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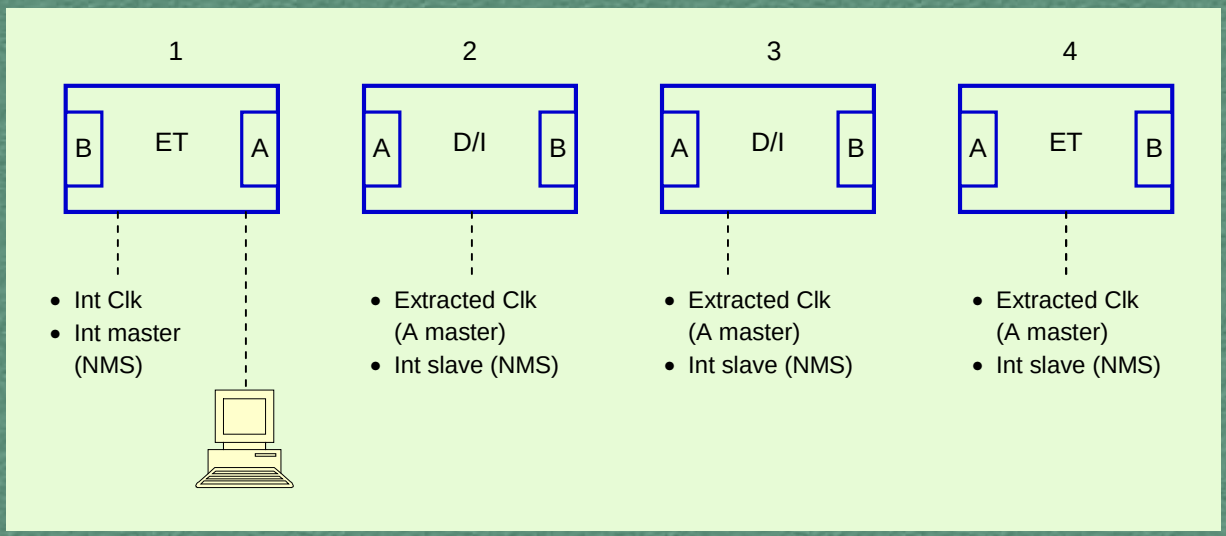
TCT3

P D H EQUIPMENT



Indian Railways Institute of
Signal Engineering and Telecommunications
SECUNDERABAD - 500 017

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INDIAN RAILWAYS INSTITUTE OF SIGNAL ENGINEERING & TELECOMMUNICATIONS, SECUNDERABAD - 500 017

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TCT3

PDH EQUIPMENT

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CHAPTER 1

V MUX

1.1 Introduction

The V MUX 30 – A (VERSATILE MUX) is manufactured by PUNJAB COMMUNICATION LTD., CHANDIGARH, INDIA. This is an advanced user configurable modular TDM drop/insert multiplexer system.

The system can be used in any of the following network applications

1. as a point to point MUX for voice & data transmission on primary rate E 1 trunk
2. as a tail end MUX in a digital transmission network
3. as a drop/insert MUX
4. as a subscriber MUX for a 2.048 Mbps primary rate user.

The system is equipped with various types of cards that provide the required interfaces for data and voice channels. VMUX 30-A complies with all the applicable requirements of ITU-T Rec. G.703, G.704, G.732 and G.823.

Please refer fig.1.1 summarizing V-MUX applications

1.2 SYSTEM CONFIGURATION:

V MUX 30-A is a multiprocessor system. The system has four basic common cards and power supply card for the operation. It can accommodate nine user specific cards (optional). The metal chassis is having 14 slots numbered 1 to 14 from right to left when viewed from front.
Slots 10 to 14 are reserved for system cards and the order of placing these cards is fixed.

Slot 14: Power supply card (PS)
Slot 13: General maintenance alarm processing card (GMAP)
Slot 12: PCM interface card (PCM I/F)
Slot 11: Multiplexing and de multiplexing card (SMX)
Slot 10: Auxiliary card (AUX)
Slot 09: Application specific supervisory / conference card.

Slot numbers 1 to 8 occupy user interface cards like

Subscriber interface
Exchange interface
E & M
Composite incoming
64 Kbps co-directional data card etc.,

.

Space on the motherboard above the card area provides terminations for all input and output connections to the MUX. Please refer fig. 1.2 showing sub-rack arrangement.

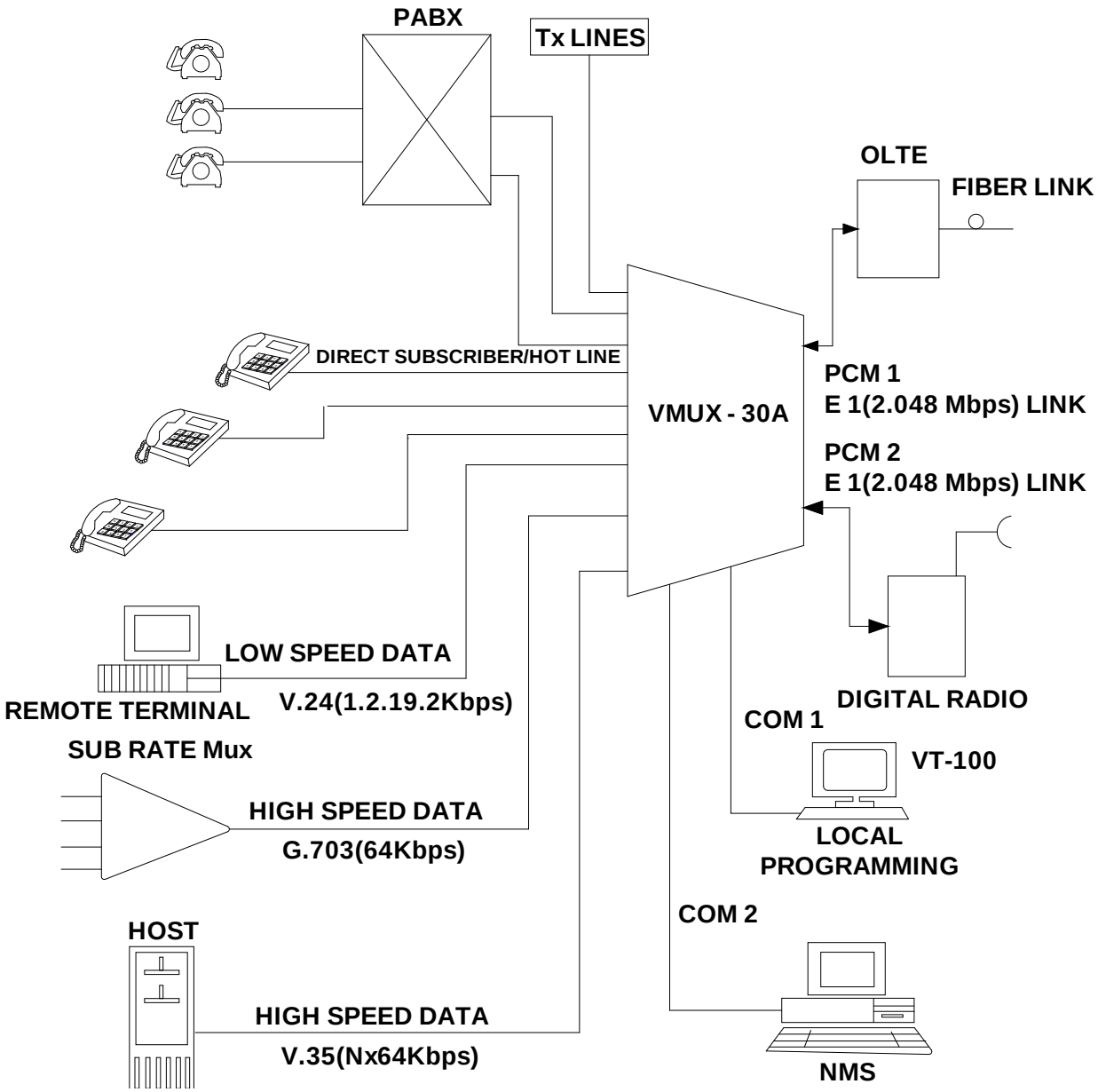


Fig.1.1 V-MUX applications

V MUX receives –48 V power and 75 V / 25 Hz ringer inputs through an 8 position terminal block. All user interfaces as well as 120 ohm interfaces of PCM 1, PCM 2, NETWORK CLK IN, CLK OUT and alarm relay contacts have their terminations brought on to six 64 pin euro connectors on the mother board. 75-ohm interface terminations for PCM 1, PCM 2 and CLK IN/OUT are also brought on to BNC connectors on the top edge of the motherboard.

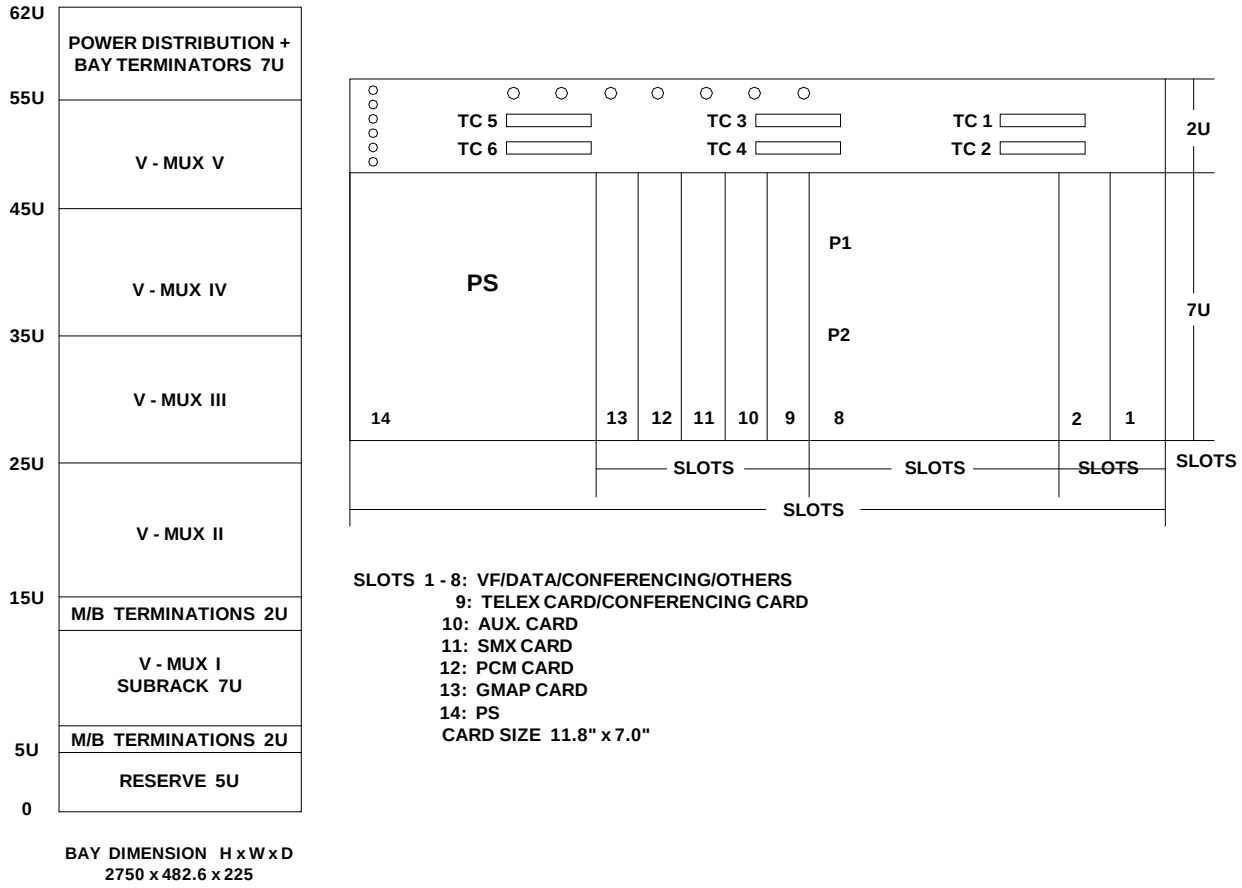


Fig. 1.2 V-MUX sub-rack arrangement

1.3 SYSTEM FEATURES and COMPARISION WITH 30 CH PCM (Primary MUX):

1. V MUX supports a variety of clock source options for network synchronization.
    a. PCM 1 Rec. clock
    b. PCM 2 Rec. clock
    c. External 2.048 MHz clock
    d. Internal 2.048 MHz Oscillator

These can be specified in order of priority. Failure of high priority clock enables next available lower priority clock automatically. Simultaneously failure alarm is generated. V MUX 30 A also gives out a 120/75 ohm G.703 2.048 MHz system clock for synchronizing the next equipment in the station.

2. Each channel can be configured for terminal or drop-insert (DTE or DCE)
3. In terminal configuration, channels' interface is at VF level
4. In 'Drop and insert configuration', any time slot of PCM 1 can be mapped to any time slot on PCM 2 to by pass channels
5. The contents of NVRAM are updated as soon as the configuration is modified.
6. Cross connecting and routing: Facility to cross connect between the two PCM trunks and the 32 user ports is available. Any time slot on PCM trunks can be mapped to any user port.

7. Dynamic reconfiguration: MUX can be programmed to reconfigure itself as per one of the four presettable routing tables. This can be manual or automatic on the occurrence of the predefined events. The events can be different alarms, failures or programmed time of day. This can be used to provide day / night service.
8. Statistics collection: MUX equipment can provide statistics of error seconds (ES), severely errored seconds and unavailable seconds over a period of time and can be restarted at any time.
9. Conference facility: Optional conference card can provide unto 15 simultaneous four party conferences. Two local ports can be put in each conference.
10. Alarms: A number of alarms are detected on PCM trunks, VF / data user ports, clocks and system status.

    a. **System alarms**:

        i. Input power supply failure
        ii. System power supply failure
        iii. Priority port failure
        iv. Configuration mismatch

    b. **Trunk alarms**

        i. Loss of signal
        ii. Frame Sync. Loss
        iii. Multi-frame Sync. Loss
        iv. Excessive FAS errors
        v. Excessive slips
        vi. Remote alarm
        vii. AIS received

11. These alarms can be programmed by user as MAJOR/MINOR alarm or no alarm. Alarm once generated can be stored in a 100 deep alarm history file, displayed on console. The alarm entries in the file include alarm source, alarm type, generation and clear timings. Cleared alarms can be removed from file to view the active alarms clearly.
12. Diagnostic capabilities: System provides diagnostics, supervision and maintenance for easy maintenance, rapid detection and location of faults.

1.4 APPLICATION CONSIDERATIONS

1. Single link operation (point to point): System is controlled by NMT. When the NMT is near the VMUX V.24/ RS 232 link can be provided by connecting a cable between the serial port and the COM 1 on the GMAP module. A modem link can also be used to cover longer distances. For E1 system the maximum available time slots are 30. If the NMS uses a main link time slot then the available time slots are 29. Please refer fig. 1.3

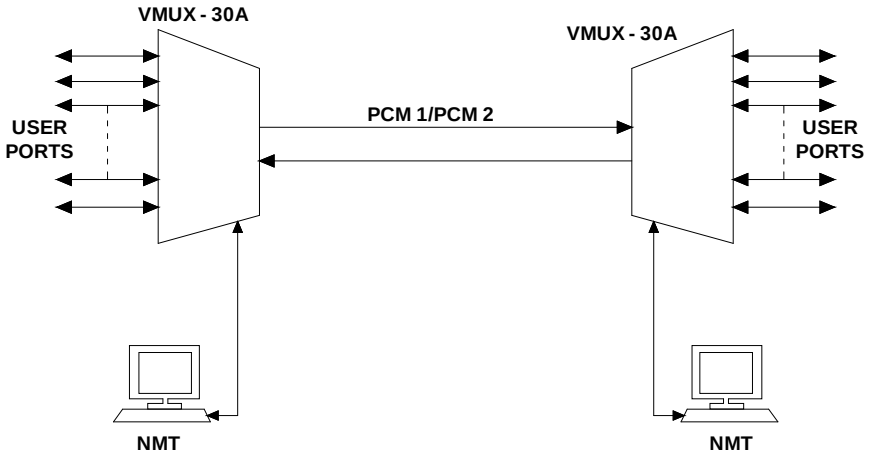


Fig. 1.3 Point-to-point application

2. Dual link operation: Two E1 links can be connected to V MUX; it is possible to have two partially filled E1 links. Cards installed in this system can be freely assigned time slots on either of two links without any restrictions. The user ports can be mapped to either or both of the PCM time slots resulting in two partially filled E1trunks. Please refer fig. 1.4 showing data-link operation

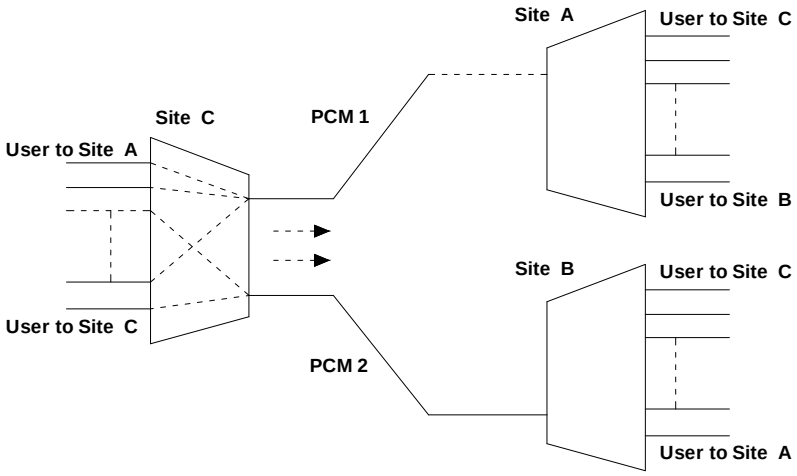


Fig. 1.4 Data-link operations

3. Drop and insert operation: It supports direct bypassing of selected time slots from link to link, by virtue of which the V MUX can be used in drop/insert applications. This does not in any way effect the capabilities of interface cards. It is possible to use the same time slot independently on both the links. The bypassed time slots and their corresponding signaling information are switched digitally in to the second link and vice versa. Please refer fig. 1.5 showing drop-insert operation

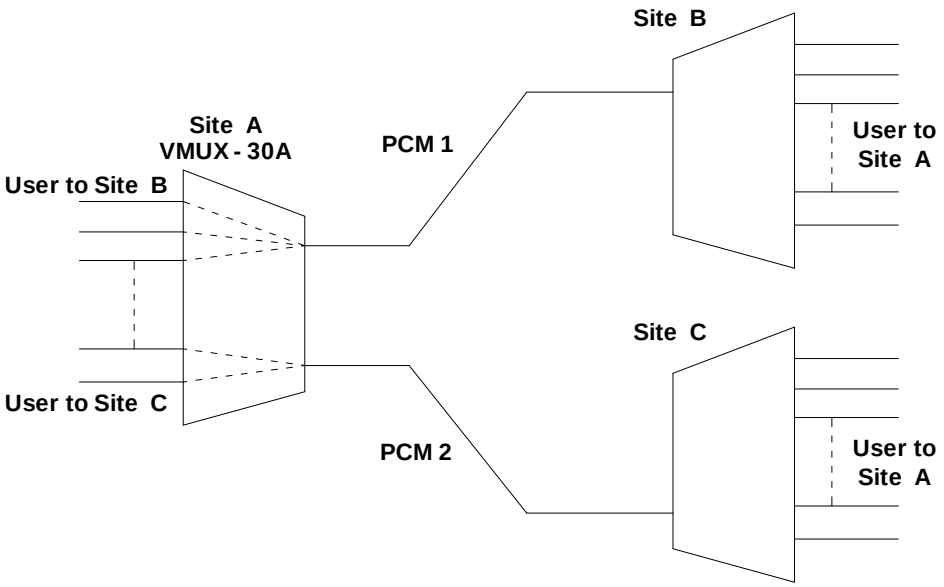


Fig.1.5 Drop-insert operation

1.5 V MUX Network

V MUX design is based on multiple processors. At the heart is a 10MHz Motorola 68000 processor on a GMAP card. That looks after the overall operations of the MUX including scanning, alarm generation, programmability and the man machine interface. Another 68000 processor on the SMX looks after the signaling of the MUX

VMUX is designed to have the following features.

1. Programmable Time slots
2. Network synchronization
3. Programmable alarms and thresholds
4. Omnibus conferencing
5. Local network management Terminal (NMT) for central Diagnostics.
6. Cross-connectivity of PCM trunks.

1.6 Programmable time slots

The operation of VMUX is programmable or configurable from a VT 100 compatible Network Management Terminal (NMT) connected to it. Through this NMT the user interacts with VMUX over multilevel user friendly screens to display the existing configuration and \ or to enter new configuration. Once entered, the configuration information is stored in a non-volatile RAM (NVRAM) and governs the operation of the MUX henceforth. This NVRAM has a battery life of several years.

The NVRAM comes programmed from the factory with a default configuration setting for all programmable parameters. This default setting can be viewed and altered at site using NMT. The default setting is generally good enough for the operation of VMUX in a typical environment and can also be supplied tailored to a specific user requirement.

1.7 Network synchronization

VMUX supports a variety of clock input options for network synchronization. These can be

1. PCM1 Receive clock
2. PCM2 Receive clock
3. External 2.048 MHz clock
4. Internal 2.048 MHz Oscillator

The user can specify up to 10 synchronizing clocks in order of priority. In case of failure of a higher priority clock, the next available lower priority clock is automatically brought into circuit. In parallel, alarms are generated in case of failure of highest and next to highest priority synchronizing clocks.

VMUX also gives out a 120-ohms/75 ohm G. 703 2.048 MHz network clock for synchronizing the next equipment in the chain.

1.8 Programmable alarms and thresholds

VMUX detects a number of alarms conditions on PCM trunks, VF / Data user ports clocks and other system status. Among the conditions supported include:

A. On PCM Trunks:

Loss of signal
Frame Synchronization Loss
Multiframe Synchronization Loss
Excessive FAS errors
Excessive CRC errors (if enabled)
Excessive slips
Remote alarms
AIS Received

B. Others:

Priority 1 or 2 Clock failure
VF/Data Port failure
Configuration Mismatch

Each of these alarm conditions can be programmed by user to generate a MAJOR alarm, a MINOR alarm or no alarm. Both these alarms generate audio/visual alarms on the bay rack.

The alarms once generated are also logged in a 100 deep alarm history file that can be displayed on the console. The alarm entries in this file include the alarm source, alarm generation and alarm clear time.

1.9 Omni bus conferencing

VMUX supports two simultaneous active 4-way Omni bus conferencing channels. These conferencing channels can be set up in such a way that any one time slot each of PCM1 and PCM2 trunks and two local VF ports can participate in each conference.

A new conferencing card which can support up to 30 three parties or 15 four parties conferencing channels is also available.

1.10 NMT for control diagnostics

Apart from programming VMUX, NMT is also used for displaying MUX status, status of its various lines and ports, displaying alarm history, running diagnostics, initiating and displaying error statistics, etc.,

NMT can also be connected to VMUX remotely using modems for which another console port has been provided. This feature can be used by a central site NMT to connect to a remote VMUX using dial up modem for diagnostic purpose.

1.11 Cross connectivity of PCM trunks

VMUX supports a full cross connect between both the PCM trunk and 32 user ports. Any time slot can be mapped to any user port. Also any time slot of PCM1 can be mapped to any time slot of PCM2 to bypass channels in Drop/insert configuration.

VMUX can maintain up to four cross connect tables any of which can be activated by user action or can be set to be activated at fixed time of the day.

1.12 SPECIFICATIONS

General

Number of PCM Trunks	:	2
Number of user port	:	32 max.
Types of interfaces supported	:	E&M (2W and 4W) Loop incoming Loop outgoing Subscriber Loop interface Exchange Loop interface Ring down (Magneto I/F) Hot line
Types of data interfaces supported	:	64 Kbps G.703 co-directional Low speed 1.2 to 19.2 Kbps V.24 direct lines 64Kbps V.35 direct lines 64 Kbps V.35/V.11 lines through NIU.
Power Supply	:	-40V to –60V (-48V nominal)
Network Clock Synchronization	:	Selected from PCM1 Receive clock PCM2 Receive clock 2.048MHz External Clock 4 KHz External Clock 2.048 MHz Internal Clock
Other Synchronizing features	:	Automatic recovery in case of clock failure
Omnibus Conferencing	:	30 three party or 15 four party conferences are available.

Alarm	:	All alarms are user programmable for threshold and type as Major/Minor/None. Alarms logged in history file
Network Console Terminal	:	A VT-100 compatible terminal available for network control and management

PCM Trunk interface

Output Impedance	:	75 ohms unbalanced/120ohms balanced
Input impedance	:	75 ohms unbalanced/120ohms balanced

VF interfaces

E & M (4W)

Coding	:	A-law rec. G.711
Nominal Impedance	:	600 ohms at I/P & O/P ports
TX level	:	-11dBr to + 4dBr adjustable in steps of 0.1dB
Rx level	:	-14dBr to 1 dBr adjustable in steps of 0.1dB

E & M (2W)

Coding	:	A-law, rec G.711
Nominal Impedance	:	600 ohms
TX level	:	-14dBr to 1 dBr adjustable in Steps of 0.1dB
Rx level	:	-11dBr to + 4dBr adjustable in steps of 0.1dB

Subscriber loop interface

Max. Loop resistance	:	2400 ohms
Battery reversal capability	:	Yes
Ring voltage	:	75 V rms (External ringer)
Ring frequency	:	17-25 Hz
Dial pulse speed	:	8-12 pps
VF Specs	:	Same as for 2W, E & M

Exchange interface

Open loop resistance	:	More than 10 K ohms
Closed loop resistance	:	Constant current sink of 20 mA
Minimum ring voltage detection	:	15 V rms
Dial pulse speed	:	8-12 pps
VF Specs	:	Same as for 2 W, E & M

Hot line

Max loop resistance	:	2400 ohms
Ring voltage	:	75 V rms. (External ringer)
Ring frequency	:	17-25 Hz
VF Specs	:	Same as for 2W, E & M

Data Interface specifications (64 Kbps G.703)

Interface	:	Co-directional as per ITU-T Rec.G.703
Nominal output impedance	:	120 ohms
Nominal input impedance	:	120 ohms

Clock Interfaces specifications

2.048 MHz clock input

Termination	:	75 ohms unbalanced/120 ohms balanced
Rate	:	2048 KHz ± 50 ppm
Maximum line attenuation	:	6 dB

4 KHz clock input

Termination	:	600 ohms balanced
Rate	:	4 KHz ± 50 ppm

2.048 MHz clock output

Nominal impedance	:	75 ohms unbalanced /120 ohms bal
Rate	:	synchronized to system clock

1.13 Power Supply Card

* This card occupies slot No. 14
* Before inserting or removing the card the power supply must be switched off
* The power supply on-off switch is provided on the top of the card
* Fuse LED glows red when internal fuse is blown due to overload or reverse polarity
* Fuse is provided near the lower euro-connector J 2
* Monitoring points are unprotected and should be carefully measured
* Measurement should be made between input & return or output & return

Please refer fig. 1.6 showing Power supply card indications

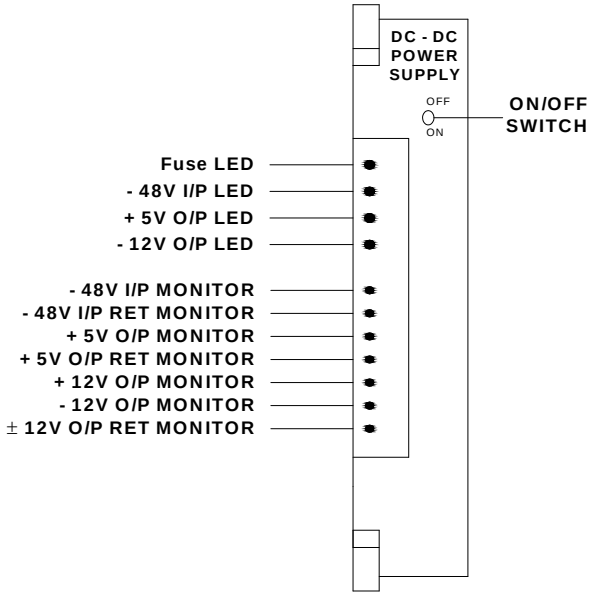


Fig.1.6 Indications on Power Supply Cards

1.14 GMAP CARD

General Maintenance and Alarm Processing Card

* Uses Motorola 68000 microprocessor
* Overall control of the system
* Implements all programmable features of system
* Scans for alarms

* Maintains history file, takes user defined action on detection of alarm condition
* Scans the system hardware for correct function and indicates any abnormality
* Interacts with the user through NMT
* This card occupies the 13th slot
* Power should be off whenever the card is removed or inserted
* Press ACO switch to cut-off audio alarm
* Health indicator, green in color blinks at nominal rate of 1 Hz in normal condition
  Blinks at a higher rate or non-uniformly in case of failure

Please refer fig. 1.7, showing G-MAP card indications.

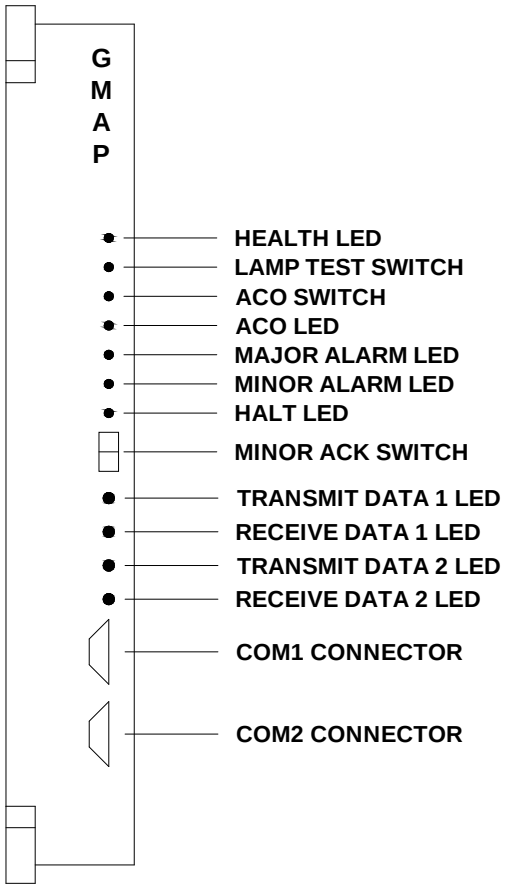


Fig.1.7 G-MAP card indications

In this card,

* COM 1 connector is a 15 pin D type female connector for connecting NMT
* COM 2 connector is a 15 pin D type female connector for connecting remote NMT or PC based NMS. (Through conference card)
* Switch on the system when all the system cards are inserted

1.15 PCM INTERFACE CARD

This card occupies the 12th slot. Indications are

* Local Yellow, normally off
  Permanently lit – Loss of signal
  Blinking – frame/ multi-frame loss

* Remote Yellow, normally off
  Permanently lit – RX AIS
  Blinking – alarm indicator far end

* ERR Yellow, normally off
  Permanently ON, excess error rate than permitted (> major threshold)
  Blinking – (> minor threshold)

* Slip Yellow, normally off
  Blinking – slip occurrence
  Permanently ON - Slip > set threshold

* Loop Yellow, normally off
  ON – remote loop

* Loop switch: Press ON for more than 2 sec. Toggles the loop status of PCM Trunk (Loop to un loop & un loop to loop)

* It remains in loop for 5 to 6 min. If test is over before, the loop can be removed by pressing the switch again.

* The PCM terminations are available on TC 6 or BNCs

Please refer figure 1.8 showing front panel of PCM interface card

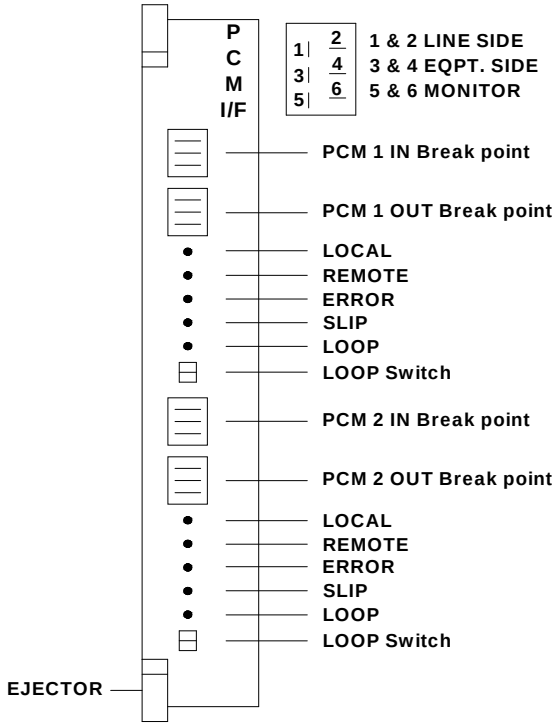


Fig.1.8 Front-panel of PCM interface card

1.16 SMX CARD

This card occupies slot No.11. Indications are:

* Health Green LED, blinks at uniform rate of approximately 2 Hz. Non-uniform blinking or continuous ON or continuous off indicates faulty condition
* At power ON or after reset a continuous off indicates GMAP failure.
* No user settings
* No user input / outputs

* Factory setting should not be disturbed
* Switch off of the power supply whenever card is removed or inserted

Please refer fig.1.9 showing front panel of SMX card

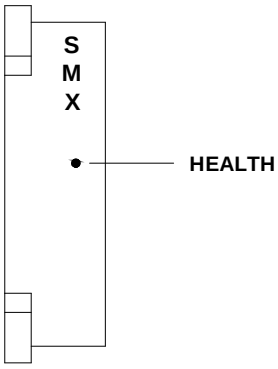


Fig.1.9 Front panel of SMX card

1.17 AUX CARD

This card occupies 10 th slot.

* Health Green LED, normally OFF. When lit indicates AUX card failure
* CLK 1 Yellow, normally off. (Indicates clock available and stable)
  When lit indicates either the priority 1 clock is not available or not stable.
* CLK 2 Same as above but for priority clock 2
* AUX card is a part of the GMAP card
* Terminations are provided for clocks on TC 5 or BNCs
* Factory setting should not be disturbed
* Switch off the power supply to remove or insert the card

Please refer fig. 1.10 showing front panel of AUX card.

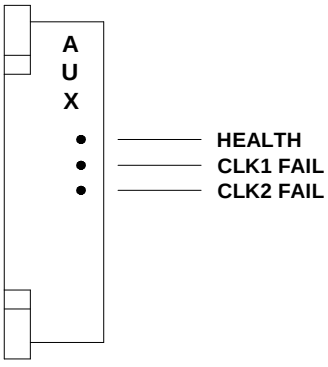


Fig.1.10 Front panel of AUX card

1.18 E & M card

This card can be put in any one of the 1 to 8 slots. Indications are:

* 2W or 4W options are settable.
* Four 2W/ 4W E & M ports are provided on each card.
* Configure the card and ports using NMT.
* Route the ports, if not routed using NMT.

* E LED Yellow
  OFF Open on E lead
  ON Ground on E lead

* M LED Yellow
  OFF Open on M lead
  ON Ground on M lead

* Loop LED Yellow, normally off. When lit indicates channel has been looped (local or remote)

Please refer fig. 1.11 showing front panel of E&M card.

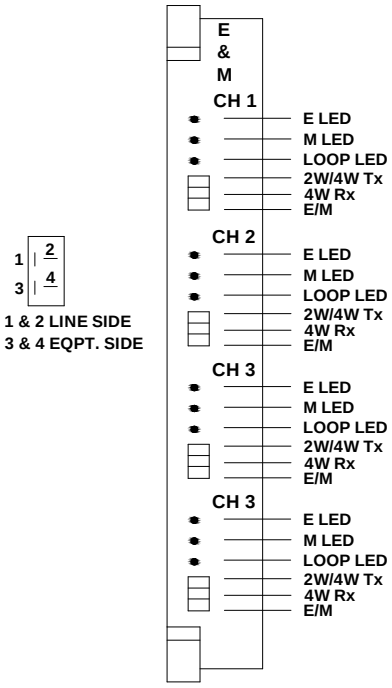


Fig.1.11 Front panel of E&M Card

1.19 Subscriber interface card

This card can be put in any one of the 1 to 8 slots. Its functions are

* Provides four 2 W direct subscriber lines.
* Works in conjunction with exchange interface or hot line interface.
* In case of hot line interface same card is used at both ends.
* Various signaling states and signaling ports like idle, seizure, dialing etc., for the subscriber interface are provided.
* The termination connector and pins depend upon the slot in which the card is inserted.
* Configure the card and ports if already not done with NMT.
* Route the ports if already not done.
* Seizure yellow LED ON indicates the seizure of the channel.

Please refer fig.1.12 showing front panel of Subscriber interface card

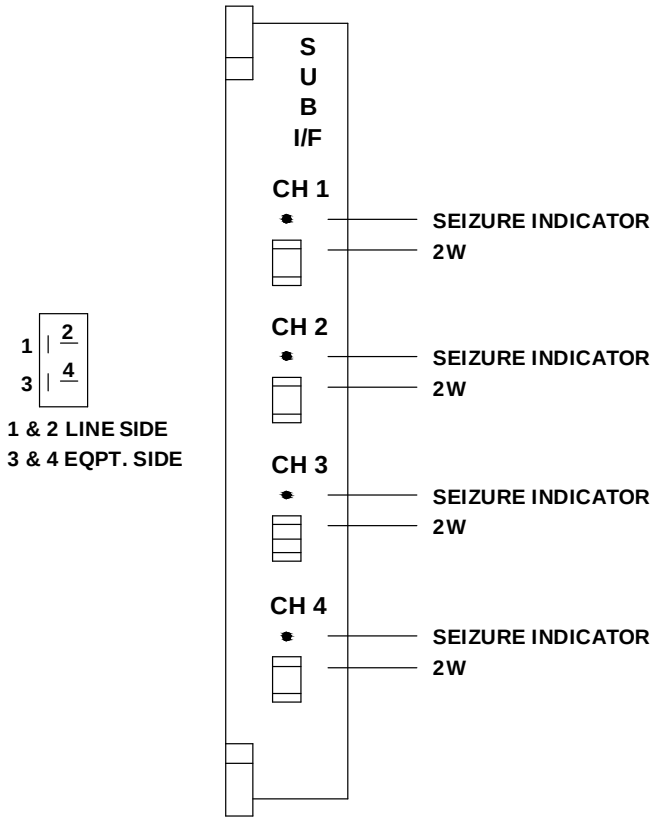


Fig.1.12 Front panel of subscriber interface card

1.20 Exchange Interface Card

This card can occupy any of the 1 to 8 cards. Its functions are

* This card is also known as composite incoming interface card

* Each card has four 2-wire Interfaces for terminating the exchange/Junction lines

* Can be configured as exchange interface to work with subscriber interface at other end

* Can be configured as incoming Junction interface to work with loop outgoing interface at other end (Tie line working)

* The various signaling states and codes like idle, seizure, dialing etc., are set

* The termination connector and pins depend on the slot in which card is inserted

* Configure the card and ports if already not done

* Root the ports if already not done

* Seizure LED (yellow) ON indicates seized condition

* Answer LED (yellow) ON indicates answer condition

* JF LED (yellow) ON indicates Junction failure or blocking of corresponding channel

Please refer fig.1.13 showing front panel of exchange interface card.

