Operating Manual

DLS 400A/H/N/HN

Wireline Simulator

Revision 1
January 1, 2000

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1. INTRODUCTION

Thank you for choosing DLS TestWorks.

DLS TestWorks has been in the wireline simulation business for over 20 years now. Since the days of the S2, DLS TestWorks has designed many new units to customers' specifications and to conform to an ever-growing range of standards. With the introduction of the DLS 100 in 1985 we sold the world's first truly wideband wireline simulator to successfully simulate attenuation, characteristic impedance and delay.

1.1 About the DLS 400 ADSL Wireline Simulator

The DLS 400 simulates twisted pair copper cables, sometimes called wirelines, to high frequencies. It provides over 30 different configurations of these cables. It is particularly suitable for testing Asymmetrical Digital Subscriber Loop (ADSL) transmission products, but can be used to test many other digital transmission products as well. The DLS 400 loop configurations address various testing requirements, depending on the model chosen (A, H, N or HN):

The **DLS 400A** offers all the ADSL test loops specified by ANSI T1.413 and a collection of other HDSL and ISDN test loops.

The **DLS 400H** offers all the loops necessary for testing to ANSI HDSL and HDSL2 specifications.

The **DLS 400N** offers all the loops necessary for testing to North American ADSL specifications, covering both ANSI and ITU G.lite loops. It also includes 5 TR 30.3 loops for evaluating the interaction of DSL modems and voiceband products.

The **DLS 400HN** combines the loops of both the DLS 400H and the DLS 400N into one single chassis.

In addition to the loop simulations, it is possible to add 1 or 2 wideband impairments generators, sometimes known as "impairments cards" to the unit. These allow the user to add a wide variety of impairments to the signals at one end of the line, and test telecommunications transmission systems according to specifications recommended by both European (ETSI) and North American (ANSI) and International (ITU–T) standards bodies.

With downloadable shapes, DLS TestWorks now offers the possibility of easily adding more crosstalk noise shapes as standards change. Impairments files can be stored on disk, and users may load these files into their noise and impairment module (NIM) using Windows® 95-compatible software. New impairments can be added simply by reading them as a new file into a DLS 400 with a NIM card or a NSA 400.

The DLS 400 is controlled by software running on any Windows® 95 computer. It includes both IEEE 488 and RS–232 interfaces for easy integration into a larger test system.

1.2 About this Manual

Experienced users can refer to chapter 2, “Quick Start”, to get their equipment up and running quickly. First-time users should read chapter 3, “Getting Started”, thoroughly before powering up the DLS 400. The remainder of the manual contains information about the software, the remote controls, warranty, specifications and performance.

If you have any questions after reading this manual, please contact your DLS TestWorks sales representative or our Ottawa Customer Service department at the locations listed in chapter 14, “Warranty”.

2. QUICK START

This section is for experienced users. If you are using the DLS 400 for the first time, please read chapter 3, "Getting Started".

1. Connect the power cord to the DLS 400 and switch the power on.
2. Connect either the IEEE 488 or the RS–232 cable.
3. Connect your "Central Office" equipment to side A of the DLS 400.
4. Connect your "Customer Site" equipment to side B of the DLS 400.
5. Start the software DLS&NSA.EXE (Wireline Simulator Control Software).
6. Select the desired loop, and if applicable, the length.
7. Select the desired impairments.
8. Begin testing.

3. GETTING STARTED

3.1 Receiving and Unpacking the Unit

The DLS 400 has been shipped in a reinforced shipping container. Retain this container for any future shipments.

Check that you have received all of the following items and report any discrepancies within 30 days:

- DLS 400 Unit
- Power Cord
- 2 extra fuses
- RS–232C interconnnection cable
- IEEE 488 interconnection cable
- 2 CF–to–twin RJ–45 adaptors
- DL4/NSA Control Software
- DLS 400 LabView driver software

3.2 Hardware and Software Requirements

To control the DLS 400, the following are required:

- DLS 400 ADSL Wireline Simulator
- DLS 400 software package
- Windows® 95 compatible computer with either:
    - National Instruments GPIB–PCII
    - IEEE 488 cable

  or

    - Serial port
    - RS–232 serial cable

3.3 DLS 400 Front and Rear Panels

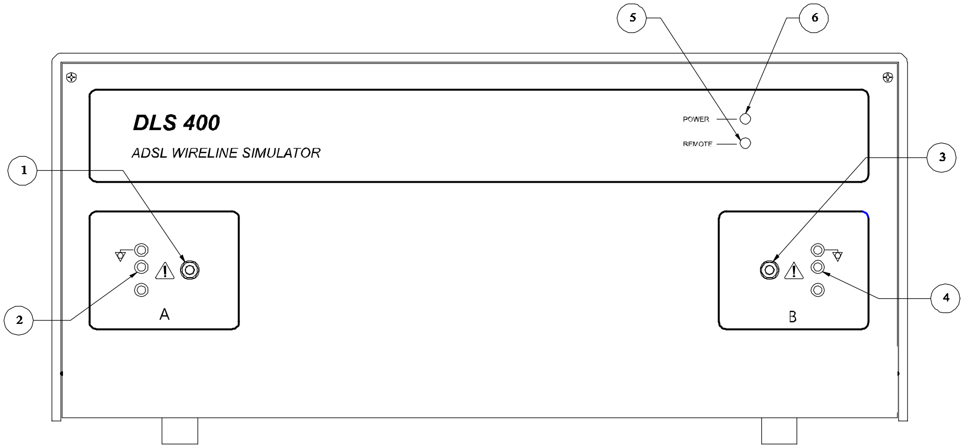


Figure 3.1 DLS 400 Front Panel

1) Side A bantam jack
2) Side A balanced CF connector
3) Side B bantam jack
4) Side B balanced CF connector
5) Remote LED
6) Power LED

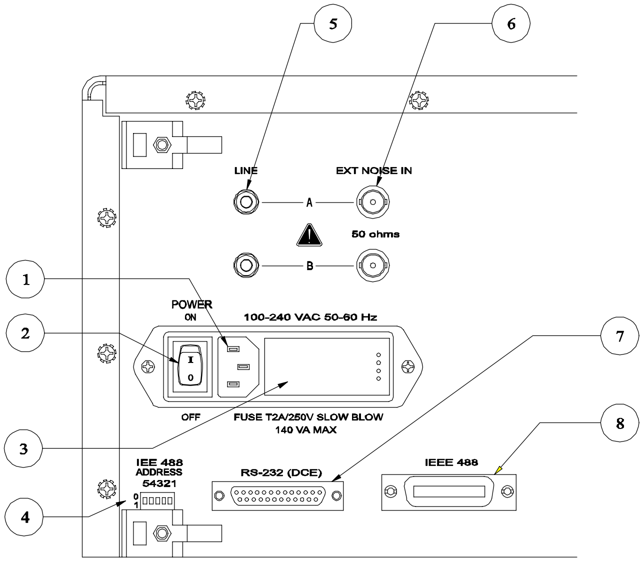


Figure 3.2 DLS 400 Back Panel

1) Power Input
2) Power On/Off Switch
3) Fuse box
4) IEEE 488 Address DIP switch
5) Side A line input/output (bantam jack)
6) Side A External Noise input (BNC connector)
7) RS–232 (DCE) serial connector
8) IEEE 488 connector

3.4 Digital Connections

The DLS 400 works with both IEEE 488 and RS–232 interfaces. Depending on your choice of interface, do one of the following:

1. **National Instruments GPIB–PCII card users only:** If necessary, install the card in your computer. (See section 3.10 for more details on installing the NI card and drivers.) Connect one end of an IEEE 488 cable to the IEEE 488 connector located on the back panel of the DLS 400. Connect the other end of the IEEE 488 cable to the IEEE 488 interface card in the computer.

2. **Serial port users only:** Connect one end of an RS–232 serial cable to the RS–232 connector located on the back panel of the DLS 400. Connect the other end to a serial port connector on the computer. The DLS 400 software works with COM1, COM2, COM3, or COM4.

3.5 Analog connections

The bantam connector on the DLS 400 is a 3-wire (ring, tip, sleeve) balanced connector with a diameter of 0.173” (4.39mm). The connector is also known under other names, such as miniature telephone connector, mini 310 connector, bantam telco jack, etc.

The CF connector is a balanced 3-pin (ring, tip, ground) connector. It is possible to use banana plugs instead of the CF connector, but note that the distance between the pins is not the 0.75” spacing used in North America.

Connect your “Central Office” equipment (or equivalent) to side “A” of the DLS 400, and connect your “Remote Device” (or equivalent) to side “B” of the wireline. You can use either the Bantam or CF connectors on the front of the unit, or the connectors on the back of the unit. Note that all the Bantam jacks and 3-pin CF connectors on each side are balanced and connected in parallel.

If an impairments card is installed in your system, many built-in impairments can be injected on to one end of the simulated line. In addition, externally-generated impairments can be injected using the “EXT NOISE IN” BNC connectors on the back of the DLS 400.

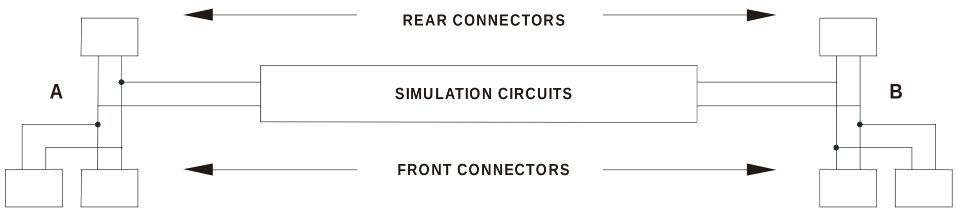


Figure 3.3 DLS 400 Internal Connection Paths

3.6 RJ–45 Adapter

In some cases, twisting of the Bantam connectors has introduced unwanted noise in testing. An RJ–45 connection will resolve this problem. Two RJ–45 adapters (one for each side) are now provided with all DLS 400 units. This adapter will convert each CF connection to two RJ–45 connections.

3.7 LEDs

The DLS 400 has 2 LEDs which indicate the power status and the remote status.

The POWER LED turns green when the power is turned on or after a reset. Exceptionally, the power LED will turn blinking red if it fails its self-test, or yellow if it detects an internal error.

The REMOTE LED turns off after a power-up and a reset. When the DLS 400 receives the first remote message, the REMOTE LED will then turn green. If the DLS 400 detects an error in the message, the REMOTE LED will then turn red and stay red until the error flags are cleared (see the command *ESR? in chapter 8 for more details). When the REMOTE LED is red, the DLS 400 can still communicate as normal, but you should investigate why the error occurred. Sections 7.1.5 and 7.2.2 show examples of programs that will read the ESR register and clear the error flags.

3.8 Connecting Power to the DLS 400

Connect the DLS 400 to an AC power supply via the power cable at the back of the unit. The unit can work with any voltage between 100 and 240 V_{RMS} ±10% and a frequency of 50 or 60 Hz.

The power LED indicates when power is connected and the unit is switched on.

3.9 DLS 400 Self-Test

When you switch on the power or issue a reset, the DLS 400 does a series of self-tests. If any of the self-tests fail, the DLS 400 will flash the POWER LED red, in which case you should call the factory.

Following is a short description of some of the self-tests the DLS 400 performs:

- Checks if the checksum of the EPROM is valid.
- Checks if the non-volatile RAM and its self-contained battery are functional. The battery has an expected life of over 10 years, and, if necessary, it can be easily replaced.
- Checks if the micro-controller is functional.

After the self-tests, the DLS 400 re-establishes the loop that was in use before the unit was turned off or reset, but an impairments card, if present, resets itself, so that NO impairments are put out.

3.10 National Instruments GPIB Card and Software Installation

Operation with an IEEE 488 interface requires installation of a National Instruments GPIB card and the associated GPIB software drivers.

Note: The GPIB software drivers must be installed before the installation of the DLS&NSA software.

If you are using an RS–232 interface, the NI card and drivers are not required.

If you already have the National Instruments card installed and working, or are using only a RS–232 interface, proceed to section 4.1 for information on installing the DLS&NSA software. Otherwise, follow the instructions below on installing the NI card and drivers.

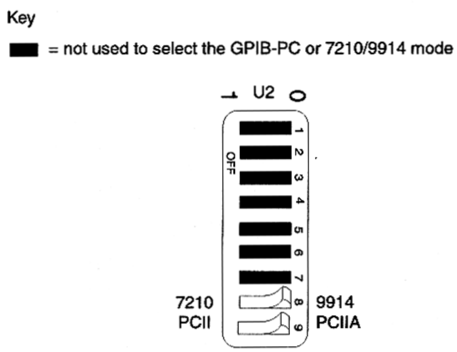
3.10.1 Installing National Instruments GPIB Software (IEEE 488 operation only)

1. From the Windows® 95 Start Menu, select “Settings” >> “Control Panel”.
2. In the control panel, select “Add/Remove Programs”.
3. Click on the “Install” button, and then “Next”.
4. Insert the first installation disk of the GPIB Software for Windows® 95 (NI–488.2M software) in drive A, and select “Next”, then “Finish”.
5. The National Instruments GPIB setup will begin, and a “GPIB Setting Options” screen will appear. Select the first option (“Install NI–488.2M Software for Windows® 95”), and follow the instructions to install the software.

3.10.2 Installing the GPIB–PCII/IIA Card (IEEE 488 operation only)

1. From the Windows® 95 Start Menu choose “Settings” >> “Control Panel”, followed by “Add New Hardware”. Click on the “Next” button to start the process. At this point, Windows will ask if it should search for your new hardware, choose “No” and click on “Next”.
2. A hardware list will appear. Choose “Other Devices” (towards the bottom of the list), and click on “Next”.
3. Choose National Instruments and the appropriate card (GPIB PC–II), and click on “Next”.
4. Windows will show some arbitrary card settings for IRQ, DMA, and Input/Output Range Settings. Click on “Next” to accept these settings, and then select “Finish” on the following screen.
5. Answer “No” when asked if you wish to re-start your computer.

6. From the Start Menu, select “Settings” >> “Control Panel” >> “System” >> “NI GPIB Interface”. Select the GPIB–PCII under Device Manager by clicking on the icon.
7. Click on “GPIB Settings” and click on the “Advanced” button.
8. Uncheck the “Automatic Serial Polling” check-box. Click “OK”.
9. Click on “Resources” to view the resource settings. Write down the resource settings.
10. Click “OK” and “OK” again to exit.
11. Shut down your computer.
12. Prepare the GPIB–PCII/IIA card for installation by configuring it for GPIB–PCII mode and 7210 mode (the default setting).



13. The manufacturer’s default resource settings for GPIB–PCII mode are:

Base I/O Address	02B8–02BF
Direct Memory Access	DMA Channel 1
Interrupt Level	IRQ 7

Compare the above settings with the settings you wrote down in step #9. If the settings are different, you must move the GPIB–PCII/IIA card’s jumper and switches to match the resource settings assigned by Windows® 95 before installing the card. For details, see chapter 2 of the National Instruments book *Getting Started with your GPIB–PCII/IIA and the GPIB Software for Windows® 95*, which comes with your National Instruments card.

14. Install the GPIB–PCII/IIA card in your computer.
15. Restart the computer.

3.10.3 How to Check if the NI card is installed properly

Check that the PC–II card is installed correctly by running the hardware diagnostic program. From the Windows® 95 Start menu, select “Programs” >> “NI–488.2M Software for Windows” >> “Diagnostic”. Click on “Test All”. If the diagnostic fails, or can’t find your GPIB card, make sure that the settings on the card match those specified in the Device Manager. If the diagnostic is successful, click “Exit” to return to Windows® 95.

4. DLS 400 SOFTWARE

4.1 Overview

The DLS 400 Control Software allows you to perform the following functions:

- set the IEEE 488 address of the software
- set the impairments card configuration of the software
- select the loop for testing, and for variable length loops, set the length of the loop and bridge tap(s)
- select Side A and/or Side B impairments and their parameters
- select Common Mode impairments and edit the longitudinal voltage
- load impairments from various standards
- save and load custom settings (or "edits") of impairments and loops

4.2 Software Installation

To install the DLS 400 Control Software, run "SETUP.EXE" from "D4 Series/NSA 400 Control Software" installation disk one and follow the instructions on the screen.

Note: Operation with an IEEE 488 interface requires installation of a National Instruments GPIB card and the associated GPIB software drivers **before** the installation of the DLS&NSA software.

If you are using an RS–232 interface, the NI card and drivers are not required.

4.3 Initial Screen

Launching the DLS 400 Control Software will bring up the initial screen of the DLS 400 software. This screen allows you to choose the system configuration corresponding to your unit (DLS 400A, DLS 400H, etc.) and the preferred communications mode (RS–232 or IEEE 488) for sending commands to the DLS 400.

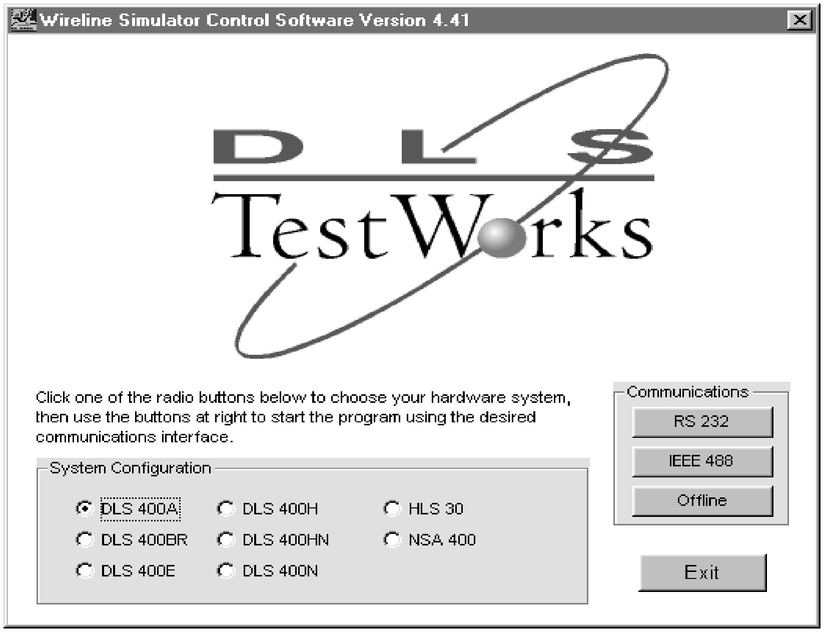


Figure 4.1 Initial Screen

There is also an Offline communications mode. This mode allows you to explore the system software. It is also used to set the IEEE 488 address and the configuration of impairment cards of your system (see section 4.4).

Note: All edits (changes made to loop and impairments settings) in Offline mode will be lost when you exit the software. However, changes to the IEEE 488 address and impairments cards configuration will be saved.

4.3.1 Changing Communications Mode

To change the Communications Mode from the main control screen, you must exit the program, either by choosing “Exit” from the File menu or by clicking the close box in the upper right-hand corner. The program must then be re-launched.

4.4 Unit Configuration

To set the software configuration of the IEEE 488 address and the impairments cards for your unit, go into Offline mode and from the main control screen select “Unit Configuration” from the Options menu.

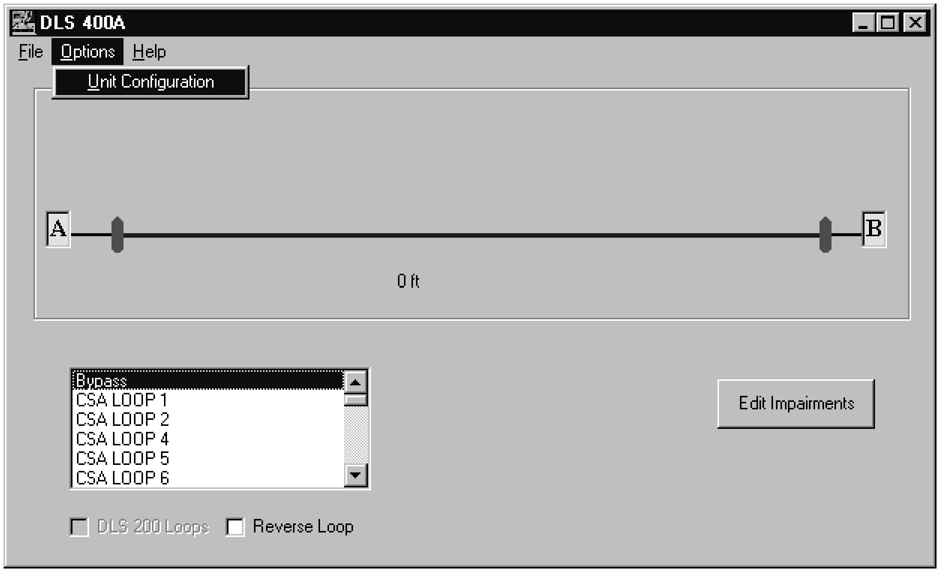


Figure 4.2 Main Control Screen

This will bring up the system configuration screen:

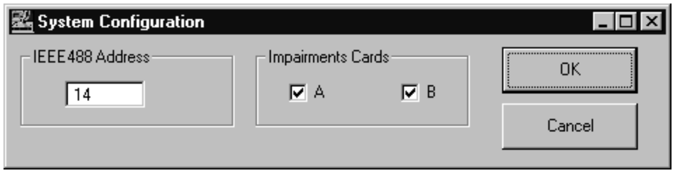


Figure 4.3 System Configuration Screen

Set the number of the IEEE 488 address to match the DIP switch settings on the DLS 400 rear panel (see sections 3.3 and 7.1.1 for details). Check the box(es) (A and/or B) corresponding to the impairments card(s) installed in your unit, if any.

Click “OK” to return to the main control screen. Exit the software and re-launch the program. The settings will be saved upon exiting the software, so they need not be set each time.

4.5 Main Control Screen

The main control screen features a schematic diagram of the simulated loop. Initially, the diagram represents the bypass loop. Use the scroll bar to see the available loops for your particular DLS 400 unit, and select the loop you wish to test for. The diagram will change to correspond to the selected loop.

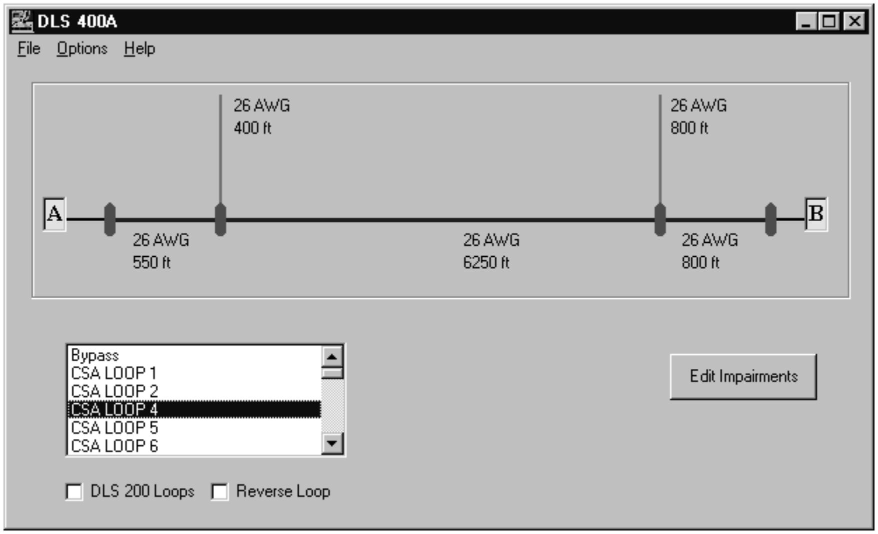
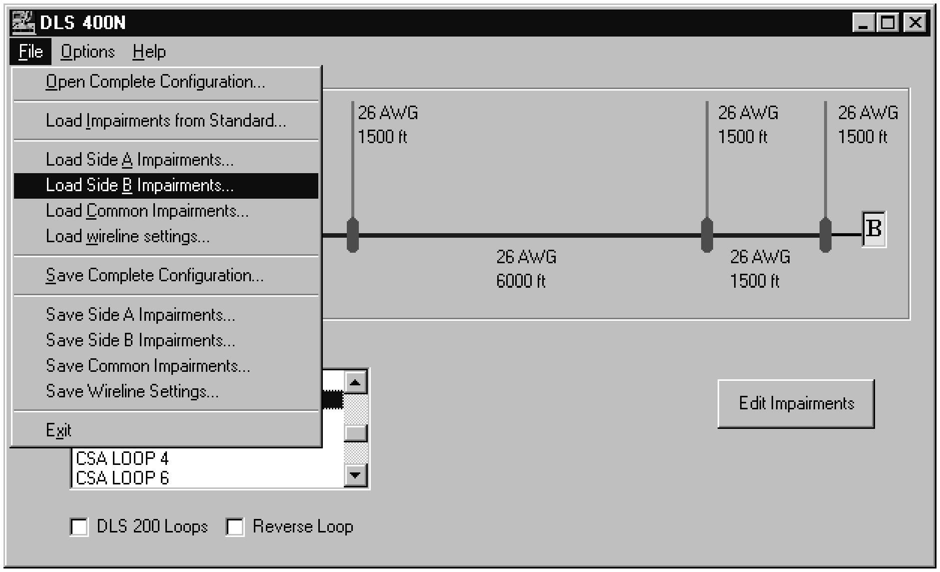


Figure 4.4 Control Screen showing CSA Loop #4

From the main control screen, the File, Options, and Help menus can be accessed. Clicking on the “Edit Impairments” button opens the Impairments Control Panel. Other options in the main control screen are “DLS 200 Loops” (see Appendix B for details) and “Reverse Loop” (see section 5.3.5).

4.5.1 Loading and Saving Settings

The File menu provides options for loading and saving impairments, wireline settings, and complete unit configurations (i.e. both wireline settings and impairments). You can also choose “Load Impairments from Standard” (see section 4.5.1.1).



The file extensions for the above file types are as follows:

File Type	File Extension
Complete Configuration	*.D4
Side A/Side B Impairments	*.D4S
Common Mode Impairments	*.D4C
Wireline Settings	*.D4W

4.5.1.1 Loading Standards Impairments Settings

The File menu item “Load Impairments from Standards” allows you to load all the impairments parameters required for testing to a particular standard, rather than having to enter each parameter individually. Note that after choosing one of the impairments combinations, you must still select the loop(s) to be tested from the main control screen, and you must also turn on the impairments card(s) in the Impairments Control Panel (see section 4.6).

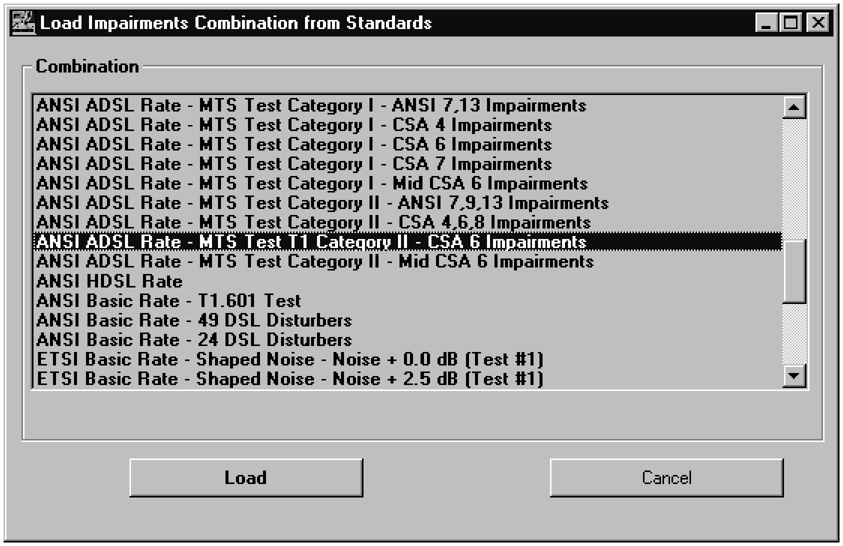


Figure 4.5 Load Impairments Combination from Standards

There are over 50 combinations of impairments available, which allows setting the impairment parameters to perform testing according to a variety of North American and European standards:

- ANSI ADSL Rate
- ANSI HDSL Rate
- ANSI Basic Rate

- ETSI ADSL Rate
- ETSI HDSL Rate
- ETSI Basic Rate
- FTZ Basic Rate

Note: The impairments parameters for other testing standards, such as ANSI HDSL2 Rate and ITU–T Splitterless ADSL Rate, can be loaded manually.

4.6 Impairments Control Panel

Clicking the “Edit Impairments” button in the main control screen opens the impairments control panel. This allows you to apply and edit impairments to Sides A & B and to start computer-controlled impulses. It also allows you to apply and edit Common Mode impairments, and to select the powerline frequency.

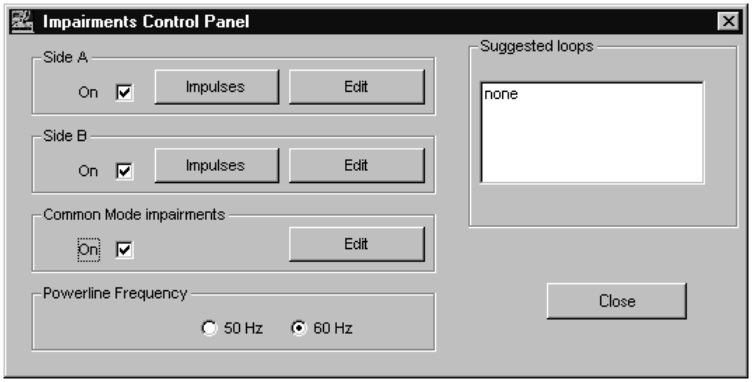


Figure 4.6 Impairments Control Panel

The various settings are detailed in the table on the following page.

Name	Description
Side A/Side B	• Check the "On" box to apply impairments to the line • Click on the "Edit" button to set the impairments • Click on the "Impulses" button to start the computer-controlled impulse generation.
Common Mode impairments	• Check the "On" box to apply impairments to the line • Click on "edit" to set the Common Mode impairments. Note that Common Mode impairments cannot be applied when the line is set to 0 length.
Powerline Frequency	Select between 50 Hz or 60 Hz.
Suggested Loops	When impairments are loaded from a standard, the loops called for in that standard will be listed in this box. Note that loops cannot be selected from this screen. To select a loop, return to the main control screen.
"Close" button	Closes the Impairments Control Panel and returns you to the main control screen.

4.6.1 Editing Impairments Screen

Clicking the "Edit" button for Side A or Side B opens the Editing Side A or Editing Side B screens. The parameters shown depend on the impairments combination selected in "Load Impairments from Standards" (see section 4.5.1.1). To see all available parameters, select "All-impairments combination".

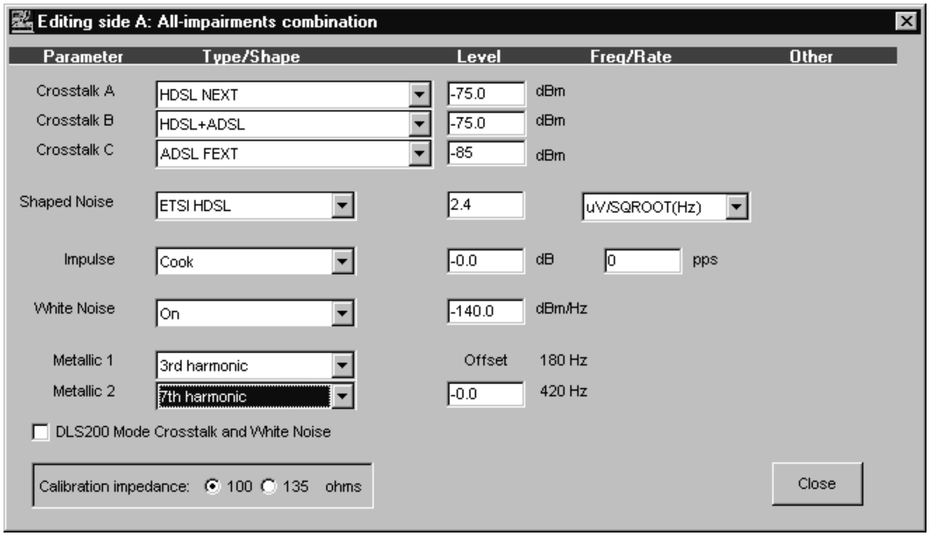


Figure 4.7 Editing Impairments Screen

The various settings are detailed in the table on the following page.

Name	Description
Parameter	The following parameters are available: • Crosstalk noise generators (A, B, C) • Shaped Noise • Impulse • White Noise • Metallic 1 • Metallic 2 • Longitudinal
Type/Shape	• Select the type for the chosen parameter from the pull-down list. Some shapes may require selection of a file from more than one crosstalk generator. • For the downloadable shapes files, placing your cursor over this field will bring up a callout which provides the shape name, description, the standard, and the range. According to which standard you are testing, there are prefixes outlining the standards associated with the shape.
Level	• Set the level of the parameter. • Placing the cursor over this field brings up a callout which tells you the minimum and maximum values that you may enter. This field will not allow you to set a value that is out of range.
Freq/Rate	Set as required.
Other	Set the width of 3-level, bipolar and unipolar impulses.
DLS 200 Mode Crosstalk and White Noise	Select this mode in order to achieve results comparable to those obtained with a DLS 200 unit. See section 6.12.3 for more details.

Name	Description
Calibration Impedance	Shows the impedance used to calculate dBm power levels. Note that when this value is changed, the absolute power of the signal being injected is not changed, but rather its dBm reading is changed.
“Close” button	Closes the Editing screen and returns you to the impairments control panel.

4.6.2 Edit Longitudinal Voltage (Common Mode Impairments)

Common Mode impairments are only enabled for the following impairments combinations: All-impairments combination, ANSI HDSL Rate, ETSI HDSL Longitudinal Test (Test #3), and ETSI HDSL Rate Common Mode Test. Clicking on the “Edit” button for Common Mode impairments opens the Edit Longitudinal Voltage screen.

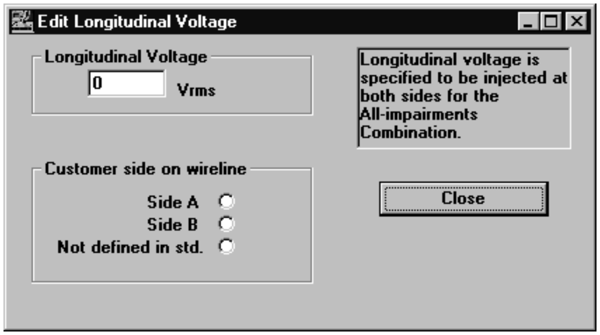


Figure 4.8 Edit Longitudinal Voltage

This screen allows you to set the level of the longitudinal voltage, within a minimum and maximum pre-determined by the standard chosen. It also allows you to select which side of the wireline (A or B) is the customer (as opposed to CO) side.

4.7 Impulse Control

The Impulse Control feature will generate a total of 15 computer-controlled impulses at an interval of 1.1 seconds. To use the Impulse Control feature, one of the impairments generators (A or B) must be on. You must then select a type, level and width (if applicable) in the Editing Impairments Screen. The pps (pulse per second) value however, must be set to zero.

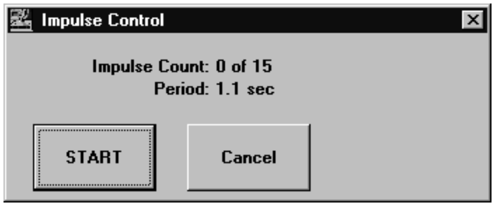


Figure 4.9 Impulse Control Screen

4.8 Operating Two or More Units from the 400 Series Concurrently

Two or more units from the 400 series (DLS 400A, DLS 400E, and NSA 400) can be operated at the same time over the IEEE bus. However, each unit must be launched by its own session of the control software and each unit must have a unique IEEE address. To create new sessions of the control software, do the following:

1. Create a new software folder for each additional unit you want to control.
2. Copy the folder containing the DLS&NSA software, including all sub-directories, to the new folder.
3. Rename the .exe file in the new folder (for example, DLS&NSA2.EXE).

Ensure that each unit has a unique IEEE address.

5. SYSTEM DESCRIPTION

5.1 DLS 400 Description

Delivering high-speed data, voice, and video to a subscriber's site over a single pair of wires requires a large bandwidth for transmission, coupled with complex algorithms of compression, error correction, and echo cancellation. The DLS 400 provides a perfect test bed for optimizing these algorithms. Due to the large bandwidth provided by the DLS 400, it is suitable for testing ADSL, HDSL, and ISDN (BRI & PRI) transmission products. The DLS 400 is equally suited for testing transmission schemes which use DMT, CAP, 2B1Q, and any other line codes.

The DLS 400 reproduces the AC and DC characteristics of real telephony cable using networks of passive discrete components (R, L & C). It contains hundreds of segments of cable simulation which are matrixed together in various configurations and line lengths. Cable is simulated accurately up to 2.0 MHz, and higher in some configurations. This makes it suitable for testing ADSL transmissions up to 7 Mbit/s. The unit provides 28 standard test loops for testing ADSL and several others can be created by the user, including bridge tap settings on either or both sides. In addition to the loops, the DLS 400 also provides optional impairments generators which can be used for testing, ISDN Basic Rate, HDSL rate or ADSL rate transmission equipment to European or North American standards.

The devices under test are connected to the DLS 400 using either the Bantam or 3-pin CF connectors, located at the front and back of the unit. All connectors on each side are connected in parallel.

The unit can be controlled via the IEEE 488 and the RS–232 serial interfaces. One simple command is all that is needed to select the loop, but other IEEE 488.2 and SCPI commands are also supported.

Impairments can be applied at one or both ends of the loop by using the impairment generator(s). A generator is always associated with either terminal A or terminal B of the DLS 400, according to where it is installed in the unit. It is possible to change a generator over from terminal A to terminal B if it is necessary to test the unit at the other end of the line.

5.2 DLS 400 Unit Loopset Configurations

Depending upon the configuration chosen, the DLS 400 can simulate up to 29 different loops defined in various standards, plus 4 variable loops.

DLS 400A

BYPASS	CSA #0	MID-CSA #0	ANSI #2
	CSA #1	MID-CSA #1	ANSI #3
VARIABLE 24 AWG	CSA #2	MID-CSA #2	ANSI #4
VAR 24 AWG+TAP	CSA #4	MID-CSA #3	ANSI #5
VARIABLE 26 AWG	CSA #5	MID-CSA #4	ANSI #6
VAR 26 AWG+TAP	CSA #6	MID-CSA #5	ANSI #7
	CSA #7	MID-CSA #6	ANSI #8
	CSA #8		ANSI #9
	EXT-CSA #9		ANSI #11
	EXT-CSA #10		ANSI #12
			ANSI #13
			ANSI #15

DLS 400H

BYPASS	CSA #1
	CSA #2
VARIABLE 24 AWG	CSA #3
VAR 24 AWG+TAP	CSA #4
VARIABLE 26 AWG	CSA #5
VAR 26 AWG+TAP	CSA #6
	CSA #7
	CSA #8
	EXT-CSA #9
	EXT-CSA #10

DLS 400N

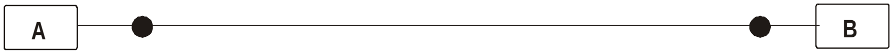
BYPASS	CSA #4	ANSI #1	EIA #1
	CSA #6	ANSI #2	EIA #2
VARIABLE 24 AWG	CSA #7	ANSI #5	EIA #3
VAR 24 AWG+TAP	CSA #8	ANSI #7	EIA #4
VARIABLE 26 AWG	MID-CSA #6	ANSI #8	EIA #5
VAR 26 AWG+TAP		ANSI #9	
		ANSI #13	
		MID-ANSI #7	

DLS 400HN

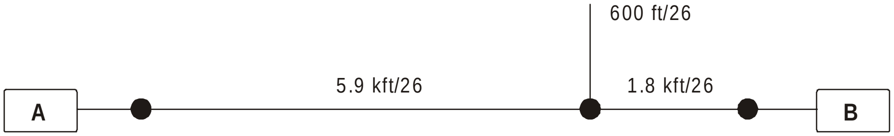
BYPASS	CSA #1	ANSI #1	EIA #1
	CSA #2	ANSI #2	EIA #2
VARIABLE 24 AWG	CSA #3	ANSI #5	EIA #3
VAR 24 AWG+TAP	CSA #4	ANSI #7	EIA #4
VARIABLE 26 AWG	CSA #5	ANSI #8	EIA #5
VAR 26 AWG+TAP	CSA #6	ANSI #9	
	CSA #7	ANSI #13	
	CSA #8	MID-ANSI #7	
	EXT-CSA #9		
	EXT-CSA #10		
	MID-CSA #6		

5.3 Loop Descriptions

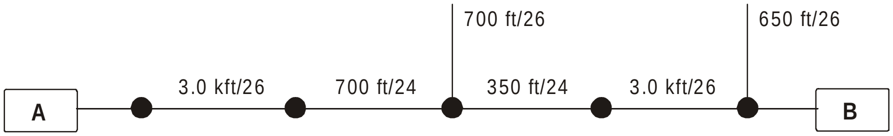
5.3.1 CSA Loops



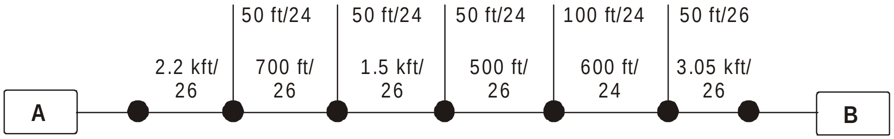
BYPASS/CSA #0



CSA #1

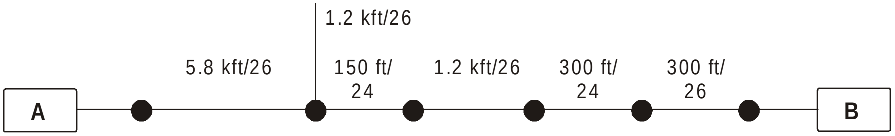


CSA #2

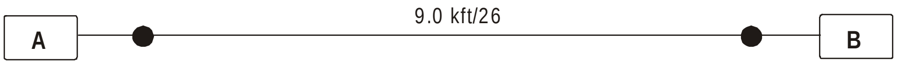


CSA #3

CSA #4

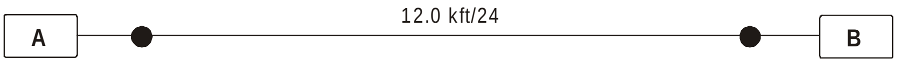


CSA #5



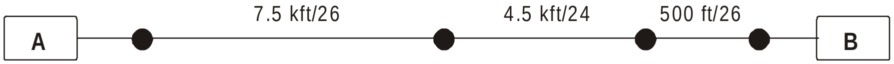
CSA #6

CSA #7



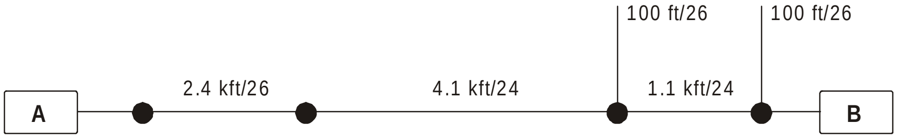
CSA #8

EXT–CSA #9



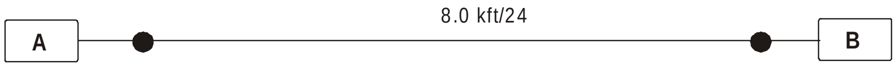
EXT–CSA #10

MID–CSA #0



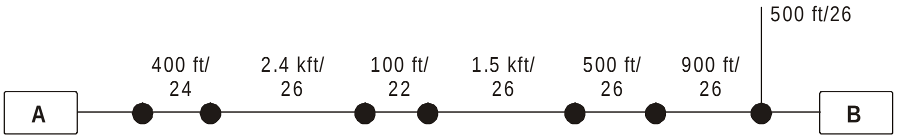
MID–CSA #1

MID–CSA #2



MID–CSA #3

MID–CSA #4



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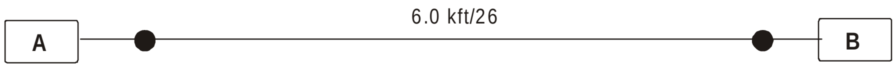
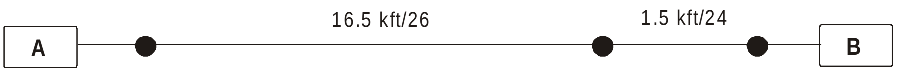
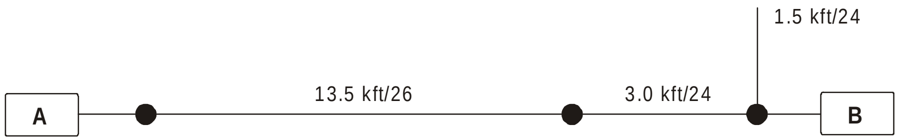


MID–CSA #6

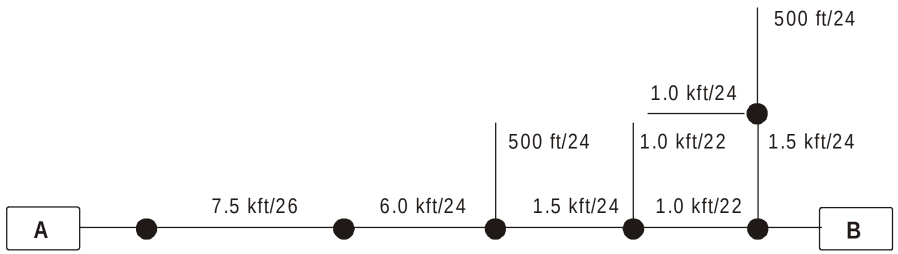
5.3.2 ANSI Loops



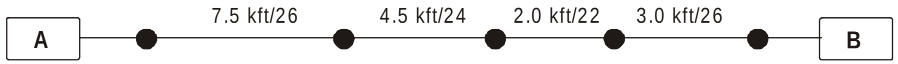
ANSI #1



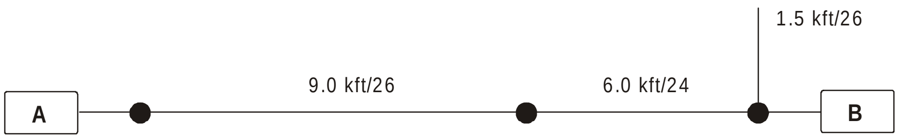
ANSI #2



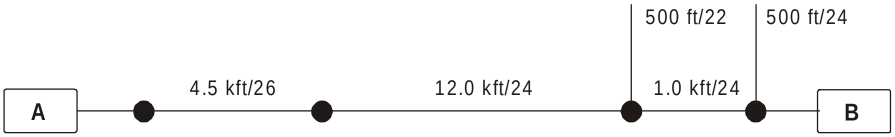
ANSI #3



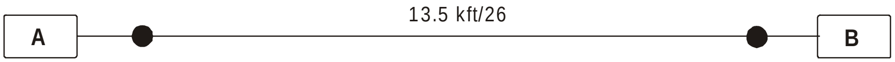
ANSI #4



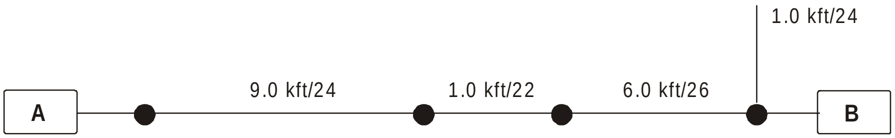
ANSI #5



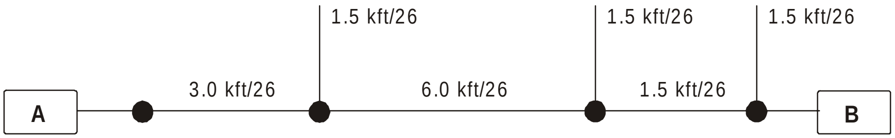
ANSI #6



ANSI #7

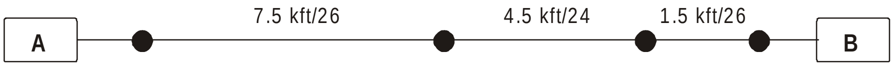


ANSI #8

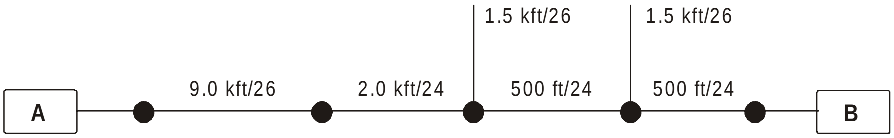


ANSI #9

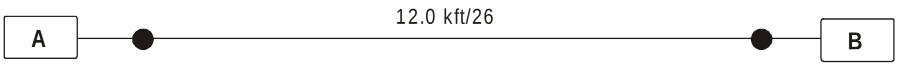
ANSI #11



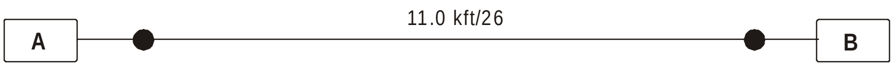
ANSI #12



ANSI #13

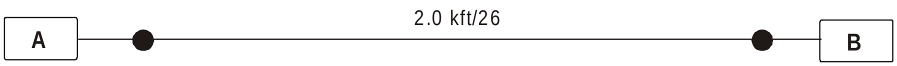


ANSI #15

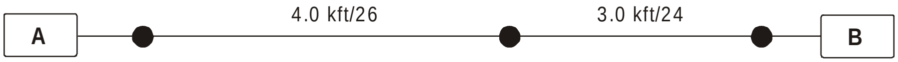


Mid-ANSI #7

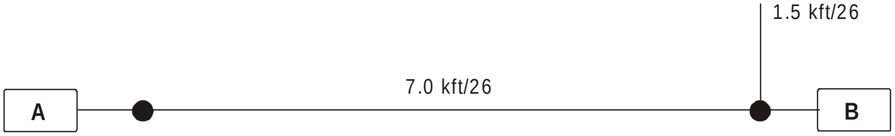
5.3.3 EIA Loops



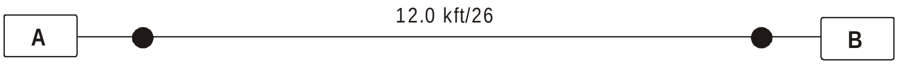
EIA #1



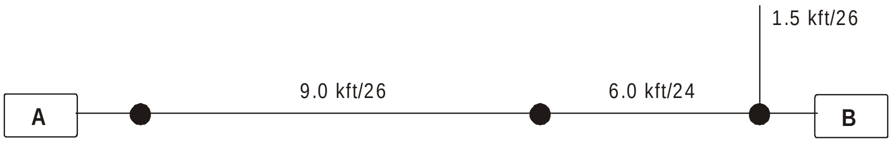
EIA #2



EIA #3

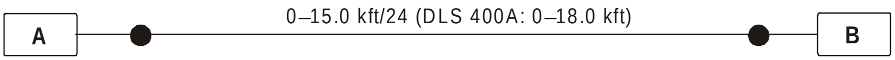


EIA #4

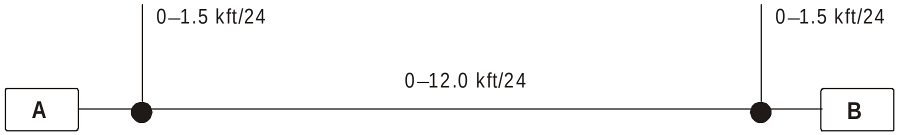


EIA #5

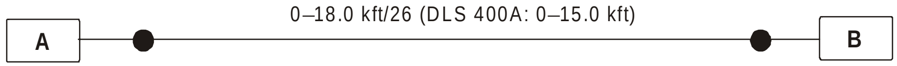
5.3.4 Variable Loops



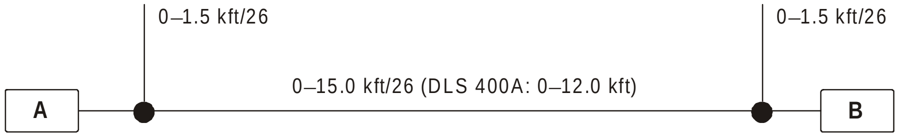
Variable 24 AWG



Var 24 AWG+Tap



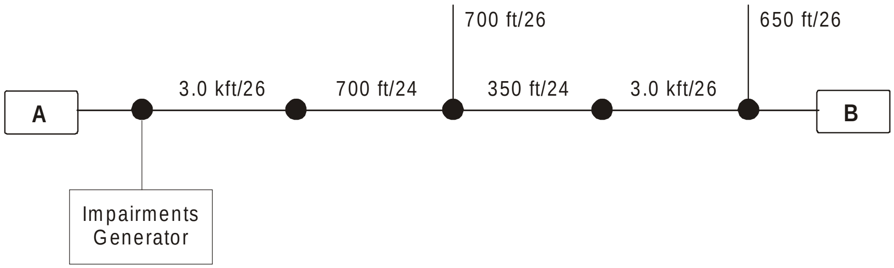
Variable 26 AWG



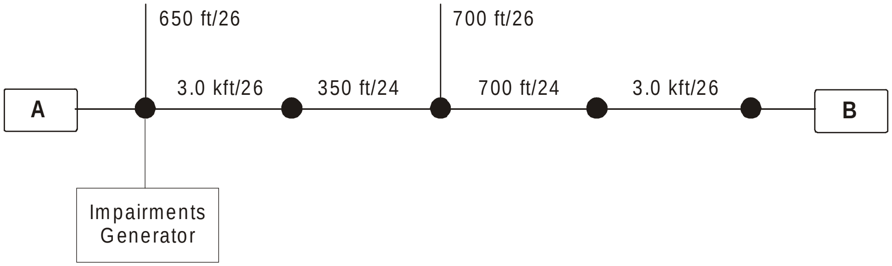
Var 26 AWG+Tap

5.3.5 Reversing Loops

All these loops can be reversed under software control. The effect of doing this is to reverse the connections to terminals A and B within the DLS 400, but leave the make up of the loop unchanged. For example, if you set CSA loop 2, with impairments on slot A, you would get this loop:



If you reverse the loop, the configuration of the loop will be as follows:



Here the loop has changed, but the position of the impairments generator has not. That is, the impairments generator is still injecting noise on side A. Injecting noise on side B of CSA loop #2 could be achieved by opening the chassis and moving the card into slot B, reversing the loop and re-connecting the ATU-C equipment to side B and the ATU-R equipment to side A. If the unit is installed with 2 noise cards (one on side A and the other on side B), noise can be injected on either side of the loop by selecting the appropriate noise card, without the need to move a single noise card nor to reconnect the ATU-C and ATU-R equipment.

