297-2011-180

DMS-100 Family

Business Set Line Engineering

Maintenance Manual

BCS36 and up Standard 02.01 August 1999

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DMS-100 Family

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Maintenance Manual

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Publication history

August 1999

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- Altered references to Meridian business set.
- Incorporated a service bulletin about engineering business sets on short loops.
- Updated references to Nortel Networks.

July 1992

BCS27 Standard 01.02

- Restructured document.
- Clarified technical information.

This document does not introduce any new constraints on the application of loop engineering for business sets.

April 1986

BCS27 Standard 01.01

First release of this document.

Contents

About this document

When to use this document

This document provides information for personnel who engineer subscriber loops to be used between business sets and DMS-100 switching systems. It contains information needed to select loops, tests to be performed on selected loops, and performance requirements for the loops.

How to check the version and issue of this document

The version and issue of the document are indicated by numbers, for example, 01.01.

The first two digits indicate the version. The version number increases each time the document is updated to support a new software release. For example, the first release of a document is 01.01. In the next software release cycle, the first release of the same document is 02.01.

The second two digits indicate the issue. The issue number increases each time the document is revised but rereleased in the same software release cycle. For example, the second release of a document in the same software release cycle is 01.02.

To determine which version of this document applies to the software in your office and how documentation for your product is organized, check the release information in the *DMS-10 and DMS-100 Family Product Documentation Directory*, 297-8991-001.

References in this document

The following documents are referred to in this document:

- *DMS-10 and DMS-100 Family Product Documentation Directory*, 297-8991-001
- *Customer Data Schema Reference Manual*
- *Maintenance System Man-Machine Interface Description*, 297-1001-520

- *Lines Maintenance Guide*, 297-1001-594
- American National Standards Institute (ANSI) publication: *Network Performance Transmission Specifications for Switched Exchange Access Network*, T1.5069-1989

What precautionary messages mean

The types of precautionary messages used in Nortel Networks documents include attention boxes and danger, warning, and caution messages.

An attention box identifies information that is necessary for the proper performance of a procedure or task or the correct interpretation of information or data. Danger, warning, and caution messages indicate possible risks.

Examples of the precautionary messages follow.

ATTENTION - Information needed to perform a task

ATTENTION

If the unused DS-3 ports are not deprovisioned before a DS-1/VT Mapper is installed, the DS-1 traffic will not be carried through the DS-1/VT Mapper, even though the DS-1/VT Mapper is properly provisioned.

DANGER - Possibility of personal injury

DANGER

Risk of electrocution

Do not open the front panel of the inverter unless fuses F1, F2, and F3 have been removed. The inverter contains high-voltage lines. Until the fuses are removed, the high-voltage lines are active, and you risk being electrocuted.

WARNING - Possibility of equipment damage

WARNING

Damage to the backplane connector pins

Align the card before seating it, to avoid bending the backplane connector pins. Use light thumb pressure to align the card with the connectors. Next, use the levers on the card to seat the card into the connectors.

CAUTION - Possibility of service interruption or degradation

CAUTION
Possible loss of service
Before continuing, confirm that you are removing the card from the inactive unit of the peripheral module. Subscriber service will be lost if you remove a card from the active unit.

How commands, parameters, and responses are represented

Commands, parameters, and responses in this document conform to the following conventions.

Input prompt (>)

An input prompt (>) indicates that the information that follows is a command:

```
>BSY
```

Commands and fixed parameters

Commands and fixed parameters that are entered at a MAP terminal are shown in uppercase letters:

```
>BSY CTRL
```

Variables

Variables are shown in lowercase letters:

```
>BSY  CTRL  ctrl_no
```

The letters or numbers that the variable represents must be entered. Each variable is explained in a list that follows the command string.

Responses

Responses correspond to the MAP display and are shown in a different type:

```
FP 3 Busy CTRL 0: Command request has been submitted.

FP 3 Busy CTRL 0: Command passed.
```

1 General information

This document describes the application of business sets to business and residential subscriber loops that subtend a North American class 5 office. While this document is specific to North America, it can be used as a general guide for application of business sets outside of North America.

The subscriber line is made of

- a loop facility connecting the subscriber equipment directly to the main distribution frame (MDF) of the DMS-100 switch
- a line circuit mounted on a line card in a line group controller (LGC)

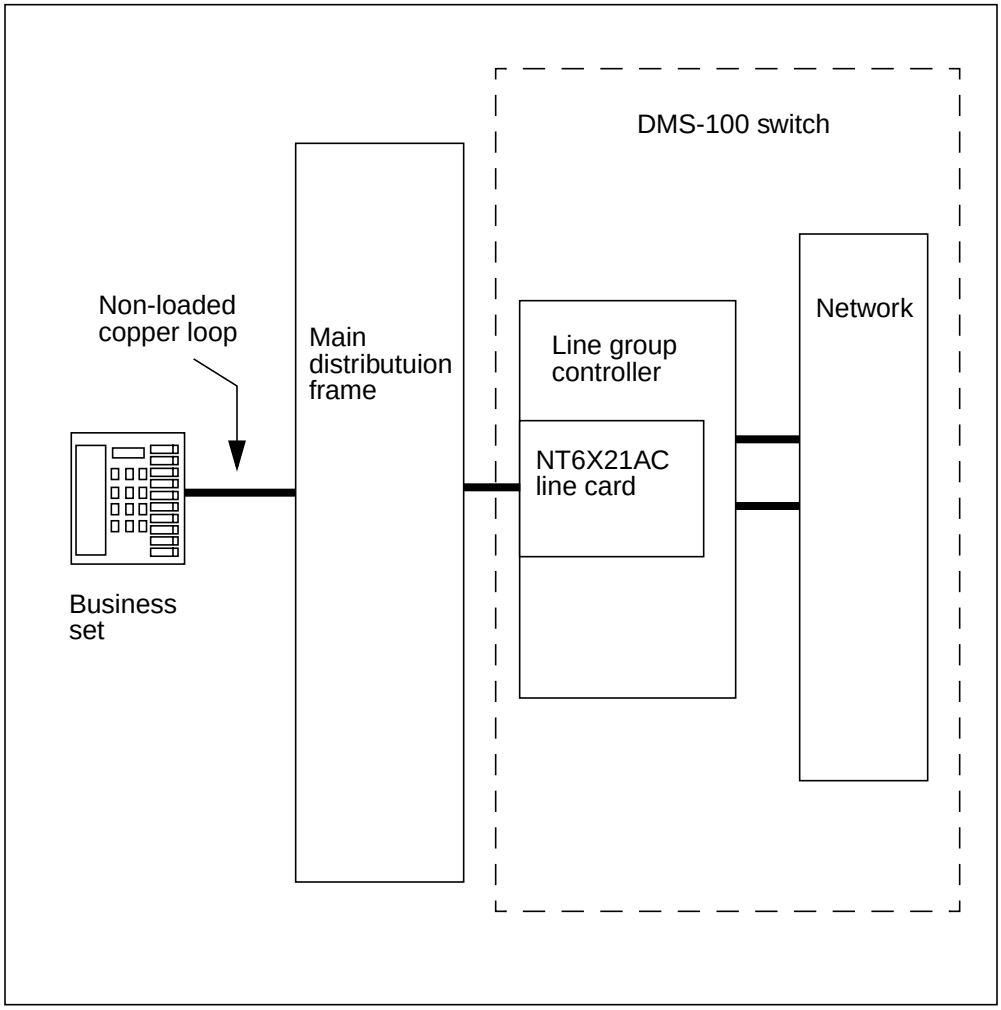
Business service uses the NT6X21AC line card. Figure 1-1 illustrates the configuration of the business set line.

Business service uses many different business sets. These sets are proprietary to the DMS-100 switch and all sets use the same base technology for signaling. The electronic business sets (EBS) and Meridian business sets (MBS) have dedicated keys that activate features. The Meridian M5212 business set, used for Automatic Call Distribution (ACD), also has dedicated keys that activate features. The MBS series includes the following model numbers:

- M5009
- M5112
- M5209
- M5212
- M5312

The wide range of features for business sets is available through the use of a modem-based system that signals at 8 kHz. This signaling system sets some limits on the application of the business sets. This document discusses these limits.

Figure 1-1 Business set line configuration



Voice frequency transmission path

The voice frequency (VF) transmission path for business set service is like a plain ordinary telephone service (POTS) telephone that uses the NT6X17AC line card. However, the NT6X21AC line card inserts a 3.5 –dB loss in the digital-to-analog path. The 3.5 –dB loss improves performance in two areas. For signaling, it reduces clipping of transients and high tone levels in the line card. For intra-office calls, it provides a better level on the short loops. The second improvement is possible due to the removal of loops longer than 15 kft from the range of the application of the business set. There is no impact on inter-office calls because operating company personnel adjust the port-to-port loss through table PADDATA.

Datafill

The following sections describe datafill for table PADDATA.

Table PADDATA

Table PADDATA, the attenuator value table, stores the transmit and receive pad (attenuator) values. Call processing determines the point at which the padding is implemented. Generally, for a line involved in the connection, the line card sets the pad. The following table shows datafill for table PADDATA.

Table 1-1 Datafill for table PADDATA

Field	Subfield	Explanation and action
PADKEY		This field contains subfields PADGRP1 and PADGRP2.
	PADGRP1	This subfield contains the pad group name that, for a business set, appears in field PADGRP in table LNINV. Enter PPHON.
	PADGRP2	This subfield contains the pad group name that appears in field PADGRP in any of the following tables: TRKGRP, LNINV, CONF3PR, CONF6PR, CPOS, or TOPSOS.
PAD1TO2		This field indicates the pad value for the network or the line pad for connection of PADGRP1 to PADGRP2. Enter 0L to 14L, where L represents loss (positive value); 0G to 7G, where G represents gain (negative value); or 0.
PAD2TO1		This field indicates the pad value for the network or the line pad for connection of PADGRP2 to PADGRP1. Enter 0L to 14L, where L represents loss (positive value); 0G to 7G, where G represents gain (negative value); or 0.

Datafilling table PADDATA

Operating company personnel must provision table PADDATA as described in the *Customer Data Schema Reference Manual*. The following figure shows the datafill for table PADDATA.

Note: The PAD2TO1 value is 3 dB less than the real loss because there is a 3 –dB fixed pad in the NT6X21AC line card.

Figure 1-2 Datafill example for table PADDATA

```
TABLE: PADDATA
PADKEY
PADGRP1    PADGRP2    PAD1TO2    PAD2TO1
-------------------------------------------------------
PPHON      STDLN          0          0
PPHON      STDLN          0          0
PPHON      LRLM           2L         0
PPHON      IAO            0          0
PPHON      LCO            0          0
PPHON      ELO            0          0
PPHON      ETLS           0          0
PPHON      ETLL           0          3L
PPHON      TLA            0          2L
PPHON      TLD            0          3L
PPHON      CONF           0          3L
PPHON      TPOS           0          3L
PPHON      PPHON          0          0
```

PADDATA adjustments Some offices can experience problems on calls between an EBS on a short loop and ELO or standard line (STDLN) circuits. Some of the problems include

- erroneous diamond appearances
- dropped calls
- spontaneous line seizures
- transmission losses

The recommended pad key adjustments for an EBS on a short loop with these types of problems is as follows:

```
PADKEY
PADGRP1    PADGRP2    PAD1TO2    PAD2TO1
-------------------------------------------------------

PPHON      STDLN          0          3L
PPHON      ELO            0          4L
```

Note: The adjustments are needed only on the PAD2TO1 receive direction.