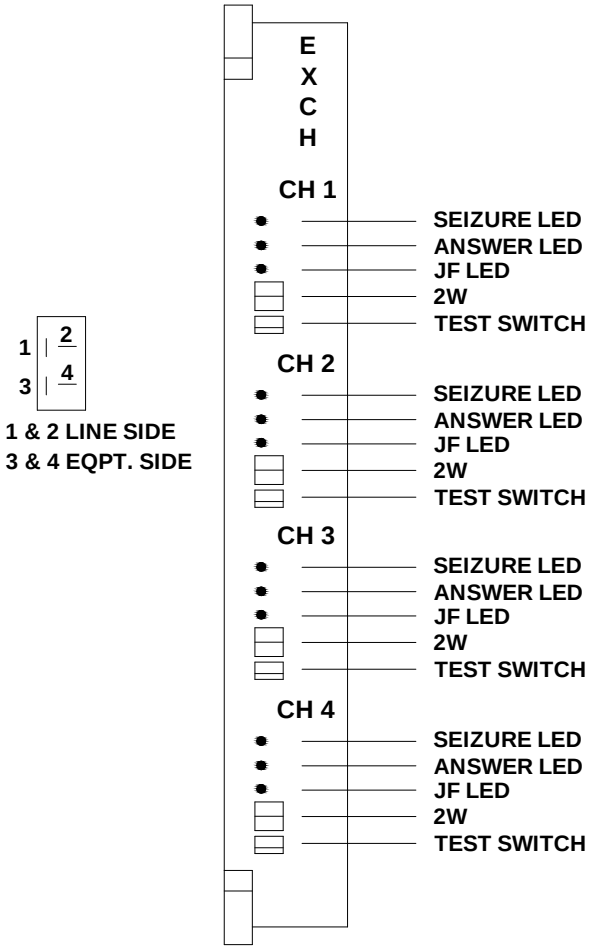


Fig.1.13 Front panel of Exchange interface card

1.21 64Kbps co-directional Data interface card (G. 703)

This card can be placed in any one of the 1 to 8 user slots. Its functions are

* This card provides four 64Kbps data ports.

* Configure the cards and ports if already not done

* Root the ports if already not done

* The termination connector and pins depend on the slot in which the card is placed

* Signal loss LED (Yellow) ON condition shows loss of signal at data input of corresponding Channel

* Violation loss LED (Yellow) indicates violation loss at data input of corresponding channel

* Loop LED ON condition indicates that the corresponding channel is looped

* There are no user settable headers in this card

(Please note that the factory settings shall not be disturbed on this card)

Please refer fig.1.14 showing front panel of G.703 card

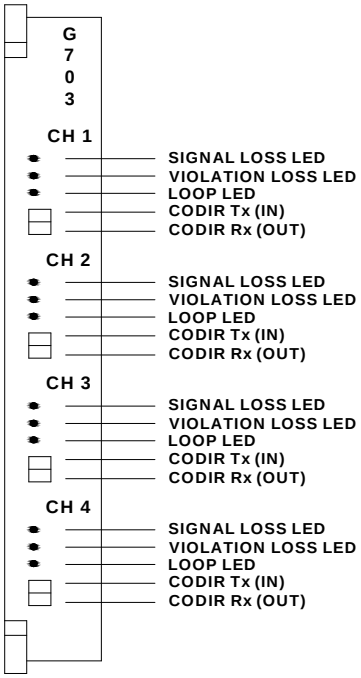


Fig.1.14 Front panel of G.703 card

1.22 Conference card

This card is placed in the 9th slot

* This card has 3 ports
* Ports P1 and P2 are RS 485 ports
* This is a 15 pin D-type female connector
* Port P3 is RS 232 ports this is a 15 pin D type female connector
* NMS is connected to port 3 of conference card through which it goes through GMAP card
* Health LED (Yellow) ON condition shows conference processor is in normal running state
* There are no user settable headers on this card
* Do not disturb the factory settings

Please refer fig.1.15 showing front panel of Conference card

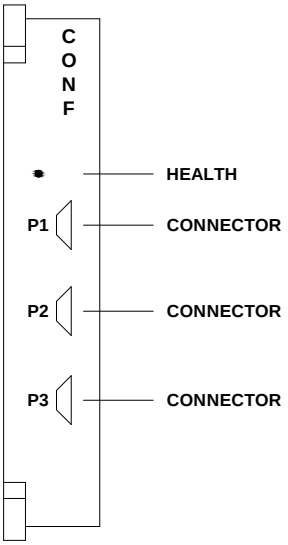


Fig. 1.15 Front panel of Conf. Card

1.23 Node Management Terminal

The operation of V MUX is configurable can be monitored from a VT-100 compatible Node Management Terminal (NMT). Through NMT user can interact with V MUX, the screen displays the existing configuration. New configuration can be entered. The newly entered configuration information is stored in a non volatile RAM. This non volatile RAM has a battery life of several years.

Generally the NVRAM comes programmed from factory with a default configuration setting for all programmable parameters. The default setting is generally good enough for the operation of VMUX in a typical environment. The NMT is also used for displaying system status.

Status of its various lines and ports displaying alarm history
Running diagnostics
Displaying error statistics etc.,

COM1 port on GMAP is the local programming port. It is a V 24/RS 232 port. Baud rate can be 300 to 9600 bauds. Default setting is 9600 bauds.

There are three levels of operation

1. User mode: only for viewing configurations, status and alarm history. No change of configuration is allowed in this mode.

2. Supervisory mode (Level 1)

This mode is password protected. The user has all facilities of user mode and configurations capabilities except erasing hardware and viewing/changing password.

3. Supervisory mode (Level 2)

This mode is password protected. The user has full control of the system.

Password can be viewed / changed.

User mode and supervisory (level 1) are possible.

Both these levels are password protected

1.24 Network management system (NMS)

A network of VMUX can be monitored and configured using a PC-AT based Network Management System (NMS). Programmable options provided by V MUX –30A can be configured from NMS.

The MS-windows based NMS provides user friendly screens for easy operation. The NMS monitors and generates alarms history files etc.,

NMS can be used for point to point networks, chain and chain network with appendages.
NMS is connected to port 3 of conference card through which it goes to GMAP card.

1.25 Hardware setup procedure

Once properly programmed, NMT is not required for day to day operation of MUX as the MUX automatically scans the hardware and network lines for alarm and abnormal conditions and takes appropriate alternate actions defined by the user. A number of LED indicators on

the VMUX cards as well as on the bay also continuously display the MUX and the line status at all times. NMT can however be used to display detailed network status, to run diagnostics and to a make further changes to the MUX programming if required.

Login

Press (F11) key

After entering the password (if required) user gets menu screens
If no interaction has been done for 3 min the system automatically logs out
One user can login at any time
Local user has higher priority over remote user
Local user can login at any time by pressing CONTROL & A keys together

Main Menu: The next screen displayed to the user is the Main Menu which is as follows:

1.	Status	2.	Routing Tables
3.	Hardware set up	4.	User options
5.	Maintenance	6.	Log off

Enter your selection (1 to 6): After the user enters his selection other menus are displayed to the user to solicit further selections from him and/or display him the information. This Main Menu and all other menus displayed to the user are given in Appendix A of this manual. User Selections 3(Hardware setup), 4(User options), 6(Log off) and relate to setting up the hardware environment of VMUX and are being described subsequently.

Hardware setup (User Selection 3): A further user screen is displayed in response to user selection 3. Under this selection following network interfaces are programmed.

PCM Trunks 1 and 2: This screen also allows enabling/disabling of the selected PCM trunks.

VF interfaces (1-32) and Data Interfaces (1-32): User can keep all 32 physical ports configured as both VF and Data. During run time the system detects the type of card actually present in the system and activates the required programming.

Erase Hardware set up: This option can only be activated by supervisory user and initializes the entire hardware to default configuration.

Setup Conferencing Channels: The setup allows selection of 2 local VF ports and one time slot each on PCM1 and PCM2 to be put in each Conferencing. Additionally it allows enabling/disabling of individual conference.

1.26 User Options (User selection 4):

Under user options the user programs following items:

Password: Password editing is however allowed only if user gives his level 2 password

Power on Routing Table: VMUX maintains up to 4 routing tables any of which can be active at a time. This entry defines the routing table number which shall be activated at power on. It is also possible to activate the last active routing table at power on.

Station ID: Each VMUX is given a station ID which can be used to access VMUX over remote or supervisory channel.

Set system ports: This screen allows the user program the NMT ports 1 and 2, for baud rate, no. of data bits & parity etc.

Time of Day reconfiguration: Through this screen up to five events (time of day and date) can be specified at which specified routing table number shall be brought into activation.

Select sync source: Through this screen the network sync clocks and their priorities are defined and the highest priority clock is automatically selected.

Define Major/Minor alarm types: This screen allows the user to define each possible alarm in the system as either major / minor / none. It also allows user to define thresholds for the alarms.

1.27 LOG OFF (user selection 6)

Link selection is used to link the NMT to the desired station. Log off command is used to log off from the supervisory mode and end the session with VMUX. The system also automatically logs off if no KBD entry from NMT is received for 5 minutes. This is to safeguard against the supervisor accidentally leaving the terminal logged in supervisor mode.

1.28 INSTALLATION

Following procedure may be followed in general before powering up of the system.

A. Insert the mandatory common cards (PS, GMAP, SMX, AUX, and PCM) into the respective slots and power up the system. Check the normal functioning of the health LED on the GMAP card.
Connect the NMT to COM 1 and see the menu on the screen.

Log in the supervisory mode and see on the display that all the four cards are displayed as available

B. Insert the user interface cards in the required slots (1 to 8) and check on the screen that the same has been updated

C. Insert the optional common cards (conferencing etc.,) and again check up the display

D. Configure the PCM trunks
Configure the network clock as per the desired priority
Connect the PCM trunks and watch the PCM trunk status on the display
Check the LED on PCM I/F card

E. Program one Routing table as per desired cross connect plan and make it active

F. Program all the VF and Data interface ports as per the requirement.

G. Program all the alarms available in the system under Major or Minor head.

H. Check for correct flow of traffic between each of the user ports and its destination on the network.

I. Set the desired station ID for the MUX.

J. Set up and program the omni bus Conferencing channels. Configure the local E&M VF Conferencing ports. Connect the Conferencing phones through the adaptor unit to the defined E & M Conferencing ports and test for the proper operation of omnibus channels.

K. Program the conditions under which bypass action is to be automatically activated.

L. Finally delete the factory defined password of level 2 and enter new password for level 1 and level 2.

M. Log off from the supervisory mode.

Objective:

1. V mux is a _____ type of MUX.
2. V mux is equipped with the required interfaces for _____ & _____ channels.
3. In V mux Slot 13 is allotted to _____
4. In V mux Slot 12 is allotted to _____
5. In V mux Slot 9 is allotted to _____
6. V mux operates on _____ power supply
7. V mux can be programmed to _____ numbers of routing tables
8. In V mux conference card can provide up to _____ four party conferences.
9. In V mux _____ mismatch generates a System alarm
10. In V mux Frame sync loss is a _____.
11. In V mux remote alarm is a _____ alarm
12. In V mux AIS received is a _____
13. 100 alarms can be stored in a deep alarm history in V Mux (T/F)
14. NMS is a compatible terminal available for ---------- and management
15. In V Mux Coding follows _____ Law Recommendation

Subjective:

1. State the System Configuration and Important Features of V Mux?
2. Write down the System Alarms and Trunk alarms present in V mux?
3. Write short notes on :
   a) GMAP card in PCL V mux
   b) PCM IF card in PCL V mux
   c) SMX card in V Mux
   d) AUX card in V Mux
4. What are the various Cards and Modules present in V Mux for interfacing the customers requirement?
5. What is the importance of Conference Card in V mux architecture and explain how does it helps in obtaining omnibus configuration of a channel?
6. Write the importance of Node Management or Network management System?
7. State the Installation Procedure for the installation of V mux?

CHAPTER 2

WEBFIL'S FLEXIMUX

2.1 INTRODUCTION:

The Flexi MUX is programmable Add/Drop multiplexing equipment which combines a variety of voice and data traffic into a 2.048 Mbps stream. This equipment is manufactured and supplied by WEBFIL Limited. The Add/Drop feature of the Flexi MUX is realized through the use of a high performance time/space non-blocking cross-connect switch with four independently controlled serial time division multiplexed buses. Conferencing of voice is done through a separate digital signal processing circuit in digital format. All the signaling information is handled by a microcontroller.

The system can be programmed for its channel assignments locally through a portable laptop computer or remotely from a Central Supervisory Terminal through a polled data channel derived through unused National bits or the overhead bit-stream of the transmission equipment. The same channel is also used for Network Monitoring and control operations. Polled mode of operation allows it to be used in tandem, loop or star to suit the network structure of the user. Various diagnostics features are built-in the system which eases the maintenance of the network.

2.2 ARCHITECTURE:

The Flexi MUX is a compact unit based on the 19" mechanical construction. The Sub-rack is a common mechanical housing with a bussed backplane which accepts all the modules with vertical mounting making a modular equipment concept possible. LEDs on the front panel indicate the status of all the individual modules. The 2 Mbps streams are accessed from the rear side either through coaxial connectors for 75 Ohms interface or through wire wrap post for 120 Ohms balanced connection.

All the voice, signaling and data information are accessed from wire wrap connectors mounted at the back. The NMS can be accessed through a 9-pin D-shell connector, mounted in the backplane for from RJ-11 jack mounted in the facia of Network Interface Module.

The basic system consists of

a) The Network Interface Module
b) Tributary Module
c) Power supply Module
d) Sub-Rack with he back plane

Analog and digital services are realized with interface specific access units connected to an internal 2 Mbps bus. The realization concept of the Flexi MUX is shown in figure 2.1.

Each of the access units accommodates one to four channels depending on the complexity of the interface. Each individual service channel consumes one time slot (voice and data up to 64 Kbps) and fractional time slots (low speed data up to 19.2 Kbps) of the 30 time slots available for use with the 2 Mbps stream.

For voice channels various interface options are available to suit the customer's requirement. The interface units are small adaptor cards which can be plugged into any one of the four adaptor sockets available on a voice access module. Flexibility of these plug-in modules allows free inter-mixing of interface units on a particular voice access module. The various interface options available t present are:

a) 4 W/2 W E&M
b) Subscriber interface
c) Exchange interface
d) Hot line interface

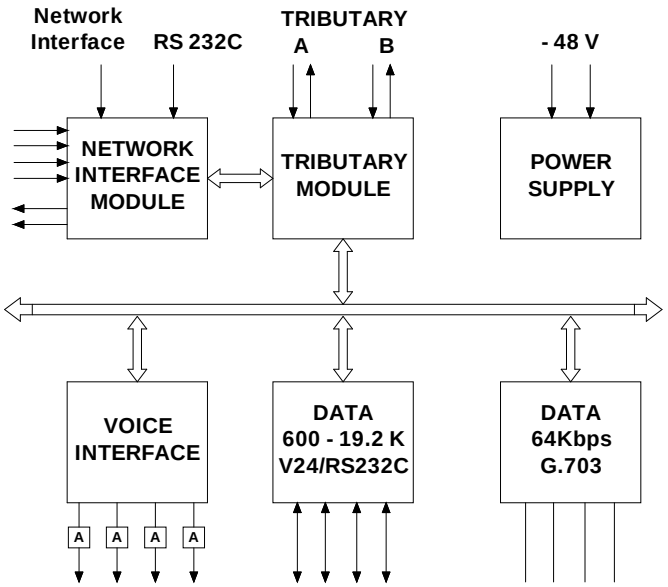


Fig.2.1 Block diagram of Flexi-MUX

SUB-RACK: The sub-rack has altogether 13 slots for housing the various modules. Out of these slot-1 and slot-2 are dedicated for PSU modules (in case of redundant power supply) and slot-3 and slot-4 are dedicated for the Network interface Module (NIM) and Tributary Module (TM) respectively. Slot-5 to slot-13 are meant for housing various access modules for both voice and data interface. Each of these slots supports access to 4 time slots of the 2 Mbps stream. Thus slot-5 to slot-11 supports altogether 28 time slots of the 2 Mbps bus. Slot-12 and slot-13 have equal and parallel access to time slots 30 and 31. This has been done for efficient utilization of the bit stream during sub-multiplexing of a time slot for low speed data. The structure of the sub-rack and time slot allocation is shown in figure 2.2 below.

PSU	PSU	NIM	TM	ACCESS MODULE TS-1 TO TS-4	ACCESS MODULE TS-5 TO TS-8	ACCESS MODULE TS-9 TO TS-12	ACCESS MODULE TS-13 TO TS-15,TS-17	ACCESS MODULE TS-18 TO TS-21	ACCESS MODULE TS-22 TO TS-25	ACCESS MODULE TS-26 TO TS-29	ACCESS MODULE TS-30 TO TS-31	ACCESS MODULE TS-30 TO TS-31

Fig. 2.2 Flexi-MUX sub-rack

Access to the 2 Mb ports is available from the back plane from the rear side. Separate connectors are available for 75 Ohms and 120 Ohms impedance matching. For 75 ohms, Spinner type threaded connector has been provided for firm contact. For 120 Ohms, three pin 1 mm square post has been provided for either wire wrap termination or termination through self lock header socket. A separate port is also available for driving the system using external clock.

Extension of voice and data has been provided on Euro type wire wrap connectors. This has enough space for wrapping 0.5mm or 0.6mm telephone cable normally used for telecommunication. Separate connector has been provided feeding input -48VDC power supply to Flexi MUX. The backplane also provided a D-Shell 9 pin connector for interfacing the V-24/RS232C serial link of the Network Monitoring System. NMS can also be accessed RJ11 jack located at the front of NIM.

2.3 Modular Description

Network Interface Module

The Network Interface Module primarily takes care of alarm acquisition function from various internal and external sources and responds to the queries and commands issued by the Network Manager through the "Super Net" Network Management System. The module runs on a high performance Intel 80C196 microcontroller with associated communication and alarm interfaces for its operation. The block diagram of the Network Interface Module is presented in Figure 2.3.

The Network Interface module is used for exchange of information among the Network Manager, the Tributary Module and the various access modules interconnected via the backplane. It has altogether four communication interfaces for information exchange. The network management system is realized through two serial interfaces, one for external NMS for interfacing the central supervisory computer while the other is used for realizing the NMS through the unused National bits of the 2 MB stream. Other than these, the tributary unit is interconnected through a serial link while the access modules are interfaced through another serial bus.

Communication for Network Supervision and Parameter uploading/downloading is done through a standard IEC65 frame format whose structure is as shown below.

Frame Header	Address	Equipment Identity	Command	Data	End of Frame

The structure has been adapted for all transmission equipment of WEBFIL make so that the same NMS system may be used to access all types of transmission equipment manufactured by WEBFIL. The baud rate of this link is 1200 bps and is operated as digital omnibus link is semi-duplex master/slave mode.

The various information/commands downloaded from the Network Management System (NMS) computer is

a) Channel Cross-connect table
b) Interface Configuration table
c) Status Response command
d) Diagnostic command
e) Alarm History Upload command
f) Global Time-set command

The cross-connect table defines the configuration of the multiplexer at a particular site. It determines which of the 30 channels from the 2 MB bus to be dropped and which channels to be passed through or which channels to be stopped. The table also defines which the channels to be operated in conferencing mode are. The tables downloaded from the network manager are stored in non-erasable Electrical Erasable Prom (EEPROM).

Altogether six cross-connect tables are downloaded to take care of the various conditions of the network.

a) Cross-connect table for normal operation
b) Alternate cross-connect table when A-tributary is having major alarm. (Faulty – A)
c) Alternate cross-connect table when B-tributary is having major alarm. (Faulty – B)
d) Modified cross-connect table when A-tributary receives a remote alarm.(Remote – A)
e) Modified cross-connect table when B-tributary receives a remote alarm.(Remote – B)
f) Digital Bypass.

The cross-connect tables switches automatically from one to the other depending on the various alarm conditions of the 2 MB bus. The digital bypass table is however switched remotely through a command from the Network Supervisor through the Super Net NMS system. The tables are prepared through a menu driven semi-graphic screen on the NMS computer which are then downloaded through the 1200 baud NMS serial bus. All the tables can be updated on-line as and when required.

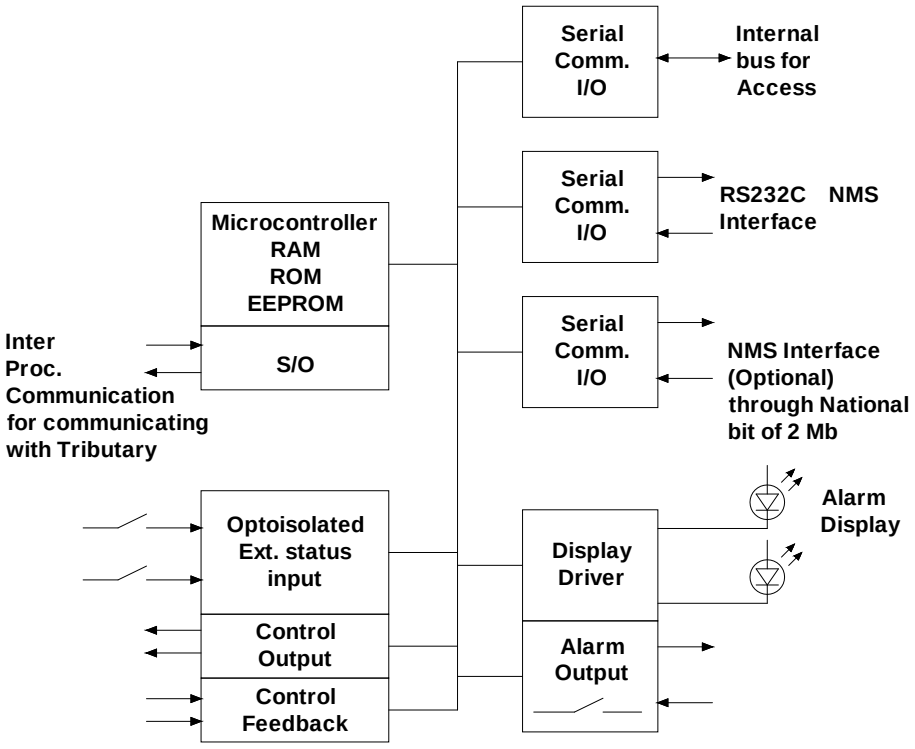


Fig: 2.3 Block diagram of Network interface module

The interface configuration table primarily defines the parameters of the voice and data access modules of a particular site. For voice channel, it defines the type of access module i.e. whether it is 2/4W E&M or subscriber interface or exchange etc. it also defines the gain/attenuation setting of the particular channel. For data channel it defines the baud rate and serial data format of the interface etc.,

The individual channel configuration is defined on a menu driven screen at the NMS computer. It is then download through the NMS serial bus to the EEPROM. During power on, the microcontroller of the Network Interface module downloads the cross-connect tables from the EEPROM to the tributary module which invokes the desired structure of the Drop/Insert configuration of the site. The microcontroller also downloads the analog and digital channel parameters to the particular access modules through backplane serial bus. Downloading of all these information to tributary or channel module is cross-checked and in case of any error or mismatch, the Network Interface Modules displays a SETUP error led.

During the normal operation of the network the NMS is kept under SCAN mode. In this mode the NMS computer scans all the network elements for its alarms and status. The network elements are identified by its address and type (OptiMUX-8, Flexi MUX etc). Scanning is done one after another in sequential mode in master/slave mode. The NMS issue a command through the Super Net serial bus which is received by all the elements in the network. However, the element whose address and identity matches with that of the frame, responds to it.

The microcontroller of the Network interface Module analyses all the packets it receives from the Network Supervisor and responds only to the one meant for the particular equipment. In response to the Status Response command, it uploads the current status of the equipment. The various alarms uploaded to the NMS from Network Interface Module are

a) Tributary Alarms: (both for Tributary A & B)
    i) 2 Mb loss (RXF)
    ii) All ones (AIS)
    iii) Sync Loss (SYNC)
    iv) Remote Multiframe alarm (RMA)
    v) BER
    vi) Remote alarm (RA)

b) System related Alarms:
    i) Problem with Network Interface Module or Tributary Module
    ii) Configuration/Set-up error
    iii) PSU alarm

c) Supervisory Input/output status

d) Equipment Temperature and battery voltage

The Network Interface Module also responds to some diagnostic commands and telecommands downloaded from the NMS. The various commands downloaded are

A) Diagnostic Commands:

i) Tributary-A local loopback: 2 Mb stream coming out of Trib-A is looped back into the input
ii) Tributary-B local loopback: Same as that of Trib-A but with Trib-B
iii) Tributary-A remote loopback: 2 Mb stream going into of Trib-A is looped back into the input
iv) Tributary-B remote loopback: Same as Trib-A but with Trib-B
v) Digital Bypass: This command is primarily meant for isolating the local access. However due to the flexibility of the channel mapping through the cross-connect table, the configuration need not be simple connections of channels of Tributary A to Tributary B. This may be utilized as switching of a modified table of a particular Flexi MUX remotely for some diagnostic purpose temporarily.
vi) Injection of 1 KHz tone to a particular voice channel. Level of this tone is typically 0 dbm.
vii) Loopback of individual time slot of Tributary A, Tributary B or local port.

All the above diagnostic commands can be withdrawn by sending an AUTO command from the NMS. Diagnostic command (i) to (v) can be invoked for a programmable time-duration after which the command is automatically withdrawn.

B) Tele commands

The NMS can operate remotely the control output relays (2 Nos.) sitting on the Network Interface Module. Separate commands are there to switch it ON and OFF.

After the command is received the Network Interface Module executes the command and uploads the success or failure of the command execution. The Network Management System prompts the status of command execution on the screen accordingly.

The Network Interface Module also stores history of the alarm status in an internal FIFO buffer with time-stamp. Whenever there is a change of alarm or supervisory input/output status, it stores the complete snapshot of the equipment marked with time. Resolution of this event logging is 1 minute and in the snapshot it latches all the changes that have occurred. Thus it can acquire more than one event in each snapshot. The depth of the FIFO is 32 snapshots. If the number of snapshots is more than 32 then the first snapshot is popped out to make room for the latest one.

The NMS downloads the date and time of the computer at the command of the supervisor. On receiving the Alarm History command, the Network Interface Module uploads all the events it has recorded in its FIFO.

Acquisition of Alarm and Supervisory Input

The Network Interface Module receives the status of the 2 Mb ports from the Tributary Module through the serial link. These network alarm information is then used for display and G.821 processing which is then reported to NMS on request.

Apart from the network alarms, the unit accepts four opto-isolated external inputs. These supervisory inputs are ON/OFF type in nature. These supervisory inputs may be used to monitor the status of some external equipment of the site, like charger ON/OFF, door open/close, blower or AC ON/OFF etc. The unit also monitors the battery voltage and the temperature inside the equipment which are very important for the operation and maintenance of the network.

Alarm and Control Output

Based on the alarm status of the 2Mb streams of Tributary A and B, the unit activates Major alarm and Minor alarm relay for extending the alarm outside the equipment. Separate relays are provided for Tributary-A and Tributary-B.

Whenever there is a change of alarm status of Tributary or System, a separate relay is activated which may be used for activating a hooter to draw the attention of the operator at site. The relay is deactivated on pressing an acknowledgement key on the front panel or when the alarm status is scanned by the NMS.

Alarm display

The Network Interface module has a number of LED displays on the front panel to indicate the alarm status of the equipment. All the major alarms are displayed by red LEDs while the minor alarms by amber LED. The various displays available on the front panel are

Alarm Description for 2 Mb stream	LED
a) RXF (2 Mb loss)	Red
b) AIS	Red
c) Sync loss (SYNC)	Red
d) Remote Multiframe Alarm (RMA)	Amber
e) BER < 10^{-3}	Red
f) 10^{-3} < BER < 10^{-6}	Blinking Red
g) Remote Alarm (RA)	Amber

Errors (a) to (g) above are separately displayed for the two 2 Mb tributaries of the link in tandem.

Alarm Description for 2 Mb stream	LED
a) SYS OK	Green
b) NMS	Green (blinking to indicate network activity)
c) CONFIG ERR	Red blinking
d) Bypass (BYP)	Red

The system OK LED provides the summary alarm of any one of the following.

a) Memory corruption (RAM, ROM, and EEPROM)
b) Inter-processor communication error
c) PSU alarm
d) Configuration error

The system OK LED blinks when no system alarm is there but records an event in the history FIFO due to some status change in the Tributary or Supervisory I/O. In case of any failure in the Network Interface module as mentioned above, the tributary module continues to perform so far as its configuration table remains intact. If however, the configuration table of tributary unit gets corrupted, it tries to retrieve the table from the Network interface module, failing which it forces the system to analog bypass.

Switch Setting of Networking Interface Module

Switch – S1

Switch Position	Status	Remarks
1	OFF	NA
	ON	NA
2	OFF	NA
	ON	NA
3	OFF	Master
	ON	Slave
4	OFF	External NMS
	ON	Internal NMS

For external NMS, separate supervisory channel is to be provided for network monitoring.

For internal NMS, no separate supervisory channel is required. The spare bits of TS0, NFAS are used for network monitoring. In this case, the craft terminal station is to be set as internal master, rest all stations in the link as internal slave.

Tributary Module

The Tributary Module is the heart of the system which interfaces to the 2 Mbps stream and realizes the add-drop function of the channel through digital cross-connect. Figure 2.4 presents the block diagram of the Tributary Module. The function of the Tributary Module is to

- Extract the master clock (MCLK) of the Network from the incoming 2 Mbps stream. The node is made synchronized to the MCLK
- Synchronize the phase of the incoming frame of the incoming 2 Mbps stream and also that of the internal 2 Mb bus for local access
- Cross-connect 64 Kbps digital data along with signaling data
- Perform PCM summing of Conference channels along with logical summing of corresponding signaling data
- Generate 2 Mbps internal TDM bus for channel units
- Generate 2 Mbps HDB-3 encoded interface signals complying with ITU-T G.703
- Collect and analyze equipment and line faults and take necessary actions
- Control jitter to a limit well below the ITU-T limit (G.823)
- Report to Network Interface module about alarm status of E1 stream & module
- Support a communication channel through the use of National bits of TS0 for Network Monitoring and Control.

Please refer fig.2.4 showing block diagram of Tributary Interface Module.

2 Mb/s Line Interface Unit

The Tributary module accepts two 2 Mbps HDB-3 signal (G.703) from two directions in G.732 format and the third 2 Mbps NRZ signal from PCM channel port (Fig.2.4). Each 2 Mbps in HDB3 format first face the NRZ line interface unit that converts the HDB-3 waveform to the corresponding logical levels. A digital phase lock loop (PLL) with 32 bit jitter attenuator is used to extract clock and data and absorb phase and frequency difference between the recovered clock and the incoming bit stream. The derived data of the two streams are then presented to frame aligners to locate and synchronize the frame and Multiframe boundaries.

Each stream of the recorded clock and data then passes through jitter attenuator to the framer which locates frame and Multiframe boundaries and extracts alarms also. Then the data enters into an elastic buffer which absorbs phase and frequency differences between the incoming stream and the master clock of the system as well as network. The stream then undergoes through cross connections as desired. The outgoing stream is transmitted in synchronization with master clock and also synchronised within them. Processed national bits may also be inserted into the TX stream which ultimately formatted to form again.

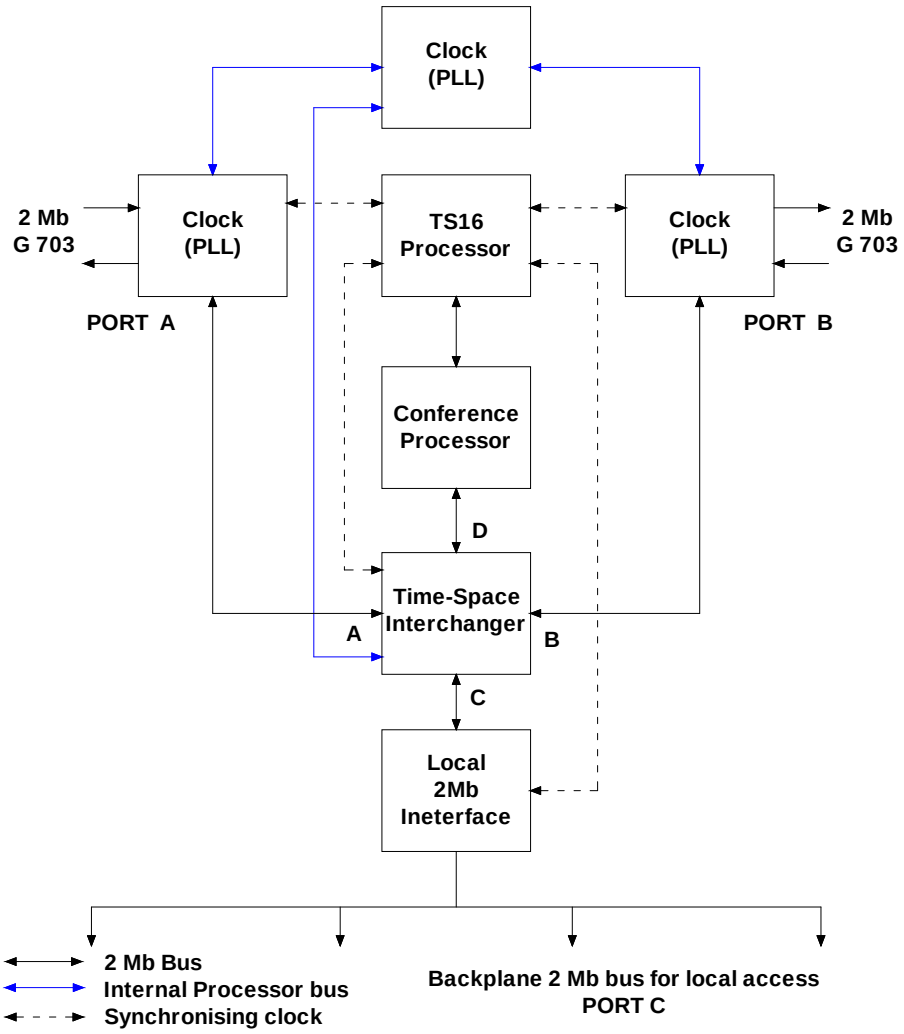


Fig.2.4 Block diagram of Tributary Interface Module

The unit also monitors the line condition and errors of the incoming stream and reports to the main processor unit for necessary actions.

Both the incoming and outgoing streams are coupled through isolation transformers. Strap option has been provided to select line impedance of 75Ω unbalanced or 120Ω balanced interface.

The Clock Section

The system can work from three clock sources internal, external & derived as selected by the user. The normal operation of the system is from the extracted clock of the 2 Mbps stream. The system also has a choice of internal clock source derived from a crystal or external clock source received in HDB-3 format.

In a tandem network, one of the 2 Mb stream is selected as the source of clock (Master) and the other 2 Mb tributary runs with the derived clock. In case the master clock fails (2Mb loss) the system automatically switches over to the alternate clock source i.e. internal or external (selectable through jumper) to keep the network operational.

DIGITAL CROSS- CONNECT AND ADD/DROP OPERATION

The heart of the system is a time-space interchanger unit which can handle four time-division multiplexed serial bit stream up to 4 Mbps. The two 2 Mbps streams received from the network are presented to the two ports (A&B) of the interchanger. The third port (C) is used for interfacing to the local channel access modules and the fourth port (D) is utilized for voice conferencing. The unit performs serial to parallel format conversion and stores the data in an internal time-slot memory. For outgoing data, the unit uses a connection memory where the address of data is stored through the microprocessor. This connection memory specifies the interchange by defining when and how the time slots leave the time slot memory. The output section performs the inverse function of the input section and converts the byte-wide data to the corresponding serial stream.

The information of the time slot interchange among the four ports are defined by the users through the use of the "Super-Net" Network Management System. With the help of a semi-graphical interactive screen, the user can simply define which time slots to add and drop which channels to undergo conferencing with local voice and which are the channels to pass through. All the switching and interchange operation is done digitally and so the voice channels do not suffer any loss of quality. The software performs all the mapping and downloading operation of the cross-connect information to the respective nodes.

The cross-connect information is stored in EEPROM in the Network Interface Module. The Tributary Module retrieves the cross-connect information as and when required. Altogether six such tables can be stored in the EEPROM to cater for various cross-connect requirements under various network conditions. The unit automatically switches over to an alternate configuration based on the alarm status of any one of the incoming 2 Mb stream.

The various channel-combinations for different situations are as under.

a) Normal Condition without any alarm
b) Major alarm in master port
c) Major alarm in slave port
d) Remote alarm received from master port
e) Remote alarm received from slave port
f) Digital bypass

The above channel cross-connect combination can be used to effectively realize link protection through diversion of important channels via alternate routes.

Local Access

Port C of the time-space interchanger is used to add and drop local channels. Timing information as obtained from the line interface unit is used to derive respective time-slot pulses. The channel units interface to these synchronizing pulses including MCLK and the serial 2 Mb data stream to get the access to the specific time-slot windows for communication.

The voice channel modules use A-law Codecs and consume all the 8 bits of a time slot. Gain of any voice channel can be programmed (in steps of 0.5 dB) through NMS. The low-speed data modules do not need the 64 Kb bandwidth of a time slot and so it can sub multiplex multiple data streams as per V.110 format to selected bits of a time slot. High speed data modules (48/58/64 Kbps) however consume the complete time slot for transmission.

Voice and Digital Conferencing

Conferencing of voice is achieved first by normalizing the A-law encoded data, then adding it to the respective normalized data of the associated channel and converting back the normalized sum data to the A-law format. This is done in real time in digital format by a separate conferencing unit conforming to G.711 in A-law format.

The fourth port of the time-space interchanger presents the individual channel data which require conferencing to the external conferencing unit. These channel data are then presented to the digital conferencing processor (implemented by a Gate VLSI and a EPROM) the output of which is then received back through the same port for necessary routing through the time-space switch.

Conferencing of digital data is different from that of voice and is also required in a network to implement polled data. This is achieved by simply logical ANDing of the respective time slot data. Since the requirement of digital conferencing is less, this feature is optionally provided on time slot 31 only.

CROSS-CONNECTION OF SIGNALLING INFORMATION

The signalling information is sent through time slot 16 of the 2 Mb stream in an interleaved format. The time-space interchanger unit cross-connects complete 8 bits of a time-slot and does not deal with the interleaved signalling information. The signalling information is extracted separately in a TS16 processor which also performs a time-space switching of signalling information in parallel to the time-slot interchanger. The processed signalling information is then presented to the two line interface units and the local channel modules in the desired format.

Signalling information of conference channels are derived by logically ANDing of the corresponding signalling data.

Service Data Channel

The system offers two modes of access for interfacing to the Network manager through the "Super-Net".