Note: When a loop is reversed, the main control screen will not show a reversed diagram of the loop. Rather, it will show the loop with the **terminal positions** (A and B) reversed and highlighted in magenta.

That is, the diagrams for CSA loop 2 and reversed CSA loop 2 are as follows:

Diagram for CSA Loop #2

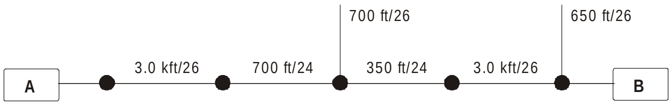
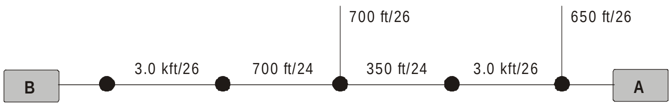


Diagram for reversed CSA Loop #2



6. ADSL NOISE GENERATOR DESCRIPTION

6.1 General

The DLS 400 system can contain up to 2 noise cards. Each is used to inject noise at one end of the wireline. A card in slot A injects differential mode impairments at the input/output connector A of the DLS 400, and the card in slot B injects noise at connector B. The card in slot B is used to inject longitudinal noise on to the wireline. When there are 2 ADSL cards, the transformer is connected to the card in slot B. If there is only 1 ADSL card, that card is connected to the transformer and is used to supply the longitudinal noise. You must indicate the impairment cards loaded, by selecting Unit Configuration from the Options menu of the Control Screen.

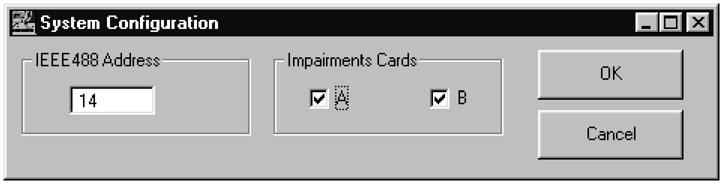


Figure 6.1 System Configuration Screen

6.2 Grouped Impairments

Most impairments generated are specified by ANSI's T1E1 committee setting standards for ISDN Basic Rate, HDSL rate and ADSL rate testing of transmission devices. Some of the impairments are specified by the ETSI committee that sets standards for the same set of transmission device tests in Europe. In addition, the ITU is also starting to set standards for ADSL testing. When grouped by the relevant standards, the impairments are as follows:

6.2.1 Basic Rate Testing, ANSI T1.E1 T1.601 standard

Impairment	Description
Longitudinal Noise	Up to 60 volts common mode injection at side B, 60 Hz (option 50 Hz).
Power related Metallic Noise	Odd harmonics of the fundamental up to 11th harmonic.
Crosstalk Noise (NEXT)	Spectrum and level as specified by ANSI for basic rate DSL 2B1Q transmission.

6.2.2 HDSL Rate Testing, ANSI Technical Report on HDSL

Impairment	Description
Crosstalk Noise (NEXT)	Spectrum and level as specified by ANSI for HDSL rate DSL 2B1Q transmission.
Power related Metallic Noise	Odd harmonics of the fundamental up to 11th harmonic.

6.2.3 HDSL2 Rate Testing, ANSI Proposed Working Draft for HDSL2 Standard (T1E1.4/98–268)

Impairment	Description
Crosstalk Noise (NEXT)	Spectrum and level as specified by ANSI for HDSL2 rate transmission.

6.2.4 ADSL Rate Testing, ANSI T1.413, Issue I and II

Impairment	Description
Impulse Noise	Both c1 and c2 types of impulses, as specified.
Crosstalk Noise	Different types of crosstalk noise, which can be injected over varying levels and in combination. There are 3 different and independent crosstalk generators. The output level of each one is variable. They can be mixed together to form a wide variety of crosstalk combinations.

6.2.5 ADSL Rate Testing, ITU Standard for G.lite

Impairment	Description
Crosstalk Noise (NEXT)	Spectrum and level as specified by ANSI for ADSL G.lite rate transmission.

6.2.6 Basic Rate Testing, ETSI TS 102 080 ISDN Standard

Impairment	Description
Shaped Noise	Multiple tones at 160 Hz and harmonics up to 300 kHz, amplitude and phase related as specified.
Impulse Test	A bipolar pulse, of selectable pulse width, rate and level.
Longitudinal Noise	Common mode at 50 Hz (60 Hz option) at up to 20 Volts

6.2.7 HDSL Rate Testing, ETSI TS 101 135 HDSL Standard

Impairment	Description
Shaped Noise	Multiple tones at 320 Hz and harmonics up to 1.5 MHz, amplitude and phase related as specified.
Impulse Test	The Cook pulse, of selectable rate and level.
Longitudinal Noise	Common mode at 50 Hz (60 Hz option) at up to 20 Volts

6.2.8 European ADSL rate testing, ETSI ETR 328 ADSL Standard

Impairment	Description
Impulse Noise	Both c1 and c2 types of impulses, as specified.
Crosstalk Tests 1 and 2	Also known as Model A and Model B crosstalk tests.
Maximum stress linearity test	White noise at –140 dBm/Hz from 1 kHz to 2 MHz

6.3 Individual Impairments

A list of all the individual impairments that can be generated is given below. These impairments can be used in one of the preset combinations mentioned above. Alternatively, all of the impairments can be loaded as follows:

1. In the main control screen, select File >> “Load Impairments from Standard”.
2. Select “All-impairments combination”.

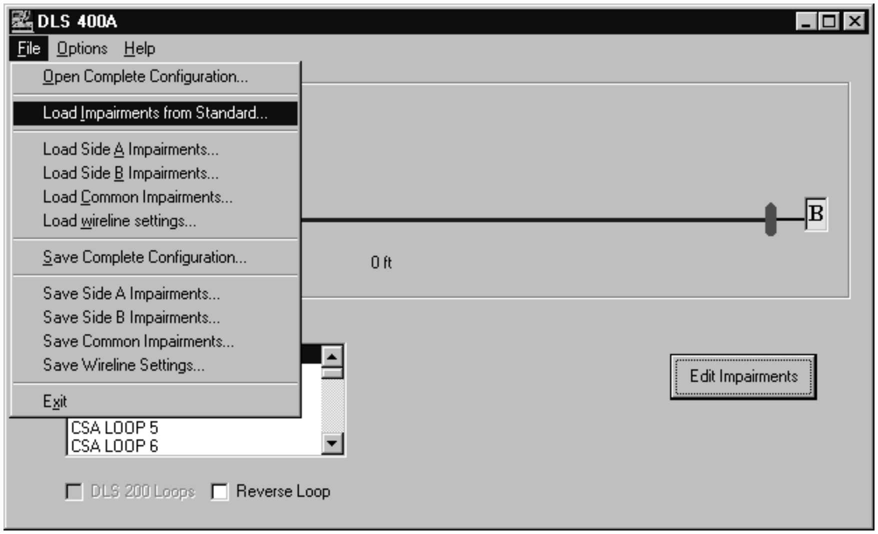


Figure 6.2 Loading all impairments

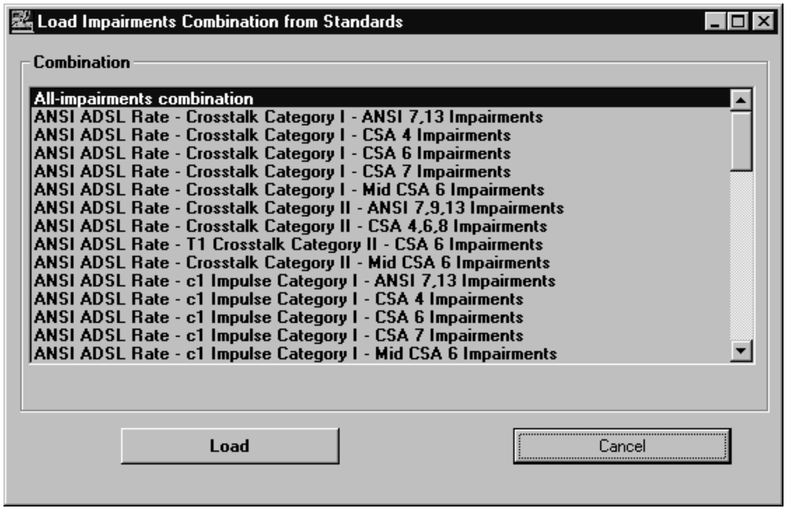


Figure 6.3 Impairments combinations

One or all of the possible impairments can be set at varying levels, and in any combination. This very powerful mix of impairments can be used to provide a rich variety of test conditions.

Name	Type	Level Range	Description
T1.601	Crosstalk	–75 to –30 dBm	For spectrum, see Figure 11.1
DSL NEXT	Crosstalk	–75 to –30 dBm	For spectrum, see Figure 11.2
HDSL NEXT	Crosstalk	–75 to –30 dBm	For spectrum, see Figure 11.3
HDSL+ADSL	Crosstalk	–75 to –30 dBm	For spectrum, see Figure 11.4
ADSL FEXT	Crosstalk	–85 to –35 dBm	For spectrum, see Figure 11.13
ADSL A	Crosstalk	–85 to –35 dBm	For spectrum, see Figure 11.14
ADSL B	Crosstalk	–85 to –35 dBm	For spectrum, see Figure 11.15
T1	Crosstalk	–85 to –35 dBm	For spectrum, see Figure 11.16
E1.AMI	Crosstalk	–85 to –35 dBm	For spectrum, see Figure 11.17
ADSL upstream NEXT (T1.413, Issue I and II)	Crosstalk	–30 to –80 dBm	For spectrum, see Figure 11.5
ADSL upstream FEXT (9 kft 26 AWG)	Crosstalk	–30 to –80 dBm	For spectrum, see Figure 11.6
ADSL upstream NEXT (ITU G.Lite)	Crosstalk	–30 to –80 dBm	For spectrum, see Figure 11.7
FDM ADSL downstream FEXT (13.5 kft 26 AWG)	Crosstalk	–45 to –95 dBm	For spectrum, see Figure 11.8
ADSL upstream FEXT (13.5 kft 26 AWG)	Crosstalk	–45 to –95 dBm	For spectrum, see Figure 11.9
HDSL2 downstream NEXT (H2TUC)	Crosstalk	–30 to –80 dBm	For spectrum, see Figure 11.10

Name	Type	Level Range	Description
HDSL2 upstream NEXT (H2TUR)	Crosstalk	–30 to –80 dBm	For spectrum, see Figure 11.11
T1 (AMI) NEXT	Crosstalk	–18 to –68 dBm	For spectrum, see Figure 11.18
EC ADSL downstream NEXT	Crosstalk	–17 to –67 dBm	For spectrum, see Figure 11.19
HDSL2 EC ADSL downstream NEXT	Crosstalk	–17 to –67 dBm	For spectrum, see Figure 11.20
FDM ADSL down-stream FEXT (9 kft 26 AWG)	Crosstalk	–40 to –90 dBm	For spectrum, see Figure 11.21
FDM ADSL down-stream NEXT	Crosstalk	–17 to –67 dBm	For spectrum, see Figure 11.22
EURO K	Crosstalk	–20 to –70 dBm	For spectrum, see Figure 11.12
ETSI BASIC	Shaped	3.2 to 100 $\mu V/\sqrt{Hz}$	ETSI Basic Rate Shaped Noise
ETSI HDSL	Shaped	3.2 to 100 $\mu V/\sqrt{Hz}$	ETSI HDSL Rate Shaped Noise.
FTZ 1TR 200	Shaped	3.2 to 100 $\mu V/\sqrt{Hz}$	Basic Rate Shaped Noise to FTZ specs.
Metallic 1		Offset ±10 dB	Any odd harmonic up to 11th of 60 Hz (or 50 Hz)
Metallic 2		Offset ±10 dB	Any odd harmonic up to 11th of 60 Hz (or 50 Hz)
Longitudinal	Common mode	0–60 V (60 Hz) 0–50 V (50 Hz)	A triangle wave common-mode
White Noise		–140 to –90 dBm/Hz	Flat white noise.

Name	Type	Level Range	Description	Rate	Width
Cook Pulse	Impulse	–20 to +6 dB	Used for HDSL rate testing. See Figure 6.5.	0–100 pps or single shot	n/a
ADSL #1 (c1)	Impulse	0–100 mV	Used for ADSL rate testing. See Figure 6.6.	0–100 pps or single shot	n/a
ADSL #2 (c2)	Impulse	0–100 mV	Used for ADSL rate testing. See Figure 6.7.	0–100 pps or single shot	n/a
Bipolar	Impulse	0–100 mV		0–100 pps or single shot	20–120 µs
3-Level	Impulse	0–100 mV		0–100 pps or single shot	20–120 µs
Unipolar	Impulse	0–100 mV		0–100 pps or single shot	20–120 µs

NOTES

1. Level ranges in dBm are on a 100 Ω dBm scale. They are measures of the total power in the bandwidth DC to 1.5 MHz.
2. Metallic noise is specified in T1.601 using a special load, and 135 Ω dBm scale. The levels are relative to the reference levels of the odd harmonics which are:

Frequency [Hz]	Level [dBm]
60	–47
180	–49
300	–59
420	–65
540	–70
660	–74

3. Cook pulse levels are relative to the reference level of 318 mV p–p, when using a 135 Ω system.
4. The level range given for shaped noise is obtained using a 135 Ω system.

6.4 Impairment Card Organization

The Impairments card contains several generators that can simulate various impairments. These generators can all generate signals simultaneously, although each individual generator can produce only one impairment at a time. The signals generated are added together in the summing amplifier. Some generators, such as Crosstalk A, can generate several choices of crosstalk, but not simultaneously.

The following block diagram shows these generators:

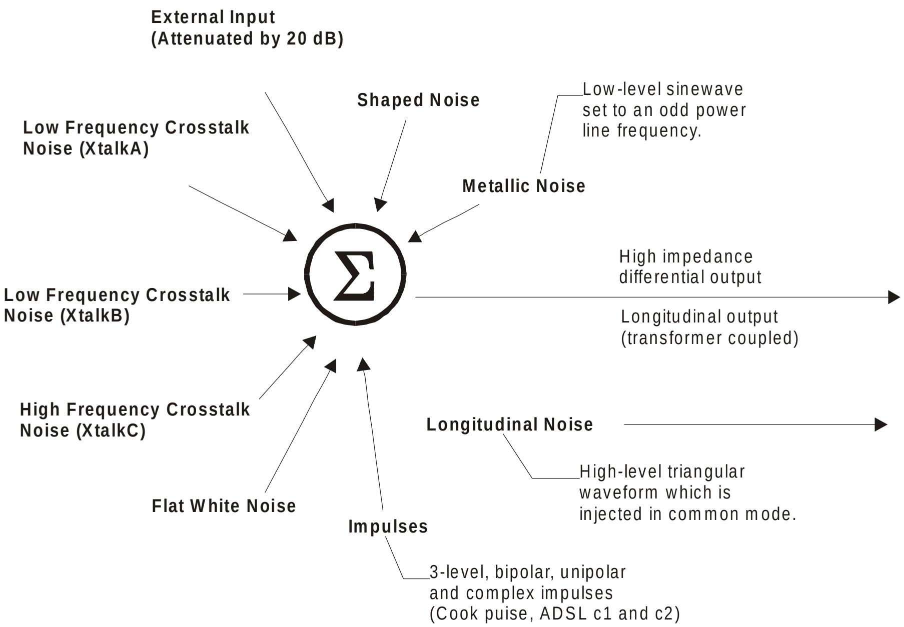


Figure 6.4 Impairment Generators Block Diagram

6.5 Output Stage

The noise generator can be completely disconnected from the line by one single relay even if impairments are still being generated inside the unit. This is done in the Impairments Control Panel by unchecking the check box for Side A and/or Side B. Doing so also removes the very slight loading effect of the impairments card.

Note: As the output impedance is high, the noise generator acts as a current source.

For any impairments except longitudinal noise, the level seen on the line depends on the line impedance.

6.6 Crosstalk Generators A and B

The impairments card contains two independent low frequency crosstalk generators able to produce a variety of shaped white noises up to 600 kHz. Generator B can produce all of the signals that generator A can produce, as well as some that generator A cannot produce. In addition, generator B is more versatile than generator A.

Reference levels of noise, with dB based on 100 Ω, are as follows:

Type	Level [dB]
T1.601	–45.0
10–disturber DSL NEXT	–56.1
10–disturber HDSL NEXT	–47.6
10–disturber ADSL NEXT	–49.9
10–disturber HDSL+ADSL	–45.6
49–disturber ADSL upstream NEXT (ANSI T1.413 Issue I and II)	–43.3
49–disturber ADSL upstream FEXT (9kft 26AWG)	–69.1
49–disturber ADSL upstream NEXT (ITU G. Lite)	–43.3
49–disturber FDM ADSL downstream FEXT (13.5kft 26AWG)	–83.9
49–disturber ADSL upstream FEXT (13.5 kft 26 AWG)	–81.8
49–disturber HDSL2 downstream NEXT (H2TUC)	–33.9
49–disturber HDSL2 upstream NEXT (H2TUR)	–36.6
EURO K	–40.1

The difference in levels due to different numbers of interferers is:

Number of disturbers	Level difference [dB] relative to 10–disturber	Level difference [dB] relative to 49–disturber
49	+4.1	+0.0
24	+2.3	–1.8
20	+1.8	–2.3
10	0.0	–4.1
4	–2.4	–6.5
1	–6.0	–10.1

6.7 Crosstalk Generator C

The (high frequency) crosstalk generator C produces noise with frequency components up to 2 MHz. Reference levels of noise, with dBm based on 100 Ω, are:

Type	Level [dB]
10–disturber ADSL FEXT	–69.6
ADSLA	–49.4
ADSLB	–43.0
10–disturber T1 NEXT	–47.8
10–disturber AMI	–46.0
49–disturber T1 (AMI) NEXT	–43.7
49–disturber EC ADSL downstream NEXT	–25.4
49–disturber FDM ADSL downstream NEXT	–43.5
49–disturber FDM downstream FEXT (9kft 26 AWG)	–70.5
49–disturber FDM ADSL downstream NEXT	–43.5

The difference in levels due to different numbers of interferers is as given above in section 6.6.

6.8 Shaped Noise Generator

The shaped noise generator is a RAM-based generator which produces a variety of discrete tones:

- ETSI Basic Rate
- ETSI HDSL Rate
- to FTZ TR.220 recommendations

It is also used to generate the 10 tones which are needed for ADSL Model A noise.

6.9 Flat White Noise Generator

The flat noise generator injects a flat white noise signal, with a –3 dB point located at 2 MHz.

6.10 Impulse Generator

Seven different types of impulses may be selected. They are: 3-level, bipolar, unipolar+, unipolar–, Cook, ADSL c1, ADSL c2.

3-level, bipolar, unipolar+, and unipolar– impulses consist of only 2 or 3 different levels. These types of impulses are calibrated in mV peak-to-peak. The pulse width, variable from 20 to 120 micro-seconds, is only enabled when one of these types is selected.

The other three types, Cook, ADSL c1 and ADSL c2, are complex waveforms, as shown in the diagrams below. Impulse rate can also be a single, “triggered” impulse or varied from 0 to 100 per second.

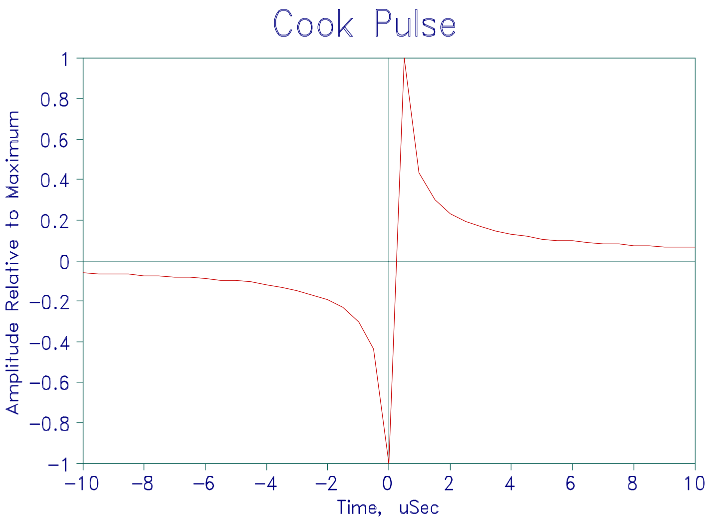


Figure 6.5 Cook Pulse

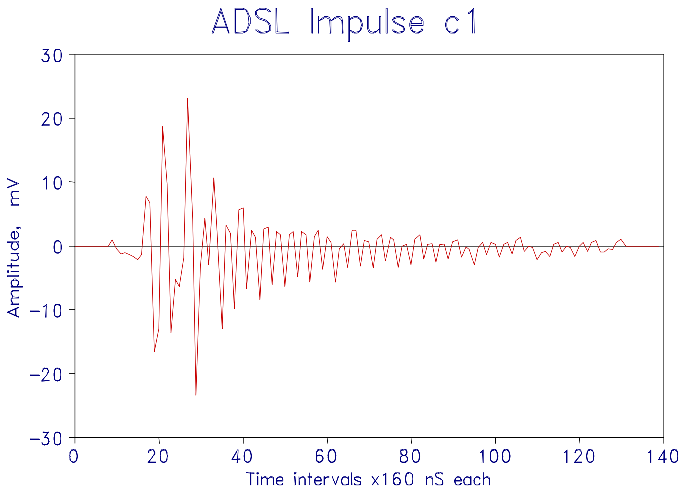


Figure 6.6 ADSL Impulse c1

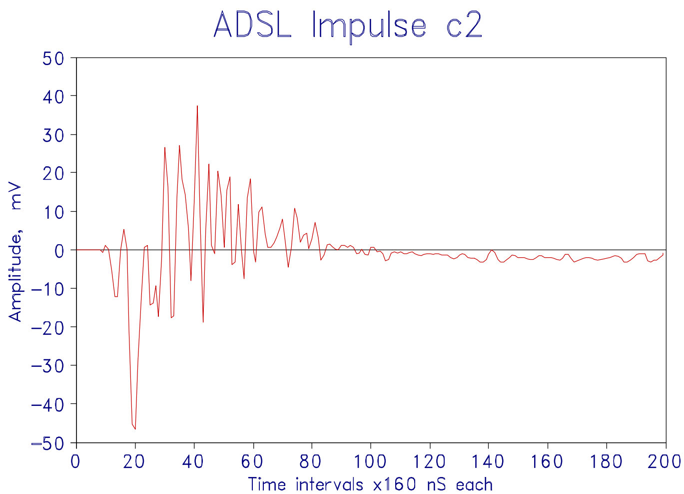


Figure 6.7 ADSL Impulse c2

6.11 External Noise

External noise may be injected via the BNC connector. Be aware that the level of noise applied to the line will be reduced by approximately 30 dB. Also, the source output must be turned on for the external noise to be applied.

6.12 Powerline Related Impairments

Two types of impairments due to the interference from AC power lines are generated by the ADSL noise card. One of them is called “metallic” and the other one “longitudinal”.

The reference powerline frequency used in both cases can be selected as 50 or 60 Hz.

6.12.1 Metallic Noise

Powerline metallic noise is a pair of low-level sine waves which are injected in differential mode. The frequency of the sinewaves can be set to any odd harmonic, from the fundamental up to the 11^{th} odd harmonic (550 or 660 Hz). The ADSL noise generator contains two generators that can be set independently. The generator will automatically disable the second tone generator if both frequencies are set equal. The relative levels of the harmonics are always the same. The levels of both tones taken together can be varied over ±10 dB relative to the ANSI reference levels.

The ANSI reference levels are shown in the following table:

Harmonic	Frequency [Hz]	Level [dBm]
1^{st}	60/50	–47
3^{rd}	180/150	–49
5^{th}	300/250	–59
7^{th}	420/350	–65
9^{th}	540/450	–70
11^{th}	660/550	–74

6.12.2 Longitudinal Noise

Longitudinal noise is a triangular waveform which is injected in common mode on the wireline using a transformer. Associated with the longitudinal noise, some longitudinal loads should also be used. The ETSI TS 102 080 ISDN Standard (formerly ETR80) requires that both pairs of loads (located on both sides of the transformer) are set any time the longitudinal voltage is generated (max voltage is 25 V_{RMS}). Otherwise only ONE pair is installed.

When one load is installed, it should be at the CO side, where no longitudinal voltage will appear. The level of longitudinal noise which appears at the customer site end of the line is 0 to 50 V_{RMS} in 1V steps when the powerline frequency is 50 Hz, and 0 to 60 V when the powerline frequency is 60 Hz.

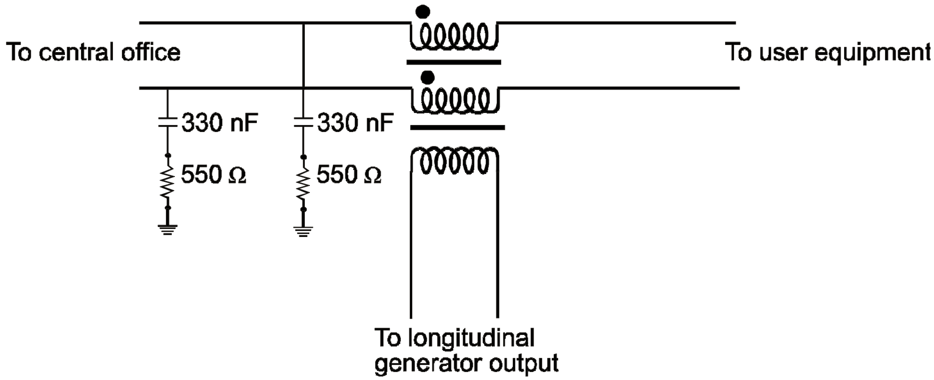


Figure 6.8 ANSI Longitudinal Load Configuration

If both loads are installed, equal and opposite-phase voltages appear at the end of the lines. They are half the voltage that appears at one end of the line if only one load is in place.

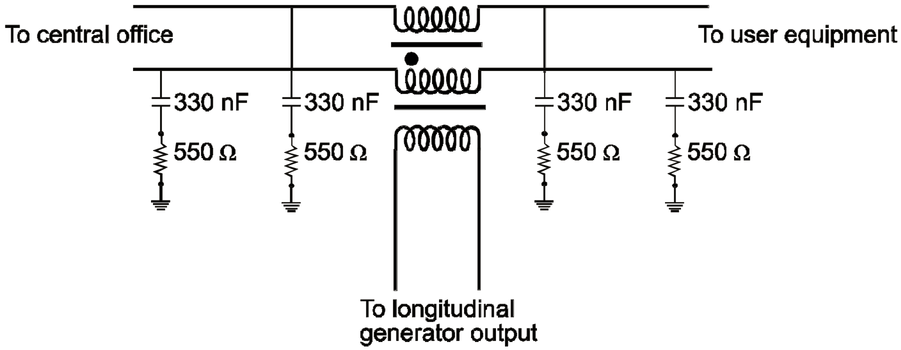


Figure 6.9 ETSI Longitudinal Load Configuration

WARNING

Inserting the longitudinal mode transformer in the loop provides additional loop attenuation which is not present when the transformer is switched out of the loop. The effective attenuation depends on the bandwidth of the signal passing through the loop, but is in the region of 1 to 4 dB. This alone accounts for some reduction in margin. When using longitudinal mode you can determine how much reduction in margin is due to the transformer by switching it in circuit, impressing 0 Volts of longitudinal mode voltage on the line, and running a test like this. Then you can run with longitudinal voltage as well, to determine additional degradation due to the longitudinal voltage.

6.12.3 DLS 200 Mode Crosstalk and White Noise

All 3 crosstalk generators and the white noise generator are based on noise produced by Pseudo Random Binary Sequences. This base noise is then used to create the appropriate crosstalk and white noises. Some customers expressed a desire for the noises generated by the DLS 400 to produce exactly the same effects as noises that come from a DLS 200H. To do this we introduced a DLS 200 compatible noise, in which the base noise is modified from the original DLS 400 base noise.

7. REMOTE CONTROL

The DLS 400 is controlled via the IEEE 488 (also known as the GPIB bus), or the RS–232 (serial) interface, allowing the integration of the DLS 400 into a larger test system. The DLS 400 remote control is designed with several standards in mind:

- The GPIB physical interface follows IEEE 488.1. The functions implemented are outlined in Section 7.1 “IEEE 488 Interface”. The Common Commands follow IEEE 488.2.
- The Device Dependent Commands (see chapter 9) are based upon the Standard Commands for Programmable Interfaces (SCPI). However, we had to create some device dependent commands since none of the pre-defined SCPI commands apply to the DLS 400.
- The serial port physical interface follows the EIA RS–232 standard.

The IEEE 488 and the serial interfaces are always enabled, and can be used alternatively. The DLS 400 directs its output to the last interface from which it received data. Both interfaces use the same command set and produce the same results. Section 7.1 describes features specific to the IEEE 488 interface; section 7.2 describes features specific to the RS–232 interface. The rest of this chapter describes commands common to both interfaces.

7.1 IEEE 488 Interface

The IEEE 488.1 Interface functions supported by the DLS 400 are as follows:

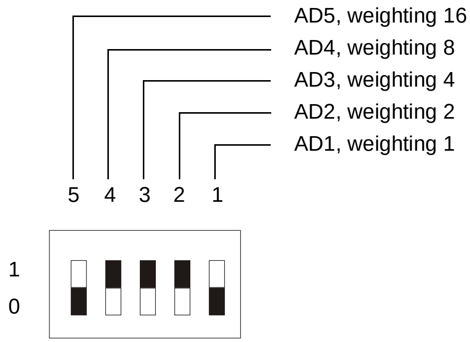
SH1	Source handshake – full capability
AH1	Acceptor handshake – full capability
T5	Basic talker – serial poll, untalk on MLA
L3	Basic listener – unlisten on MTA
SR1	Service request – full
DC1	Device clear – full
C4	Respond to SRQ
E1	Open Collector drivers
RL1	Remote Local – full

These represent the minimum required to implement the IEEE 488.2 standard. Note that the IEEE 488 interface is also known as the GPIB or HP–IB interface.

7.1.1 DLS 400 IEEE 488 Address.

The DLS 400 can use any valid IEEE 488 address (from 0 to 30). You can change the address by using the DIP switch on the back of the unit.

The following figure shows the default switch setting (address 14):



7.1.2 The Service Request (SRQ) Line

The SRQ line, as defined by the IEEE 488.1 standard, is raised when the DLS 400 is requesting service. Here are some examples of services that could raise SRQ:

- a message is available in the output buffer
- an error occurred
- all pending operations are completed
- the power was just turned on

In order to use the SRQ line, all relevant enable bits must be set. For example:

- the SRQ line can be raised automatically when there is a message available by enabling the MAV bit (bit 4) in the Status Byte Register with the command *SRE 16;

- the SRQ line can be raised automatically when there is an error by enabling the ESB bit (bit 5) in the Status Byte Register with *SRE 32 and by enabling the error bits in the Standard Event Status Register with *ESE 60 (bit 2, 3, 4 and 5).

NOTE: The Factory default is to clear all enable registers on power up. See the descriptions of the *PSC, *ESE and *SRE commands in chapter 9 for more details.

We recommend that you set the DLS 400 to raise the SRQ line when there is a message available and when there is an error.

7.1.3 Resetting the DLS 400

To reset the DLS 400, use the "Device Clear" command as defined in the IEEE 488.1 standard. This has the same effect as the power-up reset.

Shunt JP2 on the controller card determines whether the "Interface Clear" line resets the whole unit or just the IEEE 488 interface. Setting JP2 in the IFC position (pin 1 and 2) resets only the interface when IFC is received. In the "RESET" position (pin 2 and 3), IFC resets the entire unit. The factory default is to set JP2 in the IFC position, pin 1 and 2.

7.1.4 Message Terminators

Messages to the DLS 400 must be terminated with either a Line Feed character (ASCII <LF>, decimal 10, hex 0A), an IEEE 488.1 EOI signal or both. Messages from the DLS 400 are always terminated with a Line Feed character and the IEEE 488.1 EOI signal.

Note that some languages, such as BASIC, may automatically append a carriage return and a line feed at the end of messages. The carriage return character is not a valid terminator, and will invalidate the last command. To avoid this problem, you can append a semi-colon after a string (after the quotes) when printing to the IEEE 488 port. Another solution is to append a semi-colon at the end of the command itself (inside the quotes), so that the carriage return can be interpreted as a second command, and be simply discarded by the DLS 400. For example:

PRINT #1,":set:channel:length 1000"+CHR$(10);   Preferred solution

or

PRINT #1,":set:channel:length 1000;"   Alternate solution

7.1.5 Example using the IEEE 488 Interface

To select the ANSI #3 loop, do the following:

1) transmit ":SET:CHAN:LOOP ANSI_#3"
2) check that the REMOTE LED is green

To send and receive messages with error checking follow these steps:

1) set all relevant enable bits (only done once)
2) send the message
3) wait for SRQ
4) read the Status Byte
5) if MAV (bit 4) is set then read the response
6) if ESB (bit 5) is set then read the Standard Event Status Register and take all the relevant actions.

For example, to get the identification message with the IEEE 488 interface, do the following:

1)	transmit "*SRE 48"	enable MAV and ESB (needed only once)
2)	transmit "*ESE 60"	enable all the error bits (needed only once)
3)	transmit "*IDN?"	query the identification message
4)	wait for SRQ to be raised	
5)	read the status byte	use the IEEE 488.1 serial poll command, not *STB?
6)	if MAV (bit 4) is set read the response	
7)	if ESB (bit 5) is set do the followingcheck if an error was detected	
8)	transmit "*ESR?"	query the Event Status Register
9)	wait for SRQ to be raised	
7)	if MAV (bit 4) is set read the response and take all relevant action according to the error type received	

If desired, all the enable registers can be restored on power up with the *PSC command.

7.2 RS–232 Serial Interface

The DLS 400 uses a female DB–25 connector, and is configured as a DCE device.

The RS–232 standard is equivalent to the European V.24/V.28 standards. In this manual we use the term RS–232 to refer to both of these two standards. Generally, the computer literature will use the words “serial”, “COM1” and “COM2” to refer to the RS–232 interface. Note that the DLS 400 cannot use the parallel port of a computer.

To use the RS–232 interface, simply connect your computer to the DLS 400 and set the computer to 9600 bps baud rate, no parity, 8 data bits per character, and 1 stop bit.

Do NOT use a null modem with a computer that has a standard COM port configured as a DTE.

The DLS 400 stops transmitting data when the RTS line is low, and restarts when the RTS line is high. The DLS 400 lowers the CTS and the DSR lines when it cannot accept data, and raises them when it can. Note that the RTS line is not the usual “Request To Send” as defined by the RS–232 standard. If desired, the user can leave the RTS line set, and use only the CTS line.

7.2.1 Message Terminators

Messages sent to the DLS 400 through the serial interface MUST be terminated with the line feed character (decimal 10, hex 0A, LF). To ensure that no characters are left in the receive buffer of the DLS 400 from a previous incomplete command, you can send the line feed character by itself before sending new commands.

Messages from the DLS 400 are always terminated with a Line Feed character.

Note that some languages, such as BASIC, may automatically append a carriage return and a line feed at the end of messages. The carriage return character is not a valid terminator, and will invalidate the last command. To avoid this problem, you can append a semi-colon after a string (after the quotes) when printing to the IEEE 488 port. Another solution is to append a semi-colon at the end of the command itself (inside the quotes), so that the carriage return can be interpreted as a second command, and be simply discarded by the DLS 400. For example:

PRINT #1,”:set:channel:length 1000”+CHR$(10);   Preferred solution

or

PRINT #1,”:set:channel:length 1000;”   Alternate solution

7.2.2 Example using the RS–232 Interface

To select the ANSI #3 loop, do the following:

1) transmit “:SET:CHAN:LOOP ANSI_#3”
2) check that the REMOTE LED is green

To send and receive messages with error checking follow these steps:

1) set all relevant enable bits (only done once)
2) send the message
3) read the answer until you receive LF (decimal 10, hex 0A)
4) check if an error occurred with the command *ESR?

For example, to get the identification message with the RS–232 interface, do the following:

1)	transmit “*ESE 60”	enable all the error bits (needed only once)
2)	transmit “*IDN?”	query the identification message
3)	read the answer	the messages are always terminated with LF
4)	transmit “*ESR?”	check if an error occurred
5)	read the answer	if not 0, see section 8.1 for description of the error(s)

7.3 Data formats

The DLS 400 adheres to the IEEE 488.2 principle of Forgiving Listening and Precise Talking.

The data formats supported by the DLS 400 are:

Talking:	a) <NR1> Numeric Response Data – Integer b) Arbitrary ASCII Response Data

<NR1> is an implicit point representation of an integer.

Arbitrary ASCII Response Data is a generic character string without any delimiting characters. It is usually used to send data in response to a query, such as with the *IDN? command (see chapter 8, “Remote Control: Common Command Set”).

Listening: <NRf> Decimal Numeric Program Data

<NRf> is the Flexible Numeric Representation defined in the IEEE.2 standard which can represent just about any number.

The DLS 400 can accept data in the <NRf> format, which means that numbers can be made of a combination of digits, signs, decimal point, exponent, multiplier, unit and spaces. For example, any of the following is a valid representation for 12000 feet: 12kft, 12.0 kft, 12000,.12e2k, 1.2 e4 ft, +12000. If a unit (i.e. ft, m, bps, etc.) is appended to a number, that unit must be valid and not abbreviated. Note that the period separates the decimal part of a number.

7.4 Command Syntax

The DLS 400 adheres to the IEEE 488.2 format for command syntax. As with the Data Format, the principle is forgiving listening and precise talking.

Commands may take one of two forms, either a Common Commmand or a Device Dependent Command. The format of each is detailed in subsequent chapters (chapters 8 and 9, respectively). Each type may be preceded by one or more spaces, and each must have one or more spaces between its mnemonic and the data associated with it.

Common commands are preceded by the character “*”. Device Dependent commands are preceded by a colon, with a colon separating each level of the command. Commands may be either in upper or lower case. Multiple commands may be concatenated by separating each command by semi-colons.

The following are some examples:

***RST**

***RST;*WAI;:SET:CHANNEL:LOOP ANSI_#2**

***ESE 45; *SRE 16**

IEEE 488 messages to the DLS 400 may be terminated with either a Line Feed character (ASCII <LF>, decimal 10, hex 0A), an IEEE 488 EOI signal or both. RS–232 messages must be terminated with a line feed character. Messages from the DLS 400 are always terminated with a Line Feed character, and also with the EOI signal if using the IEEE 488 interface.

As defined in the SCPI specifications, a Device Dependent Command may be sent in its short form or long form, in upper or lower case. The following commands are therefore identical in operation:

:SET:CHANNEL:LOOP ANSI_#2

:SET:CHAN:LOOP ANSI_#2

:SET:chan:LoOp ANSI_#2

Queries of the system follow the same format as the commands, except that the data normally associated with a command is replaced by a question mark "?". Following receipt of such a command, the DLS 400 will place the appropriate response in the output queue, where it can be read by the controller.   Examples are:

***IDN?**

***ESE?;*SRE?**

:SET:CHAN:LOOP?

When a command does not begin with a colon, the DLS 400 assumes that the command is at the same level as the previous command. For example, to set a variable loop, one does NOT need to specify ":SET:CHANNEL" each time, such as in:

:SET:CHAN:LOOP VARIABLE_26_AWG;TAP_A 500;LINE 10k;TAP_B 500

LINE 5kft

This shorter form is valid because LOOP, TAP_A, LINE and TAP_B are at the same level.

8. REMOTE CONTROL: COMMON COMMAND SET

As specified in the IEEE 488.2 standard, a number of common commands are required to set up and control of the standard functions of remote-controlled devices. They can be used with both the IEEE 488 and the RS–232 interfaces. These common commands are as follows:

***CLS**	**Clear Status Command**
Type:	Status command
Function:	Clears the Event Status Register (ESR). Clearing the Event Status Register will also clear ESB, the bit 5 of the Status Byte Register (STB). It has no effect on the output queue (bit 4 of the STB).

***ESE <NRf>**	**Event Status Enable**
Type:	Status command
Function:	Sets the Event Status Enable Register (ESER) using an integer value from 0 to 255, representing a sum of the bits in the following bit map:

```
Bit: 7654 3210
```

- Bit 0: 1 = Operation Complete
- Bit 1: 1 = Request Control (not used)
- Bit 2: 1 = Query Error
- Bit 3: 1 = Device Dependant Error (not used)
- Bit 4: 1 = Execution Error
- Bit 5: 1 = Command Error
- Bit 6: 1 = User Request (not used)
- Bit 7: 1 = Power On

Bits 7 to 0 have values of 128, 64, 32, 16, 8, 4, 2 and 1, respectively. For example, if bits 3 and 5 are set then the integer value is 40 (8+32).

