DIGITAL SWITCHING SYSTEMS

DMS*-100 FAMILY DATAPATH*

LINE ENGINEERING GUIDELINES

FOR TWO-WIRE LOOPS

BCS24 AND UP UNLESS REISSUED

CONTENTS

CHAPTER 1

ABOUT THIS DOCUMENT

PURPOSE

This document contains specifications for Datapath two-wire loops between the data line card in the line concentrating device, and the data unit at the subscriber’s premises. These specifications have been developed to provide a method of achieving good overall transmission performance and preventing interference to existing sensitive services.

In a majority of installations, the data unit will function properly on the two-wire loop. However, there are a number of factors that may affect the two-wire loop. This document provides a description and specification for each of these factors.

Datapath service may be affected by one, or a combination of the factors described in this document.

TABLE 1.1
WHERE TO FIND RELATED INFORMATION IN OTHER DOCUMENTS

FOR	SEE
a system description of the DMS-100 switch	297-1001-100
data unit installation procedures	297-2121-226
a description of the data unit hardware	GS4X25
a description of the data line card hardware	GS6X71

APPLICABILITY OF THIS DOCUMENT

The information in this document applies to offices that have batch change supplement release 24 (BCS24) software.

Unless the document is reissued, it also applies to offices that have software releases greater than BCS24.

DETERMINING THE BCS AND NT FEATURES IN YOUR OFFICE

The Northern Telecom (NT) feature packages that are available in a specific office are associated with a BCS. To determine the BCS and NT features in your office, refer to the Office Feature Record D190; or enter the following command string at a MAP* (maintenance and administration position).

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> PATCHER;INFORM LIST;LEAVE
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For a list of all available NT feature packages, refer to the provisioning guidelines in Section 32 of 297-1001-450.

* MAP is a trademark of Northern Telecom.

CHAPTER 2

FACTORS AFFECTING TWO-WIRE LOOPS

OVERVIEW

Datapath has been designed to function over most two-wire loops. However, there are a number of factors that may affect two-wire loops and cause problems with Datapath service. These factors are the subject of this chapter.

Datapath service is best provided by connecting the data unit to the two-wire loop, then verifying the operation. You can then evaluate Datapath transmission using external test equipment, or by applying tests at the LTP level of the MAP.

Factors that may affect Datapath transmission

Problems with Datapath service may be caused by one or a combination of these factors:

* Propagation delay on page 2-2
* Signal loss on page 2-3
* Bridge taps on page 2-5
* Impulse noise on page 2-7
* Background noise on page 2-9
* Foreign voltage on page 2-10
* Resistance on page 2-11
* Inductive and capacitive devices on page 2-12

PROPAGATION DELAY

Explanation

Propagation delay is the length of time a signal takes to travel between two points of a transmission medium.

The length of the two-wire loop affects the propagation delay of the Datapath signal. The maximum loop length of the two-wire Datapath loop is limited by the one-way propagation delay between transmitted bursts of data and received bursts of data.

To measure the propagation delay, use external test equipment connected to the loop.

Specification

The one-way propagation delay must be less than or equal to 31.25 ˚s. To allow for uncertainty as to the length of the loop, use a propagation delay of 30 ˚s.

To meet the specified delay of 30 ˚s, limit the length of the two-wire loop to no more than 5.5 kilometers (18 kft). Although some cables allow for a propagation delay of less than 31.25 ˚s, the 45 dB signal loss is the limiting factor (see Signal loss on page 2-3).

Table 2.1 lists the specifications for propagation delay.

TABLE 2.1
PROPAGATION DELAY SPECIFICATION

PROPAGATION DELAY	MAXIMUM LOOP LENGTH
31.25 ˚s	5.5* kilometers (18 kft)

<u>Note:</u> * To meet the signal loss limit of 45 dB, limit the length of 26 AWG cable in a two-wire loop to 4.0 km.

SIGNAL LOSS

Explanation

Signal loss is the difference, in decibels, in signal levels between the data line card and the data unit.

Signal loss is affected by the gauge and length of the two-wire loop.

Specification

The signal loss on the Datapath two-wire loop must be less than or equal to 45 dB at a frequency of 80 kHz and an operating temperature of 21^{0} C. For colder operating temperatures during the winter, the signal loss must be less than or equal to 40 dB at a frequency of 80 kHz.

