DMS-1* DIGITAL MULTIPLEX SYSTEM

PERFORMANCE SPECIFICATION

CONTENTS PAGE

1. GENERAL

1.01 This section lists the performance specifications for the DMS-1 system. The specifications include:

- limits on environment during operation and storage
- power requirements
- input and output signal characteristics
- signal levels
- interface parameters to equipment external to DMS-1
- DMS-1 alarms
- DMS-1 protection switching.

1.02 *Reason for Reissue.* To add new and revised information. Changes are not marked by arrows in the margins.

1.03 The DMS-1 is a digital carrier system which provides service for up to 256 telephones subscriber lines on the 48 channels of two DS1 digital transmission lines.

1.04 The system consists of:

- a Control Concentrator Terminal (CCT) located in a class 5 switching office
- one through four Remote Concentrator Terminals (RCT) located near groups of subscribers
- up to three (two working and one protection) DS1 digital transmission lines, with standard order-wire and fault-locate facilities, interconnecting the CCT and RCT.

1.05 The DMS-1 system performs the following basic functions:

- codes vf and signaling information from subscriber lines into 1.544 Mb/s digital signals for transmission over DS1 digital lines
- decodes digital input signals into vf, signaling, and control information for subscriber vf drops
- provides alarm outputs to the office major and minor alarm system
- provides protection switching for DS1 digital lines.

1.06 The DMS-1 system is compatible with most types of local switching centers without modifications to the switching machines, or sleeve lead extensions.

1.07 The specifications listed in this document, unless otherwise indicated, apply to both CCT and RCT.

* DMS-1 is a trademark of Northern Telecom Limited

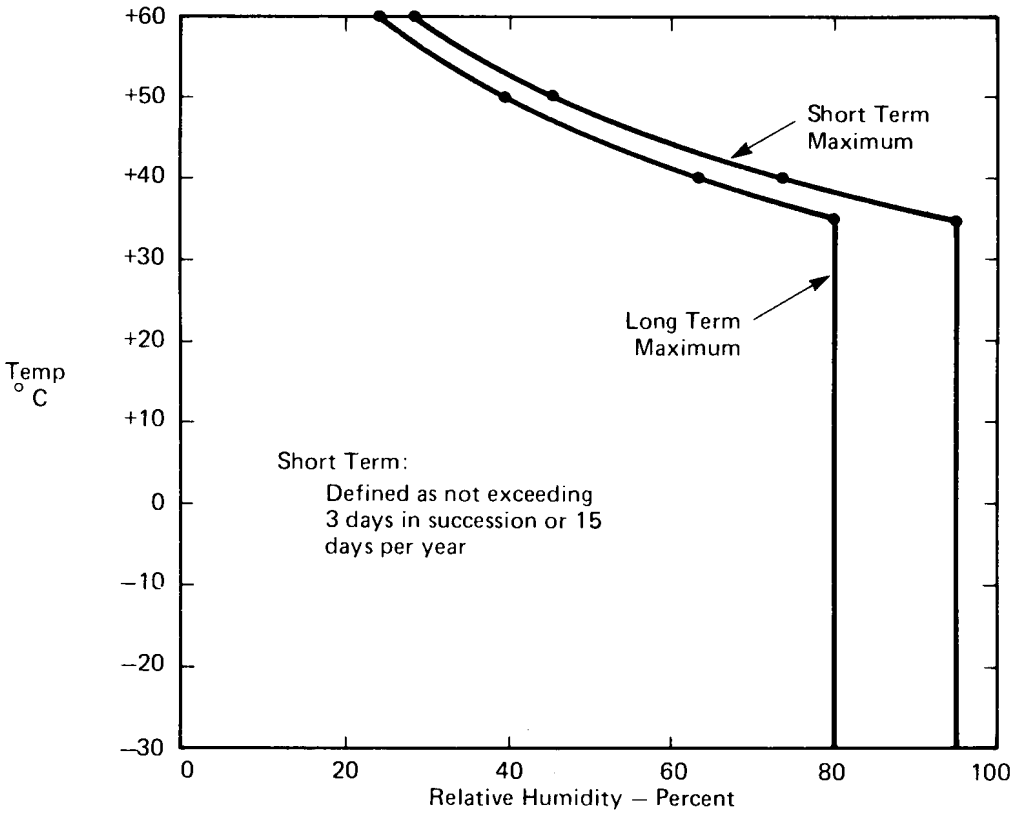


Fig. 1 — Humidity vs Temperature

2. SYSTEM SPECIFICATIONS

System capacity: 256 subscriber lines

Channel capacity: 48 channels maximum (24 per digroup)

Modulation: Pulse Code Modulation

Multiplexing: Time division

Maximum CCT to RCT distance:
1 RCT 65 miles (105 km)
4 RCT 42 miles (68 km)

Note: Intermediate power points are required beyond 25 miles on 22-gauge cable.

