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**Specification of
Digital Modem(nX64Kbps) upto 2 Mbps
(Line Driver)**

SPECIFICATION NO. RDSO/SPN/TC/80/2020

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**TELECOM DIRECTORATE
RESEARCH DESIGNS & STANDARDS ORGANISATION
Manak Nagar,
LUCKNOW-226011**

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I. SUMMARY:

This document covers the technical requirements of Digital Modem(nx64Kbps) upto 2 Mbps to be connected to Indian Railways telecommunication network.

II. SOURCE:

1. Specification RDSO/ SPN/ TC/ 80 /2008, Rev 0.0 have been prepared by RDSO, Lucknow as per Railway Board letter No. 2006/Tele/TC/1 dated 28/07/2008.
2. Revision 1.0 of the specification RDSO/ SPN/ TC/ 80 /2013, Rev 1.0 have been prepared by RDSO, Lucknow as per Railway Board letter No. 2010/Tele/9(3)/1, dated 15.03.2012
3. Revision 2.0 of the specification RDSO/ SPN/ TC/ 80 /2020, Rev 2.0 have been prepared by RDSO, Lucknow as per DG/RDSO letter No. DG/Misc. dated 10.06.2020.

III. FOREWORD:

This specification requires the reference to the following specifications:

ITU-T Recommendation K.20/ K.21	Line Interface Protection
ITU-T Recommendation G.703/ V.35/ V.36	Physical/Electrical Characteristics of Hierarchical Digital Interfaces.
IEEE 802.3	Physical/Electrical Characteristics of Hierarchical Ethernet Interface.
IEC 1000-4-2(2001), IEC 1000-4-4, IEC 1000-4-3(2002), Class A of CISPR 22(2003), ISO 9001:2000.	Electromagnetic Compatibility (EMC) Standards.
IS 8437(1993)(equipment and IEC publication 47-9-1 (1984), IS 13252 (1992) (equipment and IEC publication 95 (1986) & 215 (1987)9.	Safety Requirements
QM 333/Issue-March 2010 or latest	Specification for Environmental Testing of Electronic Equipments for Transmission and Switching use.

Wherever, reference to any specifications appears in this document, it shall be taken as a reference to the latest version of that specification unless the year of issue of the specification is specifically stated.

**RESEARCH DESIGNS & STANDARDS ORGANIZATION MINISTRY OF
RAILWAYS
MANAK NAGAR, LUCKNOW**

Specification of Digital Modem(nx64 Kbps) upto 2 Mbps

Specification No: RDSO/SPN/TC/80/2020 (Revision 2.0)

1.0 SCOPE:

This specification lays down the technical requirements of Digital Modem(nx64) upto 2 Mbps (Line Driver) to be connected to Indian Railways telecommunication network. The local cable plant network consists of mixed gauges most of which would be of 0.5/0.63/0.9 mm. diameter copper cable. It shall be able to work satisfactorily over the copper cable network of Indian Railways. The equipment shall have built in protective arrangement for safety of the equipment.

This specification is applicable to all stand-alone or rack-mounted modems. The modems shall consists of a digital interface as defined in clause 2.1 and a line interface as defined in clause 2.2. The schematic representation of Digital Modem(nx64) upto 2 Mbps (line driver) is shown in figure 1.

2.0 TECHNICAL REQUIREMENTS:

2.1 Digital Interface:

2.1.1 The equipment shall support one or any combination of the following digital interface/s. The interfaces should be plug-in type and field upgradable.

2.1.1.2 2048 Kbps structured with Nx64 Kbps (N=1 to 30) as per ITU-T Rec. G.704 with 120 ohms balanced having following minimum characteristics.