The ESER masks which bits will be enabled in the Event Status Register (ESR). See section 9.1 for more detail.

On power-on, the register is cleared if the Power-on Status Clear bit is 1, or restored if the bit is 0 (see *PSC for more details).

***ESE?** **Event Status Enable Query**

Type: Status command

Function: An integer value between 0 and 255 representing the value of the Event Status Enable Register (ESER) is placed in the output queue. The possible values are described in the *ESE command section, and in more detail in section 9.1.

***ESR?** **Event Status Register Query**

Type: Status command

Function: An integer value between 0 and 255 representing the value of the Event Status Register (ESR) is placed in the output queue. Once the value is placed in the output queue, the register is cleared. The command will turn the REMOTE LED green if the LED was red. The possible values are described in the *ESE command section, and in more detail in section 9.1.

***IDN?** **Identification Query**

Type: System command

Function: Returns the ID of the unit. Upon receiving this command the DLS 400 will put the following string into the output queue:

DLSTESTWORKS LTD,DLS 400,<SN>,<Ver>

where: <SN> is the serial number of the unit
<Ver> is the revision level of the control firmware (always 2 digits)

***OPC** **Operation Complete**

Type: Synchronization command

Function: Indicates to the controller when the current operation is complete. This command will cause the DLS 400 to set bit 0 in the Event Status Register (ESR) when all pending operations are completed. The bit is read with the *ESR? command, which also clear the bit. Communication can proceed as normal after this command, but be prepared to receive SRQ at any time. See section 9.2 for more details.

***OPC?** **Operation Complete Query**
Type: Synchronization command
Function: Indicates when the current operation is complete. This will cause the DLS 400 to put an ASCII 1 (decimal 49, hex 31) in the output queue when the current operation is complete. Communication can proceed as normal after this command, but be prepared to receive the "1" at any time. See section 9.2 for more details.

***PSC <NRf>** **Power-on Status Clear**
Type: Status and event command
Function: Indicates if the unit should clear the Service Request Enable Register and the Standard Event Status Register at power-on. If 1 (or higher) then all the enable registers are cleared at power-on, if 0 then all the enable registers are restored from the non-volatile RAM at power-on. The factory default is 1 (clear all the enable registers). Any change to the "Power-on Status" is saved in non-volatile RAM, and is always restored on power up.

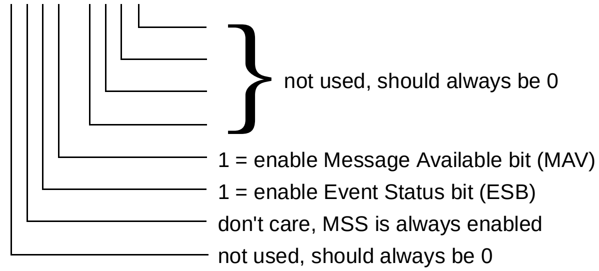
***PSC?** **Power-on Status Clear Query**
Type: Status and event command
Function: Return the Power-on Status Clear value. If 1 then all the enable registers are cleared at power-on, if 0 then all the enable registers are restored from the non-volatile RAM at power-on. The factory default is 1 (clear all the enable registers).

***RST** **Reset**
Type: Internal command
Function: IEEE 488.2 level 3 reset. This command will initialize the DLS 400 with the bypass loop, and cancel any pending *OPC operation. It will not affect the output buffer or other system settings of the unit. Note that this is NOT equivalent to the power-up reset and the IEEE 488 "Device Clear".

***SRE <NRf>** **Service Request Enable**
Type: Status command

Function: Sets the Service Request Enable Register (SRER). An integer value indicates which service is enabled, with the following bit map:

```
Bit: 7654 3210
```



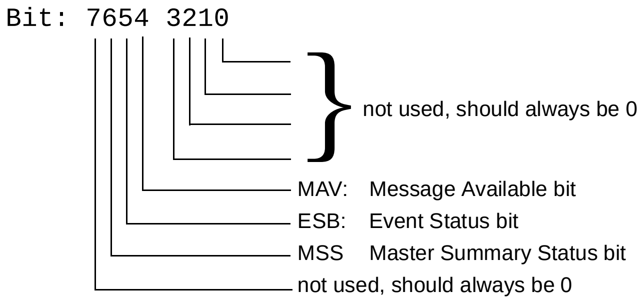
Bits 7 to 0 have values of 128, 64, 32, 16, 8, 4, 2 and 1, respectively. For example, if bits 4 and 5 are set then the integer value is 48 (16+32).

Note that if both MAV and ESB are disabled, then the bits MSS and RQS and the line SRQ are never going to be raised (see section 9.1 for more details).

On power-on, this register is cleared if the Power-on Status Clear bit is 1, or restored if the bit is 0 (see *PSC for more details).

***SRE?** **Service Request Enable Query**
Type: Status command
Function: An integer value representing the value of the Service Request Enable Register is placed in the output queue. The possible values are listed in the *SRE command section.

***STB?** **Status Byte Query**
Type: Status command
Function: The value of the Status Byte Register is put into the output queue. Contrary to the “*ESR?” command, this register is not cleared by reading it. The register will be zero only when all its related structures are cleared, namely the Event Status Register (ESR) and the output queue.



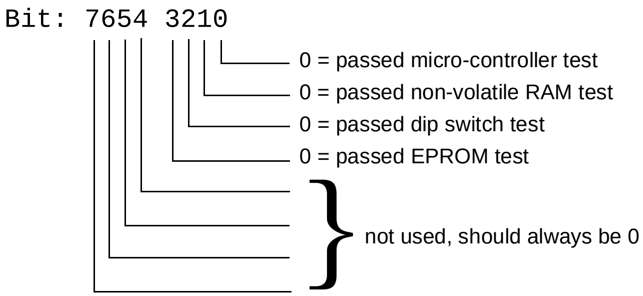
Bits 7 to 0 have values of 128, 64, 32, 16, 8, 4, 2 and 1, respectively. For example, if bits 4 and 5 are set then the integer value is 48 (16+32).

Note that bit 6 is MSS, which does not necessarily have the same value as RQS (see section 9.1 for more details).

***TST?** **Self-Test Query**

Type: Internal command

Function: Returns the results of the self-test done at power up. The number returned has the following bit map:



Bits 7 to 0 have values of 128, 64, 32, 16, 8, 4, 2 and 1, respectively. For example, if bits 3 and 5 are set then the integer value is 40 (8+32).

***WAI** **Wait to continue**

Type: Synchronization command

Function: Used to delay execution of commands. The DLS 400 will ensure that all commands received before "*WAI" are completed before processing any new commands. This means that all further communication with the DLS 400 will be frozen until all pending operations are completed. See section 9.2 for more details.

8.1 Status Reporting

There are two registers that record and report the system status, the Status Byte Register (STB), and the Event Status Register (ESR).

For both registers there are three basic commands: one to read the register, one to set the enabling bits, and one to read the enabling bits.

	Status Byte Register	Event Status Register
Read Register	*STB?	*ESR?
Set Enabling Bits	*SRE <NRf>	*ESE <NRf>
Read Enabling Bits	*SRE?	*ESE?

Where <NRf> is the new value of the register.

8.1.1 Status Byte Register (STB)

The bits of this register are mapped as follows :

bit 4: MAV (Message Available Bit)

Indicates that the Output Queue is not empty. If MAV goes high and is enabled then MSS goes high.

bit 5: ESB (Event Status Bit)

It indicates that at least one bit of the Event Status Register is non zero and enabled. If ESB goes high and is enabled then MSS goes high.

bit 6: MSS/RQS (Master Summary Status/Request Service)

MSS is raised when either MAV or ESB are raised and enabled. When the status of MSS changes, the whole Status Byte Register is copied into the Status Byte of the GPIB controller, where bit 6 is called RQS. When RQS goes high so does the SRQ line, and in response to an IEEE 488.1 Serial Poll command, both are cleared.

RQS and SRQ are defined by the IEEE 488.1 standard and are hardware related. MSS summarizes all the status bits of the DLS 400, as defined by the IEEE 488.2 standard.

bits 7, 3, 2, 1,and 0

These bits are not used by the DLS 400.

8.1.2 Event Status Register (ESR)

The Event Status Register monitors events within the system and reports on those enabled. It records transitory events as well. The DLS 400 implements only the IEEE 488.2 Standard Event Status Register (ESR). It is defined as:

bit 0 Operation Complete. This bit is set in response to the *OPC command when the current operation is complete.

bit 1 Request Control. The DLS 400 does not have the ability to control the IEEE bus, and so this bit is always 0.

bit 2 Query Error. There was an attempt to read an empty output queue or there was an output queue overflow. (maximum output queue capacity is 75 bytes).

bit 3 Device Dependent Error. This error bit is set when the DLS 400 receive a command to set the length of a fixed loop. Only variable loops can have their length changed.

bit 4 Execution Error. The data associated with a command was out of range.

bit 5 Command Error. Either a syntax error (order of command words) or a semantic error (spelling of command words) has occurred. A GET (Group Execute Trigger) or *TRG command will also set this bit.

bit 6 User Request. Indicates that the user has activated a Device Defined control through the front panel. Not used, so this bit is always 0.

bit 7 Power on. This bit is set when the DLS 400 is turn on. Sending *ESR? clears the bit and stays clear until the power is turned on again.

The setting of the Event Status Register can be read with the Event Status Register query command (*ESR?). This will put the value of the register in the output queue, AND will clear the register.

8.2 DLS 400 Synchronization

The program controlling the DLS 400 can use three different commands to synchronize with the DLS 400: *OPC, *OPC? and *WAI. Following are the main differences:

	Set Operation Complete bit when Done	**Return "1" when operation complete**	**Raise SRQ when operation complete**	**Block comm. with the NSA 400J**	**Required Enable Bit(s)**
***OPC**	Yes	No	Yes[1]	No	Operation Complete, ESB
***OPC?**	No	Yes	Yes[2]	No	MAV
***WAI**	No	No	No	Yes	none

1. if "Operation Complete" and ESB are enabled
2. if MAV is enabled

The main difference between OPC and WAI is that WAI will block any further communication with the DLS 400 until all pending operations are completed.

The main difference between *OPC and *OPC? is that *OPC sets the "Operation Complete" bit, and *OPC? will return an ASCII "1" when all pending operations are completed.

Make sure that all the required enable bits are set.

When using *OPC or *OPC?, the program controlling the DLS 400 can determine when the operation is completed by waiting for SRQ, or by reading the status byte with the serial poll or with *STB? (if corresponding bits are enabled).

If the program uses the *OPC? command and then sends more queries, the program must be ready to receive the "1" concatenated to other responses at any time. When using *WAI, the communication time out should be set long enough to avoid losing data (the DLS 400 needs approximately 2 seconds to set a loop).

9. REMOTE CONTROL: DEVICE DEPENDENT COMMANDS

9.1 Device Dependent Command Set for Loops

As recommended by the SCPI consortium and to simplify programming of the various DLS TestWorks simulators, the DLS 400 uses the following tree structure:

:SETting

    :CHANnel

        :LOOP <Loop Name>

        :TAP_A <NRf>

        :LINE <NRf>

        :TAP_B <NRf>

        :DIRection <FORward | REVerse>

        :BYPASS <NO | YES>

:SETting

    :PWRline

        :LONGitudinal

            :STate <OFF|ON>

Each section of the command may be sent in the full or the truncated form (indicated in upper case). The command itself may be sent in upper or lower case form.

The DLS 400 will round any number to the nearest number permitted by the resolution of the parameter.

Sections 7.3 and 7.4 give more information on data formats and the command syntax.

9.1.1 :SETting:CHANnel:LOOP <Loop Name>

This command selects which loop the DLS 400 will simulate, depending on the configuration purchased. <LOOP Name> can be any of the loops available to your specific unit, as follows:

DLS 400A

BYPASS	CSA_#0	MID-CSA_#0	ANSI_#2
	CSA_#1	MID-CSA_#1	ANSI_#3
VARIABLE_24_AWG	CSA_#2	MID-CSA_#2	ANSI_#4
VAR_24_AWG+TAP	CSA_#4	MID-CSA_#3	ANSI_#5
VARIABLE_26_AWG	CSA_#5	MID-CSA_#4	ANSI_#6
VAR_26_AWG+TAP	CSA_#6	MID-CSA_#5	ANSI_#7
	CSA_#7	MID-CSA_#6	ANSI_#8
	CSA_#8		ANSI_#9
	EXT-CSA_#9		ANSI_#11
	EXT-CSA_#10		ANSI_#12
			ANSI_#13
			ANSI_#15

DLS 400H

BYPASS	CSA_#1
	CSA_#2
VARIABLE_24_AWG	CSA_#3
VAR_24_AWG+TAP	CSA_#4
VARIABLE_26_AWG	CSA_#5
VAR_26_AWG+TAP	CSA_#6
	CSA_#7
	CSA_#8
	EXT-CSA_#9
	EXT-CSA_#10

DLS 400N

BYPASS	CSA_#4	ANSI_#1	EIA_#1
	CSA_#6	ANSI_#2	EIA_#2
VARIABLE_24_AWG	CSA_#7	ANSI_#5	EIA_#3
VAR_24_AWG+TAP	CSA_#8	ANSI_#7	EIA_#4
VARIABLE_26_AWG	MID-CSA_#6	ANSI_#8	EIA_#5
VAR_26_AWG+TAP		ANSI_#9	
		ANSI_#13	
		MID-ANSI_#7	

DLS 400HN

BYPASS	CSA_#1	ANSI_#1	EIA_#1
	CSA_#2	ANSI_#2	EIA_#2
VARIABLE_24_AWG	CSA_#3	ANSI_#5	EIA_#3
VAR_24_AWG+TAP	CSA_#4	ANSI_#7	EIA_#4
VARIABLE_26_AWG	CSA_#5	ANSI_#8	EIA_#5
VAR_26_AWG+TAP	CSA_#6	ANSI_#9	
	CSA_#7	ANSI_#13	
	CSA_#8	MID-ANSI_#7	
	EXT-CSA_#9		
	EXT-CSA_#10		
	MID-CSA_#6		

In addition, any CSA, EXT-CSA and ANSI loop except CSA loop 0 have a DLS 200 compatible mode. This is chosen by adding D2 immediately after the loop number.

For example, to select ANSI loop number 2, send:

:SET:CHAN:LOOP ANSI_#2

and to select the DLS 200 compatible ANSI loop number 2, send:

:SET:CHAN:LOOP ANSI_#2D2

To query the loop currently simulated by the DLS 400 send:

:SET:CHAN:LOOP?

The command will return the simulated loop. For example, if the selected loop is ANSI #4, the returned message will be:

ANSI_#4

9.1.2 :SETting:CHANNel:TAP_A <NRf>

This command selects the length of the tap on side A, where <NRf> is the length ranging from 0 to 1500 ft, in step of 500 ft. For example, to set the length to 1.5 kft, send:

:SET:CHAN:TAP_A 1.5 kft

The units of the length are optional, but they must be “ft” if present. For more details on the numeric format supported by the DLS 400, see section 7.3.

To query the length currently simulated by the DLS 400 send:

:SET:CHAN:TAP_A?

The command will return an integer number ranging from 0 to 1500 followed by the units. For example, if the length is 1.5 kft, the returned message will be:

1500 FT

9.1.3 :SETting:CHANNel:LINE <NRf>

This command selects the length of the line, where <NRf> is the length ranging from 0 up to the maximum shown in the following table. The length is variable in steps of 50 ft.

DLS 400A

Selected Loop	Maximum Length
Variable_24_AWG	18 kft
Var_24_AWG+Tap	12 kft
Variable_26_AWG	15 kft
Var_26_AWG+Tap	12 kft

DLS 400H/N/HN

Selected Loop	Maximum Length
Variable_24_AWG	15 kft
Var_24_AWG+Tap	12 kft
Variable_26_AWG	18 kft
Var_26_AWG+Tap	15 kft

For example, to set the length to 1500 ft, send:

:SET:CHAN:LINE 1500 ft

The units of the length are optional, but they must be “ft” if present. For more details on the numeric format supported by the DLS 400, see section 7.3.

To query the length currently simulated by the DLS 400 send:

:SET:CHAN:LINE?

The command will return an integer number current length followed by the units. For example, if the length is 1.5 kft, the returned message will be:

1500 FT

9.1.4 SETting:CHANnel:TAP_B <NRf>

This command selects the length of the tap on side B, where <NRf> is the length ranging from 0 to 1500 ft, in steps of 500 ft. For example, to set the length to 1.5 kft, send:

:SET:CHAN:TAP_B 1.5 kft

The units of the length are optional, but they must be “ft” if present. For more details on the numeric format supported by the DLS 400, see section 7.3.

To query the length currently simulated by the DLS 400 send:

:SET:CHAN:TAP_B?

The command will return an integer number ranging from 0 to 1500 followed by the units. For example, if the length is 1.5 kft, the returned message will be:

1500 FT

9.1.5 :SETting:CHANNel:DIRection FORward|REVerse

This command selects the direction of the signal through the wireline. For example, to select the reverse direction, send:

:SET:CHAN:DIR REVERSE

To query the current direction of the signal in the wireline, send:

:SET:CHAN:DIR?

The command will return either “FORWARD” or “REVERSE”.

(See section 5.3.5 for an example of this feature.)

9.1.6 :SETting:CHANNel:BYpass <NO|YES>

This command controls the bypass of the wireline cards. For example, to bypass the wireline cards, send:

:SET:CHAN:BY YES

To query the current setting of the bypass, send:

:SET:CHAN:BY?

9.1.7 :SETting:PWRline:LONGitudinal:STate <OFF/ON>

This command controls whether the secondary windings of the longitudinal transformer are in or out of the loop. Putting the winding in the loop can effectively add several hundred feet to the loop, so unless longitudinal mode is actively required, the state should be OFF.

9.2 Device Dependent Command Set for Impairments

9.2.1 Impairments Commands Summary

When setting impairments, the DLS 400 uses the following general format:

:Source?:AAAA:BBBB CCCC

All commands should refer to a specific slot. Use “:sourceA” to set parameters on the noise card located in slot A, and “:sourceB” for the other slot. The rest of the command can be summarized like this:

:sourceA	:xtalkA:type < choice >
	:level <numeric value> [dBm]
:xtalkB	:type < choice >
	:level <numeric value> [dBm]
:xtalkC	:type < choice >
	:level<numeric value> [dBm]
:shaped	:type < choice >
	:level <numeric value> [µV/√Hz]
	:level <numeric value> [dBm/Hz]
	:level <numeric value> [dBm]
:white	:level <numeric value> [dBm/Hz]
:impulse	:type < choice >
	:width <numeric value> [µs]
	:level <numeric value> [dB]
	:level <numeric value> [mV]
	:rate <numeric value> [pps]
	:trigger
:pwrline	:freq <choice> [Hz]
	:metallic:harmonic1 < choice >

:harmonic2 < choice >
:offset <numeric value> [dB]
:longitudinal :level <numeric value> [Vrms]

:Noise:Distribution <D4Mode|D2Mode>

:load1 <boolean>

:load2 <boolean>

:output <boolean>

:quiet

9.2.2 Crosstalk Generator A

9.2.2.1 XTalk Generator A – Type

:source?:xtalkA :type <choice>	Range: OFF T1.601 DSLNEXT HDSL HDSL+ADSL

9.2.2.2 Xtalk Generator A – Level

:source?:xtalkA :level <numeric value> [dBm]	Range: –75.0 to –30.0 dBm in 0.1 dB steps

9.2.2.3 Xtalk Generator A – Program

:sourceA:xtalkA:Program:Data

:Start	tells the system to start a new data set
:Name	must be in quotes, and is a maximum of 16 characters. (Type will, by default, be ‘external’ unless a name is programmed)
:Minimum and Maximum	as per your level range

9.2.3 Crosstalk Generator B

9.2.3.1 Xtalk Generator B – Type

:source?:xtalkB:type <numeric value>	Range:	OFF T1.601 DSLNEXT HDSL HDSL+ADSL ADSLNEXT

9.2.3.2 Xtalk Generator B – Level

:source?:xtalkB :level <numeric value> [dBm]	Range:	–75.0 to –30.0 dBm in 0.1 dB steps

9.2.3.3 Xtalk Generator B – Program

:sourceA:xtalkB:Program:Data

:Start	tells the system to start a new data set
:Name	must be in quotes, and is a maximum of 16 characters. (Type will, by default, be ‘external’ unless a name is programmed)
:Minimum and Maximum	as per your level range

9.2.4 Crosstalk Generator C

9.2.4.1 Xtalk Generator C – Type

:source?:xtalkC:type <choice>	Range:	OFF ADSLFEXT ADSLA ADSLB T1 AMI

9.2.4.2 Xtalk Generator C – Level

:source?:xtalkC :level <numeric value> [dBm] Range: –85.0 to –35.0 dBm in 0.1 dB steps

When selecting ADSLA in the high frequency crosstalk generator, make sure to select also the 10-tone type for the shaped noise generator, since ADSL Model A noise is made up of both Crosstalk noise and Shaped noise. The levels of shaped noise and ADSL model A noise that must be sent are different. The 10 tone noise must be set 36.2 dB less than the model A noise. So, to set model A noise to –55.4 dBm, you should send

:source?:xtalkC :type ADSLA

:source?:xtalkC :level –55.4 [dBm]

:source?:shaped:type 10-tone

:source?:shaped:level –91.6 [dBm]

9.2.4.3 Xtalk Generator C – Program

:sourceA:xtalkC:Program:Data

:Start	tells the system to start a new data set
:Name	must be in quotes, and is a maximum of 16 characters. (Type will, by default, be ‘external’ unless a name is programmed)
:Minimum and Maximum	as per your level range

9.2.5 Shaped Noise Generator

9.2.5.1 Shaped Noise Generator – Type

:source?:shaped :type <choice> Range: OFF
BASIC_RATE
HDSL
FTZ
10-tone

9.2.5.2 Shaped Noise Generator – Level

:source?:shaped :level <numeric value> [µV/√Hz]	Range:	3.2 to 100.0 in 0.1 µV/√Hz steps

or

:source?:shaped :level <numeric value> [dBm/Hz]	Range:	–101.3 to –71.3 in 0.1 dB/Hz steps

Level value could be issued using any of the three units (µV/√Hz or dBm/Hz or dBm). Level is typically in µV/√Hz when type selected is either BASIC_RATE, HDSL or FTZ. Level is typically in dBm when the type selected is 10-tone and is usually set to –70.0 dBm. Note that the units are NOT optional when setting the level in dBm/Hz or in dBm.

9.2.5.3 Shaped Noise Generator – Program

:sourceA:Shaped:Program:Data

:Start	tells the system to start a new data set
:Name	must be in quotes, and is a maximum of 16 characters. (Type will, by default, be ‘external’ unless a name is programmed)
:Size	

9.2.6 White Noise Generator

9.2.6.1 Flat White Noise Generator – State

:source?:white :state <boolean>	Range:	OFF, ON

9.2.6.2 Flat White Noise Generator – Level

:source?:white :level <numeric value> [dBm/Hz]	Range:	–140.0 to –90.0 in steps of 0.1 dB

9.2.7 Impulses

9.2.7.1 Impulses – Type

:source?:impulse :type <choice>	Range:	off 3-level bipolar unipolar+ unipolar– Cook adsl–c1 adsl–c2

9.2.7.2 Impulses – Width

:source?:impulse :width <numeric value> [µs]	Range:	20 to 120 µs in 1µs steps. Only applies to 3-level, bipolar and unipolar impulses

9.2.7.3 Impulses – Level

:source?:impulse :level <numeric value> [mV]	Range:	0.0 to 100.0 mV peak in 0.1 mV steps. This syntax must be used only for non-complex (Cook) impulses.

or

:source?:impulse :level <numeric value> [dB]	Range:	–20.0 to +6.0 dB in 0.1 dB steps. This syntax must be used ONLY for complex (Cook) pulses.

9.2.7.4 Impulses – Rate

:source?:impulse :rate <numeric value> [pps]	Range:	0 to 100 pulses per seconds in 1 pps steps

9.2.7.5 Impulses – Single Shot

:source?:impulse :trigger   Range: none

The single shot command generates a single impulse as soon as the command is received.

9.2.8 Powerline Related Impairments

Frequency

:source?: pwrline :freq <choice> [Hz]   Choice: 50, 60 Hz

9.2.8.1 Metallic Noise Sine Wave Generators

9.2.8.1.1 Harmonic #1 Frequency

:source?: pwrline: metallic: harmonic1 <choice>   Choice: 0 to 6

where
0 = off
1 = fundamental (50/60 Hz)
2 = 2^{nd} odd harmonic (150/180 Hz)
3 = 3^{rd} odd harmonic (250/300 Hz)
4 = 4^{th} odd harmonic (350/420 Hz)
5 = 5^{th} odd harmonic (450/540 Hz)
6 = 6^{th} odd harmonic (550/660 Hz)

9.2.8.1.2 Harmonic #2 Frequency

:source?: pwrline: metallic: harmonic2 <choice>   Range: 0 to 6

Note that the second frequency is disabled if both frequencies are equal.

9.2.8.2 Level Offset

:Source?: pwrline :metallic: offset <numeric value> [dB] Range: –10.0 to +10.0 dB
in 0.1 dB steps

To turn off a tone entirely, use the tone frequency command.

9.2.8.3 Longitudinal Noise Triangle Wave Generator

:source?:pwrline :longitudinal :level<numeric value> [Vrms]

Range: 0 to 60 Vrms in 1V steps when powerline frequency is 60 Hz.
0 to 50 Vrms in 1V steps when powerline frequency is 50 Hz.

Associated with the longitudinal noise, the longitudinal loads should also be controlled. The ETSI standard requires that both loads (located on both side of the transformer) be inserted any time the longitudinal voltage is generated. For ANSI standards, only ONE load should be inserted.

Longitudinal Loads

:source?:load1 <boolean>	Range: OFF, ON
:source?:load2 <boolean>	Range: OFF, ON

Also associated with the longitudinal impairment is the command which sets the secondaries of the longitudinal transformer in or out of circuit. See section 6.5.6

9.2.9 Quiet

This command turns off all impairments but leaves the output stage connected on tip and ring:

:source?: Quiet	Range: none

This command does a “soft” reset of the card and is equivalent to the following commands:

```
:source?:pwrline:freq 60 Hz
        :metallic :harmonic1 0
            :harmonic2 0
            :offset 0.0 dB

        :longitudinal :level 0 Vrms

:impulse:type OFF
```

:width 50 µs
:level 0.0 mV
:rate 0 pps

:shaped :type OFF
:level 3.2 µV/√Hz

:xtalkA :type OFF
:level –75.0 dBm

:xtalkB :type OFF
:level –75.0 dBm

:xtalkC :type OFF
:level –85.0 dBm

:white :level –140.0 dBm/Hz
:state off

:load1 OFF

:load2 OFF

9.2.10 Output Stage

Connects or disconnects the impairments generator to or from the line:

source? :output <boolean> Range: OFF, ON

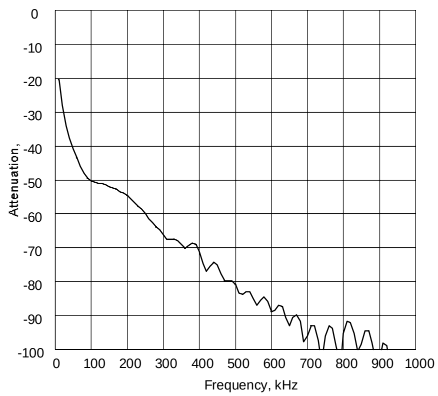
10. CHARACTERISTICS OF FIXED LOOPS

The DLS 400 is designed to simulate various cable configurations that are found in North America between the telephone company premises and a customer site. These are often known as “Local Loops”. We have chosen loops that consist of twisted pair wiring only. Further, we have selected loops that are specified, or seem likely to be specified, by ANSI’s T1 committee for the testing of ADSL transmissions. In addition we have added 4 user configurable loops.

The simulation is for differential mode (metallic) signals. Simulation characteristics include attenuation, impedance, and delay on the loop. The design goal was excellent simulation up to 1.5 MHz, which has been achieved. In fact, the DLS 400 is designed for testing beyond this frequency, up to and including 2 MHz (and higher in some configurations, although the attenuation at frequencies beyond 2 MHz precludes any practical applications).

The following graphs characterize 28 of the 29 standard loops within the DLS 400. (We have not characterized the “Bypass” loop.) We have not attempted to provide curves for the variable loops since there are far too many of them.

Each page shows the attenuation and input impedance presented by ideal cable made up in the appropriate configuration. For the attenuation graph, we have shown the ideal curve in each case and spot frequencies measured on a DLS 400. You should be aware that at attenuation levels of 60 dB or more, there is some crosstalk from input to output. If you take a network analyzer and measure attenuations greater than this, you may see some waviness in the response on some loops. As an example, a network analyzer response of ANSI Loop 5 is shown here.



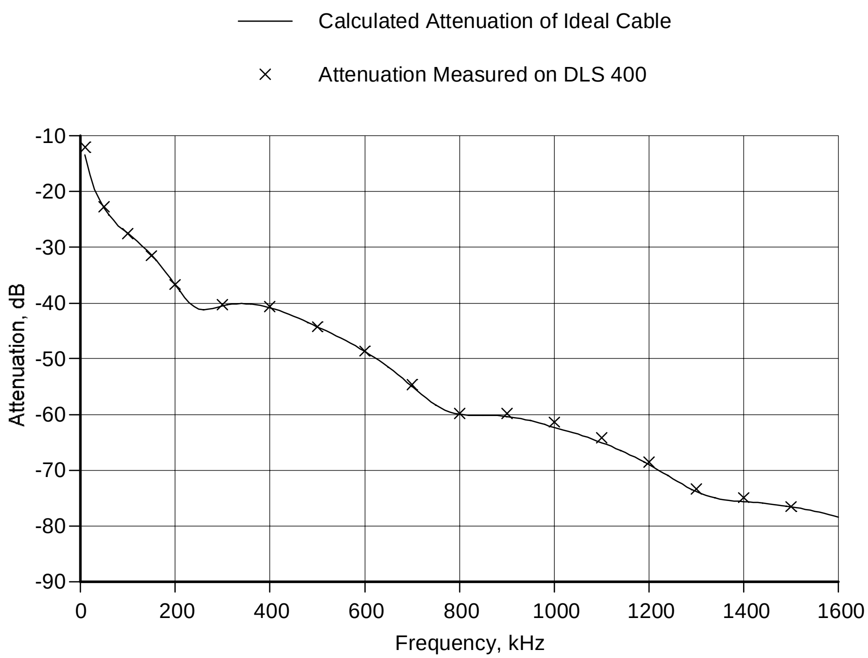
Impedance is complex, so each impedance graph plots real and imaginary part of the input impedance of the cable. The bold curves are the characteristics of the ideal cable. Superimposed on the bold curves are measured results of a prototype DLS 400.

Sometimes the curves are so close that you cannot see the difference, showing an extremely good simulation. We do not think that any differences in the 2 curves will materially affect your results, but we publish them so that you know they exist, and can take whatever actions you believe are appropriate.

10.1 CSA Loops

10.1.1 CSA Loop #1

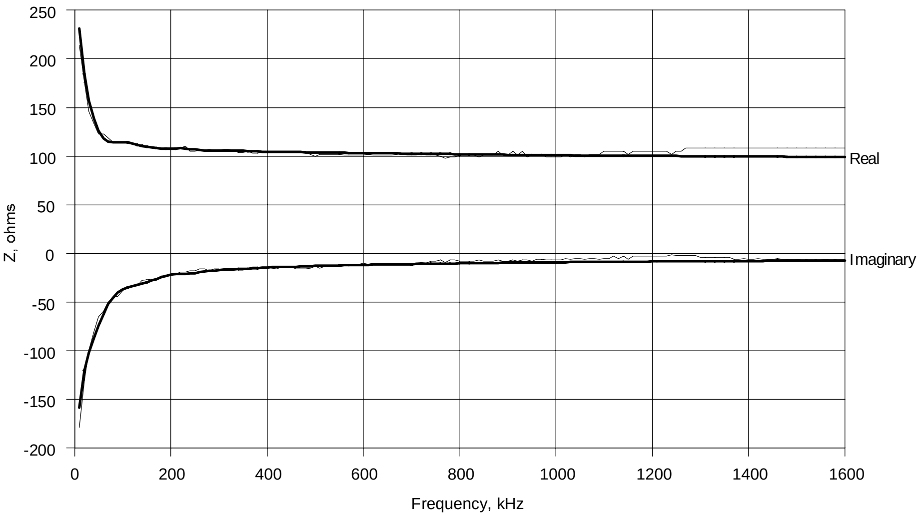
Attenuation



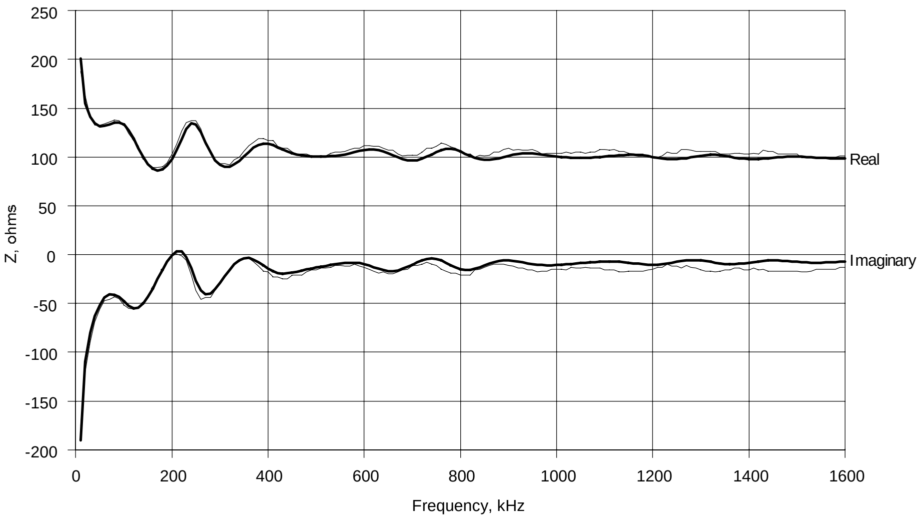
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



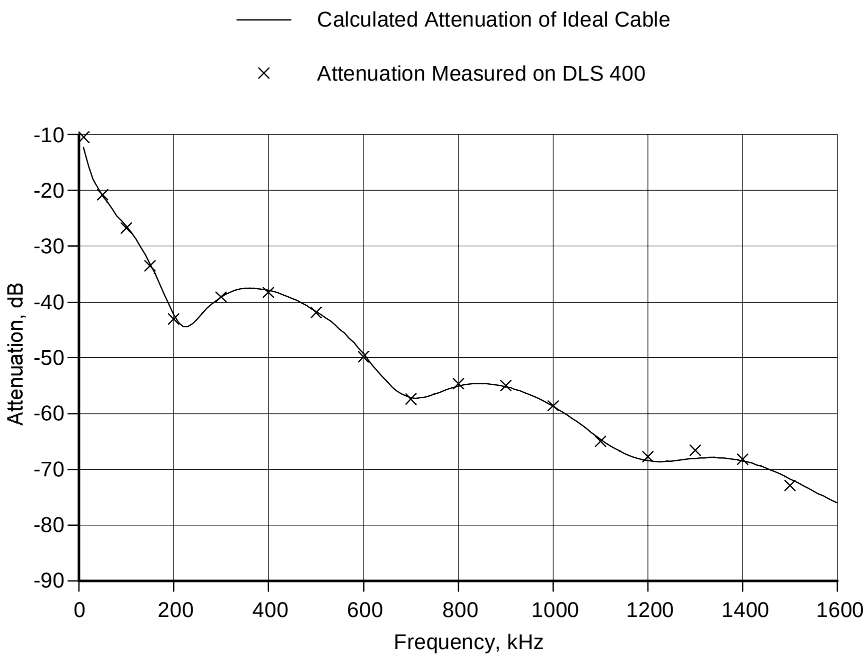
At CO Side



At Customer Side

10.1.2 CSA Loop #2

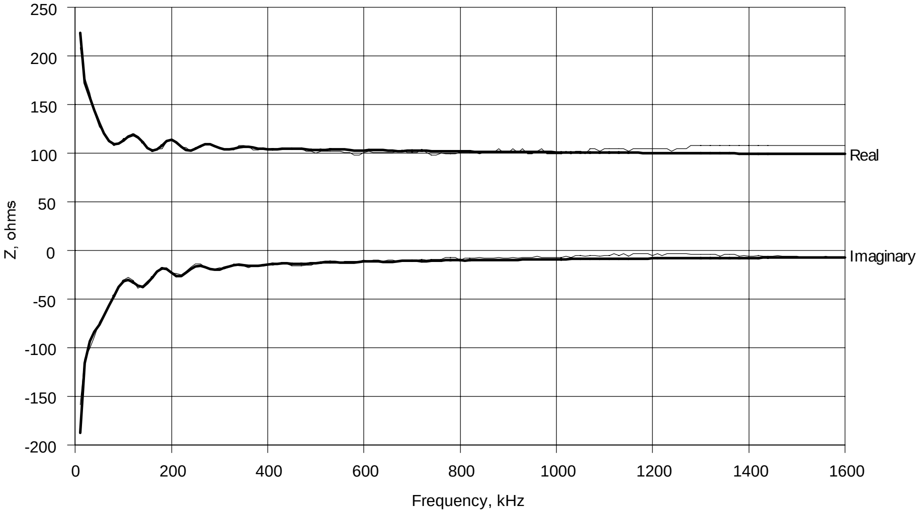
a) Attenuation



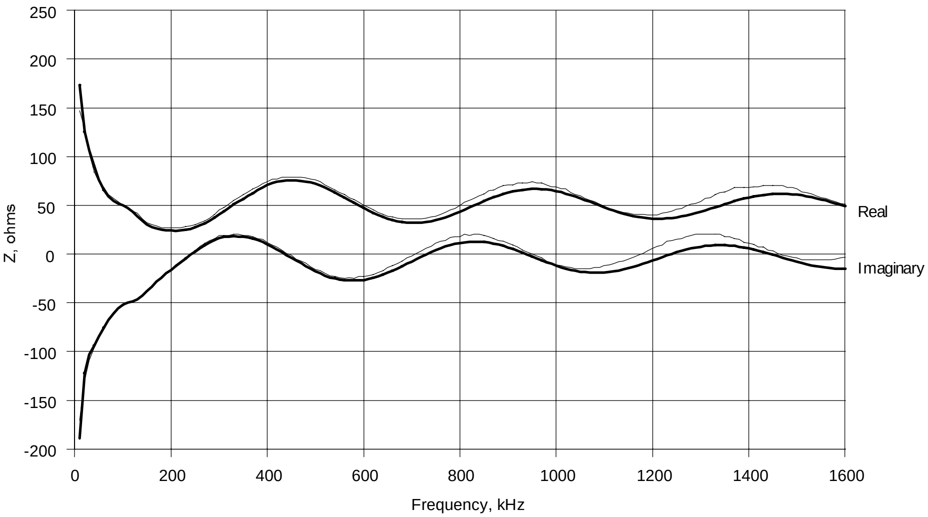
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



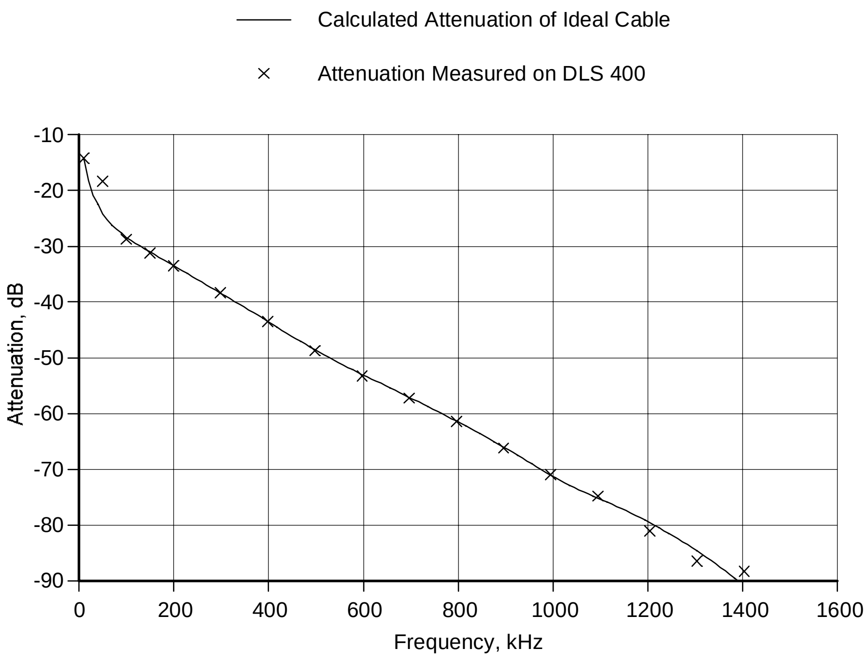
At CO Side



At Customer Side

10.1.3 CSA Loop #3

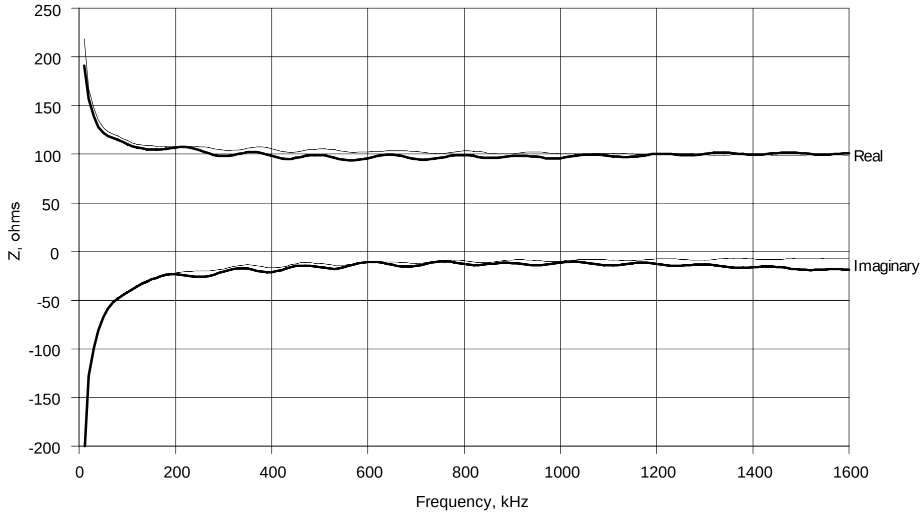
Attenuation



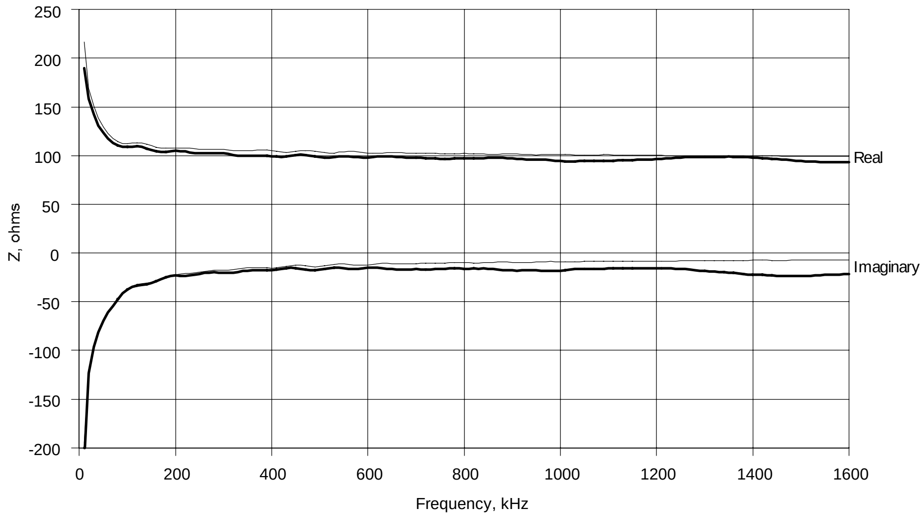
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



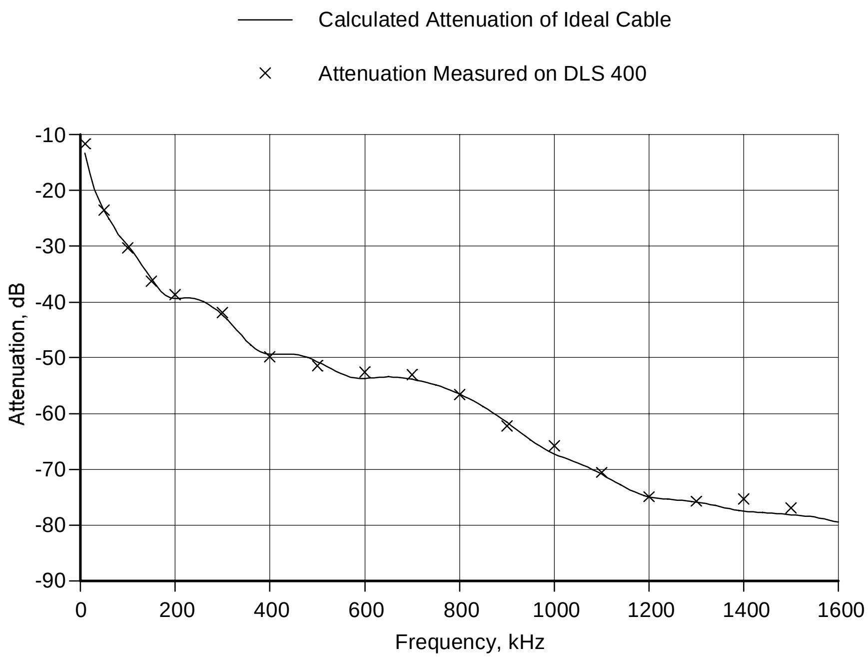
At CO Side



At Customer Side

10.1.4 CSA Loop #4

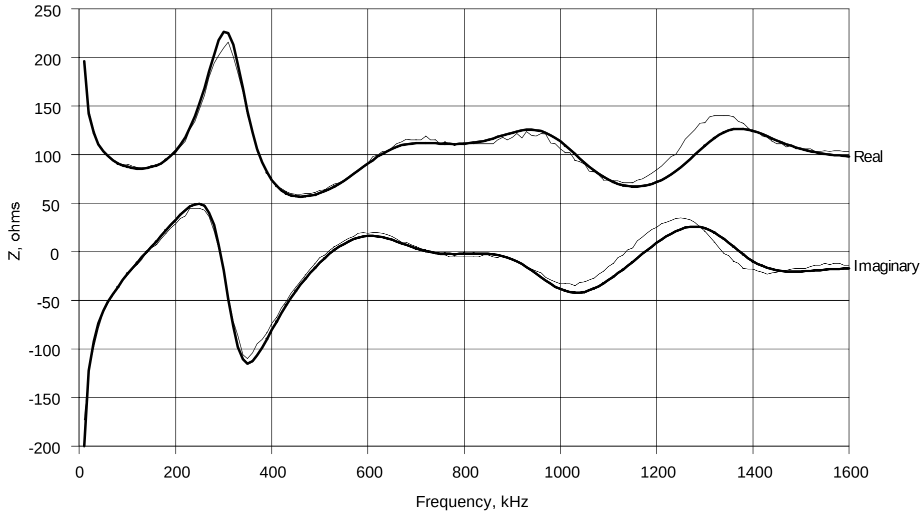
Attenuation



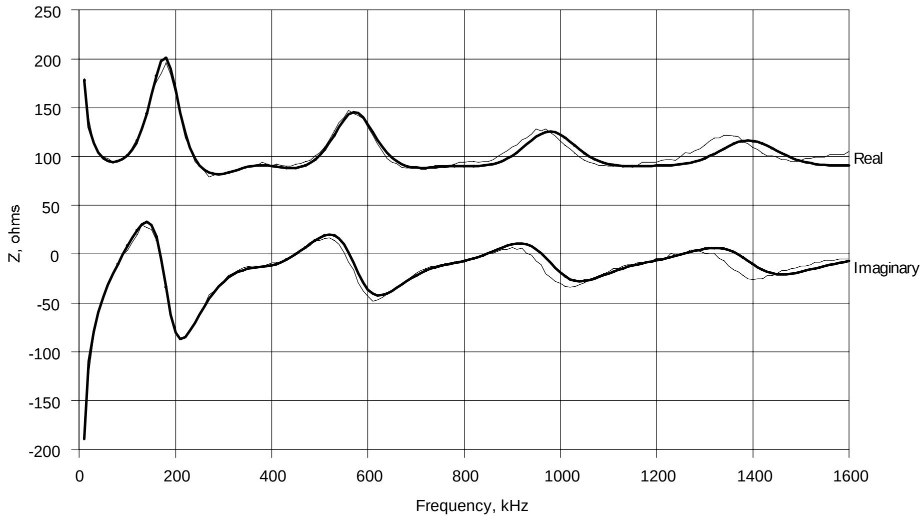
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



