



# ST2400A STM-16/OC-48 2.4 Gbit/s Test Set for DWDM Applications



The ST2400A is the first STM-16/OC-48 test product optimized for testing 2.488 Gbit/s Dense Wavelength Division Multiplexed (DWDM) client systems. Its compact size, flexibility of configuration, choice of operating modes, unique I/O features, extensive software driver support, and range of error and defect inject capabilities make it particularly effective for DWDM system test during production and installation. It can also be used in non-DWDM SDH and SONET test applications.

The ST2400A is payload-independent; external SDH/SONET 155 Mbit/s optical and electrical and 622 Mbit/s optical signals are supported in add/drop mode. The ST2400A can be ordered as an ST2400A Transceiver, as an ST2400R Receiver, or as an ST2400T Transmitter to meet a wide range of application needs economically.

The ST2400A Transceiver version can transmit and receive STM-16/OC-48 signals. The ST2400A has the ability to receive, generate and modify an STM-16c/OC-48c signal. The transmitter section can internally generate a 2.4 Gb/s signal or multiplex the higher-rate signal from STM-1 or STM-4 (OC-3 or OC-12) signal inputs. The ST2400A can also accept a STM-16/OC-48 signal in through mode and regenerate it. The receiver section receives an STM-16/OC-48 signal, demultiplexes it, and can drop out either the STM-1 or STM-4 (OC-3 or OC-12) signal as required.

The Transmitter version can generate and transmit the STM-16/OC-48 signal from an internal source, or multiplex the higher-rate signal from either STM-1 or STM-4 (OC-3 or OC-12) signal inputs. In the case of STM-4c and STM-16c (OC-12c or

Optimized for Dense Wavelength Division Multiplexing (DWDM) Transmission Quality Testing

Available in Transceiver, Receiver and Transmitter Only Versions

Tributary Testing of STM-64/OC-192 Systems

Easily Switchable to/from SDH/SONET

Optical Tributary Payload Add/Drop with Payload Independence

External Sync Reference for Timing Coordination

Active Through Mode to Simulate Fault Conditions on Installed Networks

Compact and Light Weight for Production and Installation Test

A Variety of Optics Options, Including No Optics

Emulates Network Elements Transmitting Live Traffic

OC-48c, the ST2400A can either generate four STM-4c (OC-12c) tributary signals with PRBS payloads inside an STM-16/OC-48 envelope, or generate three tributary payloads of PRBS STM-4c (OC-12c) and insert a fourth from outside the tributary interface (which could contain IP traffic). In the case of STM-16c/OC-48c, the entire (single) payload is PRBS. All applicable SDH/SONET Path Pointer Bytes (H1/H2/H3) are set correctly to indicate the type of payload being carried (STM-4c/STM-16c, OC-12c/OC-48c, etc.).

The Receiver version can receive and demultiplex the STM-16/OC-48 signal and drop either the STM-1 or STM-4 (OC-3 or OC-12) signal to an auxiliary test set, as required.

ST2400A can accept zero, one or two factory-installed 2.488 Gb/s laser transmitter modules and/or zero or one APD receiver module (also referred to as I/O modules). One type of laser transmitter – direct modulated (DM) – is available.

The ST2400A provides electrical input and output clock and data interfaces operating at 2.488 Gb/s. Base Transceiver configuration provides 2.488 Gb/s electrical interfaces and 155/622 Mb/s optical and electrical add/drop tributary interfaces. Transmitter configurations do not include 155/622 optical and electrical drop interface. Receiver configurations do not include 155/622 optical and electrical add interface.

The user can individually enable/disable laser #1 (if installed), laser #2 (if installed), and electrical outputs. Multiple outputs can be simultaneously active.

**NOTE:** RX will not measure correctly if both TX lasers are enabled and looped back to RX (since RX contains broadband optical detector which is not wavelength-selective).

### Three Operating Modes

The ST2400A Transceiver features three operating modes to provide the flexibility you need to test today's advanced STM-16, OC-48, STM-64, OC-192, and DWDM systems. Analysis is done at the SDH/SONET Regenerator Section (Section), Multiplexer Section (Line) and Path levels independent of the payload.

