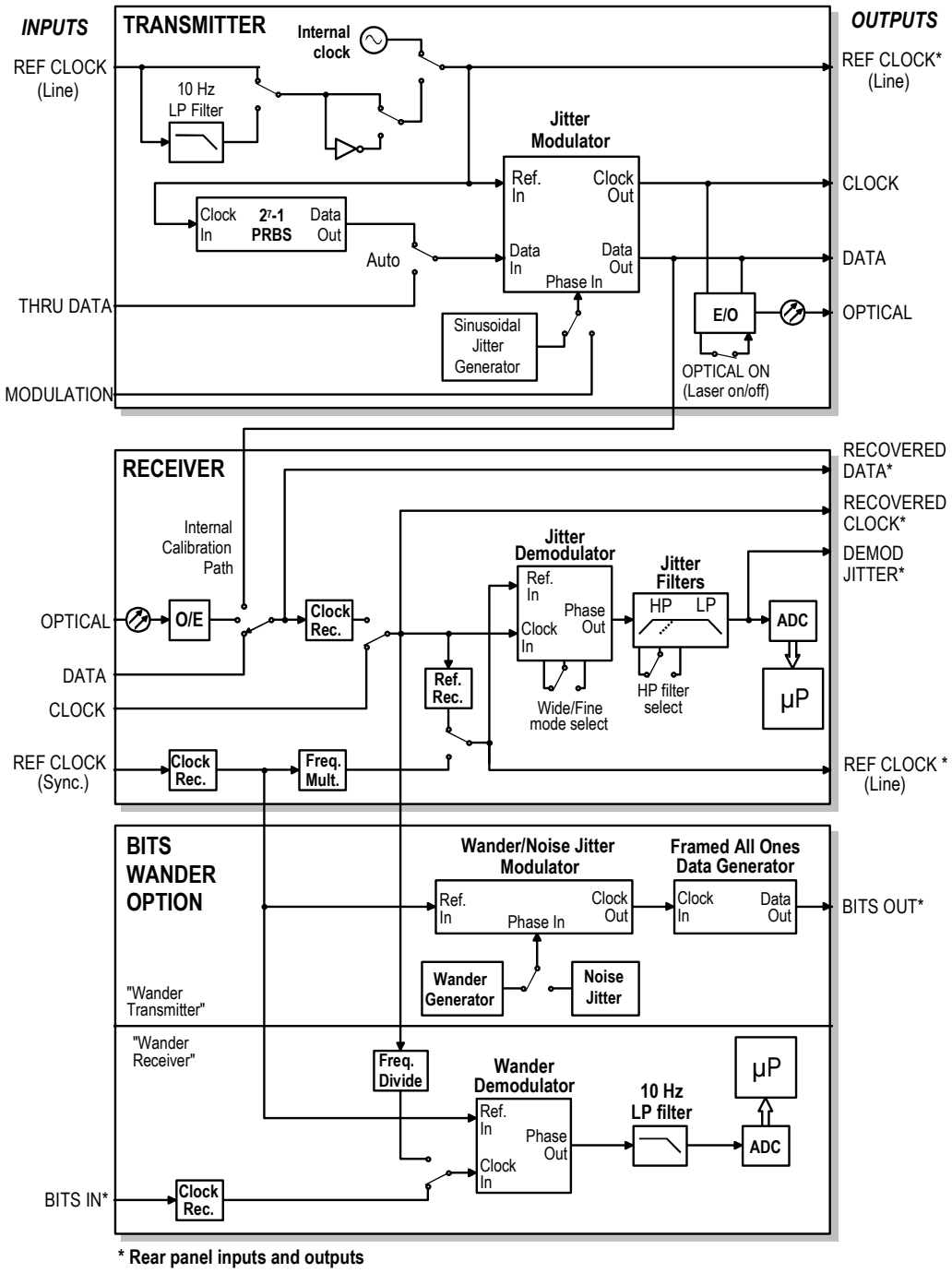


Figure 3-1 The SJ300E contains three major measurement subsystems, namely the Transmitter, Receiver, and Wander Test Option. Not shown in this diagram is the “microprocessor” subsystem comprising the instrument’s microprocessor, memory, GPIB, RS-232, and related circuits. Virtually all functions of the Transmitter, Receiver, and Wander Test measurement subsystems are under microprocessor control.

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Measurement Subsystems

The block diagram shows the SJ300E divided into three major "measurement subsystems" labeled:

- Transmitter,
- Receiver, and
- Wander Test Option.

This architecture corresponds to the arrangement of the front panel and highlights the fact that wander measurement is an option. However you can also think of the Transmitter and Receiver together as a jitter measurement system, and the Wander Test Option as a wander measurement system. Note that the Wander Test option includes both a Modulator for Wander, Noise-Jitter, and Transient functions and a Demodulator for Wander.

Microprocessor Subsystem

While it is not shown in the block diagram, the SJ300E has a critical fourth subsystem comprising its microprocessor, memory, I/O, and related components. The "microprocessor subsystem" also includes the instrument's control software stored in read-only memory (ROM). A discussion of the microprocessor and memory architecture used in the SJ300E is beyond the scope of this guide. However keep in mind that nearly every function of the instrument, from its front panel "human interface", to its data collection, storage, and analysis capabilities, is controlled by the instrument's microprocessor.

Transmitter

The SJ300E Transmitter subsystem (or simply the "Transmitter") corresponds to the TRANSMITTER section on the SJ300E front panel. The primary function of the Transmitter is to add jitter, at user-controlled frequencies and amplitudes, to SONET or SDH test signals.

The core of the Transmitter is a SONET/SDH line rate phase *modulation* circuit labeled "Jitter Modulator" in the block diagram. The Data input of the Jitter Modulator can be driven by the Transmitter's internal 2^7-1 PRBS (unframed) pattern generator, or an NRZ data signal applied to the **THRU DATA input** on the front panel. Typically the THRU DATA input is connected to a test set that can generate a framed SONET or SDH signal such as the Tektronix ST112. Switching between the internal and external data source is automatic. In other words, the Transmitter will automatically select external data when a signal is applied to the THRU DATA input, or internal PRBS data when no signal is applied.

The "Ref. In" or reference input to the Jitter Modulator may be driven by either the Transmitter's internal SONET/SDH line rate clock or a line rate clock signal applied to the Transmitter REF CLOCK input on the front panel. For proper phase alignment of external clock and data, the REF CLOCK input can be inverted. Note that from the front panel this is accomplished by pressing and turning on the INV (invert) key in the Transmitter EXT IN box. The REF CLOCK input can also be low-pass filtered to attenuate any jitter it may contain. You can monitor the currently selected clock reference signal via the Transmitter REF CLOCK output located on the rear-panel.

The "Phase In" input to the Transmitter Jitter Modulator may be driven by either an internal sinusoidal waveform generator or an external waveform generator connected to the Transmitter

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MODULATION input on the front panel. Typically, the Transmitter's internal generator is used to perform sinusoidal jitter tests while an external waveform generator is used to generate arbitrary jitter waveform, for example phase ramps or phase transients.

The clock and NRZ data outputs of the Jitter Modulator, "Clock Out" and "Data Out", are used to drive the Transmitter **CLOCK** and **DATA** electrical (ECL) outputs on the front panel. In addition, the Jitter Modulator outputs drive an electrical to optical converter—a single mode, 1300-nm Fabry-Perot (FP) laser and associated driver circuits—which in turn drives the Transmitter **OPTICAL output** on the front panel.

Receiver

The SJ300E Receiver subsystem (or simply the "Receiver") corresponds to the RECEIVER section on the SJ300E front panel. The primary function of the Receiver is to measure jitter amplitude on SONET or SDH signals.

The core of the Receiver is a SONET/SDH line rate phase *demodulation* circuit labeled "Jitter Demodulator" in the block diagram. This circuit measures jitter on the signal received at its clock input ("Clock In") relative to the signal applied to its reference input ("Ref. In"). The Jitter Demodulator clock input can be driven by either the signal applied to the Receiver **CLOCK input** on the front panel, or the output of the Receiver line rate clock recovery circuit. The Receiver clock recovery circuit can be driven by a data signal from one of three sources: 1) the front panel Receiver **DATA input**, 2) the front panel Receiver **OPTICAL input** (via an optical to electrical converter), or 3) the DATA output of the SJ300E's own Transmitter via the "Internal Calibration Path" shown in the block diagram. Thus, the Receiver can measure jitter on line rate clock or data electrical inputs, or a line rate optical input. In addition the Receiver can measure jitter on the Transmitter output, via an internal path, in order to calibrate the SJ300E prior to performing a jitter transfer test (See Chapter 5).

The Jitter Demodulator reference input may be recovered from the signal under test. Alternatively it may be derived from an external synchronization clock signal applied to the Receiver **REF CLOCK input** on the front panel. The selected reference signal can be monitored at the **REF CLOCK output** on the rear panel. Note that the signal generated by the Receiver REF CLOCK output on the rear panel will be a 52, 155, or 622 MHz line rate clock signal, while the signal applied to the Receiver REF CLOCK input on the front panel must be a 1.544 BITS or 2.048 Mb/s SETS synchronization clock signal.

The Receiver Jitter Demodulator circuit can operate in either of two measurement modes: Wide and Fine. In the Wide mode the Receiver can measure jitter amplitude up to 16 UI p-p (when using the internal recovered reference signal) at a resolution of 0.01 UI p-p. In the Fine mode the Receiver can measure jitter amplitude to 0.6 UI p-p with an improved resolution of 0.001 UI p-p.

The "Phase Out" or *demodulated jitter* output of the Jitter Demodulator is band-pass filtered by a high-pass (HP), low-pass (LP) filter combination. You may set the low-end HP filter to 10 Hz (also called B0), 12 kHz (also called B4), or either of two frequencies, B1 and B2, that depend on SONET/SDH rate. The 10 Hz HP filter is provided so you can measure "total jitter" amplitude and observe the "total jitter" waveform on the DEMOD JITTER output. The other filters are used in making jitter measurement tests as specified in current SONET and SDH standards. The HP

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filters have first-ordere cutoffs, and the LP filters have third-order Butterworth cutoffs. The jitter measurement filters for each SONET/SDH rate are summarized below:

Table 3-1 Jitter Measurement Filter Cutoff Frequencies

SONET/SDH Rate	HP Filter Cutoff (Hz)				LPF Filter Cutoffs (Hz)
	B0	B1	B4	B2	B3
52 Mb/s	10*	100	12 k	20 k	400 k
155 Mb/s	10*	500	12 k	65 k	1.3 M
622 Mb/s	10*	1000	12 k	250 k	5.0 M

* Wide mode only. Values are higher in Fine mode.

The demodulated and filtered jitter waveform is sampled by an analog-to-digital converter (ADC). The normal sampling rate is 16.8 million samples per second. Jitter data are stored and analyzed by the instrument's microprocessor. The SJ300E can locally calculate the RMS value and peak-to-peak amplitude of the jitter. The Peak-to-peak amplitude is calculated continuously. The RMS value is based on a 125 μs sample block taken every 500 ms.

For a jitter spectrum analysis, up to 16,384 jitter samples can be latched and uploaded to an external PC or workstation for further analysis. An MS-DOS compatible, FFT-based jitter power spectrum software application is available from Tektronix (See Appendix B). It should be noted that the ADC sampling rate can be set to either 16.8M or 33.6k samples per second. In addition, adjacent jitter data can be averaged, resulting in fewer data points but higher accuracy. Selection of sampling rate and the number of data points will determine the range and spacing of the frequency components developed by the FFT. For more information, see the documentation that comes with the SJ300E FFT software option (Op-FFT).

The SJ300E Receiver also provides outputs on the rear panel from which you can monitor the recovered data, recovered clock and demodulated jitter signals. These are the RECOVERED DATA, RECOVERED CLOCK, and DEMOD JITTER outputs respectively.

Wander Test Option

The Wander Test Option is a combined wander transmitter and receiver. The two functions of the Wander Test Option are: to generate clock signals with controlled levels of wander, noise jitter, or transients; and to measure the key wander parameters (TDEV and MTIE).

The core of the Wander Test Option "transmitter section" is a phase modulation circuit labeled "Wander/Noise Jitter Modulator" in the block diagram. The "Ref." or reference input of the Wander/Noise Jitter Modulator is driven by the 1.544 or 2.048 MHz clock signal recovered from the Receiver REF CLOCK input. This clock signal, after frequency multiplication, is also used by the line rate Receiver Demodulator as an external jitter reference.

The "Phase In" or phase modulation input to the Wander/Noise Jitter Modulator may be driven by either a wander or a "noise jitter" generator. The wandered or jittered "Clock" output of the Modulator drives a "framed all ones data generator" which—depending on the current SJ300E synchronization clock mode—will generate either a 1.544 Mb/s BITS or 2.048 Mb/s SETS

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synchronization signal. This synchronization clock signal, which may contain either wander or noise jitter, appears at the BITS OUT output on the rear panel.

The wander generator can modulate the BITS OUT output with any one of three different phase vs. time waveforms. These waveforms result in TDEV plots that follow, within 2 dB, the three "degradation masks" specified in ANSI T1.105.03-1994, "Synchronous Optical Network (SONET): Jitter at Network Interfaces".

The noise jitter generator can phase modulate the BITS OUT output with a jitter waveform that has frequency components in the range 10 Hz to 150 Hz , a peak-to-peak amplitude of 1000 ns, and an RMS value of 110 ns. The resulting "band-limited, truncated, white noise jitter" follows within 5% the reference clock jitter degradation specified in Bellcore GR-253-CORE section 5.4.3.3.1.

The core of the Wander Test Option "receiver section" is a phase demodulation circuit labeled "Wander Demodulator" in the block diagram. The Wander Demodulator can measure the relative wander between the signals applied to its reference and clock inputs: "Ref. In" and "Clock In". The reference input is driven by a 1.544 or 2.048 MHz clock signal derived from the Receiver REF CLOCK input. The clock input is driven by a 1.544 or 2.048 MHz clock signal derived from either the BITS IN input or (after frequency division) the currently active Receiver line rate input: CLOCK, DATA, or OPTICAL. Thus, the Wander Test Option can measure the relative wander between:

- a SONET/SDH line rate signal and a 1.544 Mb/s or 2.048 Mb/s synchronization signal, or
- two 1.544 Mb/s or 2.048 Mb/s synchronization signals.[1]

Both capabilities are necessary to make the various wander measurements required by current SONET and SDH network and equipment standards.

Front Panel Overview

As shown in Figure 3-2, the controls, indicators, and connectors on the SJ300E front panel are divided into two major sections: Transmitter and Receiver. In addition the front panel contains Display and other controls used to show setup menus, run tests, and perform other functions. Each of these major front panel sections are explained in the following pages.

TRANSMITTER Controls and I/O

The TRANSMITTER section of the front panel contains three groups or "boxes" of controls and connectors:

- **EXT IN**,
- **OUTPUTS**
- **JITTER**

[1] The SJ300E BITS IN and Receiver REF CLOCK inputs must be set up to operate at the same bit rate. Therefore the SJ300E cannot measure wander between a 1.544 Mb/s BITS signal and a 2.048 Mb/s SETS signal.

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- **RATE** (a single key)

The Transmitter EXT IN box contains three inputs (REF CLOCK, THRU DATA, and MODULATION), and three related control keys (EXT, INV, EXT). The left EXT control key, above the REF CLOCK input, is used to select either the external (LED on) Transmitter clock mode or the internal (LED off) mode. The INV control key is used, when required, to invert (LED on) the external clock input for proper phase alignment. The right EXT control key, above the MODULATION input, is used to select either the external (LED on) or internal (LED off) jitter modulation.

The OUTPUTS box contains the three Transmitter outputs (CLOCK, DATA, and OPTICAL). It also contains a single control labeled "ON" used to turn the output laser on (LED on) or off (LED off). It should be noted that the two electrical outputs, CLOCK and DATA, provide unbalanced ECL signals and are **not** compatible with STSX-1 or STSX-3 cross-connects.



CAUTION! CLOCK and DATA are ECL outputs and are not designed to be connected directly with SONET STSX-1 or STX3-3 cross-connects. To operate the SJ300E at a SONET cross-connect you must use a Tektronix SC100 or equivalent ECL to STSX-n converter.

The JITTER box contains three controls: ON, FREQ, and AMP. All are used to set up the OC-N Phase Modulator function of the Transmitter. The ON control is used to turn jitter generation on (LED on) or off (LED off). The FREQ control is used to set output jitter frequency. The AMP control is used to set output jitter amplitude. When you press the FREQ or AMP control its LED will turn on to indicate that you may edit output jitter frequency or amplitude respectively using the DISPLAY "arrow" keys (see the explanation of DISPLAY Controls on page 3-10).

The TRANSMITTER section of the front panel also contains a single key labeled RATE. This key is used to set the instrument's transmit line rate to 52, 155, or 622 MHz . You can set up the SJ300E Transmitter and Receiver to operate at different rates.

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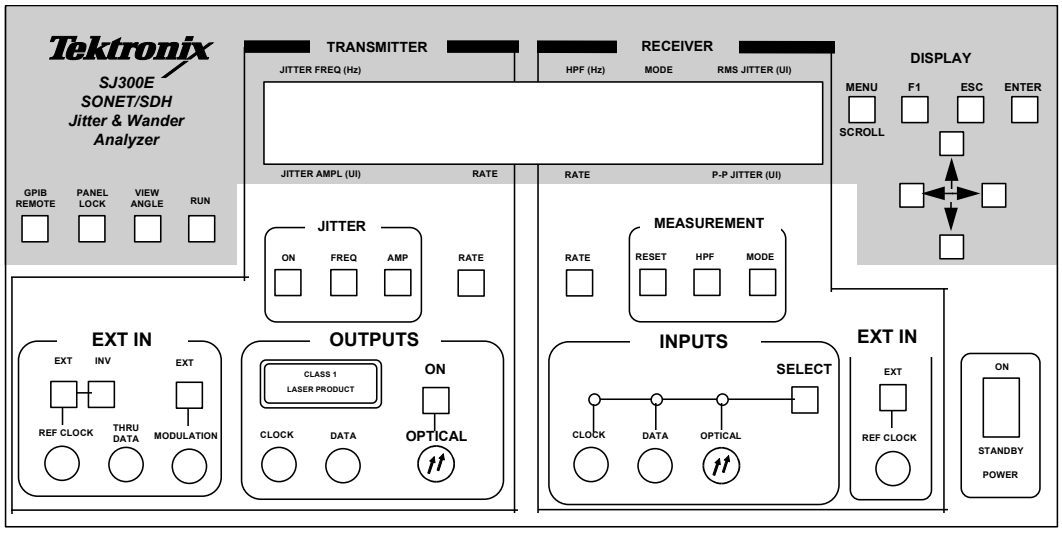


Figure 3-2 The SJ300E front panel contains controls, inputs, outputs, and a 24-character by 2-line liquid crystal display (LCD). The front panel is divided into two major sections. The TRANSMITTER section contains inputs, outputs, and controls related to the Transmitter subsystem. Similarly, the RECEIVER section contains I/O and controls related to the Receiver subsystem. Controls in the DISPLAY group are used to edit fields in the LCD display, and to display and edit setup menus.

RECEIVER Controls and I/O

The RECEIVER section of the front panel also contains three groups of controls and connectors:

- **EXT IN**,
- **INPUTS**
- **MEASUREMENT**

The EXT IN box contains the Receiver's REF CLOCK input. This input will accept either a 1.544 Mb/s BITS or 2.048 Mb/s SETS synchronization clock signal. This input is used as a reference signal for all wander measurements. In addition it may be used as a jitter reference depending on the state of the EXT control. Turn the EXT control on to measure jitter using the external reference signal applied to the REF CLOCK input, or off to measure jitter using an internally recovered reference. If you select the external jitter reference mode but do not apply the proper synchronization clock signal to the REF CLOCK input, all jitter measurements will be invalid and the instrument will display an error message in the LCD display.

The INPUTS box contains connectors for three of the four Receiver inputs: CLOCK, DATA, and OPTICAL. This box also contains the SELECT control which is used to select one of these three inputs as the "active" input. The signal appearing at the active input will be analyzed. Any signals appearing at the other two inputs will be ignored. The LED above the active input turns on while the LEDs above the two inactive inputs turn off.

The MEASUREMENT box contains three controls: RESET, HPF, and MODE. The RESET control is used to clear all current jitter and wander measurement from memory in order to begin

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a new test. The HPF key is used to select the current jitter measurement high-pass filter cut-off frequency. The MODE key is used to select either the Wide or Fine jitter measurement mode.

The RECEIVER also contains a RATE control which is used to set the OC-N/STM-N line rate of the Receiver to 52, 155, or 622 MHz . Receiver and Transmitter line rates may be set to the same or different values.

DISPLAY Controls

The DISPLAY section of the SJ300E front panel contains controls not specific to either the Transmitter or Receiver. The MENU control is used to access the SJ300E menu system. The F1 control is used to initiate actions within displayed menus. The ESC key is used to "escape" from a setup menu, normally without making any changes to SJ300E setup. The ENTER key is used to "enter" or accept changes made in a setup menu. The four arrow keys are used to edit numerical values shown in the SJ300E display. The left and right arrows are used to select a field or digit for editing. The up and down arrows are used to change (increment or decrement) the currently selected digit.

Other Front Panel Controls

The SJ300E front panel contains four additional controls located to the left of the display. The LED in the **GPIB REMOTE** key indicates whether the instrument is in the remote (LED on) or local (LED off) mode. If the instrument is in the remote mode, you can return the instrument to local control by pressing this the GPIB REMOTE key. If the instrument is in the local mode, pressing the GPIB REMOTE key will have no effect. If the instrument is in the local mode, it will automatically enter the remote mode when it receives any GPIB command. It will then remain in the remote mode until you press the GPIB REMOTE key.

The **PANEL LOCK** control is used to select either the locked (LED on) or normal (LED off) front panel mode. In the locked mode all front panel keys, except for PANEL LOCK, are disabled. Pressing the PANEL LOCK control will toggle between the locked and normal front panel modes. The **VIEW ANGLE** control is used to adjust the vertical viewing angle of the LCD display. Pressing this key multiple times will cycle through the four available viewing angles. The **RUN** key is used to start a jitter transfer measurement sequence. The LED in the RUN control will remain on while a jitter transfer test is in progress. The LED will turn off automatically when the test is complete. You can manually stop a test by pressing the RUN key while a test is still in progress.

POWER Switch

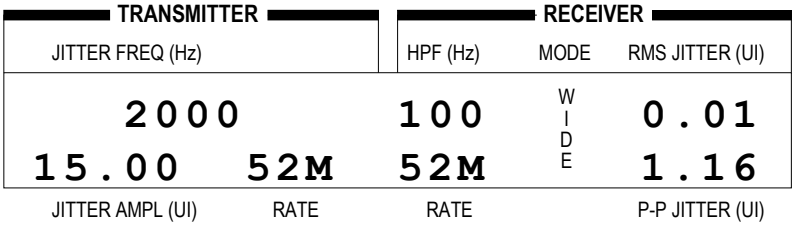
Instrument power is normally turned on and off using the front panel POWER switch. In the ON position, power is turned on. In the STANDBY position, power is turned off. Note, however, that the AC LINE switch on the *rear panel* must be turned on (i.e., set to "1") in order to use the front panel POWER switch.

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Main Display

The SJ300E provides a two-line by 24 character LCD “main display”. This display is used to show current instrument setup plus jitter measurement results.

The SJ300E display has two basic modes or formats. In its normal mode, illustrated below, the display is divided into the Transmitter half and the Receiver half:



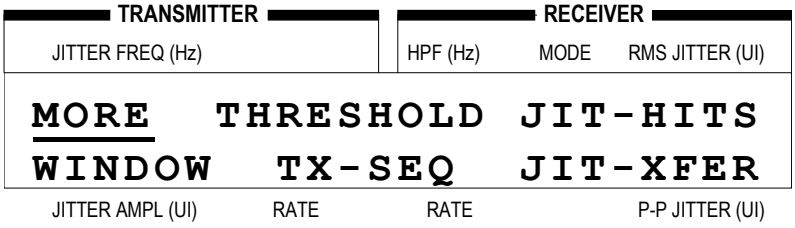
The Transmitter half of the normal format shows:

- output jitter frequency
- output jitter amplitude
- Transmitter SONET/SDH rate.

The Receiver half of the normal format shows:

- jitter measurement high pass filter (HPF) cutoff frequency
- jitter measurement mode (Wide or Fine)
- measured RMS jitter in UI
- measured peak-to-peak jitter in UI
- Receiver SONET/SDH rate.

The SJ300E display can also be used to show various setup menus by pressing the menu key. For example if the display is in the normal mode, pressing the MENU key will display the following “top level” menu:



The function of each SJ300E menu or results screen is explained in Chapters 4. and 5. In addition, you will find a summary of the SJ300E menu system in the next section.

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Menu System Overview

The SJ300E menu system is composed of:

- A top-level **Main Menu** which provides access to all lower-level selection menus, setup menus and results screens. Note that the second page of this menu is accessed by selecting “MORE” from the first page, and the third page is accessed by selecting “MORE” from the second page. Selecting “EXIT” from the third page will return the display to its normal mode.
- **Selection Menus** which are used to access to groups of related setup menus or results screens.
- **Set Up Menus** which are used to set one or more parameters.
- **Results Screens** which are used to view results.

Table 3-2 shows the over-all structure of the SJ300E menu system. Example setup selections or results are shown in fields that contain numeric data or discrete values. In the left column (Menu) of this table, the names of menus or results screens selected from the Main menu are shown in **bold**. Similarly, in the second column (Format), fields that are selected to access lower-level menus or result screens are shown in **`bold`**.

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Table 3-2 SJ300E Menu Summary

Menu	Format	Functions
MAIN - 1	**MORE THRESHOLD JIT-HITS WINDOW TX-SEQ JIT-XFER**	Top level menu, page 1.
MAIN - 2	**MORE WANDER REPORT GPIB PRINTER RS232 TIME UTIL**	Top level menu, page 2.
MAIN - 3	**EXIT CLKFILT**	Top level menu, page 3.
THRESHOLD (from Main 1)	JITTER HIT THRESHOLD: 1.500	Sets jitter hit threshold.
JIT-HITS (from Main 1)	JIT-HITS JIT-SEC TOT-SEC HIST 2 4 118	Displays jitter hit summary.
HISTORY (from JIT-HITS)	HIT: 1 START 11:23:52 MAX: 5.11 STOP 11:24:03	Gives details of each jitter hit.
WINDOW (from Main 1)	P-P JITTER OBS TIME WINDOW: 1 SEC	Sets duration in seconds of the window used to measure windowed p-p jitter amplitude. Also may be set to “infinity” for continuous results.
TX-SEQ - 1 (from Main 1)	F1>**EDIT LD-STD** 622M SEQ#: 2 DWELL: 3 SEC	Loads the standard sequence or edits the existing sequence in any selected memory location. Also can set dwell time for any selected location.
TX-SEQ - 2 (from TX-SEQ - 1)	F1>EDIT LD-STD **CAL** 622M SEQ#: 2 DWELL: 3 SEC	This version of TX-SEQ Appears after you load a standard sequence or edit a sequence. Note that the **CAL** label is flashing.
EDIT (from TX SEQ)	F1>SAVE #12 INS DEL 622M PT:8 F: 20000 A: 1.50	Appears if you select EDIT from the TX-SEQ menu. Used to set jitter frequency and amplitude for each point in a sequence.

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CAL (from TX SEQ)	CAL-LOOP ENTER>SET INT CAL EXT CAL	Appears after you select CAL from the TX-SEQ menu. Selects internal or external (patch cord) calibration path.
JIT-XFER (from Main 1)	JIT-XFER 94-05-21 15-02 PT: 1 F: 10 R:-0.02	Jitter Transfer test results screen. Shows frequency and measured transfer ratio (dB) for each point in the current sequence.

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Table 3-2 SJ300E Menu Summary (continued)

Menu	Format	Functions
WANDER (from Main 2)	**WAND MEAS WAND GEN** **DISPLAY REF SEL REF LEV**	Wander selection menu.
WAND MEAS (from WANDER)	MEAS TYPE ENTER>SET OCN BITS	Selects which input is measured for wander. "OCN" selects the active line rate input. "BITS" selects the BITS IN port.
WAND_GEN (from WANDER)	NONE DS1 DS1_FILT OCN MASK NOISE_JIT	Determines what type of wander, jitter, or transient is generated on the BITS OUT port.
DISPLAY (from WANDER)	TDEV: 69.6ns TAU: 0.4 MTIE: 1765.0ns OBS: 1.0 TIE: + 3752.0ns	Displays wander results: TDEV, MTIE, and TIE. Use the MENU key to toggle between screens. The first screen is also used to set the TAU (integration time) and OBS (observation time) when calculating TDEV and MTIE.
REF SEL (from WANDER)	REFERENCE ENTER>SET DS1/SF DS1/ESF E1 2MHZ	Sets synchronization clock mode to 1.544 Mb/s BITS ("DS1") or 2.048 Mb/s SETS ("2MB/S"). This effects the Receiver REF CLOCK input, and the BITS IN and BITS OUT ports.
REF LEV (from WANDER)	REFERENCE ENTER>SET MONITOR TERMINATE	Select TERMINATE to accept standard interface signal levels (see ITU recomendations G.703) at BITS IN and Receiver REF CLOCK. Select MONITOR to accept signals at 1/10 standard amplituide.
REPORT (from Main 2)	JIT-XFER JIT-HITS TX-SEQ ALL TX-SEQS	Prints one of four reports: Jitter Transfer, Jitter Hits,

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	TX-SEQ ALL TX-SEQS	Jitter Sequence (current), or Jitter Sequences (all).
GPIB (from Main 2)	GPIB **ADDRESS** **TERMINATOR**	GPIB selection menu.
ADDRESS (from GPIB)	GPIB ADDR ENTER>SET 16 (31=OFFBUS)	Sets GPIB address
TERMINATOR (from GPIB)	TERMINATOR ENTER>SET EOI EOI/LF	Selects the GPIB end-of-line terminator.

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Table 3-2 SJ300E Menu Summary (continued)

	Format	Functions
PRINTER (from Main 2)	PRINTER **ON/OFF PORT**	Printer selection menu.
ON/OFF (from PRINTER)	PRINTER ENTER>SET OFF ON	Turns report generation on or off.
PORT (from PRINTER)	PRINT TO ENTER>SET PARALLEL GPIB RS232	Selects the port to which all reports will be sent. Note that the rear-panel parallel port is labeled “PRINTER”.
RS232 (from Main 2)	**BAUD PARITY CHAR-SIZE** **EOL ECHO XON/XOFF**	RS-232 selection menu.
BAUD (from RS232)	BAUD ENTER>SET 300 1200 2400 9600	Sets RS-232 port baud rate.
PARITY (from RS232)	PARITY ENTER>SET NONE ODD EVEN	Sets RS-232 port parity.
CHAR-SIZE (from RS232)	CHAR-SIZE ENTER>SET 7 8 (BITS)	Sets the number of data bits per character on the RS-232 port.
EOL (from RS232)	EOL ENTER>SET CR-LF LF-CR CR LF	Sets RS-232 line terminator.
XON/XOFF (from RS232)	XON/XOFF ENTER>SET OFF ON	Enables or disables XON/XOFF flow control on the RS-232 port.
TIME (from Main 2)	TIME YY MM DD HH MM SS 1994 05 01 12 00 00	Sets time of day clock and internal calendar.
UTIL (from Main 2)	UTILITY **OPTION VERSION**	Utility selection menu.
OPTION (from UTILITY)	OPTIONS/CONFIGURATION 12 BW	Lists installed options.
VERSION (from UTILITY)	VERSION 3.7 1993/08/23	Lists installed software version and date.
CLKFILT (from Main 3)	TX REF CLOCK FILTER OFF ON ENTER>SET	Enables or disables the 10 Hz low-pass “jitter-removal” filter on the Transmitter REF CLOCK input.

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Rear Panel Overview

As shown in Figure 3-3, the SJ300E rear panel contains various signal and control inputs and outputs. In addition it contains the AC LINE switch and the line fuse holder.

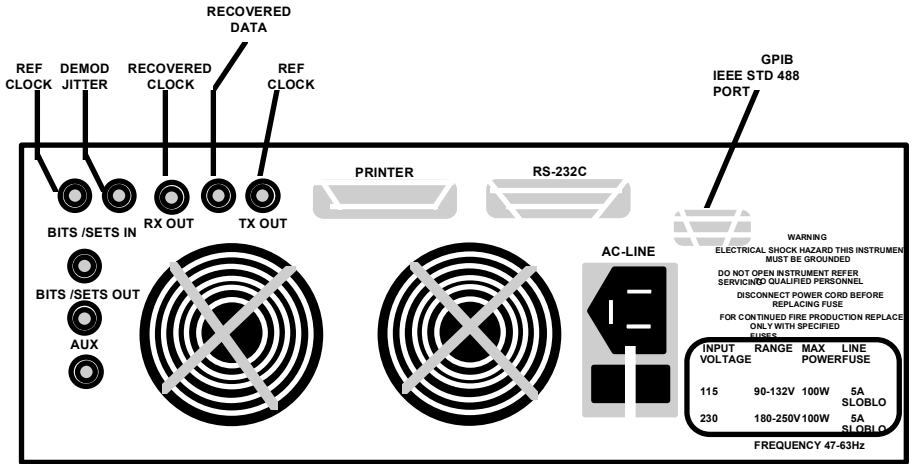


Figure 3-3 The SJ300E rear panel contains the BITS/SETS IN and BITS/SETS OUT ports, as well as various “secondary” inputs and outputs for the Transmitter and Receiver. It also contains the AC LINE switch and fuse holder.

Signal Inputs and Outputs

The following Receiver outputs are located on the rear panel: REF CLOCK, DEMOD JITTER, RECOVERED CLOCK, and REF DATA. There is also one Transmitter output: REF CLOCK. In addition, the Wander Test Option input (BITS/SETS IN) and output (BITS/SETS OUT) are both located on the rear panel. The rear panel AUX connector is not used at this time.

Control and Printer Inputs and Outputs

The SJ300E rear-panel contains two control and one printer ports. The PRINTER connector is compatible with any printer that has a PC or “Centronics” compatible parallel port. In other words, any printer that you can connect to a PC parallel port (LPT1: etc.) may be connected to the SJ300E PRINTER port. The RS-232 connector provides an interface for a serial controller—typically a PC or workstation equipped with an RS-232 I/O port. The RS-232 port may also be connected with a serial printer. The GPIB connector provides an interface for an external PC or workstation with GPIB I/O capability. You cannot connect a GPIB printer directly to the SJ300E GPIB port.

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AC LINE Switch

The rear-panel **AC LINE** switch may be used to turn instrument power on or off. Normally, however, leave the AC LINE switch in the on ("1") position and use the front panel POWER switch. The AC LINE switch assembly also includes the instrument's power fuse. Note that turning the AC LINE switch off ("0") is **not** a substitute for removing the instrument's power cord from the AC LINE assembly before you attempt to replace the fuse.



WARNING! You must always remove the power cord from the AC LINE assembly before you attempt to replace the instrument's fuse.

Inputs and Outputs

This section provides general interface information on SJ300E *test* input and outputs. Test inputs and outputs will be defined here as all SJ300E inputs and outputs other than the RS-232, GPIB, and PRINTER ports. For interface information on these "non-test" ports, see Chapter 6.

Types and Connectors

SJ300E test inputs and outputs may be classified into four types:

- optical
- ECL
- synchronization clock
- analog

The SJ300E **optical** ports sink or source SONET/SDH compatible single mode (1300 nm) optical signals at line rates of 52, 155, or 622 Mb/s. These ports allow the SJ300E to test from SONET/SDH optical cross-connect points, or to test SONET/SDH network elements from their optical inputs and outputs. You may order the SJ300E with FC/PC, ST, or SC optical connectors.

SJ300E **ECL** ports sink or source ECL logic level signals at SONET/SDH line rates of 52, 155, or 622 Mb/s. These ports allow the SJ300E to interface NRZ data and clock electrical ports on SONET/SDH test sets or network elements. In addition, through an SC100 DATA CONVERTER, ECL ports allow the SJ300E to test from STSX-1 or STSX-3 electrical cross-connect points. All SJ300E ECL ports are equipped with BNC connectors.

