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HP E4480A CERJAC 156MTS SONET Maintenance Test Set

Technical Data



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Introduction

A Comprehensive Solution

The HP E4480A CERJAC 156MTS SONET maintenance test set is a comprehensive solution for SONET testing from STS-1 to OC-12, and T-carrier testing at DS3, DS1, and DS0. In addition, the E4480A provides STS-3c, asynchronous transfer mode (ATM) testing, and jitter measurement at DS1, E1, DS3, and STS-1.

A single portable test set combines transmitters and receivers, and provides both optical and electrical interfaces. The transmitters and receivers are dynamically configured to drop and insert signals as required by specific applications.

As SONET deployment continues to expand, the E4480A is ideally positioned to handle the growing variety of applications in today's networks. Whether installing new SONET networks, troubleshooting and maintaining existing facilities, or provisioning new service, the E4480A provides field personnel with a powerful, easy-to-use tool for all their testing requirements.

Configuration Flexibility

The E4480A is based on a modular hardware and software architecture, so the instrument can be configured to meet each user's requirements.

Hardware and software options can be added to an E4480A base model to create a customized test set that provides a wide range of testing capabilities, including:

- OC-12
- OC-3
- STS-3c (OC-3c)
- OC-1
- STS-1
- VT1.5
- DS3
- Dual DS3
- E1
- DS1
- FT1 (fractional T1)
- DS0
- ATM Testing
- Jitter Measurement

Software Upgrades

Upgrades to the operating software for the E4480A will continue to be available in accordance with the needs of the evolving SONET and T-Carrier standards. New versions of the operating software can be downloaded in the field using an RS-232 link from a personal computer.

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Features

Operating Modes

The E4480A 156MTS provides three test modes to meet the needs of test applications such as installation (out-of-service) testing, facility testing (in-service), and channel access (drop and insert) testing.

Terminal mode

- Transmitter and receiver are fully independent.
- Different line rates can be set up on the transmit and receive sides to facilitate multiplexer testing and end-to-end, out-of-service testing.

Monitor mode

- Pass-through or input-only monitoring for non-intrusive, in-service testing.
- Transmit controls and overhead access are locked out to prevent accidental intrusion on the service.

Drop & Insert mode

- Pass-through monitoring with access to individual tributary payloads for monitoring and inserting test patterns and errors.
- Useful for both in-service and out-of-service applications.

Error Injection

- Many different types of errors available for each signal type.
- Single, continuous rate, or burst injection.
- Injection controlled by front-panel key or rear-panel external signal.

Automated Test Sequences

Automatic test sequences are available for more efficient testing:

Pointer adjustment

- Inserts positive or negative pointer adjustments or new data flag events.

DS1 Drop Scan

- Checks each DS1 signal for AIS, frame, and pattern.

Signaling Scan

- Displays ABCD signaling bits for each DS0 channel.

Automatic Configuration

One-key operation bypasses the setup screens and automatically configures the instrument to match the input signal.

Remote Control

Control of the instrument is available through one of the rear-panel remote interfaces.

Remote Front Panel

- Remote operation using a front-panel emulator on a terminal or PC.

Modem Control

- For modem applications, a general purpose modem can be used.

IEEE-488

- (optional) Provides a computer control interface using SCPI syntax (Standard Commands for Programmable Instruments).

Software Upgrades

MTS operating software can be upgraded at any time by downloading the new version through the rear-panel remote interface port.

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User Interface

LCD Display

- Configuration parameters and measurement results shown simultaneously.
- 12 line × 40 column alphanumeric LCD.
- Adjustable contrast.

LED Indicators

- Front-panel LED indicators show signal and test status (green LEDs), errors (yellow LEDs), alarms (red LEDs), and alarm history (yellow LEDs).
- Separate LEDs for SONET STS-N, VT1.5, DS3, and DS1/E1.

Speaker

- Audible indication of errors and alarm events.
- VF channel monitoring.
- Adjustable volume.

Menu-based Operation

- Configuration setups and test results are accessed through menus.
- Menu navigation uses front-panel keys.

Setup Storage

- Stores as many as 10 test configurations for future recall.

Results Storage

- Stores as many as 12 complete results summaries for future recall or printing.
- Data storage can be manual or automatic.
- Auto store mode stores results at the occurrence of:
  - Timed test end
  - Error event
  - Every 15 minutes
  - Every 2 hours

Event Log

Store as many as 50 user-selectable alarm or error events. The most recent 50 events remain in memory at the end of the test period.

Test Control

Front-panel keys provide the following test control:

- Start test
- Stop test
- Pause test (temporary test stop)
- Hold test (temporary display freeze)

Printing

- Printing to local printer using serial port.

Results Printing

- Printing can be manual or automatic.
- Print queue holds results until a printer is connected or the unit is powered off.
- Auto print mode prints results at the occurrence of:
  - Timed test end
  - Error event
  - Every 15 minutes
  - Every 2 hours

Event Log Printing

- Prints user-selectable alarm or error events.