#### Standalone (Internal) Mode

Where payload testing is not required, or an external 155 or 622 Mbit/s tributary signal is not available, the ST2400A can operate independently. An internally-generated 2.488 Gbit/s test signal provides full error performance analysis and reporting of the 2.488 Gbit/s signal. 1.5 Mbit/s, 2 Mbit/s, and 2 MHz external reference clock signals or an internal clock signal can be used to time the transmitted signal in internal mode. Internal mode is ideal for DWDM SDH/SONET client system testing, where transmission quality test time and cost can be lowered through the use of a high-speed signal.

#### Active Through Mode

Through Mode allows overhead bytes to be passed or edited while regenerating the received 2.488 Gbit/s signal. Alarms and errors can also be added to the received signal prior to retransmission. This mode is especially valuable for testing framing synchronization and protection switching, and for diagnosing system interoperability problems. 155 or 622 Mbit/s signals can be dropped from the receiver for path level analysis on another tester.

#### Add/Drop (External) Mode

In this mode, the ST2400A transmitter creates the 2.488 Gbit/s signal from an externally added 155 or 622 Mbit/s SDH or SONET signal. The external signal can be

copied into one or all available payload envelopes in the 2.488 Gbit/s signal. The ST2400A receiver performs 2.488 Gbit/s level testing and, as required, drops a tributary signal for path level analysis by a Tektronix CTS 850, CTS 710, ST112, or any other 155 or 622 Mbit/s SDH or SONET test set. Previous investment in lower speed test equipment is preserved.

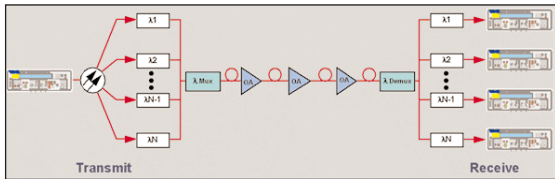
#### Emulation of Real SDH/SONET Systems

The ST2400A provides two features that let the tester emulate real network conditions. First, a  $2^{23}-1$  PRBS pattern can be generated to produce a synchronous signal that behaves like live traffic. Second, the optical receiver's decision threshold can be offset to emulate older SDH/SONET network elements that are deployed in the field and which can create interoperability issues when connected to optically amplified systems such as DWDM. By controlling what the ST2400A considers a "one" or a "zero," true system transmission quality can be determined; installed behavior predicted; and, optimized in the factory.

#### DWDM Parallel Channel Test

Because DWDM systems carrying SDH/SONET clients are expected to operate at a transmission quality level of  $10^{-12}$  BER or better per ITU-T G.692 and Bellcore GR-2918, per channel transmission quality test cycles can easily exceed twelve hours. By testing all channels in parallel, system test time can remain constant as channel counts increase from eight to sixteen to thirty two and beyond. The ST2400R Receiver provides the means for highly cost-effective simultaneous multi-channel analysis. A Receiver can measure the transmission performance of each channel of the multi-wavelength system, while a ST2400T Transmitter

is used to generate the 2.488 Gbit/s signal, which can be split to multiple inputs of the DWDM system. The Parallel Channel Test is illustrated in the figure below.



### Help in Lowering per Channel Test Time

In addition to using the ST2400A for effective parallel channel test, the product can also help lower per-channel test time.

### Accelerating Low BER Measurement through Extrapolation

Measuring the low error rates that DWDM systems promise can take a minimum of 11 hours at 2.488 Gbit/s. The ST2400A provides a way in some applications to save test time by extrapolating to low BERs through offset of the optical receiver's decision threshold.

### Improved Test Convenience

If the system has been characterized in design, then many of these tests need not be repeated further down the value chain. The power of the ST2400A is focused on system transmission quality verification during production and installation. For production test, a full remote command set plus LabView™ and LabWindows™ CVI, HP-VEE™ drivers help manufacturing engineers create automated test suites quickly and efficiently. A "pause" feature enables tests to be suspended while rearrangements are made, which allow long-term testing to proceed. Tests can also be automatically resumed after lost power is restored, again saving retest time. Finally, by using the ST2400A in constant wavelength (unmodulated) mode, optical tests such as OSNR and spectral width can be

done without the need for an additional laser source.

