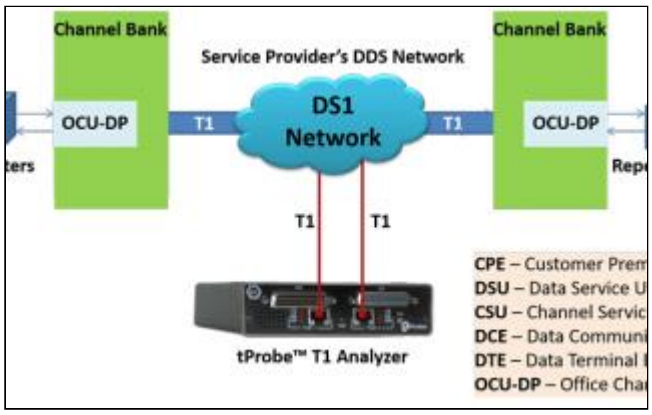
Hands-On

# DS1/T1 - DS1/HDSL - DS0 Data Loop

Installation, Maintenance & Troubleshooting

## Course Description




Telecommunications companies use copper DS1/T1 and DS1/HDSL carriers as well as the local loop to transport digital and analog data services to a variety of business customers. A well trained technical force to install and maintain these systems is vital for providing expected quality of service and world-class reliability in a highly competitive environment.

This 3-day course is an intense learning experience that combines DS1/T1, T1/ HDSL, as well as digital and analog data loop operations with Hands-On troubleshooting.

For this course, BTS provides a working classroom lab equipped with typical systems currently deployed throughout the telecommunications industry. Students learn the operational of aspects of these systems and then apply this knowledge to test, troubleshoot and repair the circuits using comparable test equipment to that which the use on the job. Troubleshooting scenarios include equipment failures, wiring problems, field repeater problems, cable pair problems, power issues and more...

## Students Will Learn

- **Review telephone loop fundamentals**
- **Learn the functions and operations of DS1/T1, DS1/HDSL, and DS0 data loop systems deployed inside the central office, the outside plant, and at the customer premise.**
- **Demonstrate use of appropriate electronic test equipment to monitor, troubleshoot and repair DS1/T1, DS1/HDSL carriers as well as analog and digital data loops.**
- **Demonstrate use of a voltmeter to test and troubleshoot power problems on DS1/T1, DS1/HDSL carriers and analog and digital data loops.**
- **Learn circuit layout from the network, through the central office, through the outside plant, to the customer premise.**
- **Learn the North American Digital Signal Hierarchy**
- **Learn voice frequency to digital code conversion (analog to digital)**
- **Learn Pulse Code Modulation (PCM) over the copper pair**
- **Learn principles of network timing and synchronization comparing synchronous, asynchronous, isochronous, and plesiochronous methods.**
- **Discuss timing options.**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- **Learn DS1/T1 signal generation Including framing, channel bank operation, framing formats, line coding (AMI vs. B8ZS) and alarm and error types and indicators.**
- **Learn of special circuits delivered over DS1/T1 and DS1/HDSL carriers**
- **Analyze the operation of T1 span line Repeaters, signal regeneration and repeater spacing.**
- **Learn the function of the NIUs (Network Interface Unit/Smart Jack) and CSUs (channel service unit) at the customer premise.**
- **Analyze the DC span power system that provides repeater operating voltage and sealing current.**
- **Demonstrate hands-on testing of conventional DS1/T1 span lines using electronic test sets and standard test patterns via various test access points.**
- **Learn HDSL coding (2B1Q for HDSL vs. TC-PAM for HDSL2 and HDSL4) and function of the HTU-C, HTU-R and HRE modules.**
- **Demonstrate hands-on testing of HDSL span lines using standard test sets and the HDSL serial port maintenance interface.**
- **Learn DS0 data concepts**
- **Analyze voice data applications and configurations including central office, outside plant, and customer premise systems**
- **Demonstrate hands-on testing of analog data loops utilizing a Transmission Impairment Measuring System (TIMS).**
- **Analyze digital data service (DDS) applications and configurations including central office, outside plant, and customer premise systems**
- **Demonstrate hands-on testing of digital data loops utilizing BERT sets (Bit Error Rate Tester).**

## Target Audience

This training course is ideally suited for both inside and outside telecommunications technicians responsible for installation, maintenance, troubleshooting, and repair of DS1/T1 and DS1/HDSL carriers as well as copper local loops delivering analog and digital data services.

