



A Division of Transnet SOC Limited

## RAIL NETWORK

## TECHNICAL SPECIFICATION

## ACCESS MULTIPLEXER EQUIPMENT

Author: Engineer  
Transmission Engineering TM Tshehla

A handwritten signature in black ink, appearing to read 'Tshehla', positioned above a horizontal dashed line.

Reviewed: Senior Technologist  
Operations & Maintenance A James

A handwritten signature in black ink, appearing to read 'A James', positioned above a horizontal dashed line.

Authorised: Principal Engineer  
Telecommunications M Mmbengwa

A handwritten signature in black ink, appearing to read 'M Mmbengwa', positioned above a horizontal dashed line.

Date: 14 December 2023

Circulation Restricted To:

Transnet Freight Rail  
Transnet and Relevant Third Parties

---

## I TABLE OF CONTENTS

I	TABLE OF CONTENTS .....	2
II	DOCUMENT CHANGE HISTORY .....	2
III	ABBREVIATIONS, ACRONYMS AND DEFINITIONS .....	2
1.	GENERAL .....	3
2.	STANDARDS .....	3
3.	OPTICAL INTERFACES .....	3
4.	LAN INTERFACES .....	4
5.	6-WIRE VOICE FREQUENCY CIRCUIT .....	4
6.	ANALOGUE SUBSCRIBER AND EXCHANGE INTERFACE .....	4
7.	DATA INTERFACES .....	5
8.	NETWORK MANAGEMENT .....	6

## II DOCUMENT CHANGE HISTORY

ISSUE NUMBER	DATE ISSUED	ISSUED BY	HISTORY DESCRIPTION
1.00	2009	TFR Transmission	This is the original version
2.00	2012-07-03	TFR Transmission	Updated and reformatted
3.00	2012-09-06	TFR Transmission	Further refinements added
4.00	2014-03-07	TFR Transmission	Split spec into Access Multiplexer and Mini Multiplexer
5.00	2023-11-03	TFR Transmission	Technology updated

## III ABBREVIATIONS, ACRONYMS AND DEFINITIONS

	DESCRIPTION
AIS	Alarm Indication Signal
BER	Bit Error Rate
FERF	Far End Receive Failure
IEC	International Electro-technical Commission
ITU-T	International Telecommunications Union
LCT	Local Craft Terminal
MSP	Multiplex Section Protection
NMS	Network Management System
OLTE	Optical Line Terminal Equipment
PCM	Pulse Code Modulation
SCADA	Supervisory Control and Data Acquisition
SFP	Small Form-format Pluggable (transceivers)

---

---

## 1. GENERAL

- 1.1 This specification covers the supply of access multiplexers for telecommunication transmission.
- 1.2 The PDH interfaces are based on the European hierarchy and voice frequency encoding is by means of PCM and based on A-law.
- 1.3 The Access Multiplexer equipment must be able to operate from a 50V DC supply, with either the negative or the positive tied to the earth, without any loss in the functionality of any of the Access Multiplexer equipment cards.
  - Sub rack. 19-inch-wide, Maximum 9 U height
- 1.4 Minimum of 5 slots available for interface cards in the sub rack, excluding the common cards (power supply, CPU, and auxiliary alarm unit).
- 1.5 The backplane switching matrix must run at a rate of at least 500 Mbit/s and be able to connect from any one port to any other.
- 1.6 Tenderers must specify the size of the TDM and packet switching matrices offered, which must be non-blocking and allow mapping between them.
- 1.7 All equipment supplied must be designed to operate without degradation under the following conditions:
  - Temperatures: from –10 to +50 Degrees Celsius
  - Relative Humidity from 0% to 95%
  - Air Pollution: dust and heavily laden saline and industrial pollutants
- 1.8 The tenderer must state his equipment's performance with respect to the following:
  - EN 60950-1

## 2. STANDARDS

- 2.1 Except where otherwise stated in this specification, all equipment must conform to the latest recommendations of the ITU-T Standards.
- 2.2 Tenderers must certify that they are familiar with these recommendations and must state all instances where their equipment offered is unable to comply.