In the external mode, the system provides an RS232C port operating at 1200 baud for the access. The "Super-Net" is then supported through the overhead bit stream of the transmission equipment and it provides a unified access to both the transmission equipment OptiMUX-8 and multiplexer equipment Flexi MUX.

In the internal mode of operation, the system utilizes the unused National bits of the non-framed time slot TS0 to service channel. Two national bits have used which supports a baud rate of 8 Kbaud. It has a three port data bridge with logic ANDing of data to form a polled data network. Two of these ports are coupled to the two 2 Mb streams A and B while the third is extended to the Network Interface module for the local access of information.

The National Manager is then interfaced to the polled internal network through the RS232C port via the Network Interface module. Only one such node is normally enabled to provide such through access to avoid collision.

Switch Setting of Tributary Card. Switch – S1

Switch Position	Status	Remarks
1	OFF	Normal mode
	ON	CRC4 mode
2	OFF	Normal End Terminal
	ON	End Terminal with protection
3	OFF	Trib-A set as Master
	ON	Trib-B set as Master
4	OFF	Transmit remote alarms to other end
	ON	Stop transmitting remote alarm to other end
5	OFF	Terminal set to D/I mode
	ON	Terminal set to End Terminal mode
6	OFF	Terminal operate in extracted clock
	ON	Terminal operated in internal clock
7	OFF	2 Mb/s port set to 75 Ω impedance
	ON	2 Mb/s port set to 120 Ω impedance
8	OFF	Remote tables switching disable
	ON	Remote tables switching enable

Jumper Settings:

Mode	Jumper	Pins
120 Ω operation	E1, E2, E3, E4, E5, E10, E11, E12, E13, E14, E15	1, 2
75 Ω operation	E1, E2, E3, E4, E5, E10,E11, E12, E13, E14, E15	2, 3
Normal Et/DT mode	E33	1, 2
Protected Et mode	E33	2, 3

Voice Access Module

The ultimate objective of the Flexi MUX is to add/drop selective time slots from the time multiplexed 2 Mb data stream for local access of voice and/or data. Each access modules accommodates four channels per card. The modules can be plugged into anyone of the physical slots of the sub rack for extending the connection to the subscriber equipment. Using the flexible channel cross-connect feature, any time slot of 2 Mb stream can be mapped to any one of the local channel access module for the necessary interconnection.

For voice, normally various types of access interfaces are required to satisfy the user's requirement. The following standard interfaces are supported by the Voice Access Module.

a) 2W/4W E&M Interface
b) Subscriber Interface
c) Exchange Interface
d) Hot Line Interface

To enhance the flexibility of the type of access, the various interfaces are provided by small plug-in modules which are fitted to any one of the four adaptor sockets of the voice module. The basic voice module provides 4W voice with 3 bit signaling as per ITU-T format. This is then converted to the necessary signaling format in the plug-in module as required for the specific interface. This flexible feature provides maximum utilization of channel access without sacrificing any time slot.

Principle of Operation

The basic operation of the voice module can be divided into 3 sections. 1) Voice interface, 2) Signaling interface and 3) programming interface.

The voice is interfaced to the 2 Mb digital streams through a Codec operating in ITU-T A-Law format. It has two sections transmit and receive. In the transmit section, the user's voice is received through the hardware analog interface and a buffer which is then scaled and fed to the Codec for analog to digital conversion. The digitized value is then inserted to the designated time slot in the 2 Mb backplane bus.

On the receive side, the Codec identifies the designated rime slot from the 2 Mb backplane bus and extracts the encoded data from the internal data stream. The digital data then undergoes digital to analog conversion to derive the analog voice signal. This is then buffered and fed to the interface hardware to meet the requisite access format of the user.

The signaling information is handled through digital ports. On the incoming side, the interface hardware converts the signaling information to the TTL level which is then read by the Tributary module by the TS16 processor. On the other hand the signaling information received by the TS16 processor from the 2 Mb stream is latched to an output port at TTL level. The TTL level signals are then fed to the interface hardware for conversion to the necessary access requirement.

The Tributary Module provides all the necessary pulses and clocks of the time slot and data through the backplane. Operation of the access modules are synchronized to all these pulses for its operation. The level of the speech signal is adjusted by the Codec internally

depending on certain parameters. These parameters are downloaded to the Codec through a backplane serial bus by the Network Interface Module. The total range of adjustment is 20 db in steps of 0.1 db for both transmit and receive direction.

2W/4W E&M Interface

For 4W interface circuit, the voice is extended through a pair of balance line for both transmit and receive. Separate line transformers are used for this purpose. The impedance is matched for 600 ohms.

Signaling is provided by separate E and M leads. M lead provides the incoming signaling which is sensed by an opto-isolator. The user's equipment normally extends earth or no-earth which is sensed by the opto-isolator against the primary -48V. E-lead provides the outgoing signaling and it extends earth or no-earth through a transistor acting as a solid-state switch.

For 2W interface of voice, both the Trans and Receive voice is fed to the outgoing transformer working in hybrid mode.

Jumper Settings:

Mode	Jumper	Pins
4W	E1, E2, E3, E4	2, 3
2W	E1, E2, E3, E4	1, 2

Potentiometer Settings:

Mode	Pot.	Value
4W	R22	9.0 KΩ
2W	R22	4.5 KΩ

Subscriber Interface

This interface is normally used for extending a voice to the plain old telephone sets (POTS). In this interface both the signaling and voice is sent over one pair of wire. The unit provides talk current from the primary – 48V source for the operation of the telephone set. Hook condition and dial pulses are sent by interrupting the loop current in the handset. The interface also has built-in ringer to buzz the phone for incoming calls.

The subscriber interface along with the exchange interface described below can be used for extending the subscribers of a local exchange to remote sites through the Flexi MUX.

To make the subscriber work as hotline or vice versa following jumper settings are to be done.

Mode	Jumper	Pins
Subs	E1, E2, E3, E5	2, 3
	E4	3, 4
Hotline	E1, E2, E3, E4, E5	1, 2

For long ring, E6 is to be positioned as 1, 2.

Exchange Interface

This interface is used for interfacing the exchange side of a subscriber line. Depending on the hook status of the subscriber, the exchange interface extends loop to the exchange. It basically emulates the function of the telephone to the exchange and reproduces the voice and signaling of the telephone set. It also senses the ring and loop reversal condition which is sent to the subscriber interface for reproduction.

Hotline Interface

This is basically subscriber to subscriber interface. Depending on the off-hook status at one end, the ringer is activated at the other end. The ringer is automatically deactivated as soon as the handset is lifted. After the conversation is over, both the user will have to comeback to the on-hook condition to enable the ring again.

By changing two straps on the subscriber interface, the same module can be converted to hotline interface.

To make the subscriber work as hotline or vice versa following jumper settings are to be done.

Mode	Jumper	Pins
Subs	E1, E2, E3, E5	2, 3
	E4	3, 4
Hotline	E1, E2, E3, E4, E5	1, 2

Power Supply Module

The power supply unit operates from 48V supply. The input power is fed through a surge protector and filter section to protect the system from high voltage spikes and lightning strikes coming along the power line. The first stage is a Gas Arrestor which can absorb high energy pulses. This is followed by LC filter which then faces a transient protector to bring down the spikes within acceptable limit. The primary supply is connected to earth through voltage capacitors to bypass AC noises but ensuring DC isolation.

Each PSU has three separate switching power supply modules, one for ±5V, one for ±10V and another for +80V. They are also mutually isolated with each other. +5V is used to operate all the digital devices of the system. The ±10V is post regulated in different card to ± 5V and is used to drive the analog devices. The card also has under-voltage and over-voltage alarm for both input and output. The capacities of the PSUs are overrated adequately so that each of the PSUs individually can support the whole system.

LED Display Status:

PSU OK	It is a green LED. When the power supply is functioning properly it glows.
PSU ERR	It is a yellow LED. Any one of the output voltages has under voltage it glows
SHUT DN	It is a red LED. When the power supply goes into shutdown due to input under voltage or overvoltage or output over voltage it glows.
SW1	It is the power ON switch.

Under-voltage alarms of +5V, ±10 & +80V are extended to the processor module to the backplane.

The power supply is rated as follows:

+5V	2.5 Amp
±10V	0.75 Amp
+80V	0.05 Amp

For a typical configuration with 20 E&M, 4 Exchange, 4 Subs/Hotline and 2 G.703 data, the typical power consumption is 48 watts.

The output voltages, adjustments can be done through the following potentiometers.

Voltages	Pots	Range
5V	R20	4.75V - 5.6V
±10V	R41	9.20V - 11.8V
80V	R67	70V - 100V

64 KB/S DATA INTERFACE (G.703)

One 64 Kb/s data card caters for two 64 Kb/s co directional data channel which conforms to ITU-T G703 requirement. Each channel consists of a general purpose line interface chip (XR-T6164). It contains both transmit and receive circuitry to interface TTL signal either from or to a twisted pair cable in conjunction with the XR-T6l64, the XR-T6165 will form a ITU-T G.703 compatible 64 Kb/s data adaption unit, interfacing between 2048 Kb/s PCM highway and a variable length twisted pair cable.

DETAILED OPERATION:

Transmit Side: Data signal coming from the DTE will face 1:1:1 isolation transformer for isolating line side interface and digital PCM interface. XR-T6164 takes balanced bipo1ar input signals, having been attenuated and distorted by twisted pair cable and outputs TTL compatible active low signals corresponding to receive positive and negative input data. In XR-T6164 received signals are fed to a peak detector and threshold generator circuit providing a slicing threshold proportional to the peak received input level. Dual stage data comparators XR-T6164 slice the input signals at this threshold and pass signals to output buffers. An alarm comparator, with hysteresis to prevent output jitter, monitors input signal levels (threshold set at 15 db).

These TTL compatible output signals then fed to XR—T6165 co directional data processor. XR-T6165 will receive coded continuous 64 Kb/s input and extract data in the form required for insertion into a 2048 Kb/s PCM timeslot. A 128 KHz clock is derived from the received data and used to perform decoding of the input signal. If lock is lost with received data the clock circuit enters seek mode, increasing the speed of the internal clock and reducing the time required to regain lock. Bipolar violations, used to identify bit 1 in the input signal are used to synchronize circuit operation for octet timing. In the absence of violations, for example in the absence of violations, for example when receiving a transmitted alarm condition, the circuit will continue to operate in synchronization with respect to the last

received violation. Under this condition the received signal PCMOUT (Received PCM output data) is held high indicating AIS. This function may BLS and the output set to all ones if required using the BLANK INPUT. ALARM goes high after eight consecutive violations are missed. TO accommodate differences between the (transmitting) and local rate, slip control logic is included in the receiver design. Under fast conditions the last output PCM data will be deleted periodically, while fast conditions the last output PCM data will be repeated. Octet timing is maintained during these operations. Data appearing at PCMOUT is arranged to be completely framed by the read timeslot signal and is glitch free.

Receive Side: In the receive direction XR-T6165 will convert eight bit 2048 Kb/s PCM timeslot data packets into coded continuous 64 Kb/s data. PCM data is read into the transmitter using a 2048 KHz local clock. Four periods are dedicated to each bit in order to code "0" (0101) and "1" (0011). Timeslot is an envelope derived externally from the 2048 KHz clock and covers eight clock pulses. Data is loaded to a storage buffer and transferred to an output shift register, controlled by the external 256 KHz signal, only after complete transmission of previously received data. A byte repetition just occurs once; if no new PCM data is received, the transmitter outputs stay high. Octet timing is maintained during these operations. Coded data is alternately fed to two output pins to release AMI coding.

The XR-T6164 transmitter contains two matched open collector output drivers capable of driving line transformers directly with currents up to 40mA. The transmitter output circuits include diode clamps to ensure non-saturating operation. Transmitter inputs are TTL compatible.

Low Speed Digital Data Module

The Low Speed Data Module is primarily meant for extending asynchronous low speed RS232C data circuits through the F1ex1MUX. The module works in bit transparent mode and acts as a data pipe irrespective of the data. It can also work in synchronous mode in which case the incoming and outgoing data will have to be synchronized to the clock signal provided by the module (contra directional data).

Each time slot of the 2 Mb frame provides a bit rate of 64 Kbps. Low speed data channels can very well be accommodate into such a high bit rate channel. However, for better utilization of the information bandwidth a V.110 sub multiplexing format is used to support multiple low speed data on a single time slot.

This module supports baud rate ranging from 600 baud to 19.2 K baud. The number of bits of a time slot required is given below:

Up to 4800 baud	:	1bit
9600 baud	:	2 bit
19.2 K baud	:	4 bit

To exploit the network bandwidth efficiently for data communication, time slots TS3O and TS31 are extended to both the card slots 8 and 9 of the sub rack. However, this does not limit the use of these slots for voice communication, if required.

Each data access module supports four channels. The channels can be configured as either synchronous or asynchronous mode of operation. Each of the channels supports all the handshaking lines required for the V.24 protocol. The handshaking signals are status information of the DTE and DCE connected at two nodes of the network which are just extended through the network.

Alarm Display

Eight LEDs (DS1 to DS8) indicate the alarm status as follows.

Description	LED Name	Colour
Configuration OK	CNF OK	Green
Receive Data of DCE	RX D	Green
Trans Data of DCE	TX D	Green
Data Channel configuration Error	DCH Error	Red

LED display status:

LED Status	CNF OK	DCH Err
Configuration OK channel disable	OFF	OFF
Configuration OK channel enabled and link OK	ON	OFF
Configuration OK channel enabled but link fail	ON	Blink
Configuration Error	OFF	ON

The transmitted and received data status of each ITAC is indicated by other eight LEDs (DS9 to DSI6), as TXD & RXD on the front panel.

NX64 DATA INTERFACE

The Nx64 Data Interface card is meant for extending the WAN based data network or video conference circuits through Flexi Mux. It works in Synchronous mode with V.35 or V.36 interfaces with the clock slaved from DCE. The module supports two channels configurable from 64 kbps (N=1) up to 1920 kbps (N=3O).

The loopback commands can be given from front panel also through switch SW1 & SW2. The LED indication gives status of TxD, RxD and Local / Remote loopbacks.

LED Indication

Channel	Description	LED Name	Colour
1	Transmit data	TxD	Green
	Receive data	RxD	Green
	Local loopback	LL	Amber
	Remote loopback	RL	Amber
2	Transmit data	TxD	Green
	Receive data	RxD	Green
	Local loopback	LL	Amber
	Remote loopback	RL	Amber

E1 BRANCHING MODULE

This module is tested to create a third tributary by cross-connecting required time slots from Port-A or Port-B to Port-C. It gives out 2 Mbps HDB3 framed output in balanced 120Ω termination at the backplane connector of that particular slot in which it is inserted. By this module it is possible to create spur link by diverting required time slots without dropping the channels at voice/data level. All the NMS functions are available in spur link.

LED Indication:

Description	LED Name	Colour
System OK	OK	Green
Receive Fail	RXF	Red
Alarm Indicating Signal	AIS	Red
Loss of Synchronization	LOS	Red
Bit Error Rate	BER 1E-3	Red
Remote Alarm	RA	Amber
Remote Multiframe	RMA	Amber
Loopback Status	LPBKC	Amber

(LPBKC -Permanent for Local / Blinking for Remote)

IDSL

The Digital Subscriber Line Interface Circuit is designed to provide ISDN basic rate access (2B+D) at U-interface. Full duplex digital transmission at 160 Kbits on a single twisted pair in conjunction with the high performance 2B1Q line code, allows the IDSL to meet the loop length requirements >4km of the digital subscriber loop at the U-interface.

It consists of two parts, IDSL-LT (at the MUX side) and IDSL-NT (at the remote side)

IDSL-LT

The two B-channels and the D-channel to be transmitted on the line are input to the LT (on the 2 BM bus) into the transmit interface. The sync word and maintenance bits are added to the data which is then formatted, scrambled and digitally encoded into 2B1Q symbols. The transceiver transfers full duplex, time division multiplexed data at 160 Kbit/s. This includes two 64 Kbit/s PCM data channels (B-channels) a 16 Kbit/s signalling channel (D-channel) and a 16 Kbit/s for synchronization and overhead. Two 64 Kbit/s channels are defined as the El and B2 channels and they carry subscriber information (data). The LT will transfer both B-channels transparently from the 2 BM bus to the line port and vice versa once the device has acquired super frame synchronization with the NT. The transceiver used the 2B1Q line code which is a four level Pulse Amplitude Modulated (PAM) code.

The IDSL-LT card consists of two IDSL-U interfaces (IDSL-1 & IDSL-2). Each IDSL-U interface occupies two 64 Kbps PCM channel as per cross connection table of the MUX. The card can be inserted in any I/0 slots.

Jumper setting

IDSL 1		IDSL 2	
E9	LT position	E12	LT position
E10	S position	E11	S position
E13	EN position	E14	EN position
E17	To enable / disable B1 ch	E19	To enable / disable B1 ch
E18	To enable / disable B2 oh	E20	To enable / disable B2 ch

Switch Setting

SW2 (IDSL-1)				Function
1	2	3	4	
ON	ON	ON	OFF	B1 chnl local loop back
ON	ON	OFF	ON	B2 chnl local loop back
ON	ON	OFF	OFF	B1+B2+D chnl local loop back
ON	OFF	ON	OFF	B1 chnl remote loop back
ON	OFF	OFF	ON	B2 chnl remote loop back
ON	OFF	OFF	OFF	B1+B2+D chnl remote loop back

SW2 (IDSL-2)				Function
1	2	3	4	
ON	ON	ON	OFF	B1 chnl local loop back
ON	ON	OFF	ON	B2 chnl local loop back
ON	ON	OFF	OFF	B1+B2+D chnl local loop back
ON	OFF	ON	OFF	B1 chnl remote loop back
ON	OFF	OFF	ON	B2 chnl remote loop back
ON	OFF	OFF	OFF	B1+B2+D chnl remote loop back

- Local loopback — data will be looped back towards the NT from the 2 Mb side.
- Remote loopback — data will be looped back towards the 2 Mb side from the U-interface (line side)

LED Indication

IDSL-1

- Green Led - Glowing NT-LT link OK, OFF NT-LT link Not OK
- Red - Glowing NT-LT link faulty (no communication)
- Yellow - Local loopback if glowing
- Yellow - Remote loopback if glowing

IDSL-2

- Green Led - Glowing NT-LT link OK, OFF NT-LT link Not OK
- Red - Glowing NT-LT link faulty (no communication)
- Yellow - Local loopback if glowing
- Yellow - Remote loopback if glowing

IDSL-NT

The function of NT is to provide customer equipment interface to the U interface and to communicate to the LT synchronously. The NT can be configured through network monitoring system as per requirement. It derives the two B-channels from the IDSL line and direct it to either G.703 or V.35 interface (as per configuration) to give customer access. The NT consists of two G.703 port, two V.35 port and one U Interface. Power to the NT is provided by a separate PSU (230V ± 10%, 1 ph, 50 Hz input, output +6 VDC).

The NT can he configured through the NMS as follows.

G.703 port-1	G.703 port-2	V.35 port-1	V.35 port-2	Data Rate
Enable (B1 chnl)	Enable (B2 chnl)	Not enabled	Not enabled	64 kbps in each G.703 chnl
Enable (B1 chnl)	Not enabled	Enable (B2 chnl)	Not enabled	64 kbps in each chnl one G.703 one V.35
Enable (B1 chnl)	Not enabled	Not enabled	Enable (B2 chnl)	64 kbps in each chnl one G.703 one V.35
Not enabled	Enable (B2 chnl)	Enable (B1 chnl)	Not enabled	64 kbps in each chnl one G.703 one V.35
Not enabled	Enable (B2 chnl)	Not enabled	Enable (B1 chnl)	64 kbps in each chnl one G.703 one V.35
Not enabled	Not enabled	Enable (B1 chnl)	Enable (B2 chnl)	Each V.35 at 64 kbps
Not enabled	Not enabled	Enable (B2 chnl)	Enable (B1 chnl)	Each V.35 at 64 kbps
Not enabled	Not enabled	Enable (B1+B2 chnl)	Not enabled	V.35 port 1 at 128 kbps
Not enabled	Not enabled	Not enabled	Enable (B1+B2 chnl)	V.35 port 1 at 128 kbps

Switch Setting

SW2 (IDSL-1)				Function
1	2	3	4	
ON	ON	ON	OFF	B1 chnl local loop back
ON	ON	OFF	ON	B2 chnl local loop back
ON	ON	OFF	OFF	B1+B2+D chnl local loop back
ON	OFF	ON	OFF	B1 chnl remote loop back
ON	OFF	OFF	ON	B2 chnl remote loop back
ON	OFF	OFF	OFF	B1+B2+D chnl remote loop back
ON	ON	ON	ON	Withdraw loop

- Local loopback — loopback towards the selected port (G.703 or V.35) at selected rate.
- Remote loopback — loopback towards the U-interface.

LED Indication

Green	Power LED	Glows when NT is ON
Green	L-OK LED	Glows when NT-LT link is OK, Off when NT-LT link is not OK
Red	LF LED	Glows when NT-LT link is not OK

Yellow	RLB LED	Glows when there is any remote loopback
Yellow	LLB LED	Glows when there is any local loopback
Green	B2-P2 LED	Glows when B2 chnl is configured to V.35 port 2
Yellow	B1-P2 LED	Glows when B1 chnl is configured to V.35 port 2
Yellow	B2-P1 LED	Glows when B2 chnl is configured to V.35 port 1
Green	B1-P1 LED	Glows when B1 chnl is configured to V.35 port 1
Green	TXD-P1	Trans, receive LED ofV.35 port I
Yellow	RXD-P1	
Green	TXD-P2	Trans. receive LED of V.35 port 2
Yellow	RXD-P2	
Yellow	Sync	G.703 port-1/2 LED - glows when any problem in G.703 port-1/2
Red	LOS	
Yellow	OVF/UVF	

2.4 INSTALLATION

Preliminary Considerations and Site Preparation

There are a number of preliminary tasks which can be completed in preparation for the equipment installation. Proper site preparation will significantly expedite the final installation process. The following tasks should he completed in advance

(I) ensure that the closed/open rack where the equipment will be fixed is properly grouted on the floor of the equipment room
(2) Cable tray should also be properly placed
(3) make sure that Digital Distribution Frame (DDF) and Main Distribution Frame (MDF) are placed properly.
(4) The battery & charger should be at reasonable distance from the equipment.
(5) Ensure that the general condition of the equipment room is not damp.

Power Supply Requirements: The standard input voltage for FIexiMUX is -48 VDC. The acceptable input voltage range is between -36 VDC and -72 VDC. Standard battery plants tend to supply approximately - 52VDC. Power requirement is 48 Watts typical.

Flexi MUX Installation

Tools Required

The following tools are required to install the equipment:

(a) Medium-size Philips screwdriver
(b) Wire stripper or knife
(c) Small flat-blade screwdriver

Mounting the Flexi MUX

To mount the system in a standard EIA 19-inch wide equipment rack or cabinet, use the mounting brackets and screws supplied in the installation kit, and follow these instructions:

1) Secure the unit L-plates to the mounting rails in the equipment rack using the eight 12-24 x ½" flathead screws supplied (for standard EIA mounting) by a screw driver.

Connecting Power to Flexi MUX

Connect power to Flexi MUX using the 4-pin connector (J16) on the rear panel. (The mating plugs are pre-installed on the rear panel at the factory). The power input terminal is located on the right-hand side of rear panel. Out of the four pins, pin no.2 and pin no.3 are for -48V DC and pin no.1 and pin no.4 are for ground.

Using two different colours of wire insulation will make it easier to distinguish between the negative and positive leads.

Note: The Largest wire that can be inserted into the power connectors is 14 gauge (2.5 sq. mm). For heavier wire, terminate the power leads at a terminal block near the system and complete the connection from the terminal block to the system using smaller wire (14 or 16 gauge/2.5 sq.mm or 1.5 sq.mm).

To connect power to the system, complete the following steps

1) Be sure the power switch at the Power Supply card of the system is in the OFF position.
2) If the power leads are already connected to the power source be sure the power source is turned off.
3) Remove the 4-pin connector from the system rear panel, observe the negative and ground orientation of the connector, and connect the wires into the power supply noting the orientation.

Note: Bare copper wire must be inserted all the way Ito the connector Exposed wire extending past the connector can short out with other wires, causing immediate outage.

4) Plug the connector back into the system rear panel. Measure the input to the connector with a voltmeter to verify that it is between -36 and -72 VDC

Ground Connection to the System: Grounding of the electronics circuit is accomplished, with the -48 VDC power connector. Although additional grounding is not required for proper equipment operation, it is recommended that the ground screw on the system rear panel be used to ground the system directly to the equipment rack ground bus, or to any other suitable ground location. If a ground wire other than the one supplied with the system is used, it must be at least 18-gauge Wire.

Tools and Test Equipment: Flexi MUX has been designed specifically for easy installation, requiring no special tools or expensive test equipment. The few common hand tools and digital voltmeter necessary are specified at the beginning of each installation procedure. Please see the list of Test Equipments required in the Maintenance Section".

Basic Components: When the Flexi MUX arrives, inspect it to be sure everything is in order and to become familiar with the actual components. The major cards of Flexi MUX are Network Interface Module, Tributary Module, Voice and Data Module (as required) and Power Supply Module. Insert the cards one by one into the system. Be sure, that for the proper operation of the system one Power Supply card, Network Interface Module and Tributary Module are inserted to the system. Ensure that the cards tightly connected to the backplane. Also, do not dejack the cards on-line when the system operation.

System layout: In accordance with ITU-T G.703 recommendation, the maximum attenuation allowed between the system and terminal equipment is 6 dB,

Station Address Switches: The Station address switches are used to give the system a specific and unique address number for "Super-Net'. Up to 99 unique station identifiers can be selected with these rotary switches, each of which has settings from 0 through 9 and A through E to allow alphanumeric or hexadecimal settings. By using a small flat-blade screwdriver, set the switches for the desired address.

Powering up the System

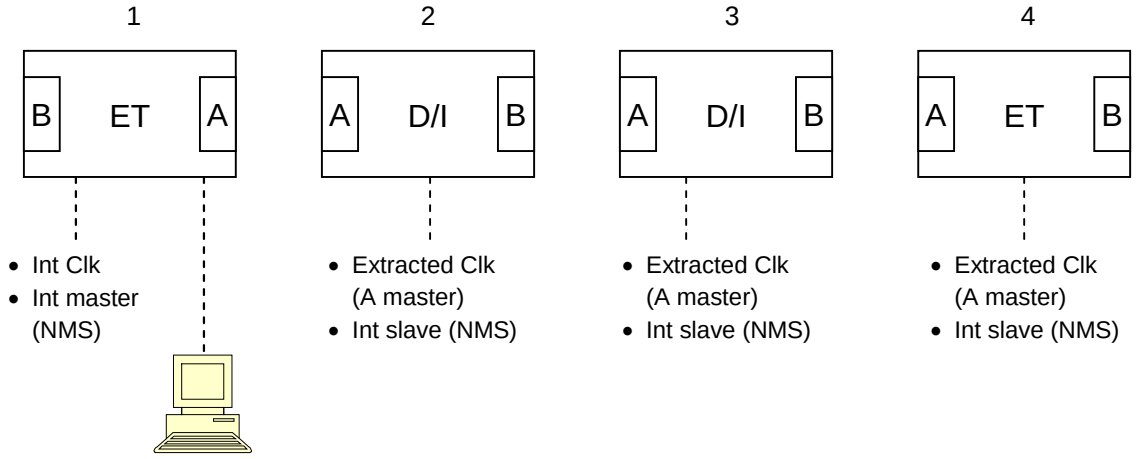
1) Ensure that powers connected properly.
2) Toggle the Power switch on.

When the power is first turned on, all LEDs of NIM card will glow steadily and all LEDs of Tributary card will blink for some time. Proper connection is to be provided at the 2 Mb level and charnel level on rear side on the appropriate connectors. Then as per the channel plan, the channel modules are to he inserted in the respective slots. With the NMS Card Parameter and Cross Connection are to be configured and downloaded in the System. The Mux then becomes ready for operation.

Some typical configurations in a network

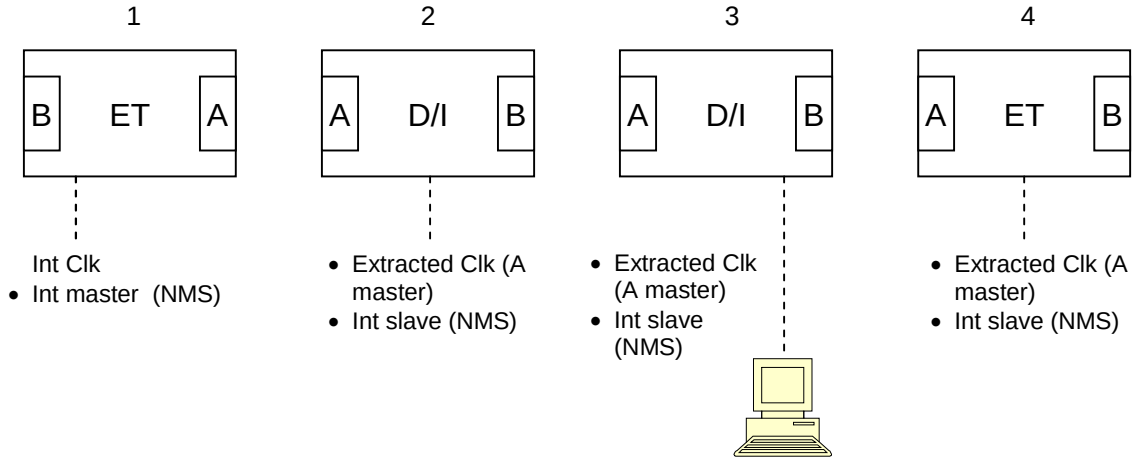
Case – I

Normal configuration with monitoring from End Terminal



Case – II

Normal configuration with monitoring from D/I



2.5 OPERATION, MAINTENANCE & TROUBLESHOOTING

Operation: The on line operation is mainly done through NMS which is discussed in 2.6

Maintenance Philosophy: In the design of FIexiMUX modular construction scheme has been followed. This results in simplified trouble-shooting and reduced downtime. Adequate alarms and monitoring points have also been provided on the system so that faulty cards can be identified.

As far as the maintenance of the system is concerned the concept of 1st and 2nd line of maintenance has been followed. The 1st line maintenance staff shall identify the faulty cards arid replace them.

The main ask of 1st line maintenance staff is as follows:

i) To carry out periodical check of various system parameters to ensure satisfactory performance of the equipment.
ii) To restore the communication link at the earliest, in case of failure.

The 2nd line maintenance staff will undertake the repair of faulty cards, assembly adjustments, testing, debugging etc.

The main purpose of routine maintenance is to perform periodic checks on the links and to verify any possible degradation in the overall service quality. Quick restoration on of a faulty link is extremely important. This is achieved by replacing the Faulty card. The routine test may be carried out weekly, monthly or yearly depending upon the importance of parameters and strength of manpower. Use of on-Line network monitoring system "Super-Net" greatly amplifies the maintenance of the link.

Diagnostic Aids: Various types of diagnostic aids have been provided to simplify the maintenance of the system.

These are as follows:

a) Alarm & Indication
b) Testing & Measurement points
c) Maintenance & diagnostics through NMS

Maintenance & Diagnostics through NMS

User of "Super-Net" can observe the current status of any terminal connected to the Net. Up to 99 equipments are possible to connect in a single network. If the equipment of any site is activated, scanning continues and data is updated at a certain interval. Any change in current status from previous one is displayed on the screen. The supervisory input, output status and performance data like Error Second, Severed Error Second, Degraded minutes etc of a particular terminal being selected by user can be observed. In case of any problem in any terminal, "Super-Net" can find fault the faulty area very intelligently. All alarm status *can* be seen with occurrence time in a history file in computer and the details of alarms can be retrieved from the logged file on the basis of query afterwards. Apart from this, alarm histories of 32 events are stored in the System and can be retrieved in situation when central monitoring is not present.

Routine Maintenance Philosophy

Routine maintenance is carried out while the system is in operation and consists of checking the important and critical parameters at the monitoring sockets provided. This will help in forecasting, to some extent a failure in a unit so that adequate steps can be taken accordingly.

Under normal operating conditions of the equipment, the following schedule is suggested for better utilization of the link.

Weekly check:

- Whether 'PSU OK' LED glows
- Whether all electrical cables and connections are properly secured and the cables are not stretched.
- To record occurrence of any type of alarm with time in a Register Book.
- Check -48V supply point of battery.
- Check alarm history and status of all stations in the network from central monitoring station.

The list of Instruments required for testing and measurement are as follows:

S.No.	Name	Make	Qty
1.	Bench Regulated Power Supply (0-80 V)	APLAB	1
2.	Digital Multimeter	HINDITRON	1
3.	Oscilloscope 400 MHz	TEKHIND	1
4.	Frequency Counter 10 MHz	FLUKE 72220 A	1
5.	Digital Transmission Analyzer	HP/W&G	1
6.	PCM Terminal Test Set	APLAB/MARCONI 2830	1
7.	Data Tester	HP/W&G	1

The list of Accessories required

S.No.	Name	Qty
1.	2 MB cables for 120 Ω and 75 Ω	2 each
2.	BNC to Banana Cord	2
3.	MDF connection module	2

FAULT LOCATING AND REPAIR INSTRUCTIONS

The system features comprehensive visual alarm indicators on the front panel of every card to assist with troubleshooting and fault isolation in the event of an equipment failure in the unit. All of the circuitry is arranged in replaceable modules which have individual alarms. Built-in diagnostics circuitry isolates the failure to the specific module which requires replacement. In addition to the individual module alarms, there are a number of alarms that assist with troubleshooting problems that occur at the remote terminals or as a result of an equipment or power failure external to the system. The cause and recommended corrective action for each alarm are explained in this section.

Transmission is not disrupted to replace the faulty channel module. For the replacement of faulty modules of the basic Mux, system has to be bypassed to avoid disruption.

This section deals with problem determination and fault isolation by using the local and remote diagnostics displayed on the front panel of the unit.

Fault Isolation and Corrective Action

The following pages discuss specific problems, possible causes, troubleshooting guidelines, and corrective actions.

The list of various fault conditions and probable fault area is furnished below:

a) Power Supply card

Indication	Diagnosis	Remarks
PSUOK-green steady	Input and output voltages are OK	
PSU ERR — yellow steady	Any of the output voltages has under voltage.	Power supply card maybe faulty.
Shutdown — red steady	Power supply is shutdown due to input under voltage or overvoltage or output over-voltage.	Line over-voltage or under-voltage condition may have occurred. Otherwise, any short circuit on the o/p side.

b)NIM & Tributary card

Indications			Diagnosis	Remarks
Sys OK- green steady		Sys OK-green steady	Indicates that there is no alarm in the link	
A Port	RXF - red steady	TAF — red steady	2 Mb loss in A-port.	If the alarm RXF goes off on loopback, it indicates a failure in the transmission side. If the cable connection is OK, then problem may be with Tributary card.
	AIS - red steady		All ones in A-port.	Transmission link failure.
	LOS—red steady		LOS indicates a frame or multiframe loss.	If the alarm RXF goes off on Loopback, it indicates a failure in the transmission side. Otherwise If the cable connection is OK, the problem may be with tributary card.
	BER—red steady		Steady glow of BER alarm indicates bit error of more than 1 error bit in 1000 bits	Probable cause lies with link performance. If link is OK, then problem may be with Tributary card.
	BER - red blinking		Blinking BER indicates bit error greater than $1X10^{-6}$ but less than $1X10^{-3}$	Probable cause lies with link performance. If link is OK, then problem may be with Tributary card.
	RA - amber		Remote Alarm.	Far end problem.
	RMA - amber steady		Remote Multiframe Alarm indicates a MF loss.	Far end multi frame loss. If RMA comes with RA then adjacent station problem.
B Port	Same alarm, indication and diagnosis as A—Port			
CNYG — red blinking			CNFG alarm blinks when there is mismatch between the types of cards actually plugged in our MUX and configuration programmed from NMS.	Card parameter not properly configured or downloaded.

Indication	Diagnosis	Remarks
INT/EXT clock – amber steady	INT/EXT clock LED glows when system runs with its own clock or external clock and remains off when it extracts from another.	
DIG BYP – amber steady	DIG BYP LED glows when DIG BYP command is executed from NMS.	
LPBK A – amber steady	LPBK A glows steadily when local loopback A command is executed from NMS and blinks when remote loopback A command is given.	
LPBK B – steady	LPBK B glows steadily when local loopback B command is executed from NMS and blinks when remote loopback B command is given.	

c) Status and Alarm of Interface Module

- **E1 Branching**

Indication	Diagnosis	Remarks
SYS OK – green steady	It indicates alarm condition in the branching link.	
RXF – red steady	2 Mb loss in A – port	If the alarm RXF goes off on loopback, it indicates a failure in the transmission side. Otherwise if the cable connection is OK, the problem may be with Branching module.
AIS – red steady	All ones in A – port	Transmission link failure.
LOS – red steady	LOS indicates a frame or multiframe loss	If the alarm RXF goes off on loopback, it indicates a failure in the transmission side. Otherwise if the cable connection is OK, the problem may be with Branching module.
BER – red steady	Steady glow of BER alarm indicates bit error of more than 1 error bit in 1000 bits i.e., 1E-3.	
RA – amber steady	Remote Alarm	Far end problem.
RMA – amber steady	Remote Multiframe Alarm indicates a MF loss.	Far end multiframe loss. If RMA comes with RA then adjacent station problem.
LPBK – amber steady	LPBK glows steadily when local loopback command is executed from NMS & blinks on RMT loopback command	

- **Voice Module**

E – amber	Indicates E-lead ON	
M – green	Indicates M-lead ON or Off-hook condition.	

- **G.703**

LOS – red	No input in the receive port	If cable and data termination and link are OK then problem may be with the card.
SYNC – amber	Sync loss in the input	- do -
OVF/UVF – amber	Violation of pattern	- do -

- **V.35**

DCH Error – red	Off indicates the link is OK	ON condition indicates a cross-connection failure.
RXD – green	Receive data of DCE	
TXD – green	Transmit data of DCE	
CONF OK – green	Steady glow indicates that configuration is OK.	

- **V.24**

CONF OK – green	Steady glow indicates that the channel configuration is OK.	
RXD – green	Receive data of DCE	
TXD – green	Transmit data of DCE	
DCH Error – red	Off indicates the link is OK	ON indicates a cross-connection failure.