Interface	: E1 Interface as per ITU-T G.703, G.704
Line Rate	: 2048 Kbps
Line Code	: HDB3
Impedance	: 120 Ohms (balanced)
Connector	: RJ45
Clock Mode	: Internal clock or G.703 recovered clock
Frame	: Framed and unframed operation
CRC	: User selectable CRC-4 generation and detection

2.1.1.3 V.35/V.36 having following minimum characteristics.

Interface	: V.35/ V.36
Connector	: 34 Pin Female connector
Data Rate	: nx64 Kbps (n=1 to 32)
Clock Mode	: Internal clock or line recovered clock, External clock

2.1.1.4 IEEE 802.3/Ethernet 10/100-Base-T-supporting bridging capability having following minimum characteristics.

- Interface : Ethernet
- No. of ports : 2 or 4
- Connector : RJ45
- Speed : 10/100 Base-TX
- MAC addresses level filtering.
- Transparent Ethernet Bridge, Auto learning and aging.
- Auto speed sensing and auto polarity detection.

2.1.1.5 64 Kbps Co-directional as per ITU-T Rec.G.703 with 120 ohms balanced having following minimum characteristics.

- Speed : 64 Kbps
- Line Code : AMI
- Connector : RJ45 or Terminal Block
- Clock Mode : Internal or G.703 Recovered clock

2.1.2 The speed/s supported at digital interface/s shall be with any combination/s of 64 Kbps between 64 Kbps to 2048 Kbps.

2.1.3 The modems shall be able to configure it's transmit clock either from the Data Terminal Equipment (DTE) (External), driver (Internal) or incoming received data (slave) as per the requirement of the type of digital interface. The receive clock shall be recovered clock from incoming received data.

2.2 Line Interface:

2.2.1 The modem may work on single or multiple copper pairs. The number of pairs against highest bit rate of digital interface/s and maximum distance of copper loop shall be specified.

2.2.2 The modem should work up to 5.5 Kms at 2048 Kbps on 0.5 mm dia. copper conductor (unloaded) on G.SHDSL based technology.

2.2.3 The modem should work up to 10 Kms at 64 Kbps on 0.5 mm dia. copper conductor (unloaded) on G.SHDSL based technology.

2.2.4 The line coding adopted shall meet all the requirements of this specification. The vender shall provide the complete details for technology used at line interface.

2.2.5 The upper bound of the power spectral density at 2 Mbps shall be limited to as per following:

- 100 KHz : - 28 dB
- 250 KHz : - 28 dB
- 500 KHz : - 43 dB
- 700 KHz : - 45 dB

2.2.6 The line interface shall have a nominal impedance of 135 ohms with tolerance, subject to minimum return loss of the equipment shall be better than 15 dB up to the Nyquist frequency depending on maximum baud rate of the driver on line interface for both transmitter and receiver.

- 2.2.7 The minimum longitudinal loss of the equipment shall be better than 45 dB up to the Nyquist frequency depending on baud rate of the modem on line interface of both transmitter and receiver.
- 2.2.8 The modem shall have a minimum resistance to common earth of 5 Mega Ohms on each limb.
- 2.2.9 The protection measures against over voltages and over currents as specified in ITU-T rec. K.20 and K.21 shall be provided on line interface.

2.3 Tests and Loop-back Facilities:

- 2.3.1 Loop backs, pattern generation, configuration and status monitoring shall be through switches /LCD or through SNMP (Simple Network Management Protocol) and TELNET using Ethernet Management port.
- 2.3.2 The driver shall be able to activate loopback diagnostics as per ITU-T V.54 standard as given below:
 - (i) Local Analog Loop test (for self test of modem).
 - (ii) Local Digital Loop test (to provide loop test to the remote modem on local loop).
 - (iii) Remote Digital Loop test (to take Loop test from the remote modem on local loop) without requiring the manual assistance of any personnel at remote end.
- 2.3.3 Built in BERT (Bit Error Rate Tester) for test pattern generation and checking shall be available.
- 2.3.4 Embedded Operation Channel (EOC) for controlling and monitoring the remote unit, without interfering with the data transmission in compliance with ITU-T G.991.2 requirements shall be available
- 2.3.5 The facility of remote rebooting/resetting should be provided in modem so that it can be rebooted from NMS using SNMP/Telnet, without the need for sending a person to physically reboot, in case it hangs due to some reason.

2.4 Performance Test:

- 2.4.1 The equipment shall be able to work over copper loops without any repeater with a zero BER (Bit Error Rate) measured in any 15 minute interval for the full length of the loop (5.5 Kms. at 2048 Kbps and 10 Kms. at 64 Kbps).