## 3. OPTICAL INTERFACES

- 3.1 This specification covers the requirements of optical line equipment for digital transmission on two G.652.D optic fibres, operating in the 1310 nm and 1550 nm windows, and line transmission rates of 155 Mbit/s, 10/100 Mbit/s, 1GbE.
  - 3.2 Optical distances to be achieved for STM-1/4, and 1GbE based on SFP technology.
    - 0 to 25 km (short haul)
    - 25 to 40 km (medium haul)
    - 40 to 80 km (long haul)
  - 3.3 The SDH frame structure must conform to G.709
  - 3.4 The following protection schemes must be available
    - SNCP
    - MSP
-

- 
- ERPS (ITU-T G.8032)

3.5 Should the optical receiver detect no signal for a period greater than 600 ms, the laser transmitter must shut down.

3.6 Should the optical path be restored, transmission must proceed. In order to achieve this, the laser source must be activated cyclically for 1 s every 60 s, and when a valid signal is detected then normal transmission must be restored.

3.7 The minimum alarm conditions that the equipment must detect and accurately display on LCT and NMS are:

- AIS;
- FERF;
- $BER > 10^{-3}$ ;
- $BER > 10^{-6}$ ;

3.8 Fault management for SDH to conform to ITU.T G784

3.9 Fault Management for Ethernet to conform to IEEE 802.1Q

## **4. LAN INTERFACES**

4.1 Data Rates n x 64 kbit/s and 10/100/1000 Mbit/s

4.2 IEEE 802.3 Frame structure.

4.3 Interfaces required is 10/100/1000 Base-T and optical

4.4 Minimum of 2 ports per card

4.5 LED indicating the following must be on the card or visible at the NMS

- Power on
- Transmit
- Receive
- Error (Buffer overflow)

## **5. 6-WIRE VOICE FREQUENCY CIRCUIT**

5.1 These circuits are used for exchange junctions and the physical connection of radio repeaters and occupies a 64 kbit/s timeslot

5.2 This circuit must consist of two voice frequency pairs (for transmit and receive paths), and two wires for a simple on-off type of signalling. This signalling will also be used to carry the PTT function for radio repeaters.

5.3 Two or more of these ports must be able to be connected together to simulate a conference with or without PTT. This conferencing must be achievable without external devices.

## **6. ANALOGUE SUBSCRIBER AND EXCHANGE INTERFACE**

6.1 This is the conventional circuit, which connects an automatic telephone instrument to an automatic exchange and occupies a 64 kbit/s timeslot.

---

- 
- 6.2 To simulate this circuit over transmission equipment requires a different interface at either end; a SUBSCRIBER interface at the instrument end, and an EXCHANGE interface.
- 6.3 All 2-wire interfaces must incorporate inductive hybrids. The nominal impedance of the 2-wire circuit must be 600 ohms balanced and 900 ohms complex.
- 6.4 Speech current must simulate a battery supply of 50 volts. However, the speech current must not exceed 90 mA, and the minimum current provided must be 20 mA. (The line resistance, including instrument, may vary from 0 to 1500 ohms).
- 6.5 Ring current must produce a voltage of 60 to 80 volts over the two wires, in the frequency range 15 to 25 Hz
- 6.6 Ring detectors must interpret a voltage between 20 and 120 volts, in the frequency range 15 to 25 Hz, as a signal.
- 6.7 When an interface is required to produce a loop, this must be by means of placing a resistance of 0 to 1 000 ohms across the line.
- 6.8 Loop detectors must interpret a line resistance less than 1500 ohms as a loop.
- 6.9 The method of signalling between the interfaces (e.g. DTMF, tone, timeslot 16, etc.) must be compatible.
- 6.10 Input attenuation must be provided with a minimum dynamic range of 10 dB in 1 dB steps.
- 6.11 The output level must be adjustable between 0 and 8 dB in 1 dB steps.
- 6.12 The equipment must be immune to transverse potentials of 240 volts (RMS) and longitudinal potentials of 150 volts (RMS), which may exist on cables and lines for any length of time. Tenderers must specify their equipment limitations

## 7. DATA INTERFACES

The typical configuration must contain at least four interfaces.