SJ300E **synchronization clock** ports sink or source BITS or SETS "framed all ones" synchronization signals at 1.544 Mb/s or 2.048 Mb/s respectively. These ports allow the SJ300E to measure wander parameters on BITS or SETS network signals or test the wander generation and other timing characteristics of SONET/SDH network elements. Standard SJ300E synchronization clock ports sink or source balanced 110 Ω signals and are equipped with WECO 310 jacks. You may also order the SJ300E with 75 Ω (unbalanced) synchronization clock ports

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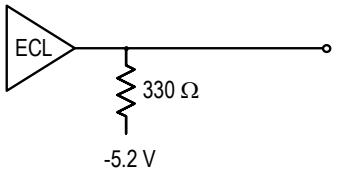
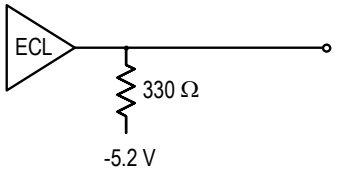
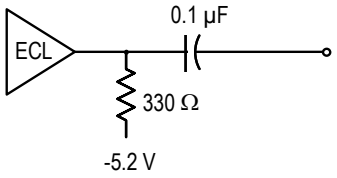
equipped with BNC connectors. Please contact our Customer Service Department for more information on this option.

SJ300E **analog** ports sink or source continuous voltage waveforms that represent jitter modulation or demodulated jitter waveforms respectively. The analog Transmitter MODULATION input may be connected, for example, to an external waveform generator to simulate non-sinusoidal jitter. The analog Receiver DEMOD JITTER output may be connected to an oscilloscope or spectrum analyzer for analysis. SJ300E analog ports have a nominal termination or source impedance of 50 ohms. All SJ300E analog ports are equipped with BNC connectors.

ECL Port Equivalent Circuits and AC Coupling

The equivalent circuit for each SJ300E ECL port is shown in Figure 3-4. Every SJ300E ECL input and output—except the Transmitter and Receiver REF CLOCK outputs which are ac-coupled—can sink or source respectively a standard ECL logic level signal. The Transmitter REF CLOCK input and the Receiver CLOCK input are ac-coupled internally and can therefore sink balanced signals as well. The Transmitter CLOCK output, the Receiver RECOVERED CLOCK output, the Transmitter DATA output, the Receiver RECOVERED DATA output, the Transmitter REF CLOCK input, and the Receiver CLOCK input can be ac-coupled externally. Recommended external ac-coupled configurations for these ports are shown in Figure 3-5. Note that only the instrument's two data inputs, Transmitter THRU DATA and Receiver DATA, are neither ac-coupled internally nor designed to be ac-coupled externally.

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SJ300E ECL OUTPUTS	EQUIVALENT CIRCUITS
❑ Transmitter CLOCK output ❑ Receiver RECOVERED CLOCK output	
❑ Transmitter DATA output ❑ Receiver RECOVERED DATA output	
❑ Transmitter REF CLOCK output ❑ Receiver REF CLOCK output	

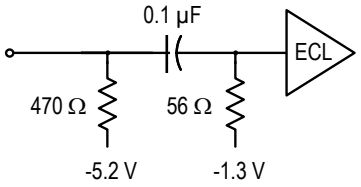
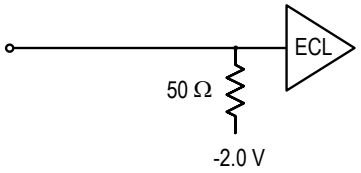
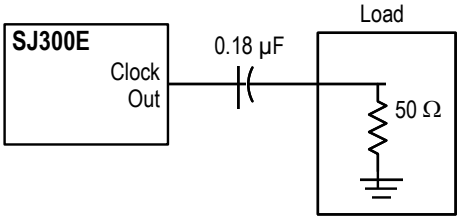
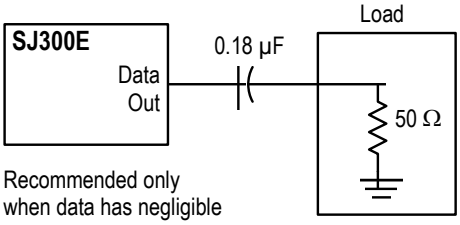
SJ300E ECL INPUTS	EQUIVALENT CIRCUITS
❑ Transmitter REF CLOCK input ❑ Receiver CLOCK input	
❑ Transmitter THRU DATA input ❑ Receiver DATA input	

Figure 3-4 All SJ300E line rate inputs and outputs, except for REF CLOCK outputs, are designed to sink or source standard ECL signals. In addition, some SJ300E input/output circuits are designed to accommodate ac coupling.

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SJ300E ECL OUTPUTS	EXTERNAL AC-COUPLED CONFIGURATIONS
❑ Transmitter CLOCK output ❑ Receiver RECOVERED CLOCK output	
❑ Transmitter DATA output ❑ Receiver RECOVERED DATA output	 Recommended only when data has negligible content below 20 kHz.
❑ Transmitter REF CLOCK output ❑ Receiver REF CLOCK output	REF CLOCK outputs are AC-coupled internally.

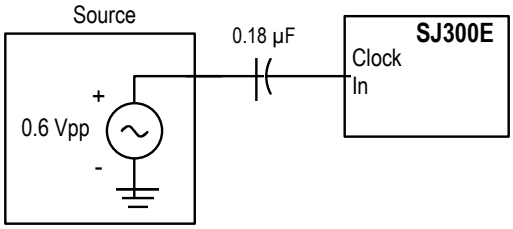
SJ300E ECL INPUTS	EXTERNAL AC-COUPLED CONFIGURATIONS
❑ Transmitter REF CLOCK input ❑ Receiver CLOCK input	
❑ Transmitter THRU DATA input ❑ Receiver DATA input	DATA inputs are **not** designed to be AC-coupled.

Figure 3-5. Except for the instrument's data inputs and REF CLOCK outputs, all SJ300E ECL inputs and outputs can be externally ac-coupled in order to source or sink balanced signals. The Transmitter and Receiver REF CLOCK outputs are ac-coupled internally.

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SJ300E Test Input/Output Summary

The following table summarizes the type, available connectors, and function of each SJ300E signal input and output.

Table 3-3 SJ300E Signal Inputs and Outputs Summary

Input or Output	Label	Type	Connector	Signal Function
Transmitter Inputs	REF CLOCK	ECL (ac-coupled)	BNC	Line rate reference clock input to Transmitter.
	THRU DATA	ECL	BNC	NRZ data input to Transmitter phase modulator.
	MODULATION	Analog	BNC	Phase (analog waveform) input to Transmitter phase modulator.
Transmitter Outputs	CLOCK	ECL	BNC	Line rate clock signal output with added jitter.
	DATA	ECL	BNC	NRZ data output with added jitter.
	OPTICAL	single mode optical	FC/PC, ST, or SC	OC-N/STM-N optical output with added jitter.
	REF CLOCK	ECL (ac-coupled)	BNC (rear)	Line rate clock signal used as a reference by Transmitter phase modulator (i.e. the Transmit clock without added jitter).
Receiver Inputs	CLOCK	ECL (ac-coupled)	BNC	Line rate clock input; may be analyzed for jitter.
	DATA	ECL	BNC	NRZ data input; may be analyzed for jitter.
	OPTICAL	Single mode	FC/PC, ST, or SC	OC-N/STM-N optical input; may be analyzed for jitter.
	REF CLOCK	Bipolar or Square wave	WECO 310	Synchronization signal input (framed all ones) 1.544 Mb/s data (DS1) or 2.048 Mb/s data (E1), or 2.048 MHz square wave (2MHZ).

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Table 3-3 SJ300E Signal Inputs and Outputs Summary (continued)

Input or Output	Label	Type	Connector	Signal Function
Receiver Outputs	REF CLOCK	ECL (ac-coupled)	BNC (rear)	Line rate reference clock signal used by Receiver for jitter measurement.
	DEMOD JITTER	Analog	BNC (rear)	Demodulated, filtered jitter waveform.
	RECOVERED CLOCK	ECL	BNC (rear)	Line rate clock signal analyzed for jitter.
	RECOVERED DATA	ECL	BNC (rear)	NRZ data signal; either the output of Receiver O/E converter or copy of signal received at front panel DATA input.
BITS Wander Input	BITS/SETS IN	bipolar or square wave	WECO 310 (rear)	Synchronization signal input (framed all ones) 1.544 Mb/s data (DS1) or 2.048 Mb/s data (E1), or 2.048 MHz square wave (2MHZ), which can be analyzed for wander.
BITS Wander Output	BITS/SETS OUT	bipolar or square wave	WECO 310 (rear)	Synchronization signal output (framed all ones) 1.544 Mb/s data (DS1) or 2.048 Mb/s data (E1), or 2.048 MHz square wave (2MHZ), with added noise jitter or wander.

Jitter Measurement Configurations

The following sections illustrate how the SJ300E may be used to make jitter measurements on synchronous networks and network elements.

Jitter Generation

Jitter generation is a network element characteristic. The jitter generation properties of a network element can be established by measuring jitter on an OC-n output while applying a jitter-free reference signal to the NE's timing input. The reference signal applied to an *externally timed* NE must be a jitter-free BITS (1.544 Mb/s) or SETS (2.048 Mb/s) synchronization clock signal. The reference signal applied to a *loop*, *line*, or *through timed* NE must be a jitter-free OC-n or STM-n line rate signal.

Figure 3-6 illustrates how the jitter generation characteristics of a 52, 155, or 622 Mb/s SONET or SDH network element can be measured using the SJ300E. In this example configuration, the

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line rate optical output of the NE is connected directly with OPTICAL input of the SJ300E Receiver while a jitter-free reference signal is supplied to the NE. Because the SJ300E can measure jitter using either its internal recovered reference or an external BITS or SETS reference, application of a reference signal the SJ300E Receiver REF CLOCK input is optional.

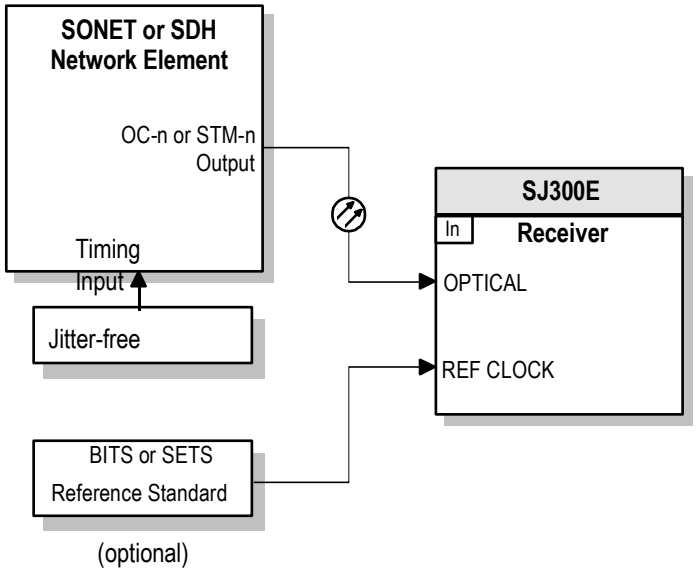


Figure 3-6 Measurement of NE Jitter Generation.

Jitter Tolerance

Jitter tolerance is a network element characteristic. Current SONET standards specify jitter tolerance as the peak-to-peak amplitude of square waveal jitter applied to the OC-N input of a network element, that causes a 1-dB power penalty at a BER of 10^{-10}. This, in other words, is the jitter amplitude that increases by 1 dB the input signal level at which the NE will operate with a BER of 10^{-10}.

Figure 3-7 shows how the SJ300E would be configured to measure the jitter tolerance of SONET OC-12 regenerator. In this example, the Transmitter section of the SJ300E converts the clock and data Transmitter outputs of an ST-103 SONET Test Set into an optical signal with added jitter. This signal is then used to stress a SONET OC-12 regenerator through an optical attenuator. The Receiver portion of the SJ300E converts the optical output of the regenerator back into clock and data signals for BER analysis by the ST-103 Receiver. This arrangement takes advantage of the high jitter tolerance of the SJ300E Receiver.

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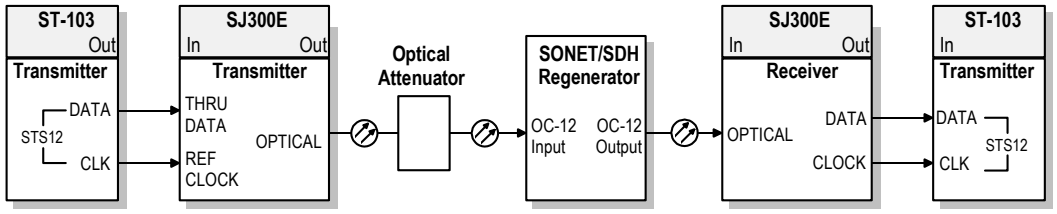


Figure 3-7 Jitter tolerance measurement of a SONET Regenerator (NOTE: For clarity, the Transmitter and Receiver sections of the SJ300E are shown as separate blocks).

The general procedure to measure jitter tolerance is as follows:

1. Set SJ300E output jitter amplitude to zero.
2. Adjust the optical attenuator until the operating BER of the regenerator is 1 x 10^{-10}.
3. Reduce attenuation by 1 dB. In other words, increase optical signal amplitude at the input to the regenerator by 1 dB. This will have the effect of decreasing the operating BER of the regenerator.
4. Add jitter to the regenerator input at a given jitter frequency (f_n) until measured BER returns to 1 x 10^{-10}. Record this amplitude as the jitter tolerance of the NE at f_n.
5. Repeat steps 1. through 4. at all jitter frequencies of interest.

It should be noted that this procedure can be speeded up greatly—with little loss of accuracy—by using an error rate of 1 x 10^{-8} if it can be shown the results are approximately the same as with a 10^{-10} error rate.

The "1 dB power penalty" jitter tolerance specification and procedure also apply to more complex network elements. Figure 3-8 shows how the
SJ300E can be configured to measure the jitter tolerance of an OC-3 ADM. In this test setup, the SJ300E adds jitter to the high-speed optical output of an OC-3 ADM which is then fed back to the high-speed input of the ADM through an optical attenuator. In effect, the high-speed output of the ADM acts like a SONET test set transmitter with full ADM functionality. The operating BER of the ADM can be measured indirectly by analyzing the BER of a daisy chained path through the ADM's low-speed (DS3) ports. This method is very accurate once a correction factor is applied to take into account the ratio of (DS3) payload bits to total OC-3 bits. The basic "1 dB power penalty" procedure can be used to determine jitter tolerance of the ADM at each jitter frequency of interest.

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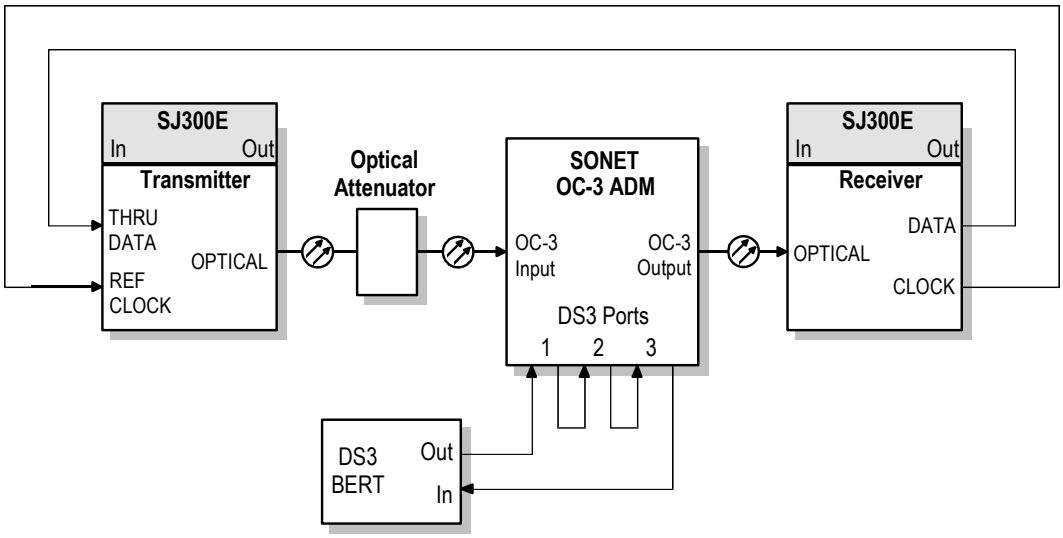


Figure 3-8 Measuring the jitter tolerance of an OC-3 ADM (NOTE: For clarity, the Transmitter and Receiver sections of the SJ300E are shown as separate blocks).

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Jitter Transfer

Jitter transfer is a network element characteristic. SONET/SDH line rate jitter transfer is measured by generating a known amount of jitter on a line input to a SONET or SDH network element while measuring jitter on the corresponding output. Two example SJ300E jitter transfer measurement configurations are presented here. In the configuration shown in Figure 3-9, the SJ300E adds jitter to a framed test signal generated by an ST-103 SONET Test Set. The SJ300E then calculates the ratio of output jitter to input jitter at each frequency in an automatically generated jitter sequence composed of up to 20 jitter amplitude/frequency pairs. The extreme accuracy required of this measurement makes it necessary to first calibrate the SJ300E by removing the NE under test from the path.

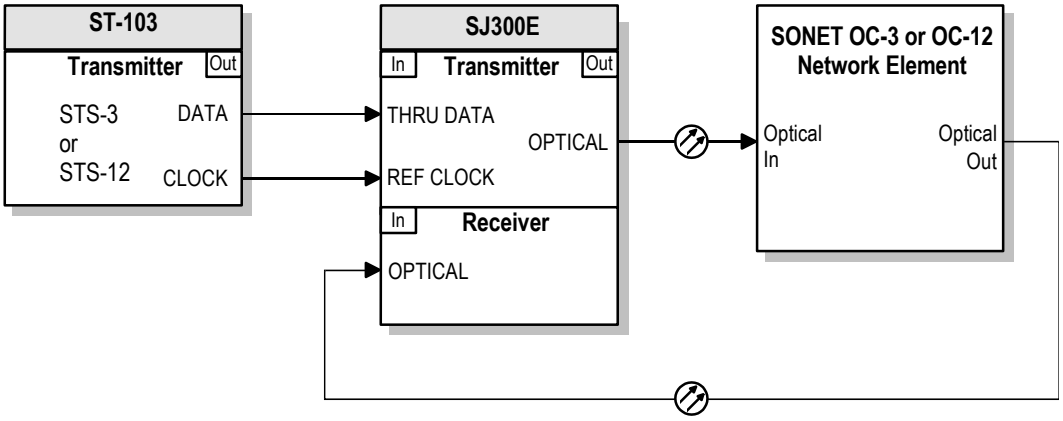


Figure 3-9 Measuring the jitter transfer properties of a network element that requires a framed SONET test signal.

As shown in Figure 3-10, the SJ300E can also be used in a stand-alone configuration to measure the jitter transfer properties of a SONET network element that does not require a framed input signal. This would be the case, for example, for most SONET regenerators. Be careful, however, not to use the stand-alone (unframed) configuration if the network element under test is designed to fallback to a free-running timing mode when it detects a loss of frame on its OC-N timing input.

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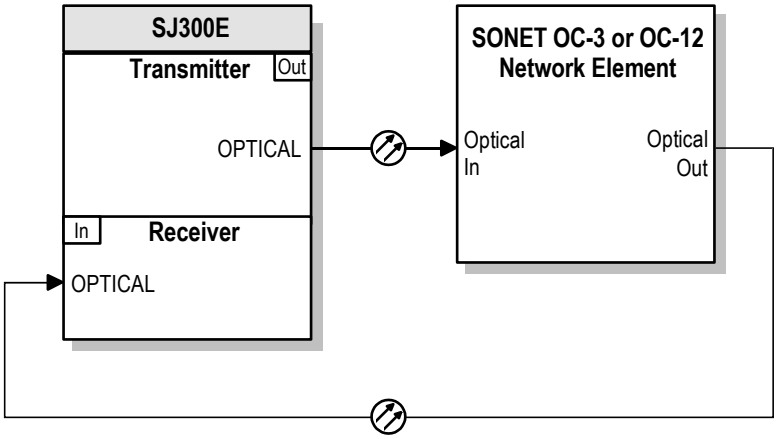


Figure 3-10 If the network element under test does not require a framed test signal, then the SJ300E can make jitter transfer measurements on a stand-alone basis.

Interface Jitter

Interface jitter, a network characteristic, is the jitter measured on output signals at network interface or "cross-connect" points. Interface jitter can be measured on in-service facilities carrying live traffic, as a maintenance procedure, or on out-of-service facilities carrying a test pattern, as a qualification procedure. SONET/SDH facility qualification and maintenance practices contain interface jitter limits to insure that overall network performance objectives are met.

Two SJ300E interface jitter measurement configurations are presented here. Figure 3-11 illustrates how the SJ300E may be used to measure SONET or SDH interface jitter directly at an *optical* cross-connect point.

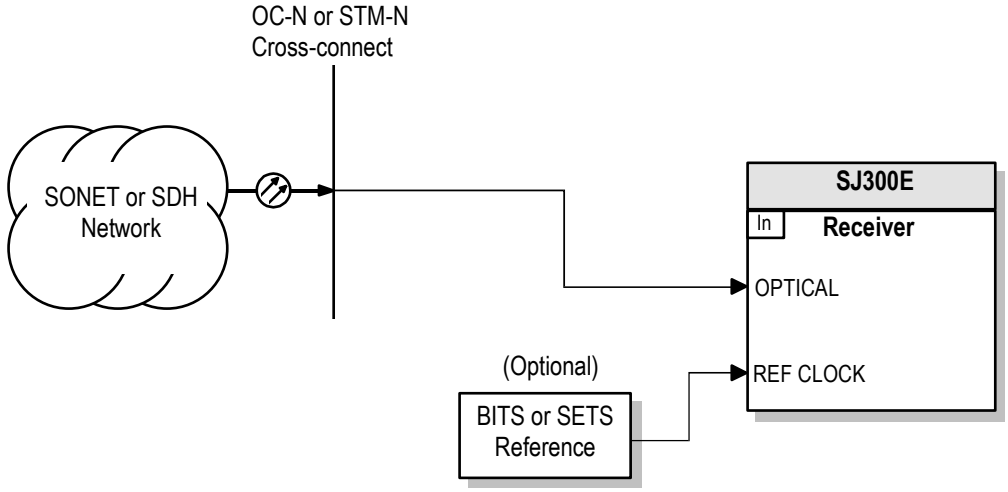


Figure 3-11 The SJ300E can measure interface jitter directly at an optical SONET or SDH cross-connect.

Figure 3-12 shows that the SJ300E, with the help of the SC100 DATA CONVERTER, can measure interface jitter at a SONET STSX-1 or STSX-3 *electrical* cross-connect point.

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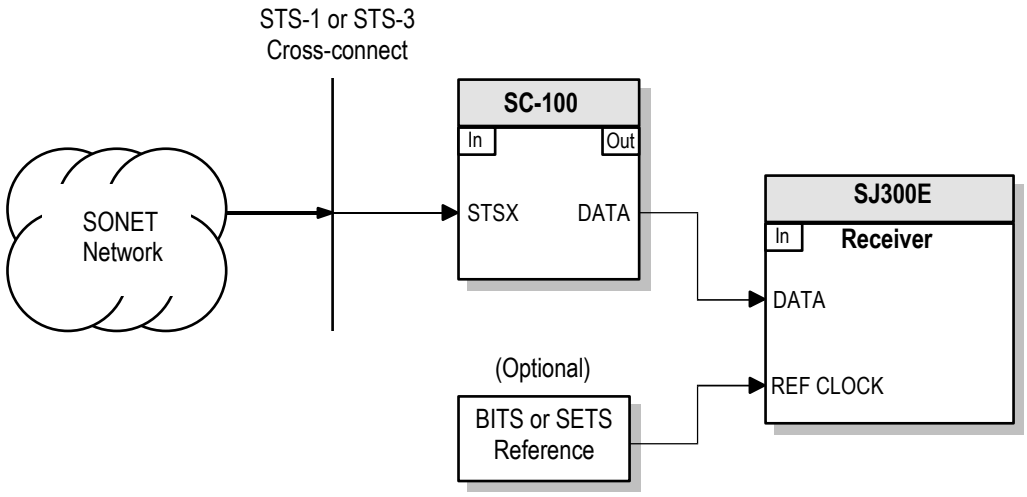


Figure 3-12 With the help of an SC100 Data Converter, the SJ300E can measure interface jitter at a SONET STSX-1 or STSX-3 *electrical* cross-connect.

Wander Measurement Configurations

The following sections illustrate how the SJ300E may be used to make wander measurements on synchronous networks and network elements.

TIE, MTIE, and TDEV

When equipped with the Wander Test Option, the SJ300E can measure the wander—TIE as a function of time where the phase has been filtered by a 10-Hz low-pass filter—between an OC-N (or STM-N) signal and a DS1 (or E1) clock reference signal, or between two DS1 (E1) clock reference signals. In addition, the SJ300E can add either calibrated wander or noise jitter to a DS1 or E1 reference signal. Thus, the SJ300E can test all of the network interface and network element wander requirements found in current SONET/SDH standards.

The SJ300E can locally calculate MTIE for a user-specified observation time and TDEV for a user-specified integration time (tau). In addition, the instrument can upload TIE data to an external PC or workstation for more extensive calculations. The SJ300E BITS/Wander Option includes MS-DOS compatible software to calculate MTIE as a function of observation time and TDEV as a function of integration time for comparison with published MTIE and TDEV “masks”.

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Wander Generation

Current SONET and SDH standards place requirements on the wander generated by the internal clocks used in network elements. Wander generation is measured by synchronizing a NE to a wander-free BITS reference signal that contains a specified level of "noise jitter" and then measuring the resulting wander on an OC-N output. Figure 3-13 illustrates how the SJ300E can measure wander generation. In this configuration, the SJ300E Transmitter adds noise jitter to a BITS clock signal applied to the timing input of the network element under test. The SJ300E Receiver measures the resulting wander (TIE) on an OC-N output of this network element. TIE data are then uploaded to a PC for calculation of TDEV and MTIE.

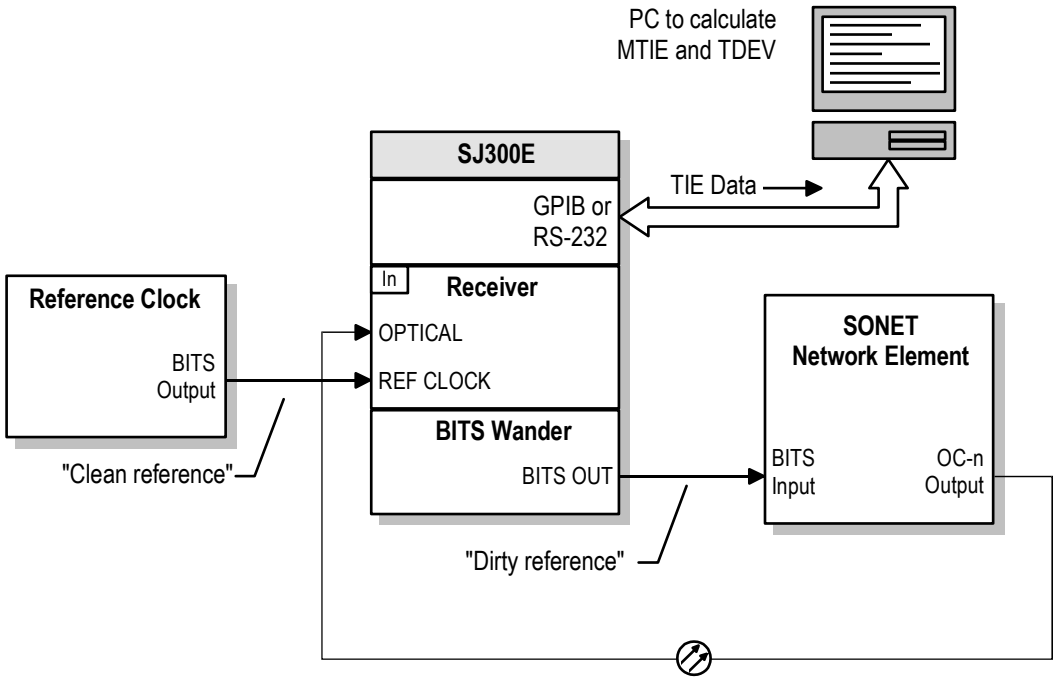


Figure 3-13 Using this configuration the SJ300E can measure wander generation of SONET or SDH network element. This configuration can also be used to test the wander transfer characteristics of an externally timed NE (see Wander Transfer below).

Wander Transfer

Wander transfer is a network element characteristic. Current SONET NE standards include two wander transfer requirements. The first is a specification on (output) short-term stability for NEs that are referenced to an external DS1 (BITS) timing signal. The second is a specification on (output) short term stability for NEs that are referenced to an OC-n line rate signal. A different "worst case" (input) short stability TDEV mask is specified for the reference signal in each case.

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The SJ300E can generate wander meeting either specified input TDEV masks on its BITS OUT port. Therefore the configuration shown earlier to measure wander generation (Figure 3-13) may also be used to test the wander transfer characteristics of an externally (BITS) timed NE. To test the second requirement, however, the BITS output of the SJ300E must be used to synchronize an external SONET signal source, for example a Tektronix ST112 test set, which in turn is used to synchronize the NE under test. The wander appearing on the OC-n output of the NE is measured by the SJ300E Receiver. This configuration is shown in Figure 3-14.

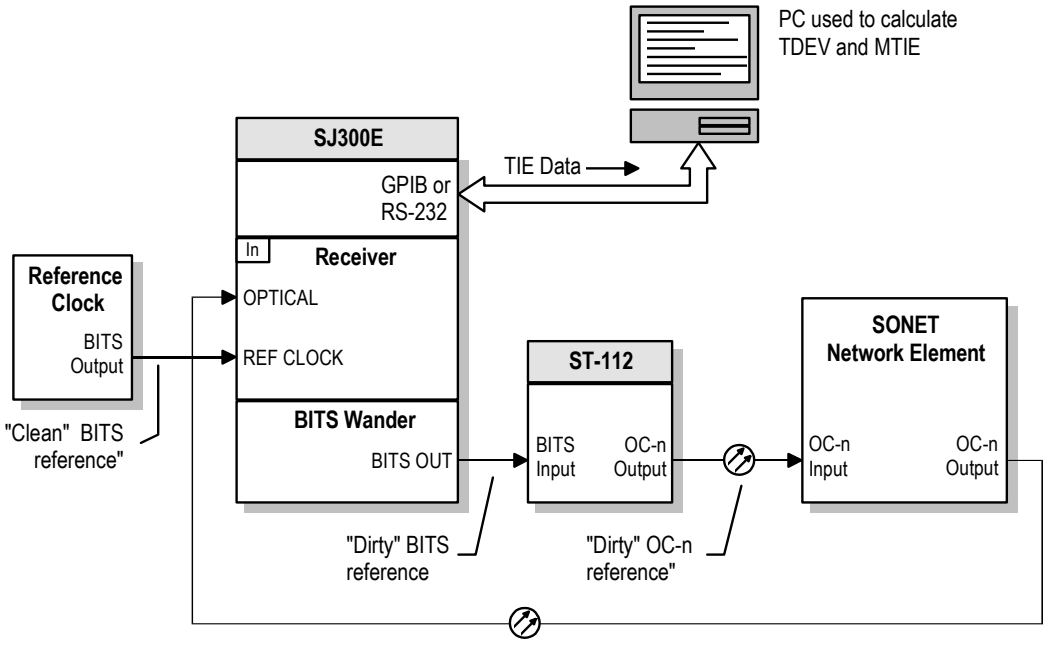


Figure 3-14 The SJ300E—with the help of a ST112 SONET Transmission Analyzer—can measure the wander transfer properties of a SONET NE.

Phase Transients

Phase Transient generation is a network element characteristic. Current SONET standards limit the size of OC-n output phase transients that can be generated by an NE during “synchronization rearrangement operations”. An example of this type of rearrangement would be the reprogramming of a network element so that it switches from one reference signal to another. NE phase transient limits are specified in terms of MTIE.

Figure 3-15 shows how the SJ- 300 can be configured to measure the phase transients generated by a network element as it undergoes a timing input switch. In this configuration, the Wander Test section of the SJ300E is used simply to add a fixed 324 ns delay between the two BITS reference signals applied to the NE under test. No wander or noise jitter is added to the BITS signal. To execute the test, the SONET NE would be issued commands from a local terminal or Operations System (OS) to change its primary reference input from “BITS #1” to “BITS #2” or to “OC-n Input”. The resulting wander on the OC-n output of the NE is measured by the SJ300E.

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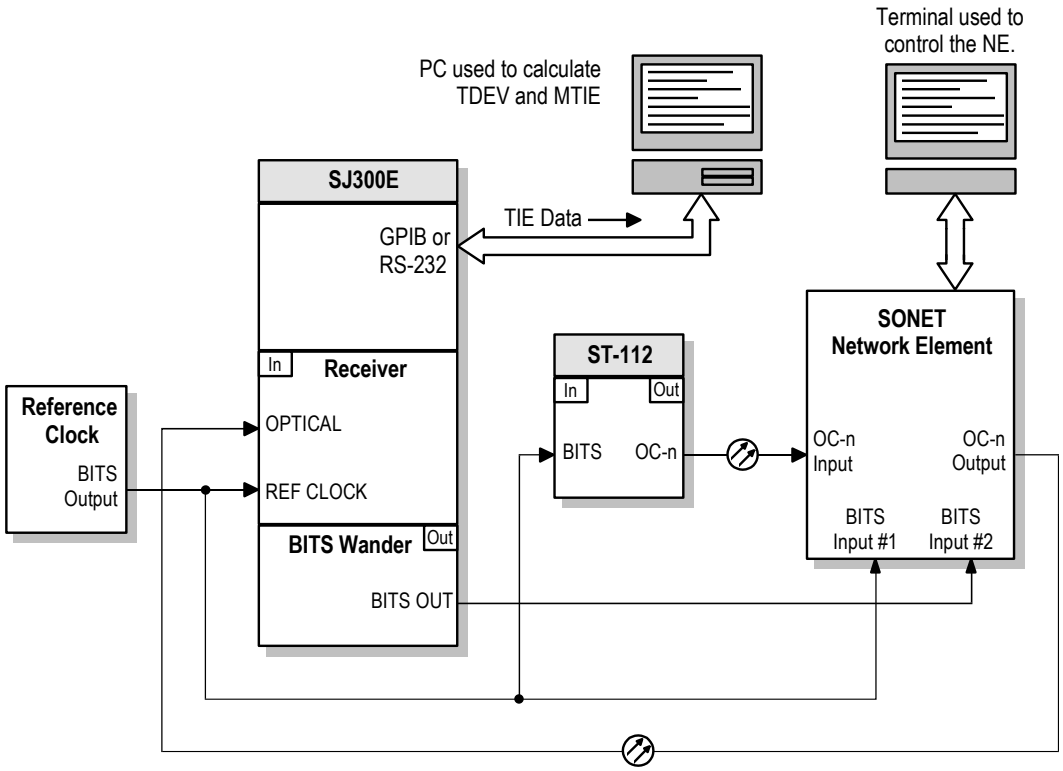


Figure 3-15 Using this configuration, the SJ300E can measure the phase transient generated by a SONET NE as the result of a synchronization reconfiguration.

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Derived DS1 Wander

Derived DS1 Wander is a SONET network element characteristic. Current standards require that in a network using SONET-based synchronization, SONET NEs must provide (two) DS1 timing reference outputs synchronized to a received OC-n timing signal. The wander on these outputs is specified in terms of MTIE and TDEV. The SJ300E can measure derived DS1 wander as shown in Figure 3-16.