### 2.488 Gbit/s Interface Choices

For manufacturers and installers of DWDM equipment, the ST2400A offers a low-dispersion, long reach 1550 nm laser option that provides enhanced performance. In addition, the low-dispersion optics can be ordered at specific ITU-T G.692 grid frequencies to meet precise requirements. If low-dispersion optics are not required, the ST2400A long-reach 1310 nm optics can be ordered. A dual 1310/1550 nm wavelength option is provided for customers who need flexibility. Finally, a customer can choose to configure units with only 2.488 Gbit/s electrical I/O. This feature is provided for applications such as laser-driver module tests where optics are not required.

### ± 1 nm Wavelength Tuning

The ST2400A provides the capability to "tune" the wavelength of its 1550 nm laser from its nominal value up or down by one nanometer. This feature allows the user to check adjacent channels on the G.692 frequency grid without purchasing additional specific wavelength lasers. This feature would typically be useful in testing DWDM systems without transponders or in testing transponder-based systems when the transponder is not part of the test set up.

### STM-64/OC-192 Tributary Testing

Testing 10 Gbit/s systems at the line rate requires very expensive test equipment. These systems can be tested more economically at the 2.488 Gbit/s tributary rate using the ST2400A.

### Adheres To The Latest Standards

The ST2400A complies with the latest ITU-T, ANSI, ETSI, and Bellcore recommendations and standards.

### Capabilities

- STM-16 SDH RS and MS Testing/OC-48 SONET Section and Line Testing
  - B1, B2, B3 Error Generation
  - B1, B2, B3 Error Measurement
  - Path REI, Path Alarms, Pattern Bit Error
  - J0, J1 Capture and J0 Edit
  - RS and MS Alarm Generation
  - RS and MS Alarm Detection
  - RS and MS Layer Alarm and Error Generation
- VC4 PRBS Mappings/STS1, STS3c PRBS Mappings
- Ability to receive, generate and modify an STM-4c/STM-16c (OC-12c/OC-48c) Payload (Opt. 41)
- External Clock Input (2 Mbps/2 MHz) or 1.5 Mbps
- User-selectable power failure recovery mode
- Electrical Offset of Receiver Decision Threshold
- ± 1 nm wavelength tuning (applies only to 1550 nm lasers)
- CW laser source mode
- 2.488 Gb/s electrical I/O
- 3-year warranty
- Automatic Optical Receiver shut-off if power exceeds maximum rating
- Specific wavelength G.692 lasers in 1550 nm region
- Portable – 11.4 kilograms (25 pounds) maximum weight
- A simple menu system
- Tributary Access at 155 Mb/s or 622 Mb/s
- Easily software switched between SDH and SONET
- Integrates with the CTS 750 or CTS 850 or ST112 for complete "all-rate" SDH or SONET analysis
- Wide optical range:
  - 3 dBm to -2 dBm Typical Output Power
  - -29 dBm to -10 dBm Receiver Sensitivity

- Through Mode with Overhead Editing, Error, and Alarm Injection
  - Direct user download of software updates
  - CCITT/ITU G.708, G.709 and GR-253-CORE framing
  - Complete Remote Control
    - RS-232 and GPIB ports, and standard printer interfaces
    - LabView, LabWindows CVI, and HP Vee
  - Standard tributary interfaces
    - STM-1e 155 electrical/ STS-3 155 electrical
    - STM-1 155 optical/ OC-3 155 optical
    - STM-4 622 optical/ OC-12 622 optical
  - Interface to Regenerator Section Terminating Element and Multiplexer Section Terminating Element and other test equipment
- With firmware version 5.0 (Opt. 42), the following new features are added to capabilities of the ST2400A:
- Payload bit error injection/B3 Injection on the TX side (TSE)
  - B3, Path-REI, Payload bit error count measurement on the RX side (TSE ES, SES (SDH only))
  - Alarm signal status (RX)
    - Path RDI, Loss of Pointer, Path AIS, Path REI
  - Path Overhead Monitor (RX) – Displays value of bytes: J1, B3, C2, G1, F2, H4, Z3/F3, Z4, N1
  - For the path overhead, C2 byte added at TX (Path Signal Label C2) – Identifies High Order Path Label Unequipped and High Order Path Label Mismatch. C2 byte can be set to any value from 0x00 to 0xFF.
  - B3 Path Analysis/J1 Path Trace (displayed as ASCII text).
  - TX Patterns. PRBS 2<sup>31</sup>-1 and 2<sup>31</sup>-1 Inverted; Fixed (00 to FF)
  - Pointers. Pointer Value displayed (0 to 782). Pointer Measurement Counts for Positive Pointer Justifications, Negative Pointer Justifications, New Data Flag (NDF)
  - Extended capability of View History button
  - APS Switch Time measurement (LOF, LOS durations). APS testing can be performed by causing protection switch via control of K1/K2 bytes and then displaying time to restore frame synchronization. Highly-accurate LOF timer enables this test to be performed with <1 ms resolution.
  - RX mapping (PRBS 2<sup>23</sup>-1 and 2<sup>23</sup>-1 Inverted; PRBS 2<sup>31</sup>-1 per ITU-T O.151 and 2<sup>31</sup>-1 Inverted per ITU-T O.181, User-defined byte 0x00 to 0xFF)