- **Nx64**

TXD – green	Transmit data of DCE	
RXD – green	Receive data of DCE	
LLB - amber	Local loopback (LLB) glows when LLB command is given from NMS	
RLB – amber	Glows when RLB command is given from NMS	

- **IDSL - LT**

IDSL OK – green	NT – LT link OK	OFF indicates NT-LT link not OK
FAULTY-red	Link faulty	NT-LT link problem
LLB-amber	Local loopback	
RLB-amber	Remote loopback	

- **IDSL - NT**

Power LED-green	Glows when NT is ON	
L-OK LED-green	Glows when NT-LT link is OK, OFF when NT-LT link is not OK	
LF LED-red	Glows when NT-LT link is not OK	
RLB LED-amber	Glows when there is any remote loopback	
LLB LED-amber	Glows when there is any remote loopback	
B2-P2 LED-green	Glows when B2 chnl is configured to V.35 port 2	
B1-P2 LED-amber	Glows when B1 chnl is configured to V.35 port 2	
B2-P1 LED-amber	Glows when B2 chnl is configured to V.35 port 1	
B1-P1 LED-green	Glows when B1 chnl is configured to V.35 port 1	
TXD-P1 – green	Trans, receive LED of V.35 port 1	
RXD-P1 – amber		
TXD-P2 – green	Trans, receive LED of V.35 port 2	
RXD-P2 – amber		
SYNC – amber	G.703 port-2 LED – glows when any problem in G.703 port-2	
LOS - red		
OVF/UVF-amber		
SYNC – amber	G.703 port-1 LED – glows when any problem in G.703 port-1	
LOS - red		
OVF/UVF-amber		

2.6 NETWORK MANAGEMENT & SUPERVISION

Introduction: Webfil Supernet Management System (WSMS) Version 4.0, is a window based network management system (NMS), designed to configure and control FLEXIMUX Equipment. It can process information, in real time mode, received from all FLEXIMUX equipments connected in a network. With the help of this software, one can also monitor health of a particular equipment and network.

The usage of this software does not require any knowledge of computer programming. However, the user must be acquainted with the general operation of Windows'98 operating system, opening and closing various applications and printing documents using printer.

BASIC FUNCTIONS OF WEBFIL SUPERNET MANAGEMENT SYSTEM

1. Real time monitoring of network.
2. Execution of various Diagnostics & Telecommands
3. Configuration of Card Type & Parameters.
4. Configuration of Timeslots.
5. Status & Alarm history logging.
6. Viewing of logged data with specified query.
7. Performance monitoring of equipment and network.

COMPUTER SYSTEM REQUIREMENT

NMS needs the minimum PC configuration as follows:

- IBM-PC compatible - Pentium-II or higher
- 128 MB RAM
- Approximately 150 MB free disk space
- Microsoft Windows'98 Operating System
- Standard RS232c Serial Port (COM1 / COM2)
- Standard Parallel Port
- Standard PS2 Mouse connected to PS2 Port
- Standard CDROM Drive
- Color Monitor (with 800 x 600, True Color (24 Bit) setting)

CONNECTING FLEXIMUX TO YOUR PC: The communication between the supervisory computer and remote equipment is done through RS-232c asynchronous serial I/O with baud rate 1.2 Kbps. The serial port COM1 or COM2 of the computer is connected to the serial port of any of the FLEUMUX equipment [connector J15 (back side) or NMS port (front side)] with the help of serial I/O cable supplied along with the system.

INSTALLING NMS SOFTWARE IN YOUR PC

To Install Webfil NMS:

1. Insert the Webfil NMS CD into your CD-ROM drive
2. Open Windows Explorer
3. Select your CD-ROM drive and browse
4. Double click on Application **Setup.**

The First screen will appear. Click **OK** to proceed further.

In the 2nd screen you may change the default destination directory *C:\Program Files\NMS* by clicking **Change Directory** button and assign a new directory name. To proceed with the selected destination directory, click on **Install** button,

In the 3rd screen you have to select the Program group. The default Program Group is **WEBFIL NMS**. Select the Program Group arid click **Continue**.

5. Follow onscreen, message and provide inputs when you are asked for.

Finally, you will receive a message: ***"NMS is installed successfully in your computer ……".***

6. Restart your computer.

You are now ready to run *WEBFIL NMS……*

IMPORTANT TERMINOLOGY

SITE

Site is the name of location where equipment is installed. There are two names for a site. One is full name, which can be up to 15 characters and other is a short name up to 4 characters long. For most of the operation site is referred by short name The *Short Name* is a unique identity of the site and thus should be unique for the entire network. The sites are represented by circle in the network diagram.

LINK

Link means the connection between sites to observe the network operation. The solid lines in the network diagram represent the links.

EQUIPMENT

Equipment refers to the FLEXIMUX installed in a site. All equipment has unique identity called *Address* by which it is accessed.

ACTIVATION

The term *activated* or *de-activated* is related to the equipment only. If the state of the equipment is marked as *activated,* NMS will display status of that equipment during scanning operation. Otherwise, that will not be polled at the time of scanning.

SCAN

The status of *Scan* may be kept in ON or OFF state. NMS can receive real time alarm, status from the activated equipment, only when the scan is in *ON* rnode.

DEDICATED SCAN

It is a special type of scanning used mainly for maintenance purpose. This option, when enabled, scans only selected equipment and response time is fast enough to get immediate feedback from the equipment.

DATA LOGGING

The data logging can be switched ON or OFF. If it is *OFF,* the status data received from the equipment will not be saved into the database for future reference.

2.7 RUNNING WEBFIL SUPERNET MANAGEMENT SYSTEM

To Run NMS:

1. Click on **Start > Program > WEBFIL NMS > NMS**

The NMS Startup Screen appears.

The Supernet Management System is password protected. Two types of user access are allowed namely 'Administrator' and Operator'. 'Administrator' has full control over the software but operator' can access only limited operations and are not allowed to configure or save changes. After installation, a default username and password will be available:

Username	**ADMIN**
Password	user

Remember that password is case sensitive and default password 'user' is accepted only in small letters. 'Administrator' type user can, change name and password of other users but the 'operator' can change only his own password. Maximum five different login IDs can be created.

2. Click on **Login** button, enter valid user name and password then click **OK**. The NMS default screen will appear:

The default screen is divided into two parts. The lower portion is allocated to display three recent changes in the network and is always gets updated, when scan is on. Scan runs as background task. Clicking more button displays additional 25 numbers of recent changes in the network. The OFF or **ON** button (toggle operation) is used to activate or de-activate scanning. The Quit button is used to quit from the software. Quitting is not allowed while scan is on. The upper portion of the screen is allocated for foreground task.

CLOSING SUPERNET MANAGEMENT SYSTEM

You will be allowed to exit from the software only when scan is OFF.

To exit NMS

1. Click **QUIT** (Main Menu Option)
2. Click **yes** if you really want to quit

NOTE: DO NOT TURN OFF YOUR COMPUTER WHILE NMS IS RUNNING. IF YOU TURN OFF YOUR COMPUTER WITHOUT CLOSING NMS, YOU RISK LOOSING INFORMATION OR CORRUPTING THE SOFTWARE ITSELF.

Objective:

1. The sub-rack of WEBFIL Mux has altogether _____ slots for housing the various modules.
2. Slot-12 and slot-13 has equal and parallel access to time slots _____ in WEBFIL mux.
3. WEBFIL Mux uses Faulty A cross-connect table when _____ tributary is having major alarm.
4. WEBFIL Mux uses Faulty B cross-connect table when _____ tributary is having major alarm.
5. WEBFIL Mux uses Modified Remote A cross-connect table when A-tributary is having _____ alarm.
6. In WEBFIL Mux _____ enables to isolate the Mux at the event of Failure.
7. In WEBFIL Mux during the normal operation of the network the NMS is kept under _____ mode.
8. In WEBFIL Mux Network Interface Module offers alarm related to _____ Module.
9. In WEBFIL Mux all the diagnostic commands can be withdrawn by sending an _____ command from the NMS.
10. In WEBFIL Mux _____ is done in NIM card to enable Clock setting.
11. Tributary module in Webfil Mux performs Generate 2 Mbps HDB-3 encoded interface signals complying with ITU-T _____
12. In WEBFIL Mux _____ setting of Tributary module in Webfil Mux enables Mux to operate as D/I or End Terminal mode.
13. In WEBFIL Mux _____ setting of Tributary module in Webfil Mux enables Mux to set the Port Impedance.

Subjective

1. Draw the System Architecture for WEBFIL Flexi mux with its Modules and Cards and write the functionality of each module?
2. Write the important Functionality of Network Interface Module (NIM card).
3. Write the important Functionalities of Tributary Module of WEBFIL Flexi mux?
4. What are the Periodical Checks and Measurement that should be carried out for Webfil Flexi Mux?

CHAPTER 3

NOKIA MUX

3.1 Introduction:

The NOKIA OFC System consists of a MUX AND OLTE organized in a single Rack as a single system. The NOKIA system is available for three data rates as 2 Mb, 8Mb and 34 Mb systems. This system is organized in two types of racks depending upon the usage. One is the 19" rack and the other is slim rack. Wherever block working is also implemented on OFC along with other circuits an interface unit for block working is used. 19" rack is used at all stations where block working is involved, otherwise, slim rack is used to save the space.

The Nokia system consists of a digital Multiplexing system and an OLTE (Optical Line Terminating Unit). The Multiplexing system of NOKIA is configured into two types of configurations. One is the DM-2 configuration and the other is the DB-2 configuration. A DM-2 configuration is used at a terminal station and a DB-2 configuration is used at a repeater station. The user interface cards are common to both the systems. DM-2 or the DB-2 is the multiplexer unit. These units are used for a data transmission rate of 2 Mb. The suffix 2 indicates the data transmission rate of the card. The OLTE used with the DM-2 or DB-2 system is designated as DF-2-8, which indicates that the same card can be configured for 2 Mb system or 8 Mb system. The entire system is controlled through software settings. For controlling the system through software a Service Terminal or an NMS is used.

3.2 PRIMARY MULTIPLEXING EQUIPMENT GENERAL DESCRIPTION.

EQUIPMENT OVERVIEW

DM 2 Primary Multiplex Equipment

The DM 2 is a multiplex equipment of the first order in the European multiplexing hierarchy, which combines 31 data channels or 30 PCM-coded voice-frequency channels into a 2.048 MHz signal. The DM 2 equipment concept consists of a digital 2 M bit/s multiplex unit common for all equipment configurations, and a number of analog and digital interface units. Analog interface units that are easily modified according to customer-specific specifications form two- or four-wire VF interfaces, including the signaling interface circuits if needed. In addition to E&M signaling, signaling alternatives include signaling solutions for subscriber and junction line interfaces, ranging from simple DC-loop signaling to complex signaling solutions specifically adapted to the customer’s specifications. The digital interface units contain different types of data interface units by means of which data traffic at different bit rates can be connected to 64 K bit/s transmission channels using one or more 64 K bit/s channels. More than one slower data channels can be combined into one 64 K bit/s channel.

DM 2 Realization principles

The DM 2 equipment concept is based on the utilization of the TM4 mechanical construction and power supply concept. The basic part is an equipment cartridge that includes an intra-cartridge bus solution, making a modular equipment concept possible. The equipment cartridges are several sizes enabling optimal utilization of equipment space as well as equipment installations according to either CEPT A (120 mm) or CEPT B (600 mm). The power supply concept is based on the employment of onboard power supply. Unit-specific processors handle the maintenance as well as the logical processing of signaling. The result is a number of independently operating channel units, which combined with the DM 2 bus solution, enable the flexible realization of various services in one DM 2 multiplex equipment cartridge.

The DM 2 implements the following CCITT recommendations regarding multiplex equipment and, where applicable, analog interfaces of a digital exchange (red book, 1984):

- G.703 digital interfaces
- G.704 basic frame structure
- G.7 l1 PCM coding law
- G.7 l2 characteristics of a speech channel 4-wire interface
- G.714 separate characteristics of a 4-wire interface of the transmit and receive directions
- G.713 characteristics of a speech channel 2-wire interface
- G.732 PCM multiplex equipment
- G.735 PCM multiplex equipment with a facility for a synchronous data interface
- G.823 jitters and wanders
- Q.507 characteristics of a speech channel in a transit exchange
- Q.517 characteristics of a speech channel in a terminal exchange

Applications

The DM 2 equipment has been designed for multiplexing analog speech and signaling as well as digital interfaces of different bit rates into the 2 M bit/s frame for transmission via a G.703 2 M bit/s interface to a digital transmission system, PABX, or exchange. A copper cable, radio relay link, or a fiber-optic cable can be used as the transmission system. The analog interface can be a 2- or 4-wire interface equipped, according to need, with signaling circuits required by a subscriber (PABX) interface, E&M interface, or some other type of junction line interface.

The digital tributary interface can be a G.703 nx64 K bit/s interface or a < 19.2 K bit/s or nx64 K bit/s interface compliant with the recommendations of the CCITT V. or X. series. Figure.3.1 shows some typical applications of the DM 2 equipment.

The first alternative presents the use of a traditional PCM Multiplexer. The equipment enables the formation of 30 speech connections, or alternatively, 30 (31) G.703 64 K bit/s connections. In addition to the basic use, the following can be realized using the DM 2 equipment concept:

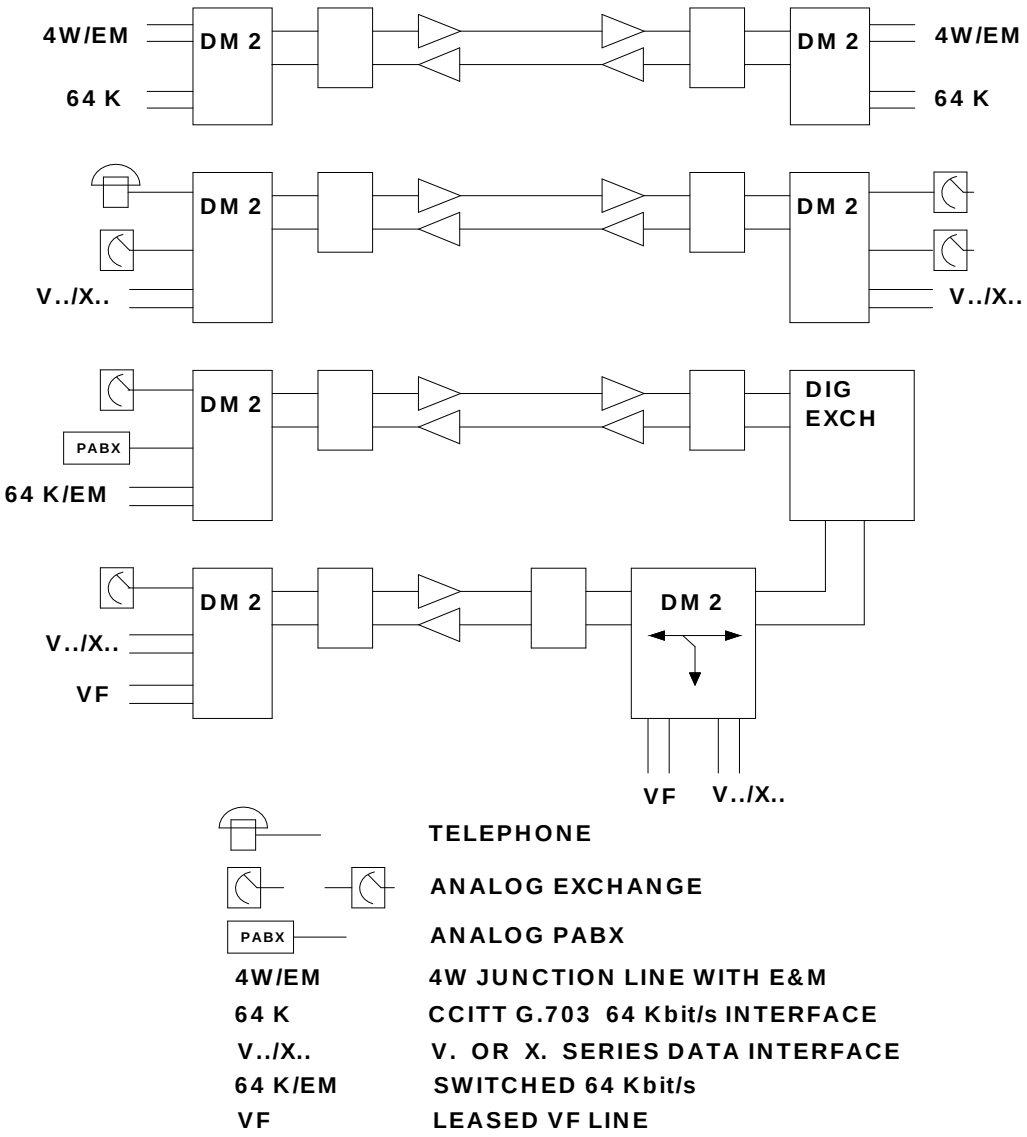


Fig.3.1 DM2 Applications

***** Different signaling adaptations and data interfaces with different bit rates that comply with the V. or X. series recommendations, in freely selected ratios.

***** Unidirectional branching. At the branching point, the freely selectable channels can be separated from the main bus. The time slots being released cannot be reused. In the example in the figure, using the DM 2 equipment, fixed data and speech connections are branched out from the transmission path before connecting to a digital exchange.

* Use of the channel units in conjunction with the DB 2 branching equipment, in which case there are no limits with regard to the use of the time slots. At the branching point, the time slots being released can be freely reused either as such or by regrouping the channels.

* Switched 64 K bit/s channels by combining the 64 K bit/s digital interface and the E&M signaling interface. Signaling to a digital exchange is taken care of using signaling time slot 16, with channel-associated signaling using code adopted by the digital exchange.

3.3 OPERATION

The realization principle of the DM 2 equipment is presented in Figure 3.2.

The DM 2 equipment consists of a MUX unit common to all equipment configurations and channel units connected to it via the DM 2 bus. The MUX unit forms the interfaces to the DM 2 bus, external G.703 64 K bit/s and 2048 K bit/s interfaces as well as the V.11 serial interface to the Service Terminal or to the TMS Transmission Management System. Analog and digital services are realized with interface-specific channel units that connect to the DM 2 bus. The channel unit includes from one to ten channels, depending on the complexity of the interface. Independent of the channel unit slot, each individual service can take for its own use any PCM time slot, several time slots, or only part of the transmission capacity served by one time slot. Processors on a channel unit level handle channel-associated signaling. Signaling can also be handled by an external signaling equipment connected to the 64 K bit/s interface of the MUX unit, e.g. by Nokia's DS 30 PCM Signaling Equipment, thus utilizing the existing signaling adapters.

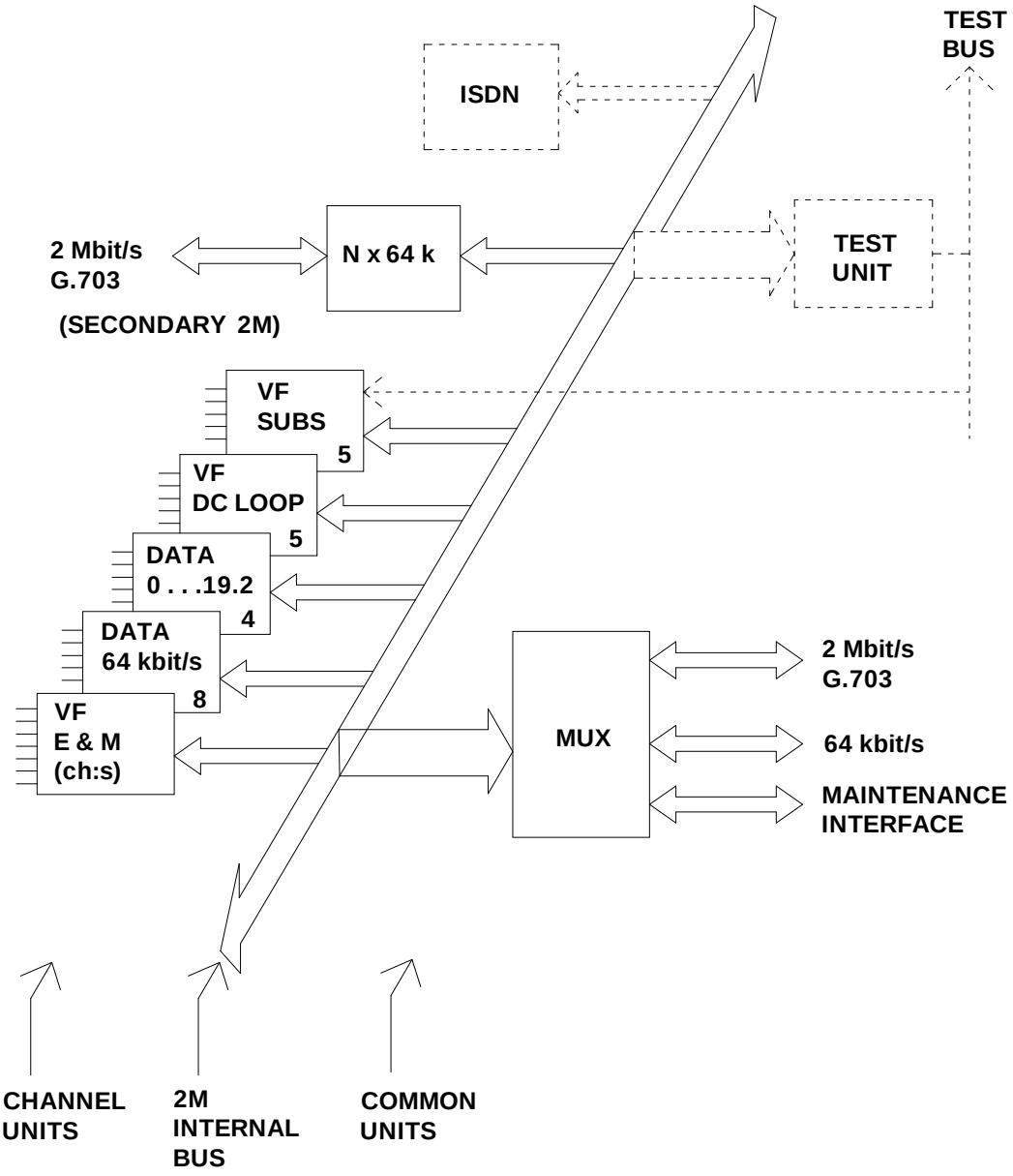


Figure 3.2 DM 2 block diagram

MUX unit Functions

Figure 3.3 presents the block diagram portraying the operation of the MUX unit.

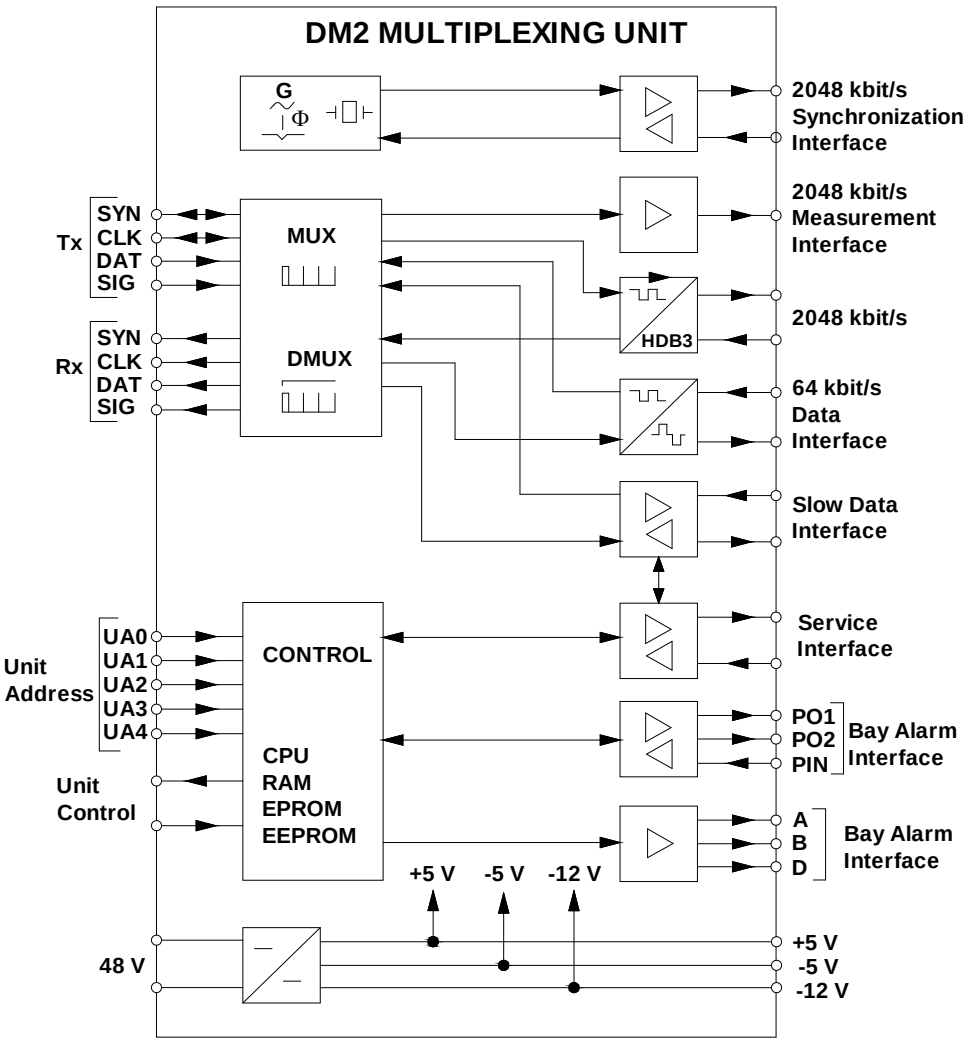


Fig.3.3 Block diagram of the Mux Unit

The functions of the MUX unit of the DM2 equipment are to:

- Generate the transmit direction clock frequency of 2048 K bit/s
- Control the time-division multiplexing occurring in the channel units
- Form the output signal frame
- Generate the interface signal complying with CCITT Recommendation G.703, as HDB3 line coded.
- Convert the input signal complying with CCITT Rec. G.703 to agree with the equipment logic sections, disassemble the line code, generate the receive direction clock signal
- Synchronize to the incoming signal frame phase
- Control the demultiplexing occurring in the channel units
- Monitor the error ratio of the received signal and recognize the AIS
- Carry out alarm functions
- Collect and analyze equipment fault information
- On the basis of fault condition information, provide alarms to the rack bus and to the service bus

Bus structure: The interfaces between the MUX units and the channel units in the DM 2 equipment are realized by means of a time-division multiplexed bus structure. Data is transferred using a frame in the 2 M bit/s speech and data bus. This frame structure is similar to that of PCM multiplex equipment.

Signaling information is transferred via a parallel 2 M bit/s signaling bus corresponding to the speech and data bus. The signaling bus contains 8 bits per each channel: 4 signaling bits and 4 internal control bits. In addition to this, the equipment is provided with an asynchronous serial bus for, e.g. the transfer of service information.

Output direction: The transmitter of the MUX unit is provided with an oscillator. The timing signals required by the output direction are generated from the clock signal produced by this oscillator. When desired, the oscillator can be locked either to the receive direction clock signal or to a 2048 kHz external clock signal. Selection of the locking signal is done via the service bus, or it can also happen automatically according to the priority order selected via the service bus.

The MUX unit controls the time-division multiplexing occurring in the channel units by means of the clock signal and the synchronization signal that it produces. The transmitter of the MUX unit inserts the frame alignment signal, alarm data going to the remote end, and equipment supervision data into the time-division multiplexed data signal coming from the channel units. The MUX unit calculates the CRC check word from the output signal and sends it in a CRC Multiframe to the remote end.

Signaling information comes from the speech channels in parallel with speech data via the signaling bus. The MUX unit multiplexes signaling information into time slot 16, inserting the multi- frame alignment signal and alarm information for the remote end signaling equipment into this time slot. The HDB-3 line code is added to the output signal and the signal is taken via an output adapter to the equipment output interface.

Input direction: In the receive direction, the incoming 2048 K bit/s signal is amplified and regenerated. Also the receive direction clock signal and all the timing signals required in demultiplexing are produced from the incoming signal.

First, the line code is disassembled from the incoming signal. The receiver of the MUX unit searches the incoming signal for the frame alignment phase and synchronizes its operation with it. The receiver controls the demultiplexing occurring in the channel units by means of the synchronization signal and the clock signal. The time-division multiplexed data is taken to the channel units where the data belonging to each channel is extracted on the basis of the time slot addressed via the service bus.

The signal receiver of the MUX unit searches time slot 16 of the incoming signal for the Multiframe alignment phase and synchronizes its operation with it. The receiver disassembles the time-division multiplexing of the signaling and connects the signaling information to the signaling bus. The MUX unit calculates the CRC check word from the input signal and compares it to the check word sent by the output direction. The CRC procedure is used for improving the frame alignment strategy and observing the quality of the transmission path.

64 K bit/s interface: The DM 2 equipment has the facility for either the transfer of channel-associated signaling or common channel signaling. The MUX unit contains a 64 K bit/s data interface for common channel signaling channel and for separate PCM signaling equipment. When this interface is not needed for signaling, one co- or contra-directional 64 K bit/s data interface can be formed. The time slot is selected via the service interface.

Service interface: The Service Terminal can be connected to the service interface located in the MUX unit, or this interface can be used for connecting to the centralized transmission management system (TMS) for telecommunications equipment. The interface complies with CCITT Recommendation V.11. The equipment is controlled via this bus, and detailed information on a fault point and the quality of the fault is obtainable through the bus. Several sets of equipment can be connected to the same service bus. When required, the MUX unit can be connected to the transmission path of the service bus by taking advantage of the free bits in the frame structure.

Control channel: The MUX unit is provided with a slow data interface, which uses the free bits in the frame structure. In this way, a data channel operating on a sampling principle can be formed; the transfer capacity is 600...2400 bit/s, depending on the number of bits to be used. The electrical interface of this channel is similar to that of the service interface. This interface can be used for transmission of, e.g. transmission management data.

Measurement interface: As controlled by the service interface, the outgoing 2 M bit/s signal, incoming 2 M bit/s signal, output direction clock, or the receive direction clock can be selected for this interface.

Channel units: The functions of the channel units are to:

- Adapt the speech transmission channels to the analog subscriber and junction line network.
- Take care of speech coding and decoding according to CCITT Recommendation G.711 (A- law).
- Adapt the signaling of the analog subscriber and junction line interface to the internal signaling bus of the equipment.
- In the output direction as controlled by the MUX unit, carry out time-division multiplexing into the DM 2 speech/data bus; in the input direction, disassemble the multiplexing from the DM 2 speech/data bus.
- Monitor the analog signaling interface and internal alarms of the equipment, and in fault conditions, control the unit operation on the basis of such information.
- Realize the data interfaces of different bit rates and multiplex them into the DM 2 speech /data bus, as controlled by the MUX unit.

Options: In addition to the VF, signaling and data units, the DM 2 equipment includes as options:

* Ringing generator unit
* Test units for the PCM subscriber connection
* ISDN U-interface unit

3.4 OPERATION AND MAINTENANCE

Using a portable, small-sized Service Terminal carries out commissioning and operation activities. The following paragraphs briefly describe the general principles as well as special features associated with the DM 2.

Operation and maintenance principles: As a general rule, commissioning and maintenance activities are based on using the portable Service Terminal that is connected to the DM 2 system via a connector on the front panel of the MUX unit. Alternatively, the Service Terminal can be permanently installed into the TM4 rack, in which case the MUX unit is accessed via the service bus that is wired into the rack. The desired channel is addressed using the Service Terminal. The settings done to the DM 2 units by the Service Terminal are stored into the EEPROM memory of the concerned unit and, in addition, into the EEPROM of some other unit. Then power supply outages or the removal of some channel unit and replacing it with a corresponding spare unit do not affect the existing settings. For fault indication and maintenance activities, the DM 2 units have three LED indicators by which a faulty unit or a unit undergoing maintenance activities is indicated. The equipment alarms are transmitted via the alarm bus to alarm relays situated in the power supply cartridge. The alarm relays forward alarms A, B, and D to the centralized transmission management center as a rack alarm.

By means of the Service Terminal, it is also possible to monitor equipment situated at other stations, e.g. at the remote end. Instead of the Service Terminal, it is possible to connect the service interface of the MUX unit to the TMS Transmission Management System, and in this way monitor the DM 2 system at the centralized transmission management center. The operation is based on a menu principle. The Service Terminal in plain language indicates fault conditions. The Service Terminal is fully independent of the equipment concept used. The actual service activities and menus required by the Service Terminal as well as the printout instructions are programmed into the non-volatile memory of either the MUX unit or the channel unit, depending on the activity.

The following DM 2 settings are possible from the Service Terminal:

- Time slot selection
- Branching of channels
- Level settings
- Balancing network settings
- Impedance settings
- Key signaling parameters
- Key data interface parameters
- Use of the free bits in time slot 0
- Use of an external 64 K bit/s interface

The Service Terminal enables controlling different equipment-specific measurements, e.g. in subscriber signaling uses, the measurements of the subscriber cable.

In the DM 2 equipment, it is possible to incorporate self-diagnostics and an internally constructed compilation of statistics on fault information, for example, the number of successful/unsuccessful calls, statistics associated with error ratio monitoring and the quality of the transmission path.

POWER SUPPLY: The internal voltages required by the DM 2 equipment are generated from the central battery voltage by the onboard power supply modules. The criterion voltages deviating from the central battery voltage that is required by the signaling are fed to the equipment cartridge via a separate criterion voltage connector. When required, separate power supply units generate special voltages such as a ringing voltage. The central battery voltages and criterion voltages obtainable from the station are fed to the equipment cartridges via the power supply cartridge. Power supply from a 50 Hz mains protected by redundant buffer batteries is possible in outdoor cabinet installations.

3.5 BASIC EQUIPMENT ASSORTMENT

With the DM 2 equipment, different equipment concepts as well as mixed equipping of them can be realized. The most important basic equipment sets are described in the following paragraphs.

* DM2-EM

The equipment forms 30 2-wire or 4-wire speech channels provided with an E&M signaling interface. There are ten channels per unit in the standard unit. The DM 2 concept also includes an 8-channel E&M unit provided with more versatile properties, such as processor-controlled level selection.

* DM 2 - 64K/G.703

The unit realizes a maximum of 31 CCITT G.703 co- or contra- directional data interfaces. The basic unit contains interface circuits for ten channels.

* DM 2 - n x 64K/G.703

The unit facilitates unilateral branching in a 2 M bit/s transmission network.

* DM 2 - 48...64K/X.21, V.11, V.35

The unit versions facilitate 48, 56, or 64 K bit/s V.35, V.11, and X.21 interfaces. The 10-channel basic versions do not support transmission of control bits. This is implemented by a 5-channel special version. A special version makes it possible to lock the system into a 48...64 K bit/s tributary.

* DM 2 - 19.2K/V.28

Slower V. or X. series data interfaces can be realized with these units. One unit contains 8 channels. The services offered by the unit can take one 64 K bit/s transmission channel or just part of it for their own use. By equipping the unit with 4-channel base band modules it can be used for base band data transmission.

* DM2-SUB

The PCM subscriber equipment forms a maximum of 30 subscriber signaling connection links over a digital 2 M bit/s transmission path. In the basic solution, there are six subscriber interfaces for the subscriber end or exchange end. Customer-specific versions are implemented by changing interface modules.

3.6 EQUIPPING ALTERNATIVES

Figure 3.4 presents a few typical sub rack-equipping alternatives.

The TM4 mechanical construction offers flexible possibilities to realize different equipment entities. The basic cartridge sizes are 20T (four unit slots) and 40T (eight unit slots). There are versions of equipment cartridges that allow a maximum of three 20T (12 unit slots) or two 40T (16 unit slots) cartridges to be electrically interconnected. The cartridges are the same irrespective of the channel unit selection. The MUX, channel, and most of the auxiliary units take one unit slot (5T). The ringing generator takes two unit slots (l0T). Units belonging to the same equipment must be inserted into the same cartridge or into interconnected cartridges that are directly on top each other. However, the ringing generator can be inserted into its own cartridge and it can be common for two 30-channel systems.

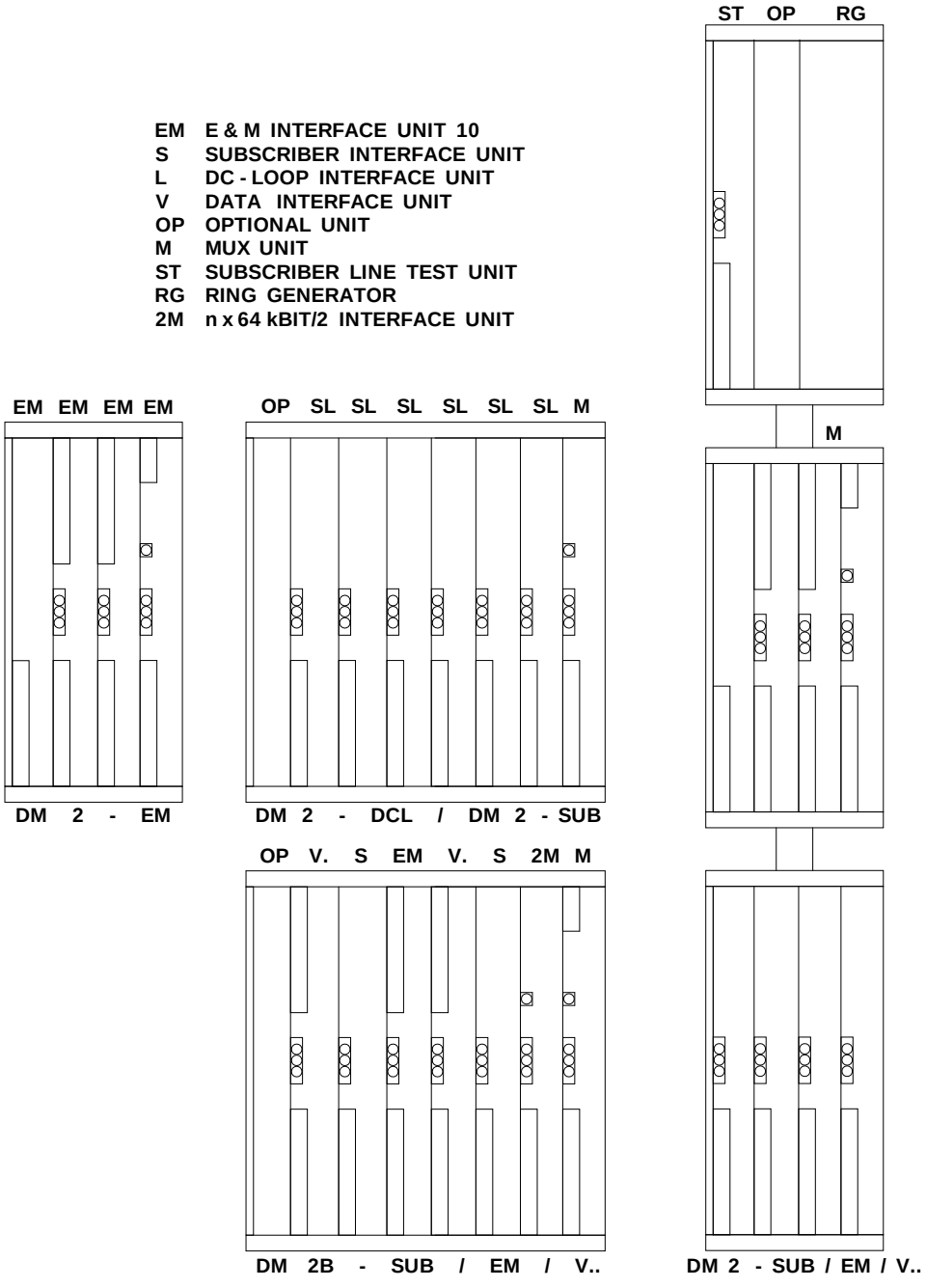


Figure 3.4 DM 2 equipping examples

The equipping examples (in Figure 3.4) are:

* 30-channel basic PCM Multiplexer equipped into a 20T equipment cartridge.
* Subscriber signaling equipment or DC-loop junction line signaling equipment, equipped into a 40T equipment cartridge. The unit slot reserved for the options in subscriber signaling use can be equipped with a subscriber interface test unit. The ringing generator must be inserted into another equipment cartridge, e.g. a 20T cartridge.
* An example of branching use (DM 2B). Branching requires the use of an n x 64 K bit/s **/** 2 M bit/s interface unit in addition to the MUX unit. Any units of the DM 2 concept can be used at the branching points as channel units; the figure exemplifies subscriber connection, E&M signaling interface and data interface units.
* SLIM RACK (CEPT A) installation alternative where three 20T equipment cartridges are electrically interconnected. In the example of Figure 3.4, auxiliary units are installed into the uppermost cartridge. They can be common for more than one DM2 equipment such as the ringing generator, subscriber interface test unit. The unit space of the two lower cartridges can be correspondingly utilized as in the 40T cartridge equipping shown in the figure.