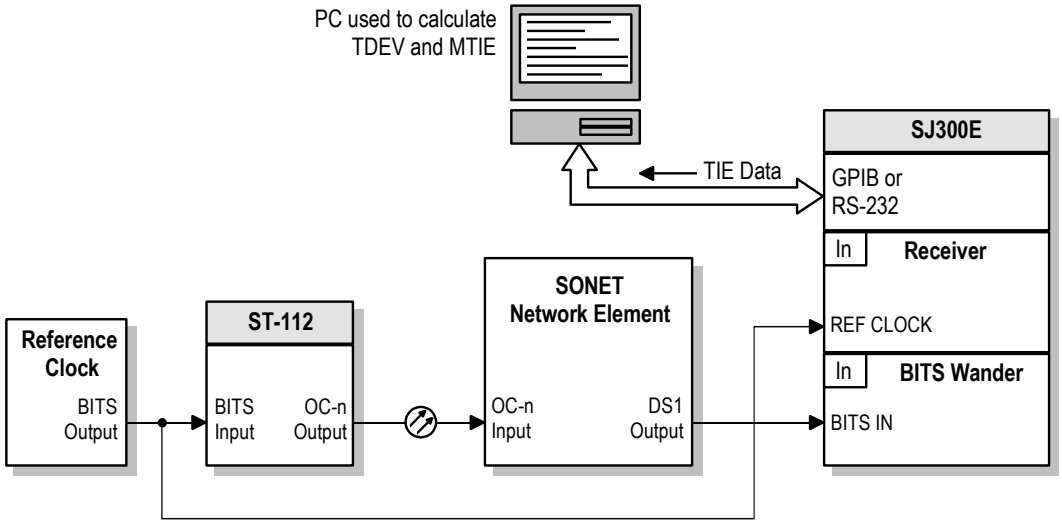


Figure 3-16 Measuring derived DS1 wander generated by a SONET NE.

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Interface Wander

Interface wander, like interface jitter, is a network characteristic. The SJ300E can measure wander on its active line rate input (CLOCK, DATA, or OPTICAL) or the BITS IN (DS1) input. Therefore, the SJ300E can measure wander on OC-n or DS1 signals at network cross-connect points. In addition, through the SC100 Data Converter the SJ300E can measure wander on STS-1 or STS-3 output signals at electrical (STSX-1 or STSX-3) SONET cross-connects. In all cases, interface wander must be measured relative to BITS or SETS reference applied to the Receiver REF CLOCK input.

Because wander is always measured on a relative basis, you may consider either the REF CLOCK input, or the input signal selected for wander measurement, to be the "signal under test". Thus, the SJ300E can make three basic types of SONET/SDH interface wander measurements:

1. wander on a line rate signal relative to a BITS or SETS reference.
2. wander on a BITS or SETS signal relative to a line rate signal.
3. wander on a BITS or SETS signal relative to another BITS or SETS signal.

Example SJ300E interface wander measurement configurations are shown in the following figures.

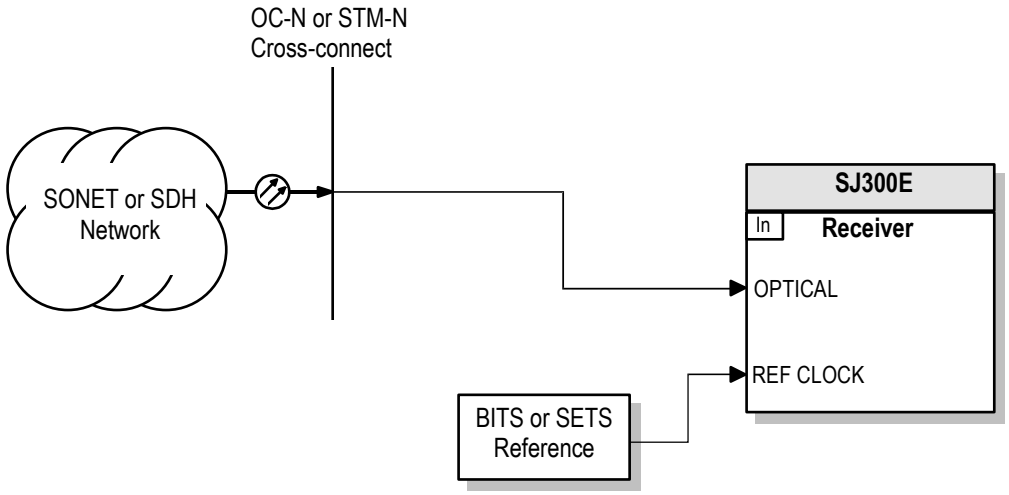


Figure 3-17 Measuring wander on a SONET or SDH optical signal using a BITS or SETS signal as reference.

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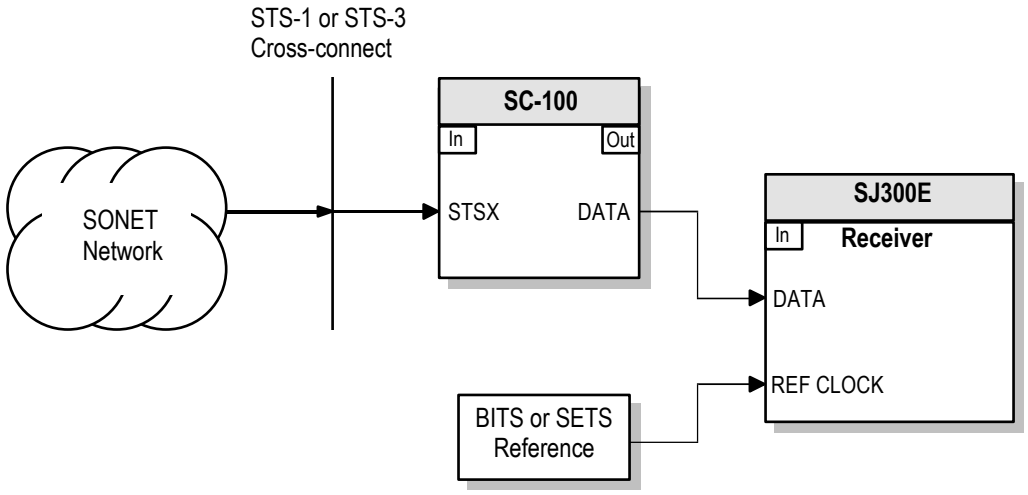


Figure 3-18 Measuring wander on a SONET electrical signal (STSX-1 or STSX-3) using a BITS signal as reference.

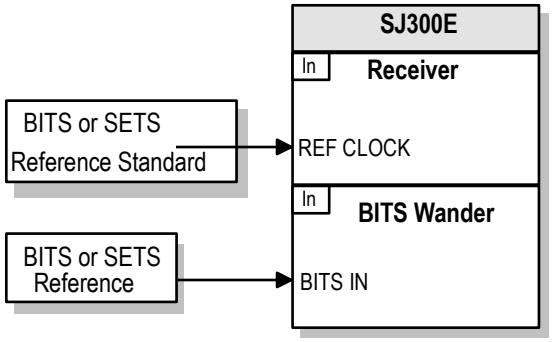


Figure 3-19 Measuring wander on a BITS or SETS signal using a second BITS or SETS signal as "standard" reference. Note that the SJ300E requires that both signals be SETS or both be BITS—a mix of the two is not allowed.

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Setup and Operation—General

This chapter explains how to set up and perform *manual* jitter and wander measurements using SJ300E front panel controls. For information on how to set up and perform *automatic* jitter transfer tests, see Chapter 5. For information on *remote* setup and operation of your SJ300E using an external PC, see Chapters 6 and 7.

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Basic Setup

This section covers setup information that is not specific to the transmitter or receiver.

Display Viewing Angle

The optimum viewing angle of the SJ300E LCD display may be adjusted using the VIEW ANGLE control. This adjustment will affect the sharpness of the characters appearing in the display. Note that this adjustment impacts vertical or "up and down" viewing angle, not horizontal viewing angle. The VIEW ANGLE key is located in the group of four "miscellaneous" keys, on the left hand side of the front panel just under the SJ300E logo.

▶ **To adjust the viewing angle of the LCD display:**

1. Press the VIEW ANGLE key one or more times until characters in the display are as clear and dark as possible. The display will cycle through four available viewing angles and then return to the original viewing angle and so on.

Time and Date

The SJ300E has an internal, battery-backed time-of-day clock and calendar. The SJ300E time and date stamps all printed reports.

▶ **To set the time of day clock and calendar:**

1. Press the MENU key.
2. Select MORE and press ENTER.
3. Use the arrow keys to select TIME.
4. Press ENTER. You should now see the TIME setup menu. The TIME menu, with example time and date values, is shown below:

```
TIME   YY MM DD HH MM SS
     1994-04-30 14:14:10
```

   The time and date values shown indicate the time and date that the menu was selected. The displayed values will not change automatically while the TIME menu is displayed.

5. Using the left/right arrow keys, select any field in the displayed menu: year, month, day, hour, minute, or second. The SJ300E keeps time in a 24-hour (00 to 23) format. Change select field(s) as required using the up/down arrow keys. Generally set time to the next whole minute.
6. When actual time reaches the displayed time you have entered, press ENTER to set the SJ300E time of day clock and calendar.

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Panel Lock

You may use the PANEL LOCK key, located on the left hand side of the front panel, to "lock" or "unlock" the front panel. While the front panel is locked, all keys, except for PANEL LOCK, are disabled. The panel lock function can be useful when you are performing a long term test and do not want the instrument setup changed accidentally.

▶ **To lock the front panel:**

❑ If the LED in the PANEL LOCK key is off, this indicates that the front panel is not locked. To lock the front panel press PANEL LOCK one time. Verify that the PANEL LOCK indicator turns on.

▶ **To unlock the front panel:**

❑ If the LED in the PANEL LOCK key is on, this indicates that the front panel is locked. To unlock the front panel, press the PANEL LOCK key one time. Verify that the PANEL LOCK indicator turns off.

GPIB Remote Lock Out

If you are operating the SJ300E using a GPIB controller, the controller can put the instrument into a "remote lock-out" mode. In this mode all front panel keys, except for the GPIB REMOTE key are disabled. While the instrument is in the GPIB remote lock-out mode, the LED in the GPIB REMOTE key will turn on. Otherwise this indicator will remain off.

▶ **To return the instrument to local control:**

1. Verify that the LED in the GPIB REMOTE key is on.
2. Press the GPIB REMOTE key one time. Verify that the indicator turns off. All front panel controls should now be enabled.

Transmitter Setup—General

This section explains how to set up the Transmitter to perform basic jitter measurements.

Clock and Data Inputs

You can operate the SJ300E Transmitter in one of three input modes:

- Internal Clock and Data
- External Clock and Internal Data
- External Clock and Data

In the Internal Clock and Data mode, the SJ300E can perform jitter tests on a stand-alone basis, without using an external SONET/SDH test set or reference clock.

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In the External Clock and Internal Data mode, the SJ300E operates with its internal 2^7-1 PRBS pattern generator synchronized to an external clock source.

In the External Clock and Data mode, the SJ300E operates in the through data mode. The Transmitter is used to add jitter to the clock and (NRZ) data outputs of an external SONET/SDH test set.

The EXT control key above the REF CLOCK input is used to select the internal or external clock mode. There is no data selection control key. The SJ300E Transmitter monitors the THRU DATA input and automatically operates in the external data mode when a signal is applied ("THRU" appears on the display). When no signal is applied the SJ300E Transmitter automatically switches to the internal data mode .

▶ **To operate using INTERNAL clock and data:**

1. Press the EXT control key (above the Transmitter REF CLOCK input) to turn the indicator LED (in this key) off.
2. DO NOT apply a signal to the THRU DATA input.

▶ **To operate using EXTERNAL clock and INTERNAL data:**

1. Apply an external clock signal to the Transmitter REF CLOCK input.
2. Press the EXT key (above the Transmitter REF CLOCK input) to turn the indicator LED (in this key) on.

   NOTE: The SJ300E will display the CAN'T LOCK REF error message if you turn on EXT before you apply a clock signal to REF CLOCK.
3. DO NOT apply a signal to the THRU DATA input.

▶ **To operate using EXTERNAL clock and data:**

1. Apply an external clock signal to the Transmitter REF CLOCK input.
2. Press the EXT key (above the Transmitter REF CLOCK input) to turn the indicator LED (in this key) on.

   NOTE: The SJ300E will display the CAN'T LOCK REF error message if you turn on EXT before you apply a clock signal to REF CLOCK.
3. Apply a corresponding (NRZ) data signal to the Transmitter THRU DATA input ("THRU" appears on the display).

A non-zero BER even with no jitter applied to THRU DATA may indicate improper clock/data phasing. The SJ300E does not have a clock/data phase "vernier" adjustment, but you can invert the clock signal using the REF CLOCK INV control key.

▶ **To invert the applied clock signal:**

1. Press the INV key above the REF CLOCK input and turn this LED indicator on.

▶ **To filter the external clock signal:**

1. Up to 0.5 UIPP of jitter can be removed from the external clock by a 10-Hz low-pass phase-locked loop. Press the "MENU" button, select "MORE" twice, and select "CLKFILT". From this submenu, the filter can be turned ON or OFF.

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Transmit SONET/SDH Rate

The Transmitter can operate at the first three SONET/SDH rates or levels, namely:

Rate (Mb/s)	SONET Designation (Logical / Optical)	SDH Designation
51.84	STS-1/OC-1	STM-0
155.52	STS-3/OC-3	STM-1
622.08	STS-12/OC-12	STM-4

Transmit rate is set using the RATE key, just under the LCD display.

▶ **To set the SJ300E transmit rate:**

1. Press the Transmitter RATE key one or more times until the desired rate (52M, 155M, or 622M) is displayed in the Transmitter Rate field of the main display.

Transmitter Outputs

The SJ300E Transmitter has three output connectors

1. CLOCK
2. DATA, and
3. OPTICAL

The CLOCK and DATA outputs generate ECL signals. DATA is NRZ. The OPTICAL output may be turned on or off. The CLOCK and DATA outputs are always on.

The transmitted data pattern may be internally or externally generated. If a signal is applied to the Transmitter's THRU DATA input, the SJ300E will automatically regenerate this signal on the DATA output and display the word "THRU". If no signal is applied to the THRU DATA input, the SJ300E will internally generate a 2^7-1 PRBS.

The CLOCK and DATA outputs are jittered together. The rising edges of the CLOCK signal are always at least 600 ps from edges in the DATA signal. Therefore CLOCK and DATA together can be used to drive the SC100 Data Converter.

Turning the Output Laser On or Off

The Transmitter OPTICAL output laser may be turned on or off using the ON key located just above the Transmitter OPTICAL connector.

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▶ **To turn the output laser on and off:**

1. Press the ON key just above the Transmitter OPTICAL connector to toggle the Transmitter output laser on or off. The ON key indicator shows whether the laser is active (indicator on) or inactive (indicator off).

Jitter Generation Setup

The primary function of the SJ300E Transmitter is to generate SONET/SDH signals containing known amounts of jitter. The SJ300E can add jitter to (i.e., phase-modulate) through-mode SONET/SDH signals. Alternatively, it can add jitter to its clock output signal which can then be used to synchronize an external SONET/SDH pattern generator.

The SJ300E provides two jitter generation modes. First, the Transmitter can internally generate sinusoidal jitter at a user-programmable frequency and amplitude. This is called the "internal modulation" mode. Second, an external waveform generator (voltage source) can be used to generate jitter with an arbitrary waveform. This is called the "external modulation" mode. The external modulation mode is useful, for example, to simulate phase ramps, transients, or noise jitter.

The SJ300E can also step through a sequence of up to 20 jitter amplitude/frequency pairs. The frequency and amplitude of each point in the sequence, as well as the step time, are user-programmable. The "jitter sequence" mode, which is part of the SJ-300's jitter transfer measurement capability, is addressed in Chapter 5.

Internal Jitter Modulation

Internal jitter modulation is set up using the three controls in the JITTER box—ON, FREQ, and AMP—plus the ON key above the MODULATION connector in the EXT IN box. The peak-to-peak jitter generation range (maximum jitter amplitude) of the SJ300E is a function of both transmit SONET/SDH baud rate and jitter frequency, as illustrated in Appendix A, Figure A-1.

▶ **To set internal jitter frequency:**

1. Press the FREQ key in the JITTER box. Verify that the LED in this key turns on and an underline appears under one of the digits in the JITTER FREQ (Hz) field in the main display.
2. Use the left/right arrow keys to select a digit position. Note that you can move the underline to digit positions that are currently empty.
3. When you have selected a digit position, use the up/down arrows to increment or decrement the current jitter frequency.
4. Repeat steps 2 and 3 until you have entered the desired jitter frequency.

▶ **To set internal jitter amplitude (UI p-p):**

1. Press the AMP key in the JITTER box. Verify that the LED in this key turns on and an underline appears under one of the digits in the JITTER AMPL (UI) field in the main display. Internal jitter amplitude is set in terms of unit intervals peak-to-peak (UI p-p).

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2. Use the left/right arrow keys to select a digit position. Note that you can move the underline to digit position that are currently empty.
3. When you have selected a digit position, use the up/down arrows to increment or decrement the current jitter amplitude.
4. Repeat steps 2 and 3 until you have entered the desired jitter amplitude.

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▶ **To start and stop internal jitter generation:**

1. Enter the desired jitter frequency and amplitude using the above procedures.
2. Verify that the indicator in the EXT key above the MODULATION connector is off. If it is not off, press the EXT key one time to turn external modulation off (i.e. turn internal modulation on).
3. You may now use the ON key in the JITTER box to toggle internal jitter generation on or off. Generation is on while the indicator is on, and off while the indicator is off.

External Jitter Modulation

Output phase can be modulated by a (voltage) waveform generator connected to the Transmitter MODULATION input. The external modulation signal must meet the following amplitude and slew rate limits:

Rate (Mb/s)	Voltage Limit	Slew Rate Limit
51.84	± 0.8 volts	0.135 V/µs
155.52	± 0.8 volts	0.405 V/µs
622.08	± 0.8 volts	1.62 V/µs

The MODULATION input has a sensitivity of 0.1 v/UI. Therefore a voltage limit of ±0.8 volts corresponds to a jitter amplitude limit of ± 8 UI or 16 UI p-p. Note that the Slew Rate limit may restrict high-frequency modulation to less than ± 0.8 volts.

External jitter modulation is set up using the EXT key above the MODULATION connector, and the ON key in the JITTER box as follows.

▶ **To start and stop external jitter generation:**

1. Connect a signal source to the Transmitter MODULATION connector.
2. Verify that the indicator in the EXT MODULATION key (above the Transmitter MODULATION connector) is on. If it is off, press the EXT one time to enable external modulation
3. You may now use the ON key in the JITTER box to toggle external modulation on or off. External modulation will be on while the indicator is on and off while the indicator is off.

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Receiver Setup—General

This section explains how to set up the Receiver to perform basic jitter and wander measurements.

Selecting the Active Input

The SJ300E can measure jitter and wander on its CLOCK, DATA, or OPTICAL input. Prior to making a jitter or wander measurement, you must select one of these inputs as the active input. The Receiver will measure jitter and wander only on the active input and ignore the other two inputs. The active Receiver input is selected using the SELECT key in the Receiver INPUTS box.

▶ **To select the active Receiver input:**

1. Press the Receiver SELECT key one or more times until the LED above the desired input turns on.

Receive SONET/SDH Rate

The SONET/SDH line rate of the Receiver must be selected prior to making jitter or wander measurements on the received CLOCK ,DATA, or OPTICAL signal. Receiver line rate is selected using the RATE key just under the main display, on the RECEIVE side of the front panel,.

▶ **To select the Receiver Rate:**

1. Press sthe Receiver RATE key one or more times until the desired rate (52M, 155M, or 622M) is displayed in the Transmitter Rate field of the main display.

Jitter Measurement Setup

This section explains how to set up the SJ-300's jitter measurement capability.

Jitter Reference (Internal or External)

In order to demodulate jitter from a digital signal, a jitter-free reference signal is required. The jitter reference signal must be phase-locked to the measured signal at wander frequencies—below 10 Hz—but have as little phase variation as possible above 10 Hz. Thus any phase difference between the reference and measured signal can be extracted as the demodulated jitter waveform.

The SJ300E can measure jitter using either an internally *recovered* reference or an external reference applied to the Receiver REF CLOCK input[1]. The external reference is either a DS1 1.544-Mb/s or an E1 2.048-Mb/s signal; the frequency is internaly multiplied up to the appropriate line rate. Either internal or external mode will produce accurate jitter measurement results. In general use the internal mode—because it is more convenient—unless the

[1] Wander measurement always requires an external reference.

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measurement practice or standard you are using specifies an external reference and an external jitter reference is available.

▶ **To select jitter reference mode:**

1. Press the EXT key above the Receiver REF CLOCK input to toggle between the internal (LED off) and external (LED on) jitter reference modes.
2. If you select the external reference mode, you must apply a 1.544 Mb/s BITS or a 2.048 Mb/s SETS signal to the REF CLOCK input, depending on the current synchronization clock mode. Synchronization clock mode is set using the REF SEL (REFERENCE) menu under the WANDER selection in the main menu
(See page 4 -17).

Jitter Measurement Mode (Wide or Fine)

The SJ300E offers two jitter measurement modes: Wide and Fine. The jitter measurement mode determines peak-to-peak jitter measurement resolution and range as shown in Appendix A, Figures A-2 and A-3. Use the Wide mode for maximum jitter measurement amplitude *range*. Use the Fine mode for maximum jitter measurement *resolution*.

There are two restrictions on using the Fine mode. First, you must select the internal jitter reference mode. If you select the external reference mode, the SJ300E will automatically set the jitter measurement mode to Wide. Second, fine mode peak-to-peak results are not available for the DATA or OPTICAL inputs.

There are no setup restrictions on using the Wide mode.

▶ **To select the jitter measurement mode:**

1. Press the MODE key in the Receiver MEASUREMENT box. Each press of this key will toggle the jitter measurement mode between Wide and Fine.

Jitter Measurement High Pass Filter

As required by current jitter measurement standards, the SJ300E provides a 12 kHz high-pass filter and two high-pass filters whose cutoff frequencies, referred to as “B1” and “B2,” depend on the SONET/SDH rate. A third high-pass filter referred to as “B0” is also provided at each rate. The B0 filter, which has a Wide mode cutoff of 10 Hz, may be thought of as the “total jitter” measurement filter. In the Fine mode, B0 has a higher value which depends on the SONET/SDH rate. The SJ300E jitter measurement high-pass filter cutoff frequencies are summarized below:

SONET/SDH Rate	HP Filter Cutoff Frequencies (Hz)				
	B0 (Wide)	B0 (Fine)	B1	B3	B2
52 Mb/s	10	13	100	12 k	20 k
155 Mb/s	10	30	500	12 k	65 k
622 Mb/s	10	120	1000	12 k	250 k

▶ **To select the jitter measurement high-pass filter cutoff:**

1. Set the Receiver SONET/SDH rate as desired: 52M, 155M, or 622M.

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2. Press the HPF key one or more times to select the desired HPF cutoff frequency. The currently selected HPF cutoff will be shown in the main display just above the HPF key.

Jitter Hit Threshold

The SJ300E Receiver can detect when measured peak-to-peak jitter amplitude exceeds a user-programmable "hit threshold". Results based on the jitter hit threshold are: **Jitter Hit Seconds**, the number of seconds in which jitter amplitude exceeds the hit threshold and **Jitter Hits**, the number of blocks of consecutive jitter hit-seconds. Jitter hits are defined to start upon the detection of a single jitter hit second and stop upon the detection of a single non-jitter hit second. Thus, each jitter hit is composed of one or more contiguous jitter-hit seconds (see example in Figure 4.3). The jitter hit threshold can be set from 0.001 to 16 UI p-p, with a resolution of 0.001 UI p-p.

▶ **To set the jitter hit threshold:**

1. Press the menu key.
2. Select THRESHOLD and press the ENTER key. You will see the following menu:

```
JITTER HIT
THRESHOLD: 5.370
```

(Example threshold value shown)

3. Use the arrow keys to edit the jitter hit threshold.
4. Press ENTER when done.

Jitter Window Duration

The SJ300E measures peak-to-peak jitter over a sliding window. The duration of this window may be set in the range 1 to 99 seconds. Alternatively, the jitter measurement window can be set to "infinity". In this mode peak-to-peak jitter amplitude is measured from test RESET to the present time.

▶ **To set the jitter measurement window duration:**

1. Press the MENU key.
2. Select WINDOW and press ENTER.
3. Use the arrow keys to set window duration (i.e., jitter observation time) in the range 1 to 99 seconds.
4. Or, to set window duration to "infinity", increment the window duration above 99 or decrement below 1. You will then see the an ∞ symbol to indicate that peak-to-peak jitter amplitude is measured continuously from test RESET to the present.

Wander Generation, DS1, and Measurement Setup

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This section explains how to set up SJ300E wander generation and measurement functions. For information on using jitter and wander analysis software available with the SJ300E, please see the list of Documentation References.

Wander, or Noise Jitter Generation

The SJ300E Wander Test Option can generate wander, noise jitter, or transients from the BITS/SETS OUT output, relative to the Receiver REF CLOCK reference input signal. The REF CLOCK and BITS/SETS OUT provide respective sink and a source synchronization signals for the BITS (1.544 Mb/s) or SETS (2.048 Mb/s or 2.048 MHz).

The SJ300E can generate three different wander functions referred to as “DS1,” “DS1 Filtered,” and “OC-N.” These are pseudorandom waveforms of TIE that are filtered to have TDEV plots within ±2 dB of the TDEV masks, shown in Figure 4-1 These masks are specified in Bellcore standards GR-253-CORE and GR-1244-CORE.

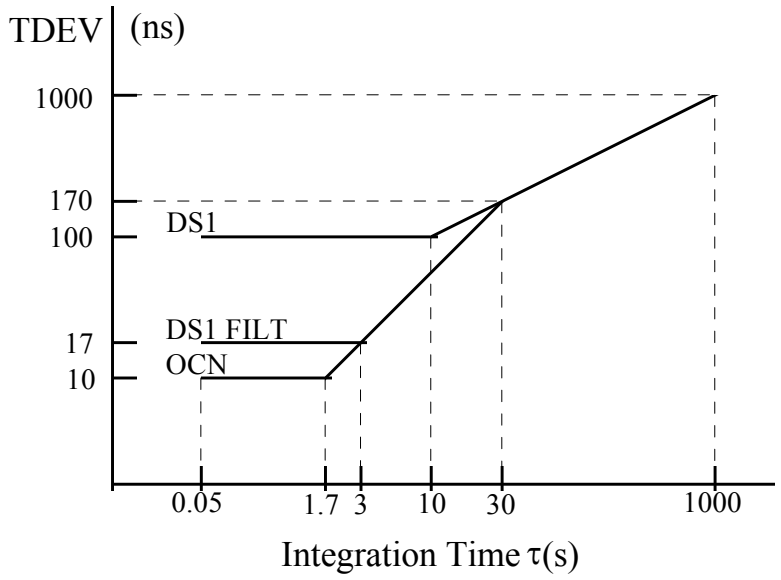


Figure 4-1 Wander Generation Selection.

The SJ300E can also generate band-limited white noise, truncated, Gaussian jitter as described in Bellcore GR-253-CORE section 5.4.4.3.1. This jitter (referred to as “NOISE”) has a peak-to-peak amplitude of 1000 ns, an rms value of 110 ns, and is frequency limited to a range from 10 Hz to 150 Hz.

The SJ300E can also generate transients of the form $\mathrm{TIE}(t) = A\ (1 - e^{-62.8t})$, where A is either 1000 ns or 1200 ns. For A = 1000 ns, the transient rises 80 ns in the first 1.326 ms. These transients (referred to as “1000TRAN” and “1200TRAN”) and the other wander generation patterns are summarized in the table below.

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SJ-300 BITS Phase Generation Patterns	Bellcore References	ANSI Reference
DS1	GR-1244-CORE, Fig. 4-2	T1.105.03-1994, Fig. D-5
DS1 FILT	GR-253-CORE, Fig. 5-15	T1.105.03-1994, Fig. D-6
OC-N	GR-253-CORE, Fig. 5-14	T1.105.03-1994, Fig. D-2
NOISE	GR-253-CORE, Sec. 5.4.3.3.1	----------
1000TRAN	GR-253-CORE, Sec. 5.4.4.3.2	T1.101-1994, Sec. 7.2.1.2
1200TRAN	20% margin test for 1000-ns transient tolerance	

► **To generate wander or noise jitter:**

1. Verify that a synchronization reference clock signal (1.544 Mb/s BITS or 2.048 Mb/s SETS) has been connected to the Receiver REF CLOCK input.
2. Verify that the synchronization mode has been set to DS1 (BITS) or 2 Mb/s (SETS) as follows:
   a. Press the MENU key.
   b. Select WANDER and press ENTER.
   c. Select REF SEL and press ENTER.
   d. Select either DS1 or 2MB/S and press ENTER.
3. From the WANDER menu, select WAND GEN. You will see the Wander Generation menu:

```
 NONE    DS1    DS1FILT   OCN
NOISE  1000TRAN  1200TRAN
```


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4. Use the left and right arrows to select one of the available wander or noise-jitter generation modes:

NONE	(generates no wander or noise jitter)
DS1	(generates the "DS1" TDEV mask)
DS1FILT	(generates the "filtered DS1" TDEV mask)
OCN MASK	(generates the "OC-N" TDEV mask)
NOISE JIT	(generates truncated, filtered "white" noise jitter)
1000TRAN	(generates transient with 1000 ns amplitude
1200TRAN	(generates transient with 1200 ns amplitude

5. Press ENTER to activate your selection.

◗ **To generate a transient:**

1. Connect a 1.544-Mbit/s BITS reference to the Receiver REF CLOCK, and press the EXT key (light will come on).
2. In the WANDER menu, enter REF SEL, and select (enter) DS1.
3. Enter WAND GEN, and select (enter) NONE.
4. The BITS OUT signal (rear panel) is now in its quiescent state before the transient. Initiate monitoring of the effect of the transient at any time now.
5. Enter WAND GEN, and select (enter) 1000TRAN for a 1000-ns transient or 1200TRAN for a 1200-ns transient. The transient occurs at the instant the ENTER key is pressed.

Note that the transients are in a direction to bring the phase of the BITS/SETS OUT signal *earlier* by 1000 ns or 1200 ns. To repeat the transient, steps 3 through 5 must be repeated.

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Active Input for Wander Measurement

The basic SJ300E can make limited measurements of wander on optical line signals (SONET and SDH). The SC100 converter box extends wander measurements to electrical interface line signals (STSX-1 and STSX-3). With the Op-BWD option installed, the SJ300E has increased slew rate capability and can also measure wander on synchronizatiion reference signals (DS1 BITS clocks and E1 SETS clocks). The Op-BWD also includes software for uploading wander data to a PC, calculatiing MTIE and TDEV, and plotting the results vs. Observation Time and Integration Time. The specifications are:

	Without Op-BWD	With Op-BWD
TIE Range	$\pm 10^8$ ns	$\pm 10^8$ ns
TIE Slew:		
OC-1	±153 ns/s	±10,000 ns/s
OC-3	±51 ns/s	±10,000 ns/s
OC-12	±13 ns/s	±10,000 ns/s
DS1	----------	±10,000 ns/s
E1	----------	±10,000 ns/s
TDEV Range	10^5 ns	10^8 ns *
Integration Time	0.1 - 99.9 s	0.02 - 10^3 s *
MTIE Range	10^5 ns	10^8 ns *
Observation Time	0.1 - 99.0 s	0.02 - 10^3 s *

* when displayed on PC screen

The SJ300E can measure wander on either the BITS IN input or the currently active Receiver line-rate input (CLOCK, DATA, or OPTICAL) relative to the Receiver REF CLOCK input. Because wander is a relative measurement, you can use the SJ300E to perform any of the following wander measurements:

1. wander on a BITS or SETS synchronization signal, relative to another BITS or SETS synchronization signal. Note that both signals must be BITS or both must be SETS signals—a mix of BITS and SETS is not allowed.
2. wander on a SONET or SDH line rate signal relative to a BITS or SETS synchronization signal.
3. wander on a BITS or SETS synchronization signal relative to a SONET or SDH line rate signal.

Measurements 2 and 3 above differ only in which of the two signals, line or synchronization, is considered the “reference” and which is considered the “signal under test”. Also note that the REF CLOCK input is always one of the two signals used to make a wander measurement.

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▶ **To measure wander between the Receiver REF CLOCK input and the BITS IN input (sync. - sync.) :**

1. Press the MENU key.
2. Select MORE and press ENTER.
3. Select WANDER and press ENTER.
4. Select WAND MEAS and press ENTER. The Wander Measurement menu should now be displayed:

```
MEAS TYPE        ENTER>SET
         OCN    BITS
```

5. Select BITS. Then press ENTER to activate (set) your choice.

▶ **To measure wander between the Receiver REF CLOCK input and the currently active Receiver line-rate Input (line-sync):**

1. Follow steps 1 through 4. from the previous procedure.
2. Select OCN and press ENTER.
3. Verify that the desired Receiver input (CLOCK, DATA, or OPTICAL) is active.

Setting the TDEV Integration Time (τ) and MTIE Observation Time

The SJ300E can calculate TDEV for a single value of tau, the TDEV integration time, and MTIE for a given observation time. Both results are calculated by the SJ300E internally based on TIE data collected since the start of the present measurement interval since the RESET key was last pressed. These two results are useful in providing a feel for how TDEV and MTIE are changing in real time. However complete TDEV and MTIE results require the use of an external PC and optional analysis software available with the SJ300E (See Chapter 1 and Appendix B).

▶ To change the TDEV integration time (τ) or the MTIE observation time:

1. Press the MENU key.
2. Select MORE and press ENTER.
3. Select WANDER and press ENTER.
4. Select DISPLAY and press ENTER. You will see the following wander results display menu:

```
TDEV:      678ns TAU:   0.4
MTIE:     2345ns OBS:   1.0
```

(Example data shown)

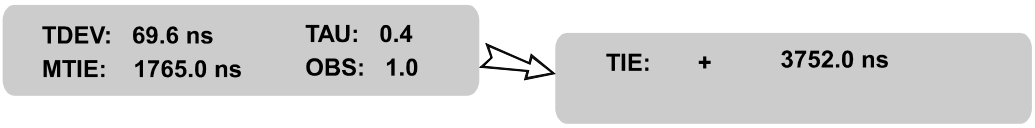
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5. Use the **F1** key to move the cursor between the **TAU** (TDEV integration time) or **OBS** (MTIE observation time). Within each field you can use the left/right arrow keys to select a digit and the up/down arrow keys to increment or decrement the selected digit. Allowable ranges for TAU and OBS are as follows:

Parameter	Allowable Range
TDEV Integration Time (TAU)	0.01 to 99.9 seconds
MTIE Observation Time (OBS)	0.01 to 99.0 seconds

Observing TIE

For firmware versions 5.1 and higher or 3.8 to 4.9, TIE data is available from the front panel by pressing the MENU key while viewing the TDEV/MTIE data (See examples following.)



TIE can be reset to zero by pressing RESET.

Synchronization Signals Type and Level

The synchronization signal ports for the SJ300E are:

- ☐ Receiver REF CLOCK input
- ☐ BITS/SETS IN input
- ☐ BITS/SETS OUT output.

These three ports expect or generate the same type of synchronization signal as to rate, clock or data, and frame pattern.

◗ **To select the synchronization type:**

1. Press the MENU key twice.
2. Select WANDER and press ENTER.
3. Select REF SEL and press ENTER. You should now see the following menu:

```
REFERENCE        ENTER>SET
 DS1/SF  DS1/ESF  E1  2MHZ
```

4. Select the desired synchronization signal type, and press ENTER.

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5. Press the ESC key until you have left the menu system.

The parameters describing the various synchronization signal types are summarized below.

Sync Signal Type	Rate	Clock or Data	Frame Pattern
DS1/SF	1.544 Mb/s	bipolar data	Superframe
DS1/ESF	1.544 Mb/s	bipolar data	Extended Superframe
E1	2.048 Mb/s	bipolar data	31-Channel, no CRC-4
2MHZ	2.048 MHz	square wave clock	----------

The two synchronization inputs (Receiver REF CLOCK and BITS/SETS IN) may be set to accept the standard interface level (TERMINATE mode) or 1/10 the standard interface level (MONITOR mode). The standard interface levels are specified in ITU recommendation G.703 in Table 6/G.703, Table 10/G.703, and Figure 10/G.703.