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SONET STS-1
Electrical Interfaces

	Transmitter		Receiver		Drop output	
Signal	**STSX-1**	Per TR-NWT-000253, Section 4.4. 0.53 Vpk ±1.2 dB. LBO = 450 ft simulated 728A cable.	**STSX-1**	Automatic equalizer for 0 to 900 ft of 728A cable.	**STSX-1**	Per TR-NWT-000253, Section 4.4. 0.53 Vpk ±1.2 dB. LBO = 450 ft simulated 728A cable.
	High	1.11 Vpk ±1.2 dB. LBO = none.	**High**	1.11 Vpk input signal, nominal.		
	900	0.35 Vpk ±2.0 dB LBO = 900 ft simulated 728A cable.	**Mon**	Up to 26 dB flat loss relative to nominal STSX-1 level.		
	Low	0.206 Vpk ±2.0 dB. LBO = Flat loss from High level.				
Line Code	B3ZS.		B3ZS.		B3ZS.	
Impedance	75 Ohm ±5%; return loss >20 dB.		75 Ohm ±5%		75 Ohm ±5%; return loss >20 dB.	
Connector	Accepts WECo 440. Optional WECo 358 or BNC.		Accepts WECo 440. Optional WECo 358 or BNC.		Accepts WECo 440. Optional WECo 358 or BNC.	

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SONET OC-N
Optical Interfaces

	OC-12/OC-3/OC-1 Intermediate Reach 1310 nm (622 Mbs)			OC-12/OC-3/OC-1 Long Reach 1310 nm (622 Mbs)			OC-12/OC-3/OC-1 Long Reach 1550 nm (622 Mbs)		
	Min.	**Max.**	**Typ.**	**Min.**	**Max.**	**Typ.**	**Min.**	**Max.**	**Typ.**
Transmitter									
Avg. Optical Power (dBm)	–12.0	–5.0	–8.0	+2.0	–3.0	0.0	+2.5	–3.0	0.0
Optical wavelength (nm)	1260	1360	1310	1280	1335	1310	1500	1580	1550
Receiver									
Optical Sensitivity (dBm)	–26.0	•	–28.0	–26.0	•	–28.0	–26.0	•	–28.0
Peak input power (dBm)	•	–7.0	•	•	–7.0	•	•	–7.0	•
Optical Wavelength (nm)	1240	1380	•	1240	1380	•	1500	1570	•
Connectors	PC/PC connectors are standard. Optional ST, D4-PC, or SC connectors are available.								

	OC-3/OC-1 Intermediate Reach 1310 nm (155 Mbs)			OC-3/OC-1 Long Reach 1310 nm (155 Mbs)			OC-3/OC-1 Long Reach 1550 nm (155 Mbs)		
	Min.	**Max.**	**Typ.**	**Min.**	**Max.**	**Typ.**	**Min.**	**Max.**	**Typ.**
Transmitter									
Avg. Optical Power (dBm)	–15.0	–8.0	–11.0	–3.0	+2.0	0.0	–3.0	+2.0	+2.0
Optical wavelength (nm)	1260	1360	1310	1280	1335	1310	1500	1580	1550
Receiver									
Optical Sensitivity (dBm)	–28.0	•	–34.0	–28.0	•	–34.0	–28.0	•	–34.0
Peak input power (dBm)	•	–7.0	•	•	–7.0	•	•	–7.0	•
Optical Wavelength (nm)	1240	1380	•	1240	1380	•	1500	1570	•
Connectors	PC/PC connectors are standard. Optional ST, D4-PC, or SC connectors are available.								

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SONET STS-N Specifications

STS-N testing features provide generation and measurement of STS-N signals. STS-N tests can be performed on OC-1, OC-3, OC-12, and STS-1 signals.

The STS-3c testing option provides generation and measurement of SONET STS-3c (concatenated) payloads. The payload is transmitted and received within either an OC-3 or an OC-12 signal.

STS-N Timing

Internal

- Stratum 3 (±4.6 ppm).

Loop

- Recovered clock from SONET receiver.

External

- 51.840 MHz clock input.
- BNC connector.
- TTL level.
- 50 Ohm impedance.

BITS input

- DSX-1 per ANSI T1X1, CB119, and TR-TSY-000449.
- 1.544 MHz SF framed all-ones signal is expected.
- 3.0 Vpk ±1.0 dB (0 dBdsx) typical.
- WECo 310 connector.
- 100 Ohm impedance.

BITS output

- DSX-1 per ANSI T1X1, CB119, and TR-TSY-000449.
- 1.544 MHz SF framed all-ones signal.
- 3.0 Vpk ±1.0 dB (0 dBdsx) typical.
- WECo 310 connector.
- 100 Ohm impedance.

STS-N Frame/Payload

Frame type

- A1/A2.

Payload types

- STS-3c.
- STS-3c/ATM.
- DS3.
- DS3/DS1.
- DS3/DS1/DS0.
- DS3/ATM.
- VT1.5/DS1.
- VT1.5/DS1/DS0.