3.7 TECHNICAL SPECIFICATIONS

Frame structure

CCITT recommendations	G.731, G.732, G.735, and G.736 (red book)
Bit rate	2048 K bit/s
Time slots per frame	32
Max. Speech channels	30
Maximum capacity for data Transmission	1984 K bit/s
Frames per multiframe	16
Frames per CRC multiframe	16

Audio frequency performance

PCM coding	CCITT Rec. G.71l
Sampling rate	8 kHz
Bits per sample	8
Compression law	CCITT A-law

Signaling

Digital signaling interface	
Internal of contra-directional	CCITT 64 K bit/s
Signaling time slot	16
Signaling code	selectable, e.g CCITT Q. 421
Sampling interval	2ms

Analog signaling interface

* E&M signaling
* Subscriber signaling
  - Basic signaling

- Additional signaling, e.g. subscriber metering

* Junction line signaling

- DC loop signaling
- Customer-specific signaling adaptations

3.8 GENERAL

The DM 2 is a 31-channel multiplex equipment family whose bit rate is 2048 K bit/s. It combines 30 (in data transfer 31) speech or data signals into one 2048 K bit/s signal using time division multiplexing. Multiplex Equipment DM 2 represents the first stage of European digital multiplex hierarchy. Figure 3.5 shows the structural principle of the equipment. The equipment comprises a multiplex section (MUX unit) common to all equipments and various adapter units (channel units) that adapt the equipment to the operating environment. The internal interfaces between the units of the DM 2 equipment are realized by means of time division multiplexed bus structure. This enables a very flexible utilization of the equipment's transmission capacity.

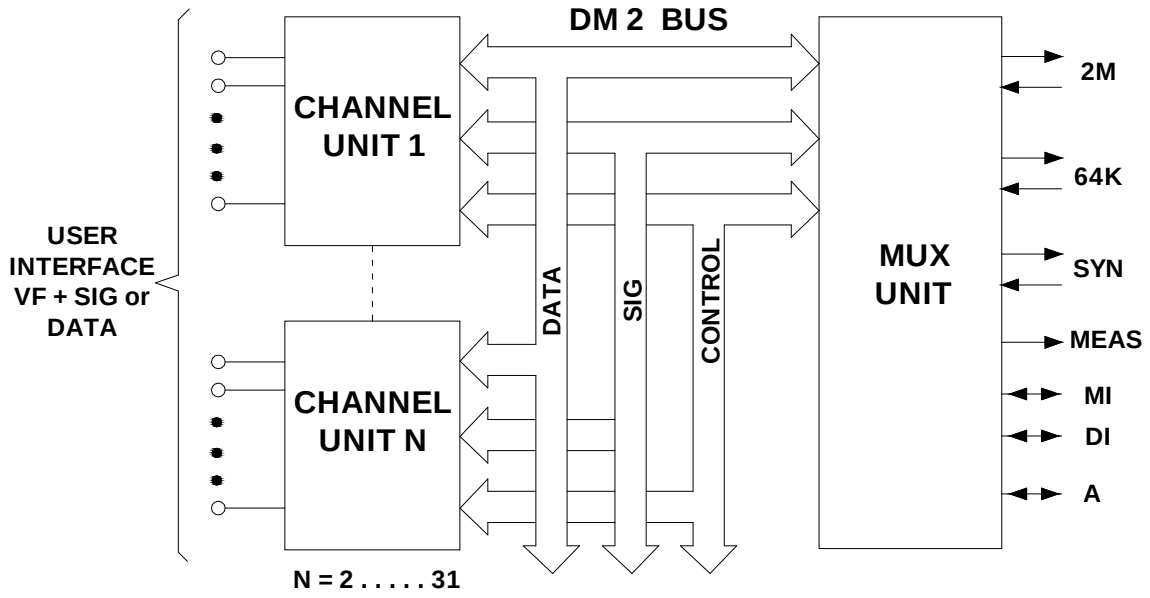


Figure 3.5 Multiplex Equipment DM 2

The multiplexing section is provided with most of the control, multiplexing and monitoring functions of the equipment. By means of the channel units, the DM 2 equipment is adapted to the operating environment. Each channel unit can be reserved with transmission capacity as required. All transmission control measures of the DM equipment are taken via the service interface (MI) of the equipment by means of the Service Terminal with various control commands. The equipment is not provided with separate transmission control switches. Via this same bus the equipment can be connected to a centralized Transmission Management System, in which case the equipment can be remote controlled. Multiplex Equipment DM 2 generates its clock signals independently. However $_{it}$ can be synchronized to an external clock source when necessary. The basic oscillator of the DM 2 transmitter can be phase-locked either to the clock signal generated from the incoming signal or to the external 2048 kHz clock signal brought to the DM 2 synchronization interface.

The PCM multiplex equipment with various signaling variations is the main adaptation area of the DM 2 equipment. The DM 2 can convey the signaling data of the exchange using either channel-associated of common channel signaling. Different data transfer needs can be flexibly met with the DM 2 equipment. Part or all of the time slots normally used for speech transmission can be reserved for data transmission. Also the free bits in the equipment frame format are available for data transmission.

Owing to the DM 2 structure unidirectional branching equipment can be realized by means of the MUX unit and the 2M-channel unit. By means of the branching equipment speech channels or 64 K bit/s data channels can be picked out of the incoming signal and data can be added to the outgoing signal.

OPERATION OF MUX UNIT

The MUX unit (TC 21100, TC 21101, and TC 21101.1) is a multiplexing section common to all DM 2 equipments. Its function, in the outgoing direction, is to control the time-division multiplexing in the channel units and to generate the frame format for the outgoing signal. In the receive direction, the MUX unit receiver synchronizes its operation to the incoming signal frame phase and it controls demultiplexing in the channel units. The equipment is also controlled via the MUX unit. It collects the fault data from the channel units and gives information of the fault situation via the rack alarm bus, separate equipment alarm outputs and service interface. The MUX unit conveys the measures taken to other units of the equipment via the internal control bus of the equipment.

Block division of MUX unit: Figure 3.6 shows the block diagram describing the operation of MUX unit. Functionally, the MUX unit is divided into 10 blocks:

* MUX Mux-Demux circuit
* OSCILLATOR phase-locked oscillator
* LINE IF equipment interface 2048 K bit/s
* SYNC IF synchronization interface
* DATA IF data interface 64 K bit/s
* MEASUR. IF- measurement interface
* CONTROL control block
* CONTROL IF service and data channel interface
* UNIT IF channel interface
* POWER unit power supply

The MUX circuit takes care of matters related to multiplexing and demultiplexing of the MUX unit. In the outgoing direction the MUX circuit controls time division multiplexing in the channel units, adds the frame alignment word to the information coming from the channels and adds the control information going to the far end. The signaling information from the channels is stored into the RAM memory in the unit, from which it is picked and multiplexed into time slot 16. HDB3 line code is added to the outgoing signal and the signal is taken to the outgoing interface in the block LINE IF.

In the receive direction, the line code is first derived from the signal coming from the LINE IF block. The receiver of the MUX circuit searches for the frame phase from the incoming signal and synchronizes its operation to it. The receiver controls demultiplexing in the channel units

by means of the synchronization signal and clock signal. The time-division multiplexed data is taken to channel units where the information belonging to each channel is picked out on the basis of time slots.

The signal receiver of the MUX circuit looks for the multiframe phase from the incoming signal time slot 16 and synchronizes its operation to it. The receiver demultiplexes the time-division multiplexing of signaling and stores the signaling information into the RAM memory, from which it is picked out and connected to the signaling bus going to the channel units in parallel with speech information. The outgoing direction clock signal is generated in the OSCILLATOR block. The oscillator can be phase locked either to the receive direction clock or to the clock coming' from the synchronization interface.

Outgoing direction

Generation of clock signal: The OSCILLATOR block of the MUX unit has an oscillator that generates a clock signal (TCK) from which the timing signals required by the outgoing direction are developed in the MUX circuit. When required, the oscillator can be locked either to the receive direction clock signal or to a clock signal (2048 KHz) brought from outside the equipment. The selection of the lock signal is done by means of a selector in the MUX circuit. The MUX circuit also has a phase detector and the related dividing circuits, as well as a lock detector that tells whether locking has been successful. The interface circuits for the external clock are in the SYNC IF block. The block also has a clock signal level detector that informs the processor (ASIB) in case the clock is missing. To the clock output in the block, either the outgoing or incoming direction clock signal can be connected via the selector in the MUX circuit.

Generation of Outgoing signal: The MUX circuit controls time-division multiplexing in the channel units by means of the clock signal (T2M) and synchronization signal (TSYN) it generates. The MUX circuit transmitter adds to the time- division multiplexed data signal (TDAT) coming from the channel units via the UNIT IF block the frame alignment signal, alarm data going to the far end and monitoring data of the equipment.

A Cyclic Redundancy Check complying with the CCITT Recommendation G.704 is performed for each block of the outgoing signal. The length of each check block is 48 bits. Information on the check result (4 bits) is sent to the receiving equipment using the first bit of the frame for transmission. The CRC information is multiplexed to this bit. The HDB3 line code is added to the outgoing signal and the outgoing signal (TD1, TD2) is taken to the equipment output interface via the output adapter in the LINE IF block.

Incoming direction

De multiplexing: In the receive direction, the incoming 2048 K bit/s signal is amplified and regenerated in the interface receiver of the LINE_IF block. From the incoming signal, the 2048 kHz clock signal (RCLK) required by the receive direction is generated. From the interface receiver the signal (RD1, RD2) is taken to the receiver of the MUX circuit, where the line code is first demultiplexed. The receiver generates all the timing signals required for demultiplexing. The receiver of the MUX circuit seeks the frame alignment phase from the incoming signal and synchronizes its operation to it. On the basis of synchronization the receiver picks out the bits belonging to the frame. The receiver controls demultiplexing in the

channel units by means of the synchronization signal (RSYN) and clock signal (RCLK). The time-division multiplexed data (RDAT) is taken to the channel units via the interface block (UNIT IF). In the channel units the information belonging to each channel is picked out on the basis of time slot.

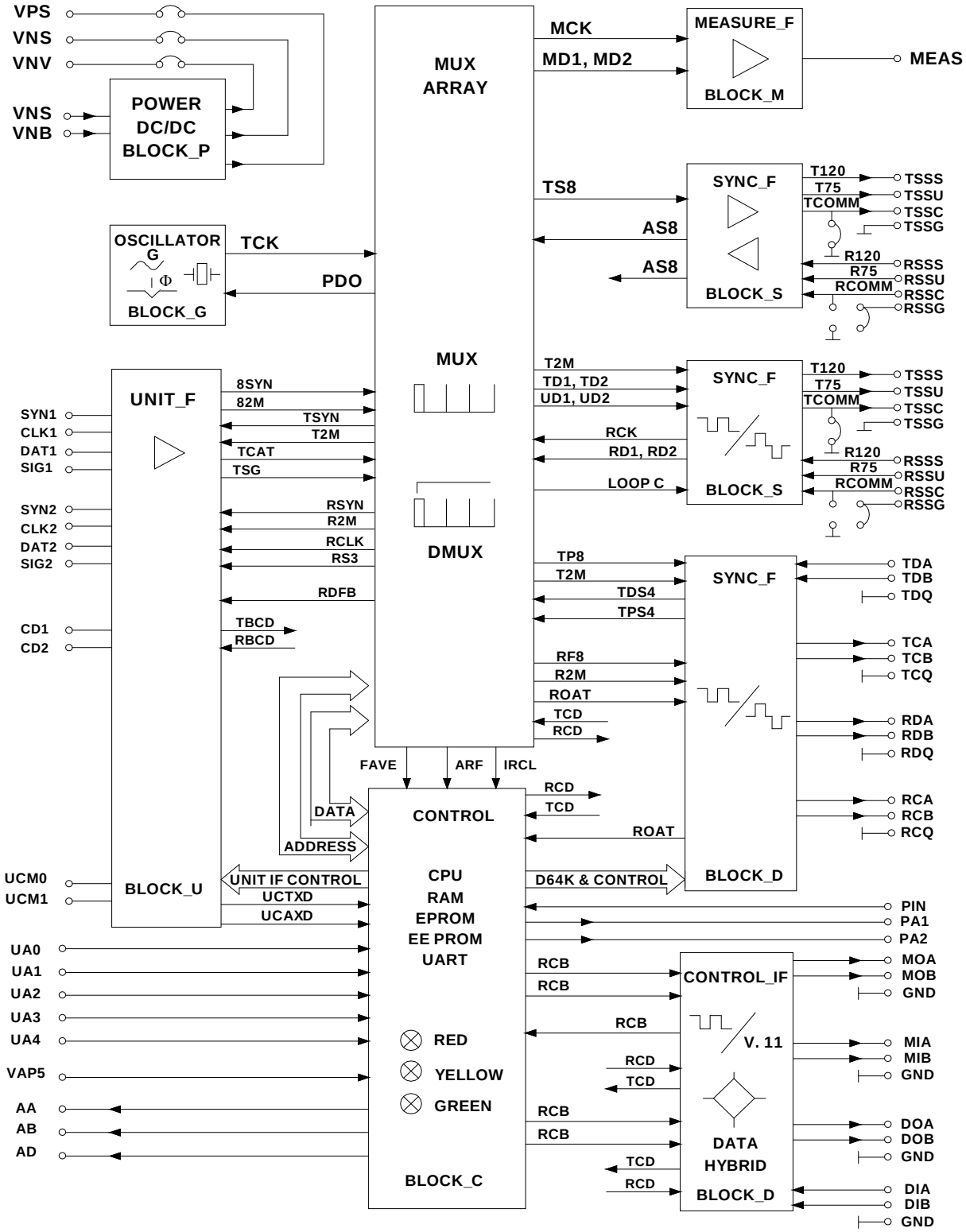


Fig.3.6 MUX Unit Block Diagram

Synchronization criteria: The criteria of the demultiplexing equipment with regard to synchronization are defined by the CCITT. Frame alignment is considered lost when three successive frame alignment signals have been received erroneously. Frame alignment is also considered lost when time slot 0 bit 2 is received erroneously three times successively in those frames that do not contain the frame alignment signal. Frame alignment is considered recovered when the frame alignment signal has been received correctly for the first time and the state of time slot 0 bit 2 in the following frame is “1” and the frame alignment signal has been received correctly from the successive frame time slot 0.Search for the frame alignment signal starts again after two frames and one bit from previous synchronization if erroneous bit 2 or erroneous frame alignment signal is received at alignment stage.

CRC frame alignment strategy: When frame alignment has been obtained, CRC locking occurs if at least two CRC. Multiframe alignment words are detected within 8 ms when the interval between two CRC Multiframe alignment signals is 2 ms or it’s multiple. The CRC frame alignment signal is only searched for in those time slots 0 that do contain the frame alignment word. If Multiframe alignment is not obtained within 8 ms, it is presupposed that the case in question is alignment to a simulating frame alignment word and search for a new frame alignment word is started immediately after the simulating frame alignment word. If Multiframe alignment is not found within 100 ms frame alignment is considered lost and appropriate action is taken.

Cyclic Redundancy Check: The MUX circuit receiver performs to the incoming signal a similar Cyclic Redundancy Check as the opposite end transmitter and compares the obtained check result to the check result sent by the transmitter. If during a check more than 915 CRC blocks are found during 1 s (1000 blocks) it is presupposed that the alignment word in question is a simulating frame alignment word and the search for the frame alignment word is restarted. The simulating frame alignment word is detected within 1 s with the probability of> 0.99. With error ratio E-3 the probability for an erroneous search due to Cyclic Redundancy Check is less than 1E-4 during one second.

Signaling:

Channel-associated signaling: Signaling information comes from the speech channels in parallel with the speech information to the MUX unit via the signaling bus (TSIG). The MUX circuit stores the signaling information into the RAM memory in the CONTROL block. The MUX circuit signal transmitter picks the signaling information out of the memory, multiplexes signaling information into time slot 16 and adds the multiframe alignment signal and the alarm information to the far end signaling equipment. The MUX circuits signal receiver searches for the Multiframe alignment phase from the incoming signal time slot 16 and synchronizes its operation to this phase. The receiver demultiplexes the time-division multiplexing of signaling and stores the signaling information into the RAM memory, from which it is then picked out and connected to the signaling bus (RSIG) going to the channels. In the receive direction, transmission of signaling to channel units is similar as in the transmit direction. Signaling information is transferred in parallel with speech data in the signaling bus. Four bits tell the actual signaling information, by means of enable bit the MUX unit can freeze the signaling information going to the channels.

Multiframe alignment is considered lost when two successive alignment signals have been received erroneously. Multiframe alignment is also considered lost when during one Multiframe only zeros have been received in time slot 16. Multiframe alignment is considered recovered when the Multiframe alignment signal has been received for the first time and time slot 16 of the previous frame has at least one “1”.

Common channel signaling: In common channel signaling, messages are sent in time slot 16 instead of channel-associated signaling. If the DM 2 does not generate the message, signaling information is taken to the DM 2 equipment via the 64 K bit/s data interface in the MUX unit. If the DM concentrator generates the message, then the concentrator unit connects the message into time slot 16 and the signaling channels are connected to the concentrator unit via the signaling bus. In this case the MUX unit does not use the signaling bus at all.

64 K bit/s data interface (D64 IF, Block D): The MUX unit has one synchronous co- or contra-directional 64 K bit/s data channel, whose time slot can be freely selected (time slot 0 forbidden). The time slot is selected by setting signals TS1... TSI6 (setting bits are inverted, e.g. selection 10000B corresponds to time slot 15).

The contra- or co-directional operation is selected by MC control:

MC = 1 contra-directional interface
MC = 0 co-directional interface

Co-directional operation: In transmit direction, the signal (TDA, TDB) coming from the data terminal equipment is taken via the interface receiver in the block to the data interface circuit (ASIC circuit). The interface circuit synchronizes its operation to synchronization signal TFS coming from the MUX circuit and to clock T2M. The interface circuit demultiplexes the line code and stores the received data into a buffer memory, from which the data is picked for the selected time slot to data TD64 going to the MUX circuit. At the same time with the data, time slot reserve request TDR is sent, on the basis of which the MUX circuit connects the data to the required time slot to the outgoing signal.

In the receive direction, the data interface circuit synchronizes its operation to synchronization signal RFS and clock signal R2M. The data interface circuit picks the receive direction data from the selected time slot of the incoming signal (RDAT) and stores it to the buffer memory. From there, the data is picked out in the phase of the 64 KHz clock, the line code is added to the picked data and the ready signal containing data and timing is taken to the output (RCA, RCB) of the co-directional data interface.

Contra-directional interface: In the transmit direction the data interface circuit generates a fetch clock (TCA, TCB) containing octet timing, in phase of which the data terminal equipment sends the data. The incoming data (TDA, TDB) is taken via interface receiver to the data interface circuit that connects it to the data going to the MUX circuit for the selected time slot.

In the receive direction, the data interface circuit picks the data from the incoming signal and then connects it to the data output (RDA, RDB) of the contra-directional interface. The data interface circuit also generates the clock signal containing 64 KHz octet timing for the equipment receiving the data. The clock interface output (RCA, RCB) is the same as the data output of the co-directional interface.

Service interface: Via the serial interface of the processor in the MUX unit CONTROL block, the DM 2 equipment is connected to the service bus, through which the equipment can be controlled either locally or remote-controlled by Service Terminal or Transmission Management Computer. The MUX unit conveys the controls going to other units via the internal control bus of the equipment. The incoming transmission management signal (MIA, MIB) is taken via the interface receiver in the CONTROL IF block to the control block (MIRD). Each of the equipment connected to the bus has its own address. On the basis of address the equipment identifies the messages directed to it, takes the appropriate measures and if required, generates a reply message.

ALARMS: The MUX unit collects the fault condition data of the equipment and indicates them further via alarm interfaces and service bus. There are two types of alarm interfaces: rack alarm interface (A, B, D) and programmable alarm interfaces (PA1, PA2).

In addition to alarm outputs, each unit has three maintenance LEDs: red, yellow and green. The red LED indicates that the unit is faulty and the yellow LED indicates that the fault is outside the unit or equipment (fault is in the received signal). The green LED indicates that the unit is subject to transmission management measure (the unit is controlled either by Service Terminal or Transmission Management Computer).

Fault conditions in MUX unit

* Service alarm (S) indicates that the service of the DM 2 equipment is no longer available. Alarm *S* is given within 2 ms from the detection of a fault condition.
* Alarm A indicates that the capacity of the equipment does not meet the specifications and the equipment demands immediate maintenance measures.
* Alarm B indicates that the capacity of the equipment has degraded but the equipment can still convey data.
* Indication to the far end multiplex equipment is sent by changing bit 3 in time slot 0 from state ‘0’ into state ‘1’ in those frames that do not include the frame alignment signal.
* Alarm indication to the far end signaling equipment is sent by changing bit 6 in time slot 16 in frame 0 into state ‘1’.

Faults in Channel units

The MUX unit collects the fault information from the channel units. For fault processing, the MUX unit first collects information about the faults, their types and their effect to the equipment alarm outputs from the channel units. On the basis of the faults, the MUX unit activates the alarm outputs and indicates the faults via the service interface.

POWER SUPPLY: The DM 2 equipment uses primarily decentralized power supply. Each unit generates the required operating voltages from the central battery voltage, with the exception of the 10-channel speech channel unit that receives its operating voltage from the MUX unit. Additionally, the MUX unit feeds the bus transmitter circuits (+5 V) of all other channel units as well.

The criterion voltages required by signaling equipment adaptations are taken to the equipment via the rack power supply bus. Likewise, the ringing voltage (RG1, RG2) required by the subscriber signaling equipment is taken from outside the equipment, if necessary.

Power Supply of MUX unit: The MUX unit power supply generates the operating voltages +5 V and -5 V required by the unit. The MUX unit also provides operating voltages for E&M speech channel units (+5 V, -5 V and -12 V or -16 V). The power supply is a DC/DC converter using pulse width adjustment and operating on the fly-back principle. The main transformer has three secondary windings, from which the output voltages are obtained by rectifying. A feedback to the voltage regulating circuit has been taken from the +5 V voltage. The values of other output voltages have been set by means of transforming ratios of the transformer. In addition, a series regulator regulates the -5 V output voltage. The power supply operates over input voltage range of 20... 72 V.

SPECIAL FUNCTIONS

Loop backs: Loop backs are used to check the interface operation with its own signal and to make measurements easier. Loop backs are switched on and off via the service interface. There are two types of loop backs: equipment loop back and interface loop back.

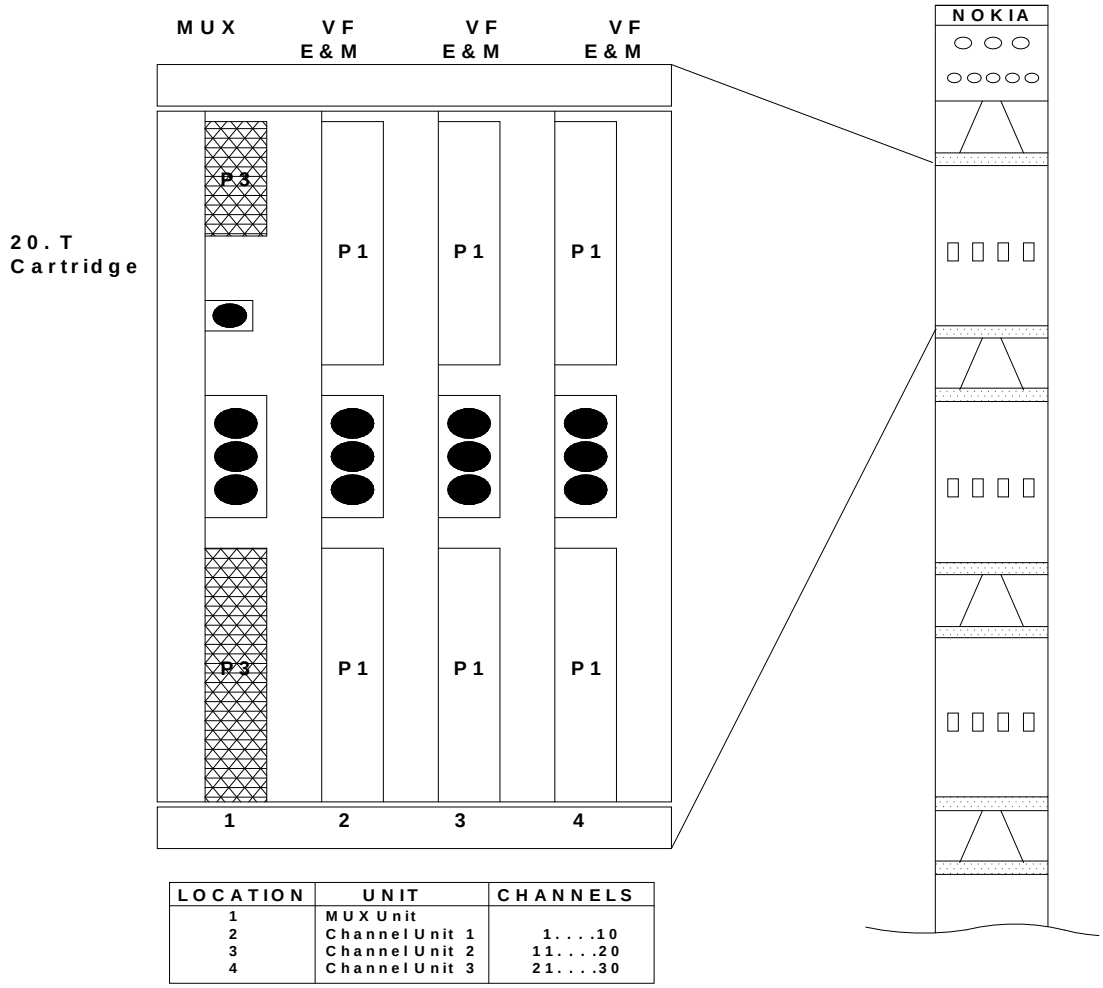
In equipment loop back the signal leaving some interface of the equipment is connected back to the equipment as close to the interface as possible. The outgoing signal is selected as the input signal. Then, AIS is sent out of the interfaces (digital interfaces) to indicate abnormal operation to other parts of the transmission system.

In interface loop back the signal fed into the interface is received from the output of the same interface. The input signal is selected as the outgoing signal. Within the equipment, the looped signal is replaced by an AIS signal.

CARTRIDGE EQUIPPING: The DM 2 equipment is installed into cartridges that are installed into racks. The rack installation and cabling are described in the Operating Handbook for TM4 Construction Practice. There are two sizes of basic cartridges: 20 T (four unit locations) and 40 T (eight unit locations). Please refer fig.3.7

The cartridge or cartridge combination used depends on the equipment configuration. The MUX unit, the channel units and most auxiliary units take one unit location (5 T). The ringing generator takes two unit locations (10 T) and can be common to several DM 2 equipments. The unit location in the cartridge is freely selectable. Each unit has its address based on unit location; this address is used when the unit is controlled via service interface either by means of Service Terminal or Transmission Management Computer. The address of the leftmost location is 1; the address of the next location is 2 etc. If required, cartridges can be connected electrically to each other (cable between cartridges). Two or three 20 T cartridges are connected into one functional entity (altogether 12 unit locations) or two 40 T cartridges are connected together (altogether 16 unit locations).

Service connector P1: Service connector P1 has the service interface (MI), the data channel interface (DI) and the programmable alarm interfaces (PA1, PA2, PIN) of the DM 2 equipment. DM 2 is connected to Service Terminal or centralized Transmission Management System (TMS) via service interface. The equipment data channel working on the sampling principle is taken into use via data channel interface. Alarm interface consists of equipment-specific programmable alarm outputs (PA1, PA2) and a programmable alarm input (PIN). Please refer fig.3.8



LOCATION	UNIT	CHANNELS
1	MUX Unit	
2	Channel Unit 1	1....10
3	Channel Unit 2	11....20
4	Channel Unit 3	21....30

Figure 3.7 DM 2 equipping example: a 20 T cartridge

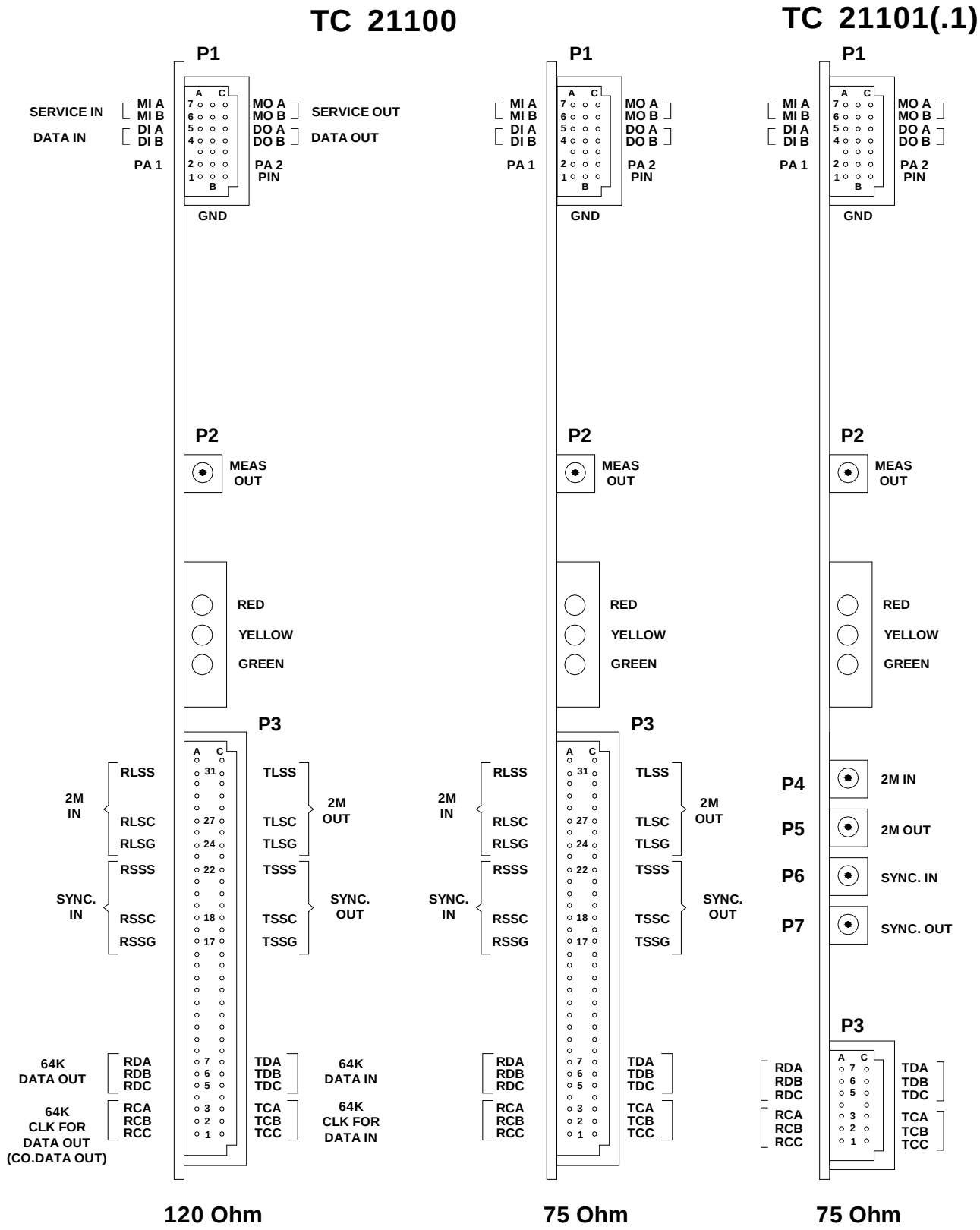


Figure 3.8 Connectors for MUX unit versions

3.9 DB - 2 MULTIPLEXING CONFIGURATIONS

DB-2 multiplexing configuration is used at a drop/insert station in the optic fiber link where channels are dropped and inserted for the local station and some channels are made through which are not required to be dropped at that station.

2 M bit/s BRANCHING

With the DB 2 system, the costs for transmission and multiplex equipment in chain and tree-configured transmission systems can be reduced. By means of the branching equipment, the channels of the 2 M bit/s system can be distributed along the chain, i.e. the 2 M bit/s 30-channel frame structure can be branched, see Figure 3.9.

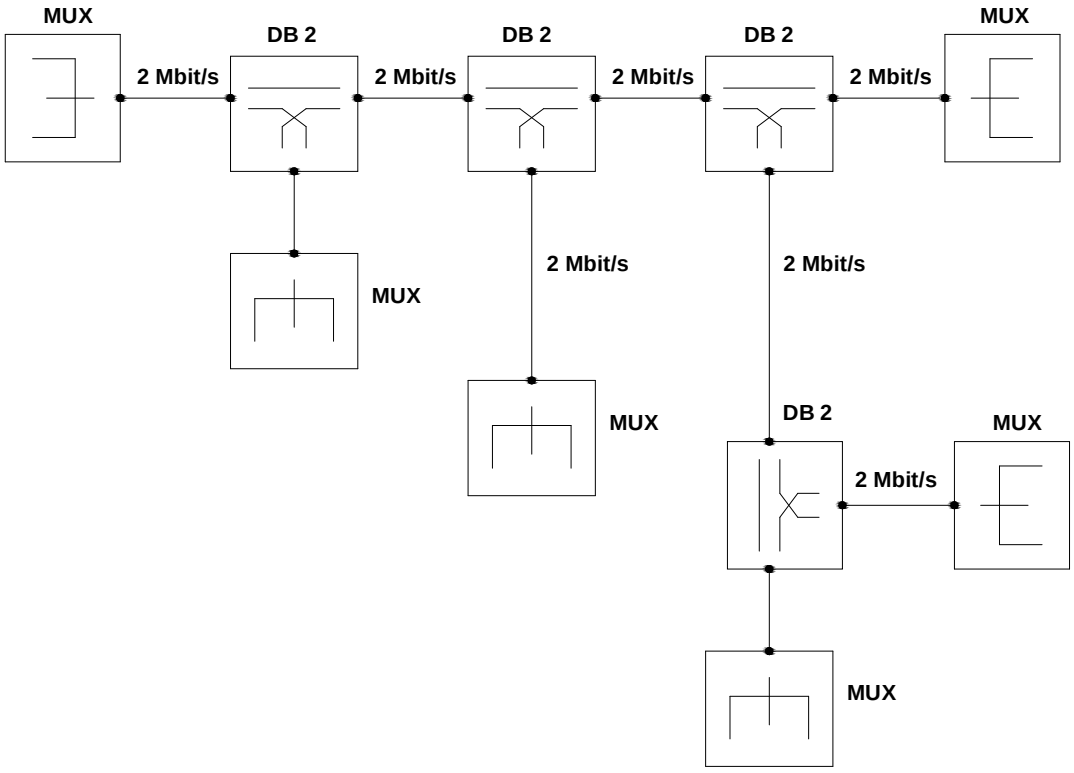


Figure 3.9 Branching of 2 M bit/s system

The channels are through connected at the branching point in digital format without disassembling the frame structure. This enables the construction of a fully digital chain network in which consecutive A/D conversions are not used. In this way the same performance values of a channel are attained as in a standard 2 M bit/s PCM system. In dedicated networks, for example, high reliability of the connections is demanded. The branching equipment chains may be very long, in which case the best method for achieving the required availability of the connections is to duplicate the transmission connection. So that the branching points would not unnecessarily lower the reliability produced by the costly duplicated transmission, duplicating the branching can also protect the branching points.

In the DB 2 system, the VF common channels that are constructed in the branching equipment in digital format are comparable to those formerly found in analog branched systems. In addition to voice channels, a varied selection of digital data interfaces operating at different bit rates is available with this system. Using the DB 2 Branching Equipment, also common channels can be realized in data channels that are the digital equivalent of VF common channels. The digital data channels do not require VF data modems at all.

DB 2 equipment types

2 M bit/s Branching Equipment DB 2B

The 2 M bit/s signal (CCITT G.703/704/706) comes to the equipment from two directions (the main branch, 2 M bit/s interfaces 1 and 2) see Figure 3.10. The desired 64 K bit/s channels are separated from the 2 M bit/s signal, and a new 2 M bit/s frame is generated for the subsidiary branch. Possible channel-associated signaling existing in time slot TS16 is usually branched in the same way as 64 K bit/s time slots. Also nx32 K bit/s and nx64 K bit/s connections can be defined for branching.

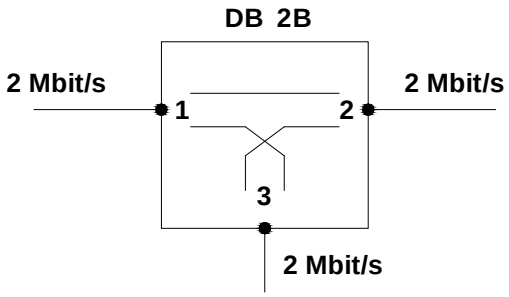


Figure 3.10, 2 M bit/s Branching Equipment DB 2B

Channels can be branched from both directions of the main branch without limitation. The types of branching are:

- Through-connection between interfaces 1 and 2
- Arrangement of channels between interfaces 1 and 2
- branching in direction 1-3
- branching in direction 2-3
- VF common channels
- Digital common channels

For example, the 1-3 branching is defined as follows:

Table 1:	Dir 1	Dir 2	Dir 3
B1:	11-18		1-8

It is thus possible to change the location of the channels in the frame structure in connection with branching. The channel dropped from direction 1 can be immediately retaken into use in the next transmission direction (direction 2). In all other types of branching except for in a VF common channel, the DB 2 equipment is fully independent of the data contents and coding. The “channels” to be branched can be any nx32 K bit/s signals, so that their location in the G.704 frame structure is not bound to anything else but to the halves of the time slots.

The branching condition is defined via the service bus common to all of the transmission equipment. This activity is done via the TMC Transmission Management Computer or by using the portable Service Terminal. The same Service Terminal is also used with other transmission and multiplex equipment manufactured by Nokia.