◗ To select the synchronization input level:

1. Press the MENU key twice.
2. Select WANDER and press ENTER.

```
REFERENCE      ENTER>SET
MONITOR    TERMINATE
```

1. Select REF LEV and press ENTER. You should now see the following menu:
2. Select the desired synchronization signal level, and press ENTER.
3. Press the ESC key until you have left the menu system.

The peak values accepted at the synchronization inputs for the two modes are summarized below.

Level Mode	100-Ω Data	100-Ω Clock	75-Ω Data	75-Ω Clock
Terminate	3.0 V ±24%	1.45 V ±31%	2.37 V ±10%	1.125 V ±34%
Monitor	0.30 V ±24%	0.145 V ±31%	0.237 V ±10%	0.1125 V ±34%

(100-Ω balanced synchronization ports are standard for the SJ300E 75-Ω unbalanced synchronization ports may be ordered as a special option.)

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How to Start a Jitter or Wander Measurement

Once the SJ300E receiver is set to make the desired jitter or wander measurement it will begin to collect data. There is no control that starts the jitter or wander measurement. However, the RESET key will clear all the accumulated results, and reset TIE to zero, initiating a new measurement cycle.

NOTE: Generation of a jitter sequence must be manually started by pressing the RUN key. See Chapter 5 for more information on using the RUN key to start a jitter transfer or tolerance test.

The Receiver RESET key is located in the MEASUREMENT box just under the display. The actions performed by the SJ300E when you press the Receiver RESET key are as follows:

1. All jitter results used to calculate RMS and peak-to-peak jitter amplitude are cleared.
2. All jitter threshold results used to calculate JITTER HITS and JITTER HIT SECONDS are cleared.
3. All wander results used to calculate TDEV and MTIE are cleared.
4. TIE is reset to zero.
5. In the external reference mode, the receiver's jitter phase detector is recentered.

▶ **To clear the jitter and wander results listed above:**

1. Press the Receiver RESET key.

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Jitter and Wander Results

The following section explains how the SJ300E calculates jitter and wander results from collected jitter data (samples), and how to view and print results.

How the SJ300E Calculates Jitter

The SJ300E makes the following local calculations from jitter data:

- Peak-to-Peak jitter
- RMS jitter
- Jitter hits
- Jitter hit seconds.

Peak-to-Peak Jitter

The SJ300E can measure peak-to-peak jitter over a sliding window or a continuous interval. If the Window Length parameter is set between 1 and 99 seconds then peak-to-peak jitter is measured over a sliding window of the indicated length. If Window Length is incremented above 99, or decremented below 1, then Window Length is set to "infinity" and peak-to-peak jitter is measured over a continous interval. A continuous interval begins when the RESET key is pressed. Figure 4-2 illustrates. In this example, WINDOW=∞ would give the result 9.75 Uip-p, while WINDOW=2 would give the result 6.25 UIp-p.

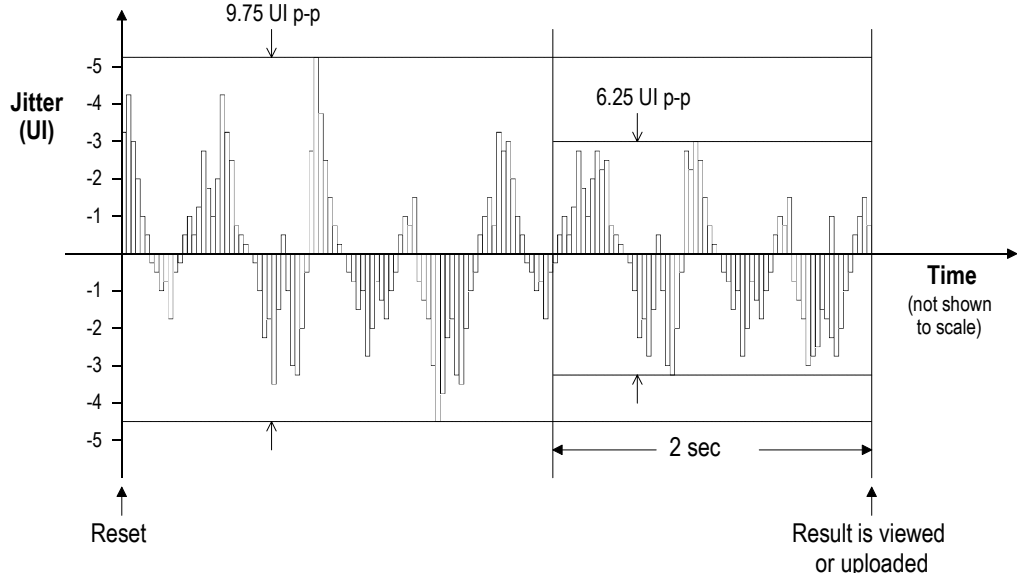


Figure 4-2 The SJ300E can calculate peak-to-peak jitter over a continuous interval—beginning with a RESET—or a sliding window of 1 to 99 seconds.

RMS Jitter

The SJ300E calculates a new RMS jitter value twice a second based on two 0.125-ms blocks of jitter data spaced 500 ms apart. This process is illustrated in Figure 4-3, where the data used to

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calculate RMS jitter are shown in black. The high-pass filter should be set to 12 kHz when making RMS measurements. This is specified by Bellcore in their requirement GR-253-CORE, section 5.6.2.3 describing the measurement of "jitter generation."

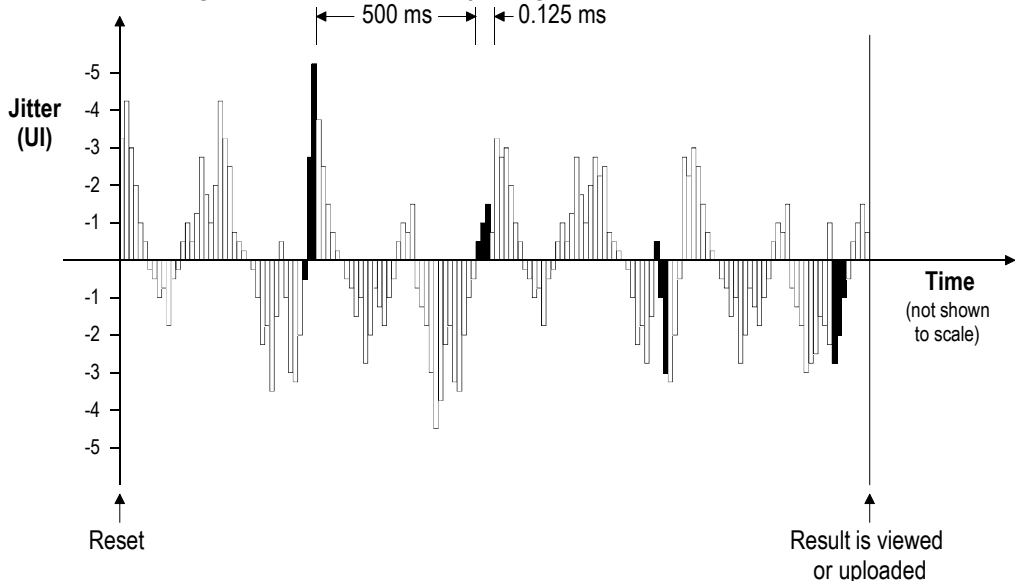


Figure 4-2 RMS jitter calculation is based on 0.125 ms blocks of data spaced 500 ms apart.

Jitter Hits and Hit Seconds

Jitter hits and jitter hit seconds are based on a user-programmable peak-to-peak jitter threshold that may be set in the range 0.001 to 16.000 UI. To calculate jitter hits and jitter hit seconds, the SJ300E compares the peak-to-peak jitter in each (non-sliding) 1-sec window with the jitter threshold. Any second in which the threshold is exceeded is a jitter-hit second. The boundaries of jitter hit seconds are determined by the SJ-300's internal clock rather than the jitter data. Thus SJ300E jitter hit seconds may be compared with "asynchronous" errored seconds, rather than "synchronous" errored seconds. Jitter Hits are contiguous jitter hit second "events". Each jitter hit begins with the detection of a jitter hit second and ends with the detection of the next non-jitter hit second. The SJ300E calculates both jitter hits and hit seconds over a continuous interval, beginning with a RESET. The SJ300E jitter hit and hit second calculation process is illustrated in Figure 4-3.

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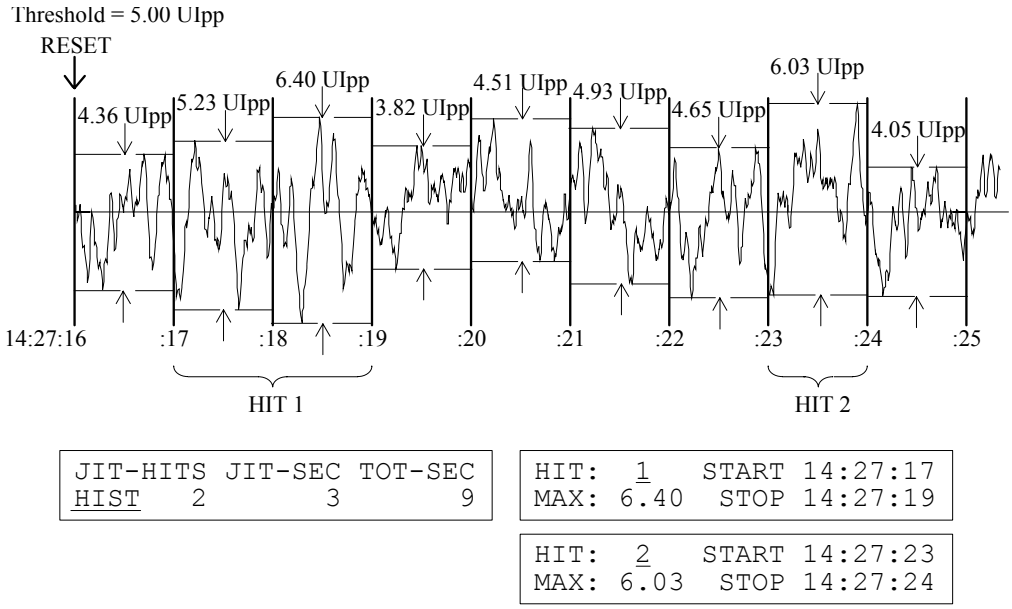


Figure 4-3 Jitter hits and hit seconds are based on a user-programmable peak jitter threshold.

How the SJ300E Calculates Wander

The SJ300E calculates two wander parameters locally:

- MTIE
- TDEV

MTIE is calculated for one user-specified observation time. TDEV is calculated for one user-specified integration time. Both results are based on a continuous measurement interval. Accumulated wander data are cleared (zeroed) when the RESET key is pressed. To calculate MTIE as a function of observation time, or TDEV as a function of integration time, SJ300E wander data must be uploaded to an external controller via the RS-232 or GPIB port. MS-DOS compatible software to calculate MTIE vs. observation time and TDEV vs. integration time is available from Tektronix (See Appendix B). For a detailed explanation of MTIE and TDEV, see "SONET Jitter and Wander—Their Origin, Effects, and Measurement—A Guide to Bellcore and ANSI Specifications", available from Tektronix.

Viewing Results

This section explains how to view the jitter and wander results calculated locally by the SJ300E For information on viewing jitter and wander results calculated externally by analysis software available from Tektronix, please see the list of reference documents under the heading Documentation References.

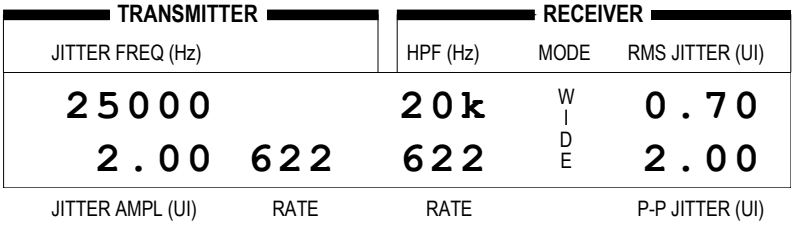
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Peak-Peak and RMS Jitter

The jitter measured on the current active input is shown in the right side of the normal display format. The upper right hand field shows RMS jitter in unit intervals. The lower right hand field shows peak-to-peak jitter also in unit intervals.

▶ **To display measured jitter:**

1. If the main display is in the menu mode, return it to the normal mode by finishing any setup operation you are performing and pressing the ESC key one or more times until the normal mode appears. An example display in which current RMS jitter is 0.70 UI, and current peak-to-peak jitter is 2.00 UI, is shown below:



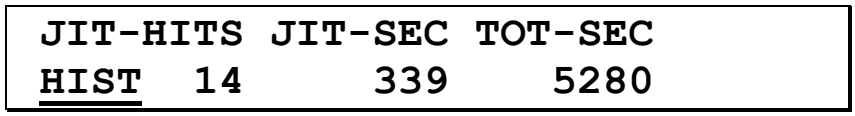
Jitter Hits and Hit Seconds

Jitter threshold results maintained by the SJ300E are:

- ❑ The number of jitter hits (**JIT-HITS**)
- ❑ The number of jitter hit seconds (**JIT-SEC**).

▶ **To view current jitter threshold results:**

1. Press the MENU key.
2. Select JIT-HITS and press ENTER. You will see the following results summary screen:



(Example results shown)

- ❑ In this example, there were 339 Jitter-Seconds (seconds in which the threshold was exceeded), 14 Jitter-Hits (blocks of contiguous Jitter-Seconds), and 5280 total seconds elapsed since the last RESET.

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▶ **to view jitter hits history:**

1. From the JIT-HITS results screen, "HIST" is underscored. Press the ENTER key, and the following screen will appear:

```
HIT: 1      START   11:23:52
MAX: 5.11   STOP    11:24:03
```

By pressing the SCROLL key or the UP/DOWN keys, you can examine the detailed results of each jitter hit. The start time, the stop time, and the maximum peak-to-peak jitter for the selected jitter hit are shown.

Wander

The wander results calculated and maintained locally by the SJ300E are:

- MTIE: Maximum time interval error for a single value of OBS (observation time).
- TDEV: Time deviation for a single value of TAU (integration time).

▶ **To view local wander results:**

1. Press the MENU key.
2. Select MORE and press ENTER.
3. Select WANDER and press ENTER.
4. Select DISPLAY and press ENTER. You will see the following results screen:

```
TDEV:   993ns TAU:   0.4
MTIE:   499ns OBS:   1.0
```

(Example results and setup parameters shown)

The displayed values of TDEV and MTIE will be updated by the SJ300E in real time. The WANDER DISPLAY screen also shows the current values of TAU, the TDEV integration time, and OBS, the MTIE observation time. You should set these values as required before beginning a wander measurement.

5. To return to the normal display, press ESC three times.

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Printing Results

The SJ300E can print four different reports:

- **JIT-XFER** (Jitter Transfer Data Report): a listing of the results from the most recent jitter transfer test.
- **JIT-HITS** (Jitter Hits Data Report): a listing of the jitter hits detected since the last reset or power on.
- **TX-SEQ** (Jitter Test Sequence Setup Report): a listing of the current jitter sequence. This report may contain up to 20 jitter amplitude/frequency pairs (points).
- **ALL TX-SEQ** (All Jitter Test Sequence Setup Report): a listing of all currently defined jitter sequences for the current SONET/SDH transmitter rate. This report may contain up to 16 sequences each containing up to 20 points.

The JIT-XFER, TX-SEQ, and ALL TX-SEQ reports are related to the SJ-300's jitter transfer test feature which are covered in the Chapter 5. The content of the JIT-HITS report and how to generate the JIT-HITS report are explained next.

Jitter Hits Report

The JIT-HITS report contains one line for each jitter hit event detected in the current measurement interval. Remember that the current measurement interval is simply the time from the last press of the RESET key (or power-up) to the present. Each event line will indicate:

- The maximum jitter amplitude detected during the event
- The first jitter hit second in the event.
- The first non-jitter hit second after the event.

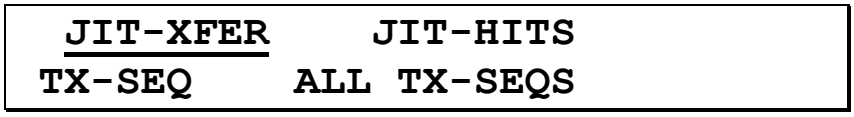
The Jitter Hits report also contains a setup information line showing:

- The Receiver rate (52, 155, or 622 Mb/s)
- The active Receiver input (CLOCK, DATA, or OPTICAL)
- The jitter reference mode (internal or external).
- The jitter high-pass filter cutoff frequency.
- The jitter measurement mode (Wide or Fine).

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▶ **To generate a Jitter Hits report:**

1. Make sure that your printer is powered, on-line, and that the SJ-300/printer interface is properly set up. (For information on configuring printers for use with the SJ-300, see Chapter 6).
2. Press the MENU key.
3. Select MORE and press ENTER.
4. Select REPORT and press ENTER. You should now see the REPORT selection menu:



5. Select JIT-HITS and press ENTER. The Jitter Hits report should begin printing immediately.

An example Jitter Hits report is shown below:

```
Tektronix  SJ300E JITTER HITS DATA
   Rate: 622M   Input: CLOCK   Ref: INT   HPF: 1000  Mode: Wide
   1  Max amp=  2.20 UI  Start=1994-04-30 14:23:55 Stop=94-04-30 14:24:25
   2  Max amp=  2.12 UI  Start=1994-04-30 14:24:37 Stop=94-04-30 14:24:40
   3  Max amp=  2.12 UI  Start=1994-04-30 14:24:45 Stop=94-04-30 14:24:48
   4  Max amp=  2.21 UI  Start=1994-04-30 14:24:52 Stop=94-04-30 14:24:55
   5  Max amp=  5.05 UI  Start=1994-04-30 14:25:00 Stop=94-04-30 14:25:21
```


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Manual Calculation to Subtract Out Intrinsic Jitter

To discount jitter measurements for the low intrinsic jitter of the SJ300E, use the stated formulas below, where, A = actual, M = measured, and I = intrinsic jitter.

To measure low intrinsic jitter, feed the TX OUT REF CLOCK from the back panel into the Rx CLOCK IN on the front panel. Read RMS and p-p jitter on the front panel.

For peak-to-peak measurements: use the simple subtraction formula (A = M – I)

For RMS measurements: use the formula A = $\sqrt{M*M - I*I}$

When measuring jitter on an Optical or Data input, the actual intrinsic jitter will be slightly higher than as calculated above.

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Setup and Operation
Jitter Sequences

 The objective of this chapter is to explain how to set up and perform jitter transfer measurements using the automatic jitter sequence generation, calibration, and measurement features of the SJ300E.

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Overview

The SJ300E provides three automated features that greatly simplify jitter transfer and tolerance measurements. First, the SJ300E can automatically generate “jitter sequences”. Specifically, the instrument can be set up to automatically step through a series of up to 20 jitter amplitude/frequency pairs or “points”, remaining at each point for the same user-specified “dwell” time. In fact, you to create and store a total of up to 48 sequences—16 for each of the three SJ300E SONET/SDH operating rates—in SJ300E non-volatile memory (NV-RAM), with each sequence containing up to 20 points (Figure 5-1). Each sequence includes its own dwell time which may be set from 1 to 99 seconds. Any one of the jitter sequences stored in NV-RAM may be selected as the current or “active” sequence.

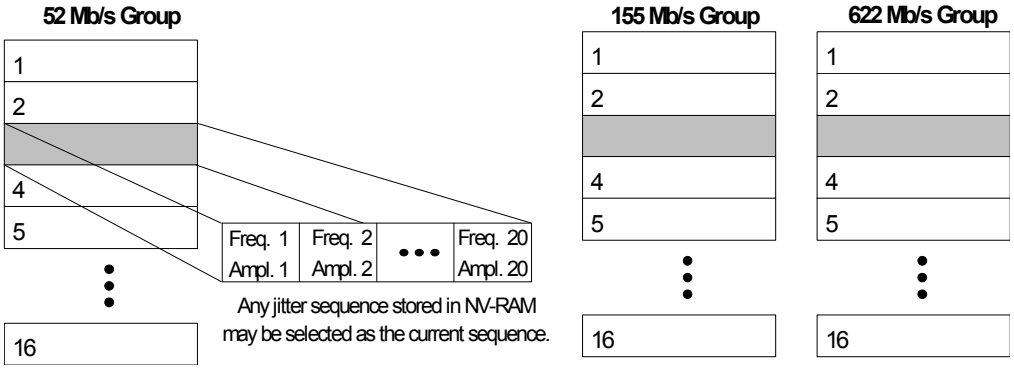


Figure 5-1 The SJ300E has a total of 48 Jitter sequence memory locations in NV RAM

Second, the SJ300E receiver will automatically self-calibrate or “zero” the current jitter sequence by measuring transmitter output jitter at each point, and recording these results as “0 dB” values. Calibration greatly reduces any jitter transfer measurement error caused by the transmitter, receiver, or both. Calibration can be performed via an internal connection between the transmitter and receiver or externally using a patch cord.

Third, the SJ300E can automatically calculate and store the jitter gain or loss (in dB) of the network element under test at each frequency in the current jitter sequence. The resulting jitter transfer vs. frequency data can be displayed or printed for comparison with the applicable standard.

Setup

This section explains how to generate and calibrate jitter sequences.

Loading Standard Sequences

When the SJ300E leaves the factory, all 48 of its jitter sequence memory locations in NV-RAM are unprogrammed. However the instrument’s ROM (read only memory) will contain one standard jitter sequence for each SONET/SDH rate your instrument supports. If your instrument

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is equipped to operate at 52 and 155 Mb/s it will contain two standard sequences in ROM. Similarly, if it is equipped to operate at 55, 155, and 622 Mb/s it will contain three standard sequences in ROM. Because standard sequences are stored in ROM they cannot be accidentally edited or deleted by the user. Table 5-1 shows the standard sequence for the three SONET/SDH rates supported by the SJ300E.

Table 5-1 SJ300E Standard Jitter Sequences (WIDE Mode)

	52 Mb/s		155 Mb/s		622 Mb/s	
Pt.	Freq.	Ampl.	Freq.	Ampl.	Freq.	Ampl.
1	10	15.00	10	15.00	10	15.00
2	14	15.00	14	15.00	14	15.00
3	21	15.00	21	15.00	21	15.00
4	30	15.00	30	15.00	30	15.00
5	65	7.00	65	7.00	65	7.00
6	141	3.20	141	3.20	141	3.20
7	300	1.50	300	1.50	300	1.50
8	560	1.50	840	1.50	1300	1.50
9	1100	1.50	2300	1.50	5700	1.50
10	2000	1.50	6500	1.50	25000	1.50
11	4286	0.70	13929	0.70	53572	0.70
12	9375	0.32	30469	0.32	117190	0.32
13	20000	0.15	65000	0.15	250000	0.15
14	54000	0.15	180000	0.15	680000	0.15
15	150000	0.15	480000	0.15	1800000	0.15
16	400000	0.15	1300000	0.15	5000000	0.15

All 16 points are available if the receiver is in the WIDE mode. Only the last five points are available if the receiver is in the FINE mode.

The standard sequence must be loaded into an NV-RAM sequence memory location before it can be used. Therefore it is a good idea to reserve one memory location for each standard sequence you plan to use. As an example, you could load the standard sequence for each rate into the first memory location of the associated sequence group.
You would then still be able to create and save up to 15 user sequences in memory locations 2 through 16 of each group. This approach is illustrated in Figure 5-2 for the 52 Mb/s jitter sequence group.

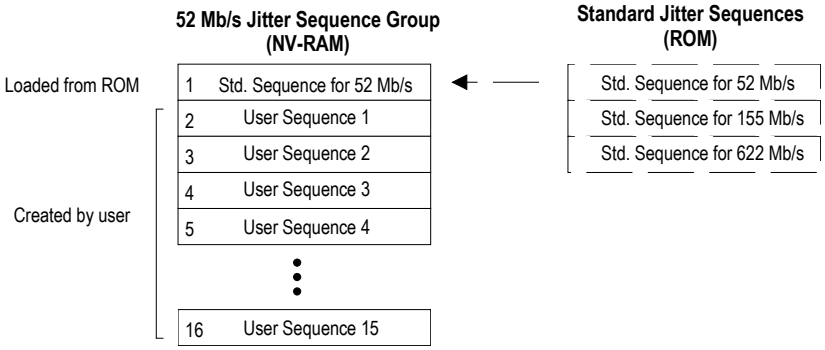


Figure 5-2 It is a good idea to reserve one memory location in each group of sequence memories for the standard sequence associated with that group.

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▶ **To load a standard sequence into a sequence memory location:**

1. Set up your instrument transmitter and receiver to operate at the SONET/SDH rate corresponding to the desired standard sequence.
2. Select the WIDE or FINE receiver mode, depending on which mode the sequence is to be used with.
3. Press the MENU key.
4. Select TX-SEQ and press ENTER. You will see the Transmit Sequence setup menu.

```
F1>EDIT LD-STD      622M
 SEQ#: 3  DWELL: 3 SEC
```

5. Use the MENU/SCROLL key, or up/down arrows to select the sequence memory location in which you want to store the standard sequence. Note that any standard or user sequence previously saved in this location will be over-written by the end of this procedure.
6. Press the F1 key to move the underline cursor under LD-STD.
7. Press ENTER. The standard sequence corresponding to the current rate setup will now be loaded into the selected memory location. (In the FINE mode, only the last five points are loaded.) The SJ300E indicates that a standard sequence has been loaded by placing an exclamation point "!" next to the LD-STD label. Also note that a flashing CAL message will be displayed to indicate that the current sequence has changed and therefore must be calibrated:

```
F1>EDIT LD-STD!CAL  622M
 SEQ#: 3  DWELL:  3 SEC
```

Creating and Saving User Sequences

You may create and save up to 48 custom or user jitter sequences in the NV-RAM. However, don't forget to allocate memory locations for any standard jitter sequences that you plan to use. A good plan is to reserve the first memory location in each group for its associated standard sequence. This still leaves 15 memory locations at each SONET/SDH rate for user-created jitter sequences.

User sequences may be created from scratch. Or, you may elect to load a standard sequence into one of your user memory locations and then edit this sequence to create the desired custom sequence.

▶ **To create a user jitter sequence:**

1. Select either the WIDE (16 points) or FINE (5 points) mode, using the front panel Measurement MODE key.
2. Press the MENU key.
3. Select TX-SEQ and press ENTER to display the transmit sequence selection menu.

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```
F1>EDIT LD-STD      622M
  SEQ#:10  DWELL: 3 SEC
```

3. Press the MENU/SCROLL key, or the up/down arrows, to select a sequence memory location (1 ... 16).
4. If you are creating a sequence from scratch, go immediately to the next step. However, if you want to create user sequence by modifying the standard sequence corresponding to the current rate setup, press F1 to select LD-STD and press ENTER.
5. Press F1 one or more times to move the cursor under EDIT. Then press ENTER. You will see the user sequence editing menu:

```
F1>SAVE#10 INS DEL  622M
 PT: 1  F:       1 A: 0.00
```

(Example shown)

6. To select a point location for insertion, deletion, or editing do either of the following:
   a) Press the MENU/SCROLL key one or more times until the desired point location number is displayed, or
   b) Move the bottom line cursor into the point number field (the leftmost field on the bottom line) using the left/right arrows. Then increment or decrement the point number using the up/down arrows.
7. To insert a new point:
   a) Select a point location as instructed in Step 6.
   b) Press F1 to move the top cursor under INS.
   c) Press ENTER to insert a new point at the current point location. Jitter points above the current point location will be bumped up. Points below the displayed point will not be affected. If you enter a point into a sequence that already has 20 points, the 20th point will be deleted.
8. To delete a point:
   a) Select a point as instructed in Step 6.
   b) Press F1 to move the cursor under DEL.
   c) Press ENTER to delete the displayed point. Points above the deleted point will be moved down. Points below the deleted point will not be affected.
9. To change the jitter frequency or amplitude of a point:
   a) Select a point as instructed in Step 6.
   b) Use the left/right and up/down arrows to edit the F: (frequency) and A: (amplitude) fields on the bottom line as desired.
10. Repeat steps 6. through 9. to edit other points in the current sequence.

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11. To save or discard all of the changes you have made to the current sequence, do one of the following:
    a) To **save** changes, press F1 to move the top line cursor under SAVE and then press ENTER.
    b) To **discard** changes, press ESC. Then if you really do want to discard your changes, press ESC again. At this point the SJ300E gives you another chance to save your changes by pressing ENTER.

Selecting the Current Sequence

The "current sequence" is the jitter sequence generated by the SJ300E when you press the RUN key. The current sequence is selected from the jitter sequences previously stored in the instrument's jitter sequence memory locations. As a result, you must either load a standard sequence or create a user sequence in one or more sequence memory locations before you can perform a jitter transfer test.

▶ **To select the current jitter sequence:**

1. Press the MENU key.
2. Select TX-SEQ and press ENTER. You will now see the Transmit Sequence selection menu.
3. Select the current jitter sequence using either of two methods:
    a) Press the MENU/SCROLL key one or more times until the desired sequence number is displayed.
    b) Using the left/right arrow keys to move the cursor under the sequence number field on the bottom line. Then use the up/down arrow keys to increment or decrement the sequence number.

The current jitter sequence will change immediately each time you increment or decrement the displayed sequence number.

```
F1>EDIT LD-STD CAL 622M
 SEQ#:15  DWELL: 3 SEC
```

You must calibrate a sequence before it can be used in a jitter transfer test procedure. Note that the CAL label will not appear if the jitter memory location you have selected does not yet contain a valid jitter sequence.

Note: If you select, as the current sequence, a sequence created in the FINE mode, then the receiver will automatically switch to the FINE mode when the RUN key is pressed. Similarly, if the current sequence was created in the WIDE mode, the receiver will automatically switch to the WIDE mode when the RUN key is pressed. Therefore, to avoid transients associated with switching modes, the receiver should be set to the mode that agrees with the current sequence before the RUN key is pressed.

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Calibrating the Current Sequence

Each time you select a new current jitter sequence it must be calibrated before you run a jitter transfer test. Once the current sequence has been calibrated it can be used to perform jitter transfer test any number of times. In addition, the SJ300E will not restrict the time over which a calibration is valid. However, for maximum result accuracy and repeatability, it is a good idea:

1. after power-on, to let the SJ300E warm-up for about 30 minutes before calibrating the current sequence.
2. calibrate (or recalibrate) the current sequence just before you perform a jitter transfer test.

The SJ300E will allow you to calibrate the current sequence either internally or externally. During an internal calibration, the SJ300E will automatically connect the data output of the transmitter to the clock recovery circuit of the receiver over an internal path. To perform an external calibration, on the other hand, you must first connect a patch cord from the transmitter output to receiver input that you plan to use during the actual jitter transfer test. For example, if you are planning to perform a jitter transfer test using the SJ300E optical ports, make OPTICAL the active SJ300E Receiver input, turn on the SJ300E Transmitter OPTICAL port, and connect an optical patch cord between these two ports.

Internal calibration will normally provide acceptable results. For greater accuracy, external calibration is recommended because it also calibrates SJ300E input/output circuits and connectors which can effect jitter transfer test results.

▶ **To calibrate the current sequence:**

1. Follow the procedure (above) to select a new current sequence
2. If you plan to perform an external calibration procedure, connect the appropriate SJ300E input and output.
3. Press the F1 key one or more times to move the cursor under the flashing CAL label and press ENTER. You will now see the Jitter Sequence Calibration menu:

```
CAL LOOP          ENTER>SET
   INT CAL    EXT CAL
```

4. Use the left/right arrow keys to select either INT CAL or EXT CAL.
5. Press ENTER to begin the calibration process.

While the calibration procedure is in progress, the LED in the RUN key will remain on. The time to complete a calibration procedure equals the number of points in the current sequence times the current dwell time. For example if dwell time is set to 3 seconds then calibration of a 20 point sequence will take 60 seconds. Calibration can be terminated early by pressing the RUN key. The LED can be will go out, and the calibration will be incomplete.

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Re-Calibrating the Current Sequence

As discussed above it is a good idea to re-calibrate the current sequence periodically if you plan to use it to perform multiple tests over an extended period of time. Recalibrate the current sequence just before you run a jitter transfer test. Let the instrument warm up for 1/2 hour before you calibrate the current jitter sequence.

▶ **To re-calibrate the current jitter sequence:**

1. If you plan to perform an external calibration procedure, connect the appropriate SJ300E input and output.
2. Press the MENU key.
3. Select TX-SEQ and press ENTER. You will see the Transmit Sequence selection menu.
4. Press the F1 key one or more times to move the cursor under CAL. Then press ENTER. You will see the Calibration menu.
5. Use the left/right arrow keys to select either INT CAL or EXT CAL.
6. Press ENTER to begin the calibration procedure.

Printing Jitter Sequences

The SJ300E can print two reports listing the contents of jitter sequence memory locations:

- **TX-SEQ:** Lists the contents of the currently selected jitter sequence memory. This report, which may contain up to 20 jitter frequency/amplitude pairs, fits onto one page.
- **ALL TX-SEQS:** Lists the contents of all "set up" jitter sequence memory locations for the current SONET/SDH rate. This report, which may comprise up to 16 sections—each containing up to 20 jitter frequency/amplitude pairs—requires up to 16 pages.

▶ **To print the TX-SEQ or ALL TX-SEQS report:**

1. Make sure that your printer has been turned on and set up correctly (See Chapter 6)
2. Press the MENU key.
3. Select MORE and press ENTER.
4. Select REPORT and press ENTER. You will now see the REPORTS menu:

```
JIT-XFER     JIT-HITS
 TX-SEQ     ALL TX-SEQS
```

5. Select TX-SEQ or ALL TX-SEQS and press ENTER.

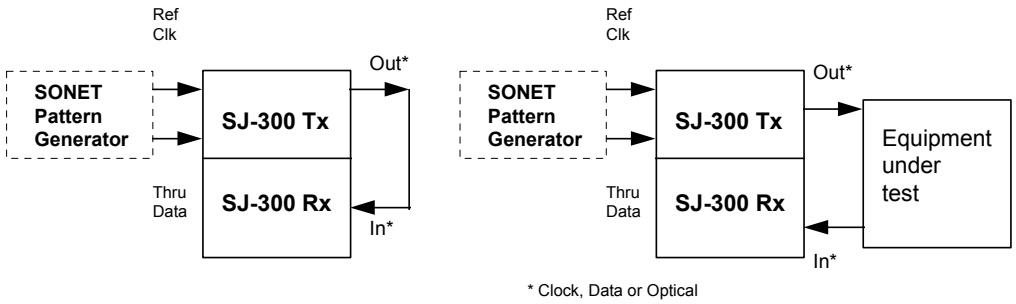
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An example TX-SEQ report is shown below:

```
Tektronix  SJ300E  JITTER TEST SEQUENCE SETUP
    Rate:  52M     Setup #11    Dwell: 3 Sec
    1   Freq:       10 Hz    Amp: 15.00 UI
    2   Freq:       17 Hz    Amp: 15.00 UI
    3   Freq:       30 Hz    Amp: 15.00 UI
    4   Freq:       65 Hz    Amp:  7.00 UI
    5   Freq:      141 Hz    Amp:  3.20 UI
    6   Freq:      300 Hz    Amp:  1.50 UI
    7   Freq:      560 Hz    Amp:  1.50 UI
    8   Freq:     1100 Hz    Amp:  1.50 UI
    9   Freq:     2000 Hz    Amp:  1.50 UI
   10   Freq:     4286 Hz    Amp:  0.70 UI
   11   Freq:     9375 Hz    Amp:  0.32 UI
   12   Freq:    20000 Hz    Amp:  0.15 UI
   13   Freq:    42300 Hz    Amp:  0.15 UI
   14   Freq:    90000 Hz    Amp:  0.15 UI
   15   Freq:   190000 Hz    Amp:  0.15 UI
   16   Freq:   400000 Hz    Amp:  0.15 UI
   17   Freq:   400000 Hz    Amp:  0.15 UI
   18   Freq:   400000 Hz    Amp:  0.15 UI
   19   Freq:   400000 Hz    Amp:  0.15 UI
   20   Freq:   400000 Hz    Amp:  0.15 UI
   Transfer Calibration Time= 94-06-30 14:49:49
```

Running a Jitter Transfer Test

Once you have selected and calibrated the current jitter sequence, you can run a jitter transfer test as follows.



CAL Setup

Test RUN Setup

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▶ **To run a jitter transfer test:**

1. Set the transmitter and receiver to the desired line rate (e.g., 155 MHz) and let the SJ300E warm up for 30 minutes.
2. Press the MODE key to set the receiver to the WIDE mode.
3. Press the MENU key, move the cursor to TX-SEQ, and press ENTER.
4. Press the SCROLL (MENU) key until an unused sequence is located (there is no CAL displayed on the top line).
5. Press the F1 key so the top cursor is on LD-STD, and press ENTER. An exclamation point appears after LD-STD, and a flashing CAL also appears.
6. Press the F1 key so the top cursor is on CAL, and press ENTER.
7. A new menu will appear that gives you the choice between INT CAL and EXT CAL. If your choice is INT CAL, move the cursor there, and press ENTER.
8. If your choice is EXT CAL (recommended for greater accuracy), configure the test setup as shown in "CAL Setup". Move the cursor to EXT CAL, and press ENTER.
9. The RUN light will come on for about a minute while the SJ300E calibrates itself.
10. When the light goes off, configure the system as shown in "Test RUN Setup", and press the RUN key. The light will come on for a minute during the test.
11. When the light goes off, press ESC, move the cursor to JIT-XFER, and press ENTER.
12. Use the SCROLL (MENU) key to view the jitter transfer gain (in dB) for each point.

For points 1 through 12, the test amplitude is greater than 0.6 UIpp, so the accuracy in the WIDE mode is ±0.03 dB or better. To improve the jitter transfer gain accuracy to ±0.03 dB for amplitudes less than 0.60 UIpp, the FINE mode must be used.

13. Press the ESC twice to return to the main display, and press MODE key to select FINE.
14. Repeat steps 3 through 12. Note that LD-STD loads only points with amplitude less than 0.6 UIpp when the receiver is set to FINE mode.

When the Transmitter Sequence is calibrated while in the FINE or WIDE mode, the SJ300E will "tag" the sequence with that mode, and will automatically enter that mode whenever the sequence is selected and RUN key is pressed.

NOTE:
If the SJ300E has to change the mode itself, the jitter transfer results will be in error, because the receiver generally won't be in lock by the time the test starts. Therefore you must perform the following steps in order:

1. Choose the proper mode.
2. Configure the test setup.
3. Wait for the receiver to lock.
4. Press the RUN key.

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Jitter Transfer Results

The results from the most recent jitter transfer test can be viewed on the SJ300E display or printed using an external printer. You may also upload results to an external PC by issuing the appropriate commands. Jitter transfer results are overwritten each time you press the RUN key. Therefore you must view, print, or upload results from a given jitter transfer test before you run the next test.

Viewing Jitter Transfer Test Results

Jitter transfer results may be viewed using the Jitter Transfer (JIT-XFER) results screen. This results screen can be used to scroll to and display the ratio of measured-to-calibrated (zero gain) jitter in dB, for each frequency in the last jitter transfer test run. Jitter gain results can be positive indicating amplification or negative indicating attenuation at the indicated frequency.

▶ **To view jitter transfer test results:**

1. Press the MENU key.
2. Select JIT-XFER and press ENTER. You will now see the Jitter Transfer results screen:

```
JIT-XFER  94-04-30 15:02
PT: 1  F:     10 R:-0.05
```

(Example results shown)

Note that the top line alternates (with a 3-second cycle) between the “run” date and time (JIT-XFER) and “calibration” date and time (CAL).

6. To view results at a particular point (i.e. jitter frequency) do either of the following:
   a) Press the MENU/SCROLL key one or more times until the desired point (frequency) is displayed, or
   b) Use the up/down arrows to increment or decrement the point value until the desired frequency is displayed.

The Jitter Transfer results screen shows the jitter frequency in Hz (F: field) and jitter gain (ratio) in dB (R: field) for each jitter frequency/amplitude point in the jitter sequence used to perform the test.

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Printing Jitter Transfer Test Results

The SJ300E Jitter Transfer Report will summarize the results from the last jitter transfer test. Specifically, this report contains the following data for each frequency in the test:

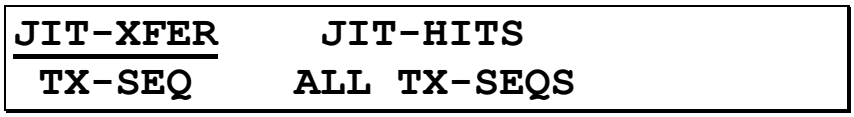
- ❑ Transmitted jitter frequency in Hz
- ❑ Transmitted jitter amplitude in UI p-p
- ❑ Calibrated transfer ratio in dB. This is the ratio of jitter amplitude measured during the test run to that measured during the calibration run at the indicated test point.

In addition, the report header shows the following data:

- ❑ Measurement date and time
- ❑ Calibration date and time
- ❑ SONET/SDH rate.
- ❑ Active input (CLOCK, DATA, or OPTICAL)
- ❑ Jitter reference mode (Internal or External)
- ❑ Jitter measurement HPF cutoff frequency
- ❑ Jitters measurement mode (Wide or Fine).

▶ **To print the latest jitter transfer test results:**

1. Make sure that your printer has been turned on and set up correctly (See Chapter 6)
2. Press the MENU key.
3. Select MORE and press ENTER.
4. Select REPORT and press ENTER. You will now see the REPORTS menu:



5. Select JIT-XFER and press ENTER.

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An example Jitter Transfer Data report for the standard 52 Mb/s jitter sequence is shown below:

```
    Tektronix  SJ300E  JITTER TRANSFER DATA
Measurement Time: 1994-04-30 15:02:26  Calibration: 94-04-30 14:58:41
   Rate:  52M   Input: CLOCK   Ref: INT   HPF: 10     Mode: Wide
 1  Freq:       10 Hz    Amp: 15.00 UI    Transfer Ratio=  -0.00
 2  Freq:       17 Hz    Amp: 15.00 UI    Transfer Ratio=  -0.00
 3  Freq:       30 Hz    Amp: 15.00 UI    Transfer Ratio=  -0.00
 4  Freq:       65 Hz    Amp:  7.00 UI    Transfer Ratio=  +0.01
 5  Freq:      141 Hz    Amp:  3.20 UI    Transfer Ratio=  +0.02
 6  Freq:      300 Hz    Amp:  1.50 UI    Transfer Ratio=  +0.04
 7  Freq:      560 Hz    Amp:  1.50 UI    Transfer Ratio=  +0.07
 8  Freq:     1100 Hz    Amp:  1.50 UI    Transfer Ratio=  +0.03
 9  Freq:     2000 Hz    Amp:  1.50 UI    Transfer Ratio=  -0.00
10  Freq:     4286 Hz    Amp:  0.70 UI    Transfer Ratio=  -0.05
11  Freq:     9375 Hz    Amp:  0.32 UI    Transfer Ratio=  -0.23
12  Freq:    20000 Hz    Amp:  0.15 UI    Transfer Ratio=  -0.97
13  Freq:    42300 Hz    Amp:  0.15 UI    Transfer Ratio=  -3.26
14  Freq:    90000 Hz    Amp:  0.15 UI    Transfer Ratio=  -7.83
15  Freq:   190000 Hz    Amp:  0.15 UI    Transfer Ratio= -15.00
16  Freq:   400000 Hz    Amp:  0.15 UI    Transfer Ratio= -20.04
17  Freq:   400000 Hz    Amp:  0.15 UI    Transfer Ratio= -20.04
18  Freq:   400000 Hz    Amp:  0.15 UI    Transfer Ratio= -20.05
19  Freq:   400000 Hz    Amp:  0.15 UI    Transfer Ratio= -20.04
20  Freq:   400000 Hz    Amp:  0.15 UI    Transfer Ratio= -20.03
```


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Using Printers and External Controllers

This chapter explains how to connect external devices to the instrument's RS-232, GPIB, and parallel ports. This chapter also includes setup procedures for the RS-232C and GPIB ports.

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Remote Control and Printer Basics

There are three ways to operate the SJ300E remotely from either the RS-232C or GPIB ports.

- Use Tektronix's jitter or wander analysis software. Either the TDEVMTIE software that comes with the SJ300E Wander Test Option (Opt. 06) or the FFT Software Application (Opt. 4S).
- A PC or workstation control program can written using any language, such as C^{++} or BASIC. This approach is useful for most factory and lab automation applications.
- Remote commands can be manually typed from a terminal or a PC running a terminal emulation program. This method is a useful way to learn the SJ300E commands and syntax, but it is not practical for most testing applications.

When operated either locally from the front panel or under remote control, the SJ300E can print reports to a printer connected to its parallel PRINTER or serial RS-232C ports. In addition, the SJ300E can print reports indirectly by sending them to an external GPIB controller. The SJ300E cannot print reports directly to a GPIB printer.

Table 6-1 summarized the above uses of the SJ300E SONET/SDH Jitter and Wander Analyzer's RS-232C, GPIB, and parallel ports.

Table 6-1 Uses of the RS-232, GPIB, and Parallel Ports

Printing or Control Function	RS-232C Port	GPIB Port	Parallel Port
Printing Reports	**yes**, using a printer that has a serial port.	**no**	**yes**, using printer that has a parallel port.
Remote Control from a user written control program	**yes**, using a PC or workstation that has a serial port	**yes**, using a PC or workstation that has a GPIB port.	**no**
Remote control from MTIE TDEV or FFT software applications	**yes**, from an MS-DOS compatible PC that has a serial port.	**yes,** from an MS-DOS compatible PC that has a GPIB port.	**no**

Using the RS-232C Port

The following section describes how to set up and use the SJ300E RS-232C serial port.

Serial Interface Parameters

SJ300E serial port parameters are listed in Table 6-2 along with their available values and default value. All RS-232C port parameters can be changed locally or remotely via the GPIB port. In addition, ECHO and XON/XOFF can be changed remotely via the RS-232C port.

Table 6-2 RS-232C (Serial Port) Parameters

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Parameter MENU and Description	Available Values	Default Value
BAUD: Baud rate in bits per second.	300, 1200, 2400, or 9600	9600
PARITY: Error detection.	Even, Odd, or None	Even
SIZE: Data bits per character.	7 or 8	8
EOL: End-of-Line terminator.	CR (ASCII decimal 13), LF (ASCII decimal 10), CR/LF, or LF/CR.	CR/LF
XON/XOFF: Flow control.	ON (enabled) or OFF (disabled)	ON
ECHO: Echo back to the controller each character received by the SJ300E).	ON (enabled) or OFF(disabled)	ON

A typical (local) RS-232C port setup session is presented next.

▶ **To set RS-232C (serial) port parameters:**

1. Press the MENU key to display the top level SJ300E menu.
2. Select MORE and press ENTER.
3. Select RS232 and press ENTER. You should now see the RS-232C setup menu:

```
BAUD   PARITY   CHAR-SIZE
EOL    ECHO     XON/XOFF
```

4. To set bit rate, select **BAUD** and press ENTER. You should now see the BAUD setup menu:

```
BAUD                ENTER>SET
 300   1200   2400   9600
```

5. Use the left/right arrows to make a selection.
6. Press ENTER to activate your selection and return to the RS-232C menu.
7. To set parity error detection, select PARITY and press ENTER. You should now see the Parity menu:

```
PARITY          ENTER>SET
    NONE   ODD   EVEN
```

8. Use the left/right arrows to make a selection.
9. Press ENTER to activate your selection and return to the RS-232C menu.

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10. To set the number of data bits per character, select CHAR SIZE and press ENTER. You should now see the Character Size menu:

```
CHAR SIZE      ENTER>SET
        7  8 (BITS)
```

11. Use the left/right arrows to select either 7 or 8 bits.
12. Press ENTER to activate your selection and return to the RS-232C menu.
13. To set the end-of-line character or character pair, select EOL and press ENTER. You should now see the End of Line menu:

```
END OF LINE
 CR-LF LF-CR  CR  LF
```

14. Use the left/right arrows to make a selection.
15. Press ENTER to activate your selection and return to the RS-232C menu.
16. To enable or disable character echo, select ECHO and press ENTER. You should now see the ECHO setup menu:

```
ECHO
                OFF  ON
```

17. Use the left/right arrows to make a selection.
18. Press ENTER to activate your selection and return to the RS-232C menu.
19. To enable or disable XON/XOFF flow control, select XON/XOFF and press ENTER. You should then see the XON/XOFF setup menu:

```
XON/XOFF
                OFF  ON
```

20. Use the left/right arrows to select either OFF (disabled)or ON (enabled).
21. Press ENTER to activate your selection and return to the RS-232C menu.
22. Press ESC several times to exit the menu system and return the display to its normal format.

RS-232C Connector Pinout

The SJ300E RS-232C interface is a 25-pin, female, D-type connector located on the rear-panel. The pin-out of this connector is shown in Table 6-3 below. Note that the SJ300E RS-232C port is wired as a DCE (data communications equipment) device—that is, it receives on pin 2 and transmits on pin 3.

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Table 6-3 RS-232C Connector Pin-out

Pin No.	Label	Function
1.	GND	Protective Ground
2.	RxD	Received Data Input: Data is received by the SJ300E on this pin.
3.	TxD	Transmit Data Output: Data is transmitted by SJ300E on this pin.
4.	CTS	Clear To Send. A high level or open applied to this pin indicates to the SJ300E that the controller or terminal is ready to receive data. A low level indicates that the controller or terminal is not ready. The SJ300E pulls this pin high internally with 27 kohms to +12V.
5.	RTS	Request to Send. The SJ300E always sets this pin high.
6.	DTR	Data Terminal Ready. The SJ300E always sets this pin high.
7.	GND	Signal Ground.
20.	DSR	Data Set Ready. This input is ignored.
all other pins		Not used.

Cables

Use a straight-through cable when connecting the SJ300E to a DTE (data terminal equipment) device, or a null-modem cable when connecting to another DCE device.

Quick Test of the RS-232C Port

You can perform a quick test of the SJ300E RS-232C port using a terminal (or a PC running terminal emulation software) as follows:

1. Turn SJ300E power off.
2. Attach the appropriate 25-pin cable from the SJ300E's RS-232C port to the RS-232C port on the terminal. Note that most terminals (and controllers) are set up as DTE and therefore should be connected to the SJ300E RS-232 port using a straight-through cable.
3. Turn SJ300E power on. Verify that the following message appears on the terminal's display:

   *******TEKTRONIX SJ300E Vx.xx mm/yy**

   where: x.xx = software version number (e.g. 1.00).
   mm/yy = month and year of software version.

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If the above message does not appear, then one or more of the following problems may exist:

1. The cable may be defective.
2. You may have selected the wrong cable type. Be sure to use a straight-through cable if the terminal is DTE, or a null-modem cable if the terminal is DCE.
3. The RS-232C port setup of the instrument (baud rate, data bits, parity, etc.) may not be compatible with that of the terminal.

Protocol

The SJ300E RS-232C port always operates in a "terminal" mode. Received characters are stored in a command buffer until a line terminator is received, at which point the command is executed immediately. While a command is buffered, that is before a line terminator is received, you may use the backspace key on your terminal to erase the last (right-most) character.

You may use EVEN or ODD parity to perform error detection on a byte-by-byte basis. In addition, if a received command mnemonic is not recognized or if an associated parameter is out of range, then the SJ300E will discard the command and issue an error message.

Command Format

Please refer to Chapter 7 for an explanation of the SJ300E command line format and a description of all commands. Note that except for terminator characters, the same command line format is used on the RS-232C and GPIB ports.

Error Messages

All commands received on the RS-232C port are checked for validity and to make sure they contain appropriate parameters. Valid commands are executed. Invalid commands will not be executed, but instead will cause the SJ300E to transmit one of the error messages shown in Table 6-4.

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Table 6-4. RS-232C Port Error Messages

ERROR MESSAGE	MEANING
"*** Input Lost	The RS-232C interface hardware has detected one or more lost or corrupted characters.
*** Input Buffer Overflow	More than 80 characters are received without a line terminator.
*** Command Mnemonic Not Found	Unknown command mnemonic received.
*** Invalid Command For Interface	Command mnemonic found, but it is not valid for the RS-232C interface.
*** Invalid Command Type	Command mnemonic found, but it has a missing or added "?" at the end.
"*** Too Few Parameters	One or more expected parameters are missing.
"*** Too Many Parameters	Too may parameters were received, or unknown characters were found trailing the command.
"*** Invalid Parameter	Parameter is not valid for the command.
"*** Parameter Out of Range	Parameter value is not in the range specified for the command.
"*** Parameter Not In Set	Parameter value is not in the set of allowed values for the command.
"*** Invalid String Length	Parameter character string is too long for the command.
"*** Parameter Separator	An expected semicolon (;) between two parameters is missing or a command line is terminated immediately after a semicolon.
"*** Invalid Non-decimal Parameter	Parameter is not in a valid non-decimal format, or the value of the parameter is out of the range 0 to 255 decimal.
"*** Command Execution Error	The instrument did not execute the command properly.
"*** Out of Memory	Processor is out of memory.

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Using the GPIB Port

The following section provides an overview of SJ300E GPIB functions and describes how to set up the GPIB port. Note that the following two
SJ300E parameters must be set up properly to use the instrument on a GPIB bus:

1. Address.
2. Message terminator.

GPIB Address and Terminator

For normal GPIB operation, the GPIB address of the SJ300E must be set in the range 0 to 30 decimal. However you can set the GPIB address to 31 in order to put the instrument "off bus". Note that the address of each instrument on a GPIB bus must be unique.

The GPIB message terminator may be set to either EOI or EOI/LF. When EOI is selected, the instrument will assert the GPIB EOI line while the last byte of each message is transmitted. When EOI/LF is selected, the instrument will add a LF (line feed) character to the end of each message and assert the EOI line while the LF byte is transmitted.

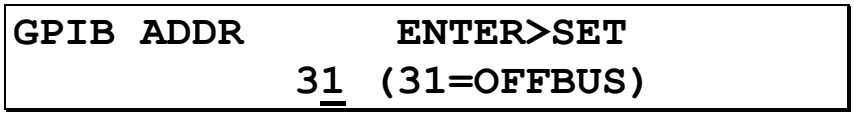
Both GPIB parameters can be set locally, using the GPIB menu, or remotely via the RS-232C port. You cannot, however, change GPIB parameters via the GPIB port. A typical (local) GPIB port setup procedure is presented next.

▶ **To set GPIB port parameters:**

1. Press the MENU key.
2. Select MORE and press ENTER.
3. Select GPIB and press ENTER. You should now see the GPIB setup menu:



4. Select ADDRESS and press ENTER. You should now see the GPIB Address menu:



   Use the arrow keys to set the instrument's address in the range 0 to 31. Press ENTER to activate this address selection and return to the GPIB menu.

5. Select TERMINATOR and press ENTER. You should now see the GPIB Terminator menu:



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6. Use left/right arrows to select the desired terminator. Press ENTER to activate this selection and return to the GPIB menu.
7. Press ESC several times to exit the menu system and return to the normal SJ300E display format.

Returning the Instrument to Local Mode

GPIB controllers can put instruments on their bus into a "remote" mode. In this mode all local controls, *except for a designated "return to local mode" key,* are disabled. The LED in the GPIB key (left-side of front panel) indicates whether the SJ300E is in the remote mode (LED on) or the normal local mode (LED off).

▶ **To return the SJ300E to local mode:**

1. If the LED in the GPIB REMOTE key is on, press this key one time to return the SJ300E to local control. Pressing this key when the LED is off will have no effect.

GPIB Interface Functions

The SJ300E is configured as a GPIB talker/listener. It does not provide any controller functions. Table 6-5 lists the GPIB functions described in ANSI/IEEE Std. 488.2-1987 that are supported by the SJ300E.

Table 6-5 GPIB Interface Functions

Subset	Implementation
SH1	Complete source handshake.
AH1	Complete acceptor handshake.
T6	Basic talker, serial poll, no talk-only, unaddressed if addressed to listen, no extended talker.
L4	Basic listener, no listen-only, unaddressed if addressed to talk, no extended listener.
SR1	Complete service request.
RL1	Remote/local capability including local lockout.
PP0	No parallel poll capability.
DC1	Complete device clear capability.
DT0	No device trigger capability.
C0	No controller capability.
E2	Tri-state drivers used on DI0 lines for maximum data transfer rate.

GPIB Connector Pin-outs

The SJ300E GPIB port is equipped with a standard GPIB 24-pin, D-type connector. The signal levels and pin assignments of this connector conform to ANSI/IEEE Std. 488.2-1987.

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GPIB Command Format

Please refer to Chapter 7 for an explanation of the general SJ300E command format and a description of all commands. Note that the basic command format used on the GPIB and RS-232C ports is the same.

ANSI/IEEE-488.2 Programming Manual Requirements

This section explains how the SJ300E implements certain standard GPIB functions, as required by ANSI/IEEE Std. 488.2-1987.

Power-On Settings

When powered-on, the SJ300E will automatically restore all device settings to their "last powered settings"—in other words to their value when the instrument was last powered-off. No remote commands will affect this power-on rule. However if the instrument detects a problem in non-volatile (battery backed) RAM at power up, then factory default settings will be restored rather than the last powered settings. A RAM problem at power up will be indicated in the LCD display by the message: **RAM Corruption**.

Message Exchange

The SJ300E implements GPIB message exchange as follows:

1. The input buffer is command line oriented. A new buffer is provided for each new command line.
2. Each command line may contain a maximum of 80 characters.
3. The only SJ300E command that can return more than one message unit is *lrn?
4. Command responses are generated immediately after they are parsed. In other words, the SJ300E will not wait for a read command before generating a response to a query command.
5. No commands are coupled.

Functional Elements

All functional elements from Tables 4.2 and 4.3 in ANSI/IEEE Std. 488.2-1987 that are used in SJ300E commands are listed below:

1. <PROGRAM MESSAGE>
2. <PROGRAM MESSAGE TERMINATOR>
3. <PROGRAM MESSAGE UNIT>
4. <PROGRAM MESSAGE UNIT SEPARATOR>
5. <COMMAND MESSAGE UNIT>
6. <QUERY MESSAGE UNIT>
7. <COMMAND PROGRAM HEADER>*
8. <QUERY PROGRAM HEADER>*
9. <PROGRAM HEADER SEPARATOR>

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10. <PROGRAM DATA SEPARATOR>
11. <PROGRAM DATA>
12. <DECIMAL NUMERIC PROGRAM DATA>
13. <CHARACTER PROGRAM DATA>

* **NOTE**: The SJ300E cannot process a <compound command program header> or a <compound query program header>.

For more information see Sections 4.3, 7.1.1, and 7.3.3 of ANSI/IEEE Std. 488.2-1987.

Specific Command Implementations

Reset Command. As defined in ANSI/IEEE Std. 488.2-1987, the SJ300E reset command (*rst) does the following:

1. Except for remote interface settings, resets all device settings to their default values.
2. Ignores macros (macros are not implemented in the SJ300E).
3. Forces the SJ300E into the Operation Complete Command Idle State (OCIS) and Operation Complete Query Idle State (OQIS).

Self Test Query. The scope of the SJ300E self test function is limited; it tests basic functionality.

Overlapped vs. Sequential Commands. All SJ300E commands are sequential.

Operation Complete Message. SJ300E command operation is always immediate. There are no overlapping commands.

GPIB Status and Event Reporting System

This section explains the GPIB status and event reporting functions provided by the SJ300E. The SJ300E is compatible with ANSI/IEEE Std. 488.2-1987. For a detailed description of GPIB status reporting functions, refer to this document.

The purpose of the SJ300E status and event reporting system is to alert the GPIB controller when either an important change-of-status or event occurs. The instrument accomplishes this by maintaining several status registers and asserting the SRQ (service request) line on the GPIB bus when one or more bits in these registers are set to one. The controller can then find out which instrument or instruments initiated the SRQ using a serial poll procedure. The user can enable or disable specific status bits and therefore control which status changes or events result in an SRQ. Status bits are enabled or disabled by setting up various enable registers.

SJ300E status and enable registers are also available when using RS-232C control. Specifically, you can read status registers and set enable registers via the RS-232C interface. However the SRQ alerting function is available only on the GPIB port.

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Overview of Status and Enable Registers

The SJ300E has two *general purpose* status registers called the:

- **Status Byte Register (SBR)** and the
- **Standard Event Status Register (SESR)**.

These two status registers, which are defined in ANSI/IEEE Std. 488.2-1987, indicate the overall status of the instrument. The Analyzer also contains a third status register that indicates the current state of various measurement processes. This register is called the

- **Test Event Status Register (TESR)**.

The TESR deals with functions specific to the SJ300E and is not defined in ANSI/IEEE Std. 488.2-1987. The SJ300E also has one enable register for each of its three status registers. These registers are called the:

- **Service Request Enable Register (SRER)**,
- **Standard Event Status Enable Register (SESER)**, and the
- **Test Event Status Enable Register (TESER)**.

A status register may contain defined (used) bits and undefined (unused) bits. Each defined bit in a status register corresponds to a given instrument status or event. Once cleared (set to zero) the value of a status bit will remain zero as long as the corresponding event or status does not occur. However if it is enabled, the value of a status bit will be set to one when the corresponding event or status occurs. Status bits are latched. That is, once a status bit is set to one, it will remain in this state, *even if the corresponding event or status becomes false,* until the bit is reset by a command or when the instrument is depowered.

Each status register has an associated enable register. Moreover, each defined bit in a status register has a corresponding defined bit in the associated enable register. When an enable bit is set to one, the corresponding status bit is said to be enabled. When an enable bit is set to zero, the corresponding status bit is said to be disabled and will therefore be ignored by the instrument. It is important to note that at power up, all SJ300E enable registers are reset to 00000000 binary effectively disabling all status reporting functions. Therefore, each time the SJ300E is powered-up you must use the appropriate set commands to configure each enable register as desired.

The contents of any SJ300E status or enable register can be read by an external controller using the appropriate query command. The contents of any enable register can be set to a particular value using the appropriate set command. The contents of the SESR register can be cleared using the Clear Status (*CLS) command. In addition, the SESR is automatically cleared (reset) after being queried. For more information on SJ300E GPIB commands, see Chapter 7.

The correspondence between SJ300E status registers, enable registers, and remote commands is summarized in Table 6-6.

Table 6-6 Status Registers, Enable Registers, and Related Commands

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Status Register	Status Register Query Commands	Enable Register	Enable Register Commands	
			Set	Query
Status Byte Register (**SBR**)	*STB?	Service Request Enable Register (**SRER**)	*SRE	*SRE?
Standard Event Status Register (**SESR**)	*ESR?	Standard Event Status Enable Register (**SESER**)	*ESE	*ESE?
Test Event Status Register (**TESR**)	TSR?	Test Event Status Enable Register (**TESER**)	TSE	TSE?

NOTE 1: Use the *CLS command to clear (reset) the SESR and return the instrument to the Operation Complete Command Idle State and the Operation Complete Query Idle State. In this state the instrument has no data in its input or output buffers and is not executing a command.

NOTE 2: The *ESR? query command also clears (resets to zero) the SESR status register.

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Test Event Status Register

The Test Event Status Register (TESR) indicates the completion of measurement intervals or the occurrence of various error events. The name of the each defined bit in the TESR is shown in Figure 6-1. The function of each defined bit in the TESR is explained in Table 6-7.

Figure 6-1 Test Event Status Register (TESR)

7	6	5	4	3	2	1	0
JET	EOS	MAF	--	--	--	--	--

Table 6-7 TESR Bit Definitions

Bit	Definition
7 (MSB)	**JET** (Jitter Exceeded Threshold): Set to one when peak-to-peak jitter amplitude on the current active input exceeds the current jitter threshold.
6	**EOS** (End of Sequence): Set to one after the last point in the current jitter sequence has been transmitted.
5	**MAF** (Maximum Amplitude or Frequency Exceeded): Set to one if the local operator or remote controller attempts to set Transmitter jitter amplitude or frequency outside the current maximum jitter generation mask. The current mask is a function of the current transmit rate, that is 52, 155 or 622 Mb/s.
0 - 4	not defined

Test Event Status Enable Register

The Test Event Status Enable Register (TESER) is the enable register associated with the TESR status register. Each enable bit in the TESER occupies the same bit position as the corresponding status bit in the TESR (See Figure 6-1 above).

Standard Event Status Register

The Standard Event Status Register (SESR) indicates errors in command syntax and related occurrences. The name of each bit in the SESR is shown in Figure 6-2. The function of each bit in the SESR is defined in Table 6-8.

Figure 6-2 Standard Event Status Register (SESR)

7	6	5	4	3	2	1	0
PON	URQ	CME	EXE	DDE	QYE	RQC	OPC

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Table 6-8 SESR Bit Definitions

Bit	Definition
7 (MSB)	**PON** (Power On): Set to one when the instrument is first powered on.
6	**URQ** (User Request): Not used.
5	**CME** (Command Error): Set to one when a command header (mnemonic) has been received that is not recognized or is invalid.
4	**EXE** (Execution Error): Set to one when an error has occurred while the instrument was responding to a set command or query. May indicate: a) parameter is out of range, b) command line has too many or too few parameters, or c) command cannot be properly executed due to the instrument's current state.
3	**DDE** (Device Dependent Error): Not used.
2	**QYE** (Query Error): Set to one if: a) an attempt has been made to query the output queue when there are no messages available or pending, b) a command is received but the output queue is not empty, or c) an attempt has been made to query the output queue when an unterminated command is in the input queue.
1	**RQC** (Request Control): Not used.
0 (LSB)	**OPC** (Operation Complete): Set to one after a *OPC command is received.

Standard Event Status Enable Register

The Standard Event Status Enable Register (SESER) is the enable register associated with the SESR status register. Each enable bit in the SESER occupies the same bit position as the corresponding status bit in the SESR (See Figure 6-2 above).

Status Byte Register

The Status Byte Register (SBR) indicates the overall status of the instrument and is used to control the SRQ line on the GPIB bus. The name of each defined bit in the SBR is shown in Figure 6-3. The function of each defined bit in the SBR is described in Table 6-9.

Figure 6-3 Status Byte Register (SBR)

7	6	5	4	3	2	1	0
--	MSS	ESB	MAV	TSB	--	--	--

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Table 6-9 Status Byte Register Bit Definitions

Bit	Definition
7 (MSB)	Not defined.
6	**MSS** (Master Status Summary) or **RQS** (See note): This bit summarizes the state of the three other bits in the SBR. The MSS bit will be set to 1 if the ESB, MAV, or TSB bit is enabled and set to 1. It is set to 0 otherwise.The status of the MSS bit is reevaluated each time the ESB, MAV, or TSB bit changes state or when any bit in the Service Request Enable Register (SRER) changes state.
5	**ESB** (Event Status Bit): This bit summarizes the Standard Event Status Register (SESR). It is set to 1 if any enabled bit in the SESR is set to 1. It is set to 0 otherwise. If the ESB bit is enabled and set to 1, then the MSS and RQS bits will be set to 1. The status of the ESB bit is reevaluated each time one of the bits in the SESR or the Event Status Enable Register (ESER) changes.
4	**MAV** (Message Available): This bit is set to 1 when there is an output available for the controller.
3	**TSB** (Test Status Bit): This bit summarizes the Test Event Status Register (TESR). It is set to 1 if any enabled bit in the TESR is set to 1. It is set to 0 otherwise.
0 -2	Not defined.

NOTE : Bit 6 in the SBR has two names. When you use a serial poll to read the SBR, bit 6 is called the **RQS** bit. When you use the *STB? query command to read the SBR, bit 6 is called the **MSS** bit.

Service Request Enable Register

The Service Request Enable Register (SRER) is the enable register associated with the SBR status register defined above. The SRER contains an enable bit for the ESB, MAV, and TSB bits in the SBR. However there is no enable bit for the MSS or RQS bits which are always enabled.

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Remote Commands

This chapter explains the general syntax of the SJ300E remote command language and defines all commands. Command definitions are grouped by function. In addition, an alphabetical list of all SJ300E commands is provided with page references to individual command descriptions.

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Overview

This section defines SJ300E command types and command syntax including: parameter types, delimiters, and line terminators.

Command Types: Set and Query

There two basic types of SJ300E commands: set commands and query commands. Set commands are used to make setting changes or to cause a status change, for example to start or stop a test. Query commands ask the instrument to respond with the contents of a status register, the value of a given setup parameter, or a measurement result. SJ300E remote commands are directly related to setup parameters and results rather than to front panel keys or setup menus. For example there is no "Press the SETUP Key" command.

SJ300E commands may have only a query form or only a set form, however many commands have both. When a command has both a set and query form, the name or "mnemonic" used for the query form will be identical to its corresponding set command form, except for an added "?". For example the following are the mnemonics for the set and query form of the view angle command:

- view_angle (set command)
- view_angle? (query command)

In this User's Guide, query commands may be referred to as simply "queries", while set commands may be referred to as simply "commands".

Parameter Types

SJ300E commands and responses may have one or more parameters. The different types of parameters used in SJ300E commands and responses are listed and defined below.

Table 7-1 Parameter Types

Parameter Type	Definition
NR1 Numeric	Numeric Representation 1: Signed decimal integer numeric value.
NR2 Numeric	Numeric Representation 2: Floating point decimal numeric value, **without** an exponent.
NR3 Numeric	Numeric Representation 3: Floating point decimal numeric value, **with** an exponent.
Decimal Numeric	May be either an NR1, NR2, or NR3 decimal numeric value.

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Parameter Type	Definition
Non-Decimal Numeric	A non-decimal integer value in the range 0 - 255 (decimal) in either hexidecimal, octal, or binary format. It will have a leading "#H" if it is a hexadecimal, "#Q" if it is an octal, or "#B" if it is a binary numeric value. Examples: Hexadecimal: #HFF Octal: #Q377 Binary: #B11111111 **NOTE**: Unless otherwise indicated, all SJ300E non-decimal numeric responses will be in the hexadecimal form, that is #Hxx, where xx is a hexadecimal number.
qstring	Quoted string: a character string with beginning and ending double quotes.

Symbols

The following table shows the symbols used in this chapter to describe SJ300E commands and responses.

Table 7-2 Symbols

Symbol	Meaning
<CR>	Carriage return (ASCII decimal 13).
<LF>	Line Feed (ASCII decimal 10).
<EOI>	End or Identify, a GPIB message terminator signal specified in ANSI/IEEE Std. 488.2-1987
< text >	Angle brackets are used to identify parameters in both commands and responses. In this guide, command parameters are given letter names, for example **<n>**, or descriptive names such as **<jitter frequency>**, so that they can be referred to in the command description. Response parameters will generally be identified simply by their parameter type, for example **<NR1>**, **<NR2>**, **<qstring>**, etc. .
{ x | y | z | ... }	Curly brackets are used to enclose a set of mnemonics—text strings that (hopefully) have an obvious meaning—from which you must select one. For example, the OPTICAL command has a syntax of: **optical { on | off }**. Therefore, this command must be issued in either of two forms: **optical on** **optical off** Note that the " | " symbol signifies an exclusive OR operation.

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Command Names (Headers)

Every SJ300E command must start with a command header. Command headers are character string mnemonics that indicate the command's name and function. For example the command header for the Transmit Jitter Query command is:

tx_jitter?

Command Line Syntax

Command Headers (Names): Every command must start with the appropriate command header. In addition, every query command header must end with a "?"

Multiple Commands. A given command line may contain one or multiple commands. If a command line contains more than one command, the second command and each additional command must be separated from the previous command by a ";" (semicolon).

Example tx_jitter on; amplitude 24.00; frequency 1000

Command Line Terminator. Command lines must be terminated as follows:

- **RS-232 Interface**: Command lines issued to the instrument must be terminated by a simple carriage return (CR). Responses generated by the instrument will be terminated as specified by the user in the RS-232 Setup End-of-Line menu function, that is: CR, LF, CR/LF or LF/CR.
- **GPIB Interface**: Command lines issued to the instrument can be terminated by either EOI or EOI/LF. Responses generated by the instrument will be terminated as specified by the user in the GPIB Setup menu function, that is: EOI or EOI/LF.

Maximum Number of Characters per Line: Command lines may contain a maximum of 80 characters before the terminator.

Upper and Lower Case: All characters in an SJ300E command line may be entered in either upper or lower case.

NOTE: For clarity, all command examples in this User's Guide are shown in lower case.

Parameters: Commands may include one or more parameters following the header. The first parameter following the header must be separated from the header by one or more blank characters (spaces). Subsequent parameters must be separated from previous parameters using commas.

Blank Characters (Spaces): One or more spaces are required between the command header and first parameter (if any). Otherwise spaces are ignored by the SJ300E and may be used on a command line between headers, parameters, or required separators for readability.

Parameters Outside of Legal Ranges

If the instrument receives a set command with a parameter that is outside the legal range for that parameter, then the instrument will set the indicated parameter to its maximum or minimum legal value, depending on which is closer to the received value.

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Command Examples

The following is a brief example of an interactive remote session. The actual commands sent to the SJ300E are shown on the left. The intended action of each command is shown on the right.

Command Sent to SJ300E	Response of SJ300E
`tx_rate r622; rx_rate r622`	Sets transmitter and receiver rate to 622 Mb/s.
`optical on`	Turns transmitter laser on.
`amplitude 24; frequency 1000`	Sets transmitter jitter generator to 24 UI at 1 kHz.
`tx_jitter on`	Turns transmitter jitter generator on.
`meas_mode wide`	Sets jitter measurement mode to WIDE.
`rx_ext_clk off`	Selects the internal (recovered) reference jitter measurement mode.
`hpf 622, b1`	Selects the B1 (100 Hz) jitter measurement high-pass filter.
`win_length 10`	Sets jitter measurement window length to 10 sec.
`reset`	Resets (clears) all previous jitter data.
`jit_total?`	Returns the number of measurement seconds
`rms?`	Returns the RMS jitter amplitude
`cont_peak?`	Returns the continuous pk-pk jitter amplitude
`win_peak?`	Returns the windowed pk-pk jitter amplitude

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Command Definitions

The following sections define all SJ300E set and query commands. Command defintions are organized into the following groups:

Group Name	These commands are used to ...	Starting Page
GPIB Common	Perform GPIB functions defined in ANSI/IEEE 488.2-1987	7-11
Transmitter	Set or query the Transmitter	7-15
Receiver	Set or query the Receiver	7-20
Jitter Sequence	Set or query Transmitter jitter sequence parameters	7-32
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Wander	Set or query the BITS wander option to measure or generate wander	7-39
Miscellaneous	Perform various functions	7-45

Note that set commands and stand-alone query commands are preceded by solid lines. Query commands in a set/query command pairs are preceded by dashed lines.

Common GPIB Commands

The following GPIB "common commands" are defined in ANSI/IEEE Std. 488.2-1987. These commands perform generic GPIB functions that are not specific to the SJ300E.

*cls

Clear Status. Clears the Standard Event Status Register (SESR) and the event status bit (ESB) in the Status Byte Register (SBR). In addition it puts the instrument into the Operation Complete Command Idle State and the Operation Complete Query Idle State. Thus after executing the *cls command, the instrument will have no data in its input or output buffers and will not be executing a command.

Example `*cls`

*ese <n>

Event Status Enable. Sets the Event Status Enable Register (ESER) to the bit sequence that corresponds to the binary value of <n> a decimal numeric value.

Parameter **<n>**: decimal numeric value in the range 0 to 255.

Example `*ese 255` (sets the ESER to 11111111 binary)

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*ese?

Event Status Enable (Query). Returns a decimal number in the range 0 to 255 corresponding to the contents of the Event Status Enable Register (ESER).

Returns <NR1> in the range 0 to 255.

Example
```
*ese?                    (query)
*ESE 255                 (response)
```

*esr?

Event Status Register (Query). Returns a decimal number corresponding to the current state of the eight bits in the Standard Event Status Register (SESR).

Returns <NR1> in the range 0 to 255.

Example
```
*esr?                    (query)
*ESR 213                 (response)
```

*idn?

Identify (Query). Returns the SJ300E identification, including company name, BERT model number, SJ300E identifier, and software version number.

Returns TEKTRONIX, SJ300E, 0, Vs.ss
where Vs.ss = software version number (e.g. V1.00).

Example
```
*idn?                    (query)
TEKTRONIX, SJ300E, 0, V1.00   (response)
```

*lrn?

Learn (Query). Returns a character string listing the instrument's current setup, *except for*:

- information on the RS-232 port and
- stored jitter sequences,

The returned string will consist of a series of commands (headers plus parameters) separated by semicolons. These commands may be stored by the controller and used to restore the instrument to the same setup at a later time.

Example:
```
*lrn?                    (command)