STS-3c Payload Patterns

BERT pattern fills entire concatenated payload:

- PRBS: 2^{15}–1, 2^{20}–1, 2^{23}–1.
- Inverted PRBS (see above).
- All ones.
- All zeros.

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STS-N Alarm and Error Injection

Error Type	Description	Injection Rates
Alarm events	Types include: LOS, LOF, LAIS, LFERF, LOPNTR, PAIS, Path Yellow.	Simultaneous or individual.
A1/A2 bytes	Inverts entire 16-bit frame word.	1, 3, 4, 5, or 23–30 consecutive frames, Continuous, or Burst.
BPV	Causes a bipolar violation.	Single, 10^{-2} through 10^{-9}, Burst.
Section BER	Causes B1, B2, B3, and data errors.	Single, 10^{-2} through 10^{-9}, Burst.
Line BER	Causes B2, B3, and data errors.	Single, 10^{-2} through 10^{-9}, Burst.
Path BER	Causes B3 and data errors.	Single, 10^{-2} through 10^{-9}, Burst.
B1 byte	Results in eight B1 BIP errors.	Single byte inversion.
B2 byte	Results in eight B2 BIP errors.	Single byte inversion.
B3 byte	Results in eight B3 BIP errors.	Single byte inversion.
H1/H2 bytes	Generates an illegal, out-of-range pointer value.	1, 7, 8, or 9 consecutive frames; Continuous; or Burst.
B1, B2, A1 bit	Inverts the least significant bit of B1, B2, or A1. Available for OC-12 modes only.	1, 7, 8, or 9 consecutive frames; Continuous; or Burst.
Line FEBE (STS-3c only)	Errors transmit Z2 byte of STS-1 #3.	Single, 10^{-4} through 10^{-8}.
Path FEBE (STS-3c only)	Errors transmit G1 byte.	Single, 10^{-4} through 10^{-8}.
Data Errors (STS-3c only)	Causes an error in the STS-3c payload.	Single, 10^{-2} through 10^{-9}, Burst.

STS-N Indicators

LEDs light to indicate presence of their respective conditions (history LEDs light to indicate past occurrence).

Status (green)	Error (yellow)	Alarm (red)	History (yellow)
STS-N Signal	B1 CV (code violation)	LOS (loss of signal)	LOS
STS-N Frame	B2 CV	LOF (loss of frame)	LOF
Valid Pointer	B3 CV	LAIS (line AIS)	LAIS
	FEBE (far-end block error)	LFERF (line FERF)	LFERF
		LOPNTR (loss of pointer)	LOPNTR
		LOCLK (loss of clock)	LOCLK
		PAIS (path AIS)	PAIS
		Path Yellow	Path Yellow

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STS-N Measurements

Measurement Type	Available Results		
Alarm Seconds	LOS LOF LAIS	LFERF LOCLK LOPNTR	PAIS Path Yellow
B1, B2, and B3 CV	Count Second Ago Average BER	Current BER Errored Seconds SES	EFS %EFS Path Unavail. Sec (B3 only)
BPV (applies to STS-1 electrical only)	Count Second Ago Average BER	Current BER Line Code Violation Rate Sec (LCVR)	Errored Seconds EFS %EFS
Line FEBE	Count Average BER Current BER	Errored Seconds SES EFS	%EFS
Path FEBE	Count Second Ago Average BER	Current BER Errored Seconds SES	Unavailable Seconds EFS %EFS
Frame (A1/A2 bytes)	Out of Frame (OOF) Events EFS	%EFS SEFS	
Electrical Signal	Frequency	dBdsx	Vpeak
Optical Signal	Frequency	Optical Power	
STS-3c Payload	Count Current BER Average BER	Errored Seconds SES EFS	%EFS
Pointer (H1/H2)	Pointer Justifications Last Justification Direction Loss of Pointer Seconds	Pointer Value (decimal) Justification Seconds New Data Flag Seconds	Pointer EFS Pointer %EFS
APS	APS State APS Type	APS Mode Request & Bridge Channels	State Change Seconds Byte Fail Seconds

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STS-N Pointer Testing

Pointer Control

- Positive or negative adjustments; selectable rate:
  - Single
  - Consecutive (7, 8, 9)
  - Continuous
  - Burst
- Individual New Data Flag events.

Pointer Results (H1/H2)

- Pointer Justifications.
- Last Pointer Justification Direction.
- Loss of Pointer Seconds.
- Pointer Value (decimal).
- Pointer Justification Sec.
- New Data Flag Seconds.
- Pointer EFS.
- Pointer %EFS.

STS-3c Pointer Testing

Pointer Control

- Concatenated pointers generated in transmitted STS-3c.
- Positive or negative adjustments; selectable rate:
  - Single
  - Consecutive (7, 8, 9)
  - Continuous
  - Burst
- Individual New Data Flag events.