A short loop is defined as a loop with less than 400 Ω total loop resistance. Total loop resistance is the product of loop length multiplied by the cable dc resistance. Values for cable dc resistance are listed in the following table.

Table 1-2 Cable dc resistance values

Cable size	26 AWG	24 AWG	22 AWG	19 AWG
dc resistance in W per kft	83	52	33	17

Approximate short loop lengths that fall below the 400 Ω limit are listed in the following table.

Table 1-3 Short loop lengths with less than 400 Ω resistance

Cable size	26 AWG	24 AWG	22 AWG	19 AWG
approximate allowable length in kft	4.8	7.7	12.1	23.5

To determine the total cable resistance of loops with sections having different AWGs, refer to chapter “Theoretical calculations” in this document.

Table LNINV

Table LNINV, the line circuit inventory table, lists the data for each line card slot. Field PADGRP contains the name of the pad group in table PADDATA. The pad group lists the values of the pad circuits that operating company personnel can switch into the line when a call is on the line. Operating company personel must assign the attribute PPHON to all business sets in table LNINV. The *Customer Data Schema Reference Manual* has more information about information about table LNINV.

Transmission plan

CAUTION

This information applies only to North America

Using the specifications presented in this document in other locations may result in an interruption of service. Consult Nortel Networks when engineering loops for networks outside North America.

The datafill described for table PADDATA is for North American Access Network and business sets located in a class 5 office. This office configuration must meet with the North American transmission plan. The American National Standards Institute (ANSI) document T1.506-1989, *Network*

Performance, Transmission Specification for Switched Exchange Access Network, describes the North American transmission plan for class 5 offices.

Centrex application

When a business set is part of a centrex system, there are other considerations. Many operating companies require the 1000-Hz loop loss to be 5.0 dB or less. This consideration is more important than any of the business set loss and noise requirements. However, to meet the 5.0 dB limit, business set operation does not permit loading of the loops.

Signaling path

The signaling for business sets uses modems that use low-level amplitude shift keying (ASK) based on an 8 kHz carrier. The selection of the keying systems and the carrier frequency is a compromise of the following items:

- service to the majority of subscribers on nonloaded loops
- power in the signaling channel that meets the North American industry standard for the band 4 kHz to 15 kHz
- signaling that does not impact the VF band

This compromise results in the selection of a signaling system that has a loss limit of 24 dB for the 8 kHz carrier. See chapter “Theoretical calculations” in this document to calculate the loss in the signaling system.

Echo control

The selection of the compromise network for the balance impedance of the NT6X21AC line card is based on several North American loop surveys. The loops used by the business set should meet with the standard North American design rules (including resistance design and unified loop design). The business set signaling system cannot use long loop designs.

It is normally enough to meet the loop selection flowchart requirements described in Appendix A. However, for a special loop design, make sure that the echo return loss (ERL) and the singing return loss (SRL) exceed 10 dB. To meet these requirements, it can be necessary to place a matching network between the loop and the NT6X21AC line card.

Note that subscribers appear to measure the level of the received voice according to the sidetone. For example, a telephone can work correctly while it appears to have a low receive level. You can correct this problem if you search and correct an incorrectly balanced hybrid transformer.

2 Engineering and troubleshooting

Nortel Networks designs business set systems to use nearly any loop in a local service area. It is normally not necessary to select and engineer loops for business set service.

Business sets are not acceptable for use on any type of party line or off-premises extension (OPX) services. In addition, the access lines for business sets must be non-loaded.

Loop engineering for a business set

Outside plant lines are designed for voice frequency transmission. Business sets use above-voiceband transmission for signaling and supervision. Operating company personnel should select outside plant lines that avoid potential sources of system limits. These sources include bridge taps and loading coils, loop insertion losses, and impulse noise.

Loops for business set service should meet the following requirements:

- no loading coils
- dc resistance must be less than
  - — 1230 Ω for a business set using local power source
  - — 250 Ω for business set using central office (CO) power
- estimated measured loss (EML) of 24 dB or less at 8 kHz with bridge taps removed
- leakage resistance must be 120 000 Ω or greater
- impulse noise count must be less than 300 at a threshold of 60 dBrn in 15 min
- C message noise must be less than 20 dBrnC

Procedure 2-1 gives a brief synopsis of the loop engineering process.

Procedure 2-1 Loop engineering for a business set

At the outside plant cabinet

1 Consult the customer line record (CLR) for a selected loop.

2 If the loop is loaded or has a loop extender, reject the loop. If several loops are loaded or have loop extenders, business set service requires special engineering of the loops.

3 Find the total dc resistance of the loop. See “Loop resistance calculation” in chapter “Theoretical calculations” in this document.

4 If the resistance is 1230 Ω or less, consider the loop current sufficient for the business set to function correctly when the display is powered by an external power source. If the resistance is 250 Ω or less, consider the loop current sufficient to power the phone from the central office (CO).

5 Find the 8 kHz loss for a loop that meets all the above criteria. See “Estimated measured loss” in chapter “Theoretical calculations” in this document.

6 If the estimated measured loss (EML) is less than or equal to 24 dB, regard the loop as satisfactory for business set service.

7 If the EML exceeds 24 dB, determine the effect of removing any bridge taps. If the EML falls below 24 dB, regard the loop as satisfactory for business set service when the bridge taps are removed.

8 If the removal of bridge taps leaves the EML above 24 dB, select another loop.

9 Perform diagnostic tests on the loop. See “Loop diagnostic tests” in chapter “Measurements” in this document.

10 If leakage resistance is less than 120 000 Ω, select another loop.

11 Measure the impulse noise. See “Measuring impulse noise” in chapter “Measurements” in this document.

12 If the impulse noise count is less than 300 at a threshold of 60 dBrn in 15 min, select another loop.

13 Measure the background noise. See “Measuring background noise” in chapter “Measurements” in this document.

14 If the C message noise is greater than 20 dBrnC, select another loop.

For more instruction in the loop selection process, see Appendix A. The loop selection flowchart shows the step-by-step method for selecting cable facilities acceptable for business set use.

Problem on initial installation

The operating company technician can follow the steps listed in procedure 2-2 to solve a problem with new service.

Procedure 2-2 Resolving difficulties with new service

At the outside plant cabinet

1 Contact the repair service bureau (RSB).

2 Examine the subscriber outside plant record for the following:

- loop extenders
- loading coils
- bridge taps

3 Take loss measurements on all lines that do not have loop extenders, loading coils, or bridge taps. Refer to chapter “Measurements” in this document.

4 Take an 8 kHz loss measurement test on all loops to which a connection of the jack directly to the subscriber loop is available through the maintenance and administration position (MAP). Refer to chapter “Measurements” in this document.

5 Request another line if the loss measurements exceed 24 dB or if no test is possible. Refer to the loop selection flowchart in Appendix A.

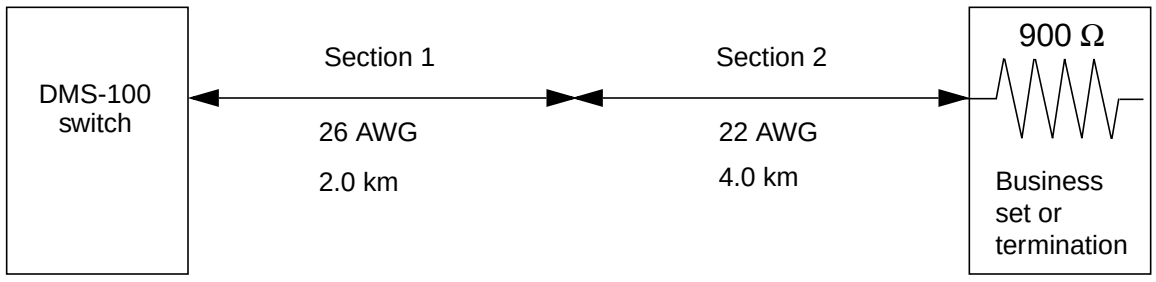
3 Theoretical calculations

This chapter discusses calculations that operating company personnel can use to engineer and analyze lines.

Loop resistance calculation

Operating company personnel can learn the dc loop resistance from the customer line record (CLR). Use standard office procedures to measure the dc loop resistance of the lines selected for business set operation. Calculate the total resistance using the formula in figure 3-1 with the resistance supplied in table 3-1. Line sections can be 22 to 26 American wire gauge (AWG).

Figure 3-1 Loop resistance calculation



Cable resistance = length x resistance (from table “Cable dc resistance in Ω per unit length”)

Total resistance for this loop = (2.0 x 270) + (4.0 x 107) = 968

Table 3-1 Cable dc resistance in Ω per unit length

26 AWG		24 AWG		22 AWG		19 AWG	
Ω/kft	Ω/km	Ω/kft	Ω/km	Ω/kft	Ω/km	Ω/kft	Ω/km
83	270	52	170	33	107	17	53

Restrictions for loop resistance on business set lines are as follows:

- Maximum loop resistance must not exceed 1230 Ω for basic Meridian business set (MBS).
- Maximum loop resistance must not exceed 250 Ω for a digit-display set when the central office supplies power to the set. The customer can power the digit-display at the customer premises to avoid the dc loop resistance restriction.
- Reduce the above limits by 1 Ω for each 1 percent of the loop that is aerial cable.

Estimated measured loss

The transmission loss is the total decrease in power in transmission from one point to another in the telephone connection. Subscribers can notice transmission losses with problems like volume, distortion, noise, and other sound disruptions in the connection.

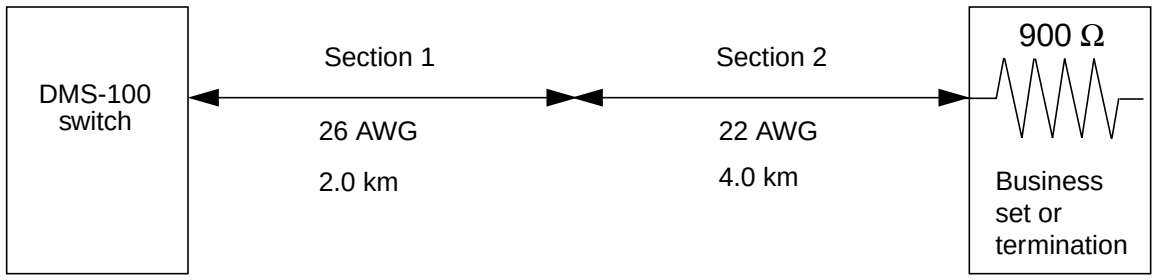
The estimated measured loss (EML) is the total measure of those problems that decrease the power in transmission over the loop. To calculate the EML for the loop use the formula EML = TCL + JL + BTL + AOL.

Total cable loss

Calculate the 8-kHz loss using the formula in figure 3-2 and the additional information in table 3-3.

Calculate the 1-kHz loss using the formula in figure 3-2 and the additional information in table 3-2.