AMPLITUDE 35E-2;         (response)
BITS_MASK MASK 1;
FFT_FORMAT NORMAL
....
WAND_SRC LINE;
WAND_TAU 4E-1;
WIN_LENGTH 1;
```


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*opc

Operation Complete. Causes the OPC bit in the Status Byte Register to be set to one. If the OPC bit is enabled, this will result in an SRQ. The ***opc** command can be issued after a group of setup commands to determine when all of the setup commands have been executed.

Example `*opc`

*opc?

Operation Complete (Query). Causes the instrument to return the ASCII character "1" when all previous commands and queries have been completed. The ***opc?** command may be used to determine when the instrument has completed a group of commands.

Example `*opc?` (query)
`*OPC 1` (response)

*rst

Reset. Causes the instrument to return to its factory default settings and to enter a known operation state. Specifically ***rst** does the following:

- puts the instrument into the Operation Complete Command Idle State.
- puts the instrument into the Operation Complete Query Idle State.
- returns most setup parameters to their factory default settings.

However ***rst** does not impact any of the following:

- the setup of the RS-232 or GPIB ports.
- GPIB address.
- calibration data.
- the Standard Event Status Register (SESR).
- the Event Status Enable Register (ESER).
- the power-on status clear flag setting.
- stored word patterns.

Example `*rst`

*sre <n>

Service Request Enable. Sets the Service Request Enable Register (SRER) to the 8-bit sequence that corresponds to the binary value of <n>.

Parameter **<n>**: decimal numeric value in the range 0 to 255, with the restriction that in its binary form the second bit from the left — that is, the second most significant bit — must be zero.

NOTE: All figures in this document, like those in ANSI/IEEE Std. 488.2-1987, number register bits from 7 to 0 (left to right). Using this

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numbering scheme, the "second bit from the left" is labeled "bit 6". Note, however, that SONET standards number bits from 1 to 8 (left to right). Using this numbering scheme, the "second bit from the left would be labeled "bit 2".

Example `*sre 51` (sets SRER to 00110011 binary)

*sre?

Service Request Enable (Query). Returns a decimal number whose binary value equals the contents of the Service Request Enable Register.

Returns <NR1> in the range 0 to 255.

Example
```
*sre?                    (query)
*SRE 51                  (response)
```

*stb?

Status Byte (Query). Returns a decimal number in the range 0 to 255 corresponding to the contents of the Status Byte Register (SBR).

Returns <NR1> in the range 0 to 255.

Example
```
*stb?                    (query)
*STB 96                  (response)
```

*tst?

Self Test. Causes the instrument to perform a self test and return the result. A result of 0 means the self test was successful. A return of any other value means the self test was not successful. The SJ300E self test is limited in scope.

Returns 0 (if successful)

Example
```
*tst?                    (query)
*TST 0                   (indicates successful self test)
```

*wai

Wait. Forces the instrument to stop processing any additional commands until all pending operations are completed.

Example
```
*wai
```


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Transmitter Commands

The following commands set or query SJ300E Transmitter parameters.

amplitude <n>

Amplitude. Sets transmitter jitter amplitude to <n> unit intervals peak-to-peak (UI pp).

Parameter **<n>**: a decimal numeric value in the range 0.00 to 24.00

Example `amplitude 1.25` (sets jitter amplitude to 1.25 UI pp)

NOTE: Maximum amplitude is dependent upon transmitter rate (52M, 155M or 622M) and jitter frequency. The absolute maximum for any jitter frequency or bit rate is 24.00 UI. For a complete specification of maximum jitter amplitude as a function of jitter frequency and transmitter bit rate, see Appendix A.

amplitude?

Amplitude Query. Returns the current transmitter jitter amplitude setting in UI pp.

Returns <NR3>

Example
```
amplitude?                    (query)
AMPLITUDE 2400E-2             (response)
```

frequency <n>

Frequency. Sets the Transmitter jitter frequency to <n> Hz.

Parameters **<n>**: a decimal numeric value; range depends on transmitter rate as follows:

Transmitter Rate	Jitter Freq. (Hz)	Step Size (Hz)
52M	1 to 400000 (0.4 M)	1
155M	1 to 1300000 (1.3M)	1
622M	1 to 5000000 (5.0 M)	1

Example `frequency 5000000` (sets jitter frequency to 5 MHz)

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frequency?

Frequency Query. Returns the current Transmitter jitter frequency in Hz.

Returns <NR1>. Range depends on transmitter rate (see table above).

Example
```
frequency?                    (query)
FREQUENCY 5000000             (response)
```

max_ampl? { r52 | r155 | r622 }, <jitter frequency>

Maximum Amplitude. This command returns the maximum jitter amplitude, in unit intervals peak-to-peak (UI pp) that the SJ300E can generate at the transmit rate specified by the first parameter and jitter frequency specified by the second.

Parameter 1
r52: specifies a transmit rate of 52 Mb/s.
r155: specifies transmit rate of 155 Mb/s.
r622: specifies a transmit rate of 622 Mb/s.

Parameter 2 **<jitter frequency>**: decimal numeric; range and step size depend on transmit rate as follows:

Transmit Rate	Jitter Frequency Range(Hz)	Jitter Frequency Step Size (Hz)
r 52 (52Mb/s)	1 to 400000	1
r155 (155Mb/s)	1 to 1300000	1
r622 (622Mb/s)	1 to 5000000	1

Returns <NR3>

Example
```
max_ampl r155, 10000          (query)
MAX_AMPL 2400E-2              (response)
```

max_freq? { r52 | r155 | r622 }

Maximum Amplitude. Returns the maximum jitter frequency that the SJ300E can generate at a specified transmit rate.

Parameter
r52: specifies a transmit rate of 52 Mb/s.
r155: specifies a transmit rate of 155 Mb/s.
r622: specifies a transmit rate of 622 Mb/s.

Returns <NR1> (max. frequency in Hz)

Example
```
max_freq r622                 (query)
MAX_FREQ 5000000              (response)
```


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optical { on | off }

Optical. Turns Transmitter output laser on or off.

Parameter **on**: turns laser on
off: turns laser off.

Example `optical on`

optical?

Optical Query. Returns a character string indicating whether the Transmitter laser is on or off.

Returns { on | off }

Example
```
optical?                    (query)
OPTICAL ON                  (response)
```

tx_ext_inv { on | off }

Transmit External Clock Invert. Sets the polarity (inverted or not inverted) of the Transmitter front panel REF CLOCK input.

Parameter **on**: Transmitter REF CLOCK input is inverted
off: Transmitter REF CLOCK input is not inverted.

Example `tx_ext_inv on`

tx_ext_inv?

Transmit External Clock Invert Query. Returns a character string indicating whether the Transmitter REF CLOCK input is inverted (on) or not inverted (off).

Returns `{ on | off }`

Example
```
tx_ext_inv?                 (query)
TX_EXT_INV OFF              (response)
```

tx_ext_jit { int | ext }

Transmit External Jitter. Sets Trasmitter jitter modulation mode to either internal or external.

Parameter **int**: selects internal modulation
ext: selects external modulation

Example `tx_ext_jit int` `(command)`

tx_ext_jit?

Transmit External Jitter Query. Returns a character string indicating the current Transmit jitter modulation mode, that is either internal or external.

Returns { int | ext }

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Example `tx_ext_jit?` (query)
`TX_EXT_JIT INT` (response)

tx_ext_src { on | off }

Transmit External (Clock) Source. Sets Transmitter REF CLOCK mode to external or internal.

Parameter **on**: sets REF CLOCK mode to external.
off: sets REF CLOCK mode to internal.

Example `tx_ext_src on`

tx_ext_src?

Transmit External (Clock) Source Query. Returns a character string indicating the current Transmitter REF CLOCK mode.

Returns { on | off }

Example `tx_ext_src?` (query)
TX_EXT_SRC ON (response)

tx_jitter { on | off }

Transmit Jitter. Turns the Transmitter's jitter generator on or off.

Parameter **on**: turns jitter generator on
off: turns jitter generator off

Example `tx_jitter on` (command)

tx_jitter?

Transmit Jitter Query. Returns a character string indicating whether the Transmitter's jitter generator is on or off.

Returns { on | off }

Example `tx_jitter?` (query)
`TX_JITTER ON` (response)

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tx_rate { r52 | r155 | r622 }

Transmit Rate. Sets the transmit bit rate to 52, 155, or 622 Mb/s.

Parameter **r52**: Sets nominal transmit rate to 51.84 Mb/s
r155: Sets nominal transmit rate to 155.52 Mb/s
r622: Sets nominal transmit rate to 622.08 Mb/s

Example `tx_rate r52` (command)

tx_rate?

Transmit Rate Query. Returns a character string indicating the current transmit bit rate.

Returns `{ R52 | R155 | R622 }`

Example `tx_rate?` (query)
TX_RATE R52 (response)

tx_ref_filt { on | off }

Transmitter Reference Filter. Enables or disables the jitter-removing (10 Hz low-pass) filter on the Transmitter REF CLOCK input.

Parameter **on**: Enables the jitter-removing filter.
off: Disables the jitter-removing filter.

Example `tx_ref_filt on` (command)

tx_ref_filt?

Transmitter Reference Filter Query. Returns a character string indicating the status of the Transmitter REF CLOCK input jitter-removing filter.

Returns { on | off }

Example `tx_ref_filt?` (query)
TX_REF_FILT ON (response)

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tx_status?

Transmiter Status Query. Returns a character string indicating the current status of the Transmitter's phase lock loop (PLL). The Transmitter's PLL may fail to lock under the following conditions:

1. the external clock source is not in the proper frequency range
2. the external jitter modulation source is out of amplitude or frequency range,

Returns UNLOCK: Transmitter PLL is not locked
CLEAR: Transmitter PLL is locked or not in use.

Example tx_status? (query)
TX_STATUS CLEAR (response)

tx_thru?

Transmit Thru (Data) Query. Returns a character string indicating the status of the Transmitter THRU DATA input. If the transmitter is using the external reference clock (see tx_ext_src) and a valid signal is applied to the Transmitter REF CLOCK input, and a valid data signal is applied to the Transmitter THRU DATA input, then the response to this query will be ON. Otherwise it will be OFF.

Returns { ON | OFF }

Example `tx_thru?` (query)
TX_THRU ON (response)

Receiver Commands

The following commands are used to set up the Receiver.

cont_peak?

Continuous Peak-to-Peak Jitter Query. Returns the peak-to-peak jitter amplitude in unit intervals (UI) measured since the last press of the RESET key.

Returns <NR3>: jitter amplitude in UI p-p

Example `cont_peak?` (query)
`CONT_PEAK 4250E-3` (response)

fft_format { normal | quick }

FFT Format. Selects either the normal or quick response format for jitter data uploaded from the SJ300E for FFT analysis. The normal format is simpler to use but takes longer to upload. The quick format is compacted using "binary encryption" which adds some complication but is much faster to upload. It is important to note that the basic 12 bit resolution of each jitter point is the same in either case.

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In the normal format, each line contains 16 data points in <NR1> (decimal integer) format. The value of each data point will be in the range 0 to 4095. Except for the first integer, each data point is separated from the previous integer with a comma. An example response line would be:

5,8,25,30,50,100,440,1059,4095,320,111,34,12,2,1,0

In the quick format, each 12 bit data point is "encrypted" into two ASCII characters. Each response line will contain 40 data points, where each point is represented by two ASCII characters. The entire response line is enclosed in quotes. Therefore each data line would comprise a string of 80 ASCII characters that is enclosed in quotes.

The first ASCI character of each point is formed by adding 64 (01000000 binary) to the six least significant bits of the data point. The second character is formed by adding 64 to the six most significant bits. So if the 12 bits of the data point are yyyyyyxxxxxx, the encryption process would result in 01xxxxxx for the first character and 01yyyyyy for the second.

For example, if all 40 data points in a given line have a value of 262 (**000100000110** binary), then the first character in each data point pair would be 01**000110** which corresponds to an ASCII "F". The second character in each point would be 01**000100** which corresponds to an ASCII "D". Therefore the response line would look like the following:

"FDFDFD ... .FDFDFDFD"

Parameter **normal**: specifies the normal (non-compacted) format
quick: specifies the binary encrypted (compacted) format**.**

Example `fft_format quick` `(command)`

---

fft_format?

FFT Format Query. Returns a character string indicating the current FFT data upload format.

Returns { normal | quick }

Example `fft_format?` (query)
FFT_FORMAT QUICK (response)

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fft_freq?

FFT Frequency. Returns the current FFT sampling frequency in decimal integer format. Note that the jitter sampling frequency is set using the fft_sam_mode command. If fft_sam_mode has been set to “normal”, then the FFT sampling rate will equal 16.7772 Mhz (16777200). On the other hand, if fft_sam_mode has been set to “slow”, then the FFT sampling frequency will equal 33.554 kHz (33554).

Returns <NR1>

Example
```
fft_freq?                                   (query)
FFT_FREQ 16777200                           (response)
```

fft_length?

FFT Length. Returns the length of the SJ300E FFT time record—that is the number of jitter data points that will be returned by the fft_upload command.

Returns <NR1>, in the range 1 to 16384

Example
```
fft_length?                                 (query)
FFT_LENGTH 16384                            (response)
```

fft_sam_mode { normal | slow }

FFT Sampling Mode. Sets the jitter sampling rate to either 16.7772 MHz (normal) or 33.554 kHz (slow). Note that the slow rate is 1/500th of the normal rate.

Parameter **normal**: sets sampling rate to 16.7772 MHz
slow: sets jitter sampling rate to 33.554 kHz

Example `fft_sam_mode` normal (command)

fft_sam_mode?

FFT Sampling Mode Query. Returns a character string indicating the current jitter sampling mode.

Returns { normal | slow }

Example
```
fft_sam_mode?                               (query)
FFT_SAM_MODE NORMAL                         (response)
```


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fft_stop

FFT Stop. Terminates uploading of an FFT time record while an upload is in progress. This command will have no effect if no upload is in progress. During an FFT upload, RMS jitter data is not available. Therefore a secondary effect of this command is to make RMS jitter data available immediately.

Parameter none

Example `fft_stop` (command)

fft_upload <n>

FFT Upload. Causes the SJ300E to upload <n> jitter data points for FFT analysis.

Parameter **<n>**: decimal numeric value in the range 1 to 16384

Example `fft_upload 1024` (command)

hpf_155 { default | 12k | b1 | b2 }

High Pass Filter for 155 Mb/s Rate. Selects the jitter measurement high pass filter cutoff frequency that is used when the receiver is set up to operate at 155 Mb/s.

Parameter **default:** 300 Hz for FINE mode or 10 Hz for WIDE mode.

12k: 12 kHz
b1: 500 Hz
b2: 65 kHz.

Example `hpf_155 b1` (command)

hpf_155?

High Pass Filter for 155 Mb/s Rate Query. Returns a character string that indicates the current 155 Mb/s jitter measurement filter cutoff requency.

Returns `{ default | 12k | b1 | b2 }`

Example `hpf_155?` (query)
HPF_155 B1 (response)

hpf_52 {default | 12k | b1 | b2 }

High Pass Filter for 155 Mb/s Rate. Selects the Receiver jitter measurement high pass filter cutoff frequency when the receiver is set up to operate at 52 Mb/s.

Parameter **default**: 100 Hz for FINE mode or 10 Hz for WIDE mode.
12k: 12 kHz
b1: 100 Hz
b2: 20 kHz.

Example `hpf_155 b2` (command)

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hpf_52?

High Pass Filter for 52 Mb/s Rate Query. Returns a character string that indicates the current 52 Mb/s jitter measurement filter cutoff requency.

Returns `{ default | 12k | b1 | b2 }`

Example
`hpf_52?` (query)
HPF_52 B2 (response)

hpf_622 {default | 12k | b1 | b2 }

High Pass Filter for 622 Mb/s Rate. Selects the Receiver jitter measurement high pass filter cutoff frequency when the receiver is set up to operate at 622 Mb/s.

Parameter
default: 1200 Hz for FINE mode or 10 Hz for WIDE mode.
12k: 12 kHz
b1: 1200 Hz for FINE mode or 1 kHz for WIDE mode.
b2: 250 kHz.

Example `hpf_622 default` (command)

hpf_622?

High Pass Filter for 622 Mb/s Rate Query. Returns a character string that indicates the current 622 Mb/s jitter measurement filter cutoff requency.

Returns `{ default | 12k | b1 | b2 }`

Example
`hpf_622?` (query)
HPF_622 DEFAULT (response)

jit_hits?

Jitter Hits Query. Returns the number of jitter hits measured since the last press of the RESET key, remote RESET command, or power on.

Returns <NR1>, in the range 0 to 999 jitter hits.

Example
`jit_hits?` (query)
JIT_HITS 53 (response)

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jit_max? <n>

Maximum Jitter Query. Returns the maximum jitter amplitude, in unit intervals peak-to-peak, during hit number <n>.

Parameter **<n>**: decimal numeric value in the range 1 to the number of jitter hits currently in memory.

Returns <NR1>, <NR3>

where the first parameter specifies jitter hit number and the second specifies the maximum jitter amplitude in UI pp detected during this jitter hit.

Example

```
jit_max? 7                    (query)
JIT_MAX 7, 5880E-3            (response)
```

jit_print

Jitter Print. Causes the SJ300E to printer a Jitter Hit Report on the currently active printer port.

Parameter none

Example

```
jit_print                     (command)
```

jit_sec?

Jitter (Hit) Second Query. Returns the number of jitter hit seconds since the last press of the RESET key, remote RESET command, or power on

Returns <NR1>

Example

```
jit_sec?                      (query)
JIT_SEC 24                    (response)
```


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jit_start? <n>

Jitter Start (Time) Query. Returns the start time of the jitter hit event specified by <n>.

Parameter **<n>** decimal numeric in the range 1 to the number of jitter hits.

Returns <NR1>, <qstring>

where:
<NR1> is **n**, the specified jitter hit number,and
<qstring> is its start time in "HH:MM:SS" format.

Example
`jit_start? 17` (query)
JIT_START 17, "14:20:59" (response)

jit_stop? <n>

Jitter Stop (Time) Query. Returns the stop time of the jitter hit event specified by <n>.

Parameter **<n>**: decimal numeric value in the range 1 to the number of jitter hits.

Returns <NR1>, <qstring>

where:
<NR1> is n, the specified jitter hit number, and
<qstring> is its start time in "HH:MM:SS" format.

Example
`jit_stop? 17` (query)
JIT_STOP 17, "14:21:05" (response)

jit_thres <n>

Jitter (Hit) Threshold. Sets the jitter hit threshold in unit intervals (UI) to the value specified by <n>.

Parameter **<n>**: decimal numeric value in the range 0.001 to 16.000 in steps of 0.001

Example `jit_thres 1.000`

jit_thres?

Jitter (Hit) Threshold Query. Returns the value of the current jitter hit threshold in UI.

Returns <NR3>

Example
`jit_thres?` (query)
JIT_THRES 1600E-2 (response)

jit_total?

Jitter Total (Time) Query. Returns the number of seconds that have elapsed since the last press of the RESET key, remote reset, or power-on. This the time used to accumulate jitter hit seconds, jitter hits, and continuous peak-to-peak jitter amplitude.

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Returns <NR1>

Example `jit_total?` (query)
JIT_TOTAL 600 (response)

---

meas_mode { wide | fine }

(Jitter) Measurement Mode. Sets jitter measurement mode to wide or fine.

Parameter **wide:** sets jitter measurement mode to wide.
fine: sets jitter measurement mode to fine.

Example `meas_mode wide` (command)

---

meas_mode?

(Jitter) Measurement Mode Query. Returns a character string that indicates the current jitter measurement mode.

Returns { wide | fine }

Example `meas_mode?` (query)
MEAS_MODE WIDE (response)

---

reset

Reset. Causes the SJ300E to perform a remote reset. This has the same effect as pressing the front panel RESET key which is to clear all accumulated jitter and wander data, reset ("total") measurement seconds to zero, and reset TIE to zero.

Parameter none

Example `reset` (command)

---

rms?

RMS (Jitter). Returns the current RMS jitter amplitude in UI. This value is based on the last 2000 jitter samples with a sample rate of 16384 MHz.

Parameter none

Returns <NR3>

Example `rms?` (query)
`RMS 3520E-3` (response)

---

rx_ext_clk { on | off }

Receiver External (Reference) Clock. Selects internal or external jitter measurement reference mode. In the "on" or external mode, a BITS or SETS reference clock signal must be applied to Receiver REF CLOCK input when making jitter measurements. In the "off" or internal mode, a reference clock signal is recovered from signal under test so that no external reference is needed

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when making jitter measurements. (NOTE: A reference clock signal always must be applied to the REF CLOCK input when making wander measurements.)

Parameter **on**: selects external reference clock mode (EXT on)
off: selects internal reference mode (EXT off).

Example `rx_ext_clk off` (command)

rx_ext_clk?

Receiver External (Reference) Clock Query. Returns a character string indicating the current jitter measurement reference clock mode.

Returns { on | off }

Example `rx_ext_clk?` (query)
RX_EXT_CLK OFF (response)

rx_input { clock | data | optical }

Receiver Input. Selects the active Receiver input.

Parameter **clock**: selects the CLOCK electrical input.
data: selects the DATA (NRZ) electrical input.
optical: selects the OPTICAL input.

Example `rx_input optical` (command)

rx_input?

Receiver Input Query. Returns a character string that indicates the current active Receiver input.

Returns { clock | data | optical }

Example `rx_input?` (query)
RX_INPUT OPTICAL (response)

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rx_rate { r52 | r155 | r622 }

Receiver Rate. Sets the operating rate of the SJ300E Receiver to 55, 155, or 622 Mb/s.

Parameter **r52**: sets nominal Receiver rate to 51.84 Mb/s
r155: sets nominal Receiver rate to 155.52 Mb/s.
r622: sets nominal Receiver rate to 622.08 Mb/s.

Example `rx_rate r622` (command)

rx_rate?

Receiver Rate Query. Returns a character string indicating the current receiver operating rate.

Returns { r52 | r155 | r622 }

Example `rx_rate?` RX_RATE R622 (response)

rx_ref_rate { ds1 | ds1_esf | two_mb | two_mhz }

Receive (Synchronization Clock) Reference Rate. Sets the type of synchronization signals accepted at the Receiver REF CLOCK input and BITS/SETS IN input, and the type produced at the BITS/SETS OUT output. The types are described as follows:

Parameter	Rate	Clock or Data	Frame Pattern
ds1	1.544 Mb/s	bipolar data	Superframe
ds1_esf	1.544 Mb/s	bipolar data	Extended Superframe
two_mb	2.048 Mb/s	bipolar data	31-Channel, no CRC-4
two_mhz	2.048 MHz	square waveal clock	----------

Example `rx_ref_rate ds1` (command)

rx_ref_rate?

Receiver Reference Rate Query. Returns a character string indicating the current synchronization signal type. This type applies to the Receiver REF CLOCK input, the BIT/SETS IN input, and the BITS/SETS OUT output.

Returns {ds1 | ds1_esf | two_mb | two_mhz}

Example `rx_ref_rate?` (query)

RX_REF_RATE DS1 (response)

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rx_ref_level {mon | term}

Receiver (Synchronization Signal) Reference Level. Sets the amplitude of synchronization signals accepted at the Receiver REF CLOCK and BITS/SETS IN inputs.

Parameter **mon**: accepts one-tenth standard interface signal level.

term: accepts Standard interface signal level.

Example `rx_ref_lev term` (command)

rx_ref_level?

Receiver Reference Level Query. Returns a character string indicating the current sychronization signal level mode. This applies to the the Receiver REF CLOCK and BITS/SETS IN inputs.

Returns {mon | term}

Example `rx_ref_lev?` (query)

RX_REF_LEV TERM (response)

rx_status?

Receiver Status. Reports the receiver status (loss of signal, loss of lock, or no loss) with highest priority. If a signal or lock is not required for a particular receiver measurement, the status is not reported.

Returns {input los | input loc | ref los | bits los | rate lock loss | data lock loss | locking | locked}

INPUT LOS: The active input is not present (when **rx_input** is not set to **clock**).

INPUT LOC: The active input is not present (when **rx_input** is set to **clock**).

REF LOS: The Receiver REF CLOCK input is not present (when **rx_ext_clk** is **on**).

BITS LOS: The BITS/SETS IN input is not present (when **rx_ext_clk** is **on** and **wand_src** is set to **ref**).

DATA_LOCK_LOSS: The clock recovery PLL is out of lock (when **rx_input** is not set to **clock**).

RATE LOCK LOSS: The reference PLL is out of lock.

LOCKING: The reference PLL is out of lock, but it is in the process of locking.

LOCKED: All signals are present and all PLLs are locked that are necessary to make the receiver measurement.

Example

```
rx_status?                          (query)
RX_STATUS RATE LOCK LOSS            (response)
```


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wand_status?

Wander Status. Reports the wander measurement status (loss of signal, loss of lock, or no loss) with highest priority. If a signal or lock is not required for a wander measurement, the status is not reported.

Returns {ref los | bits los | input los | input loc | data lock loss | rate lock loss | locking | locked}

REF LOS: The Receiver REF CLOCK input is not present.

BITS LOS: The BITS/SETS IN input is not present (when **wand_src** is set to **ref**).

INPUT LOS: The active input is not present (when **wand_src** is set to **line** and **rx_input** is set to **data** or **optical**).

INPUT LOC: The active input is not present (when **wand_src** is set to **line** and **rx_input** is set to **clock**).

DATA_LOCK_LOSS: The clock recovery PLL is out of lock (when **wand_src** is set to **line** and **rx_input** is set to **data** or **optical**)

RATE LOCK LOSS: The reference PLL is out of lock.

LOCKING: The reference PLL is out of lock, but it is in the process of locking.

LOCKED: All signals are present and all PLLs are locked that are necessary to make the wander measurement.

Example

```
wand_status?                    (query)
WAND_STATUS LOCKING             (response)
```

win_length <n>

Window Length. Sets the jitter measurement window length in seconds.

Parameter **<n>**: decimal numeric value in the range 1 to 99 seconds.

Example

```
win_length 60
```

win_length?

Window Length Query. Returns the current jitter measurement window length in seconds.

Returns <NR1>

Example

```
win_length?                     (query)
WIN_LENGTH 60                   (response)
```


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win_peak?

Window Peak-to-Peak Jitter Amplitude. Returns the peak-to-peak jitter amplitude in UI, measured in the current window. The current window is a sliding measurement interval whose length is specified by the user in the range 1 to 99 seconds. At power on or after a reset, the current window length will grow in length until it reaches the specified length. After that, the SJ300E will begin to drop old data, that is the window will begin to "slide", so that the current window represents the last "n" measurement seconds, where n is the specified window length.

Returns <NR3>

NOTE: A value of "-1" will be returned if an Out-of-Range condition has occurred during the current window.

Example

```
win_peak?                                (query)
WIN_PEAK 3700E-3                       (resonse)
```

Jitter Sequence Commands

The following commands are used to set up and calibrate jitter sequences in order to perform jitter transfer tests.

cal_ratio? <n>

Calibration Ratio Query. Returns the current calibration ratio for a specified point in the current jitter sequence. This is the ratio of the peak-to-peak jitter measured by the Receiver (during the most recent calibration process) to the Transmitter amplitude setup, for the point specified by the parameter.

Parameter **<n>**: decimal numeric value in the range 1 to the number of points in the current sequence.

Returns <NR1>,<NR3>

where the first parameter is the number of the specified point and the second is the calibration result for this point.

Example

```
cal_ratio? 10                            (query)
CAL_RATIO 10, 100E-2                  (response)
```


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cal_time?

Calibration Time Query. Returns a quoted character string that indicates the time (24 hour) and date of the most recent calibration of the current jitter sequence. If, however, the current jitter sequence is uncalibrated, this command will return a null string.

Returns <qstring>: in "YY/MM/DD HH:MM:" format, or
<null string>: ""

Example
```
cal_time?                                (query)
CAL_TIME "94/05/21 16:00"              (response)
```

seq_allprint { r52 | r155 | r622 }

Sequence All Print. Causes the SJ300E to print an "All Jitter Sequence Test Sequence Setup" report. This report lists all of the jitter frequency/amplitude points in all the currently defined jitter sequences for a given rate—that is up to 16 sequences of up to 20 points each.

Parameter **r52**: lists sequences specified for the 52Mb/s rate.
r155: lists sequences specified for the 155Mb/s rate.
r622: lists sequences specified for the 622 Mb/s rate.

Example
```
seq_allprint r52
```

seq_delete <n>

Sequence Delete. Deletes point <n> in the current sequence.

Parameter **<n>**: decimal numeric value in the range 1 to number of points in current sequence

Example
```
seq_delete 15                            (command)
```

Note: Deleting a point "n" causes the n+1 point to replace the previous "n" point.

seq_dwell <n>

Sequence Dwell (Time). Sets the dwell time of the current sequence to <n> seconds.

Parameter **<n>**: decimal numeric value in the range 1 to 99 (seconds).

Example
```
seq_dwell 5                              (command)
```

seq_dwell?

Sequence Dwell (Time) Query. Returns the dwell time of the current sequence in seconds.

Returns <NR1>

Example
```
seq_dwell?                                 (query)
SEQ_DWELL 5                              (response)
```


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seq_edit { r52 | r155 | r622 }, <n>

Sequence Edit. Selects one sequence memory location as the "edit sequence". The first parameter specifies the 52Mb/s, 155Mb/s, or 622Mb/s group of sequences. The second parameter, <n>, specifies one of the 16 sequence memory locations within this group.

Parameter 1 **r52**: selects the 52 Mb/s sequence group.
r155: selects the 155 Mb/s sequence group.
r622: selects the 622 Mb/s sequence group.

Parameter 2 <n>, decimal numeric in the range 1 to 16; selects particular sequence within group.

Example `seq_edit r155, 16` (command)

seq_edit?

Sequence Edit Query. Returns the group and number of the jitter sequence currently selected for editing.

Returns { r52 | r155 | r622 }, <NR1>

Example `seq_edit?` (query)
SEQ_EDIT R155, 16 (response)

seq_insert <n>

Sequence Insert. Inserts a new jitter point at the <n> th location in the current edit sequence. The points that were at or above the insertion point are bumped up one location each. If the sequence had 20 points before insertion then the point that was in the 20th location is bumped "off the sequence"— in other words is "errased".

Parameter **<n>**: decimal numeric value in the range 1 to the number of points in the current edit sequence before insertion.

Example `seq_insert 20` (command)

seq_load_std

Sequence Load: Standard. Causes the SJ300E to load the standard sequence for the current Transmit rate into the current edit sequence. For example, if the current Transmit rate is 622 Mb/s, and the current edit sequence is 10, then the seq_load_std command will load the standard 622 Mb/s jitter sequence into the 10th sequence memory location in the 622 Mb/s group.

Parameter none

Example `seq_load_std` (command)

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seq_number <n>

Sequence Number. Causes the <n> th sequence in the current sequence group to become the current test sequence. Note that the current test sequence and the current edit sequence may be different. Also note that you cannot specify a particular sequence group, that is the 52, 155, or 622 Mb/s group. Instead, the current test sequence is always selected from the current group which is determined by the current Transmit rate. You can set the current transmit rate using the tx_rate command.

Parameter **<n>**: decimal numeric value in the range 1 to the number of sequences in the current group.

Example `seq_number 5` (command)

seq_number?

Sequence Number Query. Returns the number of the current jitter sequence.

Returns <NR1>

Example
`seq_number?` (query)
`SEQ_NUMBER 5` (response)

seq_points <n>

Sequence Points. Sets the length of the current edit sequence to <n> points.

Parameter **<n>**: deciimal numeric value in the range 1 to 20.

Example `seq_Points 20` (command)

seq_points?

Sequence Points Query. Returns the number of points in the current edit sequence.

Returns <NR1>

Example
`sequence_points?` (query)
`SEQUENCE_POINTS 20` (response)

seq_print { r52 | r155 | r622 }, <n>

Sequence Print. Causes the SJ300E to print the <n> th sequence in either the 52M, 155M, or 622M group of sequences.

Parameter 1
r52: specifies the 52 Mb/s group
r155: specifies the 155 Mb/s group
r622: specifies the 622 Mb/s group

Parameter 2 **<n>**: decimal numeric value in the range 1 to 20. Specifies a particular jitter sequence within the group specified by parameter 1.

Example `seq_print r52, 10` (command)

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seq_state { run | stop | cal }

Sequence State. Causes the SJ300E Transmitter and Receiver to begin testing, stop testing, or calibrate using the current test sequence. Note that the current test sequence is specified using the seq_number command.

Parameter **run**: causes the SJ300E Transmitter and Receiver to start testing.
cal: causes the SJ300E Transmitter and Receiver to start calibrating.
stop: causes the SJ300E to stop the current jitter sequence test or calibration process. If neither a jitter sequence test nor calibration is in progress, issuing the seq_state command with this parameter will have no effect. Note that a test or calibration process will also stop automatically when the end of the test sequence is reached.

Example `seq_state run` (command)

seq_state?

Sequence State Query. Returns the current jitter sequence state of the SJ300E. Note that the SJ300E Transmitter and Receiver will always be in the same jitter sequence state, that is testing, calibrating, or stopped.

Returns **RUN**: if a jitter transfer test is in progress (RUN LED on)
CAL: if a cal. procedure is in progress (RUN LED on)
STOP: if neither a test nor cal. is in progress (RUN LED off).

Example
`seq_state?` (query)
`SEQ_STATE RUN` (response)

seq_value <n>, <jitter amplitude>, <jitter frequency>

Sequence Value. Sets the jitter amplitude and frequency of the <n> th point in the current edit sequence.

Parameters **<n>**: decimal numeric value in the range 1 to the number of points in the current edit sequence.

<jitter amplitude>: decimal numeric value that sets jitter amplitude; range depends on jitter frequency and SONET/SDH rate.

<jitter frequency>: decimal numeric value that sets jitter frequency; range depends on current SONET/SDH rate.

Example `seq_value 8, 2400E-2, 1000` (command)

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seq_value? <n>

Sequence Value Query. Returns jitter amplitude and frequency of the <n> th point in the current edit sequence.

Parameter **<n>**: decimal numeric value in the range from 1 to the number of points in the current edit sequence.

Returns <NR1>,<NR3>,<NR1>

where:
1st parameter is the point number
2nd parameter is jitter amplitude in UI peak-to-peak
3rd parameter is jitter frequency in Hz.

Example