#### Applications

The ST2400A meets the needs of development, manufacturing, and service engineers by providing the capabilities for:

- System interrogation and conformance testing
- Manufacturing Production Testing
- Network Integrity testing
- Network Performance monitoring
- Network Troubleshooting

### ST2400A Transmitter Specifications

#### 2.488 GBIT/S LONG REACH LASER OPTIONS 1310/1550 WAVELENGTH

- 1310 nm ± 6 nm/1550 nm ± 6 nm**
- Power** – 0 dBm (typical).
- Spectral Width** – 1 nm modulated mode (maximum), 0.3 nm (typical).
- Wavelength Stability** – ≤ ± 0.1 nm (minimum).
- Wavelength Adjustment Range** – > ± 1 nm (uncalibrated).
- Side Mode Suppression Ratio** – 30 dB.
- Output Power Variation, CW Mode** – ± 0.1 dB (typical).
- Output Power Variation, Between Modulated Mode and Unmodulated Mode** – ± 0.5 dB (typical).
- Extinction Ratio, Modulated Mode** – > 10 dB.
- Optical Waveform** – per ITU-T G.691/G.957 and Bellcore GR-253-CORE/GR-2918-CORE.
- Safety Classification** – Class IIIB per 21 CFR 1040.10; Class IIIA per IEC 825-1.
- Category** – SDH L-16.1/SONET LR-1.
- 1550 Dispersion Budget** – 1800 ps/nm; 2 dB power penalty.
- Category** – SDH L-16.2/SONET LR-2.

#### 2.488 GBIT/S ELECTRICAL OUTPUTS

Single-ended clock and data interfaces; unterminated ECL; requires connection to an AC-coupled 50 Ω termination through a bias-tee network supplying current for the ECL outputs; falling edge of output clock coincides with data edge crossing ±100 ps; SMA connectors. ECL specifications: At high output voltage, 25°C, -0.98 V (min). At low output voltage, 25°C, -1.95 V (min) and -1.63 V (max).

#### TRIBUTARY ADD INTERFACE

Inputs monitored for LOS and LOF, status displayed on front-panel LEDs.

155 Mbit/s Electrical:  
75 Ω BNC CMI per ITU-T G.703 and Bellcore GR-253-CORE.

155/622 Mbit/s Optical:  
Wideband input: 1250 nm to 1600 nm.  
Minimum sensitivity: -28 dBm at 10<sup>-10</sup> BER.  
Overload limit: -8 dBm at 10<sup>-10</sup> BER per ITU-T G.957 and Bellcore GR-253-CORE.

**PAYLOAD GENERATION**

2.488 Gbit/s signal framing and multiplexing format to meet ITU-T G.707 and Bellcore GR-253-CORE.

**Output Timing –**

**INT mode:** Generated from internal 2.488 Gbit/s  $\pm 20$  ppm clock or external 1.544 Mbit/s, 2.048 MHz, or 2.048 Mbit/s ref clock.

**THRU mode:** Generated from clock recovered from 2.488 Gbit/s input.

**EXT mode:** Generated from clock, recovered from 155/622 Mbit/s add input.

**OUTPUT SIGNAL STRUCTURE**

**1. Active THRU (Through) Mode**

Regenerated with recomputed B1, B2 but otherwise unaltered or with user-modified overhead, added defects, or added errors from the received 2.488 Gbit/s input signal using the recovered clock. Jitter transfer from 2.488 Gbit/s input to output is filtered by a 1 MHz (nominal) bandwidth PLL (typical 0.3 dB jitter transfer).