Figure 3-2 Cable loss calculations



Cable loss for each section: length of section x cable attenuation of section

Cable loss at eight kHz for this loop = (2.0 x 4.90)+ (4.0 x 2.84) = 21.16

Cable loss at one kHz for this loop = (2.0 x 1.80) + (4.0 x 1.12) = 8.08

Table 3-2 Cable attenuation at 1 kHz in dB per unit length

	26 AWG		24 AWG		22 AWG		19 AWG	
	dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km
PIC	0.55	1.80	0.44	1.43	0.34	1.12	0.23	0.75

Table 3-3 Cable attenuation at 8 kHz in dB per unit length

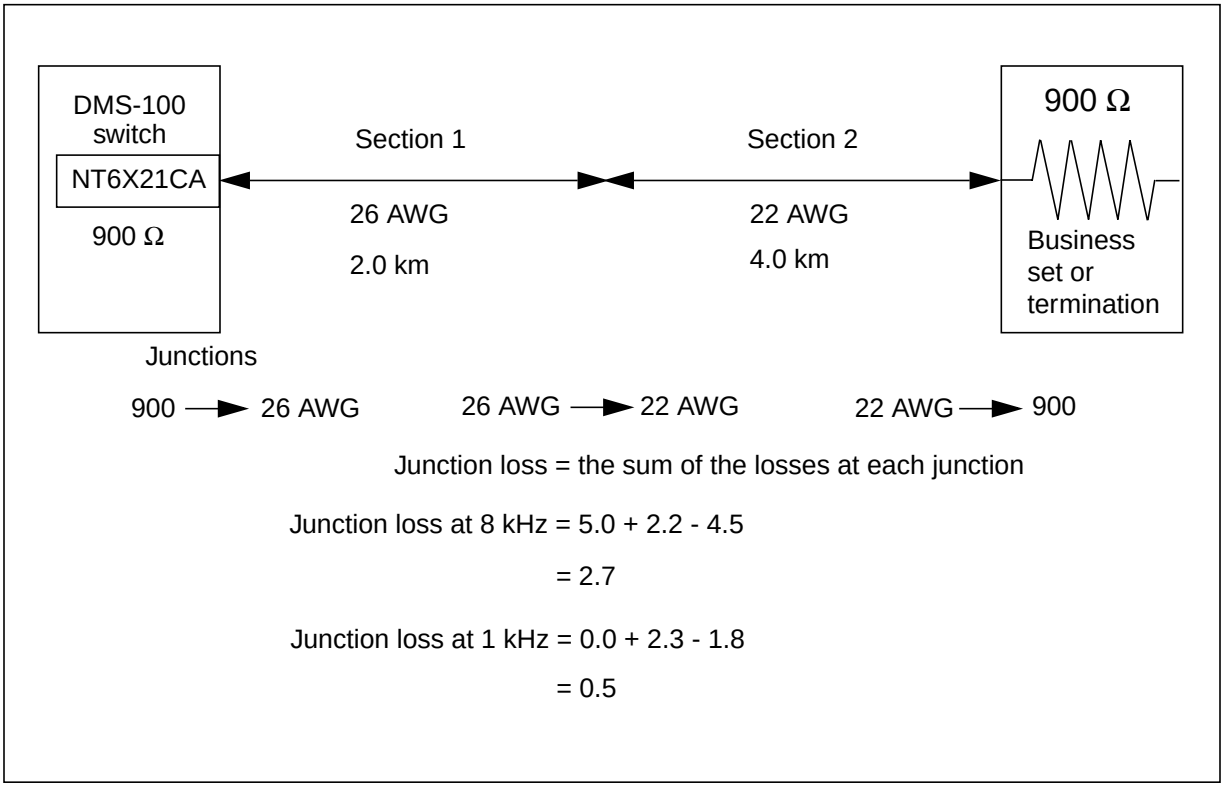
	26 AWG		24 AWG		22 AWG		19 AWG	
	dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km
PIC	1.49	4.90	1.15	3.76	0.86	2.84	0.54	1.77
PULP	1.48	4.86	1.17	3.83	0.89	2.91	0.56	1.84

Note: This table assumes AT&T outside plant cable characteristics. However, Nortel Networks cable is very similar. For example, 26-AWG Nortel Networks cable has an attenuation constant of 4.91 dB/km compared to AT&T cable at 4.90 dB/km.

Junction loss

The junction loss is that part of the transmission loss that results from interaction effects at the trunk terminals. Figure 3-3 shows an example of how to calculate the total junction loss. Tables 3-4 and 3-5 show the losses for cable junctions and 900 Ω terminations. Junctions can be between a termination and a cable or between cables of different gauges.

Figure 3-3 Junction loss calculations



The following tables shows the decibel loss for cable junctions and 900 Ω terminations. For example, when Z1 is a 900 Ω termination and Z2 is a 26 AWG cable, the junction loss is 5.0 dB. The junction loss table assumes that cable sections are longer than 0.2 km. Ignore cable sections less than 0.2 km.

Table 3-4 Junction loss at 8 kHz

		Z2			
Z1	900 Ω	26 AWG	24 AWG	22 AWG	19 AWG
900 Ω	0.0 dB	5.0 dB	6.6 dB	8.2 dB	10.5 dB
26 AWG	-3.8 dB	0.0 dB	1.0 dB	2.2 dB	3.8 dB
24 AWG	-4.2 dB	-0.9 dB	0.0 dB	1.0 dB	2.5 dB
22 AWG	-4.5 dB	-1.7 dB	-0.9 dB	0.0 dB	1.4 dB
19 AWG	-4.8 dB	-2.7 dB	-2.0 dB	-1.2 dB	0.0 dB

Table 3-5 Junction loss at 1 kHz

			Z2		
Z1	900 Ω	26 AWG	24 AWG	22 AWG	19 AWG
900 Ω	0.0 dB	0.0 dB	1.1 dB	2.3 dB	4.2 dB
26 AWG	0.0 dB	0.0 dB	1.1 dB	2.3 dB	4.2 dB
24 AWG	-1.0 dB	-1.0 dB	0.0 dB	1.1 dB	2.9 dB
22 AWG	-1.8 dB	-1.8 dB	-1.0 dB	0.0 dB	1.7 dB
19 AWG	-2.9 dB	-2.9 dB	-2.2 dB	-1.4 dB	0.0 dB

Bridge tap loss

The bridge tap is any part of the circuit that is not in the path between the main distribution frame (MDF) and the business set. The bridge tap can connect at an intermediate location or can be an extension of the circuit beyond the subscriber location. The pair related with the bridge tap introduces a frequency-dependent bridge tap loss in the loop. Calculate the bridge tap loss using the flow chart in figure 3-4, and the information provided in figures 3-5, 3-6, and 3-7. Figure 3-5 gives the bridge tap losses for different loop and bridge tap lengths. Figure 3-6, gives the bridge tap correction factor for loops > 3 km and < 4 km. Figure 3-7, gives the bridge tap correction factor for loops ≥ 4 km.

Note: For business set operation, the EML must not exceed 24 dB at 8 kHz.