The integrated 2 M bit/s interface of direction 3 in the DB 2 cannot be in use when channel units are being used. The 2 M bit/s interfaces of direction 3 can be implemented with a separate 2 M bit/s G.704 channel unit. The unit picks the desired time slots from the external 2 M bit/s G.704 signal to the internal 2 M bit/s bus. The channel units of direction 3 share the 30(31) x 64 K bit/s capacity of the internal 2 M bit/s bus of the branching equipment.

Those DM 2 Primary Multiplex Equipment units which completely fulfill the DM 2/DB 2 bus standard can be used as channel units.

Unit selection includes:

- VF/E&M interface unit,
- VF interface units with different types of signaling
- Subscriber units (exchange end and subscriber end)
- Digital data interface units 0. . .19.2 K bit/s
- Digital data interface units 48... ..Nx64 K bit/s.

Types of branching

At the same branching point, any of the types of branching listed below can be used for the different channels.

Channel drop-and-insert.

The channels can be branched to both directions (drop-and-insert), see Figure 3.11. If required, the time slot can be changed when transferring from one interface to another.

The channel to be branched can be:

- 32 K bit/s = half of a time slot
- 64 K bit/s = a time slot
- Nx32 K bit/s.

The channels can be used for the transfer of any signal (bit transparency). In conjunction with channel-associated signaling, the signaling channels are branched in the same way as the corresponding channel time slots.

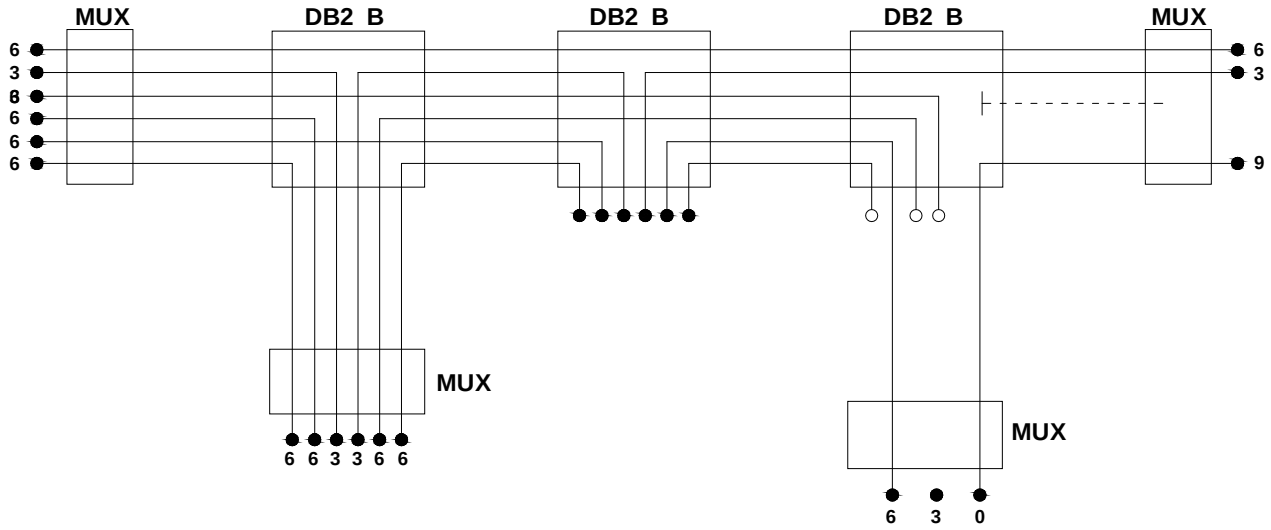


Figure 3.11 Connections of branched system

VF common channel

The VF common channel can be used for:

- polling data connections
- Base station systems for radio telephones
- Service telephone systems.

Summing is done for the VF signals PCM-coded in accordance with A-law in digital format with complete accuracy, so attenuation and propagation delay distortions, for example, do not accumulate. The types of VF common channels are:

- 3-way summing (omnibus)
- Unidirectional summing to different directions.

A digital common channel can be used in the signaling channels of the VF common channel.

3.10 EQUIPMENT FUNCTIONS

Branching Equipment DB 2B consists of two units, B2 and X2, see Figure 3.12.

B2 unit
- 2 M bit/s interfaces of directions 1 and 2
- Equipment monitoring.

X2 unit
- 3x2 M bit/s digital connection fields
- Control of connection field
- 2 M bit/s internal bus of the multiplex equipment
- 2 M bit/s interface of direction 3.

In the equipment, there is no need for a separate PCB for the power supply; each PCB has its own DC/DC converter. The DB 2B uses half of a 20 T cartridge. The battery voltage and rack alarm bus is brought to the cartridge through the rear by a flat cable.

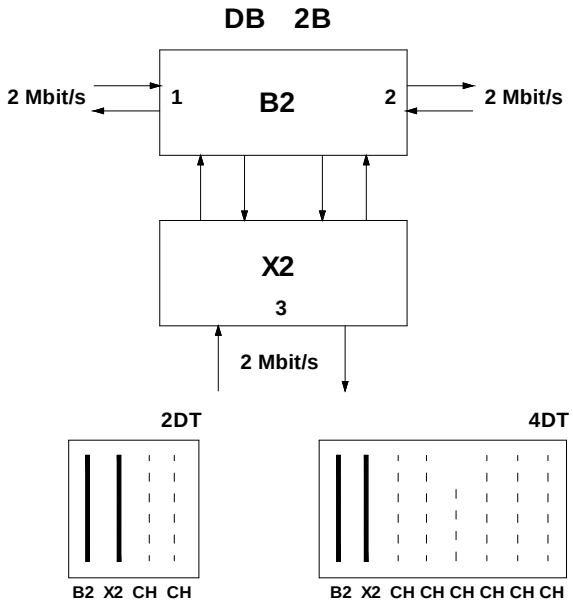


Figure 3.12 DB 2B blocks and equipping of cartridges

Functions of B2 unit

The B2 unit consists of the following blocks. See Figure 3.13.

- 2 M bit/s G.703/704/706 interfaces of directions 1 and 2
- Service interface (TMS/Service Terminal, V.11)
- Data interface (V.11) and 4-way hybrid
- Generation of the internal clock of the equipment
- Power supply -20 V. -72 V/ ±5 V
- Processor taking care of controlling and monitoring the entire equipment.

2 M bit/s interface block

Functions of 2 M bit/s Rx-direction

- Convert electrically the incoming signal that is compliant with CCITT Recommendation G.703 into one suitable for the logic parts of the equipment
- Synchronize to the frame phase and Multiframe phase of the incoming signal (CCITT G.706)
- Synchronize to the CRC Multiframe phase (CCITT G.706)
- Monitor error ratios of received signal
- 10 E-3 (TS0 frame alignment word)
- 10 E-6 (TS0/B1 CRC)
- Identify the 2 M bit/s AIS
- Receive the far-end alarm bits TS0/B3 and F0/TS16/B6 (third rate low pass filtering)
- Perform the required measures in fault conditions.

Functions of 2 M bit/s TX direction

- Generate an HDB-3 line-coded interface signal in accordance with CCITT Rec. G.703
- Generate the frame structure G.704 of outgoing signal and the Multiframe structure of time slot TS16
- Generate a G.704 CRC Multiframe to bit TS0/B1
- Transmit the far-end alarm bits TS0/B3 and F0/TS16/B6.

The cabling of the 2 M bit/s interface is performed from the front of the unit. The connector is either a 2x32-pin Euro connector (120 ohm/75 ohm) or 75 ohm SMB coaxial connector. In the Euro connector there are separate 2x7-pin blocks for both the 2 M bit/s interfaces, which mean that the cabling can be done with separate cables.

Monitoring is common for both 2 M bit/s interface blocks. The function of monitoring is to:

- Assemble and analyze the fault data of the entire equipment
- Analyze the parameters of availability for interfaces 1 and 2 (G.821)
- On the basis of fault condition data, give alarms to the rack bus
- Operate with the TMS or the Service Terminal via the service interface:
- Polling of TMS
- Handling of menus
- Transmit messages passing through the service interface to other units of the equipment.

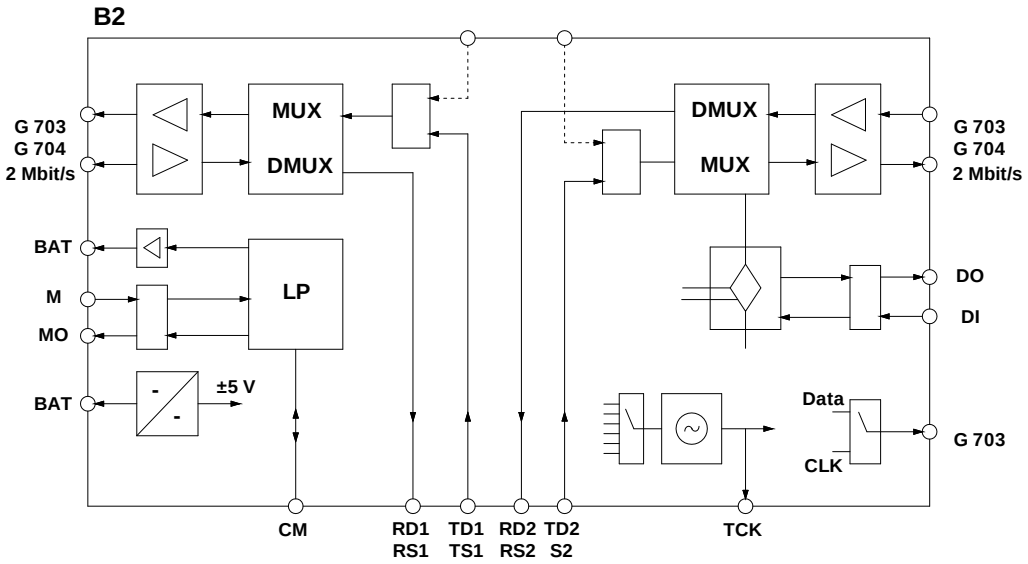


Figure 3.13 Block diagram of B2 unit

Service interface

Via the MI/MO interface in the B2 unit, the DB 2 equipment can interface with the transmission management system (TMS). The interface complies electrically with CCITT Recommendation V.11. Also other telecommunications equipment manufactured by Nokia Telecommunications can be interfaced to the same service bus.

Each set of equipment that is interfaced to the bus has its own address. On the basis of the address, the equipment identifies the messages addressed to it, takes actions according to these messages, and generates a response message. The equipment is controlled via the service interface, and detailed information on the fault item and nature of the fault is available via this interface. The contents of the menus come from the object unit.

Data channel

The B2 unit is provided with its own data interface (DI/DO) which uses the vacant bits B4. . .B8 of time slot TS0. In this way a data channel that operates on a sampling principle can be formed. The sampling frequency is 4, 8, or 16 kHz, depending on the number of bits used. Generally the 600, .2400 Baud transmission management data is transferred via the data channel from one station to another. Bit TS0/B8 (4 kHz, 600 Baud) is commonly used for this transfer.

The electrical specifications of the external interface are the same as those of the service interface (V.11).

The B2 unit contains a 4-way hybrid for the data channel, where three ports are needed for three different 2 M bit/s interfaces and one port for an external data interface. If required, the service interface can also be picked up to the data interface to form a 5-way hybrid. Both the service interface and the data interface are cabled from the unit front via a 3x7-pin Euro connector.

Functions of X2 unit

The X2 unit consists of the following blocks. See Figure 3.14

- frame phasing buffer memories for different transmission directions
- Cross-connection of nx32 K bit/s signals
- Connection control (µP)
- PCM summing of VF common channels
- Logic summing of digital common channels
- Clock interfaces (input and output) G.703
- 2 M bit/s G.703 interface (port 3 of the equipment)
- 2 M bit/s bus interface for channel units
- Power supply -20 V. -72 V/±5 V.

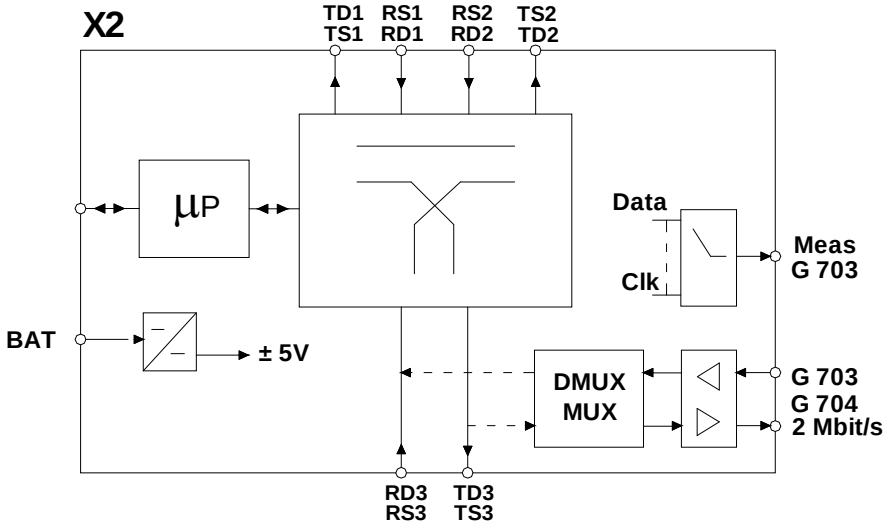


Figure 3.14 Block diagram of X2 unit

Frame buffers and connection field

The incoming 2 M bit/s signals from the interface blocks of the B2 and X2 units are phased before writing to the buffer. Each transmission direction has its own buffer. The desired branching connection is realized by means of the read controls of the buffer. The summing concerning the common channels are performed on the defined channels before taking the signal to the 2 M bit/s interface block.

Branching control

The unit obtains the branching information via the service interface of the unit B2 and further through the internal control bus of the equipment in “plain language”, in the same format as the user gave it on the Service Terminal. The format of the branching information is automatically checked since the data are given in a menu and only valid answers are accepted in menu sessions. The contents of branching-related menus come from the unit X2. The unit can store several encoded branchings, one of which is selected by an activating command to be processed into a form understood by the switching memory. At this stage, the rationality of the branching is also checked (no overlapping connections).

The processed switching information is transferred into the switching memory with an activation command. The branchings stored in encoded form are in the permanent memory (EEPROM) that does not lose its contents at power-off or when the unit is removed from the cartridge. Typically, the memory can hold approx. eight branching tables. Naturally, the number depends on the size of the branching tables.

The DB 2 can be defined to change branching tables on a condition. The user defines the equipment branchings in the installation phase and at the same time the selection condition for the branching. In normal branching equipment, the branching is permanent. When a branching is “conditional”, it is also defined under what condition the branching is used. It is possible to define several conditional branchings in which case they have a priority order.

The conditions are any states of 2 M bit/s signal bits that the processor of the X2 unit can read directly from the buffer memories of the frame aligners. The user defines which bit is used as pilot channel and what the polarity is. If external ON/OFF signals are to be used to control the branching, the controls for each branching must be fed from the E&M interface of the multiplex equipment to the signaling bits of the frame structure. Also the states of the TS0 bits of the 2 M bit/s interface can be used as changeover criteria. When defining the control signals, it must be remembered that the 2 M bit/s interface blocks insert 1-signal into the received channels in certain fault conditions.

Use of channel units in DB 2 equipment

Multiplex equipment can be mounted in place of the 2 M bit/s interface of direction 3 of the DB 2B equipment, see Figure 3.15. The channel units of the multiplex equipment are the same type as in the DM 2 Primary Multiplex Equipment. The units must, however, completely fulfill the DM 2/DB2-bus standard. For instance, those VF/E&M units, which do not contain their own power supplies and processors, can not be used in the channel unit bus of DB 2.

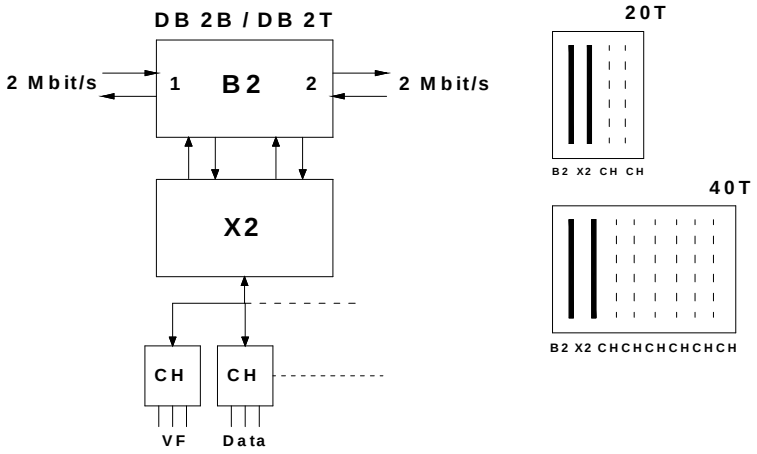


Figure 3.15 DB 2B Branching Equipment and channel units

DB2B Branching block diagram is shown in fig.3.16

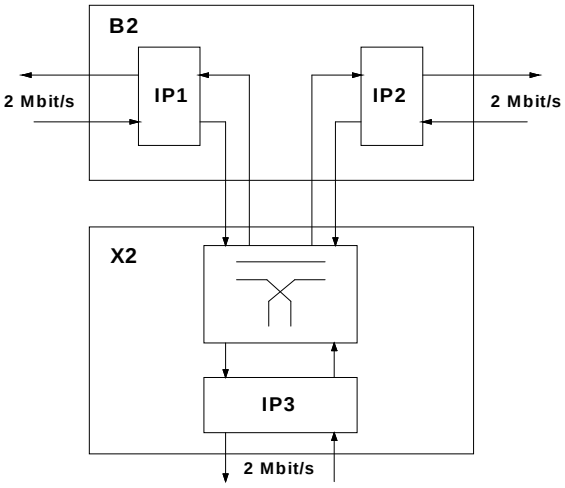


Figure 3.16 Block diagram of DB2B branching

Front connectors of B2 card are shown in fig.3.17.

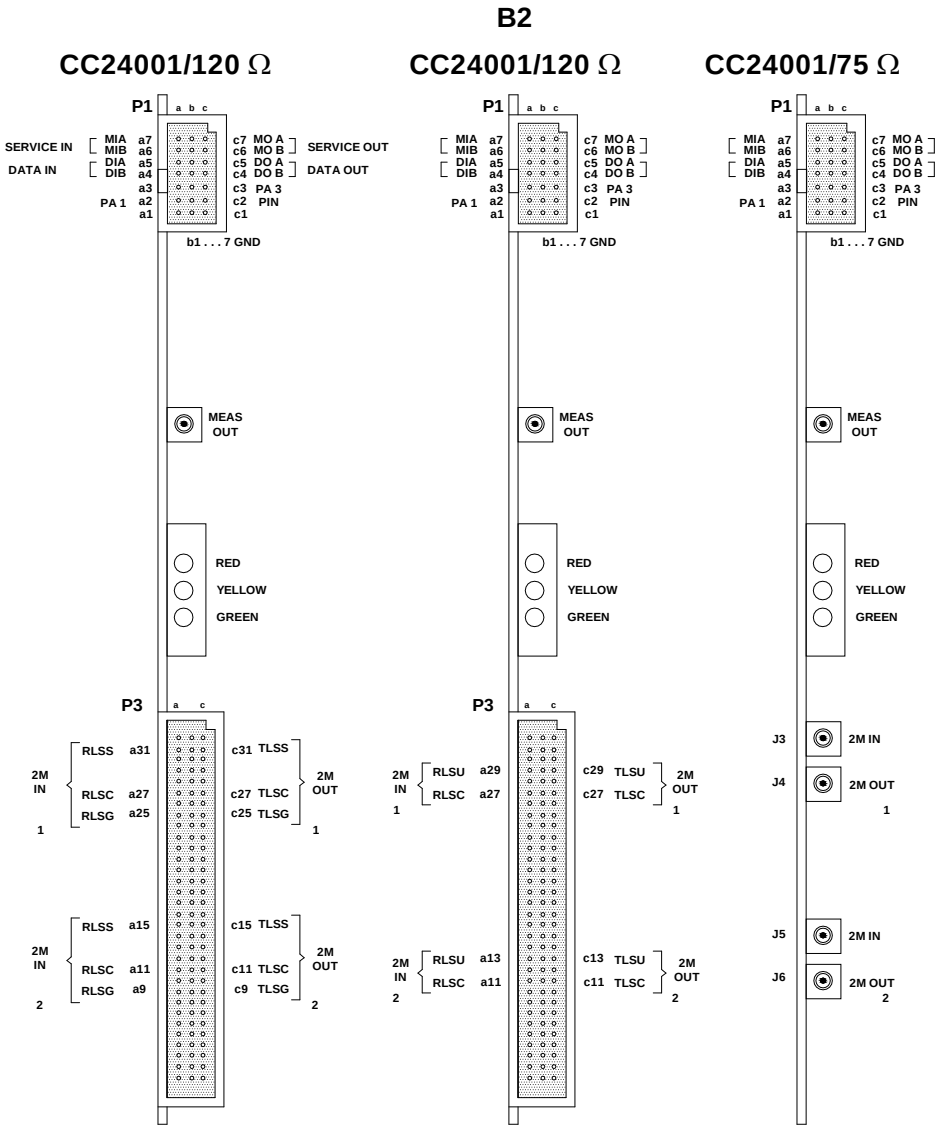


Fig 3.17 Front connectors of 2 Mb switching unit B2

Front connectors of X2 card are shown in fig.3.18

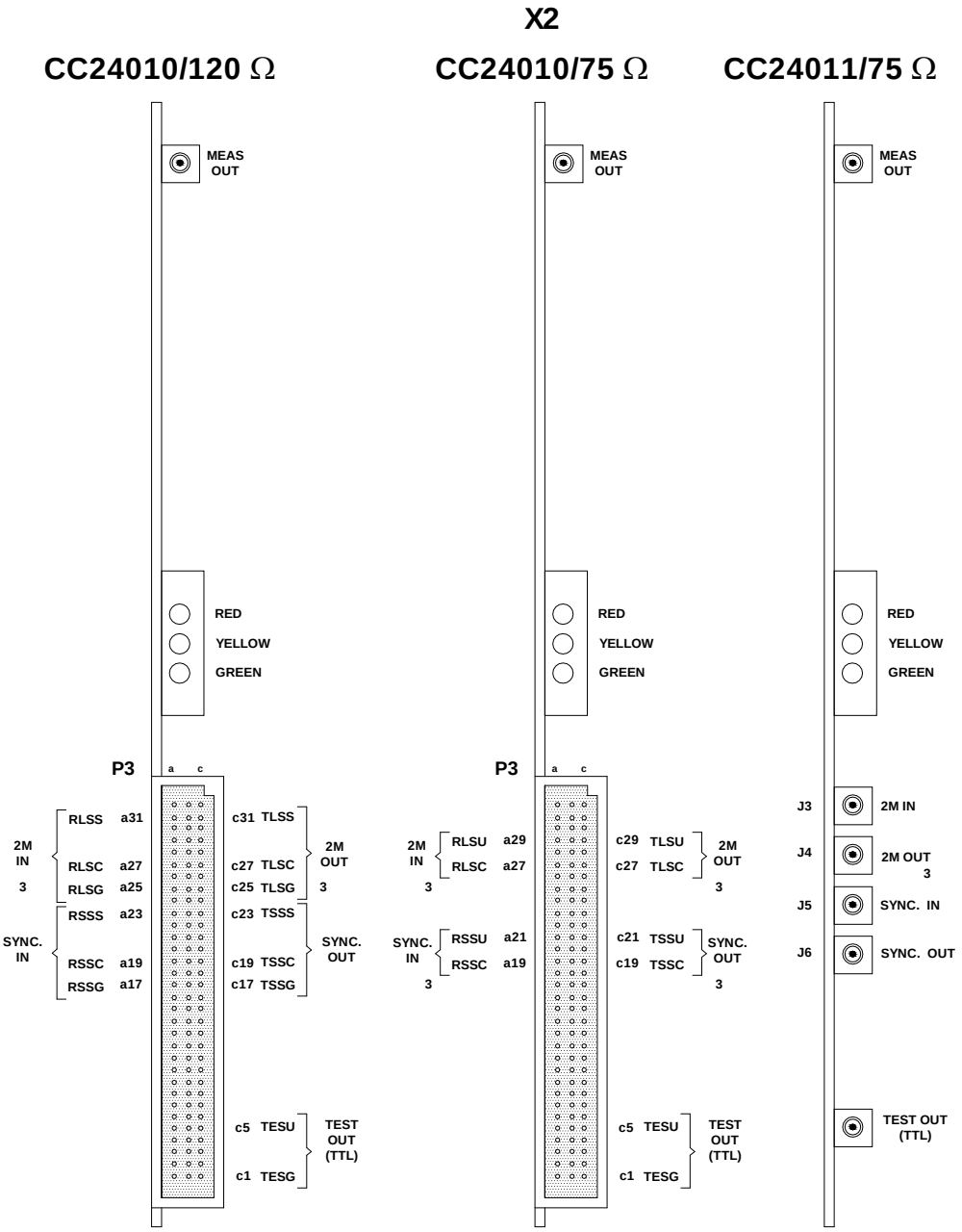


Figure 3.18 Front connectors of 2 Mb switching unit X2

All the channel units are connected in parallel to the bus, and they extract from the bus the bits belonging to them in those places in the frame that are defined at installation using the Service Terminal. The channel unit stores the settings in an EEPROM circuit. The 2 M bit/s interface integrated in the X2 unit cannot be used if there are channel units in the equipment.

The bus structure allows the connection of different types of channels:

- VF channels with E&M interfaces
- VF channels with signaling equipment
- 0. ..19.2 k bit/s V.24/V.28 data interfaces
- 64 K bit/s V.11 and X .21 data interfaces
- 64 K bit/s G.703 data interfaces
- Nx64 K bit/s in a G.703/704 2 M bit/s signal.

3.11 Structure of alarm system

The function of the monitoring and alarm system of transmission equipment is to locate and indicate the faulty maintenance section. In a fault condition or when the quality of primary service of the equipment falls under an acceptable limit, the equipment is isolated from traffic and the service of other equipment using this equipment is inhibited. The isolation of the faulty section and service blocking are realized by means of alarm S and the AIS signal. In the DB 2, the AIS insertions are done in each 2 M bit/s interface block.

The units of the DB 2 equipment are provided with three LED indicators: red, yellow, and green. The red indicator indicates an equipment fault; the equipment itself has discovered a functional disturbance. The yellow indicator indicates a fault outside the equipment, e.g. the equipment's input signal is the AIS. The green indicator shows that the transmission management actions are being used on the equipment.

In the equipment, the faults are classified as urgent (A), i.e. faults that inhibit the equipment operation, and as non-urgent (B) faults, in which case the equipment performance has weakened but its services can still be used.

The equipment gives information on a fault condition via the alarm interfaces. There are two types of interfaces: the rack alarm interface and the service interface.

The rack alarms (A, B, D) of the various equipments are transferred from the equipment to the power supply adapter cartridge via the rack bus. From there the alarms can be further connected as ground or loop contacts.

The rack alarms are:

- (A) urgent alarm
- (B) Non-urgent alarm
- **(**D) Reminder of alarm acknowledgment

Rack alarms A and B are acknowledged via the service interface of the equipment; alarm D is obtained as a reminder of the acknowledgment. Rack alarms are filtered. Filtering removes short-duration alarms lasting under 2.5 s.

Detailed fault data is required for the precise location and determination of a fault. The data is available through the service interface to which the centralized Transmission Management System (TMS) or the Service Terminal can be connected. The service interfaces of the various equipments are then connected to the service bus where each set of equipment has its own address. The service bus can be chained from one station to another. Via the service bus, also measurements can be made and control commands given to the equipment. The service interface of the DB 2 equipment is at the front connector of the B2 unit.

In the DB 2 equipment, the B2 unit collects all the fault data of the equipment using the control bus between units. The B2 unit processes the data and transmits it to the:

- Rack alarm bus
- Polling coming from the service interface.

Fault conditions

Fault conditions of B2 unit:

1 Faulty unit (self-testing)
2 Power supply fault
3 2048 K bit/s input signal missing
4 Frame alignment missing
5 2048 K bit/s input signal identified as MS
6 Error ratio in frame alignment word is 1OE-3
7 Error ratio 1 OE-6 (CRC)
8 Far end alarm (B3)
9 MS received in time slot TS16
10 Multiframe alignment missing
11 Far end alarm (B6).

Faults affecting the 2 M bit/s interface (3...11) are separately identified from both 2 M bit/s interfaces.

Fault conditions of X2 unit

1 Faulty unit (self-testing)
2 Power supply fault
3 Synchronization fault of equipment clock (external clock missing or alignment has not succeeded)
4 Network synchronization fault (slips of frame buffers).

In addition, the same fault conditions of the 2 M bit/s interface as in the B2 unit are identified.

Fault conditions of channel units

The B2 unit also collects fault condition data from the possible channel units of the equipment, and it forwards the data via the rack alarm bus and the service bus.

3.12 Settings

The equipment can be controlled either locally using the Service Terminal or remotely by the Transmission Management Computer or the Service Terminal. Setting data is brought via the service bus. The selection alternatives are presented using menus that are stored in the DB 2 equipment memory. The B2 unit also transmits the settings being directed to other units of the equipment via the equipment's internal control bus.

Settings of B2 and X2 units

- Selection of the equipment-operating mode
- Selection of the equipment's internal clock control
- Selection of the synchronization output clock
- Controls of the 2048 K bit/s interface

- Equipment looping at different 2 M bit/s interfaces
- Properties of the changeover switch of the changeover equipment
- Classification of alarms
- Use of TS0 bits
- Feeding of branching definitions.

Settings of channel units

The channel units are controlled via the B2 unit. The controls include:

- Equipment looping
- Time slot selection
- Connection to bus (on/off)
- Operating modes (e.g. bit rate of the data channels)
- VF levels.

Measurements

For the most part, Euro connectors are used as the cabling connectors of the DB 2 equipment. A measurement cable can be connected to the rear of the cabling connector. Parallel measurements are made by means of this measurement cable.

The B2 and X2 units (see Figures 13 and 14) are additionally provided with a G.703-compliant measurement point or interface out of which the desired 2M bit/s data or clock signal of the unit in question is obtained (signals of the 2 M bit/s interface block).

Options for the measurement interface:

- RX 2 M bit/s data
- TX 2 M bit/s data
- RX 2 MHz clock
- TX 2 MHz clock.

Through the service interface, the equipment can be controlled and data obtained on fault conditions, possible transmission errors, and the results of the tests performed by the equipment itself. By means of a test program in the program memory of the B2 and X2 units, the operation of the equipment units can be tested using different high-speed tests.

All the received signals of 2 M bit/s interfaces undergo an analysis with regard to the parameters of availability complying with Rec. G.821:

- Total time
- Available time
- Errored seconds
- BER> 1E-3 seconds, etc.

It is also possible to monitor the occurrence of different kinds of error conditions:

- Errors of frame alignment word
- Faulty CRC blocks
- Slips of frame buffers.

The operating voltage of units can be read directly in volts by means of a menu.

3.13 TECHNICAL SPECIFICATIONS

Frame and Multiframe structure

The frame and Multiframe structure fulfills ITU-T Recommendations G.704/706. TS0/B1 CRC structure has been implemented.

Basic properties

Bit rate	2048 K bit/s ± 50 ppm
Sampling rate	8 KHz
64 K bit/s PCM coding law	CCITT A-law

Number of:

-	Bits in a time slot	8
-	Time slots in a frame	32
-	Voice and data time slots	30 (31)
-	Frames in a Multiframe	16
-	Signaling bits per voice channel	4
-	Multiplexing principle	Sync. 32 K bit/s time slot Interleaving

The operation of the equipment is controlled via the service interface on the front edge of unit B2 with a Service Terminal. Via this interface, equipment state and alarm data is read, controls and settings are performed, loop backs are commanded, branching tables are fed, etc. The traffic in the service interface is of serial format. (See Operating Instructions for Service Terminal and the separate description available for each equipment, Operation by means of Service Terminal). The equipment can also be controlled by TMS Transmission Management System (see Operating Handbook for TMS Transmission Management System).

Service interfaces can be connected into a bus at the equipment station and the buses of different stations can be further connected into a Service Network by means of the data channel in the equipment. In this case, all equipment connected to the bus or network can be remotely controlled from one point by means of Service Terminal or Transmission Management System (see Operating Handbook for TMS Transmission Management System).

Processing of time slot TS0 bits

TS0 bits in frames containing the frame alignment word

- B1 selectable in each interface
- CRC use (CCITT)
- Permanently “1”
- B2. . .B8 always frame alignment word 0011011 (CCITT)
- Frame alignment word is regenerated in DB 2.

TS0 in frames containing alarm data

- B1 as above
- B2 permanently “1”
- B3 far end alarm, “1” active (CCITT) (3-stage filtering used in reception)
- B4 can be used as a loop network control bit (default setting B4=MCB) or selectable, permanently “1’, (CCITT) or “0,’
- B5. . .B8 selectable
- Data bus at different transfer rates (4-way hybrid; 1, 2, 3 and data interface)
- B8 = 4 K bit/s
- B7+B8 = 8 K bit/s
- B5+B6+B7+B8 =16 K bit/s
- For loop network control (default setting B5 = LCB)
- When the bit is not used for data bus transfer or for loop Network control, its state can be chosen to
- Permanently “1” (CCITT)
- Permanently “0”.

Use of time slot F0/TS 16 bits in branching when channel associated signaling is used

- B1 . **.** . B4 Multiframe alignment word 0000 (CCITT)
- B6 far end alarm, “1,’ active (CCITT)
- B5, B7, B8 can be chosen permanently to “1” (CCITT) or permanently to “0”.

3.14 DB 2 connection types

Branching is defined via the service bus using either the Service Terminal or the TMC Transmission Management Computer. Digital Branching Equipment DB 2 can store several branchings, one of which is active. The stored branchings are kept in the permanent memory.

In branching definitions, time slot numbering is used (TS1...TS31), which is the same as the 64 kb/s channel numbering till time slot TS15. From time slot TS 17, the channel number is one number smaller than the time slot number, e.g. TS31 = Ch. 30. Branching definition cannot affect the use of time slot TS0 bits. When time slot signaling bits (abcd) are to be connected separately for each channel, channel-associated signaling must be used. This is obtained by defining a multiframe structure into use in the branching table in which case the multiframe structure is switched on in all three 2 M bit/s interfaces of the DB 2.

Empty branching table

Without branching definition Digital Branching Equipment DB 2 connect the AIS pattern (11111111) to all transmitted time slots and pattern 1111 to the signaling bits (abcd bits) of all channels. The TS0 frame structure and the F0/TS16 multiframe structure are transmitted normally. The branching connections given by the operator define a new connection for the time slots of an empty branching. The time slots without a branching definition remain in the connection defined by the empty table (AIS pattern).

Branching types Bn.

In B-type branching, the DB equipment are independent of data content. Any time slots can be defined to be connected:

- Between 1 and 2 B0 type
- Between 1 and 3 B1 type
- Between 2 and 3 B2 type
- Omnibus S0 type

In branching, the time slot location in the frame can be changed between different interfaces. The operator can freely define the connection:

- 64 K bit/s time slots and nx64 K bit/s signal
- Half of time slot, 32 K bit/s.

If the multiframe structure is in use, the time slot abcd bits are connected in the same way as the corresponding time slots. In the 32 K bit/s connection, signaling bits are not connected. Also nx8 K bit/s connections are possible to some extent by means of bit mask.

3.15 User Interface Units

DIU 64 K bit/s DATA CARD

The G.703 Data Interface Unit (DLU) belongs to the channel units of the family of primary multiplex equipment. The unit includes 10 data channels which fulfill ITU-T Recommendation G.703. Its characteristics are:

— 10 data channels
— Fulfills CCITT Recommendation G.703
— Either a co- or contra directional interface can be selected for the channel
— Channel time slots can be freely selected
— Channel settings are made using the separate Service Terminal
— The status of the channels can be monitored using the Service Terminal
— The channels can be looped for tests.

CONSTRUCTION

The unit has two DATU circuits, a control block, line interfaces, and a unit power supply. Each of the DATU circuits handles the activities of five channels.

The control block includes a microprocessor, 64 Kb EPROM circuit, and an 8 Kb RAM circuit. The line interface consists of an interface hybrid and four transformers. The voltages needed by the unit are generated by the unit power supply. The unit block diagram is in Figure 3.19.

OPERATION:

There are ten identical channels in the unit. The operation of one channel is described here.

Interface types:

The interfaces of the channels can be chosen as either co-or contra directional.

Contra directional interface Signals used:

Name	
TDA	Transmit direction data
TDB	
TCA	Transmit direction timing
TCB	
RDA	Receive direction data
RDB	
RCA	Receive direction timing
RCB	

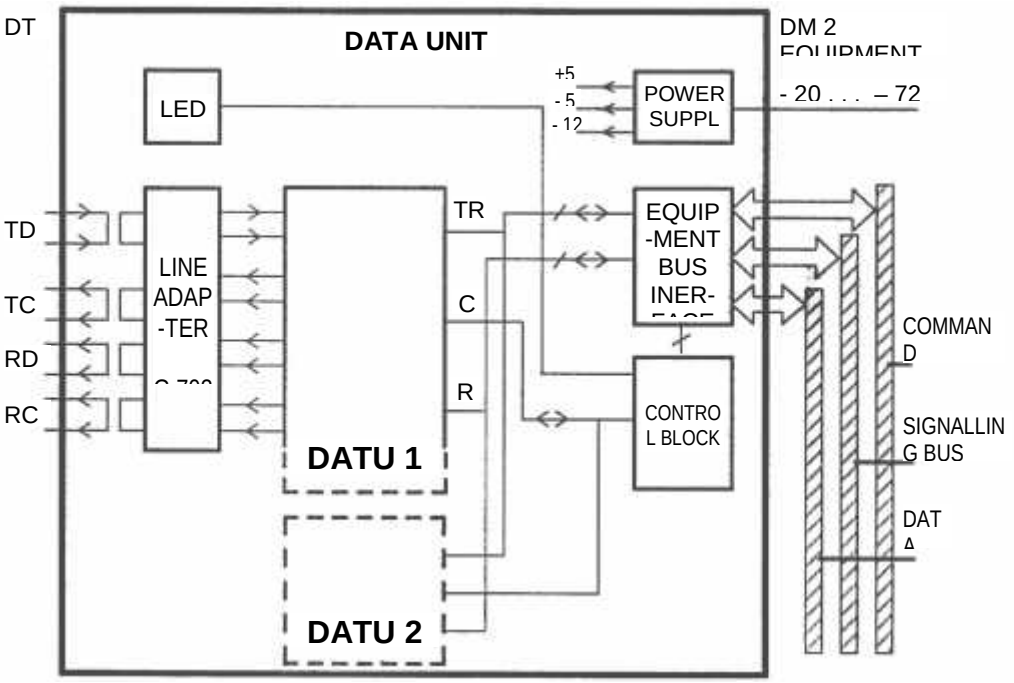


Figure 3.19 Unit block diagram

The electrical interface between the DIU and the terminal equipment (DTE) is formed by means of the line interface.