Pointer Results

- Valid concatenated pointers received.
- Pointer bytes for STS-1 #1, #2, #3.
- Pointer Justification Count.
- Last Pointer Justification Direction.
- Loss of Pointer Seconds.
- Pointer Value (decimal).
- Pointer Justification Sec.
- New Data Flag Seconds.
- Pointer EFS.
- Pointer %EFS.

STS-N APS Testing

Transmit

- Select APS (K1/K2) transmit messages in English language.

Receive

- Monitor received APS (K1/K2) messages in English language:
  - APS State
  - APS Type
  - APS Mode
  - Request Channel and Bridge Channel
- Measure State Change Seconds and Byte Fail Seconds.

Pass-through

- Selectable OC-12 K1/K2 pass-through.

STS-N Overhead Testing

Programmable

- Section E1, F1, D1, D2, D3.
- Line K1, K2, D4 - D12, Z1, Z2, Z3.
- Path J1 (64 byte trace, ASCII or Hex), C2, F2, Z3, Z4, Z5.
- DS3 O-bits.

Displayed

- Section E1, F1, D1, D2, D3.
- Line H1, H2, K1, K2, D4–D12, Z1, Z2, E2.
- Path J1 (64 byte trace, ASCII and Hex), C2, G1, F2, H4, Z3-Z5.
- DS3 O-bits.

Automatic Generation and Monitoring

- Section A1, A2, B1.
- Line H1, H2, H3, B2.
- Path B3.

DCC Channels

Section and Line DCC channels dropped and inserted through rear-panel RS-422 connector, passed through from Rx to Tx, or set to user-programmed values.

F1 User Channel

F1 Section User Channel dropped and inserted through rear-panel RS-232 connector, or set to user-programmed values.

Order Wires

E1 Section Orderwire and E2 Line Orderwire dropped and inserted from rear-panel RS-232 connector, or dropped and inserted through rear-panel 600 Ohm handset interface, or set to user-programmed values.

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VT1.5 Specifications

The VT1.5 Testing Option provides external or internal DS1 insert and drop from an STS-1 signal.

Payload

- External DS1.
- Internal DS1.
- DS1/DS0.

Alarm Insertion

Type

- VT PAIS.
- VT LOPNTR.
- VT Path Yellow.

Error Injection

VT CV

Error to data after BIP calculation:

- Single.
- 10^{-2} through 10^{-9}.
- Burst.

Pointer errors

- Consecutive pointers (1, 7, 8, 9).
- Continuous.
- Burst.

Indicators

Alarms (red)

- VT PAIS.
- VT LOPNTR.
- VT Path Yellow.

Errors (yellow)

- VT CV.
- VT FEBE.

Measurements

Alarm Seconds

- VT PAIS.
- VT LOPNTR.
- VT Path Yellow.

Errors

- VT CV (BIP-2).
- VT FEBE.

Parameters

- Total.
- Avg. Ratio.
- Current Ratio.
- Error Sec.
- Error Free Sec.
- Severe ES.

VT1.5 Pointer

- Pointer Value.
- Adjustment seconds.
- EFS.
- %EFS.

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DS3 Specifications

(including DS2 testing and optional Dual DS3 testing)

DS3 test capability includes generating and monitoring DS3 signals. A full range of measurements is provided. FEAC and C-bit control and monitoring are also available.

Dual DS3 testing options are available that provide either a second DS3 receiver, or a second complete DS3 transmitter and receiver for full-duplex DS3 testing.

DS3 Timing Source

Internal

- 44.736 MHz ±20 ppm.

Loop

- Receiver recovered timing.

External

- TTL levels, 50 Ohm, BNC connector.

Modes

- Terminal.
- Monitor.
- Through.
- DS1 Drop & Insert.

Bit Error Output

Provides a single pulse output for each DS3 error detected.

- TTL, 50 Ohm, BNC connector.

	Transmitter		Receiver		Drop output	
Signal	**DSX-3**	Per CB119, ANSI T1X1, and TR-TSY-000499. 0.48 Vpk ±1.2 dB. LBO = 450 ft simulated 728A cable.	**DSX-3**	Automatic equalizer for 0 to 900 ft of 728A cable. 44.736 MHz ±300 ppm. Jitter tolerance per Bellcore TR-TSY-000009.	**DSX-3**	Per TR-TSY-000499. 0.48 Vpk ±1.2 dB. LBO = 450 ft simulated 728A cable.
	High	0.91 Vpk ±1.2 dB. LBO = none.	**High**	0.91 Vpk input signal, nominal.		
	900	0.33 Vpk ±2.0 dB LBO = 900 ft simulated 728A cable.	**Mon**	Up to 26 dB flat loss relative to nominal DSX-1 level.		
	Low	0.186 Vpk ±2.0 dB. LBO = Flat loss from High level.	**Low**	0.186 Vpk input signal, nominal.		
Line Code	B3ZS.		B3ZS.		B3ZS.	
Impedance	75 Ohm ±5%; return loss >20 dB.		75 Ohm ±5%		75 Ohm ±5%; return loss >20 dB.	
Connector	Accepts WECo 440. Optional WECo 358 or BNC.		Accepts WECo 440. Optional WECo 358 or BNC.		Accepts WECo 440. Optional WECo 358 or BNC.	