2.4.2 Environmental / Climatic Test

2.4.2.1 The equipment shall meet the following climatic and environmental requirements:

SN	TEST	REFERENCE
1.	Cold test	Category –B2 of QM-333
2.	Dry heat test	-- do --
3.	Damp heat test (Cyclic)	-- do --
4.	Rapid temperature cycling test	-- do --
5.	Damp heat test (Steady state storage)	-- do --
6.	Vibration test	-- do --
7.	Drop and topple test	-- do --

2.5 The following items shall be specified in the Type Approval Certificate:

- 2.5.1 Digital interface/s supported in the equipment as per Clause 2.1.
- 2.5.2 Whether single pair, 2 pair or multiple pair working as per Clause 2.2.1.
- 2.5.3 Highest bit rates of the digital interfaces supported as per Clause 2.2.1.
- 2.5.4 Maximum distance of copper loop over which highest bit rate can be driven for each of the digital interfaces as per Clause 2.2.1.
- 2.5.5 MAC addresses range of the manufacturer if it supports Ethernet interface as per the requirement of Clause 2.1.1.5.

3.0 GENERAL REQUIREMENTS:

3.1 Electromagnetic Compatibility (EMC):

The modems(nx64Kbps) shall conform to the EMC requirements as per the following standards and limits indicated therein: B test certificate and test report shall be furnished from test agency. The test agency for EMI/EMC compliance shall be accredited one and details of accreditation shall be submitted.

- 3.1.1 Conducted and radiated emissions:- To comply with Class A of CISPR 22 (2003) "Limits and methods of measurement of radio disturbance characteristics of information Technology Equipment".
- 3.1.2 Electrostatic discharge:- To comply with IEC 61000-4-2(2001) "Testing and measurement techniques of Electrostatic discharge immunity test" under following test levels:
 - 3.1.2.1 Contact discharge level 2 (± 4 kV)
 - 3.1.2.2 Air discharge level 3 (± 8 kV)
- 3.1.3 Fast transients common mode burst:-To comply with IEC 61000-4-4(1995 with amendment 1 (2000) and Amendment 2 (2001)) "Testing and measurement techniques of electrical fast transients/burst immunity test" under level 2 {1kV for DC power lines; 1kV for signal control lines).
- 3.1.4 Immunity:- IEC 61000-4-3(2002) "Radiated RF electromagnetic field immunity test" under Test level 2 (Test field strength of 3 V/m) for general purposes in frequency range 80 MHz to 1000 MHz and under test level 3 (10 V/m) for protection against digital radio telephones in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 2.0 GHz.
- 3.1.5 Surges Common and differential mode :- To comply with IEC 61000-4-5 (2001) "Test & Measurement techniques for Surge immunity tests" under test levels of 0.5 kV for line to line coupling and 1 KV for line to earth coupling.
- 3.1.6 Radio frequency common mode:- To comply with IEC 6100-4-6(2001) "Immunity to conduct disturbances, induced by radio frequency fields" under the test level 2 (3 V rms); Clamp injection method for DC lines and Signal control lines.

Note: For tests for checking compliance to above EMC requirements, the method of measurements shall be in accordance with corresponding relevant Euro Norms or the above IEC/CISPR standards subject to the condition that frequency range and test level are met as per above mentioned sub clauses 3.1.1 to 3.1.6. The details of IEC /CISPR and corresponding Euro Norms are as under:

IEC/CISPR	Euro Norm
CISPR	EN5 5022
IEC61000-4-2	EN61000-4-2
IEC61000-4-3	EN61000-4-3
IEC61000-4-4	EN61000-4-4
IEC61000-4-5	EN61000-4-5
IEC61000-4-6	EN61000-4-6

3.2 Safety Requirements:

- 3.2.1 The operating personnel shall be protected against shock hazards as per IS 8473 (1993) –Guide on the effects of current passing through the human body (equivalent) to IEC publications 479-1(1984).
- 3.2.2 The equipment shall conform to IS 13252 (1992) –Safety of information technology equipment including electrical business equipment (equivalent to IEC publication 95 (1986) and IEC 215 (1987)). Safety requirements of radio transmitting equipments (for Radio equipments only).