**2. EXT (Terminal) Mode**

155 or 622 Mbit/s tributary signals are added from an external SDH or SONET test set. 2.488 Gbit/s signal is generated using clock recovered from the add input. Tributary signals added into any 1 of 16 (155 Mbit/s) or any 1 of 4 (622 Mbit/s) payload locations or duplicated to fill all payload locations. Unused payload locations are VC-4 structured STM-1 (SDH mode) STS-3C structured STS-3, or 3 x STS-1 (SONET mode) structured with unequipped path overhead (J1=0, C2=0, correct B3, remainder of path overhead =0). The remainder of the channel payload is bulk-filled with user-selected test pattern (all Zeros, ITU-T 0.181 2<sup>23</sup>-1 PRBS, or 2<sup>23</sup>-1 PRBS). In "all" mode, the tributary overhead is copied to fill all the 2.488 Gbit/s overhead; in "single" mode, one copy is made for the selected location and all other locations are filled with "unequipped" channel overhead and user-selected test patterns (all Zeros, ITU-T 0.181 2<sup>23</sup>-1 PRBS, or 2<sup>23</sup>-1 PRBS).

**3. INT (Standalone) Mode**

2.488 Gbit/s signal is VC-4 structured STM-1 (SDH), STS-3C structured STS-3, or 3 x STS-1 (SONET) structured and filled with test patterns as in External Mode. Default overhead: A1 and A2 are set to F6H and 28H, respectively; J0 byte is set to 1; 15 Z0 bytes and 32 National Use bytes (formerly C1 bytes) are numbered from 2 to 48 (decimal); H1 is set to 6AH and H2 is set to 0AH for valid STS/STM pointers.

B1 contains computed B1 BIP and B2 contains computed B2 BIP; all other overhead set to 00H.

J1 and C2 in path overhead set to 0. B3 BIP set to correctly computed parity. All other path overhead set to 00.

**OVERHEAD EDITING**

Overhead bytes in STS-1, column 1 can be independently set as hex values in the range 00 to FF.

Settable bytes: J0, E1, F1, D1-D3, K1, K2, D4-D12, S1, M1, E2.

Following bytes may not be directly edited: A1, A2, B1, B2, B3, H1-H3.

Clear-text coding and dedicated menus for S1 (Synchronization Status Byte) and K1/K2 (MSP – Multiplex Section Protection/APS – Automatic Protection Switching).

**Active THRU (Through) Mode:** Overhead bytes are regenerated from the 2.488 Gbit/s input and can be selectively overwritten. B1 and B2 are recalculated prior to transmission.

**EXT (Terminal) Mode:** All bytes except for B1 are inserted from the tributary into one or all envelopes. Settable bytes can be selectively overwritten. B1 and B2 are recalculated prior to transmission.

**INT (Standalone) Mode:** All bytes are generated internally. Settable bytes can be selectively overwritten.

**DEFECT/ALARM GENERATION – LOS, LOF, MS-AIS/AIS-L, MS-RDI/RDI-L**

Multiple defects and alarms can be set for simulation of real network conditions.

**Duration Control –**

LOS: 1 to 127  $\mu$ s (1 $\mu$ s resolution).

LOF, MS-AIS/AIS-L, MS-RDI/ RDI-L: 1 to 127 frames (1 frame resolution).

All: 0.1 to 9.9 s (0.1 s resolution).

Continuous or off.

Interval Control: Repeat On/Off.

Injection time: 0.1 to 9.9 s.

Idle time: 1.0 to 30 s.

Resolution (all): 0.1 s.

**ERROR GENERATION B1, MS-REI/REI-L, BIT**

**Error Control –**

B1 (BIP-8): Single error or continuous error rate, 2.5E-5 to 0.1E-9.

B2 (BIP-24): Single error in one or all channels or continuous error rate, 1.0E-3 to 0.1E-9.

B3: Single error in one or all channels or continuous error rate 1.0E-3 to 0.1E-9.

MS-REI/ REI-L: M1 byte is overwritten. 0 to 255 errors per frame inserted in a single frame, continuously, or for a duration of 0.1 to 9.9 s; Resolution, 0.1 s.

Bit errors in selected STM-1/STS-1 tributary or across 2.488 Gbit/s frame.