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DS3 Frame/Data

Frame type

- Auto.
- M13.
- C-Bit Parity.
- Unframed.

Patterns

- Auto.
- PRBSs: 2^{15}–1, 2^{20}–1, 2^{23}–1.
- Inverted PRBSs (see above).
- All ones.
- AIS.
- Idle.
- 8-bit programmable.
- External data.
- Passthru.
- Loop.

Control and Monitor of DS3 C-Bits

The following C-bits can be individually set and monitored (some bits may also be affected by FEAC or data link operations):

- C2 in row 1 (Nr; reserved for future network use).
- FEAC channel bits (C3 bit, row 1).
- C1, C2, and C3 in row 2.
- FEBE bits (C1, C2, & C3 of row 4).
- PMDL bits (C1, C2, & C3 of row 5).
- C1, C2, and C3 of both row 6 and row 7.

DS3 C-Bit Data Link Access

An external connector provides drop and insert of three C-bit data links.

Path Maintenance Data Link (PMDL) Drop & Insert

- The three C-Bits in row 5 of the DS3 M-frame form the 28.2 kbs PMDL.

84.6 kbs Data Link

- Formed by the nine C-Bits in rows 2, 6, and 7.

56.4 kbs Data Link

- Formed by the six C-bits in rows 6 and 7.

DS3 FEAC

FEAC Transmit

- Alarm/Status Codewords
  - Codewords per ANSI T1.107a.
  - NIU codewords as reserved per ANSI T1.404.
  - User-programmable codeword (the six bits bracketed by zeros within the codeword are programmable).
  - The Alarm/Status codes and the user defined codeword can be injected continuously, or for a burst duration of 3 to 15 codewords.
- FEAC loop code sequences
  - The sequences transmit *n* repetitions of the “Line Loopback Activate” or “Line Loopback Deactivate” message followed by *n* repetitions of the user-selected Line Identifier.
  - Where *n* = 3 to 15.

FEAC Detect

The received FEAC channel is monitored for:

- ANSI T1.107a alarm/status codewords
- User defined codeword
- Loop activate/deactivate sequences

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DS3 Error Injection

Error Type	Description	Injection Rates
Frame	Framing errors.	Single, 10^{-2} through 10^{-9}, Burst.
BPV	Bipolar violations.	Single, 10^{-2} through 10^{-9}, Burst.
DS3 Data	Bit errors in payload only.	Single, 10^{-2} through 10^{-9}, Burst.
DS3 Data, Parity	Payload parity errors.	Single, 10^{-2} through 10^{-9}, Burst.
C1, C2, C3, All	Available for both DS3 and DS2 signals.	Single, 10^{-2} through 10^{-9}, Burst.
X-Bit	Set either or both X1 and X2 to 0 or 1.	Continuous.
FEBE	C41, C42, C43 can be set from 000 through 111.	Continuous.

DS3 Indicators

LEDs light to indicate presence of their respective conditions (history LEDs light to indicate past occurrence).

Status (green)	Error (yellow)	Alarm (red)	History (yellow)
Signal	DS3 bit errors	Loss Of Signal	Loss Of Signal
M13/C-Bit Frame	P-bit or CP-bit parity errors	Frame Format Mismatch	Frame Format Mismatch
Pattern Sync	DS3 framing errors	Out Of Frame	Out Of Frame
X-Bit	Bipolar Violations	Loss Of Pattern	Loss Of Pattern
Idle Channel		AIS	AIS

Measurements

For Dual DS3, split screens show DS3 A and DS3 B measurements simultaneously.

Measurement Type	Available Results		
Alarm Seconds	Loss Of Signal Frame Format Mismatch	Out Of Frame Loss Of Pattern	AIS Line Code Violation Alarm
Bit Errors	Total Seconds Ago Avg. Ratio Current Ratio Error Sec	Severely ES Sync ES EFS %EFS Available Seconds	Unavailable Seconds Degraded Minutes Threshold ES (10^{-3} to 10^{-6}) Dribble CSES-3 (LOS, LOF, LOP reset)
BPV	Total Seconds Ago Avg. Ratio	Current Ratio LCVR Sec Error Sec	EFS %EFS
Signal	Frequency	dBdsx	Volts Peak
FFCV (Frame Format Coding Violation)	Near-end/Far-end count Near-end/Far-end ES A	Near-end/Far-end ES B Near-end/Far-end ES C	
LCVA	Line Code Violation Alarm		
DS2 Alarms	LOS OOF	AIS X-Bit	

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DS1 Specifications

(including DS0 testing and optional Fractional T1 testing)

DS1 Timing Source

Internal

- 1.544 MHz ±20 ppm.

Loop timing

- Receiver recovered timing.

External BNC

- TTL levels, 50 Ohm, BNC connector.

Modes

- Terminal.
- Monitor.
- Through.
- DS0 Drop & Insert.