Maximum difference in length between digroup A and digroup B lines between two terminals: 5 miles (8 km)

3. ENVIRONMENTAL SPECIFICATIONS

A. Physical

3.01 The DMS-1 system is designed for operation within the following limits:

Temperature:

	CCT	RCT
Lower Limits:		
Operating:	0°C	0°C (Note)
Storage:	−50°C	−50°C
Upper Limits:		
Operating and Storage:	+50°C	+60°C

Note: For cabinet-mounted RCT (heated cabinet), the outside temperature range is between −40°C and +60°C.

Relative humidity: See Fig. 1

Maximum altitude: 15 000 feet (4600 m)

B. Electrical

Battery Power Source:

Voltage:

CCT	−50±6 V
RCT	−54 V (+10, −2 V) (with J7209C-1 Power bay)

Noise:

From battery	56 dBrnc maximum, with a maximum single-tone level of 300 mV rms
To battery	36 dBrnc maximum into a 180 Ah battery

End-cell Switching:	±2 V at a rate of change of 0.1 V/μs maximum

AC Power Source — RCT:

Voltage	115 V +15, −20 V, or 230±30 V
Frequency	60±5 Hz

Battery Power Source — RCT (J2357E Rectifier):

Voltage	55 V with gelled electrolyte batteries
Current	25 A maximum
Low-Voltage Alarm	47±1 V
Over-Voltage Shutdown (operates circuit breaker)	58.5±1.5 V
Low-Voltage Shutdown (disconnects load from batteries)	43±1 V

Current and Fuse Requirements — CCT, RCT:	Reference 363-2011-150

Induction:

60 Hz Steady-State, Longitudinal:

No degradation	10 V rms maximum
Degradation of VF transmission	30 V rms maximum
ac current, no damage limit	175 mA rms per subscriber loop per wire

60 Hz Surge, Longitudinal and Metallic:	400 V rms, 1 second on, 2 seconds off, 3 times
Lightning, Longitudinal and Metallic:	1-kV peak, with no external protection
Waveform Rise Time:	10 μs from 10 to 100 percent peak
Waveform Fall Time:	1000 μs to 50 percent of peak
Source Impedance:	3 ohms minimum

4. LINE SIGNAL FORMAT

Sampling Rate:	The speech sampling rate is 8 kHz
Companding Law:	$\mu = 255$ continuous law
Voice Code:	8 bits per sample with the least significant bit modified every sixth frame for supervision and control information

Frame Format:

Frame	one 8-bit word from each of the 24 channels; plus one frame synchronizing bit per frame (a frame is 193 bits or 125 μs long)
Master frame	12 frames (1.5 ms)
Supervisory code	1 least-significant bit per channel word every odd numbered sixth frame (A bits)
Control code	1 least-significant bit per channel word every even numbered sixth frame (B bits)
Average reframe time	50 ms maximum

5. TRANSMISSION SPECIFICATIONS

A. Digital Interface (Digroup Output)

Compatibility:	DS1 signal format
Line Rate:	1.544 Mb/s ±150 b/s
Line Code:	bipolar, 50 percent duty cycle
Line Impedance:	100 ohms (nominal) at 722 Hz

Pulse Characteristics:

Peak Amplitude	6±0.6 V transmit; 1.5 to 3.0 V, receive
Width	324±30 ns at half amplitude
Minimum Density	normally 1 pulse in 8; no more than 14 consecutive zeros
Jitter	5 ns (2.8°) rms maximum, transmit; 200 ns (110°) rms maximum, receive

B. VF Interface

Test Tone:

Frequency	1004 Hz (nominal)
Level	0 dBm transmit, and −2 dBm receive; corresponding to a recurring 1-kHz digital test code of eight 8-bit words as follows:

WORD	DIGIT							
	1	2	3	4	5	6	7	8
1	1	0	0	1	1	1	1	0
2	1	0	0	0	1	0	1	1
3	1	0	0	0	1	0	1	1
4	1	0	0	1	1	1	1	0
5	0	0	0	1	1	1	1	0
6	0	0	0	0	1	0	1	1
7	0	0	0	0	1	0	1	1
8	0	0	0	1	1	1	1	0