Figure 3-4 Bridge tap loss calculation flow chart

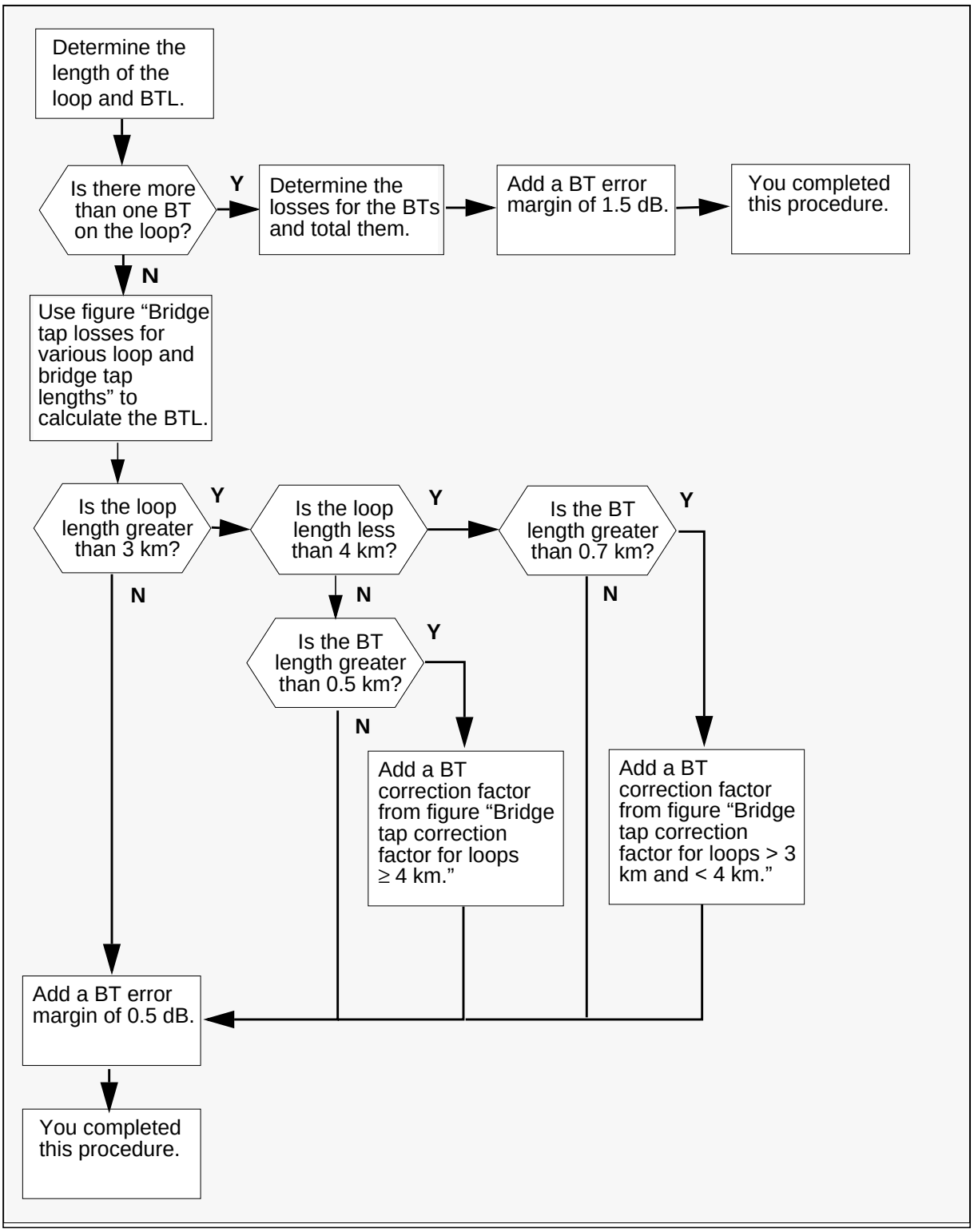


Figure 3-5 Bridge tap losses for various loop and bridge tap lengths

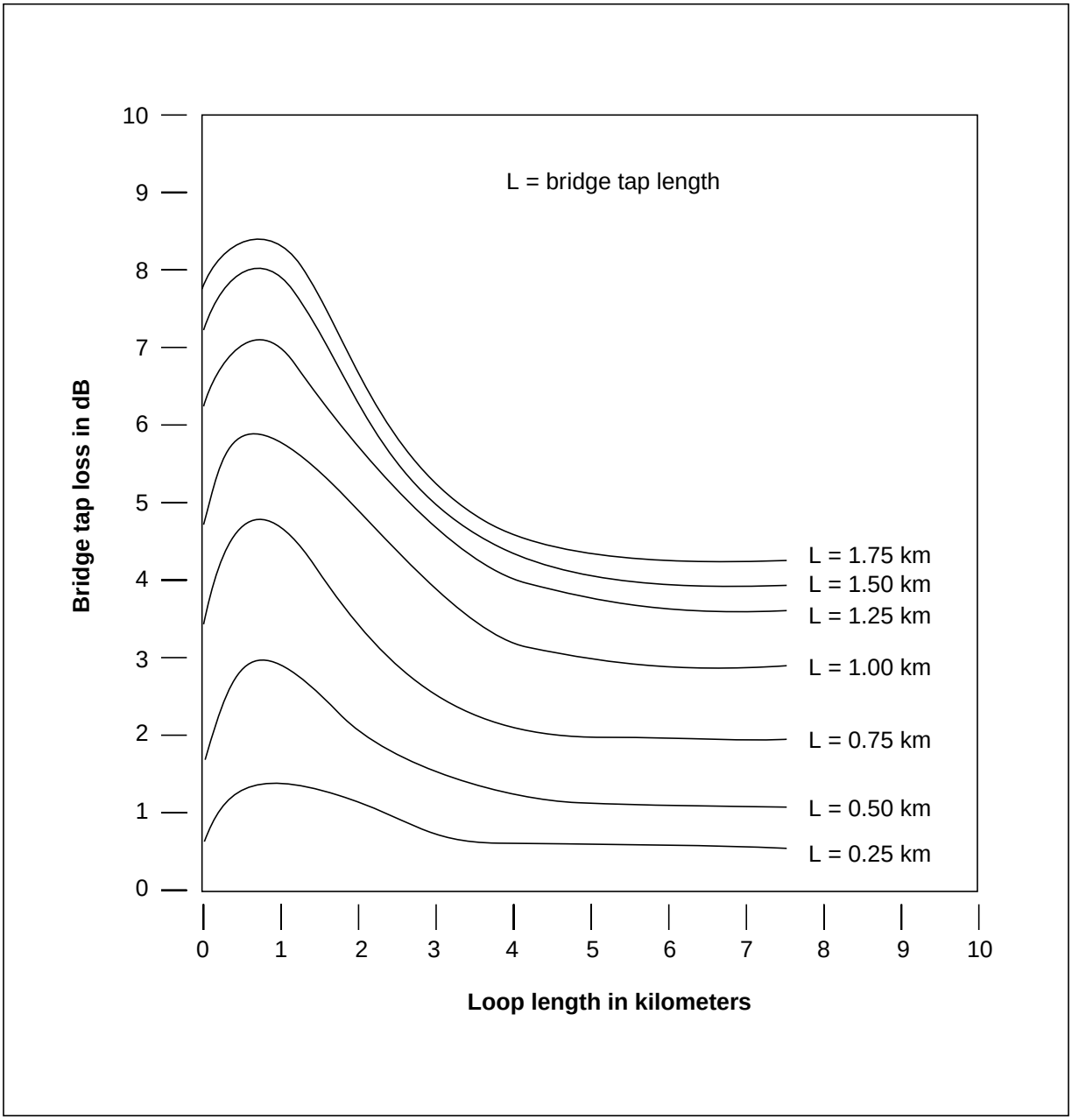


Figure 3-6 Bridge tap correction factor for loops >3 km and <4 km

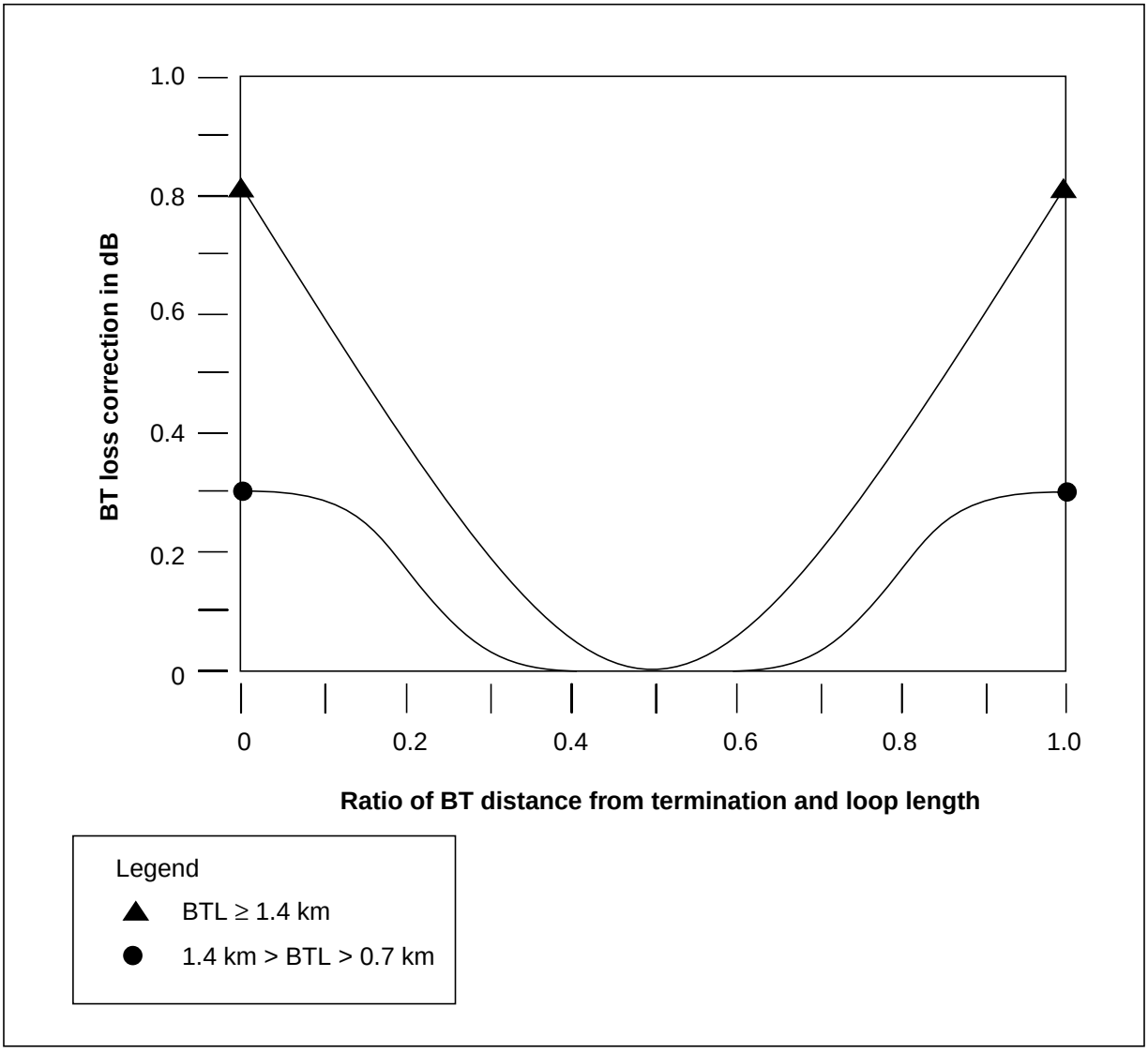
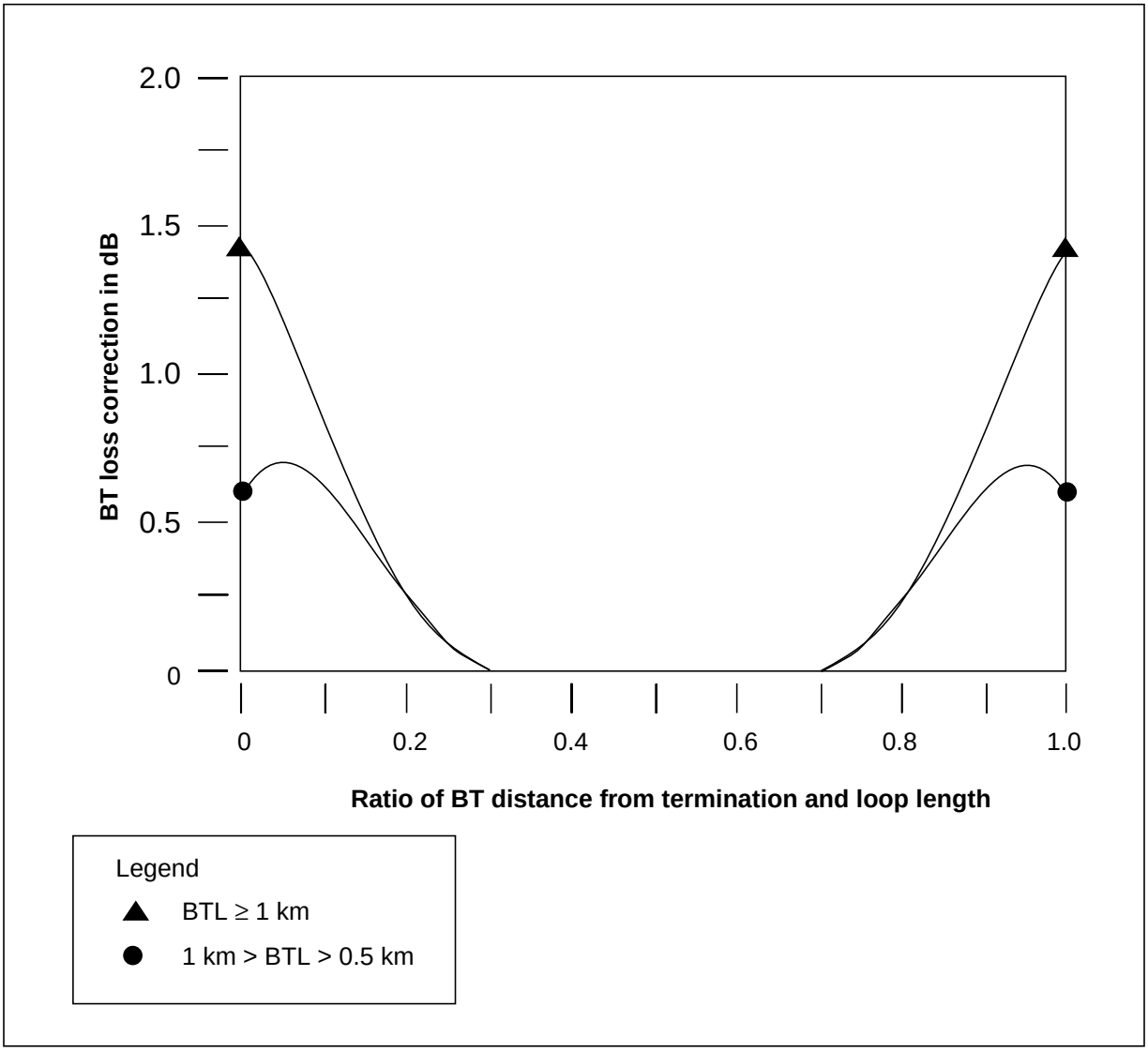


Figure 3-7 Bridge tap correction factor for loops ≥ 4 km



Add-on loss

Table 3-6 gives the additional transmission losses for loops with up to three add-on modules.

Table 3-6 Additional loss due to add-on modules (Sheet 1 of 2)

Number of add-on modules	Additional ac loss
0	0.00 dB
1	0.30 dB

Table 3-6 Additional loss due to add-on modules (Sheet 2 of 2)

Number of add-on modules	Additional ac loss
2	0.55 dB
3	0.80 dB

Example of estimated measured loss

Using the example loss calculations in this chapter, and assuming the BTL and AOL are zero, the estimated measured loss (EML) calculations for 8 kHz and 1 kHz are in figure 3-8.

Figure 3-8 Estimated measured loss equations

EML = TCL + JL + BTL + AOL

8 kHz EML = 21.16 + 2.7 + 0.0 + 0.0
= 23.86

1 kHz EML = 8.08 + 0.5 + 0.0 + 0.0
= 8.13

4 Measurements

Use the following techniques for testing the loop and obtaining measurement information. Make all measurements between matched impedances.