```
seq_value? 8                          (query)
SEQ_VALUE 8,2400E-2,1000              (response)
```

Jitter Transfer Test Commands

The following commands are used to set up and perform jitter transfer tests.

cal_loop { int | ext }

Calibration Loop. Selects either the **int**ernal or **ext**ernal jitter sequence calibration loop mode. If internal is selected, jitter sequence calibrations will be performed over the internal calibration path that exists between the SJ300E Transmitter and Receiver. If external is selected, before a jitter sequence calibration is started a connection must be made between the active SJ300E output and input using the appropriate type patch cord, .

Parameter **int**: selects the internal calibration loop mode.
ext: selects the external calibration loop mode.

Example

```
cal_loop int                          (command)
```

cal_loop?

Calibration Loop Query. Returns a character string indicating the current calibration loop mode.

Returns { int | ext }

Example

```
cal_loop?                             (query)
CAL_LOOP INT                          (response)
```


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xfer_freq? <n>

Transfer Frequency Query. Returns the frequency in Hz of the <n>th point in the current jitter sequence.

Parameter **<n>**: decimal numeric value in the range 1 to the number of points in the current jitter sequence.

Returns <NR1>,<NR1>

where:
1st parameter is the point number <n>
2nd parameter is the frequency value of this point.

Example
```
xfer_freq? 7                    (query)
XFER 7, 1500                    (response)
```

xfer_points?

Transfer Points Query. Returns the number of points in the current jitter sequence.

Returns <NR1>

Example
```
xfer_points?                    (query)
XFER_POINTS? 20                 (response)
```

xfer_print

Transfer Print. Causes the SJ300E to print a Jitter Transfer Report. This report will contain the results of the most recently performed jitter transfer test—that is, results from the last jitter sequence that was "run". If no results are available the the message "No Data" will be printed instead.

Example
```
xfer_print                      (command)
```

xfer_ratio? <n>

Transfer Ratio Query. Returns the jitter transfer result—that is, the ratio of measured jitter amplitude to transmitted jitter amplitude—for the <n> th point in the current jitter sequence.

Parameter **<n>**: decimal numeric value in the range 1 to the number of points in the current jitter sequence.

Returns <NR1>,<NR3>

where:
1st parameter is the point number <n>
2nd parameter is the jitter transfer result for this point.

Example
```
xfer_ratio? 11                  (query)
XFER_RATIO 11, 100E-2           (response)
```


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xfer_seq?

Transfer Sequence Query. Returns the rate or "group" (i.e. the 52, 155, or 622 Mb/s) and number (1 - 16) of the current jitter sequence.

Returns { R52 | R155 | R622 } , <NR1>

where:
1st parameter identifies the group
2nd parameter identifies the sequence within this group

Example

```
xfer_seq?                                   (query)
XFER_SEQ? R622, 16                          (response)
```

xfer_start?

Transfer Start Query. Returns the starting date and time of the most recently performed jitter transfer test.

Returns <qstring> in the format "YY/MM/DD HH:MM:SS"

Example

```
xfer_start?                                 (query)
XFER_START? "94/06/22 15:30:45"             (response)
```

Wander Commands

The following commands are used to set up and perform wander tests. Responses to these commands are valid only if the Wander Test Option is installed.

bits_avail?

Bits Available Query. Returns the number of 200 ms wander (TIE) measurement data that are currently stored and available for uploading. The maximum number of wander measurement data that can be stored by the SJ300E is 100 (i.e. 20 seconds worth of data). Therefore, if this query returns a value of 100 then it is likely that data older than 20 seconds have been lost.

Returns <NR1>

Example