Impedance: 900 ohms, nominal

Insertion Loss: 2±0.5 dB (initial) (±0.2 dB temperature) (±0.2 dB aging)

Overload Level: +3 dBm (+0.5, −0.7 dB) relative to the test tone level (part of tracking requirement)

Frequency Response:

FREQUENCY (Hz)	LEVEL RELATIVE TO TEST TONE LEVEL (dB)
60	−20 minimum
300 to 3200	+1 to −3
600 to 2400	+1

Idle-Channel Noise: 20 dBrnc0 maximum; 23 dBrnc0 maximum with 30 V rms of longitudinal 60 Hz and harmonics

Impulse Noise:

THRESHOLD (dBrnc)	IMPULSE COUNTS (in 5 minutes)	PERCENT OF LINES MEETING SPECIFICATIONS
50	5	50
50	100	100
59	5	100

Note: With dial pulsing 60 percent break on three lines and interrupted 20-Hz ringing on one line on the same line shelf (2 seconds on, 4 seconds off).

Level Tracking:

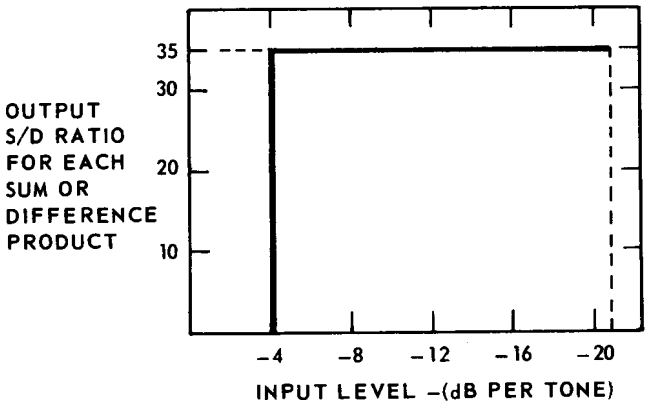
INPUT AT 1 kHz (dBm)	OUTPUT DEVIATION (dB)
+3 to −37	+0.5 to −0.7
−37 to −47	+1.0 to −1.5
−47 to −57	±3.0

Harmonic Distortion: −40 dBm maximum, at 2 and 3 kHz

Foldover Distortion: Input of 0 dBm at 0 through 12 kHz

OUTPUT LEVEL (maximum)	FREQUENCY
−25 dBm	0 to 3.6 kHz and 4.4 to 12 kHz
−22 dBm	3.6 to 4.4 kHz

Intermodulation Distortion: Two test tones, f1 = 740 Hz and f2 = 1255 Hz, applied simultaneously to the input of any line, produce intermodulation distortion as follows:



Quantizing Distortion:

INPUT (dBm)	SIGNAL-TO-QUANTIZING DISTORTION RATIO (dB C-Message)
0 to −30	33
−30 to −40	27
−40 to −45	22

Sampling Frequency Leak at 8 kHz: −50 dBm maximum

Crosstalk Coupling Loss: −67 dBm maximum C-message weighted, with 0 dBm test tone on any other line

Longitudinal Balance (IEEE Method):

FREQUENCY (Hz)	MINIMUM BALANCE (dB)
60	40
200	51
1000	59
3000	65

Return Loss:

echo	18 dB minimum against 900 ohms + 2.16 μF
singing	15 dB minimum against 900 ohms + 2.16 μF

Envelope Delay Distortion: 100 μs maximum for 1.0 to 2.4 kHz

Reorder Tone:

Frequencies	480 and 620 Hz
Tone levels	−24 dBm (−21 dBm combined output)
Interrupt rate	2 Hz
Duty cycle	50 percent
Application time	12 to 24 seconds

Local Link Detector Tones:

Frequencies	2413 Hz and 2902 Hz
Level	−26±5 dBm
Application time	450 ms, maximum
Hold-off time for ring trip	200 or 400 ms (switch option)

6. SIGNALING SPECIFICATIONS

A. Remote Concentrator Terminal

Subscriber Loop Resistance: 1900 ohms maximum, excluding the subscriber sets (battery at −54 V dc; temperature 23±5°C; ac and dc foreign EMF less than 1.0 V)