The DIU sends a timing signal to the DTE that uses the signal for data transmission. The DATU circuit places the data signal coming from the DTE into the selected time slot in the internal bus of the DM2. The data signal is transferred from the bus to the MUX unit. Correspondingly, the data signal received from the DM2 bus is sent to the DTE. A timing signal is sent to the DTE at the same time as the data. The time slots used by the channels are set using the Service Terminal.

Co directional interface Signals used:

Name	
TDA	Transmit direction data and timing
TDB	
RDA	Receive direction data and timing
RDB	

The data transfer operation is the same as in the contra directional interface except for the timing signals. The signal element timing and octet timing are coded to the data signals to be transmitted in both directions.

Control block

The function of the control block is to send the settings made by the user to the channels, send data on the status of the channels to the user, monitor the operation of the channels, and transmit alarm data to the MUX unit when required.
Monitoring fault conditions

The control block monitors the unit operating voltages and the data and timing signals coming from the DTE. In a fault condition, data is changed into an AIS signal in either one or both directions, and the fault is reported to the MUX unit. If an alarm is received from the MUX unit, then the signal to be sent to the DTE is changed into an AIS signal and octet timing is removed when required. It is possible to block the transmission of the AIS signal in fault conditions.

Loop backs

It is possible to loop the data channel in both directions. Loops are done within the DATU circuit. In a fault condition it is also possible to perform automatic test loop back. Thus it can be deduced if the fault is within the DATU circuit or elsewhere.

TECHNICAL SPECIFICATIONS

Data interface

- fulfills CCITT Recommendation G.703
- Nominal impedance 120 ohm.
- Power supply: 20.. .72 V dc
- Power consumption: n. 5 W

Equipping

The connectors of the cartridge motherboards and the back connectors of the equipment are standardized so that the voltages and rack alarm signals conveyed by them are always located in the same places in the connectors. Due to this, no unit slot in the cartridge is reserved for a particular set of equipment. The unit can be mounted to any TM 4 cartridge, which has a MUX unit, and it can be inserted to any unit slot. Other equipment of Nokia equipment generation can also be installed in the same cartridge. A data interface unit takes one unit slot (5 T) in a cartridge.

E&M/VF-P CHANNEL UNIT 8 CH.

E&M/VF-P Channel Unit is designed for DM 2 primary multiplex equipment. Unit includes 8 VF- channels and 2 (3) E&M signaling channels for each VF-channel. It is used to connect up to 30 channels to a 2 M bit/s bus. The channel-associated signaling is transferred in time slot 16. The multiplex equipment consists of the channel units described in this document and a common MUX unit.

The purpose of the unit is:

- To establish a 2-wire or 4-wire channel interface.
- To adapt the levels and impedances.
- To perform A/D conversion in the output direction.
- To multiplex the signals into a 2 M bit/s bit stream this is fed to the DM 2 bus.
- To separate the received signal on each voice channel from the DM 2 bus.
- To perform D/A conversion in the receive direction.
- To convert the DC signalling of the M wire to a digital code for the DM 2 bus.
- To convert the received digital signalling to DC signalling for the E wire.
- In 2-wire mode to perform the balance return loss compensation to a complex line impedance.
- To become synchronized with the DM 2 bus

The channel unit can be used with both the DM 2 Multiplex Equipment and the DB 2 Branching Equipment.

OPERATION OF BLOCKS

Channel unit consists of eight identical channel blocks, a control block and a unit—specific power supply system. Block diagram is shown in Figure 3.20.

Channel block

The channel block includes the voice channel and the E&M signalling circuit.

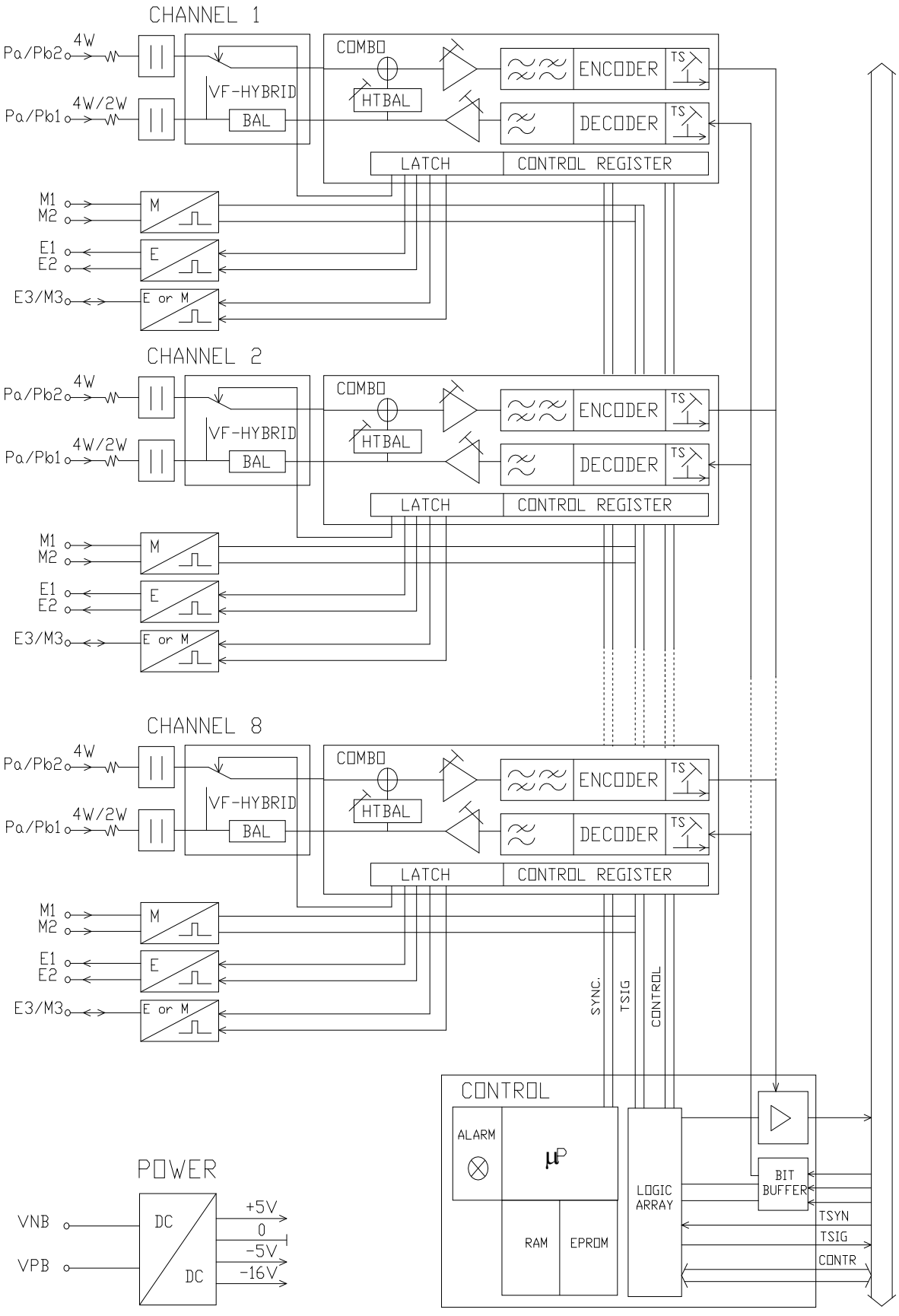


Figure 3.20 Block Diagram of channel unit

Voice channel

The analog interface is either a two-wire interface from connector Pa/Pb1 or a four-wire interface with the output direction connected to pins Pa/Pb2 and the input direction to pins Pa/Pb1. The connection is selected by means of a programmable switch which is controlled from the Latch interface of the COMBO circuit. The analog interface is connected to a VF hybrid via isolation transformers. The hybrid includes impedance matching circuitry and the selection switches for 2-wire or 4-wire connection. The control block via the control bus and the Latch output in the COMBO circuit controls the switch. In two—wire operation the VF hybrid constitutes part of an active hybrid. The balance between the two transmission directions via the BAL circuit is compensated for by a programmable compensation circuit (HYBAL) located in the COMBO circuit. The programmable COMBO performs the normal combo functions, channel filtering, encoding and decoding. It also includes a channel-specific control section (CONTROL REGISTER) and a LATCH circuit. The CONTROL REGISTER performs the following programmable functions under the supervision of the control block:

- Setting of interface levels in both transmission directions.
- Selection of time slot.
- Compensation for balance return loss to a preset impedance.
- Analog or digital loop back when performing tests.
- switching of control signal to the Latch circuit of the 2/4—wire connection.
- The Latch circuit transfers data to or from the control bus. In addition to the above setting, it is also used for signalling.

Signalling: The channel—specific signalling is two—bit E&M signalling. The signalling circuit has been implemented using a hybrid. A three-bit E or M circuit is available as an option. The signalling receiver converts the DC signalling coming from the M wire to TTL level and sends it to the sensing circuits of the control block. In the control block the parallel channel signals are converted to serial mode and transmitted in time slot T16. In the input direction the signalling is transferred to the signalling transmitter via the control bus and the Latch interface of the COMBO circuit. The signalling transmitter converts the signal to DC signalling for the E wire. In order to get a third E or M bit, an additional hybrid is required (E or M). It is set in to E or M state via the Latch circuit. The incoming or outgoing signaling is switched via the Latch circuit. Alternatively, the third signalling bit can be used to set the analog interface into 2-wire or 4-wire state by an external signal (M signal).

Control block: The control block performs the following functions:

- Connects the output of each channel at a time to the DM 2 bus for the duration of transmission. At other times, the interface- is switched to high impedance states.
- Transfers the incoming data from the bus to the register, from where they are connected to the channels under the control of the master clock.
- Converts the parallel signal coming from the signalling channels into serial mode and transfers it to bus time slot 16.
- Extracts the incoming signalling from the bus from time slot 16 and transfers it to the control input of the channels.

- Receives the output direction clock from the bus and feeds it to the channels to serve as master clock.
- Receives the frame alignment information of both transmission directions and processes it to proper form for the COMBO circuit.
- Transfers the control data of the channels between the bus and the control section of the channels.

The control block operates under the control of a microprocessor. Most of the logic circuitry is included in a Gate Array circuit. The control block communicates via the bus with a service terminal, which is connected, to the front panel connector on the MUX unit. All settings required by the channels (either channel—specific or unit—specific settings) are performed with the service terminal as required. The service terminal operates according to the MENU principle.

Power supply

The channel unit is equipped with a board—specific power supply system. A chopper power supply unit generates the +5 V and -5 V voltages required by the unit as well as the -16 V voltage for the M signalling using the central battery voltage (24 — 60 V).

ADJUSTMENTS AND SETTINGS

All adjustments required when commissioning the equipment are performed using the service terminal. In addition an outer control state for 2-or 4-wire mode selection can be selected.

The following parameters are set for each channel or alternatively for all eight channels of the unit:

- Time slot (or the time slot of the first channel)
- Interface levels
- Two-wire or four-wire connection, or outer control state
- The signalling polarities
- Power-up/down.
- For two-wire connection, the settings of the compensation circuit for the balance return loss.

RING GENERATOR CARD: TG 21261 is a unit generating the ringing voltage used for the telephone set ringing tone. It will also generate the voltage needed for the telephone set signal tone.

Structure

Ring generator is a plug—in unit constructed on a EURO—2 printed circuit board installed in the TM4 equipment cartridge. The unit is enclosed in a steel sheet case. The front edge of the printed circuit board has a LED holder simultaneously acting as the unit extractor. This LED holder has one green LED that is ON when the unit is in the operation mode. The rear edge of the printed circuit board has a 2 x 32—pin Euro connector. Through this connector the unit receives its operating and control voltages from the motherboard of the cartridge. In addition, the output voltages of this unit are connected through this connector to the motherboard of the cartridge.

Objective:

1. Nokia system come in two configuration one is the 19" rack and the other is ----------
2. The Multiplexing system of NOKIA is configured into two types of configurations DM2 and ----------.
3. In Nokia system DM-2 configuration is used at a ----------station.
4. In Nokia system DB-2 configuration is used at ---------- station.
5. For controlling the Nokia system through software a Service Terminal or ----------is used.
6. In Nokia system with Service Terminal we can configure ----------, ----------, &--------- selection in DM2.
7. In common channel signaling, messages are sent in time slot ----------instead of channel-associated signaling.
8. In Nokia System the red LED indicates that the ----------is faulty.
9. In Nokia system there are two types of loop backs ---------- & ----------in DM2.
10. In Nokia system 2 M branching can be realized using ---------- card.
11. In Nokia Type ----------branching connects Data from PCM dir 1 to PCM Dir 2.
12. In Nokia Type ----------branching connects Data from PCM dir 1 to local Dir 3.
13. In Nokia Type ---------- branching connects Data from PCM dir 2 to local Dir 3.
14. In Nokia Type ---------- branching connects Data from PCM dir 1 to PCM Dir 2 and Local Dir 3.

Subjective

1. Explain the working of DM2 in Nokia system with the help of block diagram & state its functionality?
2. In Nokia system what are the various configuration obtained from DB2 Mux?
3. Write a note on 2Mbps branching on Nokia DB2 unit?
4. What are the different channels units (customer Interface) can be connected to mux unit of Nokia system?
5. State the functional difference between B2 & X2 unit in Nokia system?
6. What are the settings done for initial configuration of Nokia Mux?

CHAPTER 4

2/34 MB SKIP MUX

4.1 Introduction

2/34 Mb/s Digital MUX equipment, also known as Skip-MUX equipment, employs latest State of the Art design for high reliability and compactness. This multiplexer on the transmit side multiplexes 16 plesiochronous 2 Mb/s bit stream into one 34 Mb/s bit stream and on the receive side de-multiplexes one 34 Mb/s bit stream into sixteen 2 Mb/s data streams. The multiplexing principle is cyclic bit interleaving and positive justification is employed. Slim rack construction practice is used to organize the system. The equipment operates on -48 V DC (-40 to -60 V) with positive earthed. Power consumption per Terminal is approximately 50 Watts.

4.2 Brief Description of Equipment

4.2.1 Rack and Sub-rack Arrangement

Please refer fig.4.1 showing all the sub-racks in the equipment bay.

The equipment is modular in construction. The sub rack can accommodate five PC boards with necessary I/O terminations. Four PC boards are engineered to realize 2/8 Mb/s MUX/de-MUX function. The 8/34 Mb/s MUX/de-MUX function is realized in the 5 th PC board. The various interconnecting signals between the PC boards are connected through a printed circuit back panel. Custom built devices, programmable logic devices and clock modules are employed to realize the various functions. All the necessary alarms are depicted on the respective PC cards for easy identification of the fault and appropriate corrective action. A separate power supply module equipped in an independent power supply sub rack provides the necessary derived output voltages required for the equipment. The power supply module operates from a nominal input supply of -48 V with a supply variation of -48 V to -60 V.

The power supply sub rack can equip two power supply modules. One power supply module will cater for one MUX sub rack. Control/protection switches are provided in the power supply sub rack. Supervisory module (Optional) equipped in the power supply sub rack will depict the various MUX alarms on a hand held terminal. Provision has been made to transmit these alarms on the RS 232 serial port. One supervisory module can cater for two Skip MUX equipments.

At the bay top provision are made for the wire wrapping of 2 Mb/s I/O terminations. However the 34 Mb/s I/O terminations are provided at the MUX sub rack itself. Necessary visual alarm is provided at the bay top for system alarm indication. Terminations are provided for audible alarm.

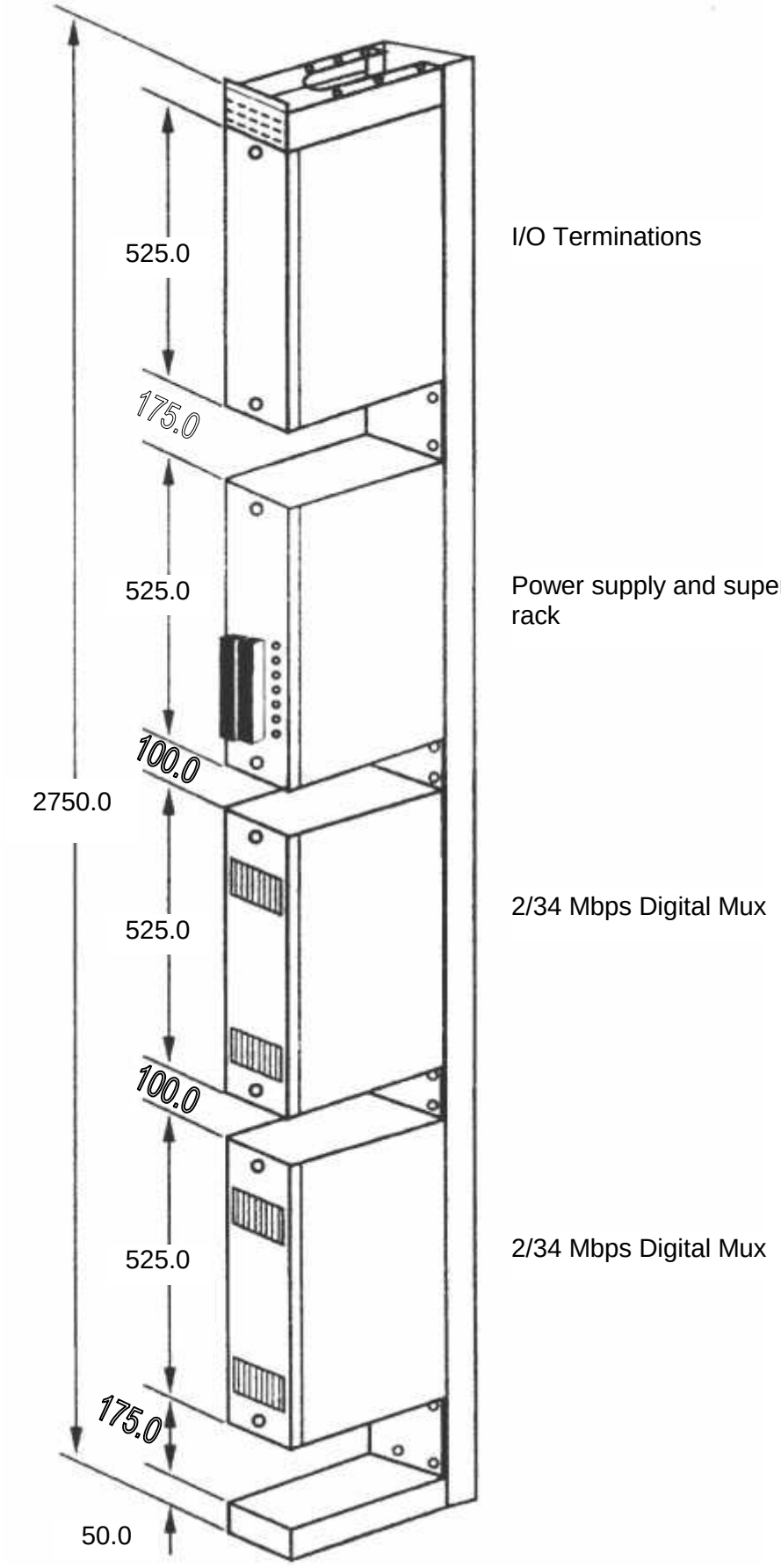


Fig.4.1 TYPICAL VIEW FOR FULLY EQUIPPED BAY

4.2.2 Brief explanation of Working

The 2/34 Mb/s Digital MUX equipment developed by M/s ITI is configured in 5 PC boards, apart from the power supply. The 2/34 Mb/s Mux and de-Mux functions are carried out in two stages.

Please refer fig.4.2 (a) showing block diagram of Transmit side. On the transmit side, first the incoming 16 Nos. of 2 Mb/s plesiochronous digital streams (tributaries) after qualization/clock extraction, HDB-3 decoding and synchronization (positive justification principle) are multiplexed by cyclic bit interleaving to obtain four tributaries of 8 Mb/s digital streams. The necessary frame alignment word and service bits are added. In the second stage these four 8 Mb/s digital streams are again multiplexed in the same way as that of 2/8 Mb/s Mux principle to obtain one 34 Mb/s HDB-3 Output.
Please refer fig.4.2 (b) showing block diagram of Receive side. On the receive side the incoming 34 Mb/s HDB-3 Input after station cable equalization/clock extraction, regeneration, HDB-3 decoding and framing, are demultiplexed to realize four tributaries of 8 Mb/s digital stream. In the subsequent stage these four 8 Mb/s Digital streams are again demultiplexed to obtain sixteen tributaries of 2 Mb/s HDB-3 O/P).

4.3 Technical Specifications

4.3.1 Digital Interface at 2048 kbps

AT INPUT PORT

1.	No. of Tributaries	:	16
2.	Bit Rate	:	2048 Kb/s ± 50 ppm
3.	Code	:	HDB-3
4.	Impedance	:	120 Ohms balanced (Nominal)
5.	Pulse Voltage	:	3.0 V ±0.3 V
6.	Pulse width	:	244 ns ± 25 ns

AT OUTPUT PORT

1. No. of Tributaries	:	16
2. Bit Rate	:	2048 Kb/s ± 50 ppm
3. Code	:	HDB-3
4. IMPEDANCE	:	120 Ohms balanced (Nominal)
5. Pulse Voltage	:	3.0 V ± 0.3 V
6. Pulse width	:	244 ns ± 225 ns

TYPE OF CONNECTOR : Wire wrapping type

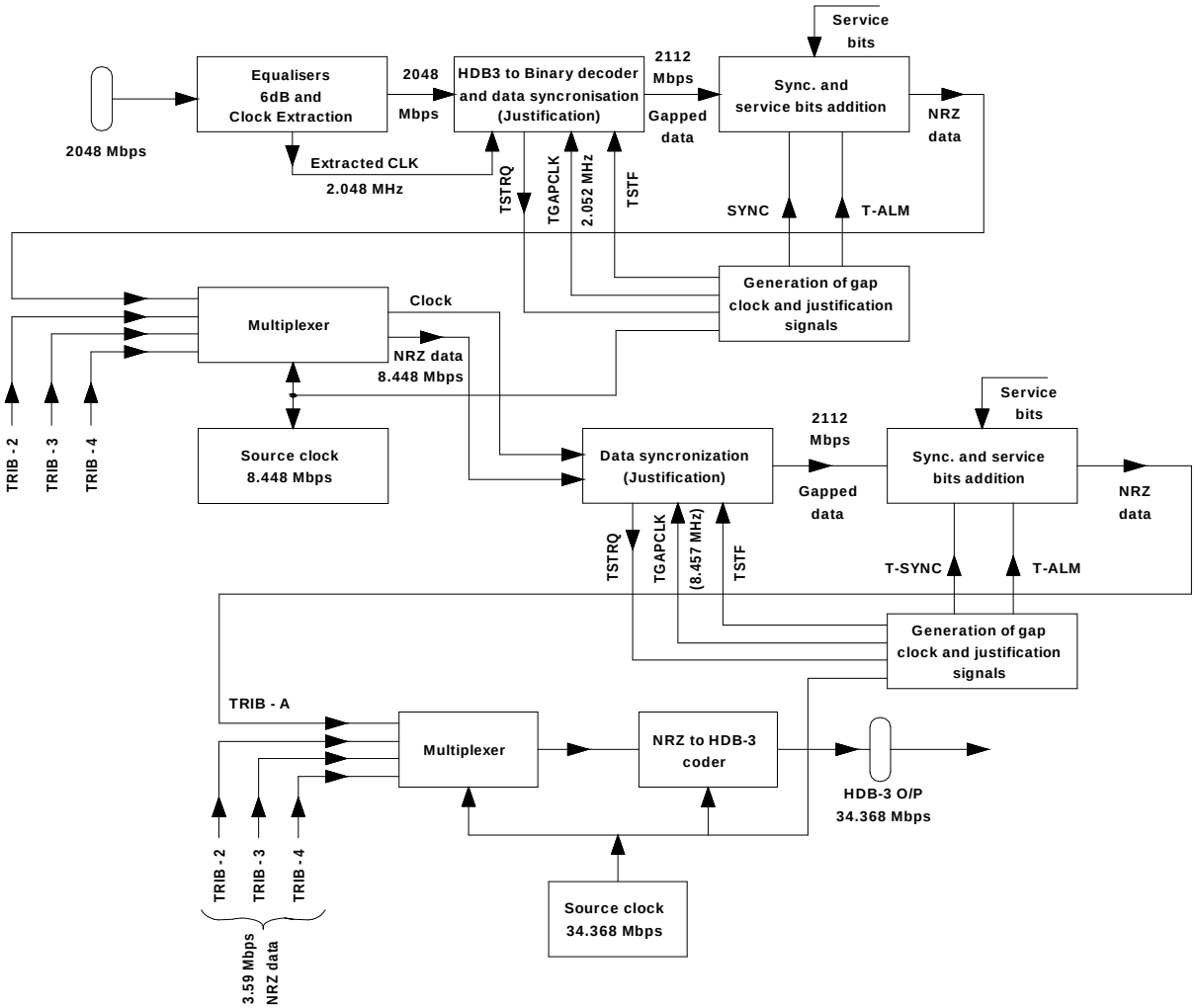


Fig.4.2 (a) Block diagram of TX path of 2/34 MUX

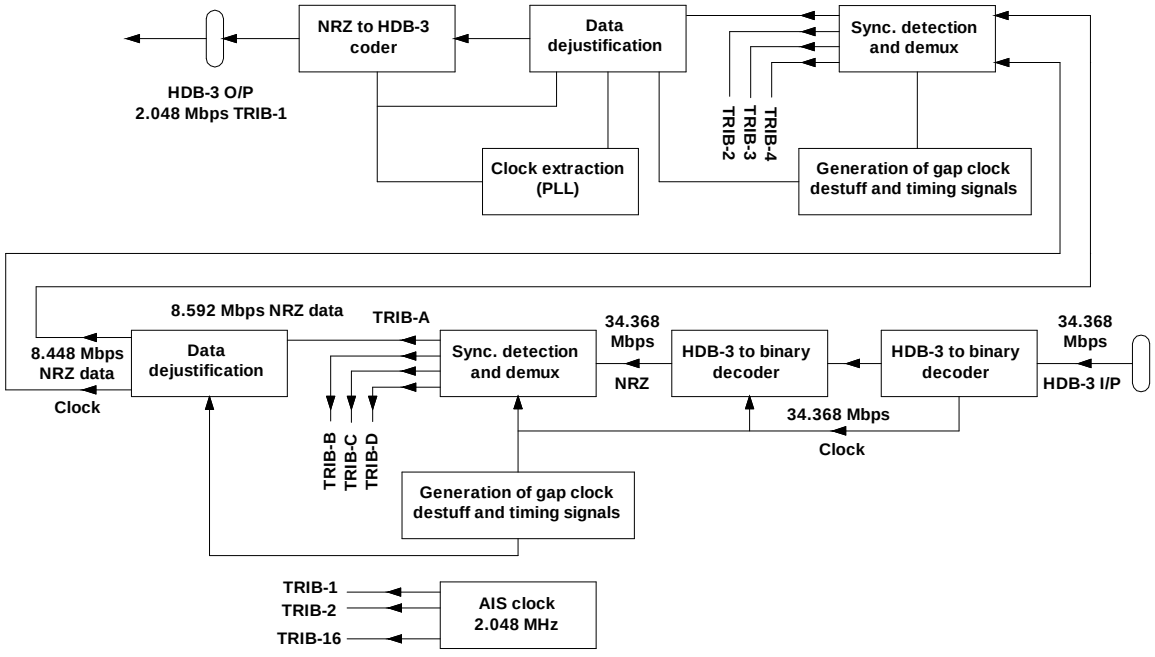


Fig.4.2 (b) Block diagram of Receive path of 2/34 MUX

4.3.2 DIGITAL INTERFACE AT 34368 Kb/s

SPECIFICATION AT INPUT PORT:

1. Bit rate :34368 K bit/s ± 20 ppm
2. Code :HDB-3
3. Impedance :75 Ohms unbalanced (nominal)
4. Pulse voltage :1 V ± 0.1 V
5. Pulse width :14.55 ns ± 2.24 ns

Jitter acceptance

The input port will be able to tolerate a digital signal modulated by sinusoidal jitter having an amplitude/frequency relationship as given below.

100 Hz to 1 KHz : 1.5 UI
10 KHz to 800 KHz : 0.15 UI

SPECIFICATIONS AT OUTPUT PORT:

1. Bit rate : 34368 K bit/s ± 20 ppm
2. Code : HDB-3
3. Impedance : 75 Ohms unbalanced (Nominal)
4. Pulse voltage : 1 V ± 0.1 V
5. Pulse width : 14.55 ns ± 2.24 ns

TIMING SIGNAL

The system can synchronize on any one of the following clock sources.

1. Internal oscillator at 34368 Kb/s.
2. 34369 Kb/s recovered clock.
3. External 34368 KHz signal.

The selection is hard wired connection.

TYPE OF CONNECTOR : Spinner.

SUPERVISORY FACILITIES:

Loop back: It is possible to loop back any one of the tributary output to the corresponding tributary input for remote testing of 2048 Kb/s tributary path.

4.3.3 ALARMS ON 8/34 CARD AND CONSEQUENT ACTIONS

1. SYS : System Alarm
2. HTF : Trans Failure
3. FAS : Receive Sync Failure.
4. AIS : All 1's received at the 34.368 Mb/s input port
5. RMT : Remote Alarm
6. HRF : Absence of input 34.368 Mb/s signal

SYS Alarm:

SYS LED lights up under the following conditions

a) 2 Mb/s input tributary failure
b) Loss of lock (LOL) of 2 Mb/s tributary receive clock.
c) Sync failure.
d) Trans failure.
e) Absence of 34 Mb/s I/P signal (HTF).

HTF Alarm: This LED lights up whenever 34.368 Mb/s source clock fails.

FAS Alarm: This LED lights up under frame alignment not received correctly.

HRF Alarm: This LED lights up whenever the 34 Mb/s I/P signal fails. Under all above conditions Bay Top alarm and audible alarm are energized.

RMT Alarm: This LED lights up under remote MUX failure condition.

AIS Alarm: This LED lights up whenever all 1's are received at the 34 Mb/s I/P port.

4.4 POWER SUPPLY CARD

Power Supply card works on the principle of forward converter using current mode control. This power supply works off 42 to 56 V DC and provides the following outputs.

+ 5 V : 6 A
- 15 V : 0.8 A
+ 15 V : 0.5 A
- 5 V : 0.8 A

All the outputs are fully protected against over current / short circuit and over voltage. In case of over-voltage on one or more outputs the power supply is tripped off. All the four output voltage and I/P voltage can be checked at the monitoring socket provided at the front plate. The nominal working voltage is -48 V DC.

4.5 MUX Sub-rack arrangement

Location of cards in MUX sub-rack is shown in fig. 4.3

2/8 MUX	2/8 MUX	8/34 MUX	2/8 MUX	2/8 MUX

Fig. 4.3 TYPICAL LOCATION OF MUX CARDS IN MUX SUBRACK

Objective:

1. 2/34 Mb/s Digital MUX equipment, also known as ----------equipment.
2. This multiplexer on the transmit side multiplexes ---------- numbers of Plesiochronous 2 Mb/s bit stream into one 34 Mb/s bit stream and on the receive side de-multiplexes one 34 Mb/s bit stream into sixteen 2 Mb/s data streams.
3. The multiplexing principle is cyclic bit interleaving and ---------- justification is employed.
4. The Skip Mux operates on ----------V DC
5. Alarm TRF pertains to Absence of ---------- data
6. Alarm ----------pertains to Loss of lock of the PLL.

Subjective:

1. Why 2/34 Mb/s mux is known as Skip Mux.?
2. Draw the connectivity diagram of Skip Mux with 34 Mbps Digital Radio system?
3. Skip Mux employs which types of interleaving (Bit or Byte). Explain in detail?
4. Why do we require Skip Mux?

CHAPTER 5

PUNCOM VMX-0100 SYSTEM

5.0 INTRODUCTION

The VMX-0100, 2Mbps ~30 Channel E1, Add-Drop Multiplexer provides full range of POTS (voice) and digital data services to subscribers located at different locations, requiring to interconnect and establish a voice and data network over E1 links. The VMX-0100 is a simple, yet powerful E1 Channel Bank for connecting and integrating analog communication equipment with digital E1 services. It has two E1 ports and it supports full cross-connect between E1 ports and voice/data physical ports. The multiplexer can provide the E1 stream path protection by using the LPC Card. The VMX-0100 has an effective, Windows based "Network Management System", which may be used for configuring the system, subsequent remote monitoring and management of the inter-connected systems in the network. An extensive set of alarms, for easy maintenance are provided in the system.

5.1 SALIENT FEATURES

- Supports Nx64, G.703/Fractional E1 interface
- Provides variety of Voice interfaces which includes E&M (2W & 4W), FXO, FXS, Loop I/C, Loop O/G and Hotline.
- Provides variety of Data interfaces which includes 64kbps G.703 Data, Low bit rate asynchronous/synchronous data with V.24, V.35, V.11 and X.21 interfaces.
- Supports ISDN Digital Subscriber Line (IDSL).
- Supports Nx64 synchronous Data, with $N_{max.}$ =30.
- Supports Software Download.
- Web Browser Interface (HTTP 1.1) for System Management.
- Supports 10Base-T Ethernet Data transfer over E1 links.
- Provides 18, 3-party conferencing channels out of which 8 conferences can be 4 party.
- Fully programmable voice & data ports locally or remotely through Network Management System.
- Comprehensive test & diagnostics features.
- Loop protection feature for increased Network availability.
- Optional redundant DC-DC converter.
- Alarm History and Status LEDs.
- Supports SHDSL (Single-pair High speed Digital Subscriber Line) as per G.991.2.

5.2 APPLICATIONS

- 4 wire E&M and FXS/FXO Remote Subscriber Extension.
- SCADA (Supervisory Control and Data Acquisition) and Add-Drop Multiplexer in chain Networks e.g. for Railways, Gas Pipelines.
- Data Circuits for PRS (Public Reservation System) / FOIS (Freight Operations Information System) etc.
- Terminal Multiplexer for SDH Networks.

- Leased Lines over IDSL/SHDSL Interface.
- As a P2P MUX for voice & data transmission on basic primary rate E1 trunk of 2.048 Mbps.
- As a tail end primary MUX in a digital transmission n/w
- As an add-drop MUX on a 2.048 Mbps PCM trunk.

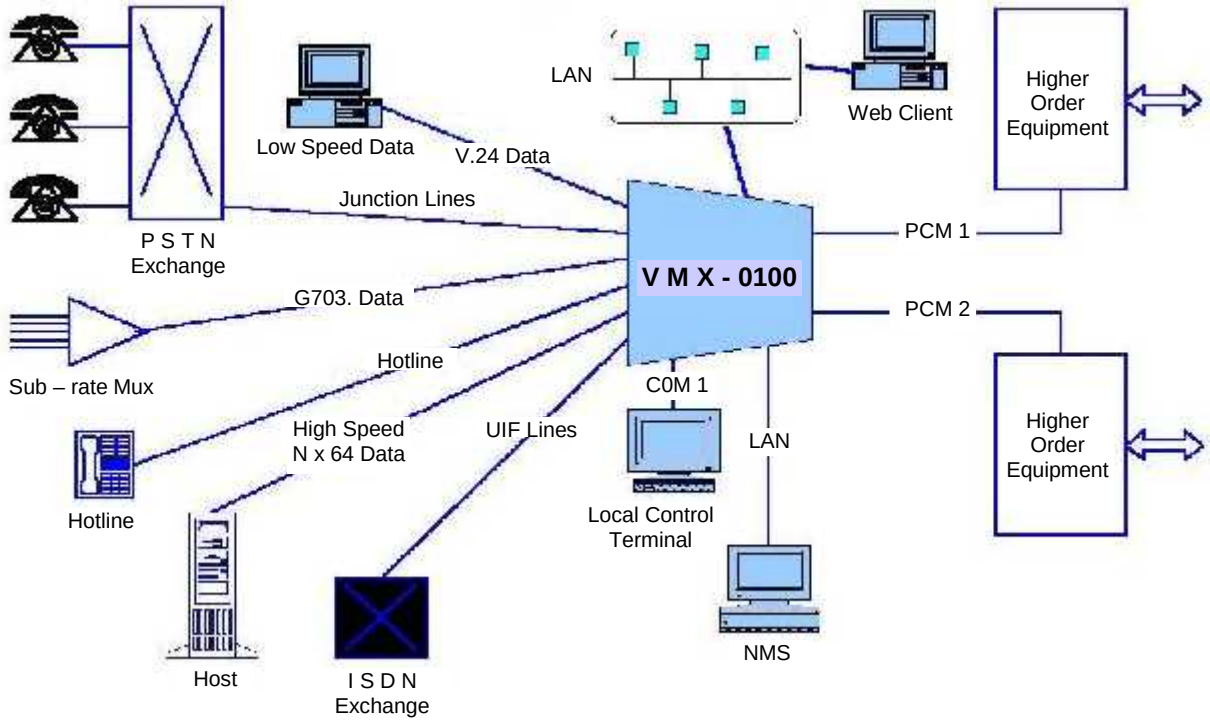


Fig. 5.1 VMUX-100 APPLICATIONS

5.3 MECHANICAL DETAILS

VMX-0100 is housed in a standard 6U Sub rack conforming to DIN /19" Standard.