## Prerequisites

None. However, a basic understanding of telephony / telecommunications is suggested.

## Course Outline

Module I: T1 and Signal Characteristics

- Circuit identification and layout
- Binary numbers
- Basic Telephone Loop
- Voice frequency (VF) signal conversion to digital code
- North American Digital Hierarchy


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- Digital signal multiplexing
- DS1/T1 channel bank operation
- Copper cable characteristics
- Network timing and synchronization
- Framing formats (SF and ESF)
- Line coding (AMI and B8ZS)
- DS1/T1 signal specs
- Hands-on verification of DS1/T1 operating parameters
- DS1/T1 signal errors and alarms
- DS1/T1 stress test patterns
- DSX-1 cross-connects
- And more...

Module II: DS1/T1 Span Line Operation and Troubleshooting

- Functional diagram analysis of DS1/T1 systems
- Central office repeater functions and signal levels
- Span line field repeater functions and signal levels
- Remote repeater functions
- NIU (Network Interface Unit/Smart Jack) and CSU (Channel ServiceUnit) functions at the customer premises.
- Measuring signal levels on the DS1/T1 span line
- DC power loop for repeater power and sealing current
- Measuring DC voltage, current and resistance on the DS1/T1 span line
- Hands-on troubleshooting DS1/T1 span line signal trouble
- Hands-on troubleshooting DS1/T1 span line DC power loop troubles
- And more...

Module III: DS1/HDSL Span Line Operation and Troubleshooting

- Functional diagram analysis of DS1/HDSL systems
- HTU-C functions and signal levels
- HTU-R (NIU; Smart Jack) functions and signal levels
- HRE functions and signal levels
- DC Power loop for repeater power and sealing current
- Side-by-side comparison for HDSL, HDSL2, and HDSL4 formats
- DS1/HDSL operational analysis using the serial port interface via laptop connection
- Hands-on troubleshooting HDSL systems with standard test sets and the serial port interface via laptop connection.
- And more...

Module IV: Basic Data Concepts

- Overview of data services delivered over the copper loop
- Power levels; TLP and DLP with lab exercise
- Impedance sources
- Noise effects and mitigation practices
- Balance vs. Unbalanced Interfaces
- Point-to-point and multipoint circuits


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- DTE and DCE functions

Module V: Voice Grade Data

- Modem signaling options; FSK, QPSK, Trellis, and QAM
- Baud vs. bit rate
- Analog impairments
- Analog data levels (DLP and TLP)
- Impedance matching; passive and equalization
- Noise measurements
- Alignment and testing using TIMS and loopback options
- Hands-on exercises

Module VI: Digital Data

- DDS Overview
- Data rates
- Secondary channel
- Error correction; ZCS, JB7
- Data circuit components and configurations; CSU/DSU, DST, OCU/DP, DSO/DP, DSU/DP
- Multi-junction units and configurations; QMJU, MJU, SRMU
- DSO-A vs. DSO-B
- Control codes
- Test patterns and standards
- Testing with DDS Test Sets and loopback options; alternating vs. latching
- Hands-on exercises

## Delivery Method

Instructor-led with multiple Hands-On labs and exercises.

## Equipment Requirements

**(This apply's to our hands-on courses only)**

BTS always provides equipment to have a very successful Hands-On course. BTS also encourages all attendees to bring their own equipment to the course. This will provide attendees the opportunity to incorporate their own gear into the labs and gain valuable training using their specific equipment.


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## Course Length

3 Days


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