Single error or continuous error rates, 1.0E-3 to 0.1E-9.

Interval Control: Repeat On/Off.

Injection time: 0.1 to 9.9 s.

Idle time: 1.0 to 30 s.

Resolution (all) : 0.1 s.

**Other Interfaces –**

Clock Sync Output: 1/8 rate, AC-coupled, 300 mV<sub>p-p</sub> (minimum), SMA connector.

Frame Sync Output: 50  $\Omega$ , ECL, 25.8 ns pulse width, BNC connector.

Event Trigger Output: 50  $\Omega$ , TTL, 25.8 ns pulse width, BNC connector.

Pulse transmitted for each alarm, error, or overhead event (selectable).

## ST2400A Receiver Specifications

### 2.488 GBIT/S OPTICAL RECEIVER:

**Type** – InGaAs APD.  
**Input tolerance** –  $\pm 20$  ppm.  
**Wavelength** – 1250-1600 nm.  
**Sensitivity** – -28 dBm minimum at  $10^{-12}$  BER.  
**Overload** – -10 dBm at  $10^{-12}$  BER.  
**Input reflectance** – Better than -27 dBm.  
**Threshold offset** – 100 settings, uncalibrated. Initial setting optimized by factory Range:  $\pm 150$  mV (typical).

### 2.488 GBIT/S ELECTRICAL INPUTS

AC-coupled 50  $\Omega$  terminated ECL clock and data interfaces; allow ST2400A to operate error-free when electrical outputs are looped to electrical inputs through a bias-tee termination; data valid when sampled within  $\pm 50$  ps of center of data eye; SMA connectors. ECL specifications: At high input voltage, 25°C, -0.98 V (min). At low input voltage, 25°C, -1.95 V (min) and -1.63 V (max).

### RECEIVER TIMING

**Analyzer Clock Recovery** –  
Input Frequency Range: 2.48832 Gb/s  $\pm 20$  ppm.  
Input Jitter Tolerance: Meets Bellcore GR-253-CORE and ITU G.825.  
**155/622 Mbit/s Output Timing** – Derived by dividing the clock recovered from the Analyzer 2.488 Gb/s input.  
**Tributary Drop Interfaces** – Allows payload analysis using an external test set such as the Tektronix CTS 850, CTS 710, or ST112.  
155 Mbit/s Electrical:  
75  $\Omega$  BNC CMI per ITU-T G.703 and Bellcore GR-253-CORE (at 25°C  $\pm 5^\circ$ C).  
155/622 Mbit/s Optical:  
Wavelength: 1310 nm (1273-1355 nm).  
Minimum average power: -15 dBm.  
Maximum average power: -8 dBm.  
Category: I-4.1/IR-1.  
Type: Class 1 laser per IEC 825-1 and 21CFR 1040.

### PAYLOAD ACCESS

A selected tributary (1 of 16 155 Mbit/s or 1 of 4 622 Mbit/s) is dropped to an external SDH or SONET test set, using the clock recovered from the 2.488 Gbit/s input. Drop Overhead: B1, B2 are recalculated; H1-H3 are copied from the selected channel. For 155 Mbit/s signal, the remainder of overhead is copied from the first three columns of the 2.488 Gbit/s input. For 622 Mbit/s signal, the first three columns of the drop signal are copied from the first three columns of the 2.488 Gbit/s signal; the last nine columns of the remainder are copied from the selected drop channel. Jitter transfer from 2.488 Gbit/s receiver to drop interface is filtered by a 1 MHz (nominal) bandwidth PLL, and divided down to the drop rate. Overhead Display: 2.488 Gbit/s, column 1 of the first STM-1 or STS-3/3c transport overhead bytes can be displayed as hex values. Displayed bytes: A1, A2, B1, E1, F1, D1-D3, H1-H3, B2, K1, K2, D4-D12, S1, E2. Clear-text decoding (for easy interpretation of G.707/GR-253-CORE message codes): S1 (Synchronization Status Byte), K1/K2 bytes (APS – Automatic Protection Switching/MSP – Multiplex Section Protection).

Defect and Alarm Measurement: LOS, LOF, OOF, AIS, MS-RDI/RDI-L. Status: Displayed as front-panel LEDs with "history" button.