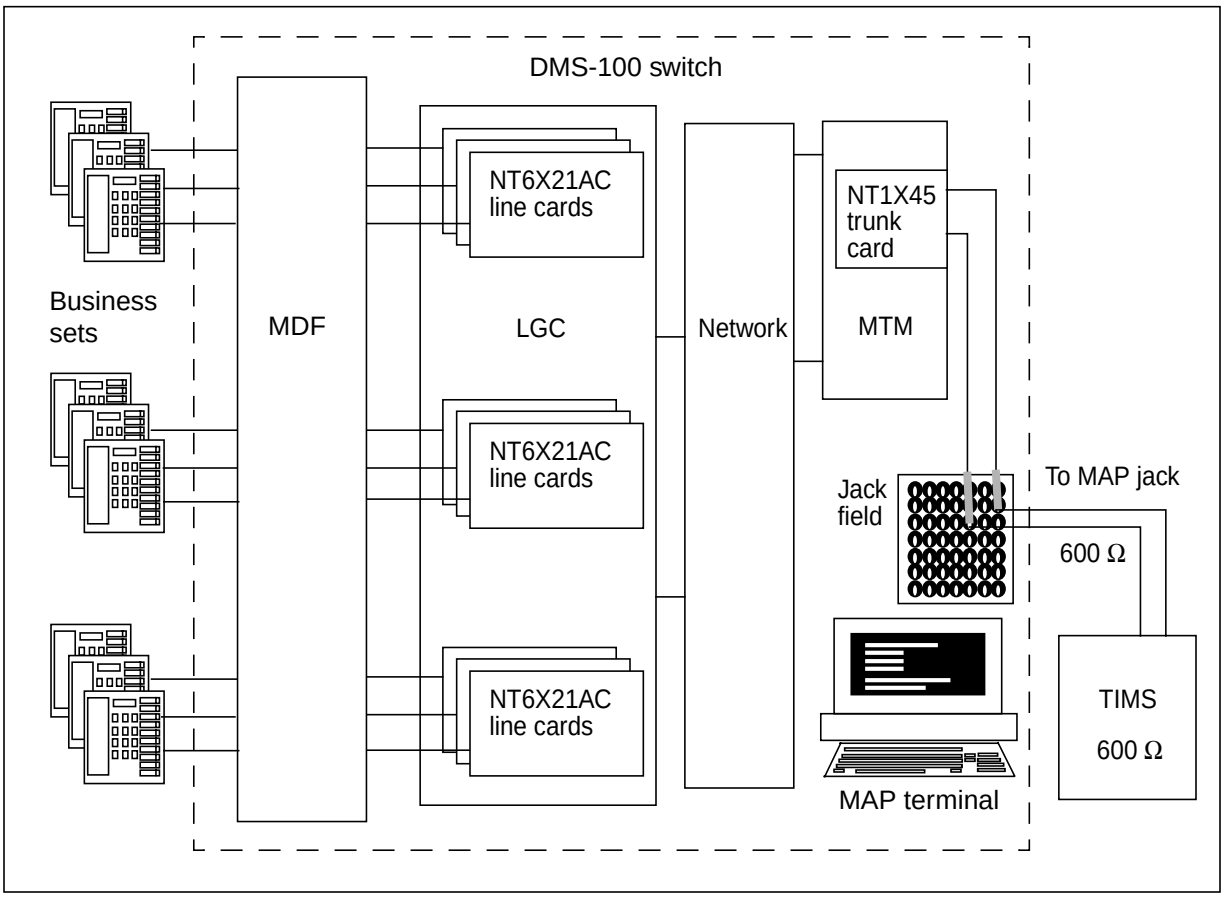
Testing from the MAP

Certain tests can be performed from the MAP (maintenance and administration position) terminal of the DMS-100 switch. A tester can perform line tests through commands accessed from the line test position (LTP) level, which is part of the line subsystem (LNS). The LTP command requests a display of the system status and the menu of tests and actions for manual line maintenance. The JACK command, invoked from the LTPMAN level menu, connects a jack-ended trunk to a subscriber line, or a jack to a subscriber loop, bypassing the line card. The METALLIC option of the JACK command connects the jack directly to the subscriber loop. Further information on line tests performed from the MAP can be found in *Lines Maintenance Guide*, 297-1001-594, and the full detail of MAP command input methods are described in *Maintenance System Man-Machine Interface Descriptio*n, 297-1001-520.

Some measurements should be done using a transmission impairment measurement set (TIMS). Connect the TIMS to the MAP jacks that are a part of the MAP station. Tests performed in this configuration, as illustrated in figure 4-1, use the aid of a MAP terminal. Alternatively, some tests can be done by using the TIMS at the main distribution frame (MDF).

Note: The TIMS should be a Northeast Electronics TTS-44 or equivalent.

Figure 4-1 Business set line test configuration



Measuring 8 kHz loss

An 8-kHz signal will not pass through the coder-decoder (CODEC) in the NT6X21AC line card. Therefore, the loss measurement should be done from a TIMS at the MDF to a TIMS at the subscriber premises. The METTALIC option of the JACK command should be used. To perform 8 kHz loss test measurements, the TIMS must be set to 900 Ω impedance.

Measuring 1 kHz loss

The following three tests can be used to find the 1-kHz loss using the inherent capabilities of the DMS-100 switch.

- From the LTPMAN level of the MAP terminal, request the DMS-100 switch to send a 1 kHz, 0-dB signal toward the business set. Use a TIMS to measure the signal level at the subscriber premises. The circuit loss will be 3.5 dB less than the loss measured by the TIMS. For example, if the measured loss is 7.5 dB, the circuit loss will be 4 dB.
- Apply a 1 kHz, 0-dB signal to the loop at the subscriber premises. Read the received signal level at the DMS-100 switch by a command from the MAP

LTPMAN level. In this situation, the measured loss is the actual circuit loss.

- The technique used for 8 kHz measurements is the same as for 1 kHz measurements. You can measure loss from a TIMS at the MDF to a TIMS at the subscriber premises.

Measuring return loss

Return loss is a measure of the impedance match between two circuits at the point of their interconnection. The voiceband frequencies in DMS-100 switch-to-business set connections are normally limited by the four-wire facilities to the 200 to 3200 Hz range. The echo return loss (ERL) is a weighted average measurement of the return losses over a frequency band of 560 Hz to 1965 Hz. Subscribers are more likely to complain of echo at these frequencies. The singing return loss (SRL) is the weighted average measurement of the return losses over the frequency band of 260 Hz to 500 Hz (SRL-low) and 2200 Hz to 3400 Hz (SRL-high). At these frequencies, subscribers are more likely to complain of singing before echo is noticeable.

Measure the ERL and SRL from the MAP terminal using a TIMS connected to the test jacks by performing the following steps:

- Ensure that the loop is terminated by an off-hook business set or 900 W impedance.
- Post the required line.
- Use the JACK command to connect the posted line to the jacks.
- Use the TIMS to measure the return loss at the required frequencies.

Note: The ERL and SRL should exceed 10 dB for business service.

Loop diagnostic tests

Use a volt-ohmmeter (VOM) to perform the tests outlined in Procedures 4-1 and 4-2.

Procedure 4-1 Foreign voltage test

At the line card or main distribution frame (MDF)

1 Set the VOM range switch to a scale of 60 Vdc or higher.

2 Connect the VOM test probes to the line card or MDF.

3 Measure the voltage between the following: T and R; T and GND; and R and GND.

Note: Voltage readings must be less than 1 Vdc.

Procedure 4-2 Leakage resistance test

At the line card or MDF

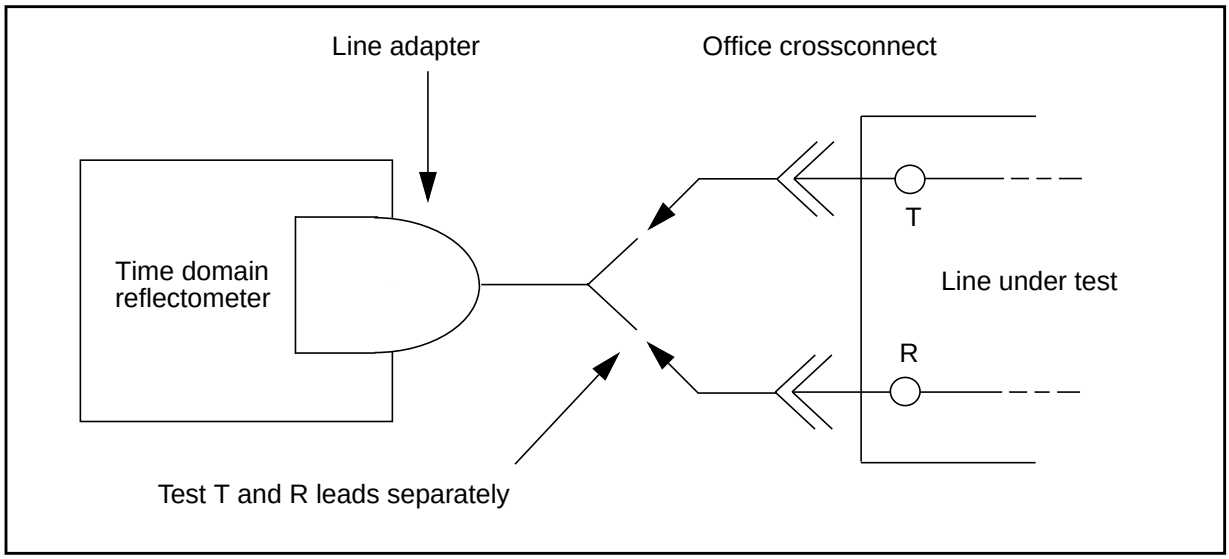
1. Set the VOM range switch to OHMS X 10 000, and adjust the meter to zero.
2. Connect the VOM test probes to the line card or MDF.
3. Measure the resistance between the following points: T and GND; and R and GND.

   Note: Resistance readings must be greater than 120 000 Ω.

Checking for loading coils and bridge taps

When there is an insertion loss greater than the limits shown in chapter "Theortical calculations," it is possible that loading coils or bridge taps are on the line without a record in the line records. Use a time domain reflectometer (TDR) to test for loading coils and bridge taps not shown in the customer line record (CLR). Refer to the TDR operating manual for setup, calibration, and measurement procedures. A simplified setup is shown in figure 4-2.