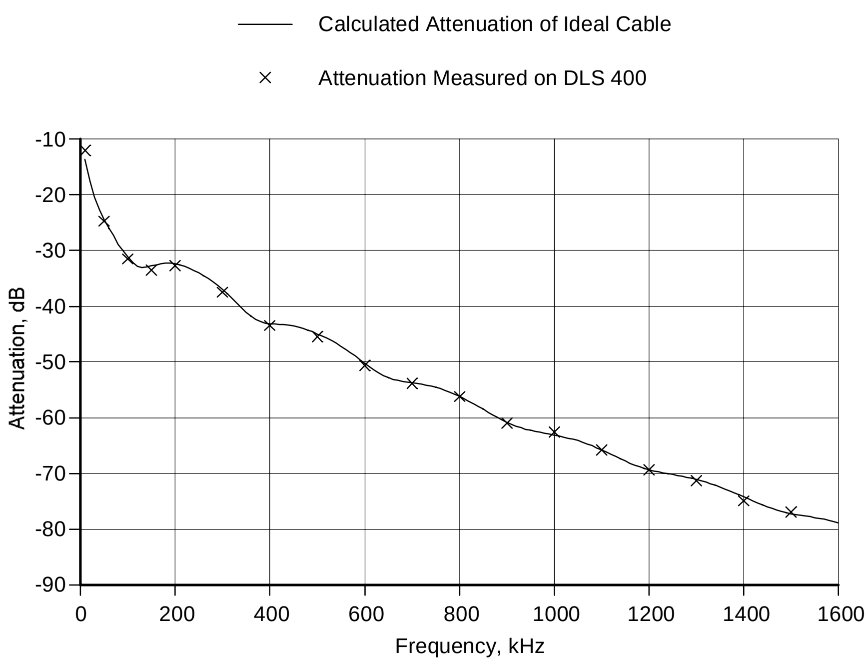
At CO Side



At Customer Side

10.1.5 CSA Loop #5

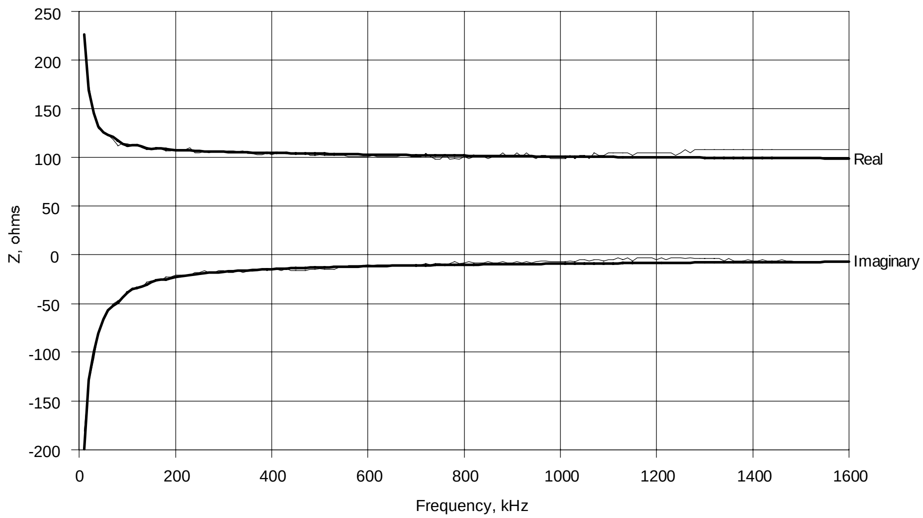
Attenuation



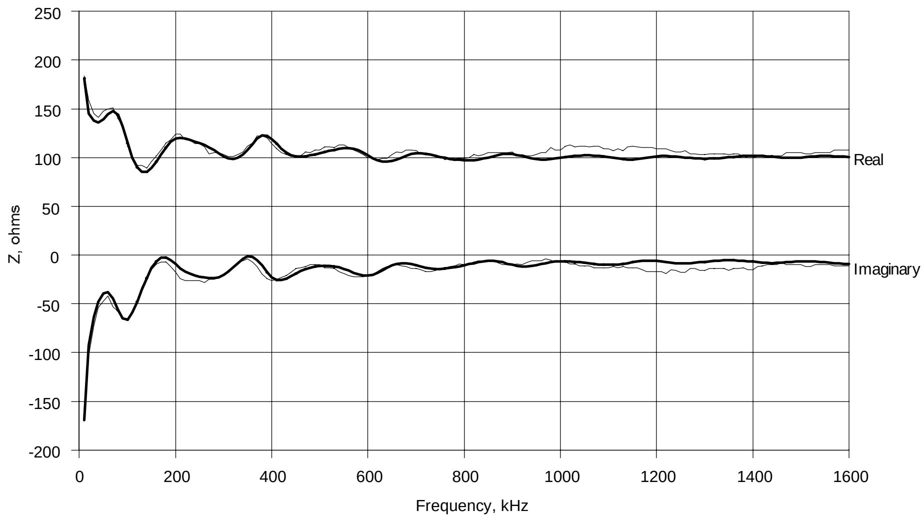
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



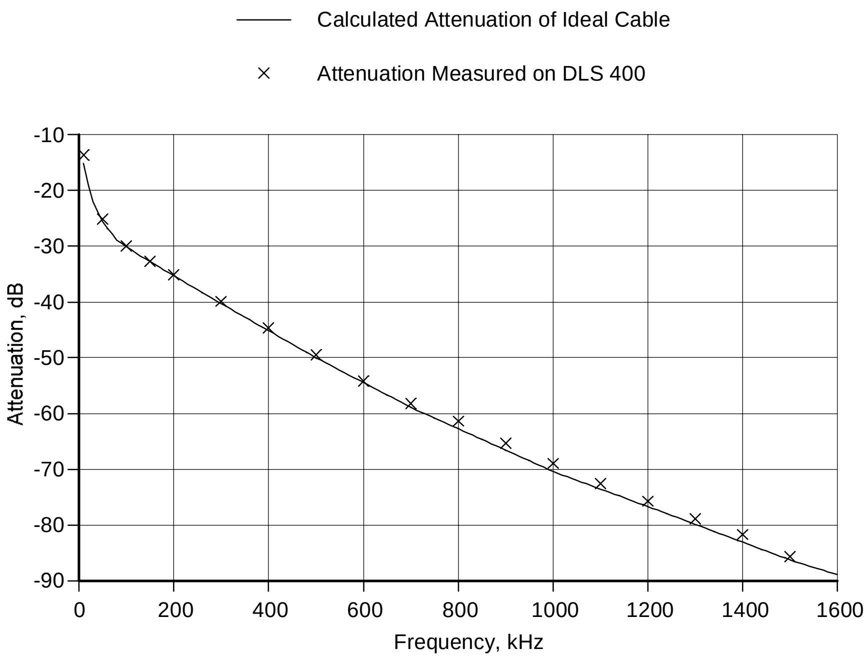
At CO Side



At Customer Side

10.1.6 CSA Loop #6

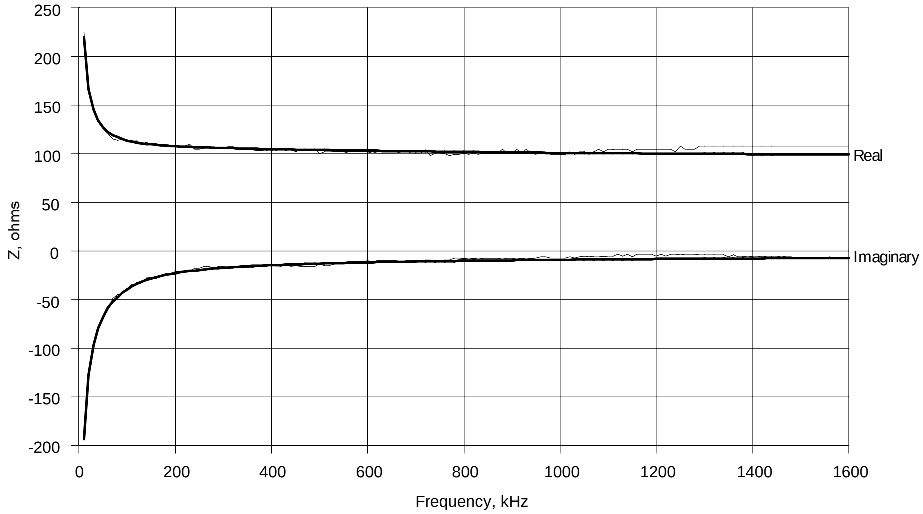
Attenuation



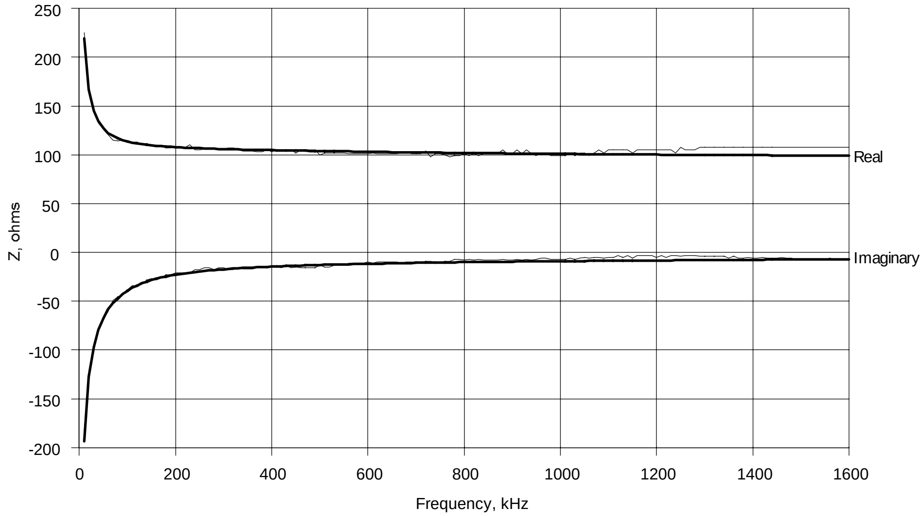
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



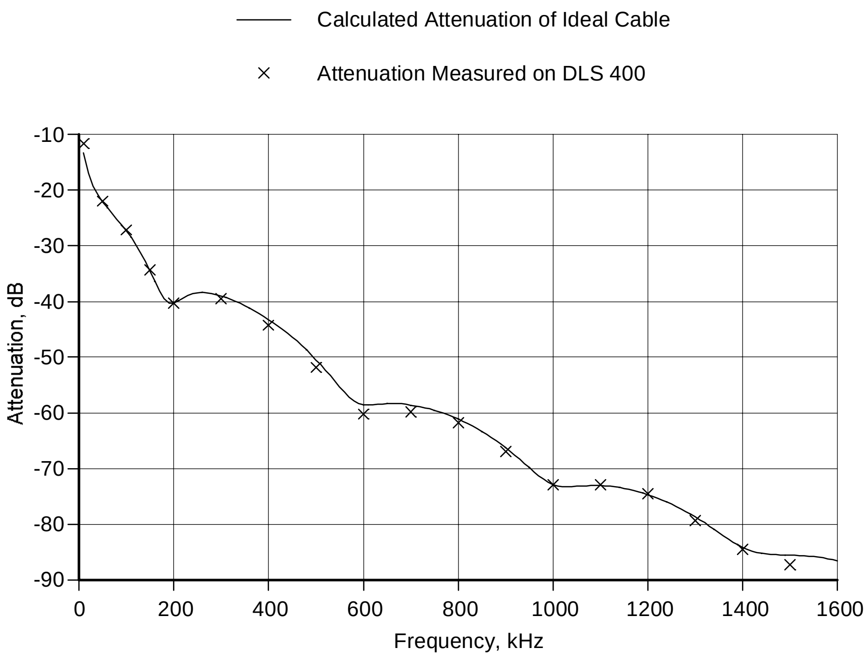
At CO Side



At Customer Side

10.1.7 CSA Loop #7

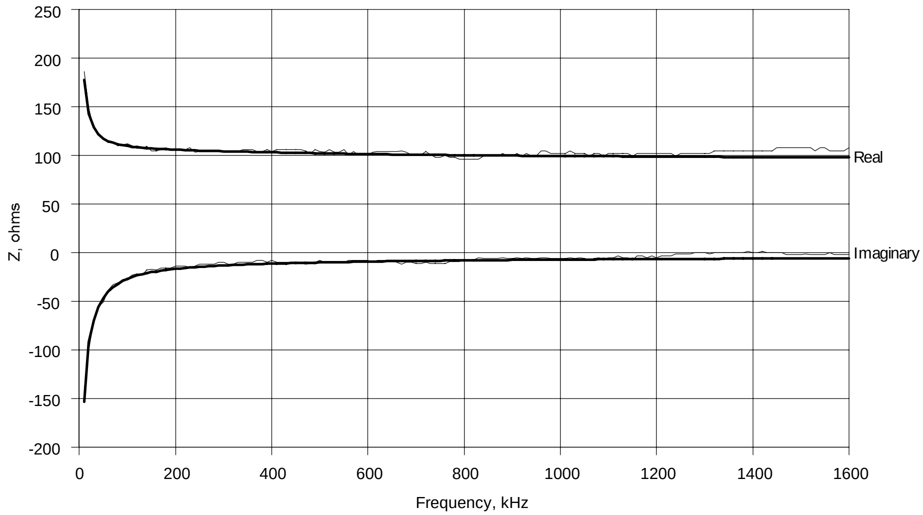
Attenuation



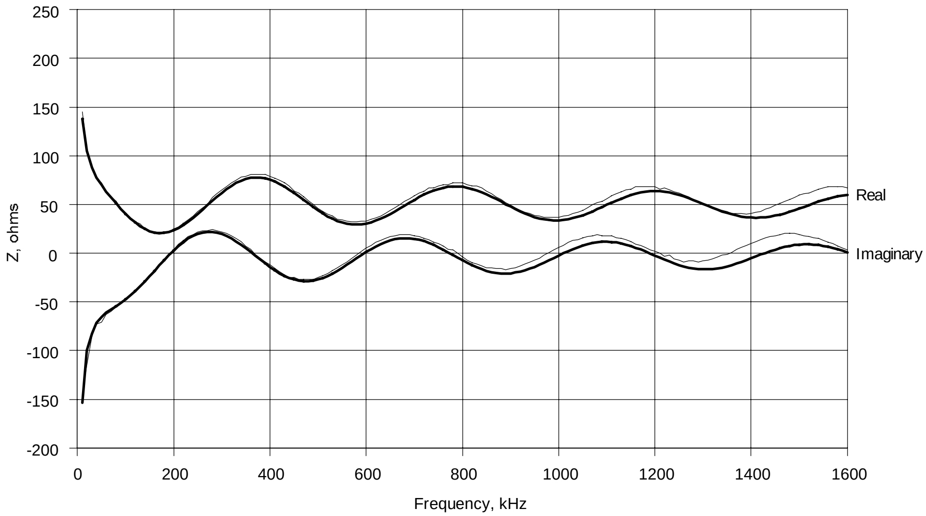
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



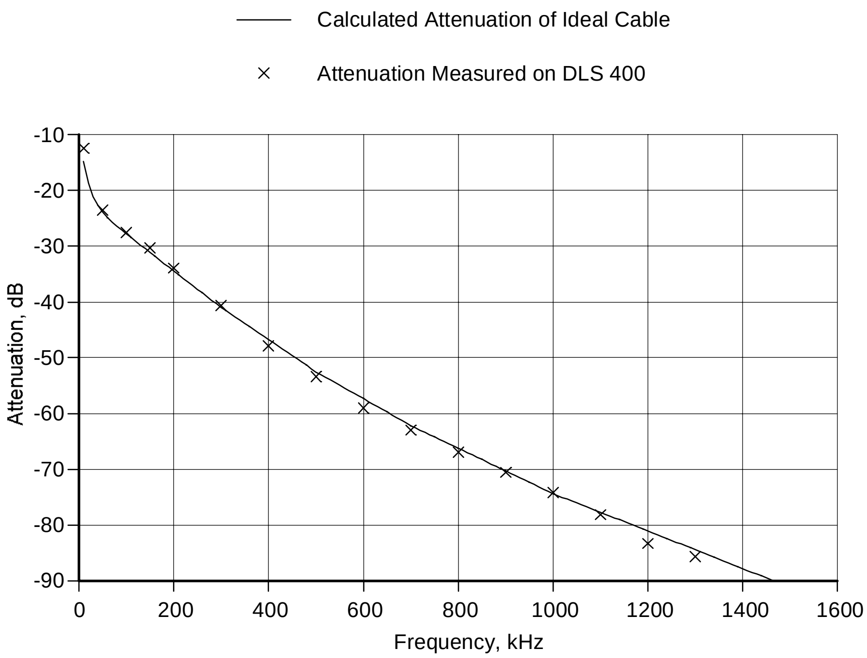
At CO Side



At Customer Side

10.1.8 CSA Loop #8

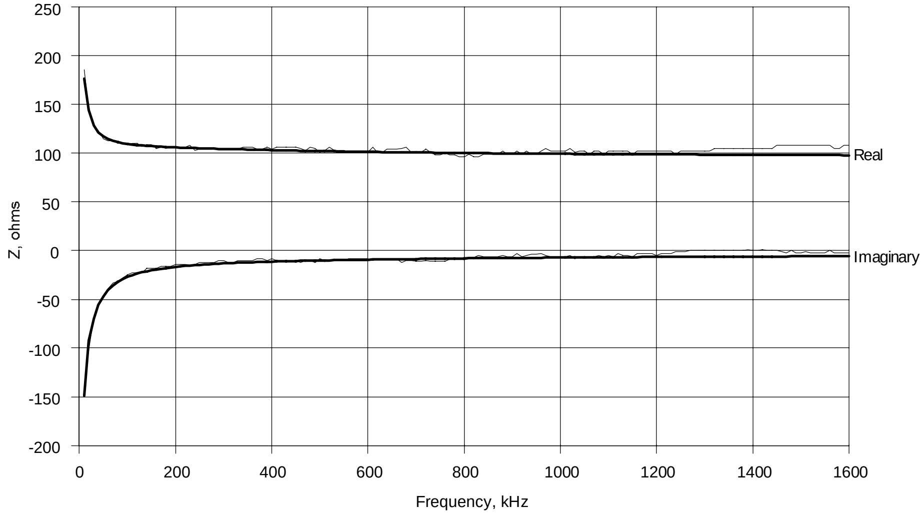
Attenuation



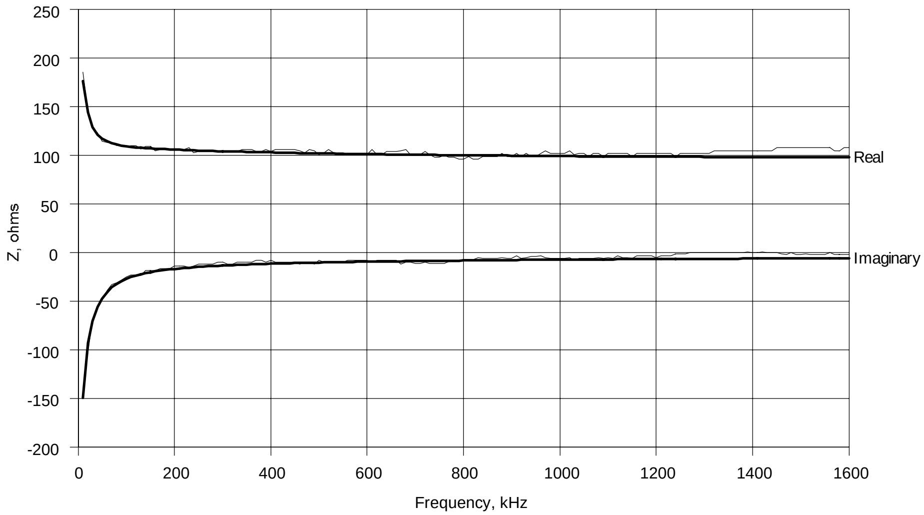
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



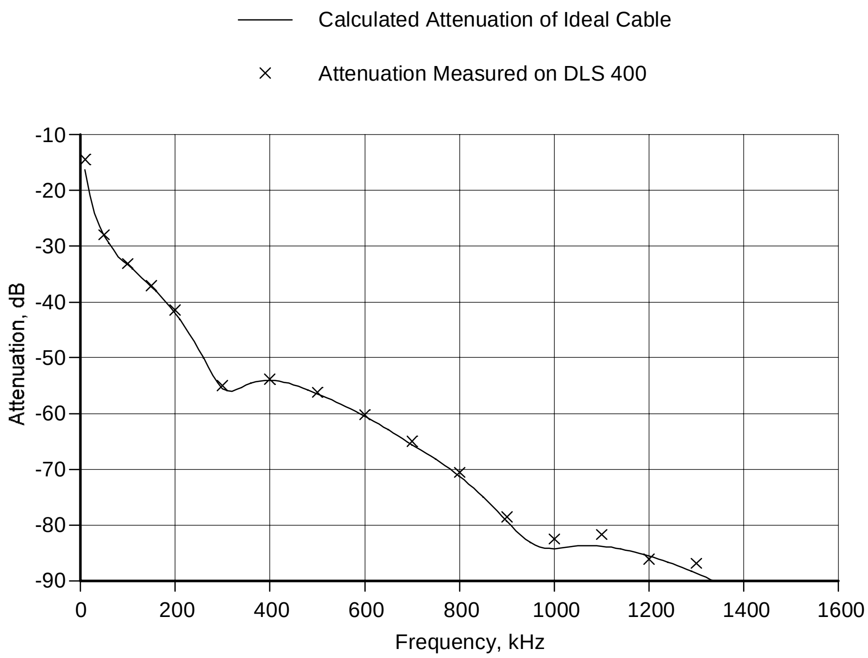
At CO Side



At Customer Side

10.1.9 Extended-CSA Loop #9

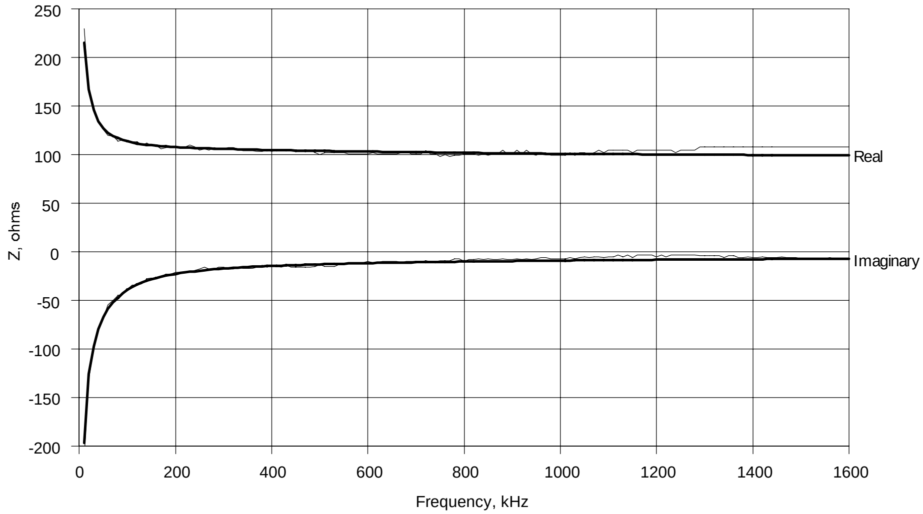
Attenuation



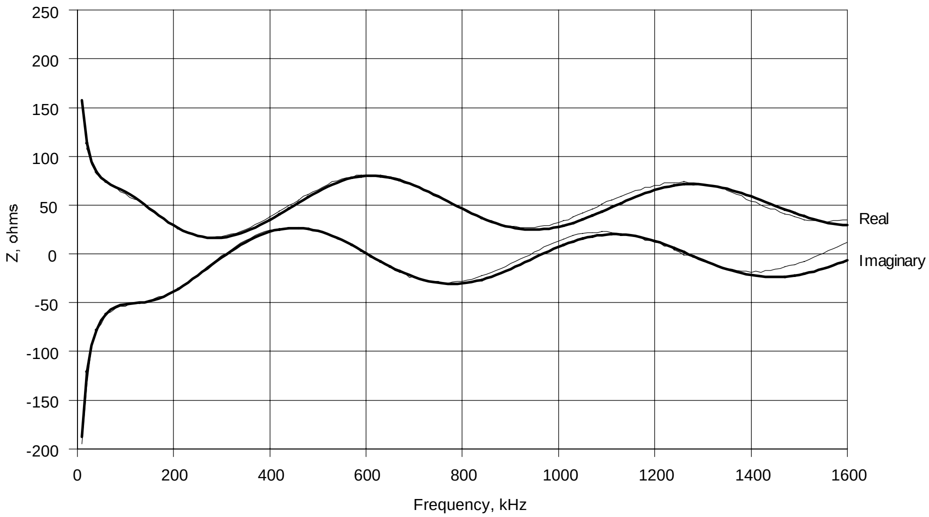
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



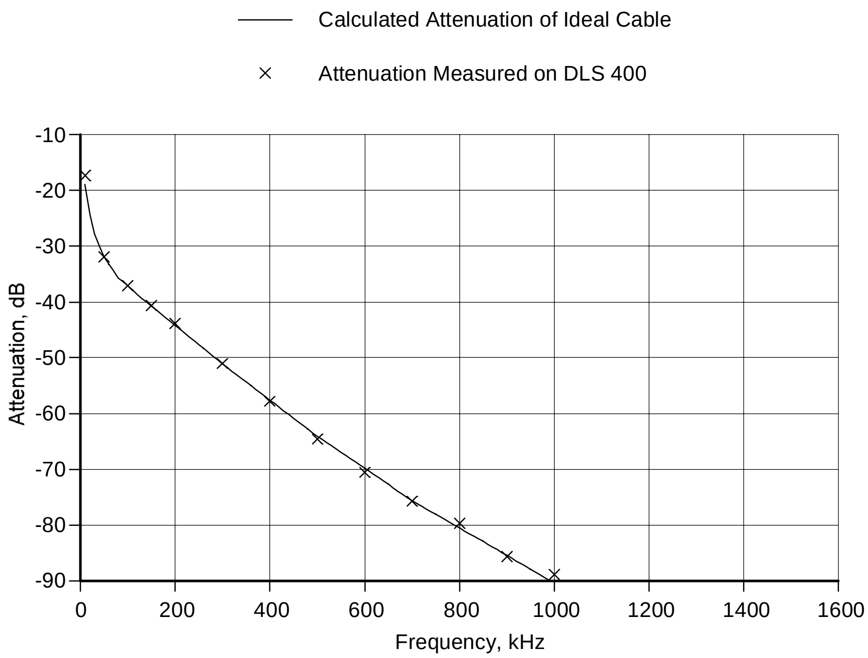
At CO Side



At Customer Side

10.1.10 Extended-CSA Loop #10

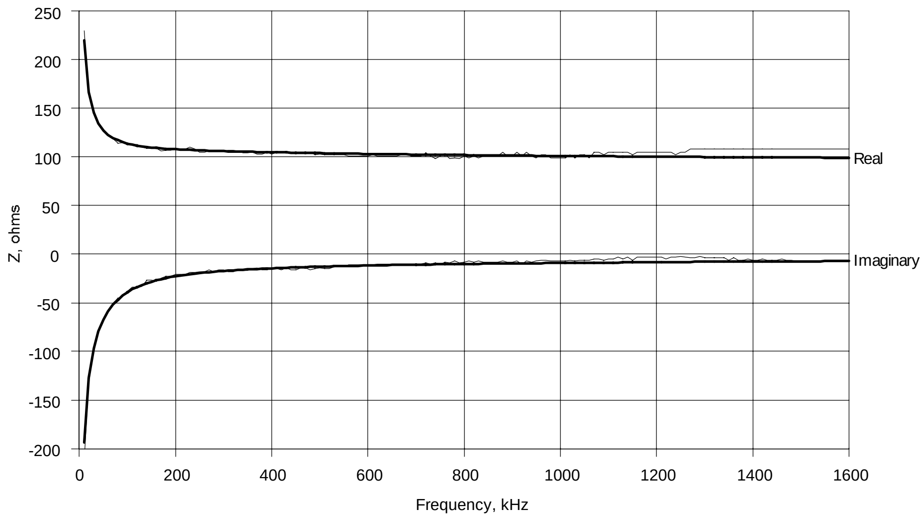
Attenuation



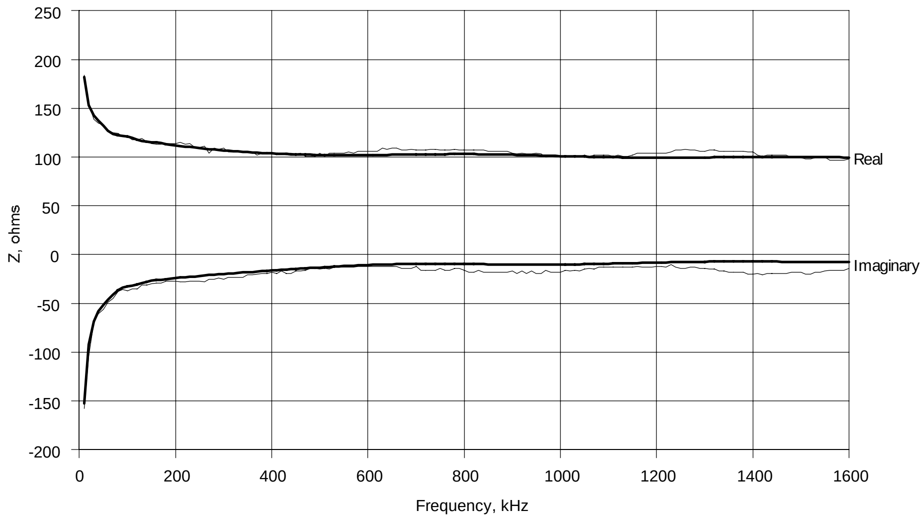
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



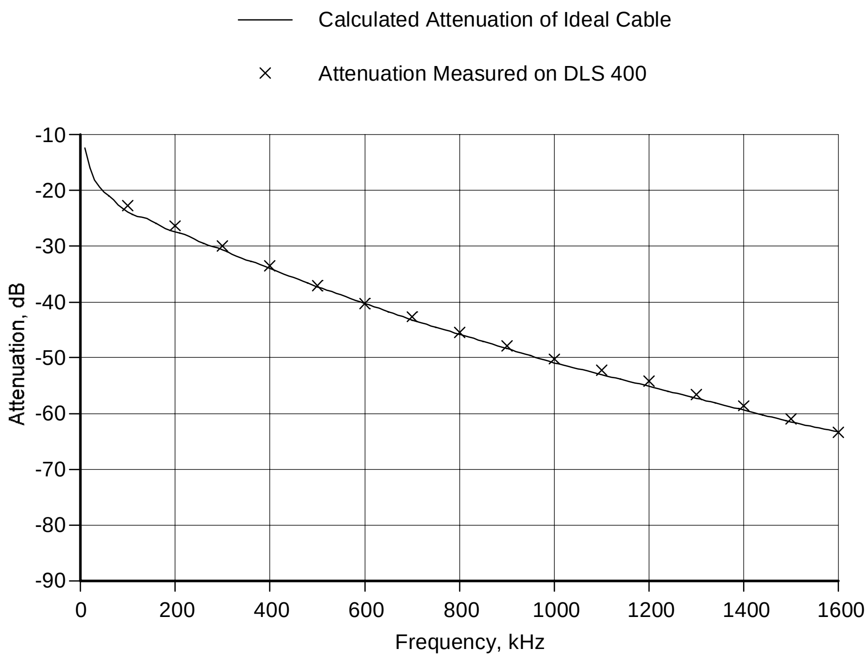
At CO Side



At Customer Side

10.1.11 Mid-CSA Loop #0

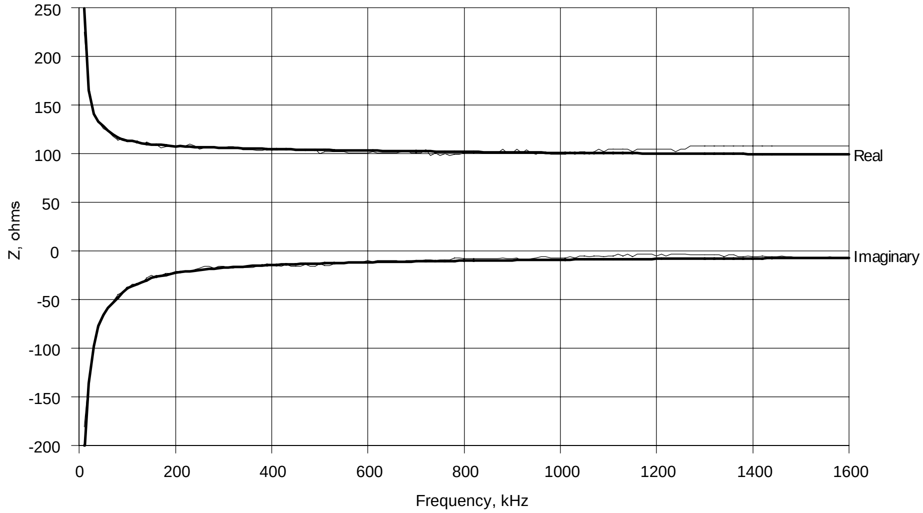
Attenuation



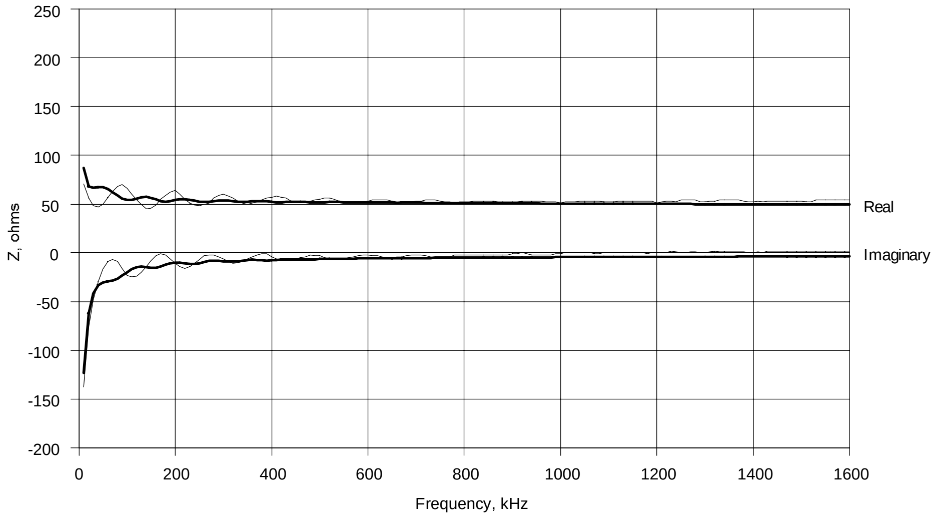
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



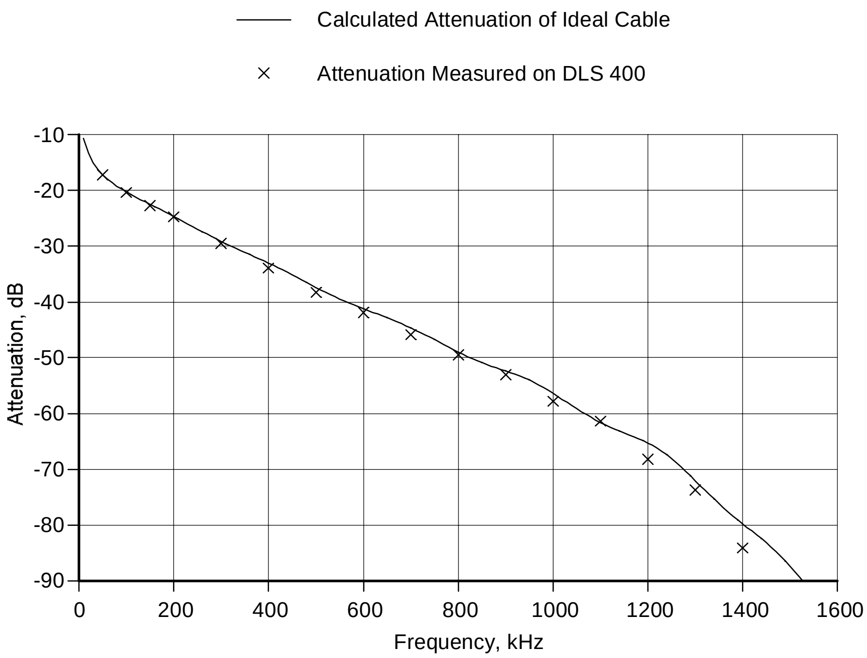
At CO Side



At Customer Side

10.1.12 Mid-CSA Loop #1

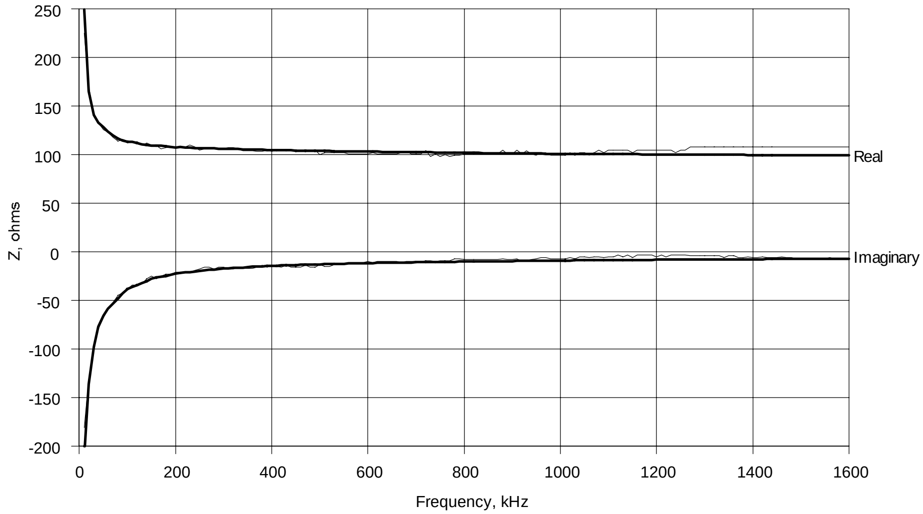
Attenuation



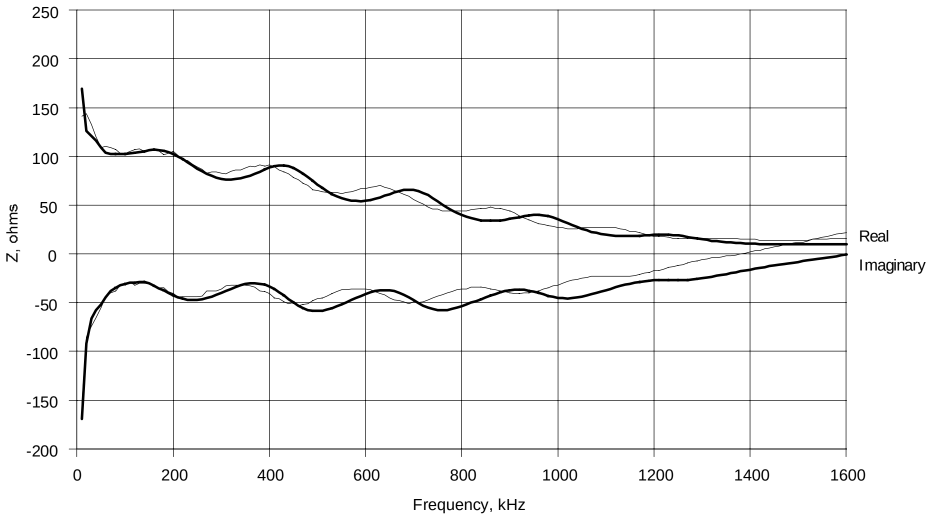
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



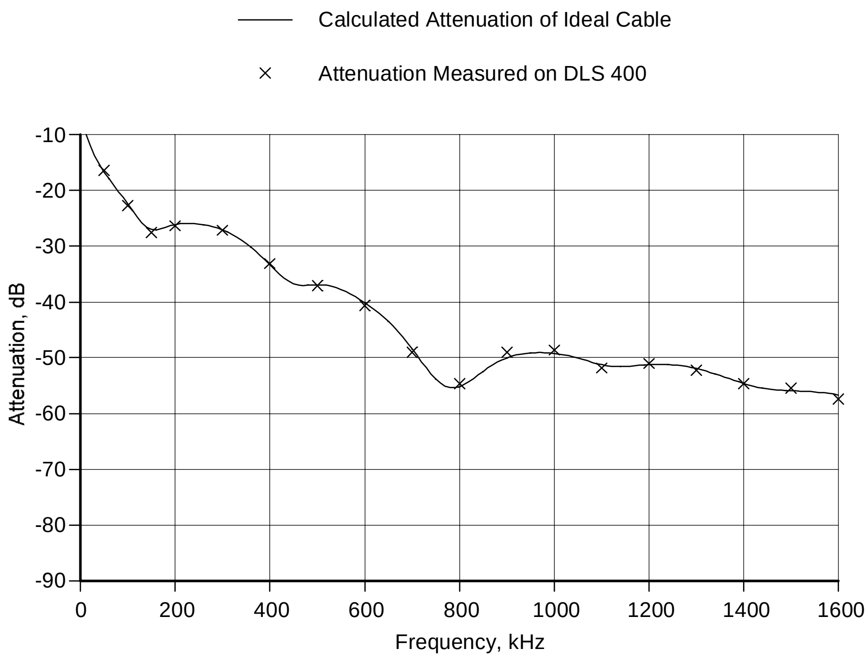
At CO Side



At Customer Side

10.1.13 Mid-CSA Loop #2

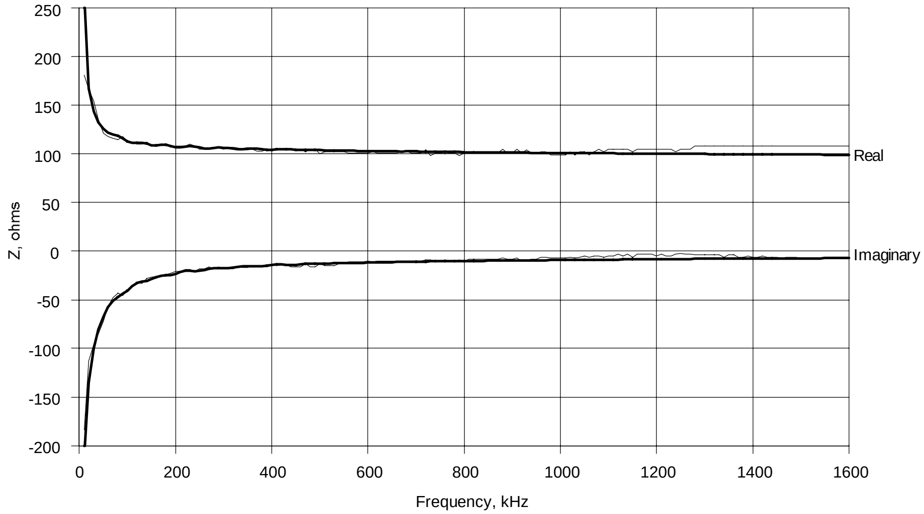
Attenuation



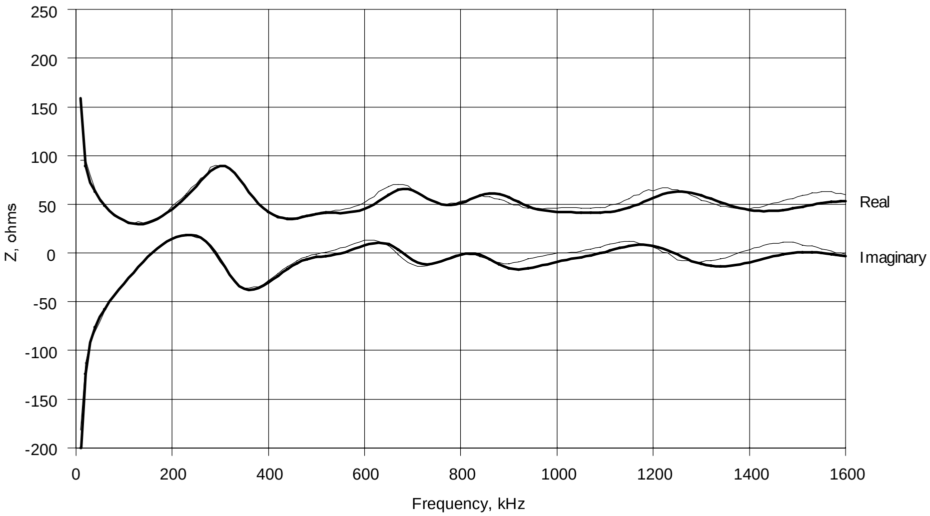
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