```
bits_avail?                                 (query)
BITS_AVAIL? 90                              (response)
```


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bits_mask {none | mask1 | mask2 | mask3 | mask4 | mask5 | mask6 | testpat}

Bits Mask. Selects wander pattern or transient or noise jitter to be generated on the BITS/SETS OUT signal. See section 4.4 for a description of the patterns.

Parameters **none**: No wander, transient, or jitter applied.

mask1: Generates the "DS1" wander pattern.

mask2: Generates the "DS1 FILT" wander pattern.

mask3: Generates the "OC-N" wander pattern

mask4: Generates the "NOISE" jitter pattern.

mask5: Generates the "1000TRAN" phase transient.

mask6: Generates the "1200TRAN" phase transient.

testpat: Applies a triangular wander waveform for checking calibration. Peak-to-peak amplitude is 4096 ns when **rx_ref_rate** is set to **ds1** or **ds1_esf**, or 3088 ns when **rx_ref_rate** is set to **two_mb** or **two_mhz.**

Example `bits_mask mask1` (command)

bits_mask?

BITS Mask Query. Returns a character string indicating the current wander pattern being generated at the BITS/SETS OUT port.

Returns {none | mask1 | mask2 | mask3 | mask4 | mask5 | mask6 | testpat}

Example BITS_MASK MASK1

bits_reset

BITS Wander Reset. Causes all BITS wander data currently stored by the SJ300E to be cleared. Generally issue this command just before you want to begin a BITS wander measurement. If desired BITS wander results are currently stored in the SJ300E, be sure to upload these data (bits_upload?) before issuing the bits_reset command. Note that this command clears wander data collected for the BITS IN input but does not impact data collected for the current active OC-N rate input.

Example `bits_reset` (command)

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bits_tie?

BITS TIE Query. Returns the current TIE (time interval error) of the BITS IN input. This represents the net phase change that has been detected— with components above 10 Hz (i.e. jitter) removed—on the BITS IN (rear panel) input relative to the Receiver REF CLOCK input (front panel) since the last BITS Wander reset (bits_reset). Note that BITS TIE is reset to zero each time a bits_reset command is executed.

Returns <NR3>

Example
```
bits_tie?                                   (query)
BITS_TIE  105E-10                           (response)
```

bits_upload?

BITS Wander Upload Query. Returns the 10 most recent BITS TIE (wander) data. Since TIE is measured every 20 ms, these 10 TIE data will represent a TIE time record for the 200 ms interval just prior to execution of the command. Note that the first parameter returned represents the current or “absolute” BITS TIE value in nanoseconds. The next nine parameters will represent offsets from the current BITS TIE value in nanoseconds. Thus if the return is 100, 2, 4, 0, ... etc., and the command was executed at time T, then the value of TIE at time T was 100 ns, the value of TIE at T - 20 ms was 102 ns, the value of TIE at
T - 40 ms was 104 ns, the value of TIE at T - 60 ms was 100 ns, etc.

Returns <NR1>, <NR1>, ... , <NR1> (a total of 10 values)

where the 1st parameter is the value of TIE at the moment the command was executed and the 2nd through 10th parameters represent TIE relative to the first parameter in 20 ms intervals.

Example
```
bits_upload?                                (query)
BITS_UPLOAD 100,3,0,-2,-3,-2,-1,1,6,4
                                            (response)
```

wand_avail?

Wander Available Query. Returns the number of wander (TIE) 200 ms data currently available. Since the maxmum number of TIE data that can be stored by the SJ300E is 100, and wander data are stored in a first in first out (FIFO) buffer, if the return equals 100, it is likely that data collected more than 20 seconds (100 x 200 ms) prior to execution of the command has been lost.

Returns <NR1>

Example
```
wand_avail?                                 (query)
WAND_AVAIL 100                              (response)
```


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wand_mtie?

Wander MTIE Query. Returns the maximum time interval error (MTIE) in seconds measured on the active OC-N rate input (CLOCK, DATA, or OPTICAL) since the last Wander reset (wand_reset). Note that MTIE is calculated using a sliding observation window that is set using the wand_obs command.

Returns <NR3>

Example
```
wand_mtie?                    (query)
WAND_MTIE 2505E-10            (response)
```

wand_obs <n>

Wander Observation Time. Sets the MTIE observation time parameter to <n> seconds. Note that the MTIE observation window is a sliding window so that MTIE measurements can and usually do take place over total intervals that are much longer than the observation window.

Parameter **<n>**: decimal numeric value in the range 0.1 to 99.0 seconds.

Example
```
wand_obs 10                   (command)
```

wand_obs?

Wander Observation (Window) Query. Returns the current duration of the MTIE observation window in seconds.

Returns <NR3>

Example
```
wand_obs?                     (query)
WAND_OBS? 100E-1              (indicates 10 sec)
```

wand_reset

Wander Reset. Causes all OC-N rate wander data currently stored by the SJ300E to be cleared. Generally issue this command just before you want to begin an OC-N rate wander measurement. If desired OC-N rate wander results are currently stored in the SJ300E, be sure to upload these data (bits_upload?) before issuing the bits_reset command. Note that this command clears wander data collected for the current active OC-N rate input (CLOCK, DATA, or OPTICAL) but does not impact data collected for the BITS IN port.

Example
```
wand_reset                    (command)
```


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wand_src { line | ref }

Wander Source. Selects which input is measured for wander. Note the instrument always measures wander relative to the 1.544 Mb/s BITS or 2.048 Mb/s SETS synchronization clock signal appearing at the Receiver REF CLOCK input.

Parameters **line**: wander is measured on the SONET or SDH line-rate signal appearing at the currently active Receiver input: CLOCK, DATA, or OPTICAL.
ref: wander is measured on the 1.544 Mb/s BITS or 2.048 Mb/s SETS (reference) synchronization clock signal appearing at the BITS IN port.

Example `wand_src line` (command)

wand_src?

Wander Source Query. Returns a character string indicating which input has been selected for wander measurement.

Returns { line | ref }

Example `wand_src?` (query)
WAND_SRC? LINE (response)

wand_tau <n>

Wander Tau. Sets the integration time (τ) in seconds used by the SJ300E to calculate TVAR (time variance) on the currently active OC-N rate input.

Parameters **<n>**: Decimal numeric value in the range 0.1 to 99.0 seconds.

Example `wand_tau 50` (command)

wand_tau?

Wander Tau Query. Returns the current value of τ (tau) in seconds.

Returns <NR3>

Example `wand_tau?` (query)
`WAND_TAU? 500E-1` (response)

wand_tie?

Wander TIE Query. Returns the current value of TIE in seconds measured on the active OC-N rate input. This parameter is reset to zero by the wand_reset command.

Returns <NR3>

Example `wand_tie?` (query)
WAND_TIE? 65E-10 (TIE = 6.5 ns)

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wand_tvar?

Wander TVAR Query. Its name notwithstanding, this command actually returns the current value of TDEV (time deviation) measured on the active OC-n rate input. This parameter is reset to zero by the wand_reset command. Note that TVAR or time variance is the square of TDEV.

Returns <NR3>

Example `wand_tvar?` (query)
WAND_TVAR 105E-10 (TDEV = 10.5 ns)

wand_upload?

(OC-n) Wander Upload Query. Returns the 10 most recent OC-n input TIE (wander) data. Since TIE is measured every 20 ms, these 10 TIE data will represent a TIE time record for the 200 ms interval just prior to execution of the command. Note that the first parameter returned represents the current or "absolute" TIE value in nanoseconds. The next nine parameters will represent offsets from the current TIE value in nanoseconds. Thus if the return is 100, 2, 4, 0, ... etc., and the command was executed at time T, then the value of TIE at time T was 100 ns, the value of TIE at T - 20 ms was 102 ns, the value of TIE at
T - 40 ms was 104 ns, the value of TIE at T - 60 ms was 100 ns, etc.

Returns <NR1>, <NR1>, ... , <NR1> (a total of 10 values)

where the 1st parameter is the value of TIE on the active OC-n input at the moment the command was executed and the 2nd through 10th parameters represent TIE relative to the first parameter in 20 ms intervals.

Example wand_upload? (query)
`WAND_UPLOAD 100,3,0,-2,-3,-2,-1,1,6,4`
(response)

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Miscellaneous Commands

The following commands perform various set up and measurement functions.

date <"s">

Date. Sets internal SJ300E calendar to the date specified by <s>.

Parameter **<s>**: a quoted string in the format "YY[YY]/MM/DD" (year, month, day). Year may be in two digit (e.g. 94) or four digit (e.g. 1994) format.

Example `date "94/07/04"` (command)

date?

Date Query. Returns the current date of the SJ300E internal calendar.

Returns <qstring> in the form "YYYY/MM/DD"

Example
`date?` (query)
`DATE? 1994/07/04` (response)

gpib_address <n>

GPIB (Bus) Address. Sets the instrument's GPIB bus address to <n>. Normal GPIB addresses may be set in the range 0 to 30. By setting GPIB bus address to 31 you effectively put the instrument "off-bus" While it is off-bus, the instrument will not respond to GPIB commands. (**NOTE**: This command can only be issued via the RS-232 (serial) port.).

Parameters **<n>**: Decimal numeric in the range 0 to 31.

Example gpib_address (command)

gpib_address?

GPIB (Bus) Address Query. Returns the current GPIB address of the instrument. (**NOTE**: This command can only be issued via the RS-232 (serial) port.).

Returns <NR1>

Example
`gpib_address?` (query)
`GPIB_ADDRESS 30` (response)

gpib_bus { talk_listen | off_bus }

GPIB Bus. Puts the instrument into a GPIB talk/listen mode or puts instrument in an off-bus mode. (**NOTE**: Allowed only on the RS-232 (serial) port).

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Parameter **talk_listen**: Puts the instrument on-bus as a talker/listener.

off_bus: Puts instument off-bus.

Example `gpib_bus talk_listen` (command)

gpib_bus?

GPIB Bus Query. Returns the current GPIB bus state of the instrument. (**NOTE**: Allowed only on the RS-232 (serial) port).

Returns { talk_listen | off_bus },

Example `gpib_bus?` (query)
GPIB_BUS talk_listen (response)

header { on | off }

Header. Enables or disables headers in query responses.

Parameters **on**: enables headers

off: disables headers

Example `header on` (command)

header?

Header Query. Returns a character string indicating whether headers are enabled (on) or disabled (off).

Returns { ON | OFF }

Example `header?` (query)
HEADER? ON (response)

logo?

Logo Query. Returns a character string that includes the instrument's product name and current software revision.

Returns TEKTRONIX SJ300E Vx.x

where x.x is the current software revision

Example `logo?` (query)
TEKTRONIX SJ300E V1.0 (response)

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options?

Options Query. Returns a character string listing currently installed options.

Example	`options?`	(query)
	OPTIONS? BITS/Wander	(response)

print_enab { on | off }

Print Enable. Enables (on) or disables (off) printing of SJ300E reports. This parameter must be set to on in order to print any reports via the SJ300E's RS-232, GPIB, or PRINTER (parallel) port.

Parameters **on**: enables report printing.

off: disables report printing.

Example	`print_enab on`	(command)

print_enab?

Print Enable Query. Returns a character string indicating whether SJ300E report printing is enabled or disabled.

Returns { on | off }

Example	`print_enab?`	(query)
	`PRINT_ENAB? ON`	(response)

print_port { parallel | serial | gpib }

Printer Port. Selects the parallel (PRINTER), serial (RS-232) or GPIB (IEEE-488) port as the destination for SJ300E reports.

Parameters **parallel**: Selects the rear-panel PRINTER port.

serial: Selects the rear-panel RS-232C port.

gpib: Selects the rear-panel GPIB (IEEE-488) port.

Example	`print_port parallel`	(command)

print_port?

Printer Port Query. Returns a character string indicating the current printer port.

Returns { parallel | serial | gpib }

Example	`print_port?`	(query)
	`PRINT_PORT? PARALLEL`	(response)

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print_string <“s”>

Print String. Causes the string “s” (without the quotation marks) to be printed on the currently enabled printer port.

Parameters **<“s”>**: any ASCII string enclosed in quotation marks.

Example
```
print_string "testing 1,2,3"          (command)
testing 1,2,3                         (this line is printed)
```

rs_echo { on | off }

RS-232 Echo. Enables or disables character echo on the RS-232 port. When enabled, the SJ300E will re-transmit on the RS-232 port each character it receives on the RS-232 port.

Parameters **on**: enables character echo on RS-232 port.

off: disables character echo on the RS-232 port.

Example
```
rs_echo on                            (command)
```

rs_echo?

RS-232 Echo Query. Returns a character string indicating whether RS-232 character echo is enabled (on) or disabled (off).

Returns { on | off }

Example
```
rs_echo?                              (query)
RS-ECHO? ON                           (response)
```

rs_pmt_lf { on | off }

RS-232 Prompt Line Feed. Enables or disables adding of a line feed character (ASCII decimal 10) at the end of the prompt line generated on the RS-232 port.

Parameters **on**: LF is added to end of prompt line.

off: LF is not added to prompt.

Example
```
rs_pmt_lf on                          (command)
```

rs_pmt_lf?

RS-232 Prompt Line Feed Query. Returns a character string indicating whether or not RS-232 prompt line feed is enabled.

Returns { on | off }

Example
```
rs_pmt_lf?                            (query)
RS_PMT_LF ON                          (response)
```


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rs_prompt <“s”>

RS-232 Prompt. Sets the prompt generated on the RS-232 port to character string “s” (quotation marks are not included in prompt).

Parameters **<“s”>**: character string inside the quotation marks becomes the new RS-232 port prompt.

Example `rs_prompt "SJ300>"` (command)

rs_xon_xoff { on | off }

RS-232 Port XON/XOFF. Enables (on) or disables (off) XON/XOFF flow control on the RS-232 port.

Parameters **on**: XON/XOFF is enabled.

off: XON/XOFF is disabled.

Example `rs_xon_xoff on` (command)

rs_xon_xoff?

RS-232 Port XON/XOFF Query. Returns a character string indicating whether or not XON/XOFF flow control is enabled on the RS-232 port.

Returns { on | off }

Example
`rs_xon_xoff?` (query)
`RS_XON_XOFF ON` (response)

time <“s”>

Time. Sets the SJ300E’s internal time of day clock.

Parameters **<“s”>**: quoted string in format “HH:MM:SS” (hours, minutes, seconds). Note that HH may be set in the range 0 to 23.

Example `time "18:30:00"` (command)

time?

Time Query. Returns the current setting of the SJ300E time of day clock in a quoted string format.

Returns “HH:MM:SS”

Example
`time?` (query)
`TIME "18:30:10"` (response)

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tse <n>

Test Status Enable. Sets the Test Status Enable Register (TSER) to the eight bit sequence corresponding to the decimal argument <n>. See Chapter 6 for a functional explanation of the TSER and other registers

Parameters **<n>**: decimal integer; may be set in the range 0 to 255.

Example `tse 255` (sets TSER to 11111111)

tse?

Test Status Enable Query. Returns the decimal number that corresponds to the current setting of the TSER.

Returns <NR1>

Example
`tse?` (query)
`TSE? 255` (response)

tsr?

Test Status Register Query. Returns the decimal number that corresponds to the current contents of the Test Status Register (TSR).

Returns <NR1> in the range 0 to 255.

Example
`tsr?` (query)
`TSR 224` (response)

view_angle <n>

View Angle. Sets the view angle of the SJ300E liquid crystal display to one of four values from 0 (lowest angle) to 3 (highest angle).

Parameters **<n>**: decimal integer in the range 0 to 3.

Example `view_angle 3` (command)

view_angle?

View Angle Query. Returns an integer indicating the current view angle setting.

Returns <NR1>

Example
`view_angle?` (query)
`VIEW_ANGLE 3` (response)

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Specifications

This Appendix contains SJ300E specifications. All specifications apply to the SJ300 after a 20 minute warm-up period in it's ambient operating environment.

These specifications apply to SJ300Es with firmware revisions greater than 5.3 and to SJ300E test sets with serial numbers 9309000 and higher.

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Standards

The jitter generation and analysis features of the SJ300E meet applicable requirements in Bellcore TR-NWT-000253, CCITT G.958, CCITT G.703, ANSI T1.101, and ANSI T1.120.

Transmitter Specifications

Jitter Generation

Jitter Frequency Range:

SONET/SDH Transmit Rate	Jitter Generation Frequency Range
52 Mb/s	1 Hz to 400 kHz
155 Mb/s	1 Hz to 1300 kHz
622 Mb/s	1 Hz to 5000 kHz

Jitter Frequency Accuracy: ± 20 ppm, 15 TO 30°C

± 30 ppm, 0 TO 40°C

Jitter Amplitude Range: Up to 22 UI, depending on jitter frequency and transmit baud rate (See Figure A-1)

Jitter Amplitude Resolution: 0.01 UI

Jitter Amplitude Accuracy:
At 10 kHz, 15 to 30° C

Y ± Z ± 3%

SONET/SDH Transmit Rate	Jitter Generation Amplitude Error Terms (UIpp)	
52 Mb/s	Y=0.01	Z=0.03
155 Mb/s	Y=0.01	Z=0.03
622 Mb/s	Y=0.02	Z=0.03

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Additional Error for other Jitter Frequencies (f_j) :	Jitter Frequency Band	Additional Error
At 52 Mb/s	10 Hz < fj < 100 Hz	± 4%
	100 Hz < fj < 20 KHz	± 2%
	20 KHz < fj < 400 KHz	± 4%
At 155 Mb/s	10 Hz < fj < 500 Hz	± 4%
	500 Hz < fj < 65 KHz	± 2%
	65 KHz < fj < 1.3 MHz	± 4%
At 622 Mb/s	10 Hz < fj < 1 kHz	± 4%
	1 kHz < fj < 250 KHz	± 2%
	250 kHz < fj < 5 MHz	± 4%

Additional Error for 0 to 40°C: ± 2% ± 0.01 UIpp

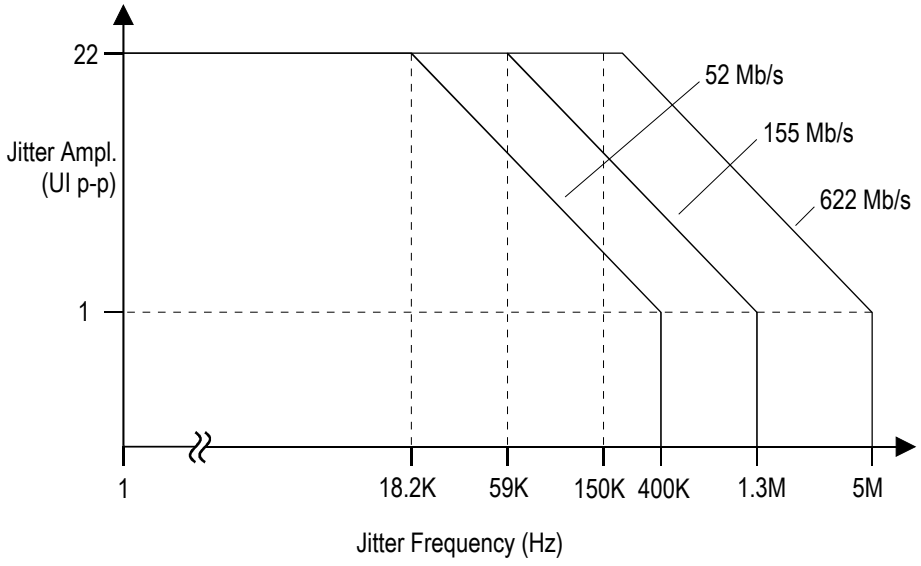


Figure A-1 Peak-to-peak Jitter Generation Range

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Operating Modes

- Internal clock and Internal data.
- External clock and Internal data.
- External clock and External data.

Internal Data Pattern

When no signal is applied to the Transmitter THRU DATA input, the SJ300E will automatically generate an unframed, 2^7-1 PRBS. The generator polynomial is

$$(1 + X^6 + X^7).$$

External Data Pattern ("Through-Data" Mode)

If an input signal, that meets input signal requirements, is applied to the THRU DATA input, *and* a reference clock is supplied, the data will be presented to the output with precision jitter added. Note that jitter attenuation occurs on the input signal if the input clock filter is ON (see REFERENCE CLOCK below.)

Reference Clock

If an input signal, that meets input signal requirements, is applied to the REF CLOCK input and it is enabled it will be used as the master timing source for the THRU DATA input, or the internal data source (PRBS.) Note that jitter attenuation is performed by a phase locked loop of 10 Hz ± 2 Hz bandwidth if the input clock filter is ON. If the clock filter is ON, the jitter components above 10 Hz, between the REFERENCE CLOCK input and the THRU DATA input, cannot exceed the limits in the table below. If the clock filter is OFF, the REFERENCE CLOCK to THRU DATA jitter cannot exceed the maximum limits in the table below.

Ref Clock input to Thru Data Jitter Tolerance:

SONET/SDH Transmit Rate	UIpp
52 Mb/s	0.20
155 Mb/s	0.20
622 Mb/s	0.40

The REFERENCE CLOCK input is nominally timed rising edge in the center of the data eye when used with the THRU DATA input. A clock inversion function is provided for systems supplying edge aligned data and clock to the SJ300E. The tolerance to mis-timed inputs is given in the table above (UI applies to static phase offset).

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Inputs

REF CLOCK Input:

Frequency Range: 51.84, 155.52, or 622.08 MHz ± 1000 ppm (Clock filter OFF)
622.08 MHz ± 20 ppm (Clock filter ON)
Termination: 50 ohms to -2V or ac-coupled
Logic levels: ECL
Connector: BNC

THRU DATA Input:

Format: NRZ
Logic levels: ECL
Termination: 50 ohms to -2V
Connector: BNC

EXTERNAL MODULATION Input:

Sensitivity: 0.1v/UI
Accuracy: ± 5%
Amplitude Limits: ± 0.8V maximum
Rate-of-Change Limits:
52 Mb/s: ±0.135 V/us
155 Mb/s: ± 0.405 V/us
622 Mb/s: ± 1.62 V/us
Termination: 50 ohms to ground
Connector: BNC

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Outputs

CLOCK Output:

Frequency: 51.84, 155.52, or 622.08 MHz
Accuracy, internal clock mode: ± 20 ppm,
Accuracy, external clock mode: output frequency equals frequency of signal applied to REF CLOCK input
Logic Levels: ECL
Required Termination: 50 ohms to -2V,
Connector: BNC

DATA Output:

Baud Rate: equals frequency of CLOCK out **Format:** NRZ
Logic Levels: ECL
Required Termination: 50 ohms to -2V,
Connector: BNC

OPTICAL Output:

Baud Rate: equals frequency of CLOCK out
Mean output power: -9 ± 3 dBm
Center wavelength: 1305 ± 35 nm
Spectral Width: 5 nm max. @ -3 dB
Available Connectors: PC, ST, or SC

REF CLOCK Output (rear panel)

Frequency: same as front panel CLOCK output but without added jitter.
Logic Levels: ac-coupled, 0.4 to 1.2 V p-p into 50 ohms.
Required Termination: 50 ohms to ground or a dc voltage.
Connector: BNC

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Receiver Specifications

Receiver Measurement Pattern

All receiver specifications, as applied to data or optical inputs, are based on a SONET/SDH formatted signal with the payload portion consisting of all zeros or all ones (e.g. AIS), or a PRBS signal of length 127 with generator polynomial: $(1 + X^6 + X^7)$.

Peak-to-Peak Jitter, Wide Mode

Frequency Response: First-order high-pass filter at 10 Hz and third-order, maximally flat, low-pass filter at 1/125 of the receiver baud rate.

Jitter Amplitude Range: Up to 16 UI p-p, depending on jitter frequency and receiver baud rate. (See Figure A-2).

Resolution: 0.01 UI

Jitter Amplitude Accuracy:
At 70 kHz for 52 Mb/s, 120 kHz for 155 and 622 Mb/s, 15 to 30°C. (10 Hz HPF filter)

Y ± 0.03 ± 3%

SONET/SDH Transmit Rate	Jitter Receiver Amplitude Error Terms (UIpp)
52 Mb/s	Y=0.03
155 Mb/s	Y=0.03
622 Mb/s	Y=0.06

Jitter Amplitude Accuracy:
At 70 kHz for 52 Mb/s, 120 kHz for 155 and 622 Mb/s, 15 to 30°C. (B1/B2 HPF filter)

Y ± 0.03 ± 3%

SONET/SDH Transmit Rate	Jitter Receiver Amplitude Error Terms (UIpp)
52 Mb/s	Y=0.03
155 Mb/s	Y=0.03
622 Mb/s	Y=0.03

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Additional Error for other Jitter Frequencies (f_j) :	Jitter Frequency Band	Additional Error
At 52 Mb/s	10 Hz < fj < 100 Hz	± 4%
	100 Hz < fj < 20 KHz	± 2%
	20 KHz < fj < 400 KHz	± 4%
At 155 Mb/s	10 Hz < fj < 500 Hz	± 4%
	500 Hz < fj < 65 KHz	± 2%
	65 KHz < fj < 1.3 MHz	± 4%
At 622 Mb/s	10 Hz < fj < 1 kHz	± 4%
	1 kHz < fj < 250 KHz	± 2%
	250 kHz < fj < 5 MHz	± 4%

Additional Error for 0 to 40°C: ± 3% ± 0.010 UIpp

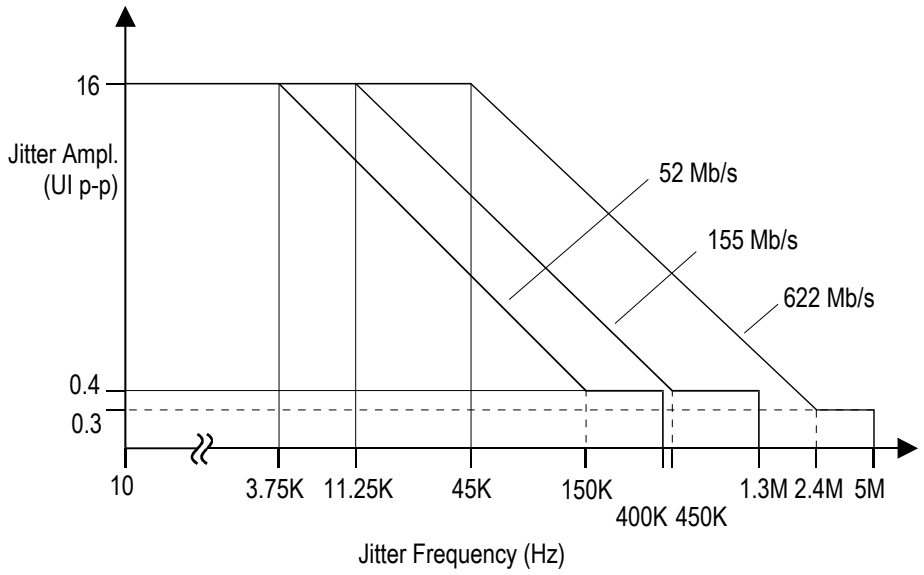


Figure A-2 Peak-to-peak Jitter Measurement Range — Wide Mode

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Peak-to-Peak Jitter, Fine Mode

Input Restrictions

Peak-to-peak in Fine mode for CLOCK input only.

Frequency Response:

First-order high-pass filter with cutoff frequencies that depend on receiver baud rate as follows:

52 Mb/s:	13 ± 3Hz
155 Mb/s:	30 ± 10Hz
622 Mb/s:	120 ± 35Hz

Jitter Amplitude Range:

Up to 0.6 UI p-p, depending on jitter freq. and Receiver baud rate (See Figure A-3).

Resolution:

0.001 UI

Jitter Amplitude Accuracy:

At 70 kHz for 52 Mb/s, 120 kHz for 155 and 622 Mb/s, 15 to 30°C

Y ± Z ± X%

SONET/SDH Transmit Rate	Jitter Receiver Amplitude Error Terms (UIpp)		
	Y	Z	X
52 Mb/s	0.002	0.002	3
155 Mb/s	0.003	0.003	3
622 Mb/s	0.009	0.009	5

Additional Error for other Jitter Frequencies (f_j) :

	Jitter Frequency Band	Additional Error
At 52 Mb/s	10 Hz < fj < 100 Hz	± 4%
	100 Hz < fj < 20 KHz	± 2%
	20 KHz < fj < 400 KHz	± 4%
At 155 Mb/s	13 Hz < fj < 500 Hz	± 4%
	500 Hz < fj < 65 KHz	± 2%
	65 KHz < fj < 1.3 MHz	± 4%
At 622 Mb/s	30 Hz < fj < 1 kHz	± 5%
	1 kHz < fj < 250 KHz	± 3%
	250 kHz < fj < 5 MHz	± 5%

Additional Error for 0 to 40°C: ± 3% ± 0.010 UIpp

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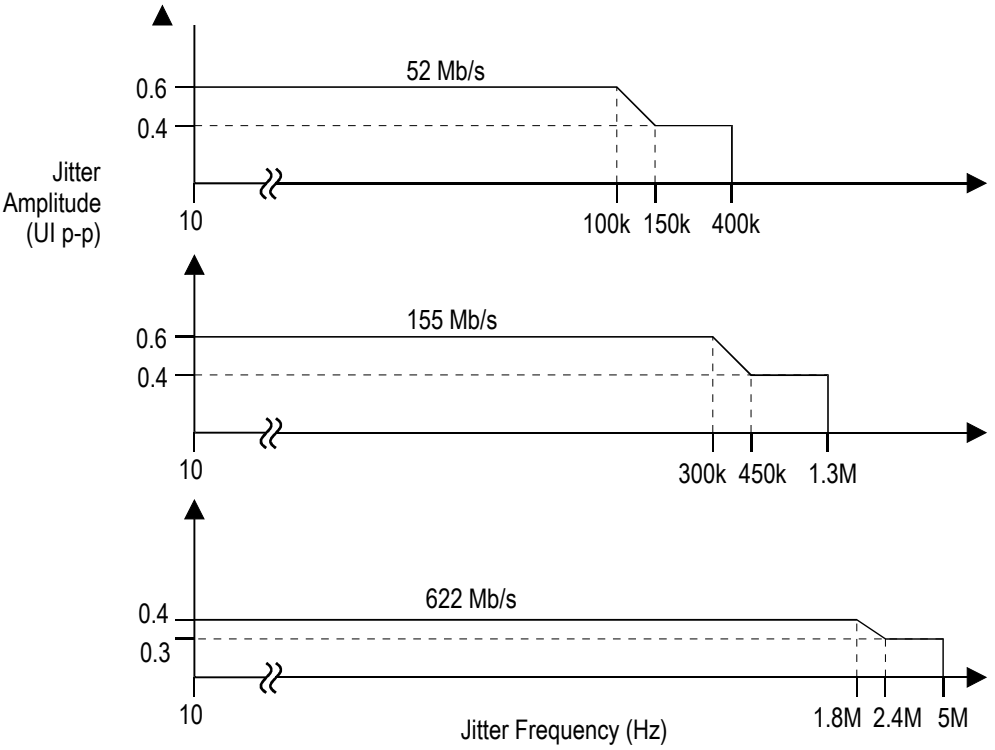


Figure A-3 Peak-to-peak Jitter Measurement Range — Fine Mode

RMS Jitter, Wide Mode

Frequency Response: First-order high-pass filter at the greater of 12 kHz and the selected high-pass filter. Third-order, maximally flat, low-pass filter at 1/125 of the receiver baud rate.

Range: Measures RMS value of jitter that meets the wide mode peak-to-peak jitter tolerance.

Resolution: 0.01 UI

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Jitter Amplitude Accuracy:
At 70 kHz for 52 Mb/s, 120 kHz for 155 and 622 Mb/s, 15 to 30°C

Y ± Z ± 3%

SONET/SDH Transmit Rate	Jitter Generation Amplitude Accuracy (UIrms)	
	Y	Z
52 Mb/s	0.01	0.01
155 Mb/s	0.01	0.01
622 Mb/s	0.02	0.02

Additional Error for other Jitter Frequencies (f_j) :

	Jitter Frequency Band	Additional Error
At 52 Mb/s	12 kHz < fj < 20 kHz	± 2%
	20 KHz < fj < 400 KHz	± 4%
At 155 Mb/s	12 kHz < fj < 65 kHz	± 2%
	65 KHz < fj < 1.3 MHz	± 4%
At 622 Mb/s	12 kHz < fj < 250 kHz	± 3%
	250 kHz < fj < 5 MHz	± 5%

Additional Error for 0 to 40°C: ± 3% ± 0.010 UIrms

RMS Jitter, Fine Mode

Frequency Response: First-order high-pass filter at the greater of 12 kHz and the selected high-pass filter. Third-order, maximally flat, low-pass filter at 1/125 of the receiver baud rate.

Range: Measures RMS value of jitter that meets the peak-to-peak requirements.

Resolution: 0.001 UIrms

Jitter Amplitude Accuracy:
At 70 kHz for 52 Mb/s, 120 kHz for 155 and 622 Mb/s, 15 to 30°C

Y ± Z ± X%

SONET/SDH Transmit Rate	Jitter Generation Amplitude Accuracy (UIrms)		
	Y	Z	X
52 Mb/s	0.001	0.001	±3
155 Mb/s	0.001	0.002	±3
622 Mb/s	0.003	0.002	±5

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Additional Error for other Jitter Frequencies (f_j) :	Jitter Frequency Band	Additional Error
At 52 Mb/s	12 kHz < fj < 20 kHz	± 2%
	20 KHz < fj < 400 KHz	± 4%
At 155 Mb/s	12 kHz < fj < 65 kHz	± 2%
	65 KHz < fj < 1.3 MHz	± 4%
At 622 Mb/s	12 kHz < fj < 250 kHz	± 3%
	250 kHz < fj < 5 MHz	± 5%

Additional Error for 0 to 40°C: ± 3% ± 0.002 UIrms

Selectable Parameters

Windowed Measurements

Window Range: 1 to 99 seconds or infinity (continuous)

Resolution: 1 second

High Pass Filters:	Frequency	Accuracy
At 52 Mb/s	10 Hz*	2 Hz
	12 kHz	± 20%
	100 Hz	± 20%
At 155 Mb/s	20 kHz	± 20%
	10 Hz*	2 Hz
	12 kHz	± 20%
At 622 Mb/s	500 Hz	± 20%
	65 kHz	± 20%
	10 Hz*	± 2 Hz
	12 kHz	± 20%
	1000 Hz	± 20%
	250 kHz	± 20%

* Applies to Wide Mode.

Jitter Events

Threshold Range: 0.000 to 16 UIpp

Resolution: 0.001 UIpp

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Transfer Functions

Range: + 3 to - 50 dB

Note: The maximum jitter amplitude received cannot exceed the maximum receiver input range.

Resolution: 0.01 dB

Accuracy (Wide Mode)

Jitter Amplitude (J_a)	Accuracy
At 52 Mb/s Data	0.6 UIpp < J_a < 15 UIpp	± 0.03 dB
52Mb/s Clock	0.6 UIpp < J_a < 15 UIpp	± 0.03 dB
At 155 Mb/s Data	0.6 UIpp < J_a < 15 UIpp	± 0.03 dB
155 Mb/s Clock	0.6 UIpp < J_a < 15 UIpp	± 0.03 dB
At 622 Mb/s Data	0.6 UIpp < J_a < 15 UIpp	± 0.05 dB
622 Mb/s Clock	0.6 UIpp < J_a < 15 UIpp	± 0.04 dB

Accuracy (Fine Mode)

Jitter Amplitude (J_a)	Accuracy
At 52 Mb/s Data	0.3 UIpp < J_a < 0.6 UIpp	± 0.03 dB
	0.15 UIpp < J_a < 0.3 UIpp	± 0.04 dB
52Mb/s Clock	0.3 UIpp < J_a < 0.6 UIpp	± 0.03 dB
	0.15 UIpp < J_a < 0.3 UIpp	± 0.04 dB
At 155 Mb/s Data	0.3 UIpp < J_a < 0.6 UIpp	± 0.03 dB
	0.15 UIpp < J_a < 0.3 UIpp	± 0.04 dB
155 Mb/s Clock	0.3 UIpp < J_a < 0.6 UIpp	± 0.03 dB
	0.15 UIpp < J_a < 0.3 UIpp	± 0.04 dB
At 622 Mb/s Data	0.15 UIpp < J_a < 0.4 UIpp	± 0.10 dB
622 Mb/s Clock	0.15 UIpp < J_a < 0.4 UIpp	± 0.06 dB

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Inputs

CLOCK Input:

Frequency Range: 51.84, 155.52, or 622.08 MHz ± 20 ppm
Termination: 50 ohms to -2V or ac-coupled
Logic levels: ECL
Connector: BNC

DATA Input:

Baud Rate: 51.84, 155.52, or 622.08 Mb/s ± 20 ppm
Format: NRZ
Logic levels: ECL
Termination: 50 ohms to -2V
Connector: BNC

Optical Input

Baud Rate: 51.84, 155.52, or 622.08 Mb/s ± 20 ppm
Power: -22 to -5 dBm
Wavelength: 1200 to 1600 nm

REF CLOCK Input

DS1: 1.544 Mb/s AMI, framed all ones
E1: 2.048 Mb/s HDB3, framed all ones
2MHZ: 2.048 MHz square wave
Connector:nWECO 310 (100 Ω balanced) BNC (75 Ω unbalanced)

REF CLOCK peak value

TERMINATE Mode (100 Ω balanced):
DS1: 3.0 Vp ±24%
E1: 3.0 Vp ±24%
2MHZ: 1.45 Vp ±31%

MONITOR Mode (100 Ω balanced):
DS1: 0.30 Vp ±24%
E1: 0.30 Vp ±24%
2MHZ: 0.145 Vp ±31%

TERMINATE Mode (75 Ω unbalanced):
E1: 2.37 Vp ±10%
2MHZ: 1.125 Vp ±34%

MONITOR Mode (75 Ω unbalanced):
E1: 0.237 Vp ±10%
2MHZ: 0.1125 Vp ±34%

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Outputs

REF CLOCK Output (rear panel)

Frequency: In the internal reference clock mode it is the same as the RECOVERED CLOCK output, but with jitter above 2 Hz removed,
In the external reference clock mode the frequency is the same the selected Receiver rate with the same ppm accuracy as the reference applied to the Receiver REF CLOCK input.
Logic Levels: ac-coupled, 0.4 to 1.2 Vpp**.**
Required Termination: 50 ohms to ground or a dc voltage.
Connector: BNC

RECOVERED DATA Output (rear panel)

Bit Sequence and Format: Same as signal applied to front panel DATA or OPTICAL input when active.
Logic Level: ECL
Connector: BNC

RECOVERED CLOCK Output (rear panel)

Frequency: Same as that of signal applied to front panel CLOCK input when active, or recovered clock from DATA or OPTICAL input when one of these are active.
Logic Level: ECL
Connector: BNC

DEMODULATED JITTER Output (rear panel)

Signal: Jitter demodulated from active input (DATA, CLOCK, or OPTICAL).
Sensitivity, Wide Mode: 0.1 V/UI ±10%
Sensitivity, Fine Mode: 2.0 V/UI ±10%
Connector: BNC

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BITS Wander (Option)

Wander Measurement

Frequency Range: 0 to 10 Hz (First order low-pass filter at 10 Hz ± 2 Hz.)

Amplitude Range: MTIE: 99999 ns
TDEV: 99999 ns

Amplitude Resolution: 1 ns

Amplitude Accuracy: ± 5%, ± 2 ns

Slew Rate: ± 80000 ns/s max.

MTIE Observation Time Range **Internal**: 0.1 to 99.9 seconds
External (using PC and optional software): 0.02 to 10^5 seconds.

TDEV Integration Time Range **Internal**: 0.1 to 99 seconds
External (using PC and optional software): 0.02 to 1000 seconds.

Wander, Noise Jitter, and Transient Generation (Phase Modulation at BITS/SETS OUT)

Noise Jitter: **Spectrum:** flat accross the band from 10 Hz to 150 Hz, 20 dB/dec rolloff at the cutoffs. Cutoff frequencies ±10%.
Pk-pk amplitude: 1000 ns ± 10%
rms value: 110 ns ±10%

Wander **Spectrum:** Pseudorandom noise with an 11.6 hour period and a spectrum shaped to match Bellcore standard waveforms shown in Figure A-4, within ±2 dB.
The masks are specified for the three standard patterns, as follows:
DS1: GR-1244-CORE, Fig. 4-2
DS1FILT: GR-253-CORE, Fig. 5-15
OCN: GR-253-CORE, Fig. 5-14

Transients **1000TRAN:** $A\ (1 - e^{-at})$, where
A = 1000 ns ±10%, and
a = 62.8 s^{-1} ±10%
1200TRAN: $A\ (1 - e^{-at})$, where
A = 1200 ns ±10%, and
a = 62.8 s^{-1} ±10%

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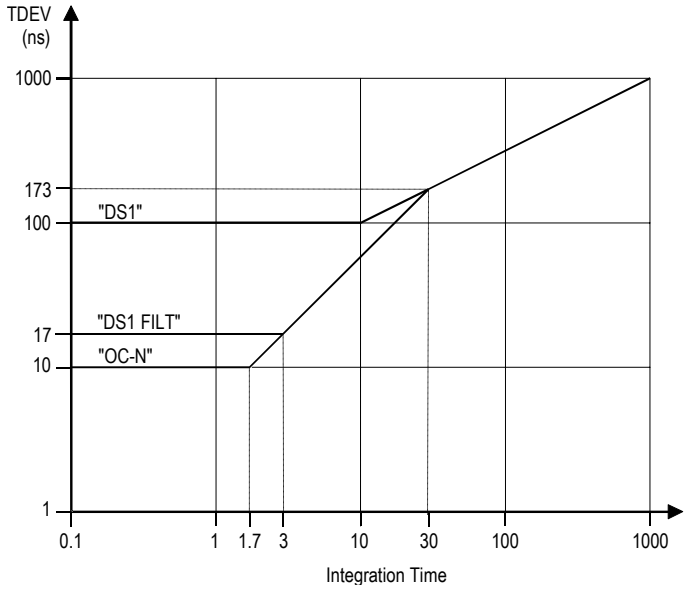


Figure A-4 TDEV vs. integration time plots for each of the three wander waveforms that can be generated by the SJ300E on the BITS OUT port.

BITS/SETS INPUT Interface

BITS IN Input

DS1: 1.544 Mb/s AMI, framed all ones
E1: 2.048 Mb/s HDB3, framed all ones
2MHZ: 2.048 MHz square wave
Connector: WECO 310 (100 Ω balanced)
BNC (75 Ω unbalanced)

BITS/SETS IN peak value

TERMINATE Mode (100 Ω balanced):
DS1: 3.0 Vp ±24%
E1: 3.0 Vp ±24%
2MHZ: 1.45 Vp ±31%
MONITOR Mode (100 Ω balanced):
DS1: 0.30 Vp ±24%
E1: 0.30 Vp ±24%
2MHZ: 0.145 Vp ±31%
TERMINATE Mode (75 Ω unbalanced):
E1: 2.37 Vp ±10%
2MHZ: 1.125 Vp ±34%
MONITOR Mode (75 Ω unbalanced):
E1: 0.237 Vp ±10%
2MHZ: 0.1125 Vp ±34%

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BITS/SETS OUT Interface

BITS OUT Output

DS1: 1.544 Mb/s AMI, framed all ones
E1: 2.048 Mb/s HDB3, framed all ones
2MHZ: 2.048 MHz square wave
Connector: WECO 310 (100 Ω balanced)
BNC (75 Ω unbalanced)

BITS/SETS OUT peak value

100 Ω balanced:
DS1: 3.0 V ±20%
E1: 3.0 V ±20%
2MHZ: 1.45 V ±31%
75 Ω unbalanced:
E1: 2.37 V ±10%
2MHZ: 1.125 V ±20%

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Physical and Environmental

Size:	6” high, 14.4” wide, 16.5” deep (15.24 cm x 36.6 cm x 42 cm)
Weight:	22 lbs (10 kg)
Power:	115 VAC ± 10% or 220 VAC ± 10% 47 to 63 Hz 100 VA maximum
Operating Temperature	5° to 40° C (41° to 104° F)

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Functional Verification

This section provides a performance test to verify the SJ300E Test Set. The unit under test must have a warm-up period of at least twenty minutes before testing begins.

Conventions

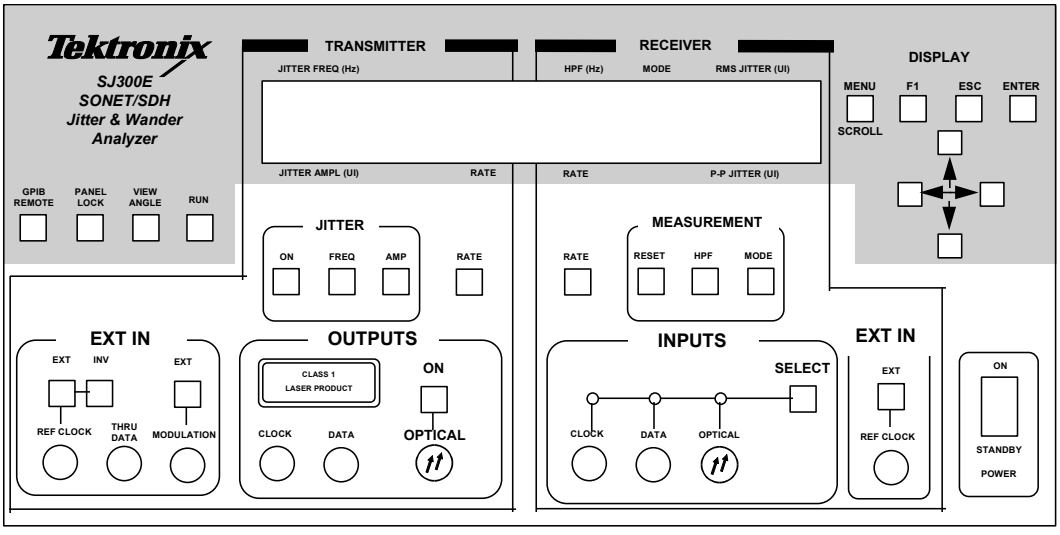


Throughout the procedure, the following conventions apply:

- All words in capital letters represent one of the following conditions:
  - the name of a button or LED on the front panel.
  - a selection that may be made on the LCD display.

- The procedure refers to the **Receiver side** and the **Transmitter side** of the front panel. The **Receiver side** refers to the right section of the front panel. The **Transmitter side** refers to the left section of the front panel. Refer to Figure 4-1 below for a representation of the front panel.

Note: The procedure assumes that you are proceeding through it in sequential order. Each section assumes the current setup reflects what existed at the end of the section before, unless otherwise stated.



Transmitter side *Receiver side*

Figure 4-1: SJ300E Front Panel

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Required Equipment

The equipment required for the Functional Verification of the SJ300E is listed below.

- Fiber optic cable - must be a single mode cable and have connectors matching those on the unit under test (Tek PN 174-1387-00 with Optical Connector Kit Tek PN 020-1885-00)
- 10 dB optical attenuator (Tek PN 119-5118-00)
- DS1 signal source (Tek CTS710 or equivalent)
- two DS1 cables with connectors matching those on the unit under test and those on the DS1 source (Switchcraft PN 18QH18)
- two 50 ohm BNC m-m coaxial cables (Tek PN 012-0057-01)

NOTE: Depending upon the configuration of your unit, you may not need all of the cables required above. The equipment list assumes you have optics and Bits Wander in the unit under test.

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Factory Default



The procedure requires the SJ300E to be in a known state before beginning. Therefore the first step of the Functional Verification is to Factory Default the unit. This sets the unit into a known set of conditions from which the Functional Verification will begin. To Factory Default the SJ300E follow the steps below.



WARNING: Always avoid exposure to the laser beam. Before power is applied to the SJ300E be sure that all laser outputs are covered with the screw cap provided.

1. Power off the SJ300E.
2. Press and hold down the AMP and the MENU buttons.
3. While holding down the buttons, power on the SJ300E.
4. Once the display is lit with the SJ300E name, release the buttons. The display should then flash "DEFAULT SETTING" and continue with the power up cycle. If the Factory Default message does not appear in the display, power off the SJ300E and repeat this procedure.

Now that the unit has been correctly defaulted, you may continue with the next section of the procedure.

NOTE: Allow the SJ300E at least thirty minutes of warm-up time before beginning the procedure. If the SJ300E is not allowed time to warm-up the measurements made may be inaccurate.

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Frequency and Rate

This section verifies that the clock frequency and the data patterns are functioning properly. It also verifies that the transmitter and receiver link properly. The fiber optic cable and the optical attenuator are required for this procedure.

1 . On the front panel, remove the protective caps from the optical output connector on the transmitter side and from the optical input connector on the receiver side.



WARNING: Before removing the protective caps, verify that the red LED within the ON switch is not lit. If it is lit, press the ON switch once or until the LED is no longer lit.

2. On the receiver side of the front panel, connect the optical attenuator to the optical input.
3. Connect one end of the fiber optic cable to the transmitter optical output and connect the other end of the fiber optic cable to the attenuator on the receiver optical input.
4. On the transmitter side of the front panel under the OUTPUTS heading, press ON once or until the red LED within the switch is lit. The laser output is now active.
5. On the transmitter side of the front panel, locate the EXT IN heading and verify that all LEDs within that section are off. If any are lit, press the switch once or until the LED turns off.
6. On the transmitter side of the front panel, press RATE until the display shows a rate of 52M.
7. On the transmitter side of the front panel, press FREQ under the JITTER heading once or until the green LED within the switch is lit. Using the cursors on the right side of the front panel, change the jitter frequency to 100000 (100 KHz).
8. On the transmitter side of the front panel, press ON under the JITTER heading once or until the green LED within the switch is off.
9. On the receiver side of the front panel, locate the EXT IN heading and verify that all LEDs within that section are off. If any are lit, press the appropriate switch once or until the LED turns off.
10. On the receiver side of the front panel, press MODE until the display shows the receiver in WIDE mode.
11. On the receiver side of the front panel, press RATE until the display shows a rate of 52M.
12. On the receiver side of the front panel under the INPUTS heading, press SELECT until the green LED over OPTICAL is lit. Observe that the INPUT CLOCK LOSS error on the right side of the display has been replaced by data.

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13. On the right side of the display, verify that the RMS Jitter shows 0.00UI and the P-P Jitter shows 0.00UI.
    Note: The P-P Jitter reading may drift as much as 0.04UI.
14. On the transmitter side of the front panel, press RATE until the display shows a rate of 155M.
15. On the transmitter side of the front panel, use the cursors to change the jitter frequency to 1 Hz.
16. On the receiver side of the front panel, press RATE until the display shows a rate of 155M.
17. On the right side of the display, verify that the RMS Jitter shows 0.00UI and the P-P Jitter shows 0.00UI.
    Note: The P-P Jitter reading may drift as much as 0.06UI.
18. On the receiver side of the front panel, press RATE until the display shows a rate of 622M.
19. On the transmitter side of the front panel, press RATE until the display shows a rate of 622M.
20. On the transmitter side of the front panel, use the cursors to change the jitter frequency to 5 MHz.
21. On the right side of the display, verify that the RMS Jitter shows 0.00UI and the P-P Jitter shows 0.00UI.
    Note: The P-P Jitter reading may drift as much as 0.09UI.

Wide Mode

At this point, you have determined that the unit links error-free with no jitter introduced. The next step is to introduce jitter and verify the jitter reading. The two BNC coax cables are also required for this section. There are thirty-seven steps in this section of the procedure.

1. On the front panel, connect a BNC coax cable between CLOCK of the transmitter and CLOCK of the receiver.
2. On the front panel, connect a BNC coax cable between DATA of the transmitter and DATA of the receiver.
3. On the transmitter side of the front panel, press RATE until the display shows a rate of 52M.
4. On the transmitter side of the front panel, press FREQ under the JITTER heading once or until the green LED within the switch is lit. Using the cursors on the right side of the front panel, set the frequency to 100 KHz.
5. On the transmitter side of the front panel, press AMP under the JITTER heading once or until the green LED within the switch is lit. Using the cursors, set the jitter amplitude to 1.00UI.
6. On the transmitter side of the front panel, press ON under the JITTER heading once or until the green LED within the switch is lit.
7. On the receiver side of the front panel, press RATE until the display shows a rate of 52M.

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8. On the receiver side of the front panel, press SELECT under the INPUTS heading once or until the green LED over CLOCK is lit.
9. On the receiver side of the front panel, press HPF under the MEASUREMENT heading until the display shows a HPF of 10 Hz.
10. On the right side of the display, the P-P Jitter should be 1.00UI. *Note: The P-P Jitter may drift as much as 0.06UI.*
11. On the right side of the display, the RMS Jitter should be 0.36UI ±0.03UI.

Note: For sinusoidal jitter, the RMS jitter may be verified by mathematical calculation. In short, divide the Jitter Amplitude in half and then multiply by 0.707 and the resulting number should be the RMS Jitter reading.

---

12. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over DATA is lit.
13. On the right side of the display, the P-P Jitter should be 1.00UI. *Note: The P-P Jitter may drift as much as 0.06UI.*
14. On the right side of the display, the RMS Jitter should be 0.36UI ±0.03UI.
15. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over OPTICAL is lit.
16. On the right side of the display, the P-P Jitter should be 1.00UI. *Note: The P-P Jitter may drift as much as 0.06UI.*
17. On the right side of the display, the RMS Jitter should be 0.36UI ±0.03UI.
18. On the receiver side of the front panel, press RATE until the display shows a rate of 155M.
19. On the transmitter side of the front panel, press RATE until the display shows a rate of 155M.
20. On the right side of the display, the P-P Jitter should be 1.00UI. *Note: The P-P Jitter may drift as much as 0.06UI.*
21. On the right side of the display, the RMS Jitter should be 0.36UI ±0.03UI.
22. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over DATA is lit.
23. On the right side of the display, the P-P Jitter should be 1.00UI. *Note: The P-P Jitter may drift as much as 0.06UI.*
24. On the right side of the display, the RMS Jitter should be 0.36UI ±0.03UI.
25. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over CLOCK is lit.
26. On the right side of the display, the P-P Jitter should be 1.00UI. *Note: The P-P Jitter may drift as much as 0.06UI.*
27. On the right side of the display, the RMS Jitter should be 0.36UI ±0.03UI.
28. On the receiver side of the front panel, press RATE until the display shows a rate of 622M.
29. On the transmitter side of the front panel, press RATE until the display shows a rate of 622M.

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30. On the right side of the display, the P-P Jitter should be 1.00UI.
    Note: The P-P Jitter may drift as much as 0.08UI.
31. On the right side of the display, the RMS Jitter should be 0.36UI ±0.04UI.
32. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over DATA is lit.
33. On the right side of the display, the P-P Jitter should be 1.00UI.
    Note: The P-P Jitter may drift as much as 0.08UI.
34. On the right side of the display, the RMS Jitter should be 0.36UI ±0.04UI.
35. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over OPTICAL is lit.
36. On the right side of the display, the P-P Jitter should be 1.00UI.
    Note: The P-P Jitter may drift as much as 0.08UI.
37. On the right side of the display, the RMS Jitter should be 0.36UI ±0.04UI.

Fine Mode

This section of the procedure ensures that the fine mode is working accurately. There are thirty-three steps in this section of the procedure.

1. On the transmitter side of the front panel, press RATE until the display shows a rate of 52M.
2. On the transmitter side of the front panel, press FREQ under the JITTER heading once or until the green LED is lit.
3. Using the cursors, set the jitter frequency to 100 KHz.
4. On the transmitter side of the front panel, press AMP under the JITTER heading once or until the green LED is lit.
5. Using the cursors, set the jitter amplitude to 0.50 UI.
6. On the receiver side of the front panel, press RATE until the display shows a rate of 52M.
7. On the receiver side of the front panel, press MODE under the MEASUREMENT heading until the display shows a mode of FINE.
8. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over CLOCK is lit.
9. On the receiver side of the front panel, press HPF under the MEASUREMENT heading until the display shows an HPF of 12K.
10. On the right side of the display, the P-P jitter should be 0.50 UI.
    Note: The P-P Jitter may drift as much as 0.06UI.
11. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.03UI.
12. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over DATA is lit.

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13. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.03UI.

Note: In Fine Mode, the P-P measurement is not available when using the Data input. However, the P-P measurement is available when using the Clock input. Since the last section proved that the Jitter measurements should be the same between the different input mediums, the P-P measurement found with the Clock input may be used as the standard for the RMS jitter reading when using the Data input.

14. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over OPTICAL is lit.
15. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.03UI.

Note: In Fine Mode, the P-P measurement is not available when using the Data or Optical input. However, the P-P measurement is available when using the Clock input.

16. On the receiver side of the front panel, press RATE until the display shows a rate of 155M.
17. On the transmitter side of the front panel, press RATE until the display shows a rate of 155M.
18. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over CLOCK is lit.
19. On the right side of the display, the P-P jitter should be 0.50 UI.
    Note: The P-P Jitter may drift as much as 0.06UI.
20. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.03UI.
21. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over DATA is lit.
22. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.03UI.
23. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over OPTICAL is lit.
24. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.03UI.
25. On the receiver side of the front panel, press RATE until the display shows a rate of 622M.
26. On the transmitter side of the front panel, press RATE until the display shows a rate of 622M.
27. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over CLOCK is lit.
28. On the right side of the display, the P-P jitter should be 0.50 UI.
    Note: The P-P Jitter may drift as much as 0.08UI.

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29. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.04UI.
30. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over DATA is lit.
31. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.04UI.
32. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over OPTICAL is lit.
33. On the right side of the display, the RMS Jitter should be 0.175 UI ±0.04UI.

High pass Filters

This section of the procedure ensures that the High Pass Filters (HPF) are operating correctly. There are twenty-one steps in this section of the procedure.

1. On the receiver side of the front panel, press MODE under the MEASUREMENT section until the display shows a mode of WIDE.
2. On the receiver side of the front panel, press HPF until the display shows an HPF of 10 Hz.
3. On the receiver side of the front panel, press RATE until the display shows a rate of 52M.
4. On the transmitter side of the front panel, press RATE until the display shows a rate of 52M.
5. On the transmitter side of the front panel, press AMP under the JITTER heading until the LED within the switch is lit.
6. Using the cursors, set the jitter amplitude to 1.00 UI.
7. On the transmitter side of the front panel, press FREQ under the JITTER heading until the LED within the switch is lit.
8. Using the cursors, set the jitter frequency to 10 Hz.
9. On the right side of the display, verify that the P-P Jitter should be 0.70 UI ±0.14UI.

Note: At this point, we are at the -3 dB down point of the High Pass Filter which is 30% down.

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10. On the receiver side of the front panel, press HPF under the MEASUREMENT heading until the display shows a HPF of 100Hz.
11. On the transmitter side of the front panel, press FREQ until the LED within the switch is lit.
12. Using the cursors, change the frequency to 100 Hz.
13. On the right side of the display, verify that the P-P Jitter should be 0.70 UI ±0.14UI.

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14. On the transmitter side of the front panel, press FREQ until the LED within the switch is lit.
15. Using the cursors, change the frequency to 14 Hz.
16. On the transmitter side of the front panel, press AMP until the LED within the switch is lit.
17. Using the cursors, set the jitter amplitude to 0.50 UI.
18. On the receiver side of the front panel, press SELECT under the INPUTS heading until the green LED over CLOCK is lit.
19. On the receiver side of the front panel, press MODE under the MEASUREMENT heading until the display shows a mode of FINE.
20. On the receiver side of the front panel, press HPF until the display shows a HPF of 14 Hz.
21. On the right side of the display, the P-P Jitter should be 0.35 UI ±0.07UI.

Note: At this point, we are at the -3 dB down point of the High Pass Filter which is 30% down.

OCn Wander

This section of the procedure runs an OCn Wander test to ensure its accuracy. This section requires two BNC cables, a DS1 cable, and a DS1 signal source. There are thirty-one steps in this section of the procedure.

Note: The optical options of the SJ300E are not required to run this test. Despite the name of this section, this test actually verifies the operability of the STSn electrical circuitry within the unit.

1. On the transmitter side of the front panel, press ON under the OUTPUTS heading once or until the LED within the switch is off. The laser is now disabled.
2. Remove the optical cable from the optical connectors on the front panel. Replace the optical caps over the optical connectors.
3. Remove the BNC cable from the data input and output connectors on the front panel.
4. On the rear panel, connect one end of a BNC cable to the REF CLK connector under the Rx Output heading and connect the other end to the REF CLOCK connector under the Tx EXT IN heading.
5. Verify that the BNC between the Tx Output and Rx Input CLOCK connectors is still attached and that the green LED over CLOCK is lit in the Rx INPUTS section.
6. Connect a DS1 cable between the DS1 signal source output and the REF CLOCK connector under the EXT IN heading on the receiver side of the front panel.
7. On the transmitter side of the front panel, press EXT REF CLOCK under the EXT IN heading until the red LED within the switch is lit.

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8. On the transmitter side of the front panel, press FREQ until the green LED within the switch is lit.
9. Using the cursors, set the jitter frequency to 1 Hz.
10. On the transmitter side of the front panel, press AMP until the green LED within the switch is lit.
11. Using the cursors, set the jitter amplitude to 1.00 UI.
12. On the transmitter side of the front panel, press RATE until the display shows a rate of 52M.
13. On the receiver side of the front panel, press EXT under the EXT IN heading until the red LED within the switch is lit.
14. On the receiver side of the front panel, press HPF until the display shows an HPF of 10 Hz.
15. On the receiver side of the front panel, press MODE until the display shows a mode of WIDE.
16. On the receiver side of the front panel, press RATE until the display shows a rate of 52M.
17. On the right side of the front panel, press MENU.
    Note: The display now shows different menu selections. The selections are chosen by using the cursors to select the desired option (the option becomes underlined when it is selected) and then pressing ENTER to make the selection.
18. Using the cursors, select MORE and then press ENTER.
19. Using the cursors, select WANDER and then press ENTER.
20. Using the cursors, select WAND MEAS and then press ENTER.
21. Using the cursors, select OCn and then press ENTER.
22. Using the cursors, select REF LEV and then press ENTER.
23. Using the cursors, select TERMINATE and then press ENTER.
24. Using the cursors, select REF SEL and then press ENTER.
25. Using the cursors, select DS1/SF and then press ENTER.
26. Using the cursors, select DISPLAY and then press ENTER.
27. You are now in the Wander results display screen. This is where the TDEV and MTIE measurements are displayed. The TAU and OBS (observation) settings must be changed still. However the cursor does not shift between them. The cursor now selects the desired value. In order to change between TAU and OBS, press F1.
28. Using the cursors and the F1 key, set OBS to 1.0 and then press F1 to set the TAU value.
29. Using the cursors and the F1 key, set TAU to 0.4 and then press RESET on the receiver side of the front panel.
    Note: Reset clears the old values and makes a new measurement.
30. Observe the values displayed for TDEV and MTIE. The MTIE value should be 19.6ns (16ns lower limit and 22ns upper limit) and the TDEV value should be 7.5ns (5ns lower limit and 10ns upper limit).
31. To return to the regular display, press ESC until the measurement screen appears.

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Bits Wander

This section of the procedure runs a Bits Wander test to ensure its accuracy. There are thirty-three steps in this section of the procedure.

NOTE: This test may only be run if the SJ300E contains a Bits Wander option.

1. Remove the BNC cable connected between the rear panel and the transmitter side of the front panel.
2. Remove the BNC cable from the clock input and output connectors on the front panel.
3. On the rear panel, connect a DS1 cable between the BITS IN connector and the BITS OUT connector.
4. On the transmitter side of the front panel, press EXT REF CLOCK under the EXT IN heading until the red LED within the switch is off.
5. On the right side of the front panel, press MENU.
   Note: The display now shows different menu selections. The selections are chosen by using the cursors to select the desired option (the option becomes underlined when it is selected) and then pressing ENTER to make the selection.
6. Using the cursors, select MORE and then press ENTER.
7. Using the cursors, select WANDER and then press ENTER.
8. Using the cursors, select WAND MEAS and then press ENTER.
9. Using the cursors, select BITS and then press ENTER.
10. Using the cursors, select WAND GEN and then press ENTER.
11. Using the cursors, select NONE and then press ENTER.
12. Using the cursors, select REF LEV and then press ENTER.
23. Using the cursors, select TERMINATE and then press ENTER.
24. Using the cursors, select REF SEL and then press ENTER.
25. Using the cursors, select DS1/SF and then press ENTER.
26. Using the cursors, select DISPLAY and then press ENTER.
27. You are now in the Wander results display screen. This is where the TDEV and MTIE measurements are displayed. The TAU and OBS (observation) settings must be changed still. However the cursor does not shift between them. The cursor now selects the desired value. In order to change between TAU and OBS, press F1.
28. Using the cursors and the F1 key, set TAU to 6.7 and then press F1 to set the observation value.
29. Using the cursors and the F1 key, set OBS to 20.0 and then press RESET on the receiver side of the front panel.
    Note: Reset clears the old values and makes a new measurement.

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At this point, the TDEV and MTIE measurements should both show values of zero. The Bits Wander option has a built in 1/8Hz sine wave wander pattern of 1000ns peak-to-peak which you need to turn on. To start this pattern, the following buttons must be pressed in sequence: RIGHT CURSOR, F1, LEFT CURSOR, F1, RESET. The internal test pattern is now active.

30. On the receiver side of the front panel, press reset. The values of TDEV and MTIE should be rising. After twenty seconds, you should see the measured values of TDEV and MTIE.
31. Observe the values displayed for TDEV and MTIE. The MTIE value should be 4096ns (3891ns lower limit and 4301ns upper limit) and the TDEV value should be 1365ns (1297ns lower limit and 1434ns upper limit).
32. Once the test is completed and the results verified, you must turn off the internal test pattern. Once the pattern is turned off, the values of TDEV and MTIE should be zero.

To turn off the internal test pattern, the following buttons must be pressed in sequence: RIGHT CURSOR, F1, LEFT CURSOR, F1, RESET. The internal test pattern is now disabled.

33. To return to the regular display, press ESC until the measurement screen appears.

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