DS1 Slips Reference

- DSX-1, per TR-TSY-000499.
- 3.0 Vpk input level, typical.
- WECo 310 connector.

	Transmitter		Receiver		Drop output	
Signal	**DSX-1**	Per CB119, ANSI T1X1, and TR-TSY-000499.	**DSX-1**	Per CB119, ANSI t1X1, and TR-TSY-000499.	**DSX-1**	Per ANSI T1X1 and TR-TSY-000499.
		3.0 Vpk ±1.0 dB (0 dBdsx).		3.0 Vpk ±1.0 dB (0 dBdsx).		3.0 Vpk ±1.0 dB (0 dBdsx).
		Supports Simplex power.		1.544 MHz ±1000 ppm.		
		LBO = –7.5, –15.0, or –22.0 dBdsx.		Sensitivity = 26 dB below 0 dBdsx.		
				Jitter tolerance per Bellcore TR-TSY-000009		
			ALBO	Automatic LBO equalized for 400 to 4000 ft of 22 AWG pulp insulated cable.		
			Mon	10 to 25 dB flat loss relative 0 dBdsx.		
Line Code	AMI or B8ZS.		AMI or B8ZS.		AMI or B8ZS.	
Impedance	100 Ohm ±5% balanced; return loss >20 dB.		**Term**	100 Ohms ±5%, return loss >20 dB.	75 Ohm ±5%; return loss >20 dB.	
			Bridge	>1000 Ohms.		
Connector	Accepts WECo 310 plug. Optional Bantam.		Accepts WECo 310 plug. Optional Bantam.		Accepts WECo 310 plug. Optional Bantam.	

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DS1 Frame/Data

Frame type

- Auto.
- SF (D4).
- ESF.
- SLC-96.
- MBLT (Mobile Both-Line Terminal; Ericsson format).
- Unframed.

Patterns

- Auto.
- QRSS.
- PRBSs: 2^6–1, 2^9–1, 2^{11}–1, 2^{15}–1, 2^{20}–1, 2^{23}–1.
- Inverted PRBSs (see above).
- All ones.
- 3-in-24.
- 55 Octet.
- AIS.
- 24-bit programmable.
- External data.
- Passthru.

DS1 Loop Codes

Loop up

- In-band, two programmable loop up patterns (2 to 24 bits).

Loop down

- In-band, two programmable loop down patterns (2 to 24 bits).

DS1 Alarm Insertion

Alarm

- D4 Yellow alarm.
- ESF Yellow alarm.
- AIS.

DS1 Error Injection

- DS1 Data:
  - Single
  - 10^{-2} through 10^{-9}
  - Burst
- DS1 Data, CRC (ESF mode only):
  - Single
  - 10^{-2} through 10^{-9}
  - Burst
- BPV:
  - Single
  - 10^{-2} through 10^{-9}
  - Burst
- DS1 Frame:
  - Single
  - 10^{-2} through 10^{-9}
  - Burst

Additional DS1 Interfaces

Network Interface

DS1 Rx/Tx, DB-25S (parallel connection to front panel)

Pin	Function
1	DS1 Tx tip
9	DS1 Tx ring
3	DS1 Rx tip
11	DS1 Rx ring

DS1 Errors out

- TTL, 50 Ohm, BNC connector.

Serial Data Link

- ESF FDL and SLC-96 data links RS-232, DB-25S.

Fractional T1 Testing

The fractional T1 testing option allows non-contiguous n×64 and n×56 testing within the DS1 signal. General DS1 specifications apply.

DS0 Testing

DS0 Payload

- DRS Tone:
  - 1004 Hz
  - 1012 Hz
  - 1020 Hz
- External VF:
  - Applied to VF insert port
- Patterns:
  - QRSS
  - PRBSs: 2^6–1, 2^9–1, 2^{11}–1, 2^{15}–1, 2^{20}–1, 2^{23}–1
  - All ones
  - 3-in-24
  - 55 Octet

DS0 Measurements

- Level range: –55 dBm to +3.0 dBm (0 dBm = 774.6 Vrms).
- RMS power in dBm (reference to 1 mW).
- ≥3 dBm Sec: seconds during which the dropped Voice frequency is greater than or equal to 3 dBm.
- Frequency.
- Received byte (8-bit word).
- ABCD signaling bits

DS0 Interfaces

- VF Drop Port
  - 600 Ohm, internal codec.
- VF Insert Port
  - 600 Ohm, internal codec.
- ABCD Signaling Bits Drop
  - TTL, DB-9S connector, 50 Ohms.

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DS1 Indicators

LEDs light to indicate presence of their respective conditions (history LEDs light to indicate past occurrence).