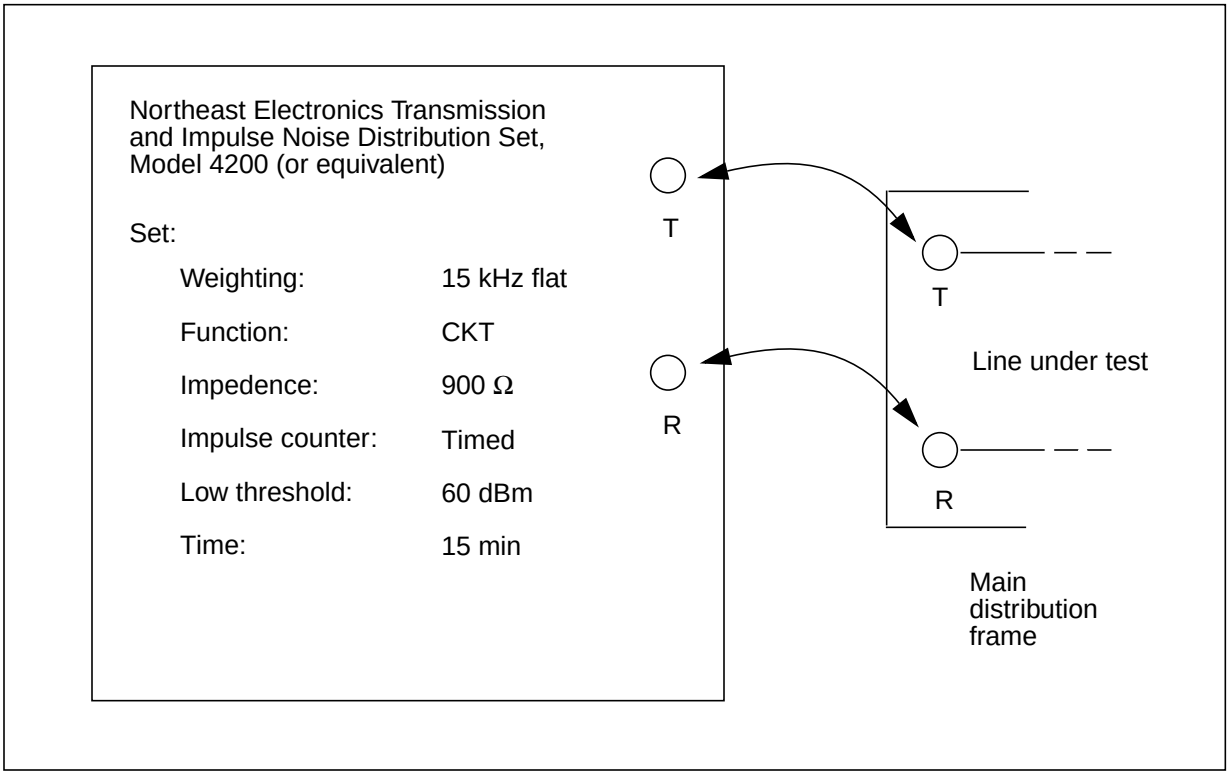
Figure 4-2 Simplified test setup to check for loading coils and bridge taps



Measuring impulse noise

Measure the impulse noise on the selected line at the central office during busy hours. Use a Northeast Electronics Transmission and Impulse Noise Distribution Set, Model 4200, or equivalent. Refer to the operating manual of the test set for detailed setup, operating, and measurement procedures. A simplified test setup is shown in figure 4-3. The measured impulse noise count must be less than 300 at a threshold of 60 dBrn over a period of 15 min. This limit, measured with 15-kHz flat weighting, assumes maximum loop length (15 kft or 4.57 km) of 26 gauge wire.

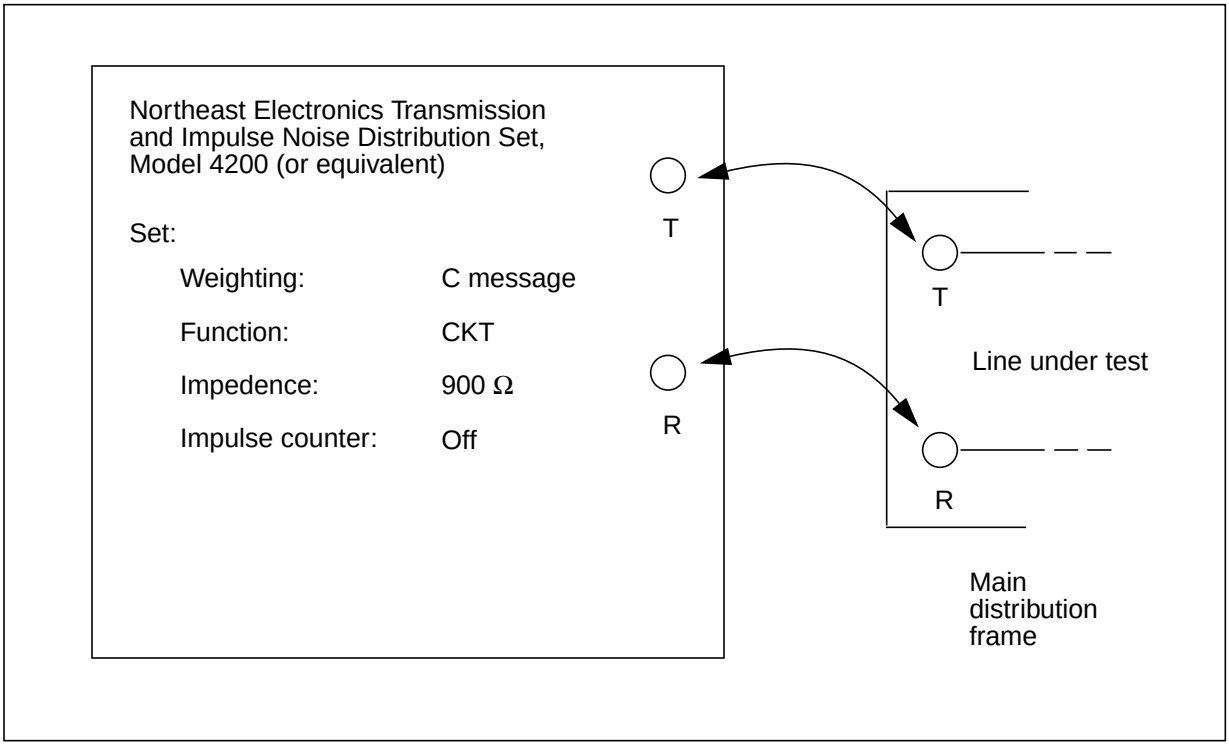
Figure 4-3 Simplified test set-up to measure impulse noise



Measuring background noise

Measure background noise with a Northeast Electronics Transmission and Impulse Noise Distribution Set, Model 4200, or equivalent. The test set must be set for C Message weighting and 900 Ω termination. Refer to the operating manual of the test set for detailed setup, operating, and measurement procedures. A simplified test setup is shown in figure 4-4. Background noise levels must not exceed 20 dBrnC, assuming white Gaussian noise.

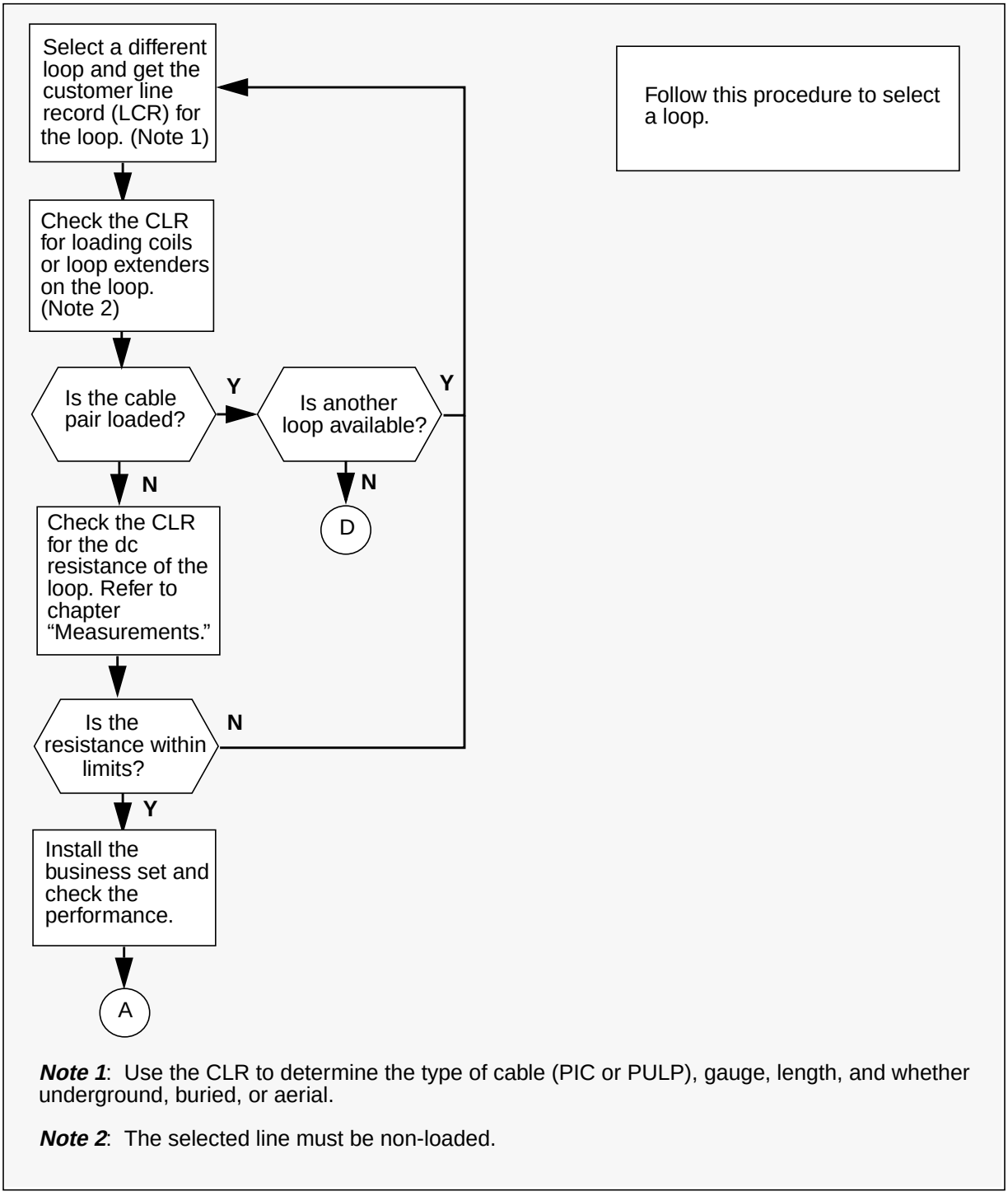
Figure 4-4 Simplified test setup to measure background noise



Appendix A Loop selection flowchart

The loop selection flowchart shown in figure A-1 illustrates the step-by-step method for selecting and testing cable facilities acceptable for business set use.

Figure A-1 Loop selection flowchart (Sheet 1 of 6)



Note 1: Use the CLR to determine the type of cable (PIC or PULP), gauge, length, and whether underground, buried, or aerial.

Note 2: The selected line must be non-loaded.

Figure A-1 Loop selection flowchart (Sheet 2 of 6)