### ERROR MEASUREMENT

**SDH:** B1, B2, B3, MS-REI per G.821 and G.826; unavailability per G.827. Errored Blocks, Errored Seconds, Severely Errored Seconds, Unavailable Ratio, Unavailable Seconds, Errored Seconds Ratio, Severely Errored Seconds Ratio, Consecutive Severely Errored Second Periods, Background Block Errors, Background Block Error Ratio, Total Count, Available Errored Blocks, Available Errored Seconds, Available Background Block Errors, Available Severely Errored Seconds, BER.  
**SONET:** B1, B2, B3, REI-L per GR-253-CORE. Errored Seconds, Severely Errored Seconds, BER, Total Count.  
B1, B2, MS-REI/REI-L Status: Displayed as front panels LEDs with "history" button.

### ERROR REPORTING

**Test Period** –  
Manual start/stop, timed start/stop, and repeated gate.  
Duration: 1 s to 99 days.  
Resolution: 1 s.  
**Report Printout** –  
Comprehensive printout of alarms, errors, performance analysis, test start/stop/pause time.  
Print on event, at end of test, both, or on demand.  
**Event Log** –  
Previous tests held in memory for subsequent printing.  
Alarms, error counts and S1 (SSM) byte changes logged per second, output to printer or PC as required.

### REMOTE CONTROL

**Interfaces** –  
IEEE-488.2 (GPIB) and RS-232.  
Command Set: High-level ASCII.  
**Printer** –  
Interface: DB-25 translation of Centronics.  
Signal: TTL.  
Description: Byte serial ASCII printer interface. Follows industry standard.  
Connector: DB-25.  
**Drivers** –  
National Instruments LabWindows CVI or LabView; Hewlett-Packard HP-VEE.

### EXTERNAL REFERENCE TIMING INTERFACES

**SDH:** 2.048 Mbit/s or 2.048 MHz SETS input per G.703, except that ST2400A input requires  $\pm 40$  ppm. BNC connector on front panel.  
**SONET:** 1.544 Mbit/s BITS input per ANSI T1.101-1994, except that ST2400A input requires  $\pm 40$  ppm. Bantam connector on rear panel.

**ST2400A**  
**General**  
**Characteristics**

**ENVIRONMENTAL**

**Temperature –**

Operating: 0 to +40°C.  
Nonoperating: –20 to +60°C.

**Electromagnetic Compatibility –**

EC Council Directive 89/336/EEC. Low Voltage Directive 73/23/EEC.  
Emissions Standard EN50081-1: Class A for radiated and conducted emissions.

**Laser Safety –**

Laser output keyswitch interlock, remote interlock, and front-panel LED indication ensure operator safety.  
2.488 Gbit/s optical output: Class IIIA per IEC 825-1; Class IIIB per 21 CFR 1040.  
155/622 Mbit/s optical output: Class I per IEC 825-1 and 21 CFR 1040.

**Power –**

Source Power  
Voltage Requirements (auto-ranging):  
110 (90 to 135) VAC or 220 (180 to 270) VAC.  
Line Frequency: 47 to 63 Hz.  
Power Consumption: 250 Watts maximum.

**CONNECTORS**

**Optical Connectors –** Customer choice of one (1): FC/PC, SC/PC, or ST/PC.

**PHYSICAL CHARACTERISTICS**

<b>Dimensions</b>	<b>cm</b>	<b>in</b>
Height	11.6	4.5
Width	37.2	14.5
Depth	44.9	17.5

<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	11.4	25

**Recommended Calibration Interval –**  
1 year.

**Standard Warranty –** 3 years parts and labor.

## ST2400A Ordering Information

### ST2400A STM-16/OC-48 SDH/SONET Transceiver

**Includes:** 2.488 Gbit/s Transmitter and Receiver with electrical clock and data, tributary add/drop, power cord, user manual.

**Opt. 13** – Add wideband receive optics and 1310 nm intermediate-reach 2.488 Gbit/s laser.

**Opt. 15** – Add wideband receive optics and 1550 nm long-reach 2.488 Gbit/s laser.

**Opt. 17** – Add wideband receive optics and switchable 1310 nm intermediate-reach and 1550 nm long-reach 2.488 Gbit/s lasers.