Status (green)	Error (yellow)	Alarm (red)	History (yellow)
Signal	Data	Loss Of Signal	Loss Of Signal
Frame Sync	Frame	Out Of Frame	Out Of Frame
Pattern Sync	BPV	Loss Of Pattern	Loss Of Pattern
B8ZS	CRC	AIS	AIS
		Yellow	Yellow
		Change Of Frame Alignment	Change Of Frame Alignment

DS1 Measurements

Measurement Type	Available Results		
Alarm Seconds	LOS OOF LOP	AIS Yellow COFA	Ones Density
BPV Frame Bit CRC-6	Total Avg. Ratio Current Ratio Error Sec ES-A ES-B	SES CSES CSES-3 Error Free Sec %EFS Sync ES	Degraded min Available Sec Unavailable Sec Threshold ES (10^{-3} –10^{-6}) Dribble LCVR Sec
DS1 Block Errors	Est. Total Block Count Block Error Count	Burst Error Sec Severe Error Event (SEE)	CATV UAS
DS1 Slips	Bit slips	Frame slips	Slip Seconds
Excess Zeros	AMI: >15 consecutive zeros	B8ZS: >7 consecutive zeros	
Signal	Received Frequency	Delta Frequency (Rx minus reference frequency)	Vpeak dBdsx
Auto Scan	Scans all 28 DS1 channels.		

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E1 Specification

(includes optional E1 Timeslot testing)

E1 testing provides generation and measurement of CCITT standard 2.048 Mbs signals. Timeslot drop and insert testing is available for channelized E1 signals.

Modes

- Terminal.
- Monitor.
- E1 Drop from DS3.
- Through.

E1 Timing Source

Internal

- 2.048 MHz ±20 ppm.

Loop

- Receiver recovered timing.

External

- TTL levels, 50 Ohm, BNC connector.

	Transmitter		Receiver		Drop output	
Signal	**DSX**	Per CCITT G.703.	**DSX**	Per CCITT G.703.	**DSX**	Per CCITT G.703.
		3.0 Vpk ±1.0 dB (0 dBdsx).		3.0 Vpk ±1.0 dB (0 dBdsx).		3.0 Vpk ±1.0 dB (0 dBdsx).
				2.048 MHz ±1000 ppm.		
				Equalized for 0 to 655 ft of 22 AWG pulp insulated cable.		
				Sensitivity = 26 dB below 0 dBdsx.		
				Jitter tolerance per CCITT G.823.		
			Mon	Per CCITT G.703.		
				0.3 Vpk input level typical (–20 dBdsx).		
Line Code	AMI or HDB3.		AMI or HDB3.		AMI or HDB3.	
Impedance	120 Ohm ±5% balanced; return loss >20 dB.		**Term**	120 Ohms ±5%; return loss >20 dB.	120 Ohm ±5%, balanced; return loss >20 dB.	
			Bridge	>1000 Ohms.		
Connector	Accepts WECo 310 plug. Optional Bantam.		Accepts WECo 310 plug. Optional Bantam.		Accepts WECo 310 plug. Optional Bantam.	

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E1 Frame/Data

Frame type

- TS0.
- TS0/TS16.
- TS0/CRC.
- TS0/TS16/CRC.
- Unframed.

Patterns

- QRSS.
- PRBSs: 2^6–1, 2^9–1, 2^{11}–1, 2^{15}–1, 2^{20}–1, 2^{23}–1.
- All ones.
- 3 in 24.
- 55 Octet.
- AIS.
- 24-bit programmable.
- External data.
- Passthru.

Adds channelized E1 data with DS2 framing to DS3 test modes.

E1 Timeslot Testing

Timeslot Payload

- DRS Tone:
  - 1004 Hz
  - 1012 Hz
  - 1020 Hz
- External VF:
  - Applied to VF insert port
- Patterns:
  - QRSS
  - PRBSs: 2^6–1, 2^9–1, 2^{11}–1, 2^{15}–1, 2^{20}–1, 2^{23}–1.
  - All ones
  - 3 in 24
  - 55 Octet

E1 Timeslot Measurements

- Level range: –55 dBm to +3.0 dBm (0 dBm = 774.6 Vrms).
- RMS power in dBm (ref. to 1 mW).
- ≥3 dBm Sec: Seconds in which the dropped VF is greater than or equal to 3 dBm.
- Frequency.
- Received byte (8-bit word).
- ABCD signaling.

Timeslot Interfaces

- TS VF Drop Port
  - 600 Ohm, internal codec.
- TS VF Insert Port
  - 600 Ohm, internal codec.
- Signaling Drop
  - ABCD bits; TTL, DB-9S connector, 50 Ohms.

E1 Alarm & Error Injection

Error Type	Description	Injection Rates
Alarm	Types include: Remote (Yellow) alarm, Multiframe Alarm, and AIS.	Single or continuous.
E1 Data	Errors to payload.	Single, 10^{-2} through 10^{-9}, Burst.
E1 Data, CRC	Cyclic redundancy checksum & payload errors.	Single, 10^{-2} through 10^{-9}, Burst.
BPV	Bipolar violations.	Single, 10^{-2} through 10^{-9}, Burst.
E1 Frame (TS0)	Errors to timeslot 0.	Single, 10^{-2} through 10^{-9}, Burst.
E1 Frame, CRC	Cyclic redundancy checksum & framing errors.	Single, 10^{-2} through 10^{-9}, Burst.
E1 MFrame (TS16)	Errors to timeslot 16.	Single, 10^{-2} through 10^{-9}, Burst.
E1 MFrame, CRC	Cyclic redundancy checksum errors (CRC).	Single, 10^{-2} through 10^{-9}, Burst.
C-bits	Errors to the C-bits.	Single, 10^{-2} through 10^{-9}, Burst (DS3 and DS2 channelized payloads).