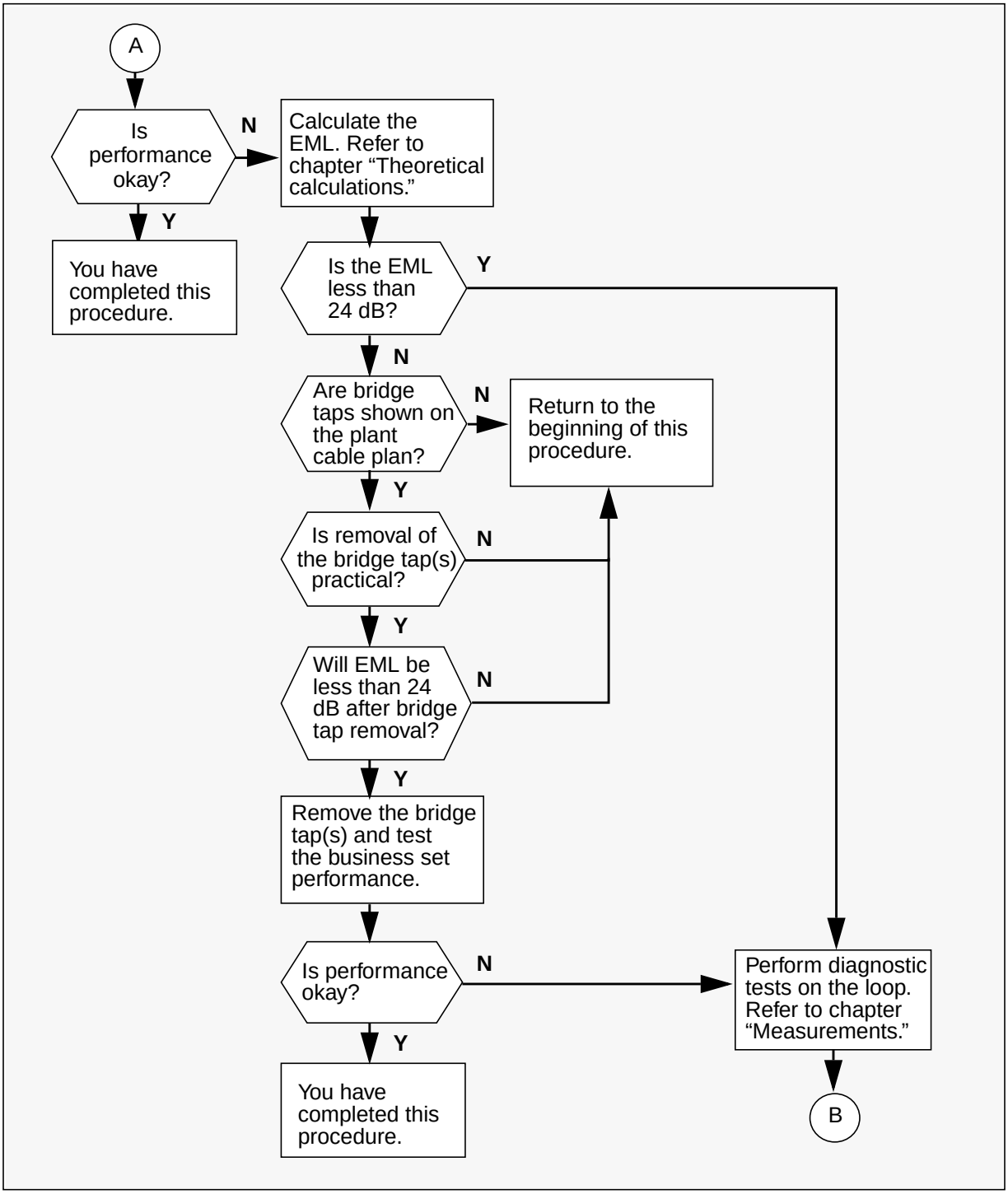


Figure A-1 Loop selection flowchart (Sheet 3 of 6)

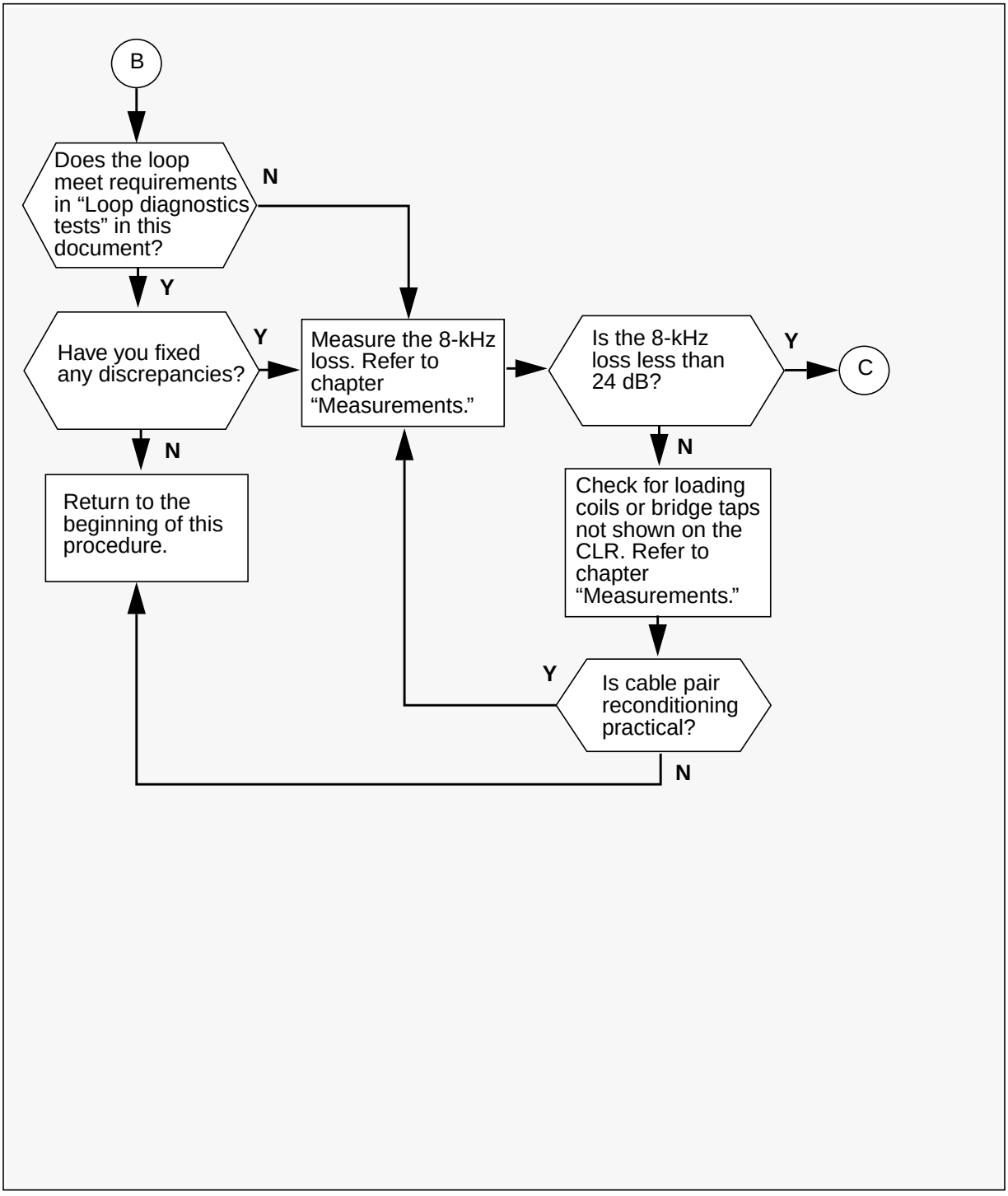


Figure A-1 Loop selection flowchart (Sheet 4 of 6)

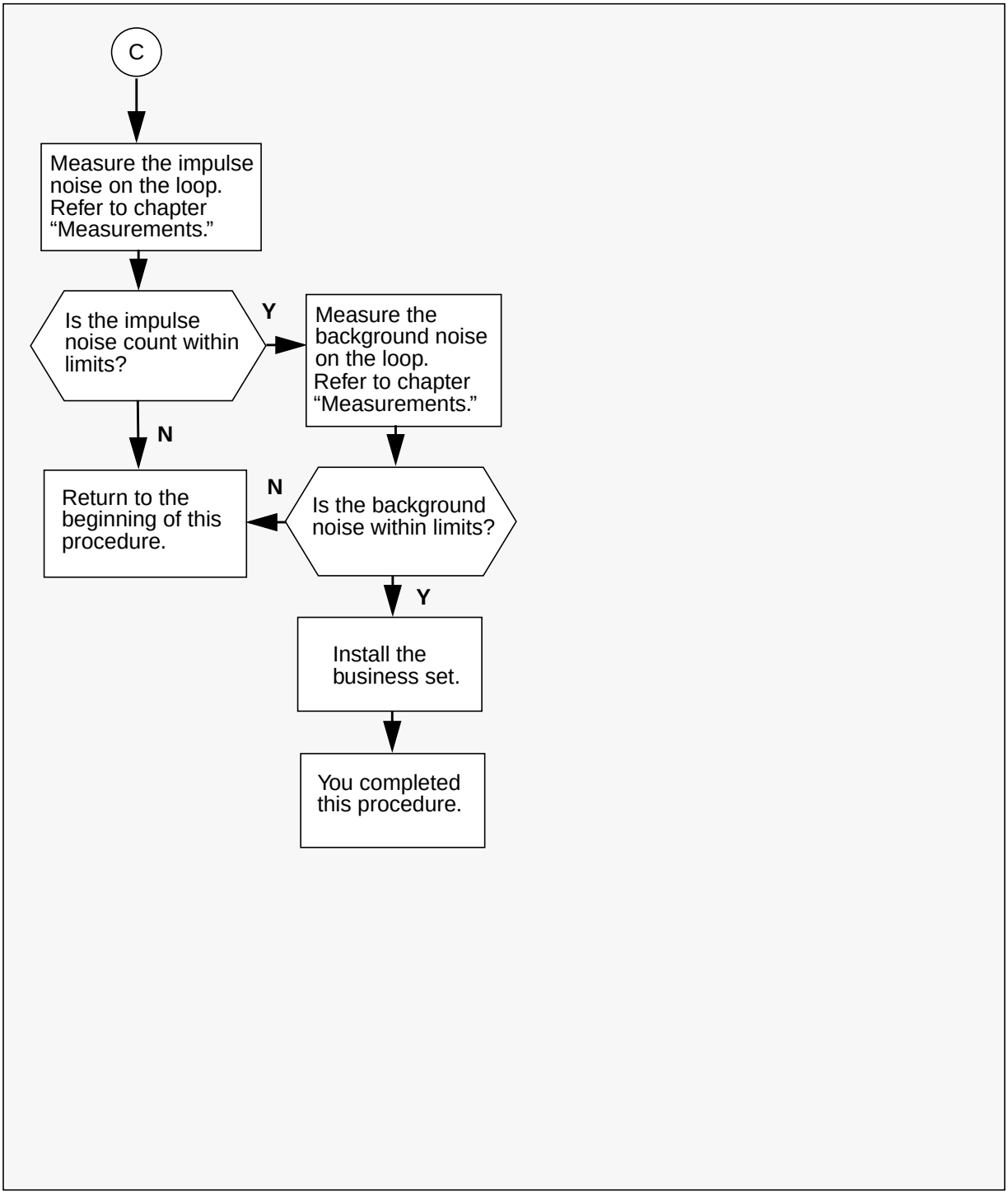


Figure A-1 Loop selection flowchart (Sheet 5 of 6)