**Opt. 35** – Add wideband receive optics and 1550 nm G.692 specific frequency long-reach 2.488 Gbit/s laser.

**Opt. 41** – Add STM-16C/OC-48C payloads.

**Opt. 42** – Add B3 path analysis.

### ST2400R STM-16/OC-48 SDH/SONET Receiver

**Includes:** 2.488 Gbit/s Receiver with electrical clock and data, tributary drop, power cord, user manual.

**Opt. 11** – Add wideband receive optics.

**Opt. 42** – Add B3 path analysis.

### ST2400T STM-16/OC-48 SDH/SONET Transmitter

**Includes:** 2.488 Gbit/s Transmitter with electrical clock and data, tributary add, power cord, user manual.

**Opt. 13** – Add 1310 nm intermediate-reach 2.488 Gbit/s laser.

**Opt. 15** – Add 1550 nm long-reach 2.488 Gbit/s laser.

**Opt. 17** – Add switchable 1310 nm intermediate-reach and 1550 nm long-reach 2.488 Gbit/s lasers.

**Opt. 35** – Add 1550 nm G.692 specific frequency long-reach 2.488 Gbit/s laser.

**Opt. 41** – Add STM-16C/OC-48C payloads.

**Opt. 42** – Add B3 path analysis.

### ST2400A, ST2400R, and ST2400T Common Options

**Opt. 01** – FC/PC optical connectors (Opt. 01, 02, or 03 must be chosen).

**Opt. 02** – SC/PC optical connectors (Opt. 01, 02, or 03 must be chosen).

**Opt. 03** – ST/PC optical connectors (Opt. 01, 02, or 03 must be chosen).

**Opt. 05** – Rack mount.

**Opt. 06** – FC/PC 15 dB attenuator for 2.488 Gbit/s receiver.

**Opt. 07** – SC/PC 15 dB attenuator.

**Opt. 08** – ST/PC 15 dB attenuator.

**Opt. C3** – Three year calibration service.

**Opt. C5** – Five year calibration service.

**Opt. D3** – Three year calibration data report.

**Opt. D5** – Five year calibration data report.

**Opt. R5** – Extended warranty to five years.

## Related SDH/ SONET Test Products

**CTS 850** – SDH/DPDH/Jitter/Wander Test Set for E1 to STM-4/4c.

**CTS 710** – SONET/DS3/DS1 Test Set for DS1 to OC-12.

**ST112** – SONET/DS3/DS1 Test Set for DS1 to OC-12/12c. Includes TroubleScan software that interoperates with ST2400A in SONET mode.

**SJ300E** – SDH/SONET Jitter Analyzer Portable jitter analyzer for 52 Mbit/s, 155 Mbit/s, and 622 Mbit/s.

**CSA803C** – Communications Signal Analyzer: Eye pattern analyzer offering STM-1/OC-3 to STM-64/OC-192 eye patterns.

**11801C** – Digital Sampling Oscilloscope.

**ORR24** – 2.488 Gb/s Optical Reference Receiver.

**OA5002** – Optical Attenuator.

**Q8347** – Optical Spectrum Analyzer (N. America only).

**Q8221** – Optical Power Meter (N. America only).

**TQ8325** – Optical Wavelength Meter (N. America only).

## International Power Plug Options

**Opt A1** – 220 V, Universal Euro 220 V, 50 Hz.

**Opt A2** – 240 V, United Kingdom 240 V, 50 Hz.

**Opt A3** – 240 V, Australian 240 V, 50 Hz.

**Opt A4** – 240 V, 240 V, 60 Hz.

**Opt A5** – 220 V, 220 V, 50 Hz.

## Recommended Accessories

**1 m BNC-to-BNC 75 Ω Coaxial Cable** – Order 012-1338-00.

**Adaptor Plug, BNC-1.6/5.6** – Order 013-0300-00.

**2 m FC-PC to FC-PC Optical Patchcord** – Order 174-1387-00.

**9 ft. 25-pin DB25 Male to 9-pin DB9**

**Female RS-232 Cable** – Order 012-1298-00.

**AMP 06-0033 FC Style Build Out Attenuator, 15 dB Fixed Value** – Order 119-5610-00.

**Rackmount Kit** – Order 016-1407-00.

**Hardside Transit Case** – Order 016-1494-00.

## For further information, contact Tektronix:

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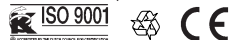
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