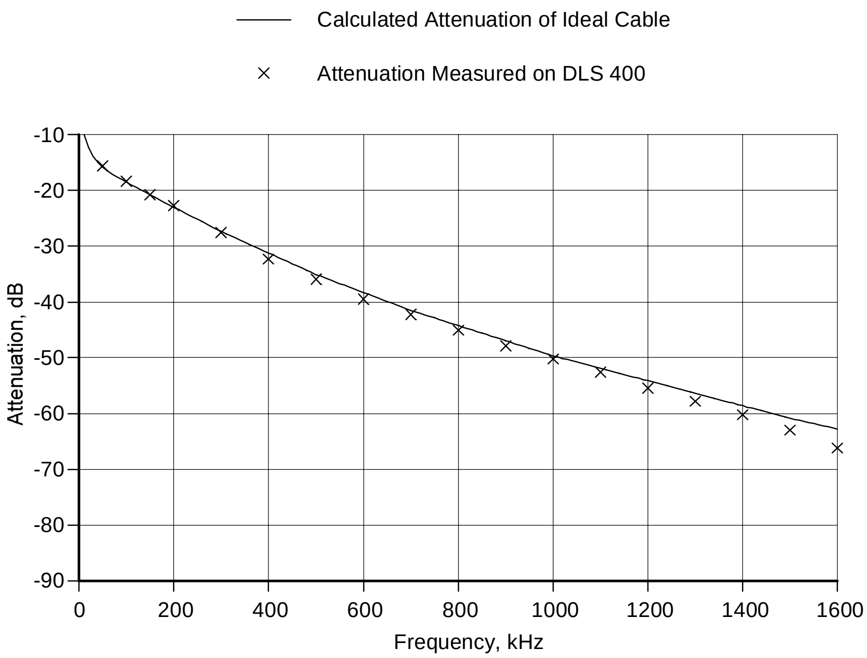
At CO Side



At Customer Side

10.1.14 Mid-CSA Loop #3

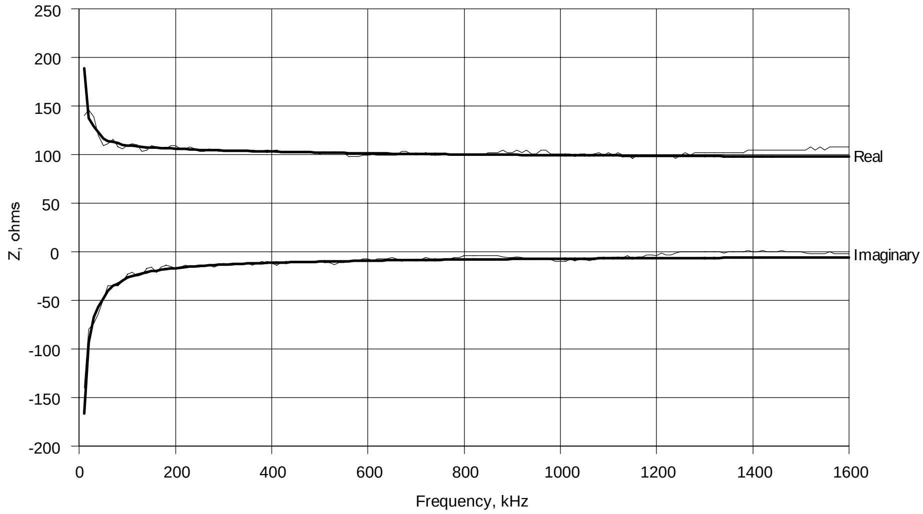
Attenuation



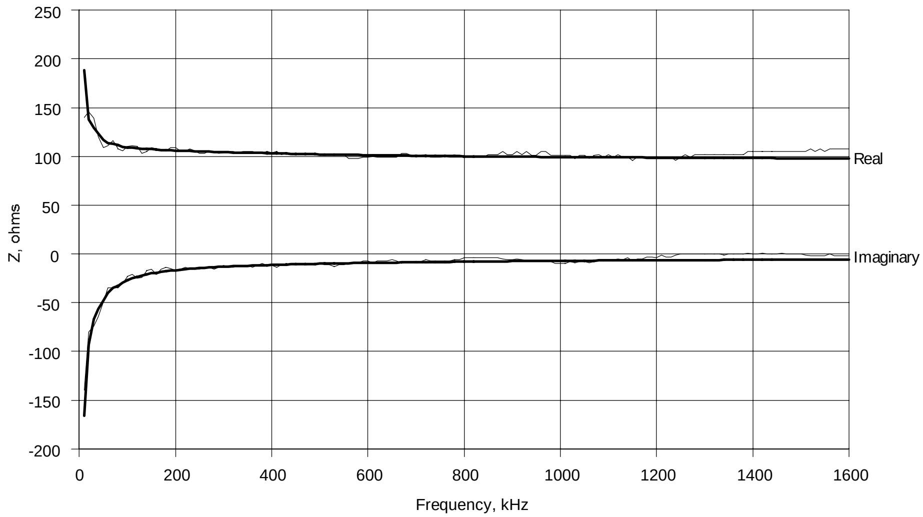
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



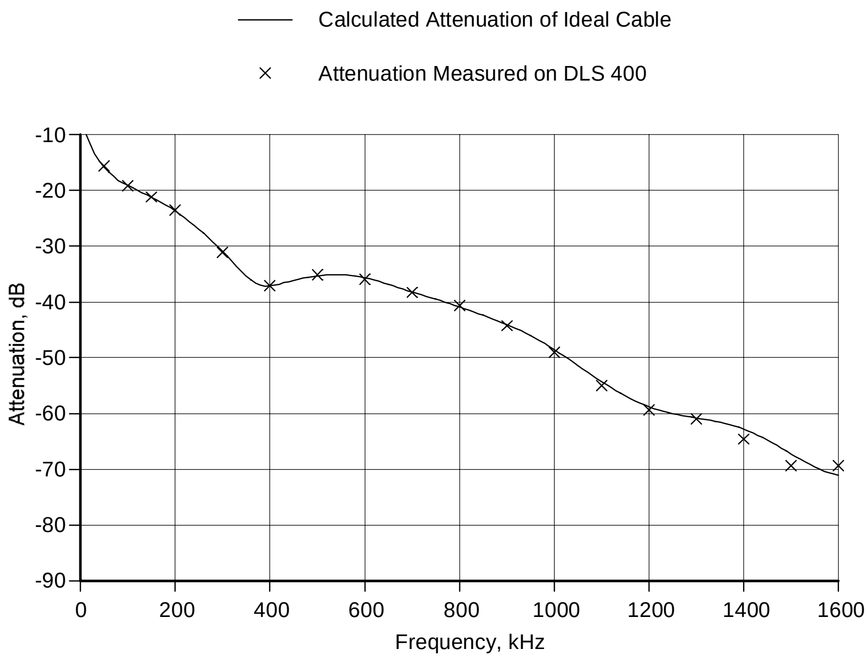
At CO Side



At Customer Side

10.1.15 Mid-CSA Loop #4

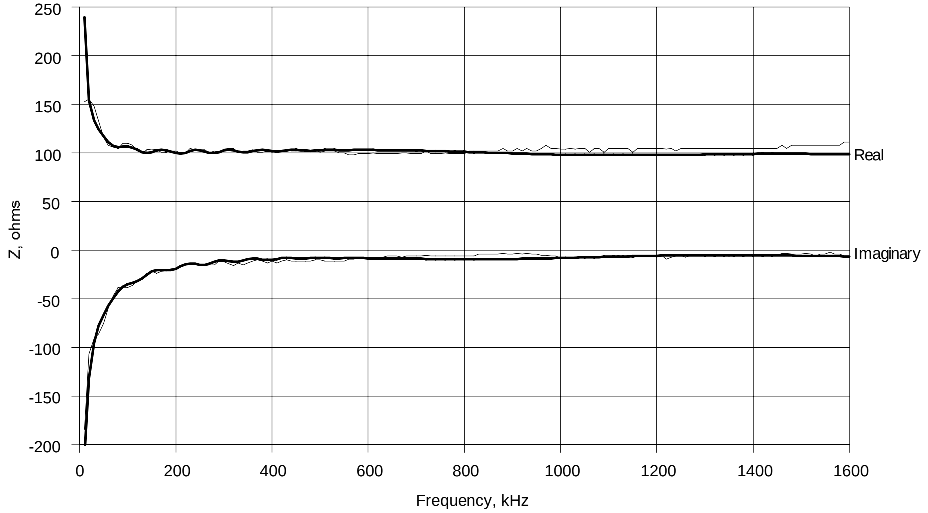
Attenuation



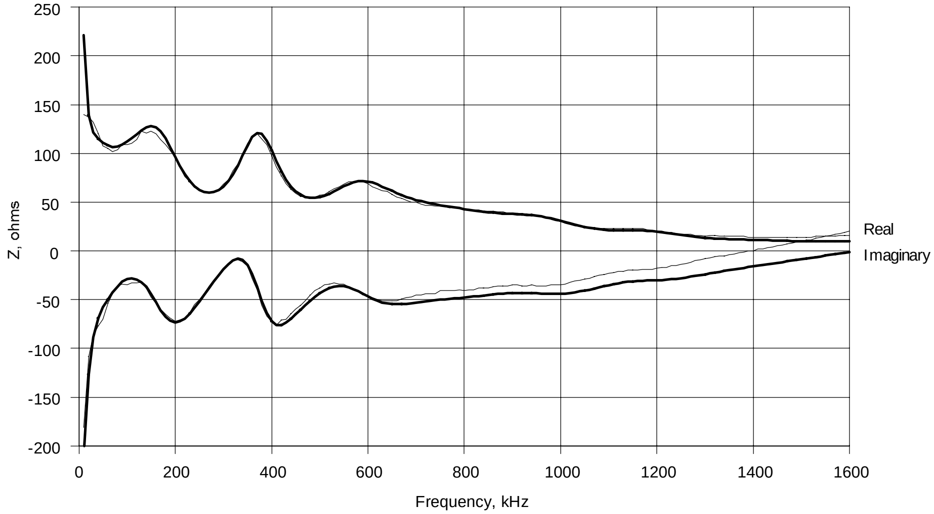
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



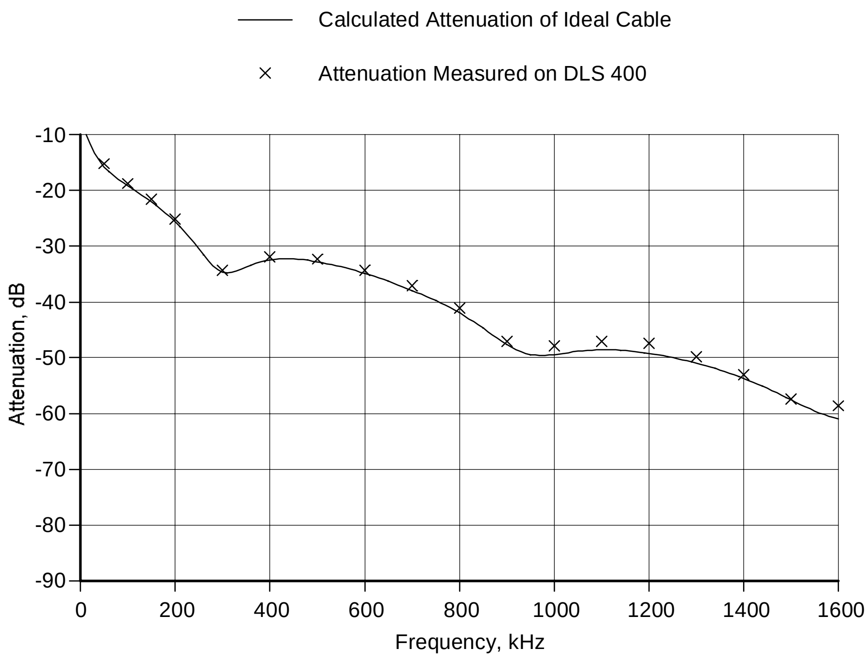
At CO Side



At Customer Side

10.1.16 Mid-CSA Loop #5

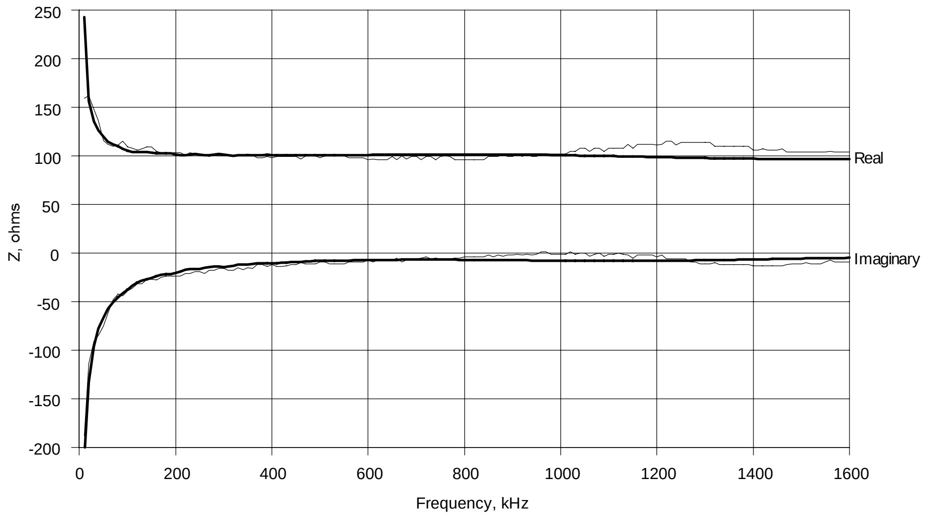
Attenuation



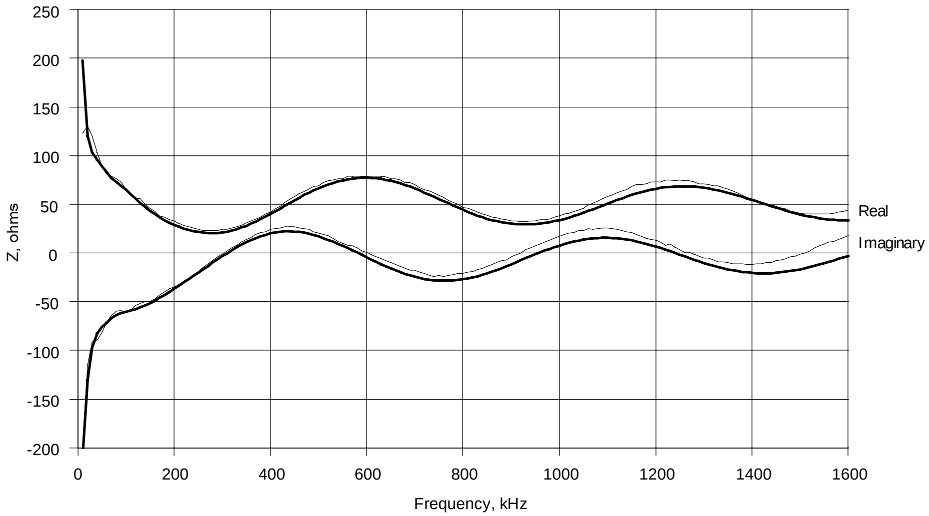
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



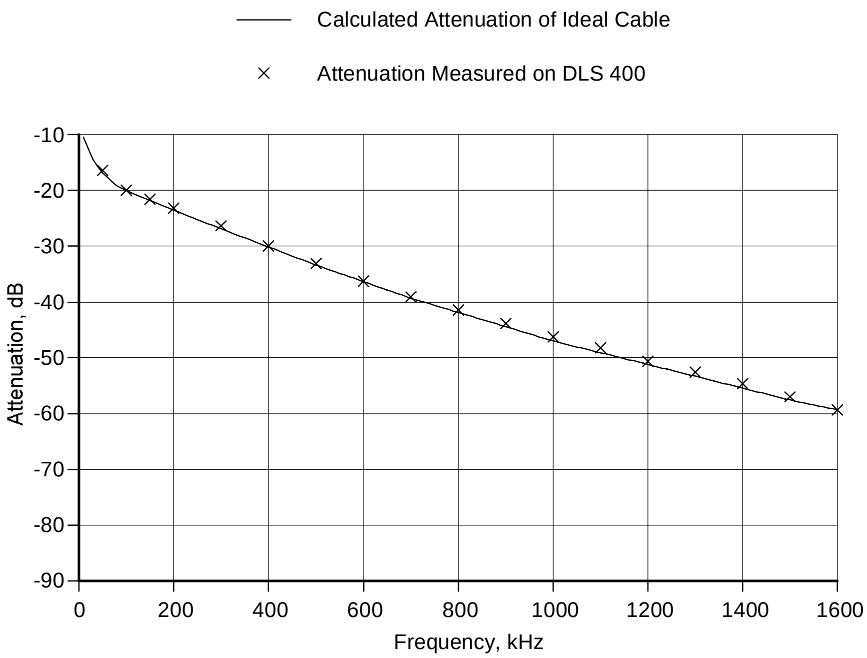
At CO Side



At Customer Side

10.1.17 Mid-CSA Loop #6

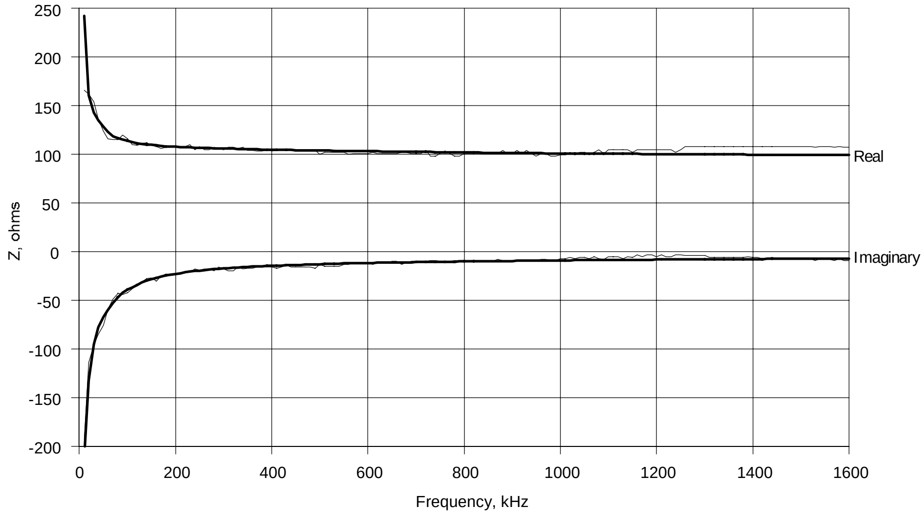
Attenuation



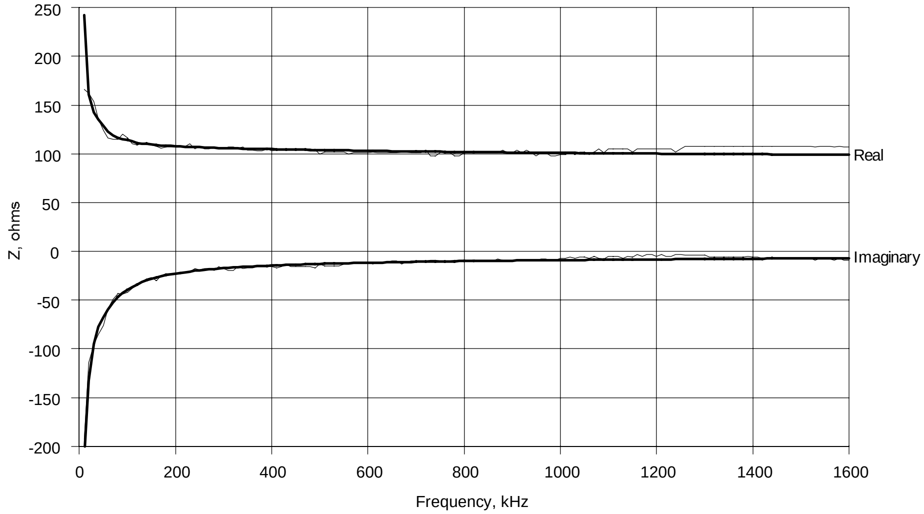
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



At CO Side

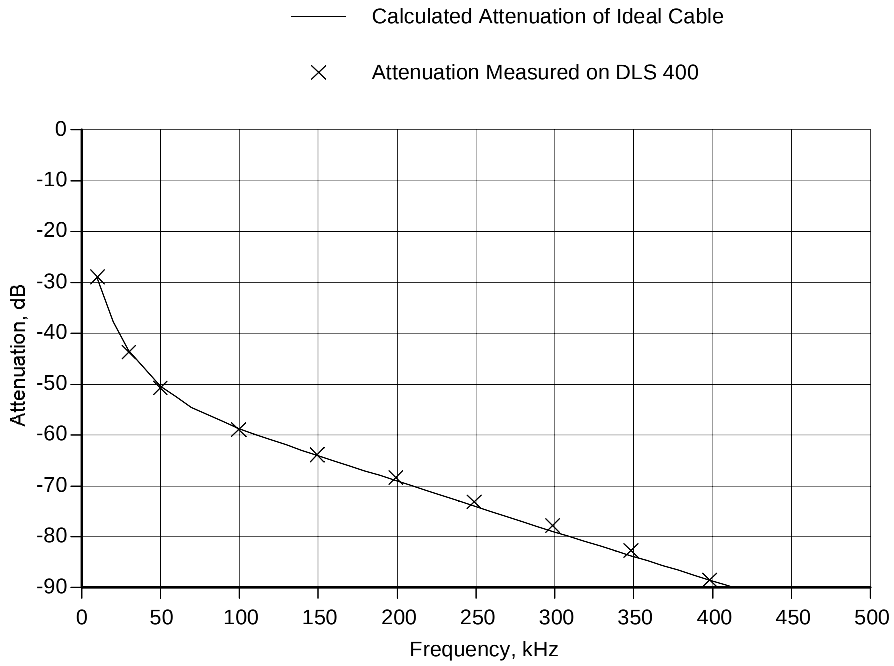


At Customer Side

10.2 ANSI Loops

10.2.1 ANSI Loop #1

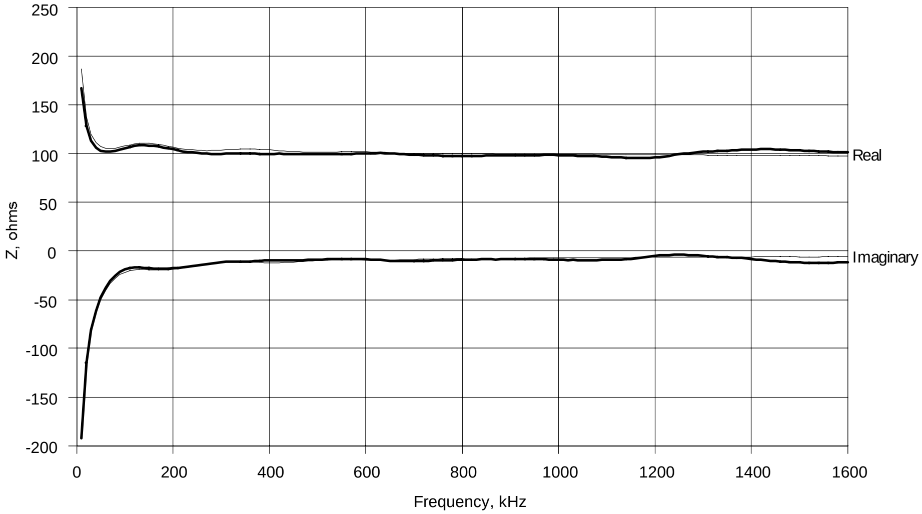
Attenuation



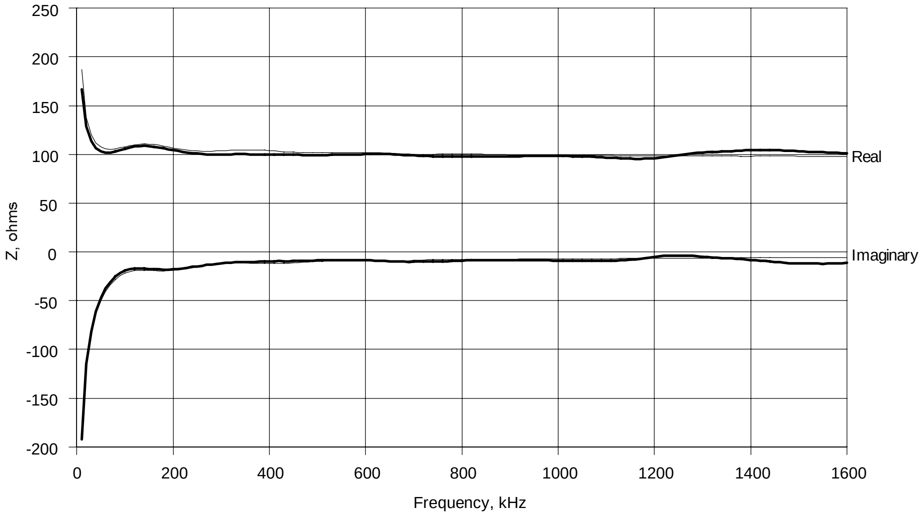
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



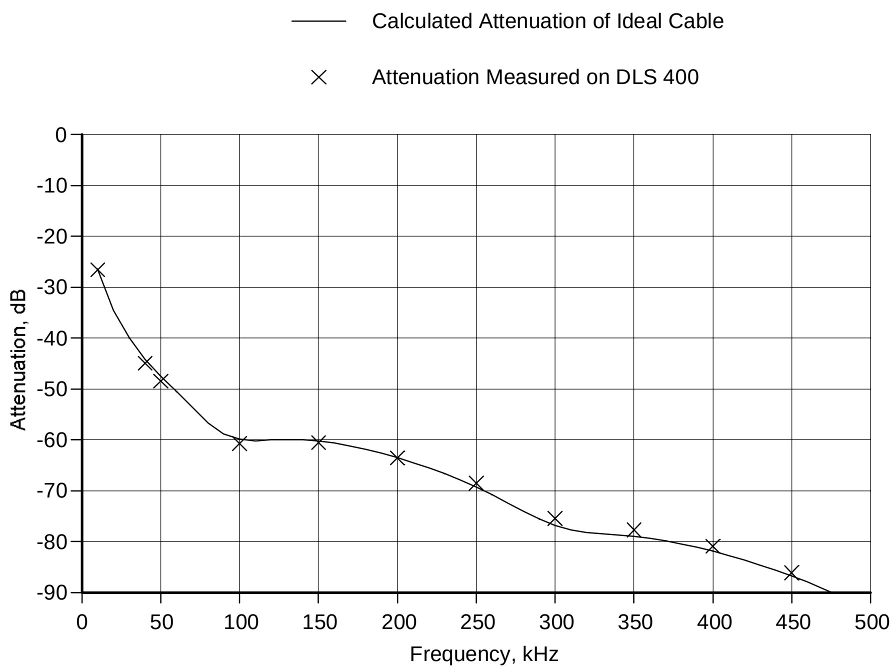
At CO Side



At Customer Side

10.2.2 ANSI Loop #2

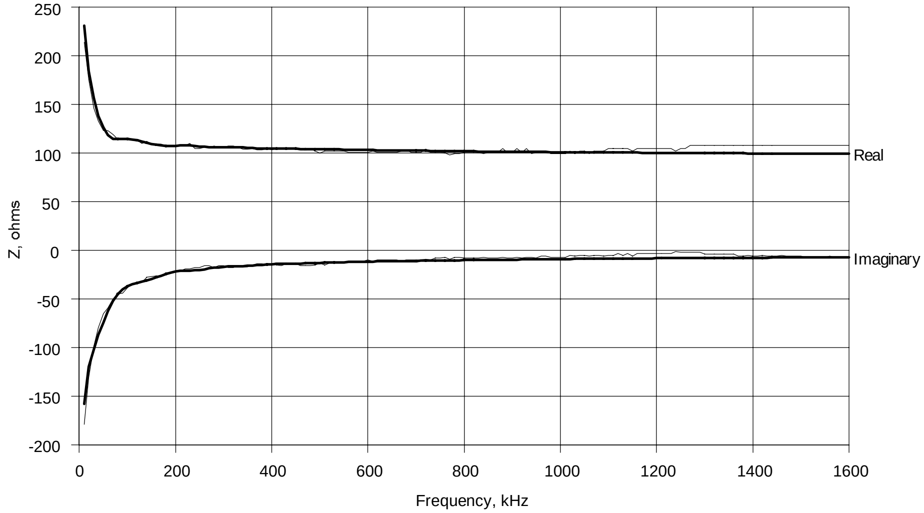
Attenuation



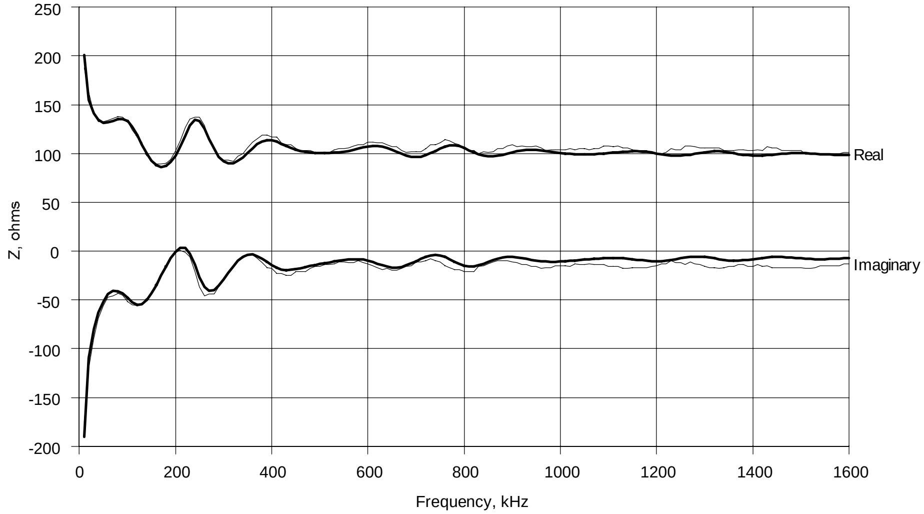
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



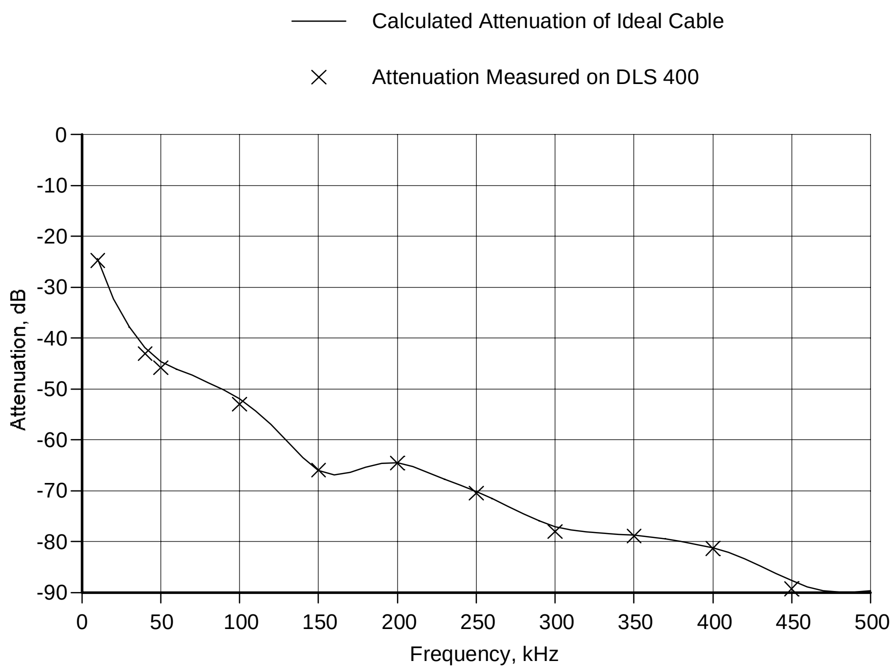
At CO Side



At Customer Side

10.2.3 ANSI Loop #3

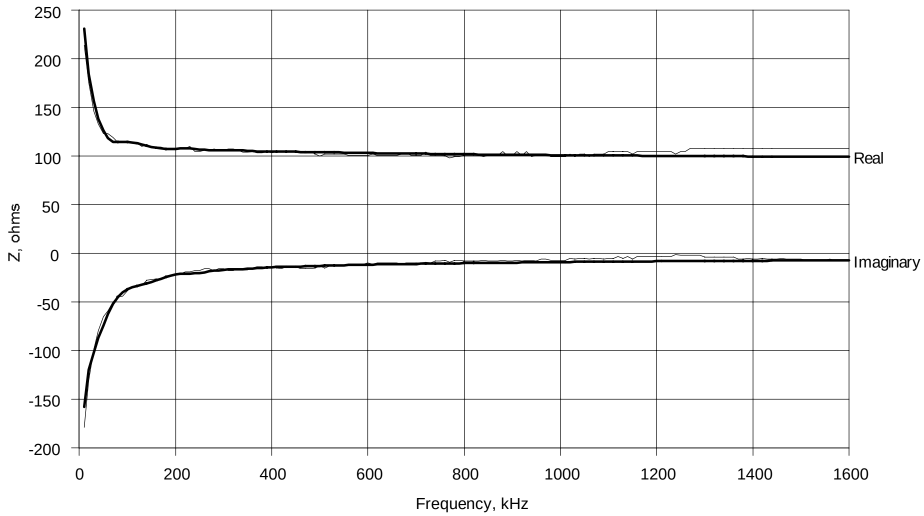
Attenuation



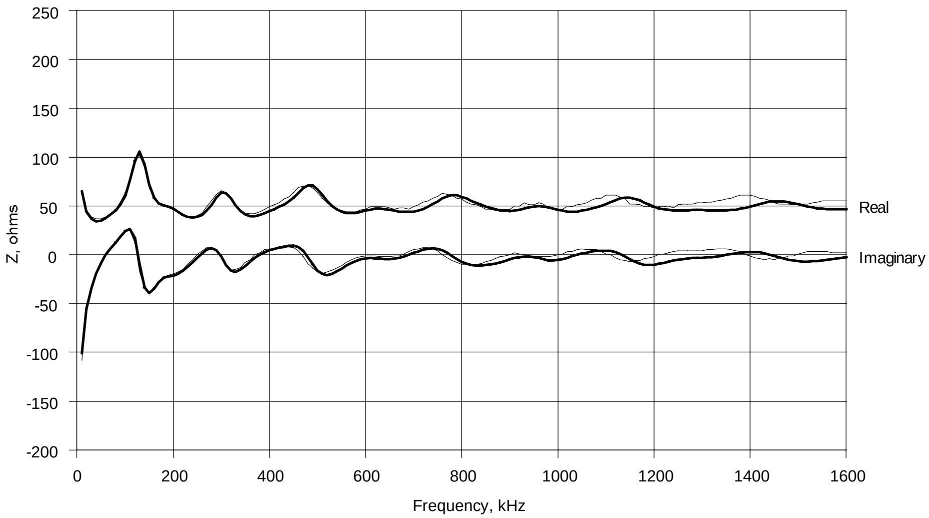
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



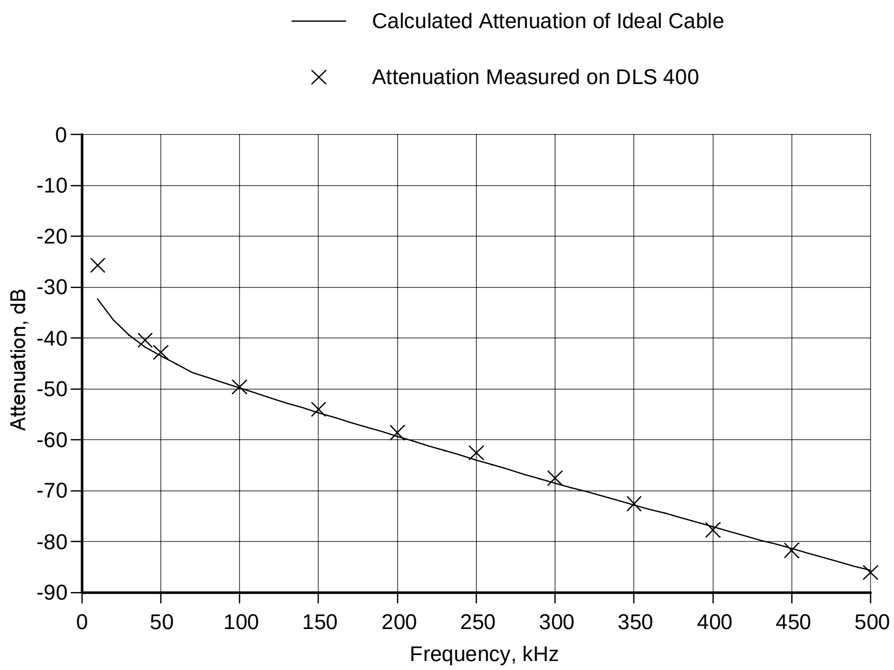
At CO Side



At Customer Side

10.2.4 ANSI Loop #4

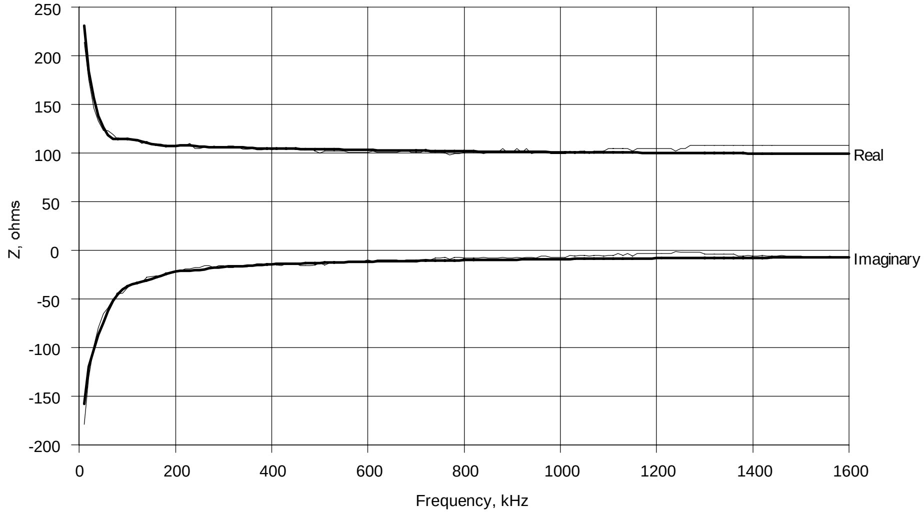
Attenuation



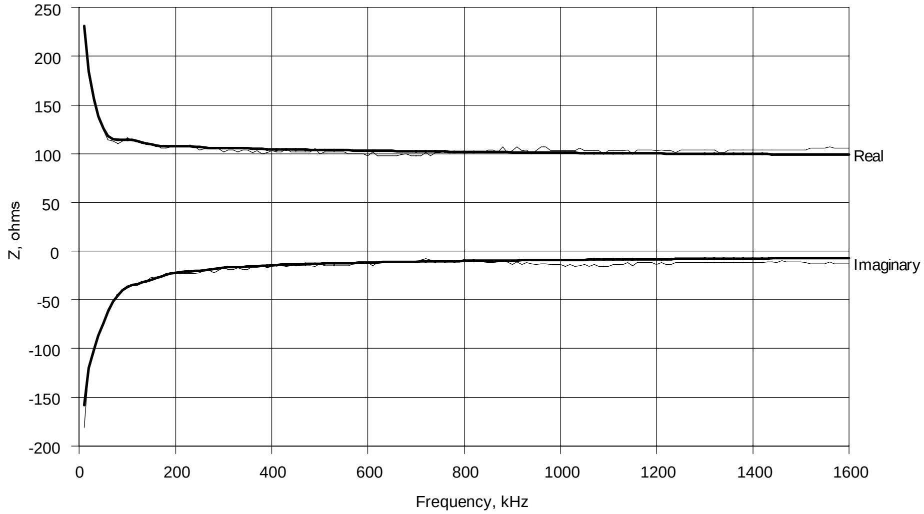
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



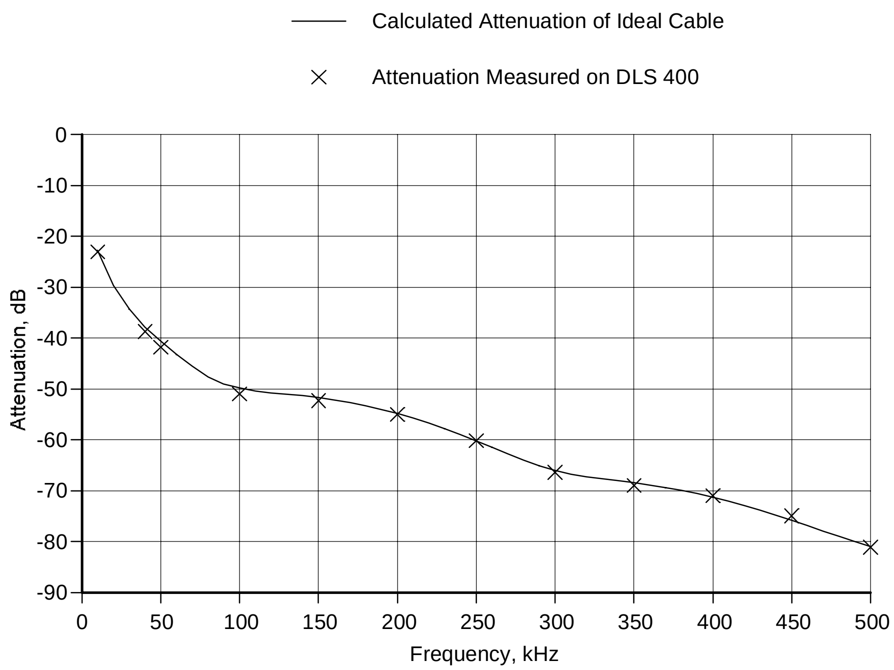
At CO Side



At Customer Side

10.2.5 ANSI Loop #5

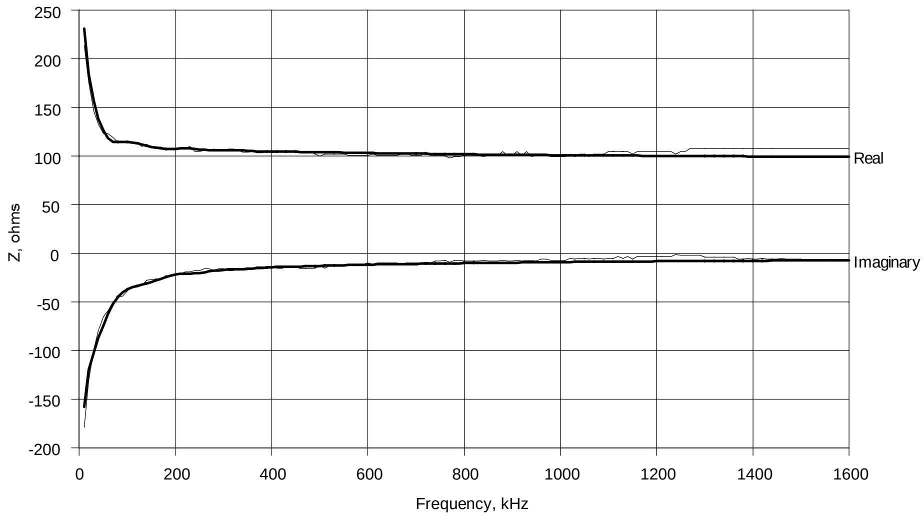
Attenuation



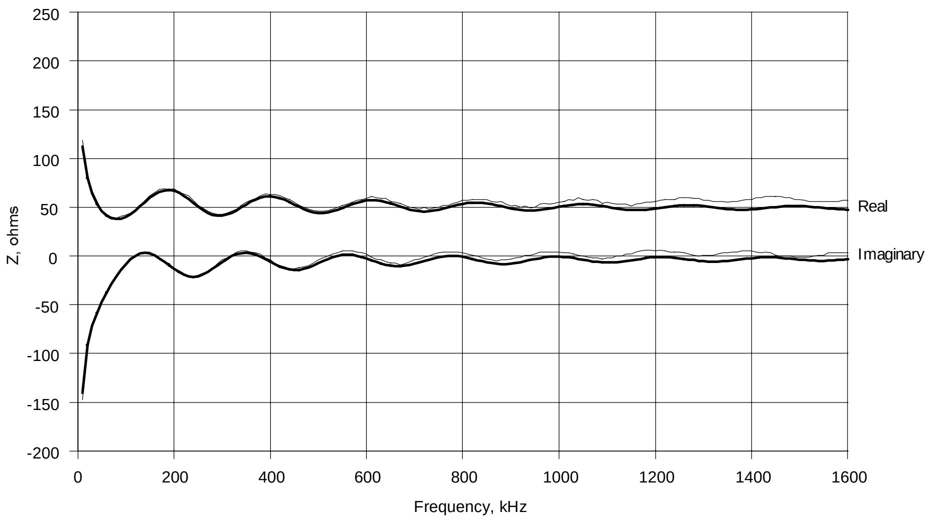
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



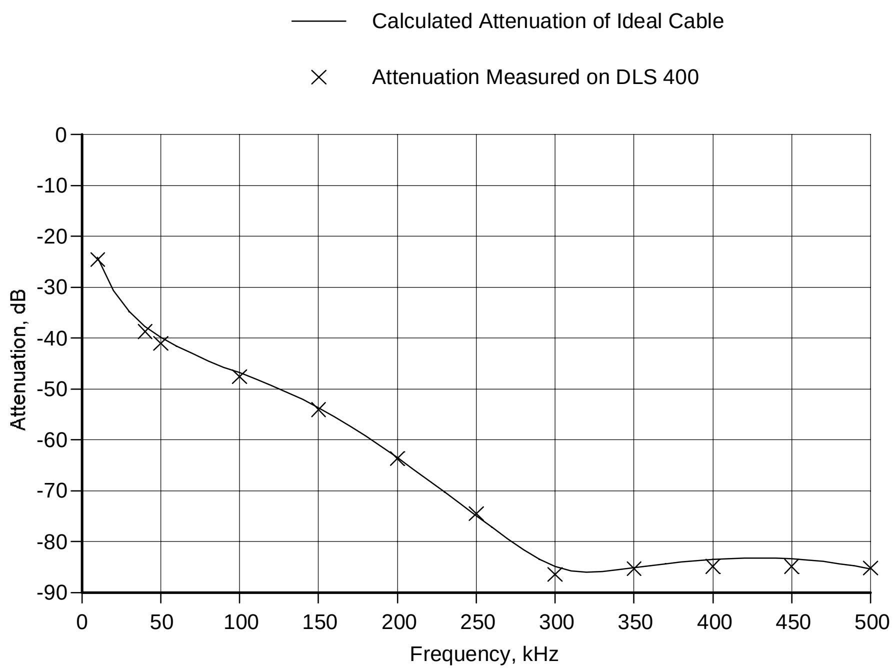
At CO Side



At Customer Side

10.2.6 ANSI Loop #6

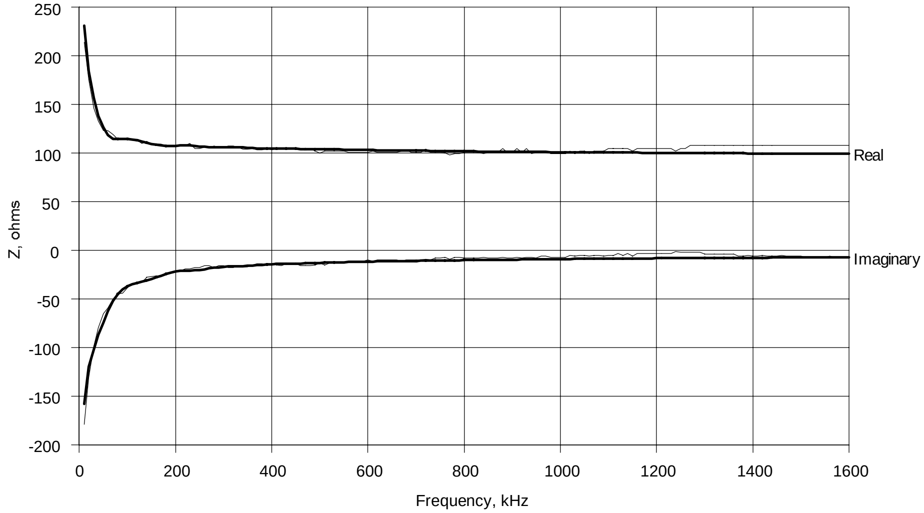
Attenuation



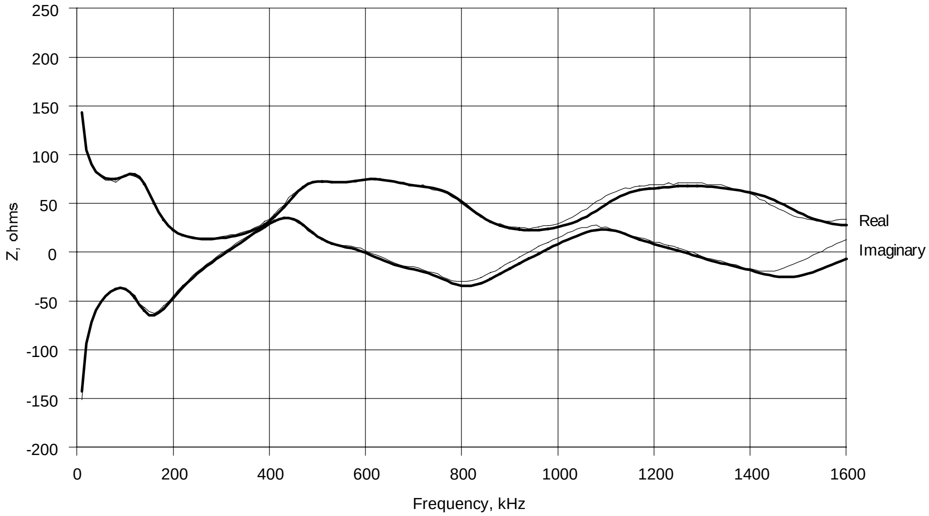
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