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E1 Indicators

LEDs light to indicate presence of their respective conditions (history LEDs light to indicate past occurrence).

Status (green)	Error (yellow)	Alarm (red)	History (yellow)
Signal	Data	Loss Of Signal	Loss Of Signal
Frame Sync	Frame	Out Of Frame	Out Of Frame
Pattern Sync	BPV	Loss Of Pattern	Loss Of Pattern
HDB3	CRC	AIS	AIS

E1 Measurements

Measurement Type	Available Results		
Alarm Seconds	LOS OOF LOP	AIS Remote Alarm Distant Alarm	Excess Zeros
Status	TS0 Sync	TS16 Sync	CRC-4 Sync
Bit Errors	Total Avg. Ratio Current Ratio Error Severely ES	Sync ES EFS %EFS Available Seconds Unavailable Seconds	Degraded Minutes Threshold Error Sec (10^{-3}–10^{-6}, dribble) CSES-3 (LOS, LOF, LOP reset)
TS0 Frame Errors	Total Avg. Ratio	Current Ratio Error Sec	EFS %EFS
CAS Frame Errors	Total Avg. Ratio	Current Ratio Error Sec	EFS %EFS
CRC-4 Errors	Total Avg. Ratio	Current Ratio Error Sec	EFS %EFS
BPV	Total Avg. Ratio Current Ratio	LCVR Sec Error Sec EFS	%EFS
E1 Slips	Bit Slips	Frame Slips	Slip Seconds
Excess Zeros	AMI: >15 consecutive zeros	HDB3: >4 consecutive zeros	
Signal	Received Frequency	VPeak dBdsx	Delta Frequency (Rx minus reference frequency)

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Jitter Measurement

(option required)

Measurement Response

		Cut-off Frequencies		Roll-off (per decade)	
Rate	**per Standard**	**Wideband**	**Highband**	**Below lower 3 dB pt.**	**Above higher 3 dB pt.**
DS1	TR-TSY-000499	10 Hz to 40 kHz	8 kHz to 40 kHz	≥20 dB	≥60 dB
E1	CCITT G.823	20 Hz to 100 kHz	20 kHz to 100 kHz	≥20 dB	≥60 dB
DS3	TR-TSY-000499	10 Hz to 400 kHz	30 kHz to 400 kHz	≥20 dB	≥60 dB
STS-1	TR-NWT-000253	100 Hz to 400 kHz	20 kHz to 400 kHz	≥20 dB	≥60 dB

Jitter Measurements

Measurement	**Range**	**Resolution**	**Accuracy**
Maximum Peak Positive Jitter	0.1 to 6.0 UI	0.1 UI	±5% of reading, ±0.05 UI.
Maximum Peak Negative Jitter	0.1 to 6.0 UI	0.1 UI	±5% of reading, ±0.05 UI.
Current Peak-to-Peak Jitter	0.1 to 12.0 UI	0.1 UI	±5% of reading, ±0.05 UI.
Max Peak-to-Peak Jitter	0.1 to 12.0 UI	0.1 UI	±5% of reading, ±0.05 UI.

	Rate	**Wideband Mask**	**Highband Mask**
Percent of Mask	DS1	5.0 UI	0.1 UI
	E1	1.5 UI	0.2 UI
	DS3	5.0 UI	0.1 UI
	STS-1	1.5 UI	0.2 UI

Demodulated Jitter Output

- Connector: BNC.
- Impedance: 50 Ohm.
- Scale: 0.5 V/UI.
- Range: 0 to 6 Vdc.

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Physical and Electrical

Physical

- Size: (W×H×D) 14.5×7.5×16.0 in. (36.8 × 19.0 × 40.6 cm).
- Weight: 25.0 lbs (11.5 kg).

Electrical

- AC Line: 115 Vac ±10%, 50/60 Hz
- Fuse rating: 5 Amp, slow-blow.

Environmental

Temperature

- Operating: 0 to +45 °C (+32 to +113 °F).
- Storage: –20 to +70 °C (–4 to +158 °F).

Humidity

- 5 to 90 %RH, noncondensing.

Rear Panel Interfaces

RS-232 Printer Port

- Baud: 9600, 4800, 2400, 1200, or 300.
- Data bits: 8 or 7.
- Parity: None, Even, or Odd.
- Format: RS-232C, DTE, with request-to-send and clear-to-send.
- Connector: DB-25P.

RS-232 Remote/Download Port

- Format: RS-232C, DCE, with request-to-send and clear-to-send.
- Connector: DB-25S.

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