3.3 Other Requirements :

- 3.3.1 The modem's hardware/software shall not pose any problem due to changes in date and time caused by events such as changeover or millennium/century, leap year etc. in the normal functioning.
- 3.3.2 Wherever, the standardized documents from ITU-T, IETF, FR forum etc. are referred, the latest issues and number with the amendments and addendum shall be applicable.
- 3.3.3 Digital modem shall be capable of operating on built in AC 230 V \pm 10%, 50 Hz as well as DC 48V (In the range of 40V to 60V DC) but not simultaneously. Type of power supply (AC or DC) shall be specified by purchaser at the time of procurement.
- 3.3.4 The modem shall support following minimum management / diagnostic features:
a) Front Panel indications for PWR (Power), DATA (Transmit/Receive Data), TEST (To indicate test mode), SYNC (Status of DSL line / E1), AIS, ALARM / Error.
b) System status, configuration, diagnostics using LCD Display & push buttons.
- 3.3.5 The supplier / manufacturer shall manufacture the equipment locally in India with international quality standards ISO 9001 for which the manufacturer shall be duly accredited. The quality plan describing the quality assurance system followed by the manufacturer shall be submitted.

4.0 TEST PROCEDURES:

- 4.1 Check up all the digital interfaces for physical and electrical specifications from document.

The following tests should be taken for the digital interface/s for which the modem has been offered for interface approval:

- 4.1.1 **G.703 Interface:** The tests should be conducted on the input and output ports at least for impedance(120 Ω) for, return loss, pulse mask, jitter and configuration of transmit clock for internal/ recovered clock etc. as defined in the ITU-T Rec. G.703 for the concerned speed.

4.1.2 **V.35/V.36 Interface:** At least the following tests should be done as per ITU-T Rec. V.36:

- (i) Type of connector,
- (ii) Pin details,
- (iii) Electrical characteristics like voltage etc.,
- (iv) Implementation of control signals like DTR, DSR, CTS, RFS for V.35/V.36 Interface,
- (v) Selection of Transmit clock for external/internal /recovered.

4.1.3 Ethernet Interface:

- a). The Ethernet testers supporting the electrical 10/100 Mbps interface should be used. The testers should be connected at the Ethernet interfaces of the both converter units. The tests should also be taken for transmitting the data transparently without any errors.
- b). Alternatively the following method can be adapted for electrical Ethernet interfaces:
 - i). Connect PC's Ethernet Port to the driver's Ethernet port.
 - ii). Configure the PC's Ethernet/ LAN Port for 10/ 100 Mbps speed and also parameters of all the other layers required for the connectivity and working with the modem.
 - iii). Connect and configure the other PC's as per above steps no. i) & ii) to the other modem.
 - iv). The modems should be configured for bridge mode connection for end to end connectivity.
 - v). Ping the other end PC's IP address. The same can be tested using FTP or other way.

- 4.2
 - i). Vendor should have testing arrangement to test return loss, power spectrum density, pulse mask, jitter & resistance to earth.
 - ii). The details for the line coding used at line interface shall be asked.
 - iii). The resistance to Earth shall be maggered at 100 V.
 - iv). The Protective Devices built inside the equipment shall be tested for safety of the equipment.

4.3 The modems shall be connected back to back and it should be checked that modems provide all the loops supported by the product. The loops shall be checked from both ends.

4.4 The performance tests should be taken connecting modems in back to in the set-up as shown in Figure 2 for all the speeds and all the interface as per clause 2.1 of interface requirements.

4.5 The certificates for compliances of EMC requirements shall be submitted from accredited lab.

4.6 The certificates for compliances of IS 8437 (1993) and IS 13252 (1992) requirements shall be submitted from accredited lab.

- 4.7 i. Check up that the latest standards of ITU-T, IETF etc., are supported and implemented.
- ii. Power supply requirements for all the components (working range, protection against short circuit & overload) should be confirmed from literature.