### 7.1 V.24 Interface

- 7.1.1 The interface must be configurable for full- or half-duplex operation.
- 7.1.2 It must be possible to give local and remote loops on the analogue or digital side of the interface.
- 7.1.3 The interface must be capable of internal or external clock operation.
- 7.1.4 The interface must be selectable as a DTE or DCE
- 7.1.5 Conferencing. Conferencing must be possible without any external devices
- 7.1.5.1 Point-to-multipoint operation must be possible (conferencing).
- 7.1.5.2 Master – slave operation. Master must be operator selectable without any reprogramming.
- 7.1.5.3 The V.24 interfaces of a module in a conferencing are all equal in priority. The transmit data of each V.24 interface are forwarded to all other V.24 interfaces participating in the conference.
- 7.1.6 Asynchronous transmission with oversampling (transparent)
- 7.1.7 Transmission of data signals with frame structure in compliance with ITU-T V.110, synchronous (full-duplex) or asynchronous (transparent) with oversampling.
- 7.1.8 Data rates
- Synchronous 600 to 19,2 kbit/s
  - Asynchronous 600 to 38,4 kbit/s
-

---

#### 7.1.9 Alarms and indication

- Loss of Signal in
- Loss of Signal out
- Loss of Sync of data channel

### 7.2 V11 / X.21 Interface

7.2.1 Data rates 64kbit/s and n x 64kbit/s in compliance with the ITU V.110

#### 7.2.2 Alarms and indications

- Loss of signal in
- Loss of signal out
- Loss of sync of data channel

### 7.3 2 Mbit/s (E1 using HDB3) equipment interface

7.3.1 The port interface must be 120 ohms balanced.

7.3.2 Remote looping of individual ports must be possible

7.3.3 The LCT and NMS must indicate that the relevant E1 port has been looped

### 7.4 Auxiliary / Alarm interface

7.4.1 Typical configuration must include this module, it should contain a minimum of:

7.4.1.1 Four relay or opto-coupled contacts (typically used for door open indication)

7.4.1.2 Four Sensors

- Polarity any
- Typically used for temperature and battery level measurements

## 8. NETWORK MANAGEMENT

### 8.1 General software conditions

8.1.1 The network control software must be such that it allows the user to control, configure and monitor the system in an intuitive and user-friendly way.

8.1.2 A centralized server type management platform is required.

8.1.3 All relevant licenses must be included

8.1.4 The software must run with a multitasking operating system. The software must preferably be in a Windows type set-up. The operating systems must be Windows Server, Unix, or Linux.

8.1.5 Network data must be kept at the central server. The connection to the server must be via a client interface. At least 15 simultaneous client connections to the server must be possible.

8.1.6 The software must be such that it will prompt the user if an alarm condition occurs, irrespective of the level in which the user is busy in

8.1.7 The alarm must be in a different colour to the rest of the display and must give an audible indication.

---

- 
- 8.1.8 The network layout must be graphically displayed, and it must be possible for the user to zoom into the detail of each network element up to card/module level where the fault occurred.
  - 8.1.9 It must be possible to freely assign channels to timeslots with software in through, drop/insert, conference, point to multipoint or terminal mode without affecting other channels.
  - 8.1.10 It must be possible to change the attenuation levels of individual channels through the NMS.
  - 8.1.11 It must be possible to specify the required clock synchronisation source and a list of priorities in the event of clock source failing.
  - 8.1.12 It must also be possible to monitor network performance via software and must be in accordance with ITU-T Recommendation G821, G826, G828, G829, M2100, M2101, and must be available in Microsoft Office.
  - 8.1.13 It must be possible to conduct loop-back tests to all network elements.
  - 8.1.14 It must be possible to provide real time printouts of alarm conditions at one or more locations.
  - 8.1.15 Performance measurements of a minimum of 1 E1 per link must be possible and in accordance to G.826. The storage and format must be on Microsoft Office.
  - 8.1.16 Access to individual nodes for fault diagnostics must be possible via a LCT and access to the LCT must be given by the NMS.

## **8.2 The Web Client Station**

- 8.2.1 Web access to the system shall be provided, with no extra software to be installed, on any web browser (recent enough) and on any machine, whatever the operating system is. This access to be password protected.
- 8.2.2 It must be possible to view status of the alarms on any node.
- 8.2.3 For security reasons, the following functions shall not be available by any means (even using user/password protection).
  - Resource administration.
  - Physical network documentation.
  - Deletion of circuits and nodes.
- 8.2.4 At least 5 simultaneous accesses to the server via the Web shall be possible.

**END OF SPECIFICATION**

---