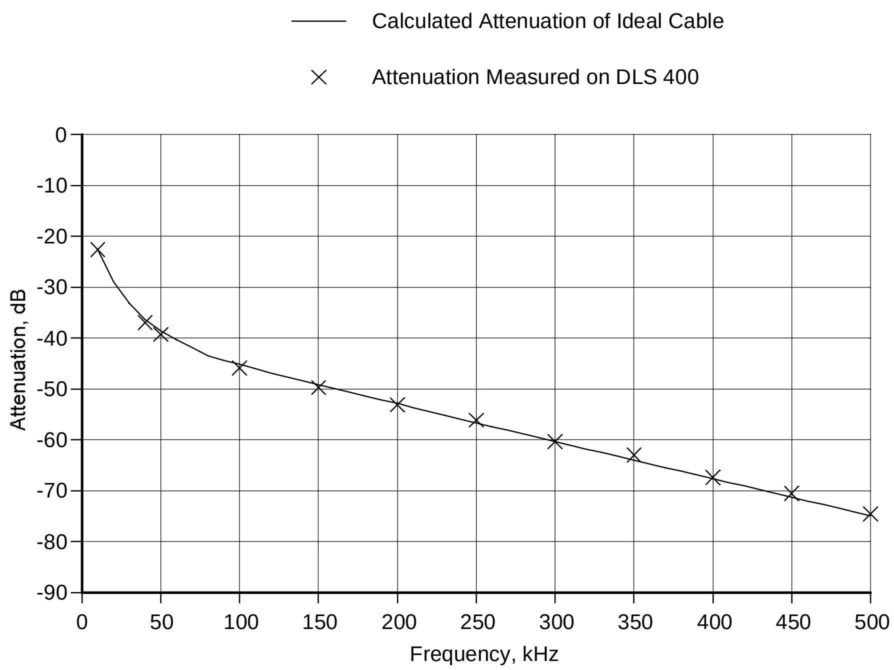
At CO Side



At Customer Side

10.2.7 ANSI Loop #7

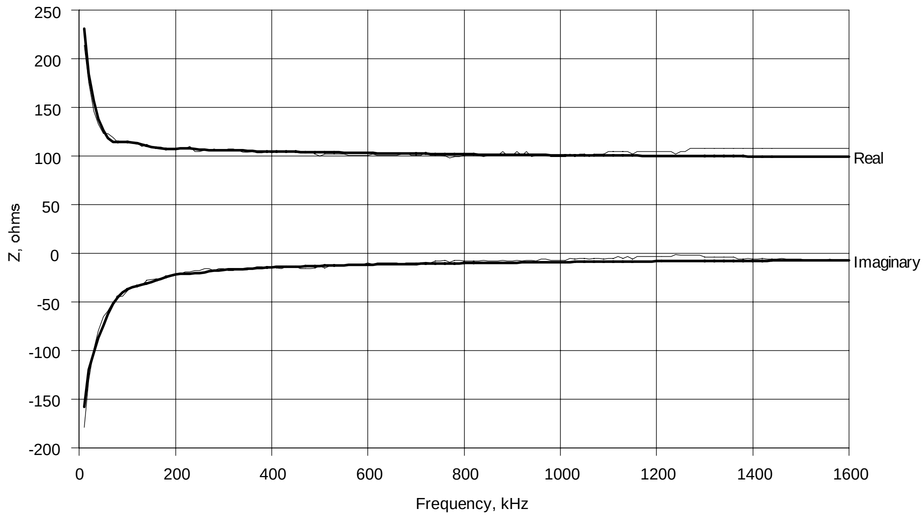
Attenuation



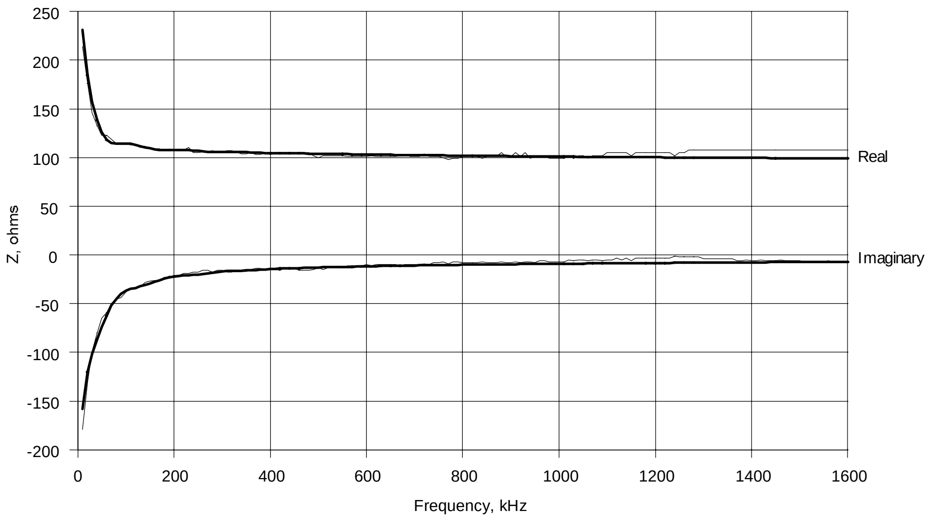
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



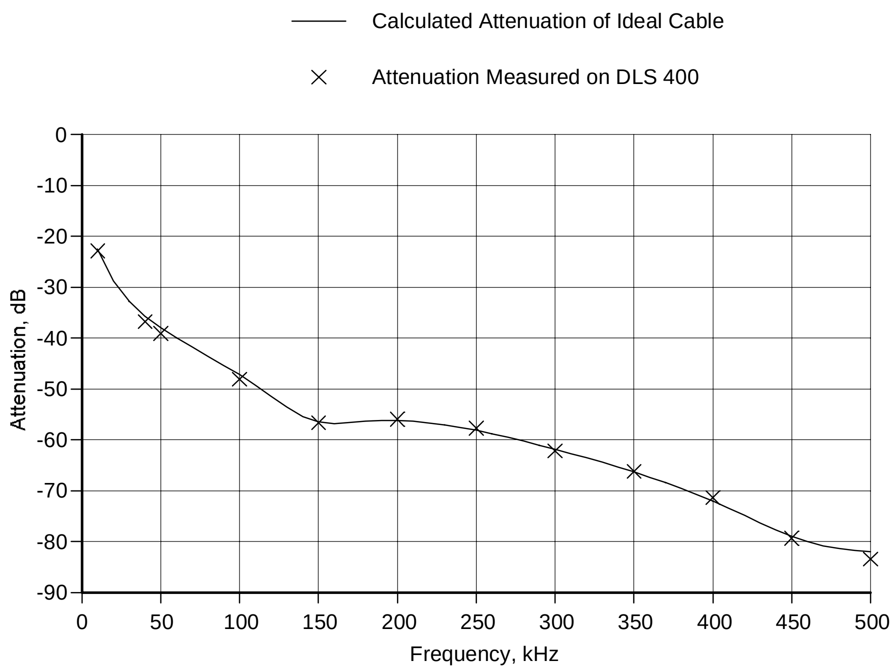
At CO Side



At Customer Side

10.2.8 ANSI Loop #8

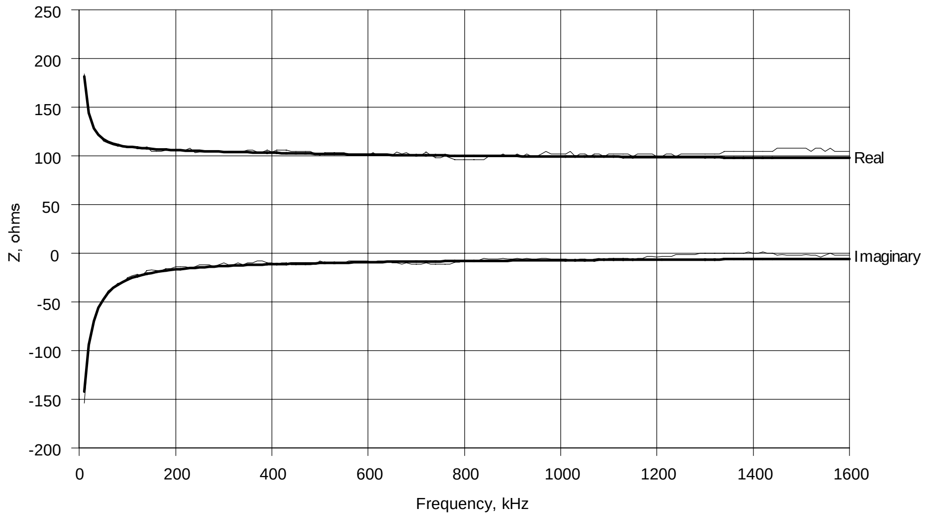
Attenuation



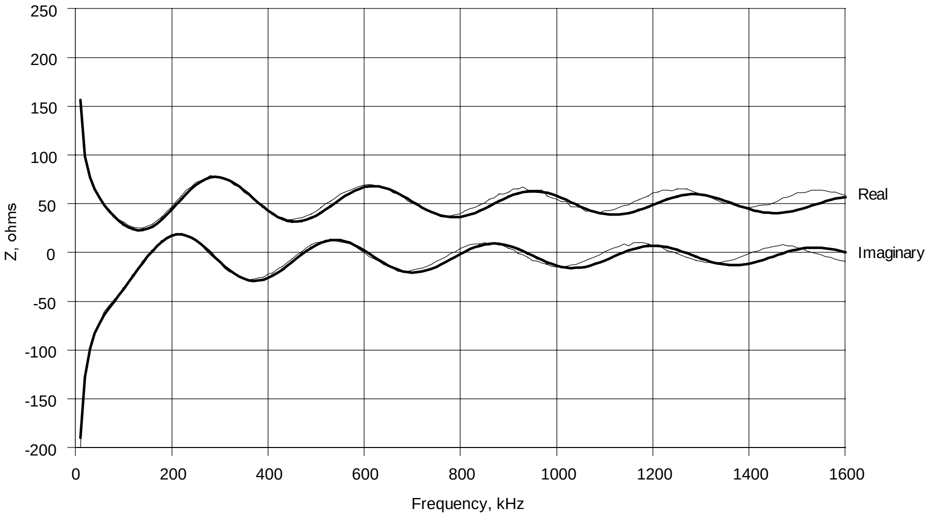
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



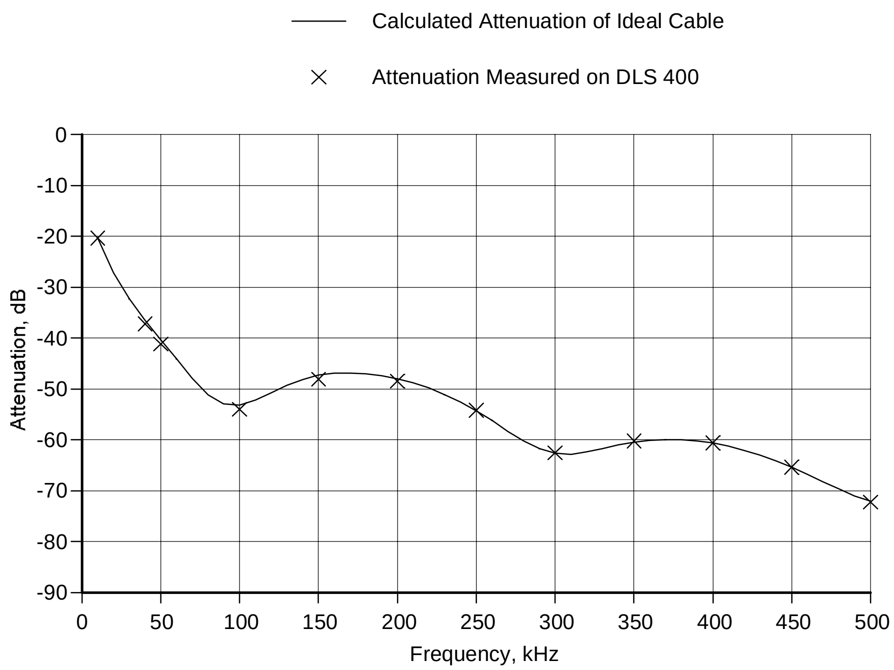
At CO Side



At Customer Side

10.2.9 ANSI Loop #9

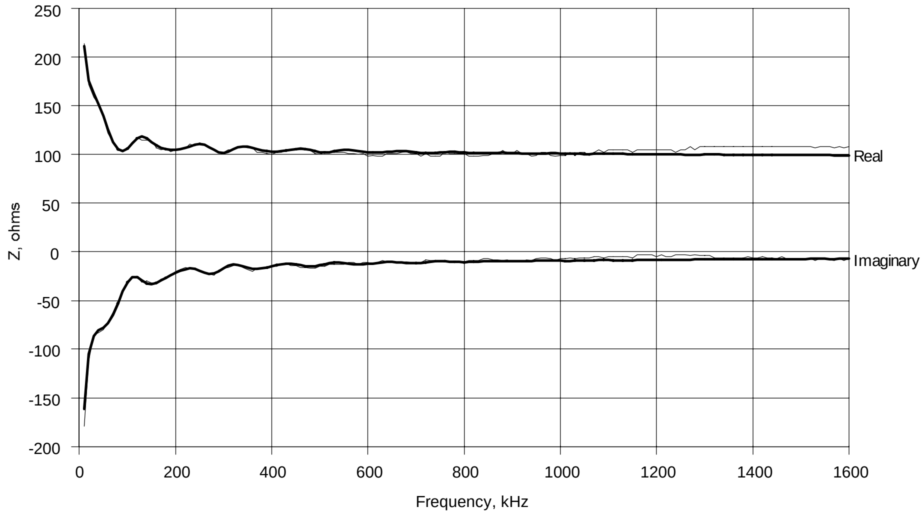
Attenuation



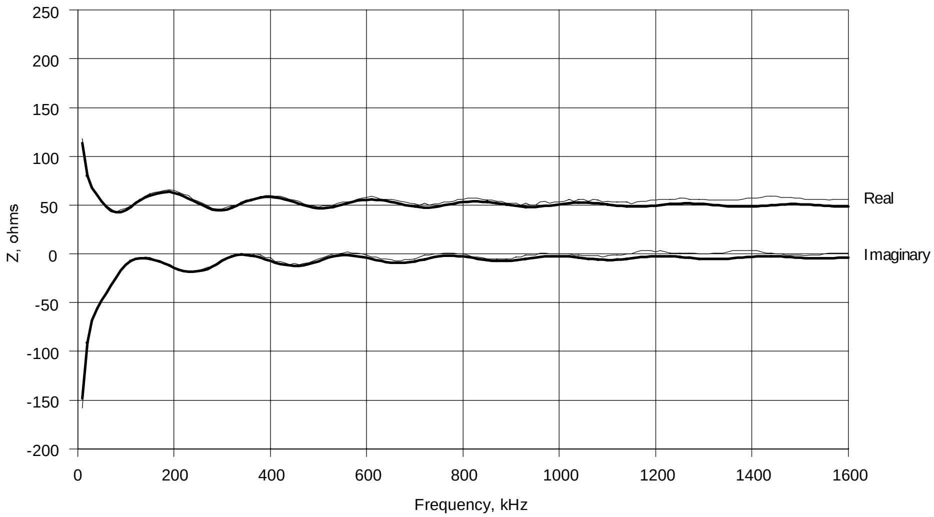
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



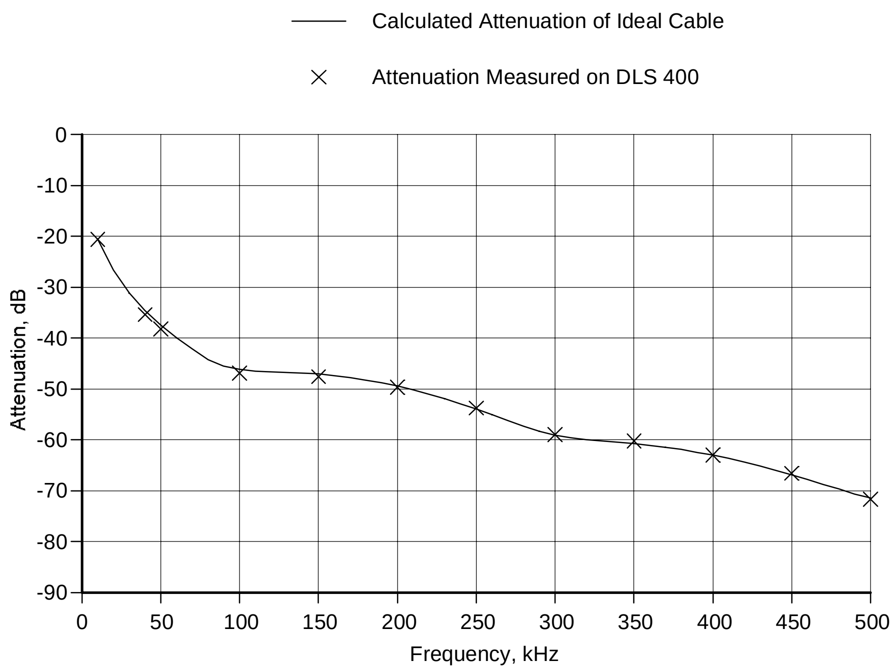
At CO Side



At Customer Side

10.2.10 ANSI Loop #11

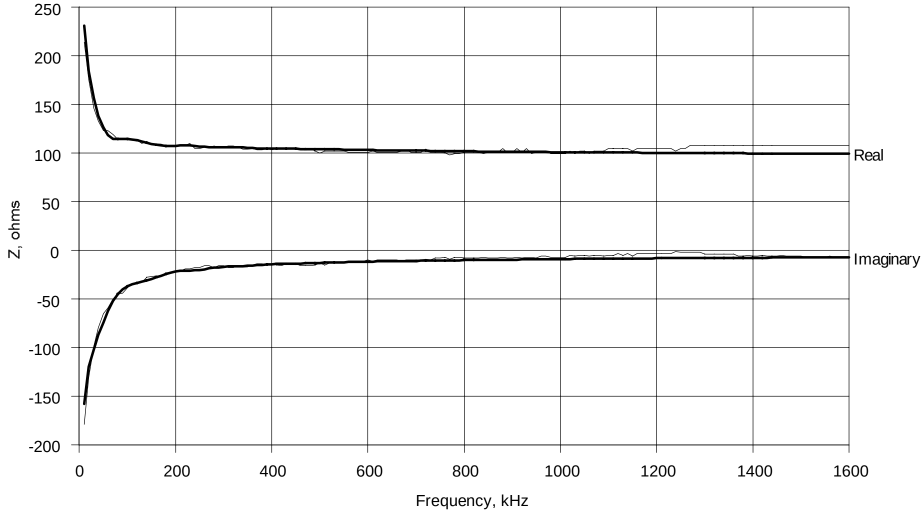
Attenuation



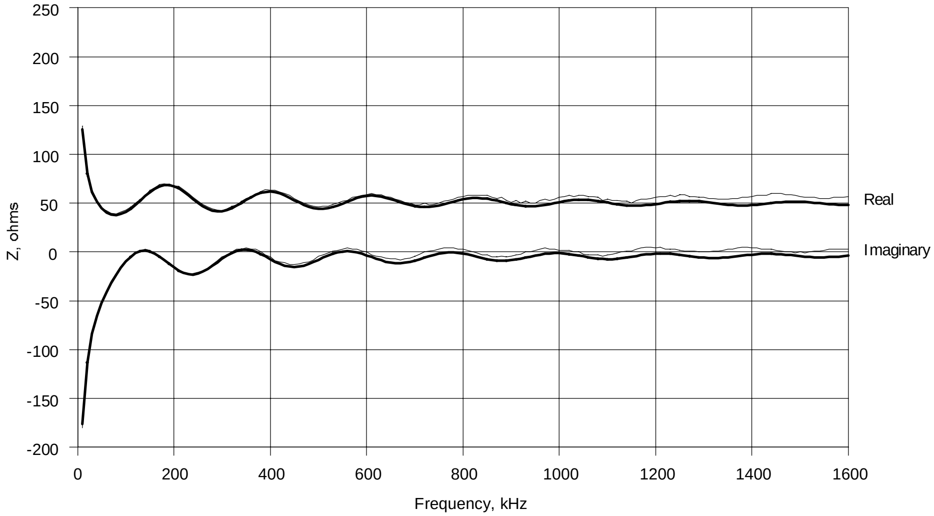
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



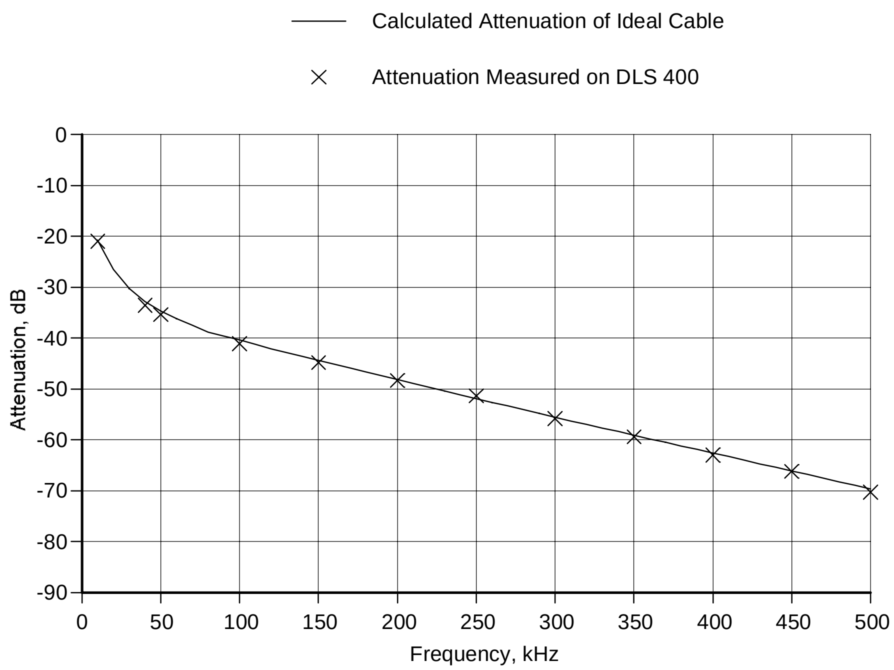
At CO Side



At Customer Side

10.2.11 ANSI Loop #12

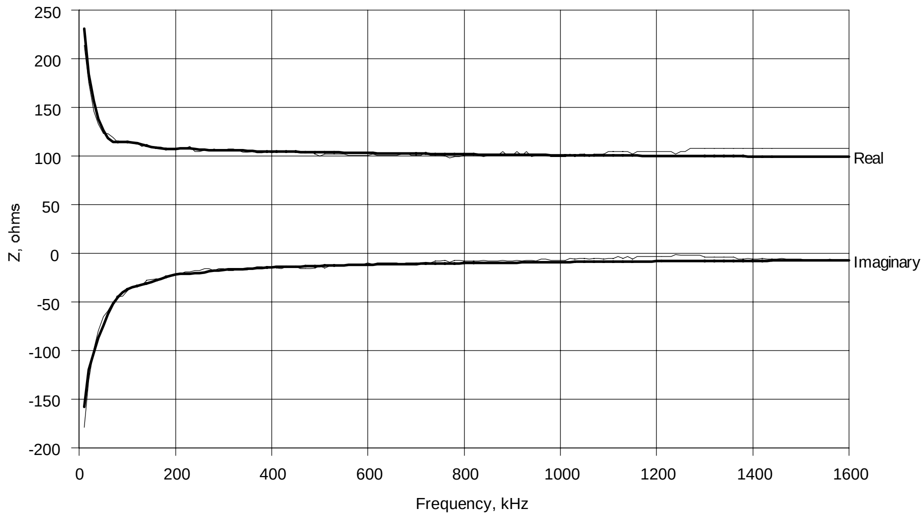
Attenuation



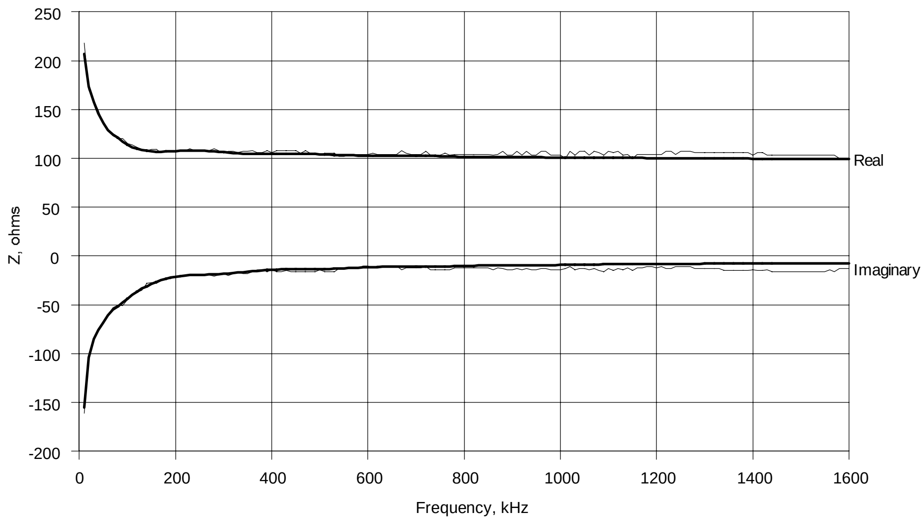
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



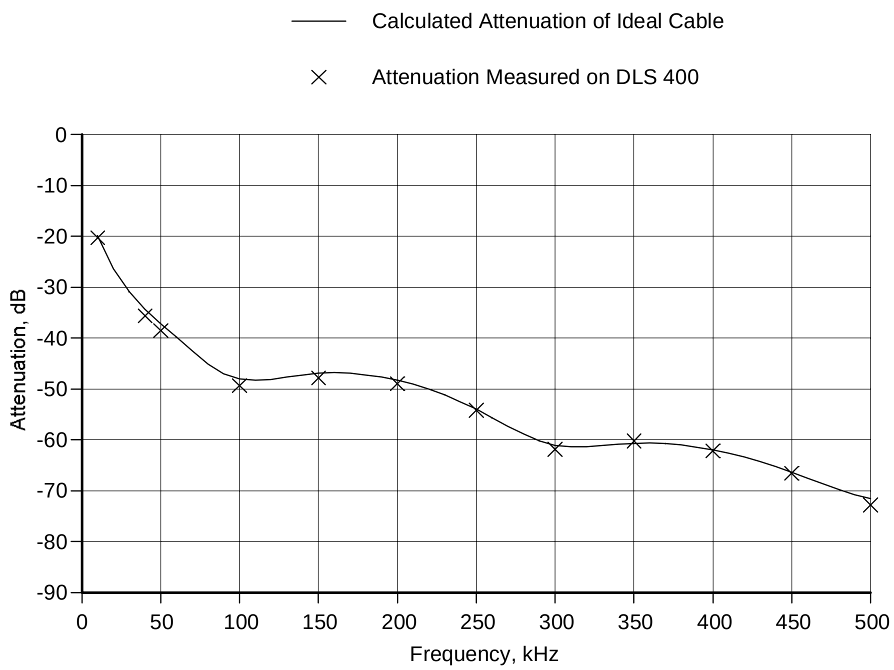
At CO Side



At Customer Side

10.2.12 ANSI Loop #13

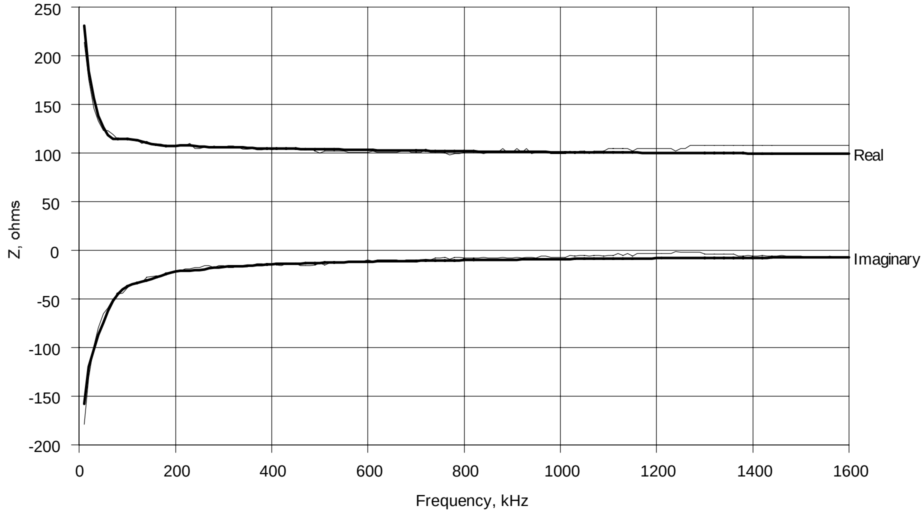
Attenuation



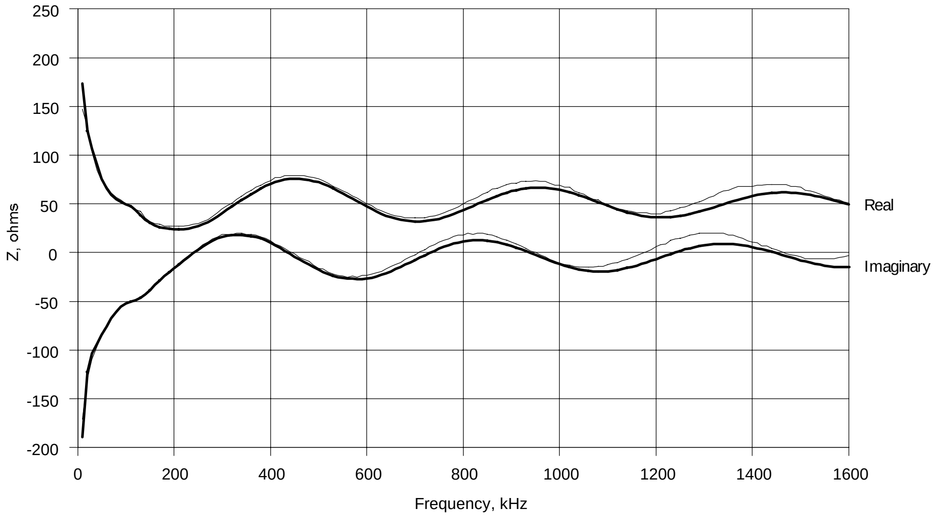
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



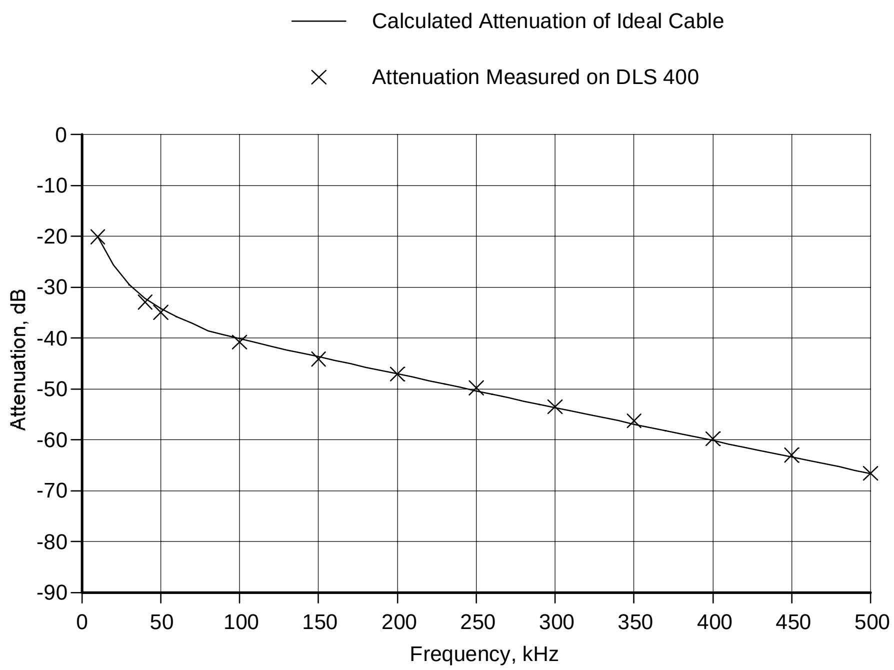
At CO Side



At Customer Side

10.2.13 ANSI Loop #15

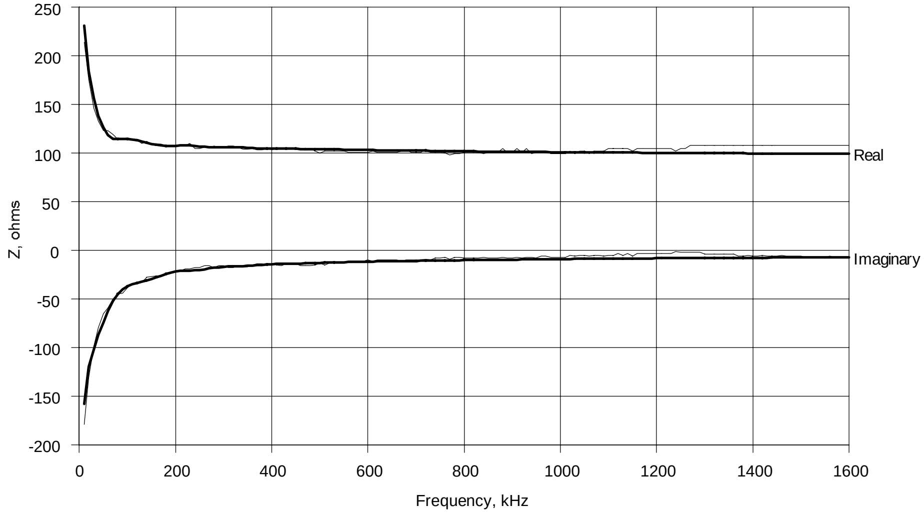
Attenuation



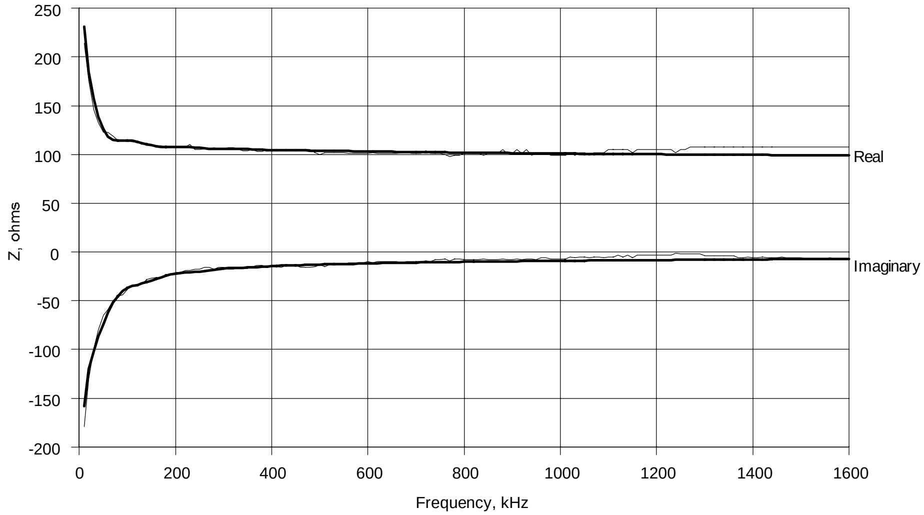
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



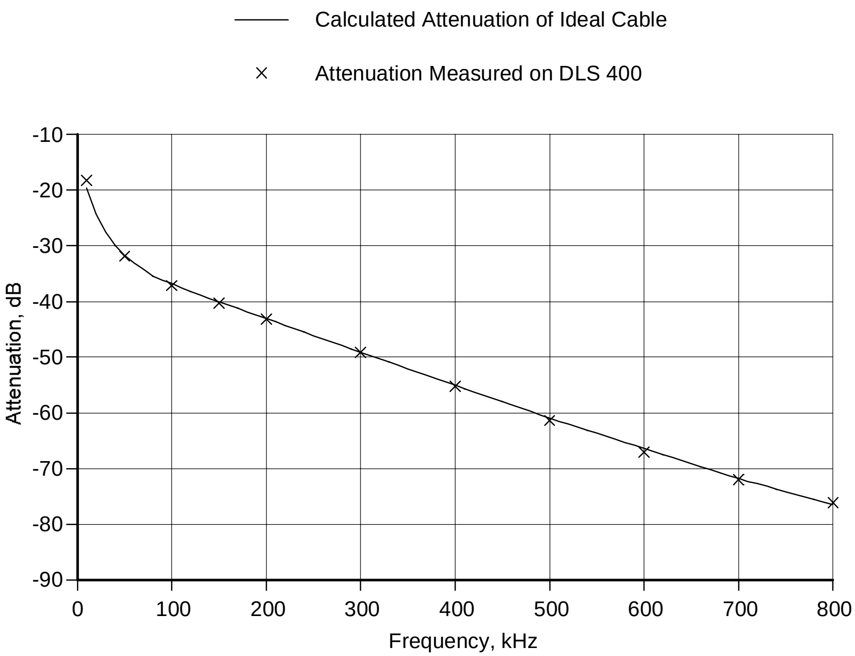
At CO Side



At Customer Side

10.2.14 Mid-ANSI Loop #7

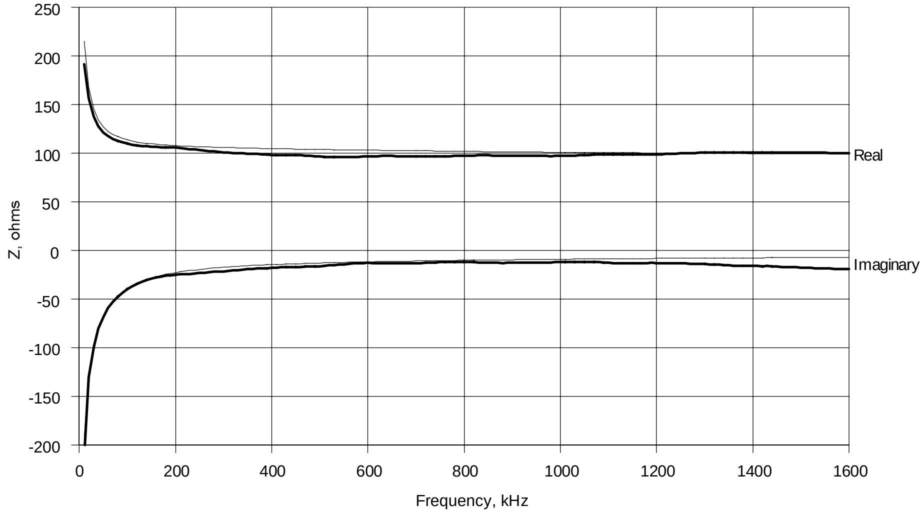
Attenuation



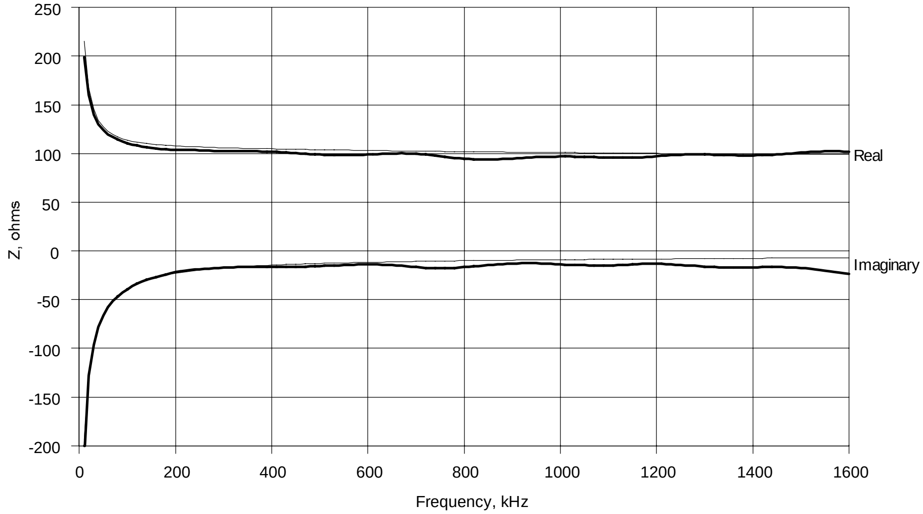
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



At CO Side

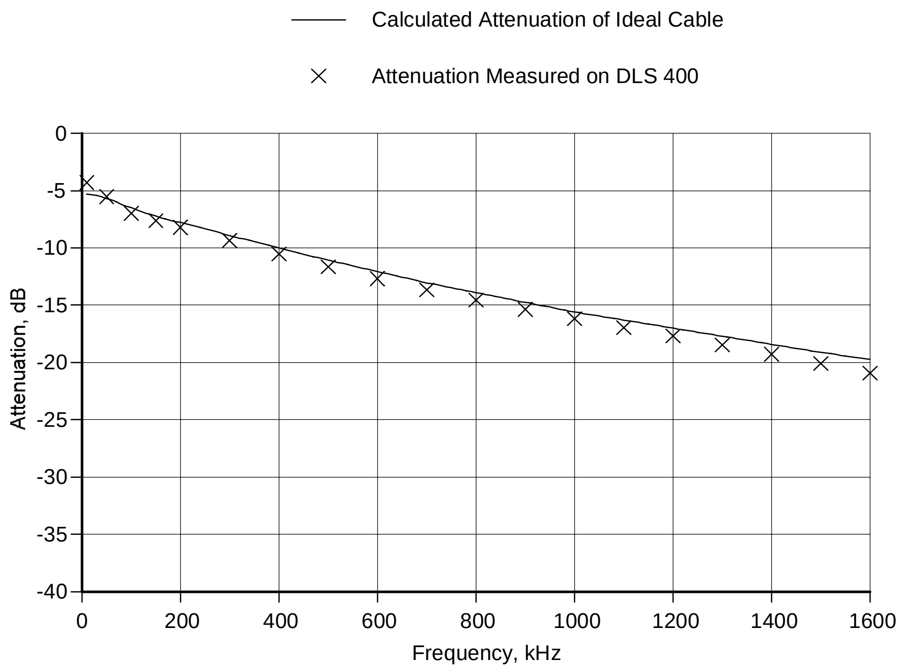


At Customer Side

10.3 EIA Loops

10.3.1 EIA Loop #1

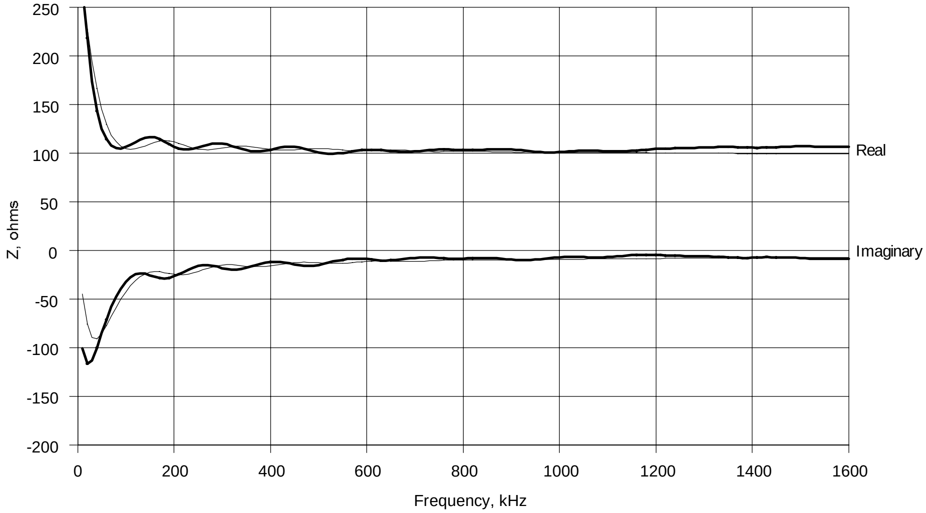
Attenuation



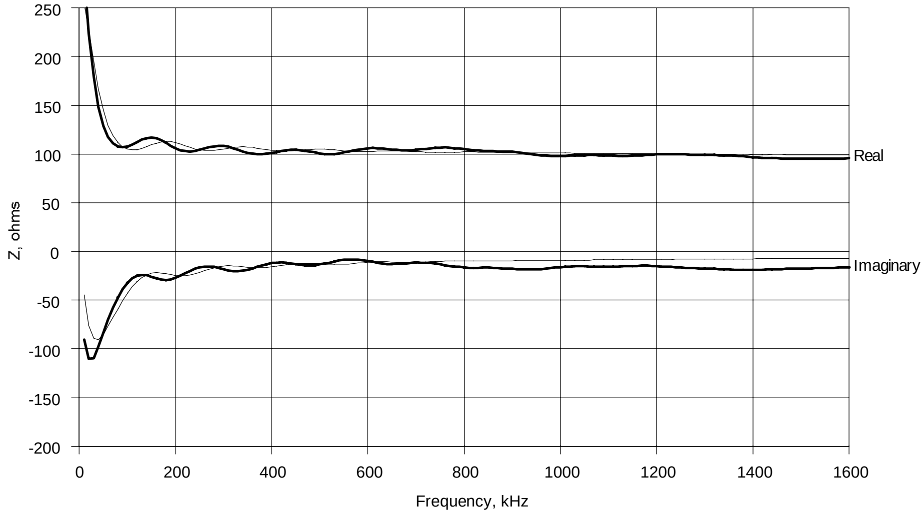
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