4.8 Check up for proper documentation for the equipment.

4.9 **Visual Inspection:** Each modem (line driver) shall be visually inspected to ensure compliance with the requirement of clause 2 & 3 of this specification. The visual inspection shall broadly include:

4.9.1 System Level Checking:

- i) Constructional details.
- ii) Dimensional check.
- iii) General workmanship.
- iv) Configuration.
- v) Mechanical polarization of cards.

4.9.2 Card Level Checking:

- i) General track layout.
- ii) Quality of soldering and component mounting.
- iii) Conformal Coating.
- iv) Legend printing.
- v) Green or Black masking.

4.9.3 Module Level Checking:

- i) Indications and displays.
- ii) Mounting and clamping of connectors.
- iii) Proper housing of cards.

5.0 TESTS:

The test procedure shall be as specified in ITU -T or IEC and approved by the testing authority.

5.1 TYPE TESTS:

5.1.1 Two sets of Modems(nx64Kbps) (Line Drivers) shall be offered for type tests so as to completely test the requirement of this specification as per Clauses 2 & 3 and test procedures mentioned in Clause 4.

5.1.2 If any one of the equipment fails in any of the type tests, the inspecting authority or his nominee at his discretion, may call for another equipment/ card(s) of the same type and subject it to all tests or the test(s) in which failure occurred. No failure shall be permitted in the repeat test(s). After successful completion type tests, these items are to be submitted to RDSO.

5.1.3 Any other test to be specified by testing authority at the time of type approval shall also be carried out.

5.2 ACCEPTANCE TESTS:

5.2.1 The following shall constitute the acceptance tests which shall be carried out by the inspecting authority for the purpose of acceptance on 20% of the lots (minimum 2 numbers of modems) offered for inspection by the supplier:

- i) Digital Interface Test (Clause 4.1)
- ii) Insulation Resistance Test (Clause 4.2)
- iii) Performance Test (Clause 4.4)
- iv) Visual inspection (Clause 4.9)

5.2.2 Any other tests shall be carried out as considered necessary by the inspecting authority.

5.3 ROUTINE TESTS:

5.3.1 The following shall comprise the routine tests and shall be conducted by manufacturer on every modem and the test results will be submitted to the inspection authority before inspection.

- i) Digital Interface Test (Clause 4.1)
- ii) Insulation Resistance Test (Clause 4.2)
- iii) Performance Test (Clause 4.4)
- iv) Visual inspection (Clause 4.9)

5.3.2 Any other tests shall be carried out as considered necessary by the inspecting authority.

6.0 QUALITY ASSURANCE:

6.1 All materials & workmanship shall be of good quality.

6.2 Since the quality of the equipment bears a direct relationship to the manufacturing process and the environment under which it is manufactured, the manufacturer shall ensure Quality Assurance Program of adequate standard.

6.3 Validation and system of monitoring of QA procedure shall form a part of type approval. The necessary plants, machineries and testing equipments required for production & quality assurance as per schedule of Technical Requirements (STR) shall be available with the manufacturer.

7.0 MARKING & PACKING:

7.1 The following information shall be clearly marked at a suitable place on each equipment:

- i) Name and Address of the manufacturer.
- ii) Month & Year of the manufacturing.
- iii) Serial number of Equipment.
- iv) Specification number.

7.2 The equipment and its subassemblies shall be packed in Florafoam boxes and the empty spaces shall be filled with suitable filling material. Before keeping in the Florafoam box, the equipment shall be wrapped with bubble sheet. The equipment shall be finally packed in a wooden case of sufficient strength so that it can withstand bumps and jerks encountered in a road/rail journey.

8.0 INFORMATION TO BE FURNISHED BY THE PURCHASER:

8.1	Type of Digital Interfaces required against clause no. 2.1	(E1 as per ITU-T G.703 or V.35/V.36 or Ethernet or 64Kbps Co-directional as per ITU-T Rec.G.703) (To be specified by the purchaser).
8.2	Power Supply requirement against clause no. 3.3.3	(AC or DC) (To be specified by the purchaser).

9.0 DOCUMENTATION:

The supplier shall provide the complete operation, maintenance and installation manuals in English for the product under test.