Table 2.2 shows the maximum length for each gauge of cable.

TABLE 2.2
SIGNAL LOSS SPECIFICATIONS

CABLE GAUGE (AWG)	MAXIMUM LENGTH FOR 45 DB LOSS
19	5.5 km
22	5.5 km
24	5.5 km
26	4.0 km

Note: Although some cable gauges allow for a distance of more than 5.5 kilometers, the 31.25 ˚s propagation delay is the limiting factor (see Propagation delay on page 2-2).

Table 2.3 shows the loss (in decibels) for each kilometer of paper-insulated cable, filled polyethylene-insulated cable (PIC), or air PIC. To determine the loss of a given loop configuration, measure the frequency response of the loop from 50 Hz to 210 kHz with a 135-ohm termination. The loss should increase smoothly as the frequency increases. The loss deviation for small increases in frequency must not exceed 0.1 dB.

All values in Table 2.3 are for a Nyquist frequency of 80 kHz.

TABLE 2.3
SIGNAL LOSS FOR EACH KILOMETER OF CABLE

CABLE TYPE	26 AWG	24 AWG	22 AWG	19 AWG
paper	10.4 dB	7.45 dB	5.18 dB	3.74 dB
filled PIC	10.04 dB	6.76 dB	4.69 dB	2.95 dB
air PIC	10.34 dB	7.21 dB	5.12 dB	3.34 dB

BRIDGE TAPS

Explanation

A bridge tap is a branch of two-wire cable that is connected to the two-wire loop at one end, and is open (unterminated) at the other end.

Bridge taps cause signal loss in the attached cable under two conditions:

* There is an impedance discontinuity at the point where the cable is attached to the two-wire loop.

* The impedance mismatch presented by the unterminated end of the bridge tap reflects the signal back to the two-wire loop.

The length of a bridge tap and the quantity of bridge taps determine how much signal rejoins the two-wire loop, and at what time relationship to the transmitted signal the reflections rejoin the two-wire loop.

Bridge taps are acceptable within certain limits because the Datapath system distinguishes and masks most interfering signals. If the length and quantity of bridge taps are not within the limits described below, they can produce reflected signals that interfere with the original signal.

Specification

Short bridge taps must be less than 1 kilometer each. When added, they must not exceed a total length of 1.25 kilometers.

Long bridge taps must be more than 1.5 kilometers in length.

Do not use bridge taps between 1.0 kilometer and 1.5 kilometers in length on a Datapath two-wire loop.

Table 2.4 on page 2-6 lists the specifications for bridge taps.

TABLE 2.4
BRIDGE TAP SPECIFICATIONS

BRIDGE TAP	LENGTH
Short	less than 1 km
Long	more than 1.5 km
Prohibited	between 1.0 and 1.5 km

Table 2.5 shows signal loss versus bridge tap length. To obtain the total loop loss, add the individual bridge tap losses, then subtract this amount from 45 dB.

TABLE 2.5
APPROXIMATE SIGNAL LOSS VERSUS BRIDGE TAP LENGTH

BRIDGE TAP LENGTH	SIGNAL LOSS IN DB
100 meters	0.9 dB
200 meters	2.25 dB
300* meters	3.5 dB
400 meters	3.5 dB
500 meters	3.5 dB

Note: * From 300 meters on, the loss remains constant at 3.5 dB.

IMPULSE NOISE

Explanation

Impulse noise is a type of cross talk that occurs when a digital signal with relatively high power induces voltage spikes into other loops in the same cable.

The effect of impulse noise diminishes as the loop length decreases. Therefore, impulse noise is not a consideration on short loops.

To measure impulse noise, use a wide-band test set with 136-kilo-Hertz time compression multiplex (TCM) weighting.

Specification

To prevent Datapath two-wire loops from interfering with other loops in the same cable, service coordination may be required, as follows:

* Put AML-1 carriers in a separate cable.

* Put Anaconda S6A in a binder group that is not adjacent to the Datapath binder group.

* Put N carriers in a separate cable.

* A high binder fill of 88% to 99% can cause interference problems with a 15-kiloHertz program channel. To correct the problem, put the Datapath two-wire loops in a separate cable; or reduce the maximum loss of the 15-kiloHertz program channel by 1 dB.