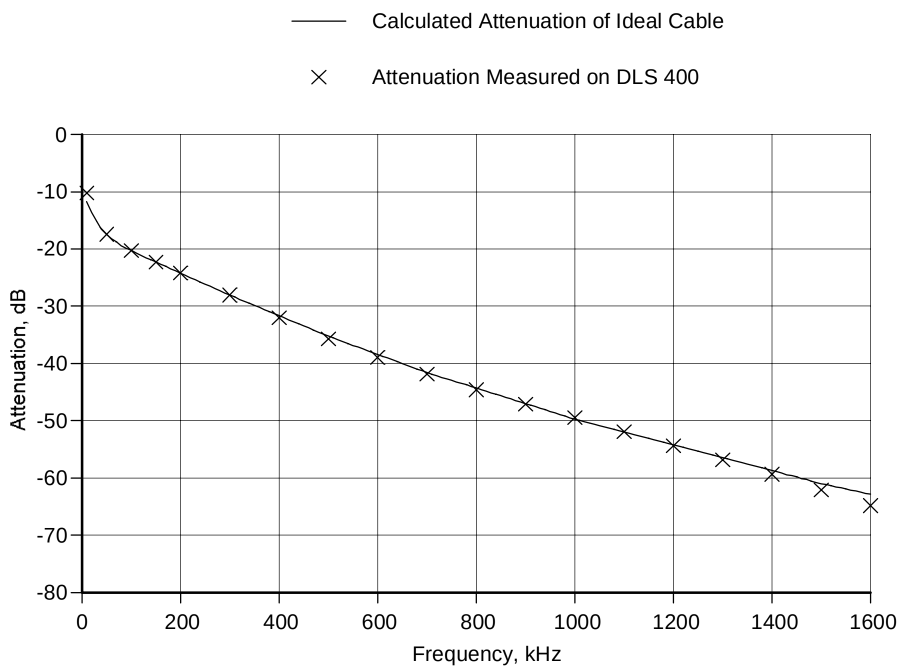
At CO Side



At Customer Side

10.3.2 EIA Loop #2

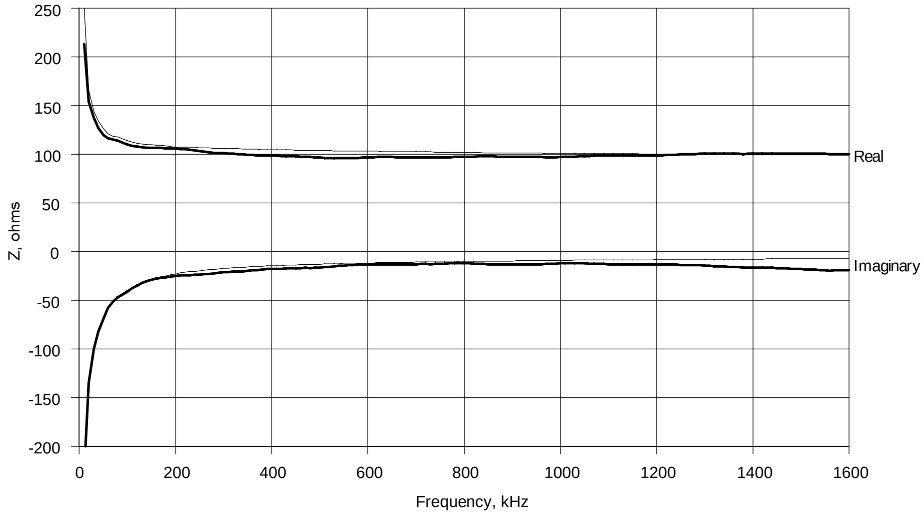
Attenuation



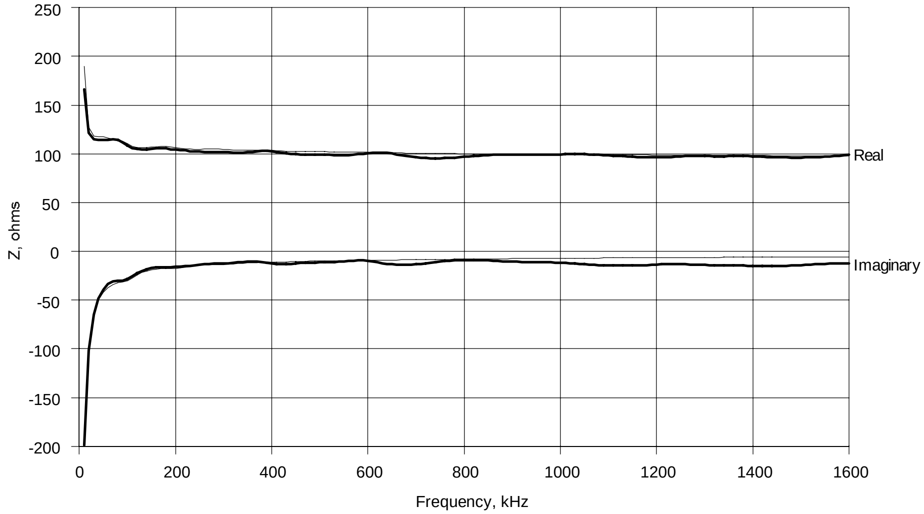
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



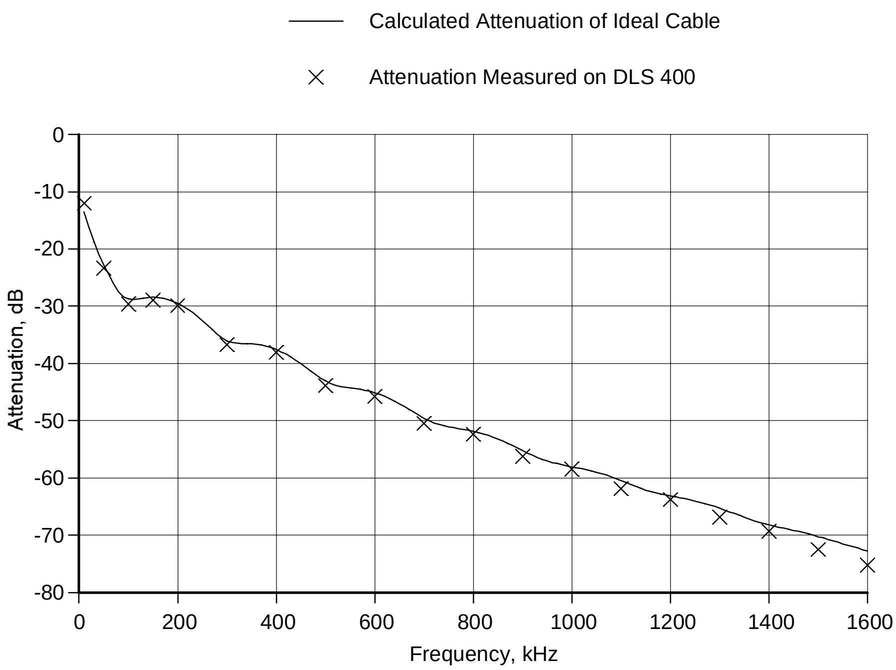
At CO Side



At Customer Side

10.3.3 EIA Loop #3

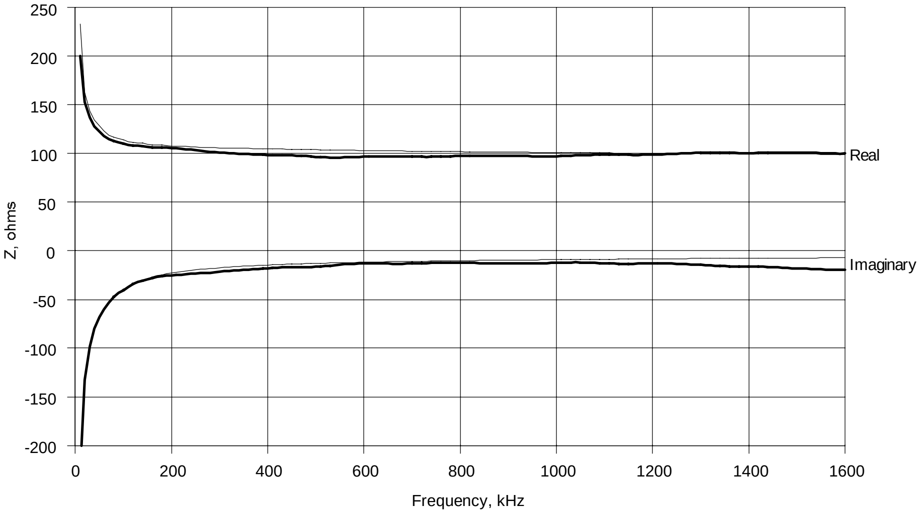
Attenuation



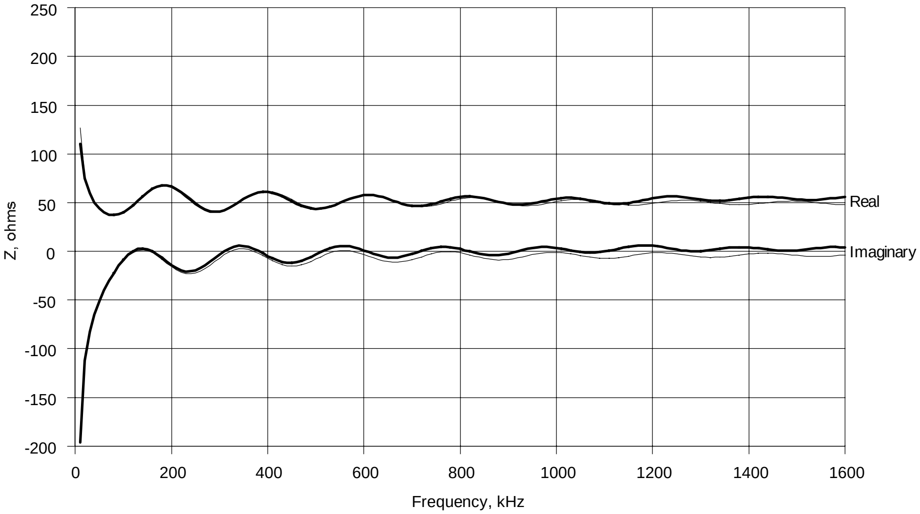
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



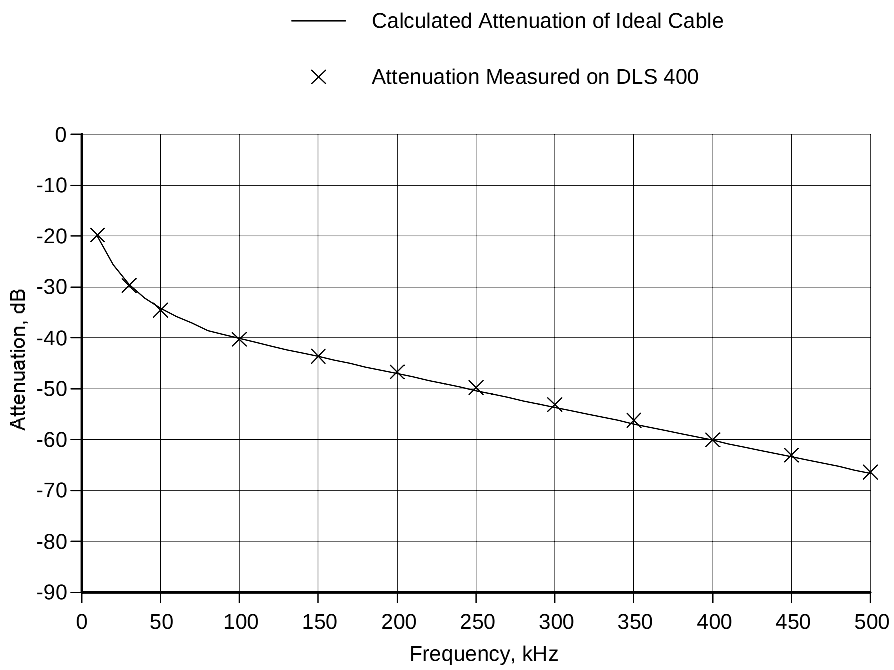
At CO Side



At Customer Side

10.3.4 EIA Loop #4

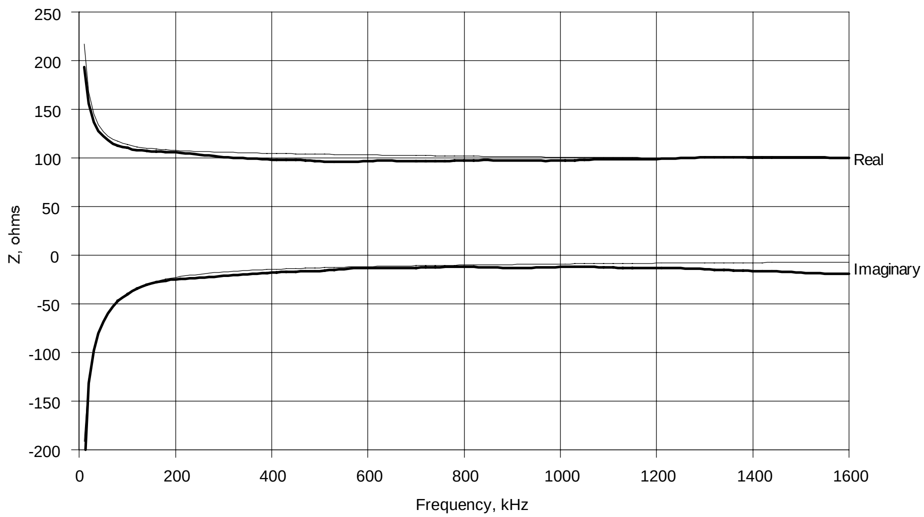
Attenuation



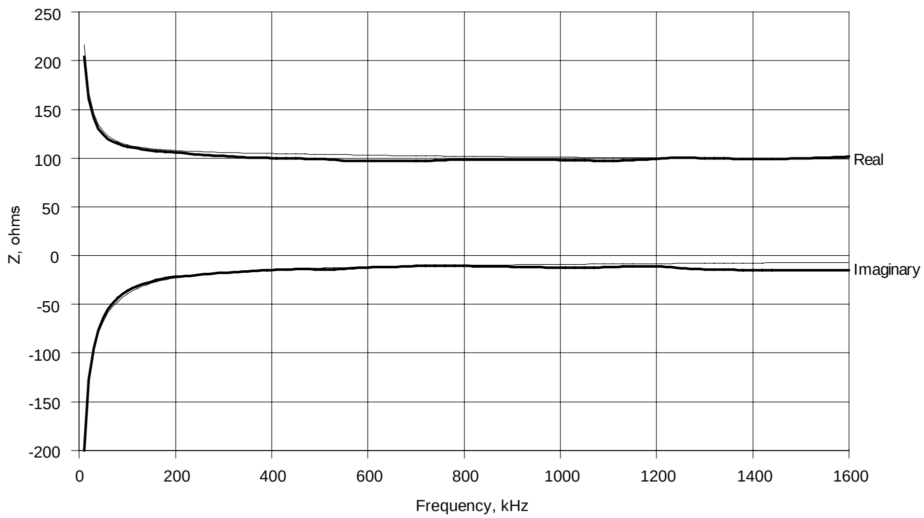
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



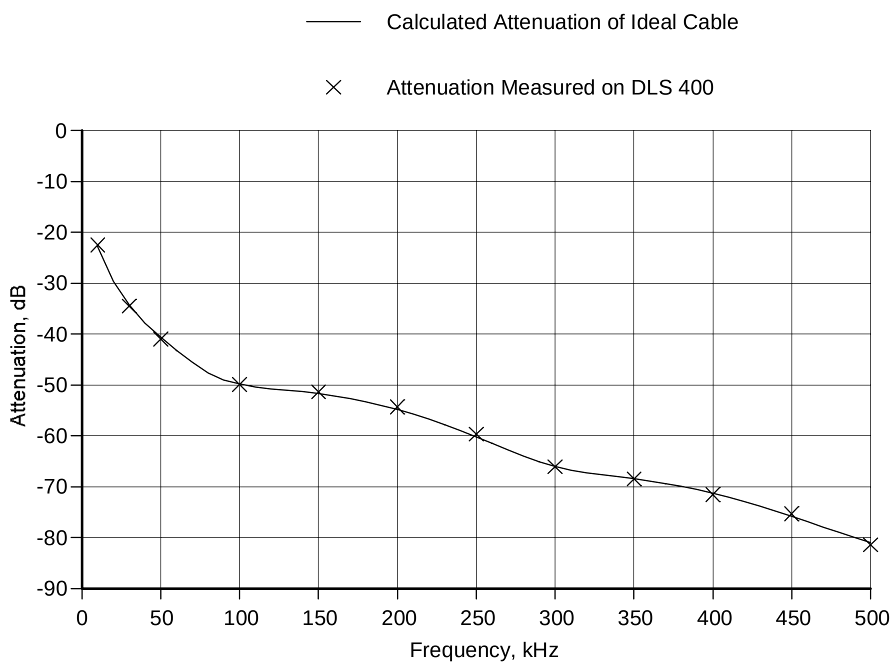
At CO Side



At Customer Side

10.3.5 EIA Loop #5

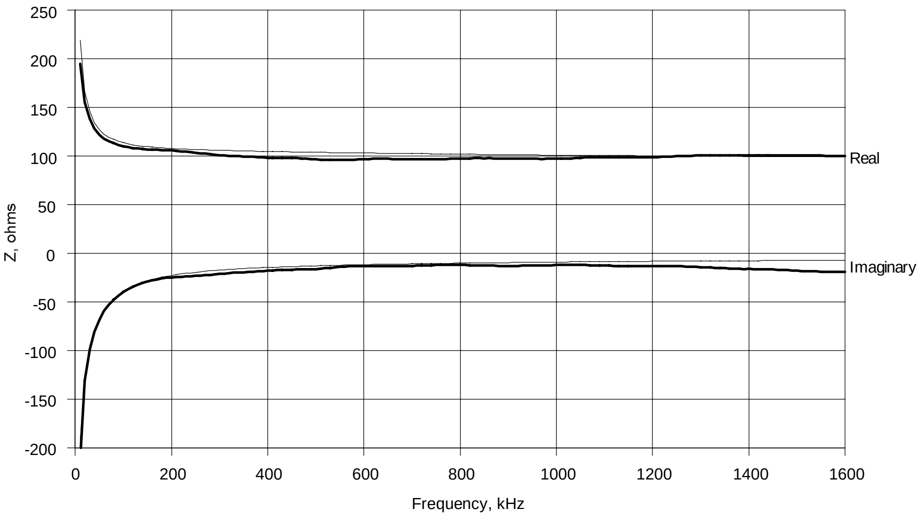
Attenuation



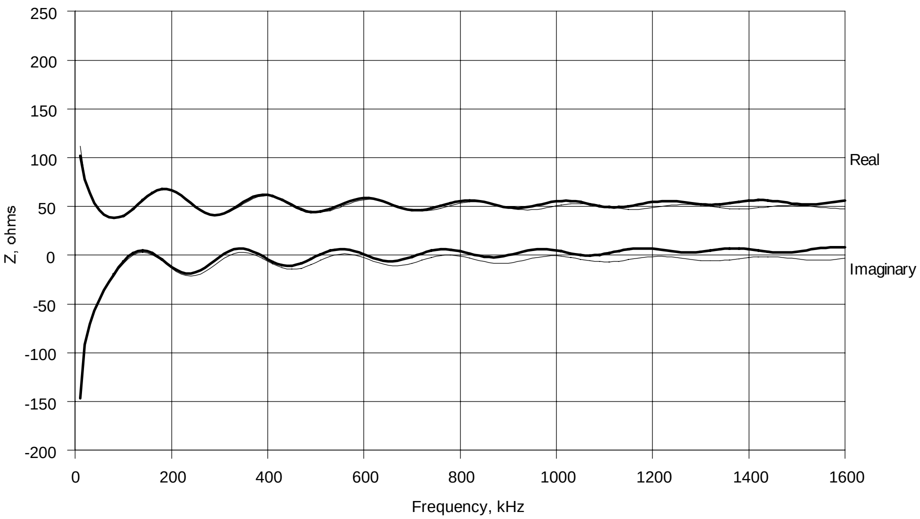
Impedance

The bold line shows the calculated value for ideal cables; the other shows values measured on a DLS 400.

Impedance Graphs



At CO Side



At Customer Side

11. CHARACTERISTICS OF IMPAIRMENTS

11.1 Noise shapes produced by Generators A & B

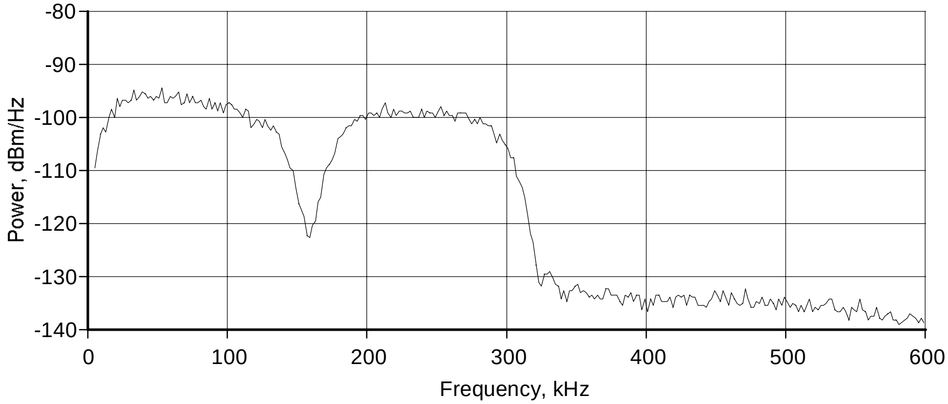


Figure 11.1 T1.601 NEXT

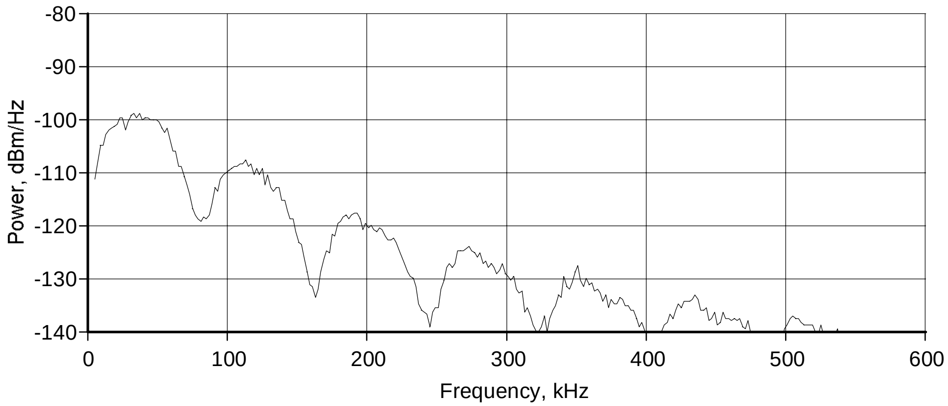


Figure 11.2 DSL NEXT

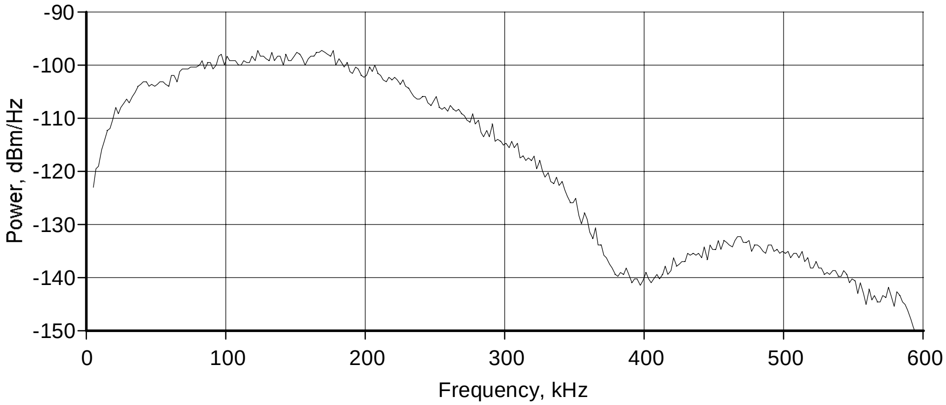


Figure 11.3 HDSL NEXT

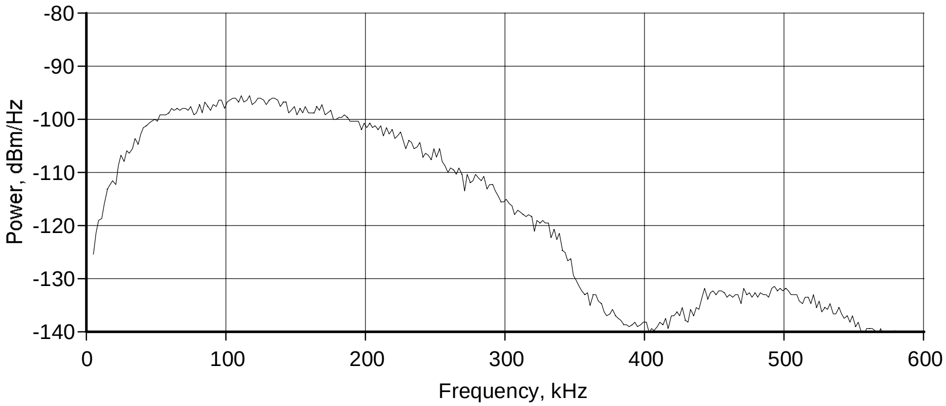


Figure 11.4 HDSL + ADSL NEXT

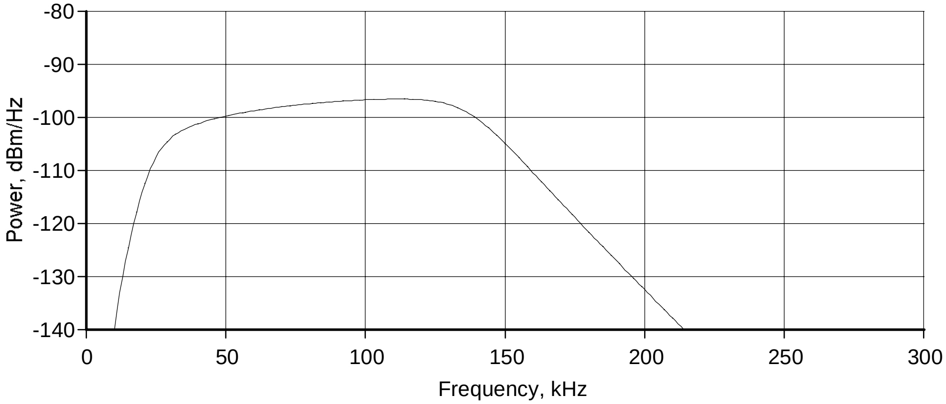


Figure 11.5 T1.413 II EC ADSL upstream NEXT

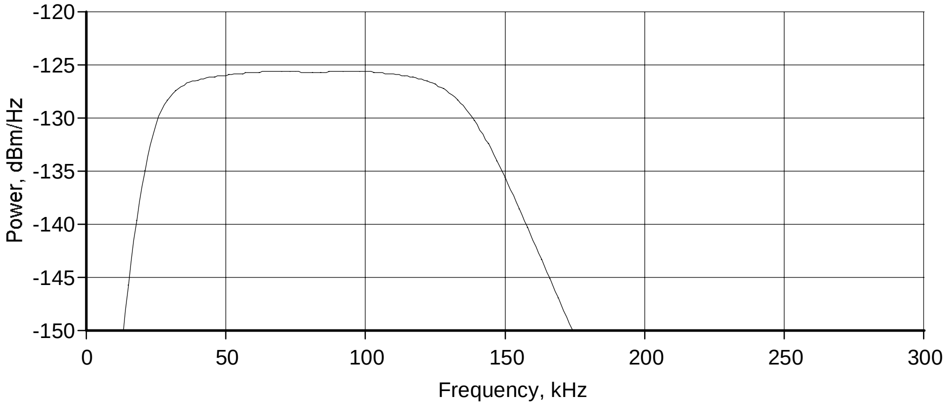


Figure 11.6 T1.413 II EC ADSL upstream FEXT (9 kft 26 AWG)

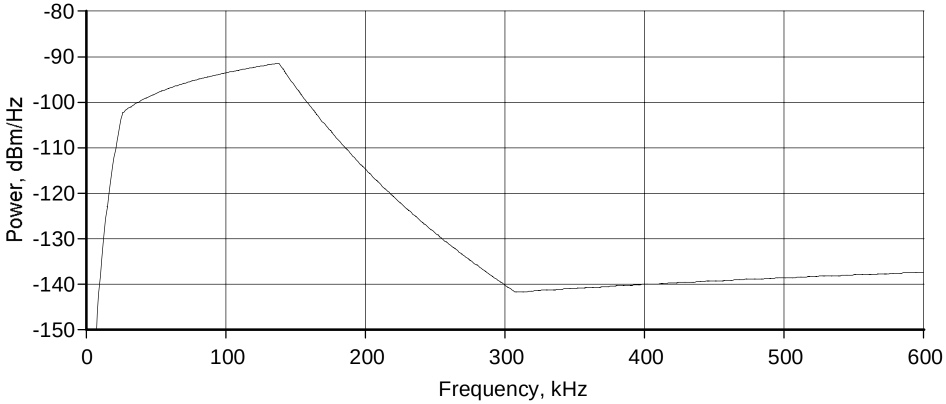


Figure 11.7 T1.413 II FDM ADSL upstream NEXT
ITU-T NA ADSL Upstream NEXT

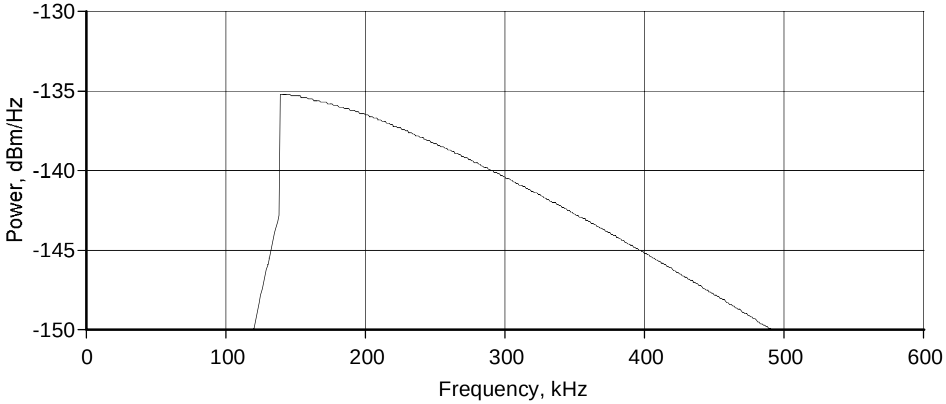


Figure 11.8 ITU-T NA FDM ADSL Downstream FEXT

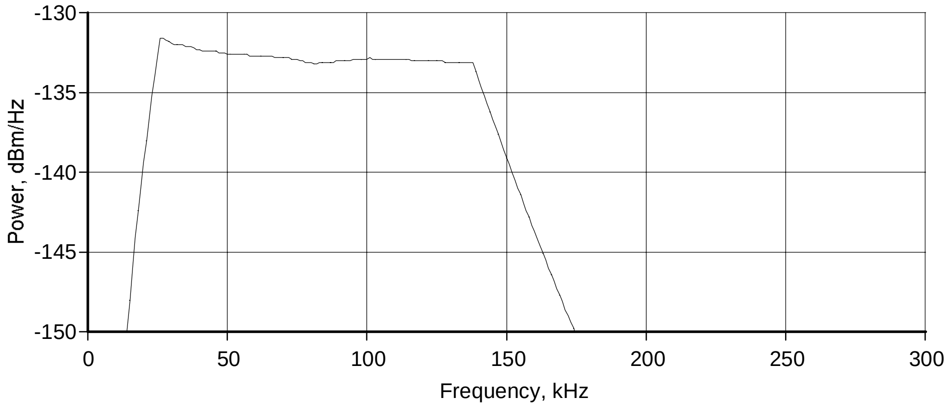


Figure 11.9 ITU-T NA ADSL Upstream FEXT

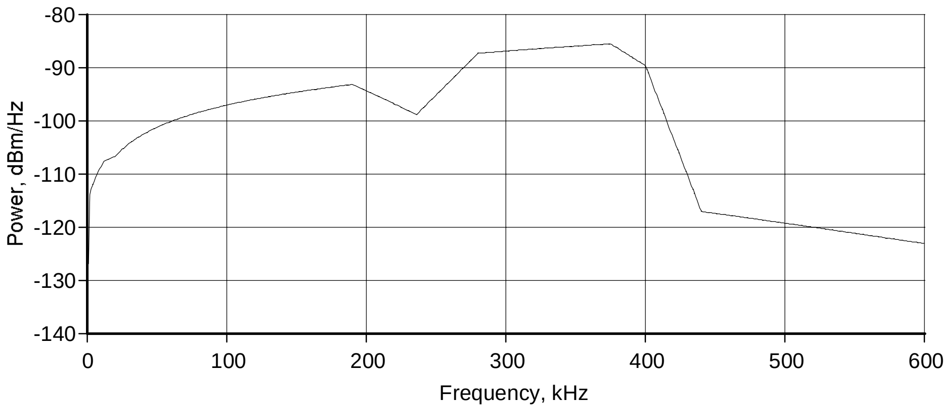


Figure 11.10 HDSL2 downstream NEXT (H2TUC)

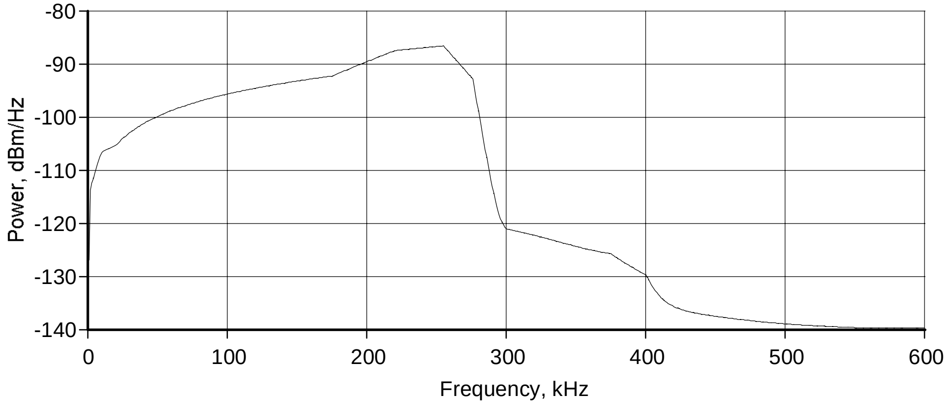


Figure 11.11 HDSL2 upstream NEXT (H2TUR)

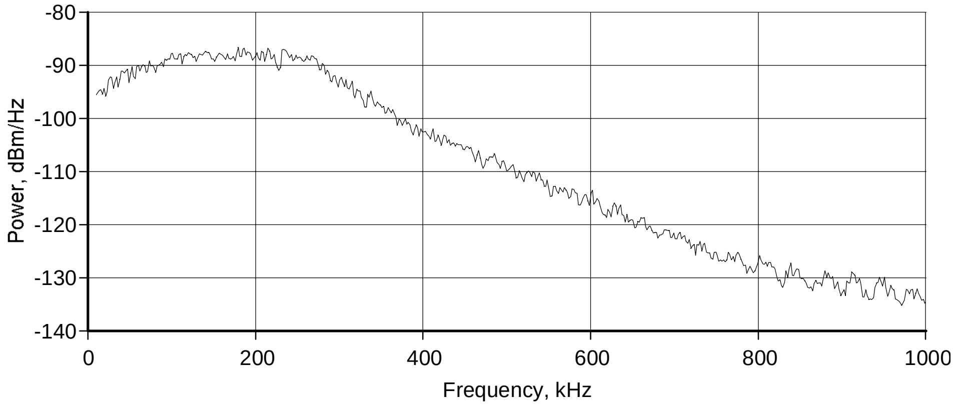


Figure 11.12 ITU-T Euro-K or Kirkby noise

11.2 Noise shapes produced by Generator C

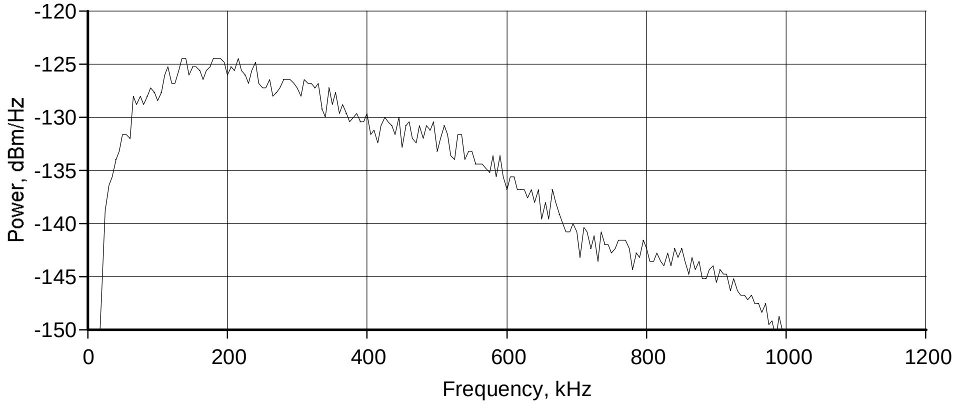


Figure 11.13 ADSL FEXT (T1.413, Issue I & II)

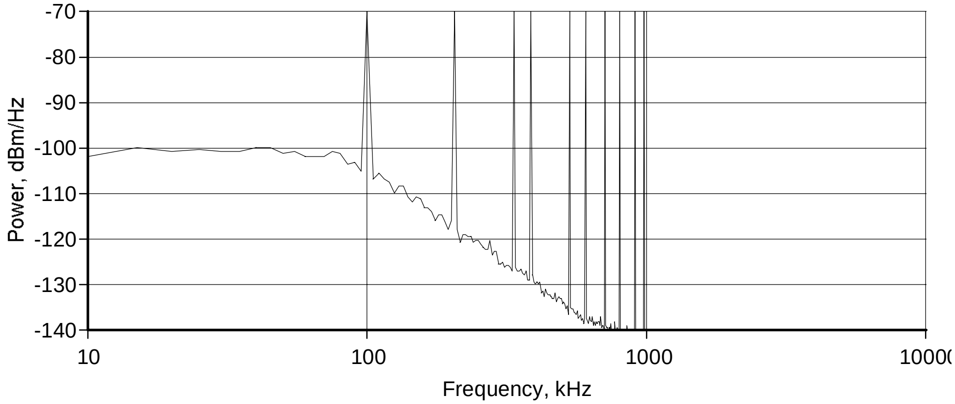


Figure 11.14 Model A

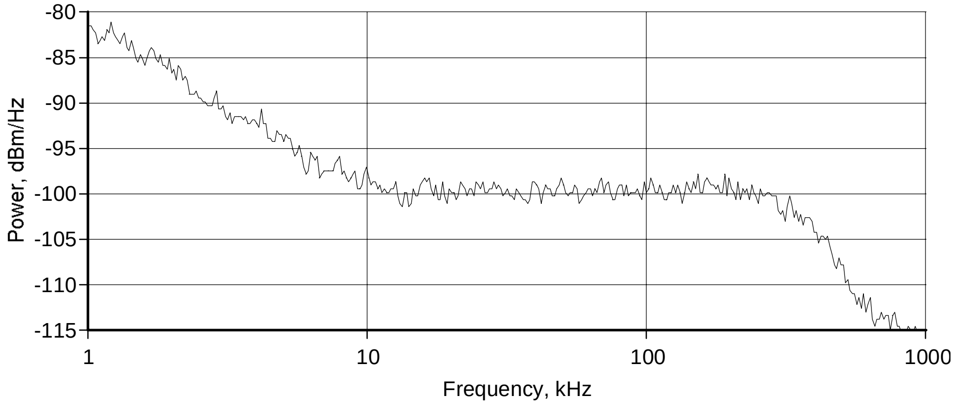


Figure 11.15 Model B

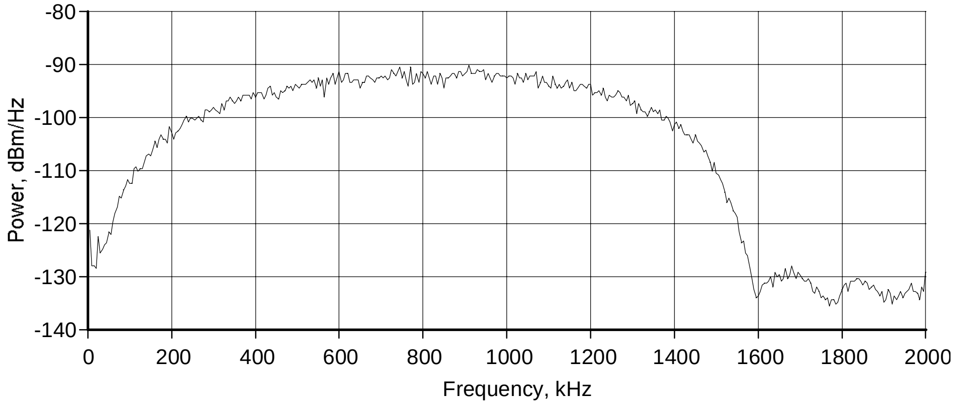


Figure 11.16 T1 NEXT (Original DLS 400A shape)

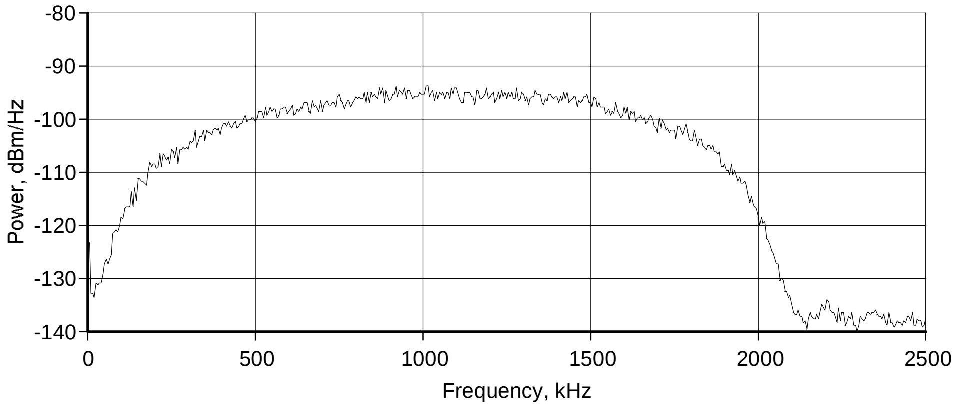


Figure 11.17 International AMI

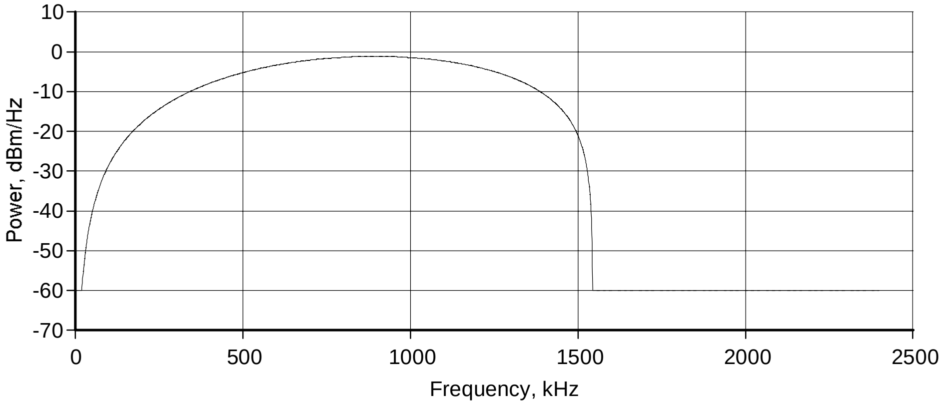


Figure 11.18 T1. 413 II T1 (AMI) NEXT
ITU-T NA T1 (AMI) NEXT
HDSL2 T1 (AMI) NEXT

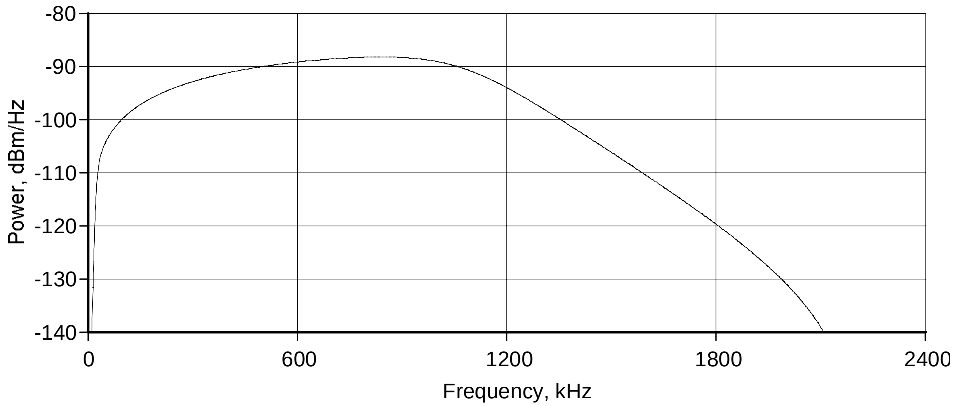


Figure 11.19 T1.413 II EC ADSL downstream NEXT

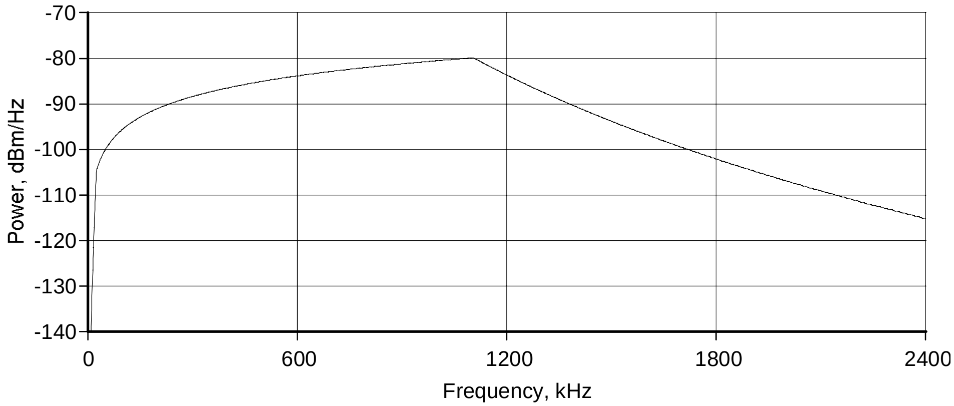


Figure 11.20 HDSL2 EC ADSL downstream NEXT

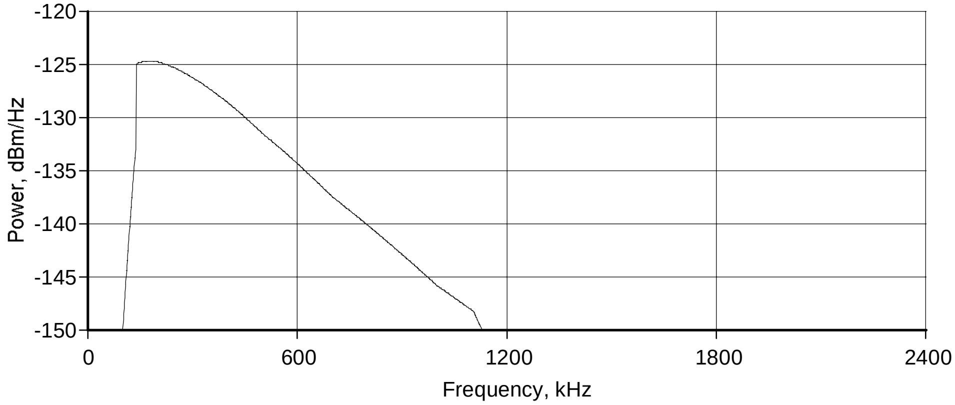


Figure 11.21 T1.413 II FDM ADSL downstream FEXT (9kft 26 AWG)

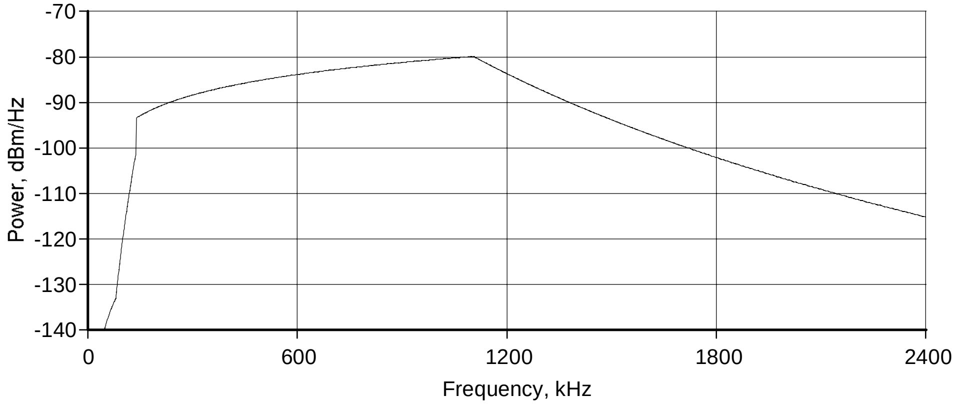


Figure 11.22 ITU-T NA FDM ADSL downstream NEXT
HDSL2 FDM ADSL downstream NEXT
T1.413 II FDM ADSL downstream NEXT

12. TROUBLESHOOTING

1. The power LED flashes red:
    - At power up, the DLS 400 performs a self-test. If this self-test fails, the power LED flashes red. If this happens, consult the factory.