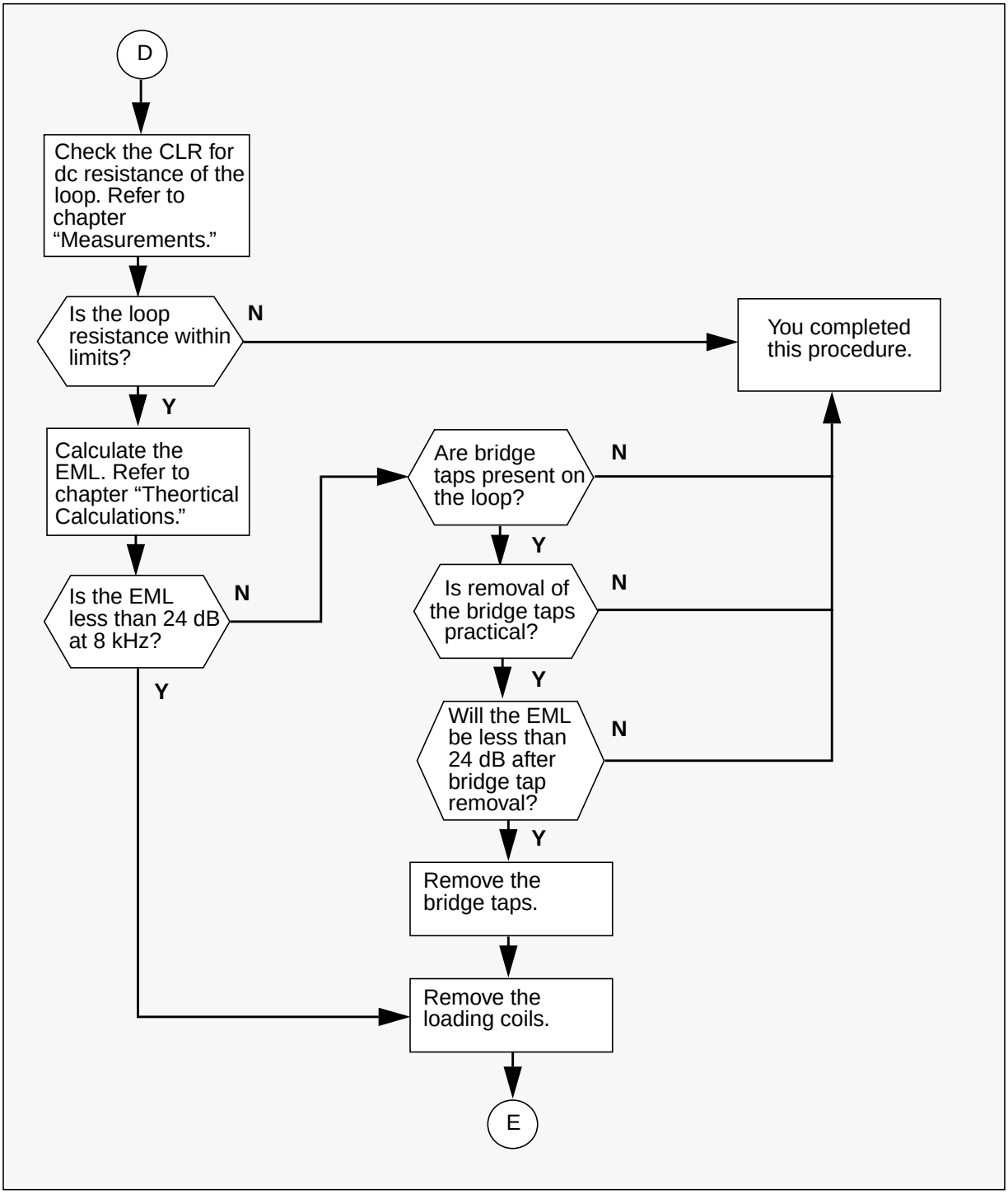
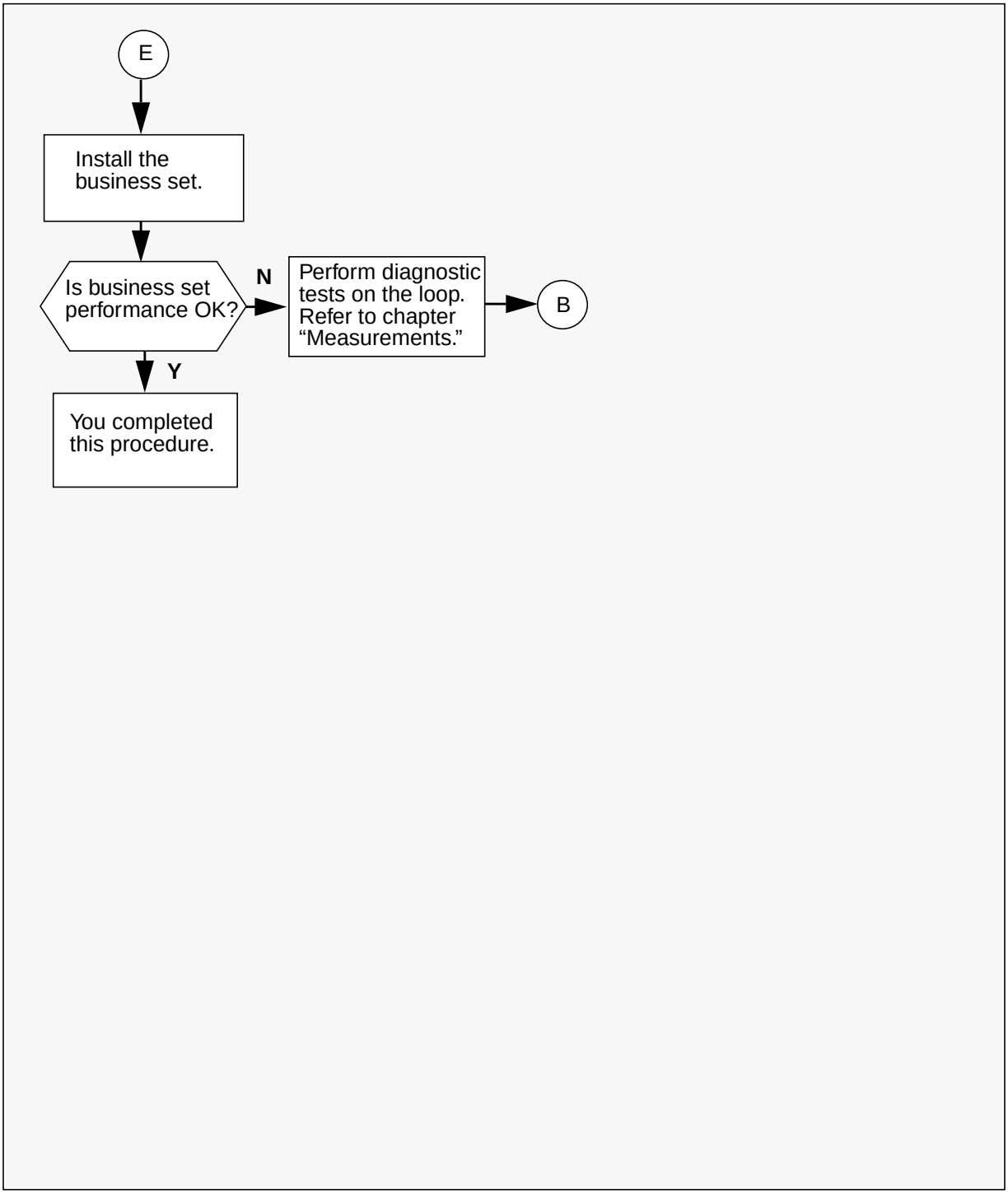


Figure A-1 Loop selection flowchart (Sheet 6 of 6)



List of terms

ACD

Automatic Call Distribution

add-on loss (AOL)

Add-on loss is the loss in decibels that results from using add-on modules on a line.

American wire gauge (AWG)

Standard measuring gauge for non-ferrous conductors. The higher the AWG, the thinner the wire.

amplitude shift keying (ASK)

Data signals that produce a number of different amplitude levels of a sine-wave carrier.

ANSI

American National Standards Institute

AOL

Add-on loss

ASK

Amplitude shift keying

Automatic Call Distribution (ACD)

A set of Meridian Digital Centrex features that assigns answering priorities to incoming calls, and then queues and distributes them to a predetermined group of telephone sets designated as answering positions.

AWG

American wire gauge

bridge tap (BT)

An undetermined length of wire attached between the normal endpoints of a circuit that introduces unwanted impedance imbalances for data transmission.

bridge tap loss (BTL)

The loss at a given frequency that results from connecting an impedance across a transmission line. This is measured as a ratio in decibels of the signal delivered to the part of the system that is down stream of the bridge tap after the bridge tap was installed, and the signal to that part of the system before the bridge tap was installed.

BT

Bridge tap

BTL

Bridge tap loss

CLR

Customer line record

central office (CO)

A switching office arranged for terminating subscriber lines and provided with switching equipment and trunks for establishing connections to and from other switching offices. Also known as class 5 office; end office (EO); local office.

CO

Central office

CODEC

Coder-decoder

coder-decoder (CODEC)

An assembly comprising an encoder and a decoder in the same equipment. It produces a digital output from an analog input and an analog output from a digital input.

customer line record (CLR)

This is a record maintained by operating company personnel. The record contains information about the subscriber line such as dc loop resistance, coils, and bridge taps.

Digital Multiplex System (DMS)

A central office switching system in which all external signals are converted to digital data and stored in assigned time slots. Switching is performed by reassigning the original time slots

DMS

Digital Multiplex System

EBS

Electronic business set

echo return loss (ERL)

This is the difference between a frequency signal and the echo on that signal as it reaches its destination.

electronic business set (EBS)

A telephone set that provides subscribers with push-button access to various business features. Also known as electronic telephone set.

EML

Estimated measure loss

ERL

Echo return loss

estimated measured loss (EML)

This is the total measure of the problems that decrease power in transmission over a loop. *See* junction loss, bridge tap loss, and add-on loss.

JL

Junction loss

junction loss

This is the part of the transmission loss that results from interaction effects at the trunk terminals.

LCM

Line concentrating module

LGC

Line group controller

line concentrating module (LCM)

A peripheral module which interfaces the line group controller and up to 640 subscriber lines, using two to six DS-30A links.

line group controller (LGC)

A peripheral module that connects DS-30 links from the network to line concentrating modules (LCM).

line test position (LTP)

A MAP that has been specially equipped for performing line tests.

lines maintenance subsystem (LNS)

A DMS-100 Family subsystem for maintenance of subscriber loops.

LNS

Lines maintenance subsystem

LTP

Line test position

main distribution frame (MDF)

A frame containing terminal blocks where cables from outside plant and office equipment are terminated. Outside plant equipment is terminated on vertical rows of blocks and office equipment on horizontal rows. Cross-connection flexibility and organization is provided by jumper pairs between horizontal and vertical terminal blocks.

maintenance and administration position (MAP)

A group of components that provide a user interface between operating company personnel and the DMS-100 Family system. A MAP consists of a display and keyboard, a voice communications module, test facilities, and MAP furniture.

maintenance trunk module (MTM)

A peripheral module located in a trunk module equipment frame. The MTM is equipped with test and service circuit cards and contains special buses to accommodate test cards for maintenance purposes. The MTM provides an interface between the DMS-100 Family digital network and digital or analog test and service circuits.

MAP

Maintenance and administration position

MBS

Meridian business set

MDF

Main distribution frame

Meridian business set (MBS)

Telephone set that provides subscribers with push-button access to various business features. This set, used by the supervisor, has one more field display than does the electronic business set (EBS).

MTM

Maintenance trunk module

off-premises extension (OPX)

A local or interexchange private-line voice service that connects a remote extension to a main station or business communication system and allows

users of that extension to access the public telephone network as though they were on the main premises.

OPX

Off-premises extension

plain ordinary telephone service (POTS)

Basic conventional telephone service. In the context of service screening, POTS is a pseudoservice that is derived from the combination of a bearer service of speech with no supplementary services.

POTS

Plain ordinary telephone service

repair service bureau (RSB)

A class of operating company personnel authorized to access the input/output system of DMS-100 Family systems to obtain data for maintenance purposes.

RSB

Repair service bureau

singing return loss (SRL)

The loss at which a circuit oscillates at the extreme low and high ends of the voice band.

SRL

Singing return loss

TCL

Total cable loss

TDR

Time domain reflectometer

time domain reflectometer (TDR)

A device that measures network cable characteristics such as distance, impedance, levels of radio frequency interference and electromagnetic interference, connector and terminator problems, and the presence of opens and shorts. It uses radar-like principles to determine the location of metallic circuit faults.

total cable loss (TCL)

Signal attenuation due to the transmitting cable's size, length, impedances, or other characteristics. *See* estimated measured loss.

TIMS

Transmission impairment measurement set

VF

Voice frequency

visual display unit (VDU)

voice frequency (VF)

The band of frequencies from 300 Hz to 3400 Hz used for telephony transmission. This band of frequencies is known commonly as the commercial speech band.

VOM

Volt-ohmmeter

DMS-100 Family

Business Set Line Engineering

Maintenance Manual

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