1300 ohms (battery at −44 V dc; temperature at −40 or +60°C; ac and dc foreign EMF less than 30 V)

Current from RCT: 115 mA dc maximum (short circuit)

21 mA dc minimum (1900-ohm loop)

Voltage from RCT:

Battery	−54 V (+10, −2 V) (with J7209C Power bay) +54 V maximum at 200 mA maximum
Coin collect	+130 V maximum at 100 mA maximum
Coin return	−130 V maximum at 100 mA maximum

Ringing Voltage:

Connected at RCT	86±15 V rms, 20, 25, or 30 Hz (superimposed on −48 V battery 71 to 101 V rms, 20 Hz (superimposed on +54 V − superimposed ringing) 300 V dc chopped at a 16 to 67 Hz rate (frequency selective)

Number of Ringers:

Divided ringing	5 per tip, 5 per ring maximum
Superimposed Ringing	3 per polarity, per conductor
Bridged ringing	3 per loop maximum
Simultaneous ringing	20 ringers per system maximum

Dial Pulsing:

Rate	10±2.5 pps
Distortion (measured at the CCT)	40 to 70 percent (58 to 64 percent with QPP440B); with 60 percent break at RCT and 'A' leak on 0 to 1500 ohm loop

Note: Under test conditions continuous pulsing without an interdigit gap may cause a working channel to be taken down with resultant interruption in dial pulsing. This does not occur in normal operation.

Leakage:	15 000 ohms minimum; tip to ground, or ring to ground
Automatic Number Identification (ANI):	2800 ohms, maximum 1000 ohms, minimum
ANI Resistance Presented to CCT Line:	2550±100 ohms 1500±100 ohms for superimposed ring
Coin Ground:	1300 ohms maximum 950 ohms minimum
Coin Ground Resistance Presented To CCT Line:	1150±100 ohms

B. Control Concentrator Terminal

CCT Line Terminating Resistance:

off-hook	760±80 ohms
on-hook	80 to 100k tip-ring simplexed to ground tip to ground, ring grounded ring to ground, tip grounded

Voltage from Switching Equipment to CCT:

Note: The unrung side of the line must be grounded, with no simultaneous ringing on tip and ring conductors.

dc voltage	60 V dc maximum, tip to ring
20, 25, 30 Hz Ringing	74 to 115 V rms, (superimposed on 48 V battery)
Coin Supervisory Signaling	±130 V tip-to-ground, ring open; or ±130 V tip and ring, simplexed to ground

Frequency Selective Ringing:

Frequency	16.7 to 66.7 Hz
Voltage	90 to 155 V
Revertive Ringing	gap between ringing signal ⩾ 0.5 seconds
Ringing Waveshape	harmonic distortion <30%
dc pulsing	±250 V dc, maximum; tip to ground, or ring to ground, or tip-ring simplexed to ground

Superimposed Ringing:

Frequency	20 Hz
ac Voltage	75 to 101 V rms
dc Voltage	±(35 to 56) V dc
Peak to rms Ratio	1.4 to 1.5

7. PROTECTION SWITCHING

Switch Initiation:

Bipolar violation rate	< 10^{-4} errors/bit for 50 ms
signal loss	< 40 ms
Switching Time:	50 ms/section; maximum (from signal loss to restoration)

Bypass:

delay	40 ms
operate	10 ms

Loopback:

CCT control delay	1 second
operate	0.25 second/section

Switch Release Delay:

one-for-two	10 seconds
one-for-n	10 to 80 seconds, selectable

8. TRAFFIC

Recorder Output:

current	80 mA maximum from −60 V maximum
ground pulse length	100 ms
count rate	5 pps maximum (50 percent duty cycle)

9. ALARMS

Office Alarm Output:

major	three contacts, closure to isolated return
minor	three contacts, closure to isolated return

Contact Voltage Rating: 60 V maximum

Contact Current Rating: 100 mA dc maximum

10. SUBSCRIBER LINE TESTS

Measurement Ranges:

ac volts	0 to 150 V rms
FEMF (dc)	−60 to +60 V
Resistance	0 to 750k ohms
Capacitance	0 to 5 μF

11. SUBSCRIBER LINE TEST EXTENSION

Bypass Termination: +100 V or greater for more than 1 second (5 seconds for coin lines)

Bypass Release: −100 V or greater for more than 1 second (5 seconds for coin lines

Bypass Release Detector: Shunt resistance 4.5 megohm minimum

Automatic Bypass Release Timeout: 10 minutes