10.0 SCHEMATIC DIADGRAM OF VARIOUS INTERFACES AND MODEM (LINE DRIVER):

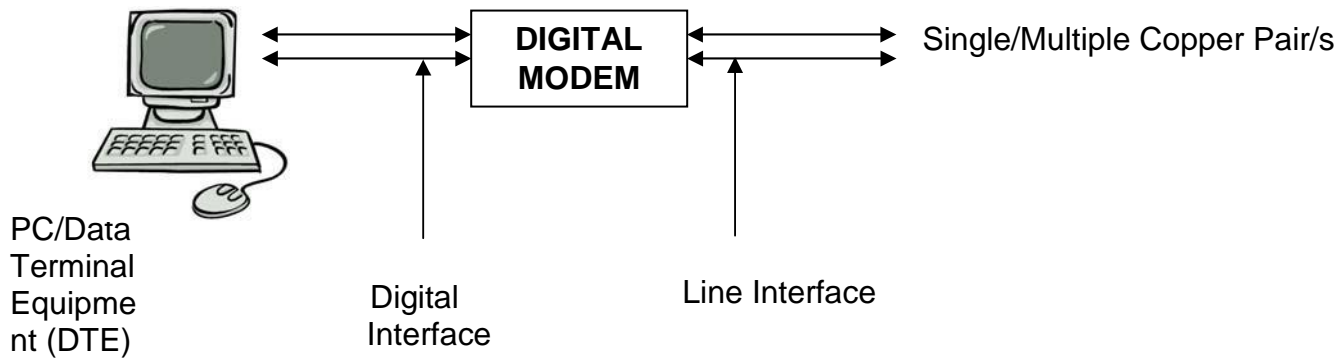


FIGURE - 1

11.0 TEST SET-UP FOR PERFORMNCE TESTING OF MODEMS:

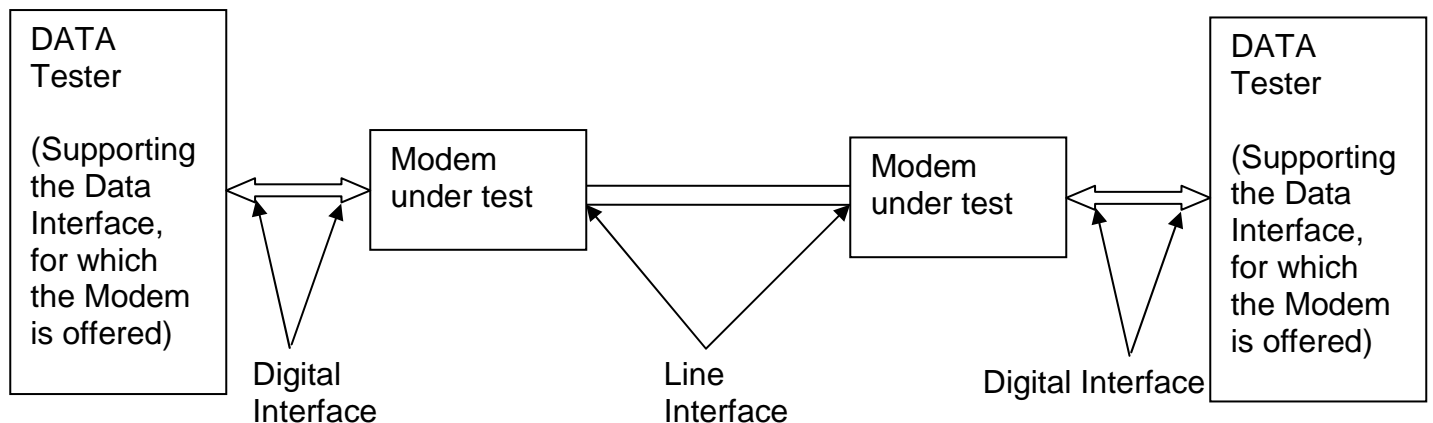


FIGURE - 2

12.0 All the provisions contained in RDSO's ISO procedures laid down in Documents No.- QO-D-8.1-11 dated 01.07.2020 (titled "Vendor-Changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways."

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