The impulse noise specifications that are listed here are based on a 136-kiloHertz TCM weighting, a blanking time of 25 ˚s, and a bit error rate of 4 x 10›^{8} .

When measuring the impulse noise with external test equipment, ensure that the number of impulse noise counts over a 15-minute interval do not exceed the following:

* 19 counts at a threshold level of 49 dBrnT
* 5 counts at a threshold level of 55 dBrnT

Table 2.6 on page 2-8 lists the specifications for impulse noise.

TABLE 2.6
IMPULSE NOISE SPECIFICATIONS

MAXIMUM NOISE COUNT OVER 15-MINUTE INTERVAL	THRESHOLD LEVEL
19	49 dBrnT
5	55 dBrnT

BACKGROUND NOISE

Explanation

Background noise is the wideband random ambient noise that is associated with a transmission system.

If the background noise exceeds the specified level, the Datapath signal can be affected.

The effect of background noise diminishes as the loop length decreases. Therefore, background noise is not a consideration on short loops.

Specification

With a 100-kiloHertz flat weighting, the background noise must be as follows:

* less than 36 dBrn for 9.6-kilobit/s data transmission
* less than 32 dBrn for 19.2-kilobit/s data transmission

Table 2.7 lists the specifications for background noise.

TABLE 2.7
BACKGROUND NOISE SPECIFICATIONS

DATA RATE	MAXIMUM NOISE LEVEL
9.6 kb/s	less than 36 dBrn
19.2 kb/s	less than 32 dBrn

FOREIGN VOLTAGE

Explanation

Foreign voltage is voltage that appears on the two-wire loop but is not put on the loop by the Datapath system.

Some examples of foreign voltage on the two-wire loop are:

* an AC voltage induced onto the loop from an adjacent parallel run of commercial hydro power

* a DC voltage conducted through a wet cable

Specification

Use the information in Table 2.8 to determine the maximum allowable foreign voltages for tip to ring, tip to ground, and ring to ground.

TABLE 2.8
FOREIGN VOLTAGE SPECIFICATIONS

LOCATION	MAXIMUM ALLOWABLE VOLTAGE
Tip to ring	less than or equal to 1 V ac less than or equal to 1 V dc
Tip to ground	less than or equal to 50 V ac less than or equal to 1 V dc
Ring to ground	less than or equal to 50 V ac less than or equal to 1 V dc

RESISTANCE

Explanation

Loop and insulation resistance affect the amplitude of the Data-path signal.

Loop resistance is the resistance of the pair of wire conductors that extend from the data unit to the data line card. Cable gauge and length affect the loop resistance.

Insulation resistance is the resistance to current flow offered by the insulation of the cable.

Specification

The resistance of the loop must be less than 1500 ohms. The resistance of the insulation must be more than 500 kohms.

Table 2.9 lists the specifications for loop and insulation resistance.

TABLE 2.9
RESISTANCE SPECIFICATIONS

RESISTANCE TYPE	VALUE
Loop resistance	less than 1500 ohms
Insulation resistance	more than 500 kohms

INDUCTIVE AND CAPACITIVE DEVICES

Explanation

Inductive and capacitive devices such as loading coils, bridge lifters, and build-out capacitors are often used to condition analog lines. These devices are unacceptable on Datapath two-wire loops.

To detect and locate loading coils on the loop, use a time domain reflectometer, or measure the characteristics of the insertion loss.

Specification

Inductive and capacitive devices severely attenuate the Datapath signal. Do not use these devices on Datapath two-wire loops.

Table 2.10 lists the resistance specifications.

TABLE 2.10
INDUCTIVE AND CAPACITIVE DEVICES

DEVICE	REQUIREMENT
loading coil	not allowed
bridge lifter	not allowed
build-out capacitor	not allowed

CHAPTER 3

ABBREVIATIONS

ABBREVIATION LIST

AWG	American wire gauge
BCS	Batch change supplement
BER	Bit error ratio
DLC	Data line card
DMS	Digital multiplex system
DU	Data unit
EMF	Electromotive force
LCM	Line concentrating module
LTP	Line test position
MAP	Maintenance and administration position
Paper	Paper insulated cable
PIC	Polyethylene insulated cable
Pulp	Pulp insulated cable
TCM	Time compression multiplex