2. The power LED is yellow:
    - If the DLS 400 detects an internal error, it does a full system initialisation and turns the power LED yellow. If this happens, consult the factory.

3. The remote LED is off:
    - This is normal after a power-up and a reset.

4. The remote LED is red:
    - The DLS 400 received an invalid command from the control computer. See section 3.7 for more details.

5. The DLS400 program gives a communication error:

- Check that the GPIB and VISA drivers are installed.

- If using the serial interface:

  Check that no device (such as a mouse) is connected to the same serial (COM) port as the DLS 400.

- If using the IEEE 488 interface:

  1) Check that no device has the same IEEE 488 address as the DLS 400.

  2) Check that the IEEE 488 address of the DLS 400 corresponds to the address set in the program. See section 7.1.1 for more details.

- For both interfaces:

  1) Check the cabling.

2) Check that all the cards in the system are firmly seated in their sockets. Using anti-static precautions, open the lid and push down on all the cards.

6. The DLS 400 does not raise SRQ after a query:

- You must enable all the relevant bits before using SRQ. For example, to raise SRQ when there is a message available (MAV) send the command “*SRE 16”. See sections 7.1.2 and 8.1 for more details.

- If the remote LED is red, you may have sent an invalid command. See chapter 8 for more details.

- Queries must be terminated with a question mark.

13. REFERENCES

- ANSI T1.601–1991, ISDN Basic Access Interface for use on Metallic Loops for Application on the Network Side of the NT (American National Standards Institute, 11 West 42^{nd} Street, New York, NY 10036, USA)
- ANSI Technical Report on High Bit Rate Digital Subscriber Lines (HDSL) – June 1992 (American National Standards Institute, 11 West 42^{nd} Street, New York, NY 10036, USA)
- ANSI T1.413–1995, Asymmetric Digital Subscriber Line (ADSL) Metallic Interface, and ANSI T1.413 Issue2 (American National Standards Institute, 11 West 42^{nd} Street, New York, NY 10036, USA)
- ETSI ETR–80, ISDN Basic Access Digital Transmission System on Metallic Local Lines (European Telecommunication Standards Institute Secretariat 06921 Sophi Antipolis, Cedex, France, Tel:+33 92 94 4200, Fax:+33 93 65 4716)
- ETSI TS 102 080 ISDN Standard (European Telecommunication Standards Institute Secretariat 06921 Sophia Antipolis, Cedex, France, Tel:+33 92 94 4200, Fax:+33 93 65 4716)
- ETSI TS 101 135 Transmission and Multiplexing (TM): High bit-rate Digital Subscriber Line (HDSL) Transmission Systems on Metallic Local Lines (European Telecommunication Standards Institute Secretariat 06921 Sophia Antipolis, Cedex, France, Tel:+33 92 94 4200, Fax:+33 93 65 4716)
- ETSI RTR/TM 03036, High Bit Rate Digital Subscriber Line (HDSL) Transmission on Metallic Local Lines (European Telecommunication Standards Institute Secretariat 06921 Sophia Antipolis, Cedex, France, Tel:+33 92 94 4200, Fax:+33 93 65 4716)
- FTZ 1TR220, PCM Data Transmission at 64 kbps (FTZ, DBP Telekom, Postfach 100 003, D–64276, Darmstadt, Germany).
- IEEE 488.1–1987, IEEE Standard Digital Interface for Programmable Instrumentation (The Institute of Electrical and Electronics Engineers, Inc. 345 East 47^{th} Street, New York, NY 10017–2394, USA)
- IEEE 488.2–1992, IEEE Standard Codes, Formats, Protocols, and Common Commands (The Institute of Electrical and Electronics Engineers, Inc. 345 East 47^{th} Street, New York, NY 10017–2394, USA)

REFERENCES

- SCPI Standard Commands for Programmable Instruments, available from some interface controller manufacturers (SCPI Consortium, 8380 Hercules Drive, Suite P.S., La Mesa, CA 91942, Phone: (619) 697-8790, Fax: (619) 697-5955)
- ITU–T G.992.2 Draft (formerly G.lite), Splitterless Asymmetric Digital Subscriber Line (ADSL) Transceivers (International Telecommunication Union, Place des Nations, CH1211 Geneva 20, Switzerland)
- ETSI ETR 328 Asymmetric Digital Subscriber Line (ADSL) Requirements and Performance (European Telecommunications Standards Institute, F-06921 Sophia Antipolis, Cedex, France)

14. WARRANTY

DLS TestWorks warrants all equipment bearing its nameplate to be free from defects in workmanship and materials during normal use and service, for a period of twelve (12) months from the date of shipment.

In the event that a defect in any such equipment arises within the warranty period, it shall be the responsibility of the customer to return the equipment by prepaid transportation to a DLS TestWorks service centre prior to the expiration of the warranty period for the purpose of allowing DLS TestWorks to inspect and repair the equipment (see chapter 8 for shipping details).

If inspection by DLS TestWorks discloses a defect in workmanship or material it shall, at its option, repair or replace the equipment without cost to the customer, and return it to the customer by the least expensive mode of transportation, the cost of which shall be prepaid by DLS TestWorks.

In no event shall this warranty apply to equipment which has been modified without the written authorization of DLS TestWorks, or which has been subjected to abuse, neglect, accident or improper application. If inspection by DLS TestWorks discloses that the repairs required to be made on the equipment are not covered by this warranty, the regular repair charges shall apply to any repairs made to the equipment.

If warranty service becomes necessary, the customer **must** contact DLS TestWorks to obtain a return authorization number and shipping instructions:

DLS TestWorks
(Ottawa)
169 Colonnade Road
Nepean, Ontario, Canada
K2E 7J4
Telephone: (613) 225-6087
In North America Only: 1-800-465-1796
Fax: (613) 225-6315
sales@dlstestworks.com

Consultronics (Europe)
Unit A
Omega Enterprise Park
Electron Way
Chandlers Ford
Hampshire, England
SO5 3SE
Telephone: 0703 270222
Fax: 0703 270333

Or your local DLS TestWorks representative

WARRANTY

This warranty constitutes the only warranty applicable to the equipment sold by DLS TestWorks and no other warranty or condition, statutory or otherwise, expressed or implied, shall be imposed upon DLS TestWorks nor shall any representation made by any person, including a representation by a representative or agent of DLS TestWorks, be effective to extend the warranty coverage provided herein.

In no event (including, but not limited to the negligence of DLS TestWorks, its agents or employees) shall DLS TestWorks be liable for special consequential damages or damages arising from the loss of use of the equipment, and on the expiration of the warranty period all liability of DLS TestWorks whatsoever in connection with the equipment shall terminate.

15. SHIPPING THE DLS 400

To prepare the DLS 400 for shipment, turn the power off and disconnect all cables, including the power cable, and pack the simulator in the original carton. Do not place any cables or accessories directly against the front panel as this may scratch the surface of the unit. We suggest that you mark all shipments with labels indicating that the contents are fragile.

If sending a unit back to the factory, ensure that the return authorization number given by our customer service department is shown on the outside.

16. SPECIFICATIONS

16.1 General

The DLS 400 simulates a single twisted-pair cable, and up to 2 optional impairments cards. The user can select the simulated loop and the length of the variable loops using the IEEE 488 or the RS–232 interface. The command language in both cases is based on the Standard Commands for Programmable Interfaces (SCPI) standard.

16.2 Simulated loops

16.2.1 DLS 400 Unit Configurations

Depending upon the configuration chosen, the DLS 400 can simulate up to 29 different loops defined in various standards, plus 4 variable loops.

DLS 400A

BYPASS	CSA #0	MID-CSA #0	ANSI #2
	CSA #1	MID-CSA #1	ANSI #3
VARIABLE 24 AWG	CSA #2	MID-CSA #2	ANSI #4
VAR 24 AWG+TAP	CSA #4	MID-CSA #3	ANSI #5
VARIABLE 26 AWG	CSA #5	MID-CSA #4	ANSI #6
VAR 26 AWG+TAP	CSA #6	MID-CSA #5	ANSI #7
	CSA #7	MID-CSA #6	ANSI #8
	CSA #8		ANSI #9
	EXT-CSA #9		ANSI #11
	EXT-CSA #10		ANSI #12
			ANSI #13
			ANSI #15

DLS 400H

BYPASS	CSA #1
	CSA #2
VARIABLE 24 AWG	CSA #3
VAR 24 AWG+TAP	CSA #4
VARIABLE 26 AWG	CSA #5
VAR 26 AWG+TAP	CSA #6
	CSA #7
	CSA #8
	EXT-CSA #9
	EXT-CSA #10

DLS 400N

BYPASS	CSA #4	ANSI #1	EIA #1
	CSA #6	ANSI #2	EIA #2
VARIABLE 24 AWG	CSA #7	ANSI #5	EIA #3
VAR 24 AWG+TAP	CSA #8	ANSI #7	EIA #4
VARIABLE 26 AWG	MID-CSA #6	ANSI #8	EIA #5
VAR 26 AWG+TAP		ANSI #9	
		ANSI #13	
		MID-ANSI #7	

DLS 400HN

BYPASS	CSA #1	ANSI #1	EIA #1
	CSA #2	ANSI #2	EIA #2
VARIABLE 24 AWG	CSA #3	ANSI #5	EIA #3
VAR 24 AWG+TAP	CSA #4	ANSI #7	EIA #4
VARIABLE 26 AWG	CSA #5	ANSI #8	EIA #5
VAR 26 AWG+TAP	CSA #6	ANSI #9	
	CSA #7	ANSI #13	
	CSA #8	MID-ANSI #7	
	EXT-CSA #9		
	EXT-CSA #10		
	MID-CSA #6		

16.2.1 Description

Technology: Cable simulation using networks of discrete R, L & C components

Cable simulated: Balanced twisted copper pair

Cable impedance: Complex, varies over frequency with length and gauge

# of conductors: 2

Types of cables: 22, 24 & 26 AWG PIC cables as specified in Bell Pub 62310

DC Rating: up to 300 VDC, between tip and ring, tip and ground, or ring and ground, 100 mA (150 mA peak)

Bandwidth: DC to 2.0 MHz

Accuracy: For the specified bandwidth; ±0.5 dB for all attenuations up to 20 dB, for attenuation from 20 to 70 dB the tolerance is within 5% of design to a maximum of 1.5 dB.

16.3 Impairments Card

The card can be used to test according to the following national and international standards:

- ANSI T1.601 ISDN Basic Access Interface
- ANSI Technical Report on HDSL
- ANSI T1.413, Issue I
- ANSI T1.413, Issue II
- ANSI Proposed Working Draft for HDSL2 Standard (T1E1.4/98 – 268)
- UAWG U–ADSL Framework Document
- ITU Standard for G.lite
- ETSI TS 102 080 ISDN Standard
- ETSI TS 101 135 HDSL Standard
- ETSI ETR 328 ADSL Standard

It operates in a specially designated slot in the chassis of the DLS 400 Wireline Simulator and consists of seven discrete generation sections. The features associated with one generator operate independently of the others. However, the options within a section can only be activated one at a time. The seven sections are:

- White noise generator
- 2 x low frequency (500 kHz) NEXT shaped PSD generator
- 1 x high frequency (2.0 MHz) NEXT shaped PSD generator
- Multi Tone generator
- Powerline related metallic noise
- Longitudinal noise

The output circuit is balanced with a minimum Thevenin impedance of 4000 ohms over the range 50 Hz to 2.0 MHz.

16.3.1 White Noise Generator

Level:	–90.0 to –140.0 dBm/Hz, variable in 0.1 dB steps
Form:	Gaussian amplitude distribution to 5 sigma
Bandwidth:	50 Hz to 2.0 MHz

16.3.2 NEXT Generators A and B

Level:	Levels are varied in 0.1 dB steps over a range from 10 dB below the 1–disturber level to 10 dB above the 49–disturber level. The absolute power associated with each will vary according to the NEXT PSD shape selected. The minimum level of any point on a shape is –140 dBm/Hz.
Power:	The total power of each shape is accurate to within ±0.5 dBm
Accuracy:	Each shape will track the reference shape to within ±1.0 dB, down to a level 45 dB below the peak. Each reference may deviate its null frequencies by ±5.0%.
Shapes:	The following shapes are available in Generators A and B:

- ANSI T1.601 – 320 KHz bandwidth
- ANSI HDSL Technical report – DSL Next
- ANSI HDSL Technical report – HDSL Next
- ANSI T1.413, Issue I – ADSL + HDSL Next

and Generator B also provides these shapes:

- ANSI T1.413, Issue I – ADSL Next
- ANSI T1.413, Issue II – ADSL upstream NEXT
- ANSI T1.413, Issue II – ADSL upstream FEXT (9 kft, 26 AWG)
- ANSI Proposed Working Draft for HDSL2 Standard – HDSL2 downstream NEXT (H2TUC)
- ANSI Proposed Working Draft for HDSL2 Standard – HDSL2 downstream NEXT (H2TUR)
- ITU–T Standard for G.lite – FDM ADSL downstream NEXT
- ITU–T Standard for G.lite – FDM ADSL downstream FEXT (13.5 kft, 26 AWG)
- ITU–T Standard for G.lite – ADSL upstream FEXT (13.5 kft, 26 AWG)

16.3.3 NEXT Generator C

Level: Levels are varied in 0.1 dB steps over a range from 10 dB below the 1–disturber level to 10 dB above the 49–disturber level. The absolute power associated with each will vary according to the NEXT PSD shape selected.

The minimum level of any point on a shape is –140 dBm/Hz.

Power: The total power of each shape is accurate to within ±0.5 dBm

Accuracy: Each shape will track the reference shape to within ±1.0 dB, down to a level 40 dB below the peak. Each reference may deviate its null frequencies by ±5.0%.

Shapes: The following shapes are available in the High Frequency NEXT Generator:

- ANSI T1.413, Issue I – ADSL FEXT
- ETSI ETR 328 – Model A
- ETSI ETR 328 – Model B
- North American 1.544 MBps T1
- International 2.048 MBps AMI
- ANSI T1.413, Issue II – T1 (AMI) NEXT
- ANSI T1.413, Issue II – EC ADSL downstream NEXT
- ANSI T1.413, Issue II – FDM downstream FEXT (9kft, 26 AWG)
- ITU–T G.996.1 (G.test) – EC ADSL downstream NEXT
- ITU–T G.996.1 (G.test) – FDM ADSL downstream NEXT

16.3.4 Multi Tone Generator

This section is used to generate a series of discrete tones. Its main application is to generate either the shaped noise called for in both the ETSI ISDN and HDSL recommendations or the 10 discrete tones called for in ETR 328.

Noise: Shaped to either ETSI ISDN, ETSI HDSL or FTZ 1TR 220

Level: –40.0 to +20.0 dB relative to the published reference level

“10 Tone”: As per ETSI ETR 328

Level:	–20.0 to +20.0 dB relative to the published reference level

16.3.5 Impulses

Types:	This generator produces 7 different impulses. 4 are standard multi-level (unipolar + & –, bipolar, 3-level), 2 are complex as per ANSI T1.413, and one is the ETSI Cook pulse
Timing:	The duration of the 4 multi-level impulses can be varied between 22 and 120 microseconds in 2 microsecond steps
Levels:	Multi-level: 0.5 to 100.0 mVolts, 0.1 mV steps ANSI: 5.0 to 100.0 mVolts, 0.1 mV steps Cook: –20 to +6 dB relative to the reference, 0.1 dB steps

16.3.6 Powerline Related Metallic Noise

Type:	Dual tones as per ANSI T1.601
Level:	–15.0 to +9.0 dB relative to ANSI reference levels, 0.1 dB steps.

16.3.7 Longitudinal Noise

Type:	Triangular waveform
Frequency:	50 or 60 Hz
Level:	0–60 Volts rms at 60 Hz; 0–50 Volts at 50 Hz, 1 volt steps
Injection:	Balanced transformer at 25–75% of loop length (DLS 400)

16.3.8 Externally Generated Signals

In addition to the generators, this section conditions externally-generated signals, and applies them to the line.

Frequency:	50 Hz to 2.0 MHz at all levels up to –30 dBm 1 kHz to 2.0 MHz at levels up to –10 dBm
Input:	50 ohm BNC

Output:	External signals are summed with other noise signals and injected through the standard output circuit

16.4 Mechanical

Construction:	Main chassis plus plug-in wireline modules
Available slots:	27
Noise card slots:	2
Wireline modules:	24
Connectors:	Bantam jacks and 3-pin balanced CF

16.5 IEEE 488 Remote Control

The unit can be controlled via an IEEE 488 interface. The unit supports the following functions:

1) Listener
2) Talker
3) Local Lockout
4) Serial Poll
5) Selective Device Reset
6) Bus Reset
7) Primary Addressing from 0 to 30

16.6 RS–232 Remote Control

The unit can be controlled via an RS–232 serial interface. The unit is configured with 9600 bps baud rate, no parity, 8 data bits per character, 1 stop bit and RTS/CTS hardware flow control.

16.7 Included

1) DLS 400 Chassis
2) DLS 400 Control Software
3) Manual
4) IEEE 488 shielded cable
5) RS–232 cable
6) Power cord
7) 2 fuses

16.8 Options

National Instruments GPIB–PCII interface card.

16.9 Electrical

16.9.1 AC Power

Rated Input Voltage:	100–240 VAC (±10%)
Rated Frequency:	50–60 Hz
Rated Power consumption:	140VA max
Line Fuses:	Type “T” 2A/250V SLOW BLOW (2 required, 5mm x 20mm).

16.9.2 On Simulated Wireline

300 Volts maximum peak AC+DC voltage between:

Tip and Ring, or
Tip and Ground, or
Ring and Ground.

Maximum Current: 100 mA DC sustained,150 mA peak

16.10 Environmental

Operating Temperature:	+10°C to +40°C.
Storage Temperature:	+10°C to +40°C.
Humidity:	90% relative humidity (RH) (non-condensing) max.

16.11 Physical

Weight:	28 kg
Dimensions:	194mm x 452mm x 494mm (H x W x D).

16.12 Operating Conditions

In order for the unit to operate correctly and safely, it must be adequately ventilated. The DLS 400 contains ventilation holes for cooling. Do not install the equipment in any location where the ventilation is blocked. For optimum performance, the equipment must be operated in a location that provides at least 10 mm of clearance from the ventilation holes. Blocking the air circulation around the equipment may cause the equipment to overheat, compromising its reliability.

17. SAFETY

17.1 Information

17.1.1 Protective Grounding (Earthing)

This unit consists of an exposed metal chassis that is connected directly to ground (earth) via a power cord. The symbol used to indicate a protective grounding conductor terminal in the equipment is shown in this section under “symbols”.

17.1.2 Before Operating the Unit

- Inspect the equipment for any signs of damage, and read this manual thoroughly.
- Become familiar with all safety symbols and instructions in this manual to ensure that the equipment is used and maintained safely.

WARNING: To avoid risk of injury or death, ALWAYS observe the following precautions before operating the unit:

- Use only a power supply cord with a protective grounding terminal.
- Connect the power supply cord only to a power outlet equipped with a protective earth contact. Never connect to an extension cord that is not equipped with this feature.
- Do not willfully interrupt the protective earth connection.

CAUTION: When lifting or handling the unit do not touch the cooling fan, which is located on the bottom of the chassis towards the front-right front corner. The unit may be lifted by utilizing the space beneath the chassis away from the cooling fan.

17.1.3 Power Supply Requirements

The unit can operate from any single phase AC power source that supplies between 100V and 240V (±10%) at a frequency range of 50 Hz to 60 Hz. For more information, see chapter 16 of this manual.

WARNING: To avoid electrical shock, do not operate the equipment if it shows any sign of damage to any portion of its exterior surface, such as the outer casting or panels.

17.1.4 Main Fuse Type

The fuse type used is specified in the specifications section of this manual.

17.1.5 Connections to a Power Supply

In accordance with international safety standards, the unit uses a three-wire power supply cord. When connected to an appropriate AC power receptacle, this cord grounds the equipment chassis.

17.1.6 Operating Environment

To prevent potential fire or shock hazard, do not expose the equipment to any source of excessive moisture.

17.1.7 Class of Equipment

The unit consists of an exposed metal chassis that is connected directly to earth via the power supply cord. In accordance with the HARMONIZED EUROPEAN STANDARD EN 61010-1 1993, it is classified as a Safety Class I equipment .

17.2 Instructions

The following safety instructions must be observed whenever the unit is operated, serviced or repaired. Failing to comply with any of these instructions or with any precaution or warning contained in the Operating and Reference Manual is in direct violation of the standards of design, manufacture and intended use of the equipment.

DLS TestWorks Ltd. assumes no liability for the customer's failure to comply with any of these requirements.

17.2.1 Before Operating the Unit

- Inspect the equipment for any signs of damage, and read the Operating and Reference Manual thoroughly.
- Install the equipment as specified in the relevant section of this manual.
- Ensure that the equipment and any devices or cords connected to it are properly grounded.

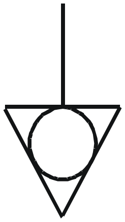
17.2.2 Operating the Unit

- Do not operate the equipment when its covers or panels have been removed.
- Do not interrupt the protective grounding connection. Any such action can lead to a potential shock hazard that could result in serious personal injury.
- Do not operate equipment if an interruption to the protective grounding is suspected. Ensure that the instrument remains inoperative.
- Use only the type of fuse specified.
- Do not use repaired fuses and avoid any situation that could short circuit the fuse.
- Unless absolutely necessary, do not attempt to adjust or perform any maintenance or repair procedure when the equipment is opened and connected to a power source at the same time. Any such procedure should only be performed by qualified service professional.
- Do not attempt any adjustment, maintenance or repair procedure to the equipment if first aid is not accessible.
- Disconnect the power supply cord from the equipment before adding or removing any components.
- Operating the equipment in the presence of flammable gases or fumes is extremely hazardous.
- Do not perform any operating or maintenance procedure that is not described in the Operating and Reference Manual or the Service Manual.

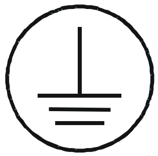
- Some of the equipment's capacitors may be charged even when the equipment is not connected the power source.

17.3 Symbols

When any of these symbols appear on the unit, this is their meaning:



EQUIPOTENTIALITY–FUNCTIONAL EARTH TERMINAL



PROTECTIVE GROUNDING CONDUCTOR TERMINAL

CAUTION - REFER TO ACCOMPANYING DOCUMENTS

Appendix A INTERPRETATION OF LEVEL UNITS

This appendix discusses the relation between the simulator setting and the real noise it represents.

In all cases the objective is to choose a setting that corresponds to the reading of a level meter connected to the equipment. Since we know that the noise SOURCE is unchanged, the reading will only change according to the bandwidth and the impedance of the meter (designated the Load Impedance).

In Impairment modules the units used in setting levels are designed to give a compromise between commonly used units and those that are unambiguous.

There are three forms of Units that are used.

1) μV/√Hz – Is independent of the Load Impedance and the bandwidth of the measuring device. It therefore requires the most manipulation to be translated into a meter reading.
2) dBm/Hz – Is independent of the bandwidth of the meter but not of the impedance. Therefore, when using a setting of X dBm/Hz the Load Impedance must be previously defined.
3) dBm – Is related to both Load Impedance and bandwidth. When using a setting of X dBm the Load Impedance and the bandwidth must both have been previously defined.

Following is a set of examples on how to convert a unit to dBm, the most common readout of level meters.

1) μV/√Hz to dBm

For this example we will assume that the load impedance is 135 Ω and the bandwidth is 3 kHz.

Assume that the setting is 10 μV/√Hz :

V * V = (μV/√Hz) * (μV/√Hz) * Bandwidth
= (10E–6) * (10E–6) * 3000
= 3.00E–7

P (load) = V * V / R watts
= (3.00E–7) / 135 watts
= 2.22E–9 watts

P (ref) = 1E–3 watts
dBm = 10*LOG [P(load)/P(ref)] dBm
= 10*LOG [(2.22E–9)/(1E–3)] dBm
= –56.5 dBm

2) dBm/Hz to dBm

Here we will assume that the bandwidth is 3000 Hz and the setting is –70 dBm/Hz.

dBm = dBm/Hz + 10*LOG (bandwidth) dBm
= –70.0 + 10*LOG (3000) dBm
= –70.0 + 34.8 dBm
= –35.2 dBm

Notes:

A) To change a level in µV/√Hz by a certain number of dB use the following formula: (Assume x is the amount to change the µV/√Hz setting by, and the dB change required is –6 dB.)

x = 10** (y / 20)
= 10** (–6 / 20)
= 0.50

Therefore the original setting in µV/√Hz should be multiplied by 0.50 to give a change of –6 dB.

B) To change a level in dBm/Hz by a certain number of dB simply change the dBm/Hz setting by the required amount. An examination of the formula on the previous section will bear this out.

LOADING

As can be seen from the above discussion the choice of loads plays a large part in the level that the meter will read.

One of 3 loads are used when calibrating DLS TestWorks Impairments (Noise) generators. In all cases any wirelines in place are set to zero length. They are 50 Ω, 67.5 Ω, and one 135 Ω resistor in parallel with one complex impedance as described in appendix E.

These impairments are calibrated using a 50 Ω load:

> Crosstalk Noises
> ADSL FEXT, ADSL NEXT, ADSL MODEL A, ADSL MODEL B, T1, E1
> AMI, ADSL+HDSL
> White Noise
> Impulses: Complex Impulse A and B (used in ANSI ADSL testing)

These impairments are calibrated using a 67.5 Ω load:

> Crosstalk Noises
> DSL, HDSL
> Shaped Noises
> ISDN (ETSI), HDSL (ETSI), FTZ
> Impulses: 3–LEVEL, COOK PULSE

These are calibrated using a load of 135 Ω in parallel with an ANSI Load (see Appendix E for a description of the complex ANSI load):

> Crosstalk Noises
> T1.601
> Dual Tones

Appendix B DLS 200 MODE

In February 1997, an enhancement to the DLS 400 was made to adjust the loop and impairments. The effect of this addition is to allow users to obtain test results using a DLS 400 that are very close to test results using a DLS 200 and DLS 200H.

Before this enhancement was released, customers found that, for example, testing HDSL modems with a DLS 200H gave performance results that were up to 3 dB better than when the same equipment was tested using a DLS 400, with resulting confusion. The enhancement enables users to test using a “DLS 200 Compatible” mode if they wish. Of course, the original “DLS 400” mode is still available so that users can obtain the same test results they got in the past using a DLS 400.

The enhancement can be retro-fitted if desired, to all DLS 400s, and is standard on present production. This manual describes the DLS 400 with the enhancement included. The full enhancement involves changes to both the loops and the impairments generator.

DLS 400 mode is the default mode, so a user taking no special action will be using the original impairments and loops.

Note: DLS 200 Compatible mode is not available for downloadable crosstalk shapes.

Appendix C MEASUREMENTS

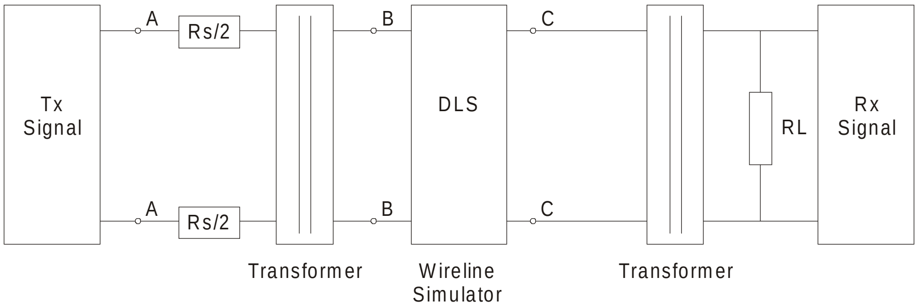
C.1 Measurement of Wireline Simulators

Data for the characteristics of 19, 22, 24 and 26 AWG lines were obtained from Bell System Technical Reference PUB 62310. This provides information on the line's attenuation FOR AN INFINITELY LONG LINE. Data for other wirelines are generally specified in terms of resistance, impedance, capacitance and conductance per unit length of line as it varies with frequency. This is easily converted into characteristics of an infinitely long line.

When measuring the response of a simulated line, the following considerations may apply: it is of finite length; it may be made up of several different gauges of wire; it is usually terminated in a real load. There are several common ways to measure the amplitude response of electronic systems. Referring to the figure these are:

1) The amplitude of the TRANSFER FUNCTION from BB to CC.
2) Some engineers include the source resistors in the system and measure from AA to CC.
3) Yet others measure using method 2, subtract 6dB from the attenuation and quote the result. This is called the INSERTION LOSS of the system.

For wireline measurement, method 3, the insertion loss method is standard.



Attenuation of a wireline simulator is correct when used with balanced, metallic (differential mode) signals which are injected and received by transformers. See the figure above.

The transformers may be included with the Transmit (Tx) Signal generator and Receive (Rx) Signal device. The centre tap of the receive transformer need not be grounded, but may be if no other point between the transformers is grounded.

THE USE OF UNBALANCED SIGNALS THROUGH THE DLS 400 WILL USUALLY RESULT IN INCORRECT MEASUREMENTS.

C.2 Common Errors

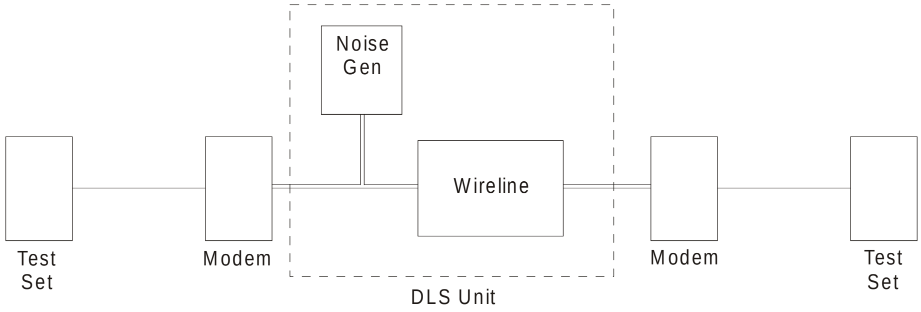
- Coupling between input and output via the two transformers. When trying to measure attenuations of 60 dB or so, approximately 1/1000 of the input voltage, or 1/1000000 of the input power is present on the output. It is very easy for transformers—or even wires—placed close to each other to couple together far more than this. Take care to keep inputs and outputs separate.
- The use of a high impedance measuring device with no load from tip to ring at the receive end. This results in reflections due to a bad mismatch at the end of the line, and leads to very peculiar response curves.
- Ground injected directly onto the tip or ring of the wireline simulator. This almost always leads to a very noisy spectrum, with high background noise levels and often harmonically related spectrum “spikes”.

Appendix D NOISE GENERATOR CONNECTIONS

The theory behind connecting up the impairments generator to the wireline is simple, but sometimes leads to confusion. When testing access equipment, the tests generally consist of:

1) A pair of modems, the equipment under test.
2) A wireline or wireline simulator, over which the modems communicate
3) One, or sometimes two, impairments (noise) generators, which impair the transmission conditions on the wireline, and make it more difficult for the modems to train up and communicate.
4) A pair of error rate testers (test sets), which send data to and receive data from the modems. These may also perform call set up and termination, and always have some method of determining the quality of the received data.

This is shown here, diagrammatically, assuming one noise generator is used:



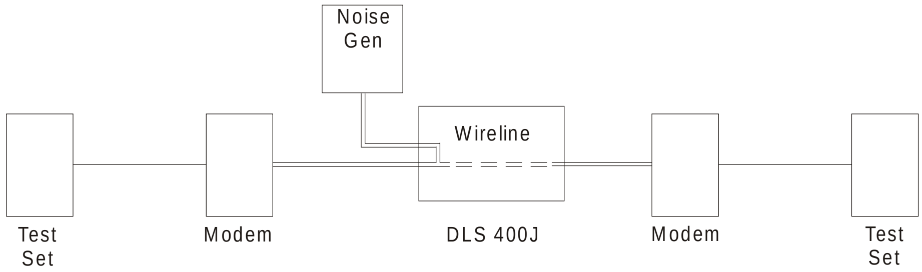
Simulators such as the DLS TestWorks DLS 400(E), DLS 200 and DLS 100A can all contain both the wireline simulation and the noise generator, and is the equipment enclosed in the dotted lines. You do not have to worry about connecting wireline simulator and noise generator together because this is already done inside the unit.

External to the unit, you must connect up the modems using a balanced interface. This balanced line is shown diagrammatically, both inside and outside the unit by the ═══ lines. You just connect up using twisted pair wire—or better, screened twisted pair—from the modems to the DLS unit. It is best to keep the connecting wire short, since then it picks up less noise, and does not give unwanted reflections. Screened twisted pair is better because it picks up less noise, and there is less chance of unwanted crosstalk.

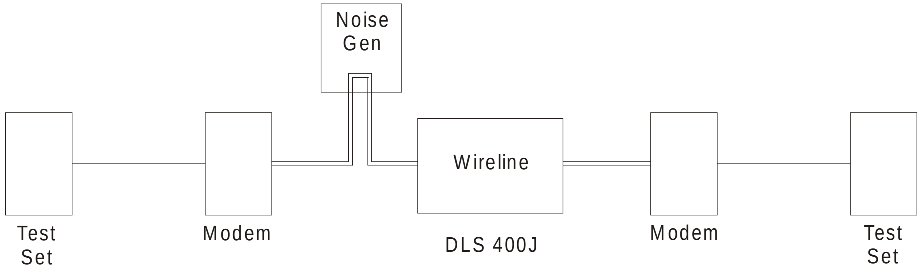
Note that when the noise generator is applied to the line it must not disturb the signals already on the line. Otherwise communication between the modems would be altered. For this reason, the noise generator has a high output impedance. Some people like to look at it as a current generator rather than a voltage generator. All present DLS TestWorks generators have an output impedance of 4 kohms or more.

Depending on the simulator type, connectors on the DLS may be an RJ45 jack, a Siemens CF connector (which will also take banana plugs) a bantam jack, a terminal strip, or some combination of these. Note that the bantam jack goes under several names, such as mini-bantam, mini 310, bantam telco jack. For the DLS 400, there are bantam jacks front and back and CF connectors on the front. On side A of the unit, all 3 of these connectors are equivalent, and internally connected. You may connect to any or all of them. The same is true for side B. Of course, if you connect to two of them, this joins the two plugs electrically together.

Sometimes you may want to connect the noise generator from, say, an NSA 400J to a wireline simulator such as a DLS 400, if it is not equipped with its own impairments generator. This is easy. Connect the DLS 400, modems, and error rate testers together in the usual way. At the side of the DLS 400 where you want added impairments, plug in one end of your connecting wire to one of the spare connectors on the DLS 400. It is either a bantam jack or a CF connector. Plug the other end in to the NSA 400J. The diagram shows the connections together with connections internal to the NSA.

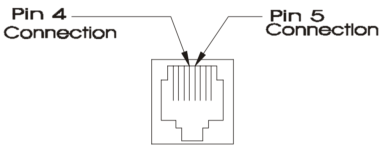


As an alternative, you could use the extra parallel connectors on the NSA 400J to connect the line to the impairments generator like this:



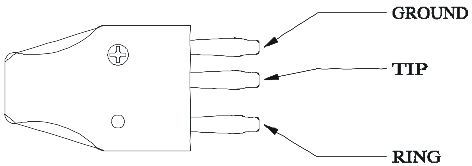
The diagram shows a DLS 400 as the wireline simulator, but it could equally well be a DLS 90, any other DLS TestWorks line simulator, or even real cable.

The various types of jacks and plugs referred to above are shown in the diagrams below.



For the RJ-45 connectors, pins 4 and 5, the centre 2 pins are the ones which carry the signal. If you wish, you can use an RJ-11 plug.

A CF plug looks like the diagram at the right. There are 3 prongs spaced unevenly, as shown. You can use banana plugs if the correctly spaced CF connector is not available.



The bantam plug looks like the diagram shown on the right. Its corresponding jack on the front of the NSA 400J, as seen on the front panel, is a hole, roughly 1.75” in diameter.

Appendix E COMMONLY ASKED QUESTIONS

Q) How much will an impairments module affect the signals travelling along the wire-line?

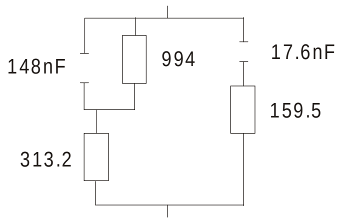
A) It depends on the loop, the frequency, and the impedance of the modems being tested. For frequencies above 100 kHz, and with a Receiver/Transmitter that provides 135 Ω, connecting the impairments generator reduces the signal at the receiver by 0.14 dB.

Q) How can I disconnect the Impairments module completely from the simulated loop?

A) Turn off all impairments (disconnect from the loop by clicking “off” in the impairments check box).

Q) What loads do you use to calibrate impairments.

A) For ISDN and HDSL specified noises, we generally set the loop length to 0, and provide a 67.5 Ω load at the terminal where the generator is located. Then we measure the voltage. For two types of impairments specified by ANSI, (Crosstalk Noise type ANSI FULL BW, and Powerline Noise type ANSI) we use 135 Ω in parallel with the ANSI load specified shown below:



For ADSL impairments, which are specified on a 100 Ω scale, we use a 50 Ω resistor instead of the 67.5 Ω resistor.

Q) How does wideband noise in dBm/Hz relate to total noise in dBm?

A) See Appendix A.

Q) Does the loop selected affect the noise level output by the Impairments module?

A) Yes. Since impairments are injected from a 4.05 kΩ impedance, the power injected on to the loop depends heavily on that impedance. Different loops have different impedances.

Q) Why is the noise not at the calibrated level when injected on to a simulated line?

A) No real loop provides the same load as the one used for calibrating the module, with the possible exception of the ANSI special load, and one of the ANSI loops.

Q) Why do I have to use a balanced meter to measure noise levels from the DLS 400? What happens if I just use the meter that I already have?

A) The Transmitters/Receivers under test provide a balanced load, so we should measure them the same way. Most meters ground one connection. This upsets the simulation at higher frequencies. Even if the meter is floating, it may be that capacitance to ground from one lead is more than the other, and this can lead to incorrect results.

Appendix F PROGRAM EXAMPLE

F.1 Downloadable Crosstalk Noise

For each downloadable shape, the file on disk is an ASCII text file. Three types of files are available and are differentiated by their extension: .LO1, .LO2 and .HI. The .LO1 files may be downloaded to either crosstalk generator A and B. The .LO2 files may only be downloaded to crosstalk generator B, while the .HI files may only be downloaded to crosstalk generator C. Keywords are used, and each starts with "**_**" and ends with "**:**". Note that these parameters are stored in volatile RAM, which means that if the unit is turned off, or if another crosstalk noise is selected (including "**OFF**"), the entire programming sequence needs to be re-sent.

The following example describes how to send the file "HDSL2 Dn NEXT (H2TUC).Lo1 Rev 00" to the simulator. An entire captured programming sequence is also shown.

```
_Name: HDSL2 Dn NEXT (H2TUC).Lo1 Rev 00
```

This identifies the loaded xtalk shape. This is generally the same name as the filename.

```
_Description:

Name:      HDSL2 Dn NEXT (H2TUC).Lo1 Rev00
Type:      HDSL 2 downstream NEXT (H2TUC)
Std:       ANSI T1E1.4 HDSL 2 Recommendation
Range:     –30 to –80 dBm
Cal:       135 ohm
49 dist:   –33.9 dBm
39 dist:   –34.5 dBm
24 dist:   –35.6 dBm
10 dist:   –37.9 dBm
```

Free form description. Skip to the next section.

```
_ Category:
```

For future use.

```
_Max: –30
```

Send **:sourcea:xtalka:program:maximum <_Max>**
e.g. **:sourcea:xtalka:program:maximum –30**

```
_Min: –80
```

Send **:sourcea:xtalka:program:minimum <_Min>**
e.g. **:sourcea:xtalka:program:minimum –80**

```
_Compatibility:

FLASHLO: 10
CONTROLLER: 16
```

The keywords **FLASHLO** and **CONTROLLER** are used in this section.

The symbol "**:**" precedes the minimum requirement. Any revision equal to **or** greater than the value which follows this symbol will be considered compatible.

In this example, the file can only be downloaded if the **FLASHLO** rev is equal to or higher than 10 AND if the **CONTROLLER** rev is 16 or higher.

Get the **FLASHLO** rev by issuing the command: **:sourcea:test:revision:flashlo.** Get the **CONTROLLER** rev by issuing the command: ***IDN?**

```
_Coefficients:
```

Send **:sourcea:xtalka:program:start.** The “start” command may be issued at any time, but must be done **before** issuing any data commands.

Send **:sourcea:xtalka:program:data xx,yy,zz,…**for dB Offset and the prg filter data in **1** command – this information will be contained in the first 2 lines under **_Coefficients**.

Throughout this process, numbers should be translated from decimal (or binary) to hexadecimal format. No suffixes are required (e.g. **81h** should be sent as **81**). Anything following a semi-colon should be discarded, as well as any “db” or “dw” statement. The db statement indicates that the number is a byte, dw indicates that it is a word. A hexadecimal value is followed by an “h”, a binary value is followed by a “b”, and a decimal does not have any suffix. Any blank line should be discarded.

```
db 081h,010h           ;dB Offset Hi/Lo
db 001h,01Dh,021h,036h ;prg filter data[0..3]: 3.5 dB/
                        166 kHz
```

Send **:sourcea:xtalka:program:data xx,yy,zz,…** for the mux setting and FIR parameters in 1 command. This information will be contained in the next 8 lines.

```
db 00000000b           ;b3 = selxt1/ b4=selxt2/ b5=
                        selxt3
db 00101000b           ;Base+0 – FIR Configuration
db 59                  ;Base+1 – FIR Length
db 01101000b           ;Base+3 – FIR Input format
db 00100001b           ;Base+4 – FIR Output timing
db 11001100b           ;Base+5 – FIR Output format
db 00000010b           ;Base+6 – FIR Symmetry (ODD
db 01101000b           ;Base+7 – FIR Mix Factor
```

Send **:sourcea:xtalka:program:data xx,yy,zz…** for the FIR coefficients. This would require several commands. The maximum size of a command is 64 characters (including the LF), which means that several data lines may be concatenated together. When sending consecutive commands it is not necessary to always re-send the entire message if the heading is the same as the previous one. For example, sending **:sourcea:xtalka:program:data xx,yy,zz.…**. and then data **xx,yy,zz** is valid and has the advantage of reducing programming time.

```
db 03Bh,035h,097h,0FFh;File: -0.0031980000
db 092h,0B2h,045h,000h;File: +0.0021270000
db 071h,08Eh,03Ah,000h;File: +0.0017870000
db 0DDh,058h,0F5h,0FFh;File: -0.0003251000
db 0EDh,033h,01Dh,000h;File: +0.0008912000
db 010h,0E9h,0B7h,0FFh;File: -0.0022000000
db 02Ch,0D8h,046h,000h;File: +0.0021620000
db 02Ch,044h,087h,000h;File: +0.0041280000
db 03Bh,0FFh,076h,0FFh;File: -0.0041810000
db 0E7h,0CAh,0FBh,0FFh;File: -0.0001284000
db 047h,021h,0C9h,000h;File: +0.0061380000
db 067h,0B7h,096h,0FFh;File: -0.0032130000
db 0E8h,04Dh,045h,000h;File: +0.0021150000
db 0A4h,076h,01Ah,000h;File: +0.0008076000
db 0EBh,06Eh,09Eh,0FEh;File: -0.0107900000
db 015h,01Dh,0C9h,001h;File: +0.0139500000
db 0FEh,026h,014h,002h;File: +0.0162400000
db 0FDh,0D9h,08Fh,0FCh;File: -0.0268600000
db 037h,0A7h,092h,0FFh;File: -0.0033370000
db 0DBh,0F9h,07Eh,002h;File: +0.0195000000
db 005h,086h,0ACh,0FEh;File: -0.0103600000
db 07Ah,0FCh,0DEh,002h;File: +0.0224300000
db 0FBh,05Ch,06Dh,001h;File: +0.0111500000
db 04Ah,046h,0CEh,0F6h;File: -0.0718300000
db 0AFh,05Ah,099h,004h;File: +0.0359300000
db 02Dh,095h,0B7h,00Bh;File: +0.0915400000
db 05Ah,00Dh,089h,0F3h;File: -0.0973800000
db 063h,0EDh,0EFh,0FEh;File: -0.0083030000
db 014h,0AEh,047h,021h;File: +0.2600000000
db 000h,000h,000h,000h;File: +0.0000000000
```

When downloading a file to the ADSL noise card, the following error messages may be received:

Too many pgm filter data
Too many FIR coefficients
Too many FIR taps

When any of these errors occurs, the crosstalk noise will not be generated properly. Note that the message will be preceded by <**01**> when programming an ADSL noise card in slot A and by <**02**> when programming a card on side B.

Once all the FIR coefficients have been received, the ADSL noise card will automatically get out of the “download” mode and will be ready to accept any other commands (e.g. level command).

When querying the type (i.e. **:sourcea:xtalka:type?**), the response will be “**External**” after the first **:sourcea:xtalka:program:data xx,yy,zz,…** command has been received.

If a “type” command is sent (e.g. **:sourcea:xtalka:type:t1.601**), the user-defined shape will stop being generated and the selected one will become active. To re-enable the user defined shape, re-do the entire programming sequence.

If for any reason the process needs to be cancelled when programming the user shape, send the **:sourcea:xtalka:type OFF** command to avoid using incomplete data. When doing another programming, sending the “**start**” command will reset the appropriate pointers.

Issuing an ***ESR?** command on a regular basis (e.g. after every command) ensures that there is no command or syntax error. If there is no error, the controller will send back “**0**”. Refer to section 8.1.2 for other error codes.

F.2 Captured Programming Commands

:SOURCEA:XTALKA:PROGRAM:START
*ESR?
:SOURCEA:XTALKA:PROGRAM:MINIMUM -80
*ESR?
:SOURCEA:XTALKA:PROGRAM:MAXIMUM -30
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 81 10 01 1D 21 36

```
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA  0 28 3B 68 21 CC 2 68
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 3B 35 97 FF 92 B2 45 00
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 71 8E 3A 00 DD 58 F5 FF
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA ED 33 1D 00 10 E9 B7 FF
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 2C D8 46 00 2C 44 87 00
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 3B FF 76 FF E7 CA FB FF
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 47 21 C9 00 67 B7 96 FF
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA E8 4D 45 00 A4 76 1A 00
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA EB 6E 9E FE 15 1D C9 01
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA FE 26 14 02 FD D9 8F FC
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 37 A7 92 FF DB F9 7E 02
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 05 86 AC FE 7A FC DE 02
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA FB 5C 6D 01 4A 46 CE F6
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA AF 5A 99 04 2D 95 B7 0B
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 5A 0D 89 F3 63 ED EF FE
*ESR?
:SOURCEA:XTALKA:PROGRAM:DATA 14 AE 47 21 00 00 00 00
*ESR?
:SOURCEA :XTALKA :level -75.0
*ESR?
```

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