The details of the sub rack are:

Frame Height : 265mm
Width : 483mm
Depth : 260mm

Dimensions of each card are:

Height : 233.35mm
Width : 25.4mm
Depth : 220mm

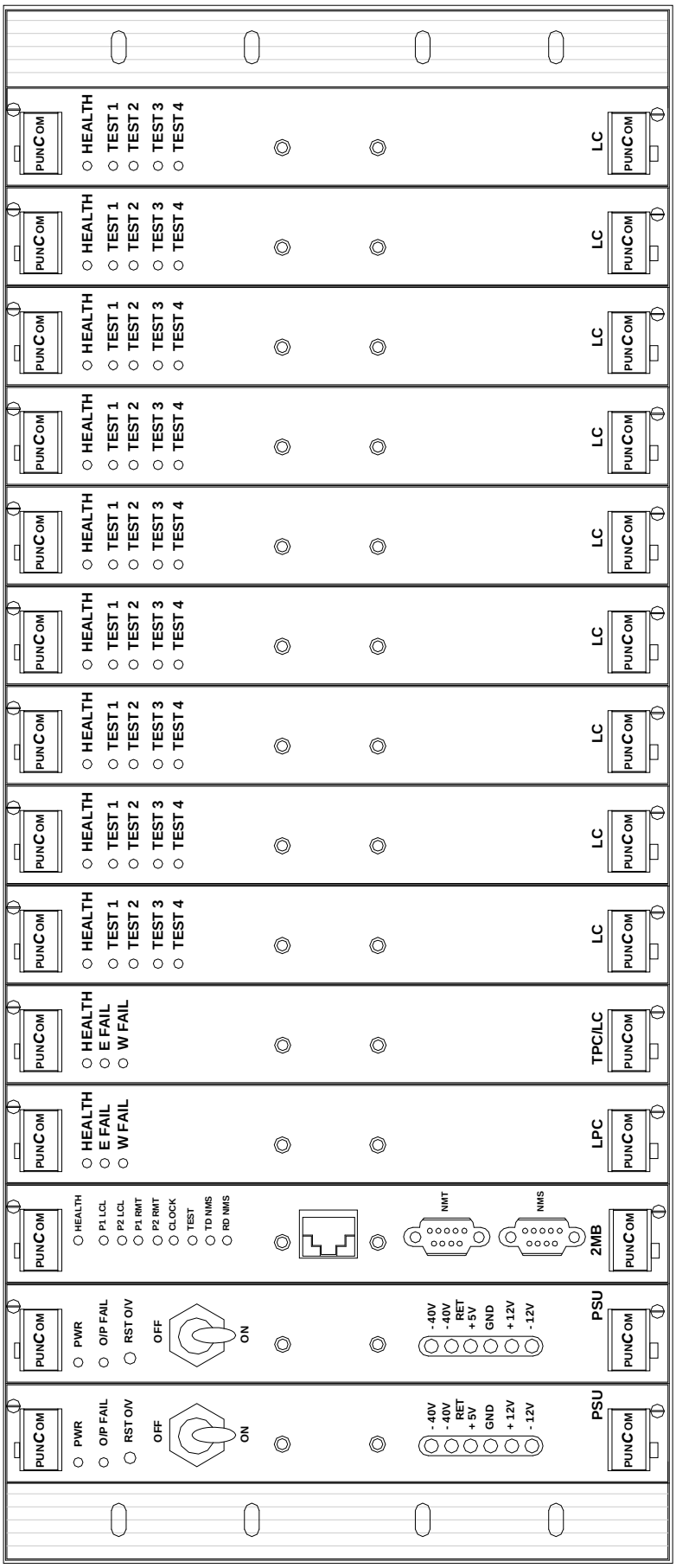


Fig 5.2 Front View of VMX-0100

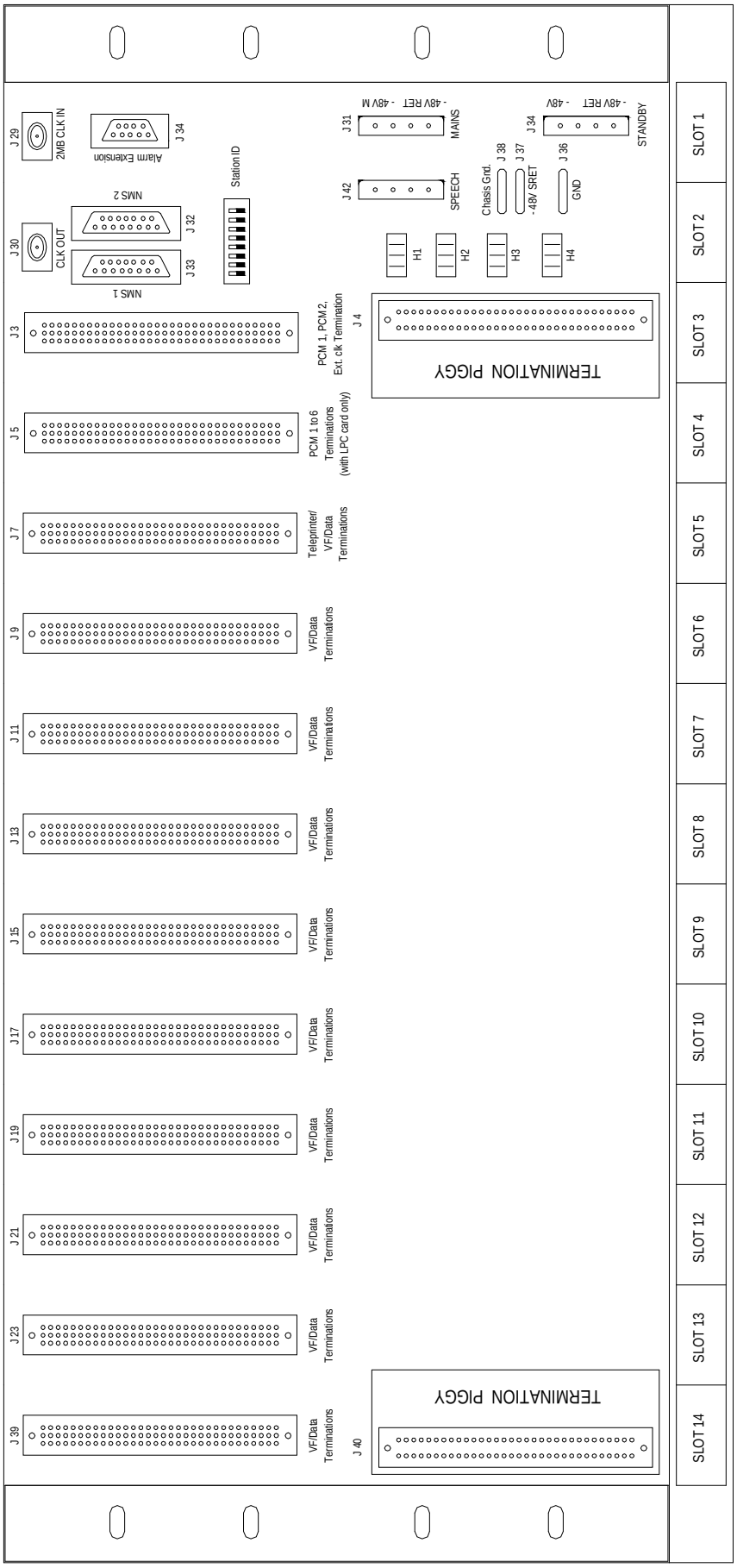


Fig 5.3 Rear view of VMX-0100

5.4 SYSTEM ARCHITECTURE

SHELF ARRANGEMENT

VMX-0100 shelf has 14 slots. Four card slots are reserved and rest ten for user interfaces.

Slot 1	Power Supply (PSU) Card #1
Slot 2	Power Supply (PSU) Card #2 Redundant
Slot 3	TME Card
Slot 4	Loop Protection (LPC) Card (Optional)
Slot 5-14	User Interface Cards

Table 5.1

Most user interface cards provide four VF/Data ports and therefore a maximum of 40 VF/Data ports can be accommodated in a VMUX-100. Out of which only 30 can be configured at a time. The slots 5-14 can have any of the available user interface cards. VMUX-100 automatically detects the presence and type of interface card available in a particular slot. The front view of the VMUX-100 System is shown in figure.

5.4.1 CARDS

The design of VMUX-100 is modular and is based on multiple processors. Broadly VMUX-100 system can be partitioned as follows.

i) Common Cards

- TME card
- Redundant PSU Card

ii) User Interface Cards

(a) VF Cards

- E & M card: Required for E & M 2W and 4W interfaces.
- FXO card: Required for Loop I/C and Exchange Line interfaces.
- FXS card: Required for Subscriber, Loop O/G and Hotline interfaces.

(b) Data Cards

- G 703 Card : Required for 64 Kbps G. 703 Co-directional Data
- UDT Card: Required for 1200/2400/4800/7200/9600/19200 baud synchronous or asynchronous data.
- N64 Card: Required for N X 64 data where N max. = 30
- UIF Card: Required for 64/128 K Data Extension to remote sites.
- FE1 Card: Required for supporting two fractional E1 streams.

(c) Optional Cards

- LPC Card : Required to protect the 2 Mb tributary carrying the Omnibus Channels in case of any major failure in the network
- DAC Card : Required for monitoring the voltages and other environmental Parameters like Temperature, Pressure, Humidity, Battery Voltage, AC voltage etc.,

iii) PSU Card: Power supply in the VMUX-100 is DC-DC converter based on SMPS technology. VMUX-100 supports optional redundant PSU card for higher availability. The two modules go in slot 1and 2 of the mother board. Apart from generating the output voltages required for the functioning of the system, it also generates the 75 V rms, 25 Hz ring signal required for the FXS card. The input and output specifications are as under:

Input: -36 V to -72 V (-48 V nominal)

Output
+ 5V/10 A
+12V/1.05 A
-12V/1.05 A

A filtered -48 V is given to loop signalling VF cards for powering the VF Loop interfaces. Typical power consumption of VMUX-100 is 75 W.

iv) TME Card: TME Card forms the heart of VMUX-100 system and goes in slot no.3 of the VMUX-100 shelf. This is a microprocessor based card employing Motorola's MC68EN302 Microprocessor and functions as the overall controller of the system. It implements all programmable features of the MUX, scans the MUX for alarm conditions, maintains history files as well as takes the user defined action whenever the alarm condition is detected. It also scans the MUX hardware for correct functioning and signals the user whenever any abnormality is seen. It also interacts with the NMT user over a user-friendly menu based man machine dialogue for various actions requested by him. It implements full featured cross-connect between PCM-1, PCM-2 trunks and the local user ports. It also functions as the signalling processor card and extracts the signalling information coming on time slots 16 of PCM-1 AND PCM-2 and sends them to the VF ports and vice-versa. It also interacts with the NMS either through RS-232 or Ethernet interface for providing Network Monitoring and control. It houses the clock handling logic and PLL.

v) LPC Card: This card is used to protect the P1 & P2 streams carrying the traffic in case of any major failure in the network. It provides the protection to the main 2 Mb stream in manner that all nodes on the chain remain connected to each other on the omnibus channels. It uses two 2 Mb streams one spare and one backup for providing the protection.

vi) DAC Card: This Card has

- 8 auxiliary input ports, which can be used for getting status of events.
- 8 auxiliary dry contacts for controlling 8 tasks.
- 6 analog inputs for monitoring up to 6 environmental parameters.
- System voltages monitoring.

This card can go into any line card slot. All auxiliary inputs/outputs, analog inputs and AC supply I/P, Temperature sensor module can be connected to the DAC card through additional unit called EACU (External Alarm and Control Unit).

5.4.2 EQUIPMENT ID

An 8-position DIP switch has been provided on the mother board to set the equipment ID. With 8-positions maximum of 256 Ids can be set. This ID is required for NMS operation and forms the address of NMS basic frame.

5.4.3 WIRING and TERMINATIONS

All the connections are terminated on the connectors on the rear side of the motherboard. VMUX-100 receives -48 V power supply through a shrouded connector located on the rear of the motherboard. All user interfaces as well as 120 Ohm interfaces of PCM-1, PCM-2, network clock-in, and clock out have terminations on the Euro connectors on the rear side of the motherboard. 75 Ohm interface terminations for Clock input and Clock output are also brought on to BNC connectors. Two DB15 connectors have been provided for the NMS. One DB9 connector has been provided to extend the Major and Minor alarms to the Bay Top Panel. Please refer the Block diagram of VMUX-100 is shown in Fig 5.4.

5.5 FUNCTIONAL DESCRIPTION

The two incoming PCM streams P1 and P2 enter the TME card via the upper Card connector, from the rear side. 75/120 ohm operation is selected by one Jumper and programming through the NMT. The incoming streams are connected to the two separate Combined Line Interface Unit and Framer IC through line transformers, which give two TTL level ST-Bus compatible VF and signalling streams.

- The combined Line Interface Unit and Framer IC carries out
- Line equalization
- HDB-3 to binary conversion
- Deframing
- Clock Extraction
- Extraction of information on spare bits
- Alarms monitoring etc.

These TTL level VF and signalling streams are further connected to VF and signalling cross-connect switches respectively. These switches perform the TSI function on these streams as programmed by the user in the routing tables.

The local add-drop channels are placed on the TDM1 and CAS streams, which are connected to various Line Cards through the system Bus. The other signals required for the operation of Line Cards are also generated in TME card and connected to Line Cards via the system Bus. The TME Card Processor and Line Card Processors communicate with each

other through IP Bus. The clock priorities can also be set through NMT. The selected clock is also extracted to the connector on the motherboard. In the Line Cards the ST Bus compatible data and signalling information is suitably processed according to the type of the User Interface Card.

The Loop Protection function of the equipment can be achieved by using LPC Card (Optional). This card is used to protect the P1 and P2 streams carrying the traffic in case of any major failure in the network. It provides the protection to the main 2 Mb stream in a manner that all nodes on the chain remain connected to each other on the omnibus channels. It uses two 2 Mb streams one spare and one backup for providing the protection.

5.5.1 PROGRAMMABLE TIME SLOTS

The operation of VMX-100 is programmable or configurable from a VT 100 compatible Network Management Terminal (NMT) connected to it. Through the NMT the user interacts with VMUX-100 over multi-level user-friendly screens to display the existing configuration and / or to enter new configuration. Once entered, the configuration information is stored in a non-volatile RAM (NVRAM) and governs the operation of the MUX henceforth. The NVRAM has a battery life of several years.

The NVRAM comes programmed from the factory with default configuration setting for all programmable parameters. This default setting can be viewed and altered at site using NMT. The default setting is generally good enough for the operation of VMUX-100 in a typical environment and can be supplied tailored to a specific user requirement.

5.5.2 NETWORK SYNCHRONIZATION

Vmux-100 SUPPORTS A VARIETY OF CLOCK INPUT OPTIONS FOR NETWORK SYNCHRONIZATION. These can be:

- Extracted PCM-1 Clock
- Extracted PCM-2 Clock
- Extracted Synchronous Data channel Clock
- External 2.048 MHz Clock
- Internal Oscillator Clock

The user can specify synchronizing clocks in order of priority. In case of failure of a higher priority clock, the next available lower priority clock is automatically brought into the circuit. In parallel, alarms are generated in case of failure of highest and next to highest priority synchronizing clock.

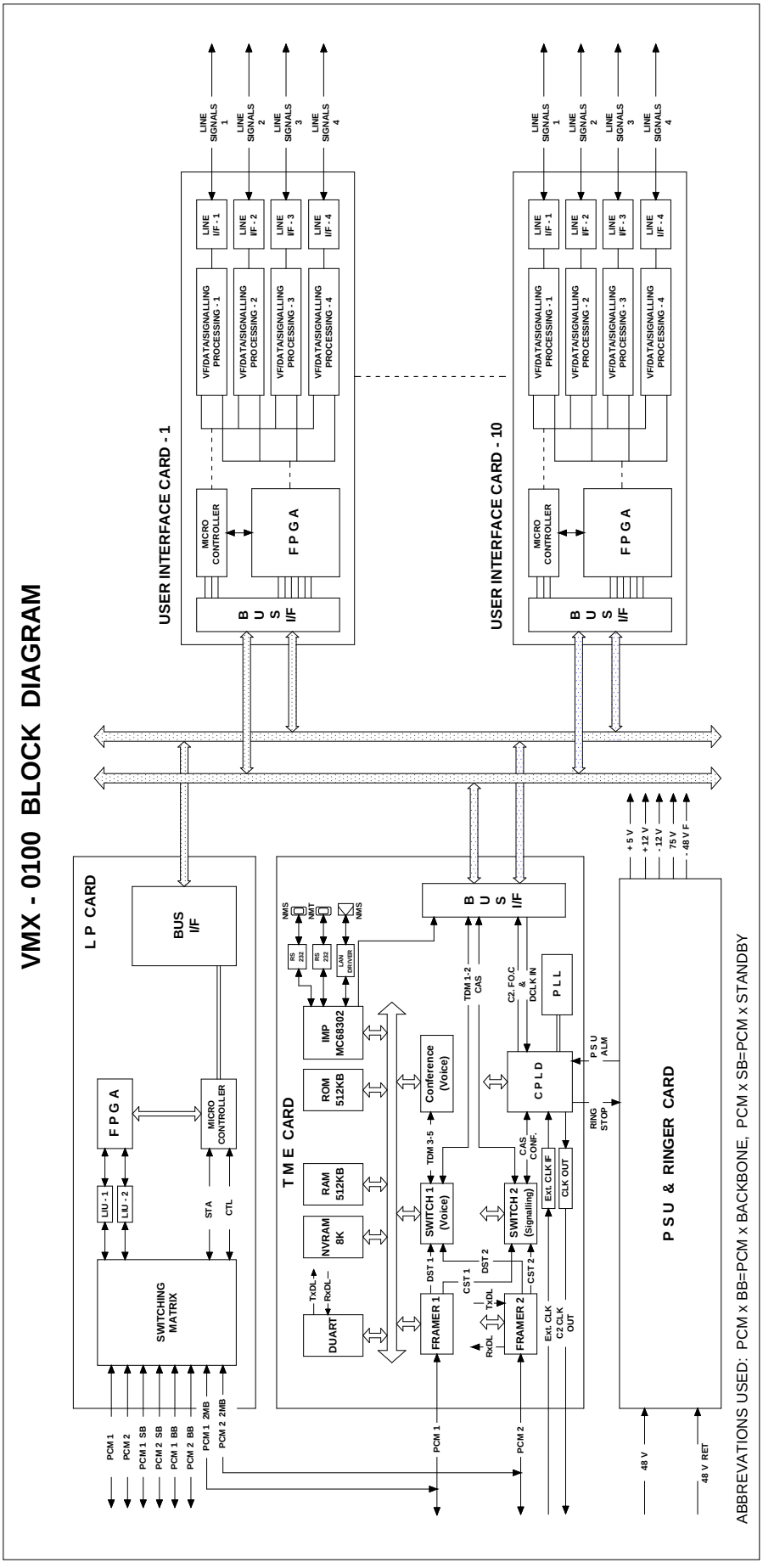


Fig. 5.4 BLOCK DIAGRAM OF VMX - 0100

5.5.3 PROGRAMMABLE ALARMS AND THRESHOLDS

VMUX-100 detects a number of alarm conditions on PCM trunks, VF/Data user ports, clocks and other system status. Among the conditions supported include:

i) On PCM Trunks

- Loss of Signal
- Frame Sync Loss
- Multiframe Sync Loss
- Excessive FAS errors
- CRC Sync Loss
- Excessive Slips
- Remote Alarm
- AIS received

ii) Others

- Priority clock failure
- VF/Data Port Failure
- Configuration Mismatch

Each of these alarm conditions can be programmed by user to generate a Major, Minor or no alarm. The Major and Minor alarms can also be extended to Bay Top Panel to generate the audio and visual indications.

The alarms once generated are also logged in a 100 entries deep alarm history file that can be displayed on the console. The alarm entries in this file include the alarm source, alarm type, alarm site, alarm generation and alarm clear time.

5.5.4 OMNI BUS CONFERENCING

VMUX-100 has provision for 18 three/four party conferencing, of which maximum 8 conferences can be 4-party. These conferencing channels can be set up in such a way that any one time slot each of PCM-1 and PCM-2 trunks and one/two local VF port can participate in each conference.

5.5.5 NMT FOR CONTROL DIAGNOSTICS

Apart from programming VMUX-100, NMT is also used for displaying MUX status, status of its various lines and ports, displaying alarm history, running diagnostics, initiating and displaying error statistics, etc.

5.5.6 CROSS CONNECTIVITY OF PCM TRUNKS

VMUX-100 supports a full cross connect between both the PCM trunks and the 40 user ports. Any time slot on PCM trunks can be mapped to any user port. Also any time slot of PCM-1 can be mapped to any time slot of PCM-2 to bypass channels in ADD/DROP configuration. Though 40 user ports have been provided to increase the modularity but only 30 of them can be configured at a time. VMUX-100 can maintain up to four cross connect tables any of which can be activated by user action.

5.6 CARDS INSTALLATION

i) Power supply card

The front view of the power supply card is shown in figure below.

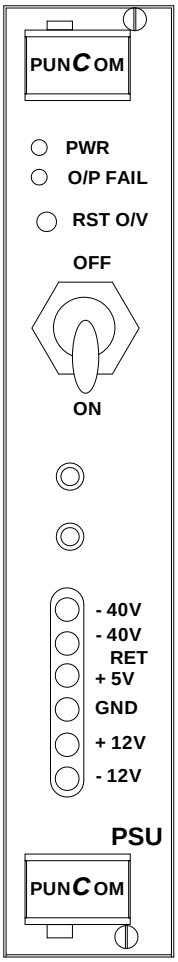


Fig. 5.5

The following table describes the front panel of the power supply card.	
ITEM	**DESCRIPTION**
ON/OFF Switch	Turns the power ON/OFF. UP position OFF. Down position ON
Power	Green LED glows when -48V input is present.
Output Fail LED	Red LED lights when any of the output voltages i.e. +5V, +12V or -12V fail.
Monitoring points	Monitoring points for input -48V, -48V return, +5V, Ground, +12V and -12V. **Warning** The monitoring points are unprotected and should be carefully monitored.

Table 5.2

Header Settings

There are no user installable headers in the power supply Card.

Fuses

The power supply card includes one fuse, which is located near the Euro connector J1.

Installation

Set the ON/OFF Switch on the card to OFF position

Insert the card in slot No.1 or slot No.2 and lock it in position in the enclosure with the help of ejectors and screws.

Make sure that ON/OFF switch on the power supply card is in OFF position, before inserting /removing the card in slot. Inserting and removing the card in ON condition may damage the power supply connectors.

ii) TME CARD

The front panel of TME card is shown in figure below.

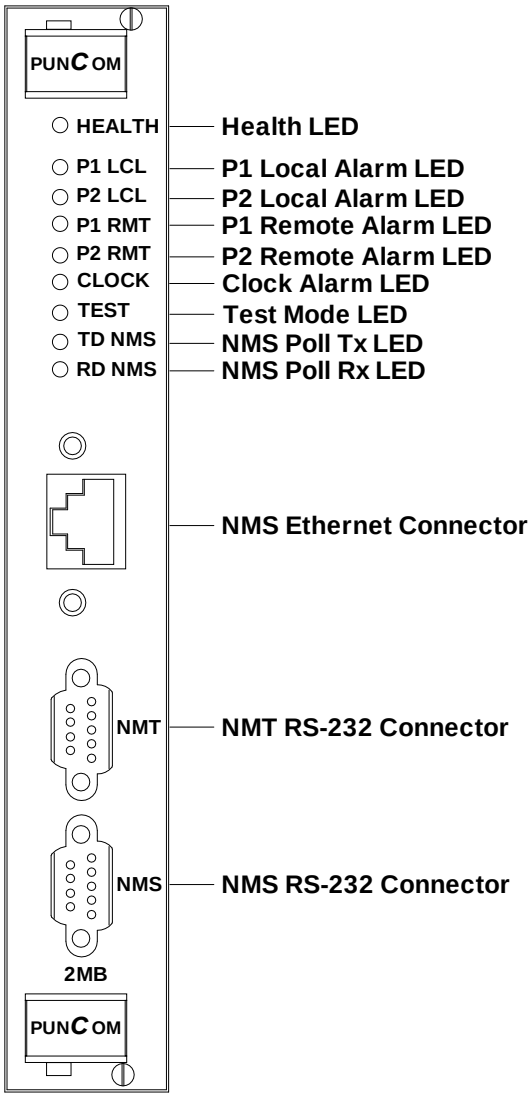


Fig.5.6

The following table describes the front panel of the TME card.

ITEM	LED STATUS	LED FUNCTION
Health	Blinking (Green/Red) Red ON	Card is working OK Card hardware has gone faulty
P1 LCL	ON Fast Blinking Fast Blinking Fast Blinking Slow Blinking Slow Blinking	PCM-1 Loss of signal PCM-1 Frame Sync Loss PCM-1 Multi-Frame Sync Loss PCM-1 CRC Frame Sync Loss PCM-1 error rate > E 10^{-3} PCM-1 error rate > E 10^{-6}
P2 LCL	ON Fast Blinking Fast Blinking Fast Blinking Slow Blinking Slow Blinking	PCM-2 Loss of signal PCM-2 Frame Sync Loss PCM-2 Multi-Frame Sync Loss PCM-2 CRC Frame Sync Loss PCM-2 error rate > E 10^{-3} PCM-2 error rate > E 10^{-6}
P1 RMT	ON Slow Blinking Slow Blinking Slow Blinking	PCM-1 Receive AIS (All 1s) PCM-1 Receive Remote FSL PCM-1 Receive Remote MFSL PCM-1 Receive AIS in TS16
P2 RMT	ON Slow Blinking Slow Blinking Slow Blinking	PCM-2 Receive AIS (All 1s) PCM-2 Receive Remote FSL PCM-2 Receive Remote MFSL PCM-2 Receive AIS in TS16
Clock	Blinking ON	Slips Selected Clock Fail
TEST	On	Card in diagnostics or Loop back Mode
TD NMS	Blinking	NMS polls Transmitted
RD NMS	Blinking	NMS Polls Received
NMS Ethernet Connector	RJ-45 Connector for connection to NMS on LAN	
NMT connector	DB9 female Connector for connection to NMT.	
NMS RS-232 connector	DB9 female Connector for connection to PC based NMS.	

Table 5.3

HEADER SETTINGS: There are only eight user selectable headers, rest all the headers are factory set. The settings of the factory set headers should not be changed otherwise equipment may malfunction. The function of these headers is tabulated below.

User selectable Headers

S.No.	Header Name	Position	Remarks
1.	H1	1-2 for 75 Ohm 2-3 for 120 Ohm	PCM-1 Output Impedance selection. Default setting 120 Ohm
2.	H4	1-2 for 75 Ohm 2-3 for 120 Ohm	PCM-1 Input Impedance selection. Default setting 120 Ohm
3.	H5	1-2 for 75 Ohm 2-3 for 120 Ohm	PCM-2 Output Impedance selection. Default setting 120 Ohm
4.	H9	1-2 for 75 Ohm 2-3 for 120 Ohm	PCM-2 Input Impedance selection. Default setting 120 Ohm
5.	H2 & H3	1-2 2-3	PCM-1 Output Connected PCM-1 Output disconnected
6.	H6 & H8	1-2 2-3	PCM-2 Output Connected PCM-2 Output disconnected
7.	H22	1-2 for 120 Ohm 2-3 for 75 Ohm	External clock impedance selection. Default impedance is 75 Ohm.

Table 5.4

Factory Set Headers

S.No.	Header Name	Position	Remarks
1.	H16	1-2	Watchdog strobe selection
2.	H7	1-2 TDM-FE2 2-3 TDM4	Default setting is TDM4
3.	H10	1-2 TDM-FE2 2-3 TDM4	Default setting is TDM4
4.	H19	1-2	RS-485 Port Mode
5.	H20	1-2	RS-485 Port Mode
6.	H24	Short	Gain selection for clock
7.	H25	1-2 C16, 2-3 C8	Default setting is C8
8.	H26, H27	Open	Unused
9.	H11,H12,H14,H15,H17,H19, H20,H21, and H23	Open	Testing

Table 5.5

Termination Signal Details

When installed in designated slot (slot No.2), the terminations are available on the various connectors available on the rear of the motherboard. The signal details of these connectors is as under:

Connector Designation: J3

Connector Type: 64-Pin Euro male

PIN	A	C
1	-------	--------
2	PCM-1 IN (A)	PCM-1 OUT (A)
3	GND	GND
4	PCM-1 IN (B)	PCM-1 OUT (B)
5	GND	GND
6	PCM-2 IN (A)	PCM-2 OUT (A)
7	GND	GND
8	PCM-2 IN (B)	PCM-2 OUT (B)
9	-----	-----
10	EXT CLOCK IN (A)	EXT CLOCK OUT (A)
11	GND	GND
12	EXT CLOCK IN (B)	EXT CLOCK OUT (B)
All other pins should not be used		

Table 5.6

Connector Designation: J31, j43
Connector Name: Power input
Connector Type: 4-Pin male

PIN	SIGNAL
1	-48V IN
2	-48V IN
3	-48V RET
4	-48V RET

Table 5.7

INSTALLATION

- Switch Off the power supply, if ON
- Set the headers for 75 or 120 Ohm termination as per the installation plan.
- Insert the TME CARD IN SLOT No.3 and lock it with the help of ejectors and screws.
- If PDP switch for the system is ON, then immediately Major alarm will come ON and Buzzer will sound.
- Press ACO switch to cut Audio alarm, ACO indicator should glow in this case.
- If no audio alarm is generated check ON/OFF switch on PDP and wiring alarm extension connector.

iii) LPC CARD

The front Panel of the LPC Card is shown below.

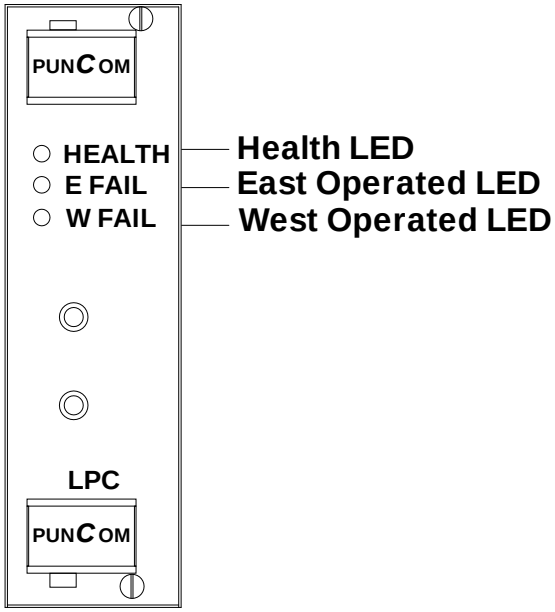


Fig 5.7

The following table describes the front Panel

Item	LED status	LED Function
Health	Green ON Red ON	Card is working OK Card Hardware has gone faulty
E Fail	ON	East link connected to PCM-1 is fail
W Fail	ON	West link connected to PCM-1 is fail

Table 5.8

Header Settings

There is no user settable header in this card. All the headers are factory set. The setting of these headers should not be changed otherwise equipment may malfunction. The function of these headers is tabulated below.

S. No.	Header	Position	Remarks
1.	H1	1-2	Watchdog strobe selection
2.	H2	----	System resetting
3.	H3 – 6	----	For future use
4.	H7	1-2	IP control
5.	H8	Short	Grounds shorting

Table 5.9

Setting of Main station and Way side

There are two 8 position dip switches SW1 and SW2. If all the 16 positions are closed it represents Main station and if all are open it represents a way side. The main station selection is done for terminal stations and the way side selection is done for all the intermediate stations.

Termination Signal Details

When installed in designated slot (slot No. 4), the terminations are available on the various connectors available on the rear of the motherboard. The signal details of the connector are as under:

Connector Designation: J5
Connector Type: 64-pin Euro male

PIN	A	C
1	-------	--------
2	PCM-1 IN (A)	PCM-1 OUT (A)
3	GND	GND
4	PCM-1 IN (B)	PCM-1 OUT (B)
5	GND	GND
6	PCM-2 IN (A)	PCM-2 OUT (A)
7	GND	GND
8	PCM-2 IN (B)	PCM-2 OUT (B)
9	-----	-----
10	PCM-3 IN (A)	PCM-3 OUT (A)
11	GND	GND
12	PCM-3 IN (B)	PCM-3 OUT (B)
13	GND	GND
14	PCM-4 IN (A)	PCM-4 OUT (A)
15	GND	GND
16	PCM-4 IN (B)	PCM-4 OUT (B)
17	GND	GND
18	PCM-5 IN (A)	PCM-5 OUT (A)
19	GND	GND
20	PCM-5 IN (B)	PCM-5 OUT (B)
21	GND	GND
22	PCM-6 IN (A)	PCM-6 OUT (A)
23	GND	GND
24	PCM-6 IN (B)	PCM-6 OUT (B)
25	----	----
All other pins should not be used		

Table 5.10

INSTALLATION

- Switch Off the power supply, if it is ON.
- Ensure that the TME card is already inserted in its designated slot.
- Insert the LPC card in slot No.4 and lock it with the help of ejectors.
- The health LED will glow green when the system is switched ON

iv) E & M CARD

The front panel of E & M Card is shown in figure below.

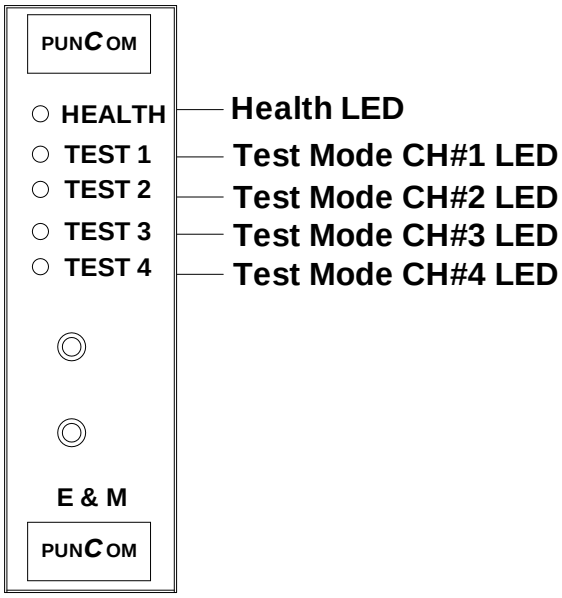


Fig 5.8

The following table describes the front panel

ITEM	LED STATUS	LED FUNCTION
HEALTH	Green ON Red ON Blinking	Card is working OK Card hardware has gone faulty Card's hardware is OK but it is not configured by main TME card.
Test-1	ON	Channel-1 is in test and diagnostic mode
Test-2	ON	Channel-2 is in test and diagnostic mode
Test-3	ON	Channel-3 is in test and diagnostic mode
Test-4	ON	Channel-4 is in test and diagnostic mode

Table 5.11

Header Settings

There are no user selectable headers. All the headers are factory set. The setting of these headers should not be changed otherwise equipment may malfunction. The function of these headers is tabulated below.

S. No.	Header name	Position	Remarks
1.	H1	Short	SPROM program enable/disable
2.	H2	1-2	Watchdog strobe selection
3.	H3	1-2	System resetting
4.	H4,6,8,10	Open	For future use
5.	H12	1-2	IP control
6.	H14	1-2	Programming supply selection

Table 5.12

Signalling Codes

a) The signalling codes transmitted for various M lead conditions are given below

Signalling state	Transmitted bits			
	a	b	c	d
M lead open	1	0	0	1
M lead ground	0	0	0	1

Table 5.13

b) The received signalling codes are interpreted in the following way.

Signalling state	Received bits			
	a	b	c	d
Open on E lead	1	X	X	X
Ground on E lead	0	X	X	X

Table 5.14

Termination Signal details

When installed in designated slot, the terminations are available on the various connectors available on the rear of the motherboard. The signal detail of these connectors is as under.

Connector designation: J7, 9, 11, 13, 15, 17, 19, 21, 23, 29
Connector Type: 96-Pin Euro male

Pin	A	B	C
1	----	----	----
2	2W/4W RX1 A (OUT)	NC	2W/4W RX1 B (OUT)
3	4W TX1 A (IN)	NC	4W TX1 B (IN)
4	E1	NC	M1
5	2W/4W RX2 A (OUT)	NC	2W/4W RX2 B (OUT)
6	4W TX2 A (IN)	NC	4W TX2 B (IN)
7	E2	NC	M2
8	NC	NC	NC
9	----	----	----
10	2W/4W RX3 A (OUT)	NC	2W/4W RX3 B (OUT)
11	4W TX3 A (IN)	NC	4W TX3 B (IN)
12	E3	NC	M3
13	2W/4W RX4 A (OUT)	NC	2W/4W RX4 B (OUT)
14	4W TX4 A (IN)	NC	4W TX4 B (IN)
15	E4	NC	M4
16	NC	NC	NC
All other pins are not connected			

Table 5.15

Installation

- Slide the card in the required slot and lock in position with the help of ejectors
- Configure the card and ports using either NMS or NMT, if already not configured.
- Route the ports, if already not routed

v) FXO CARD

The front panel of the FXO card is shown below.

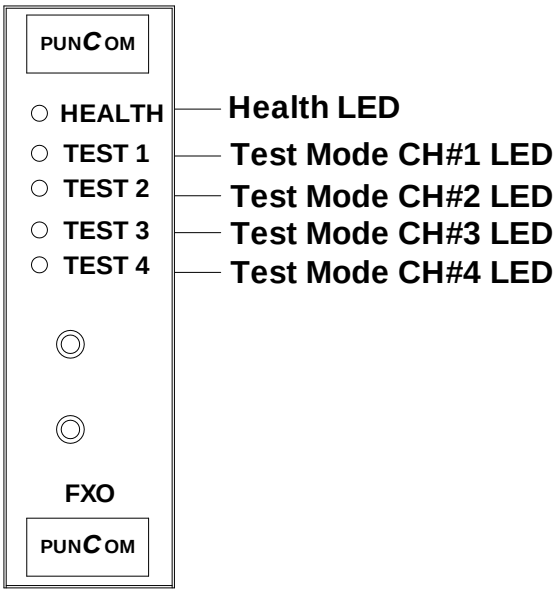


Fig 5.9

The following table describes the front panel of FXO card.

ITEM	LED STATUS	LED FUNCTION
HEALTH	Green ON Red ON Blinking	Card is working OK Card hardware has gone faulty Card's hardware is OK but it is not configured by main TME card.
Test-1	ON	Channel-1 is in test and diagnostic mode
Test-2	ON	Channel-2 is in test and diagnostic mode
Test-3	ON	Channel-3 is in test and diagnostic mode
Test-4	ON	Channel-4 is in test and diagnostic mode

Table 5.16

Header settings

There are no user selectable headers. All the headers are factory set. The setting of these headers should not be changed otherwise equipment may malfunction. The function of these headers is tabulated below.

S. No.	Header name	Position	Remarks
1.	H2	2-3	SPROM program enable/disable
2.	H1	1-2	Watchdog strobe selection
3.	H3	1-2	System resetting
4.	H4,5,6,7	Open	For future use
5.	H13	1-2	IP control
6.	H15	1-2	Programming supply selection

Table 5.17

Signalling codes

When FXO Card is set in FXO mode, for remote subscriber extension, the various signalling states and codes are as given below.

Call originated by exchange

Signalling condition	Status of exchange port	Status of exchange interface card	Transmitted bits				Received bits			
			a	b	c	d	a	b	c	d
Idle	Normal potential	High resistance Loop	1	1	0	1	1	1	X	X
Ring	Ringing voltage 75V rms	High resistance Loop	1	1/0	0	1	1	1	X	X
Ring Tip	Normal potential	Low resistance Loop	1	1	0	1	0	1	X	X

Table 5.18

a) Call originated by subscriber

Signalling condition	Status of exchange port	Status of exchange interface card	Transmitted bits				Received bits			
			a	b	c	d	a	b	c	d
Idle	Normal potential - ve on 'a' limb +ve on 'b' limb	High resistance Loop	1	1	0	1	1	1	X	X
Seizure	-do-	Low resistance Loop	1	1	0	1	0	1	X	X
Dialing	-do-	Loop Make/Break	1	1	0	1	0	1	X	X
Answer by called Subscriber	Reverse potential + ve on 'a' limb - ve on 'b' limb (Only in case of CB/PBX otherwise Normal potential)	Low resistance Loop	0 1	1 1	0 OR 0	1 1	0	1	X	X
Clear forward	Reverse or Normal potential	High resistance Loop	0 1	1 1	0 OR 0	1 1	1	1	X	X

Table 5.19

Installation

- Slide the card in the required slot and lock in position with the help of ejectors
- Configure the card and ports using either NMS or NMT, if already not configured.
- Route the ports, if already not routed

vi) FXS CARD

The front panel of the FXS card is shown below.

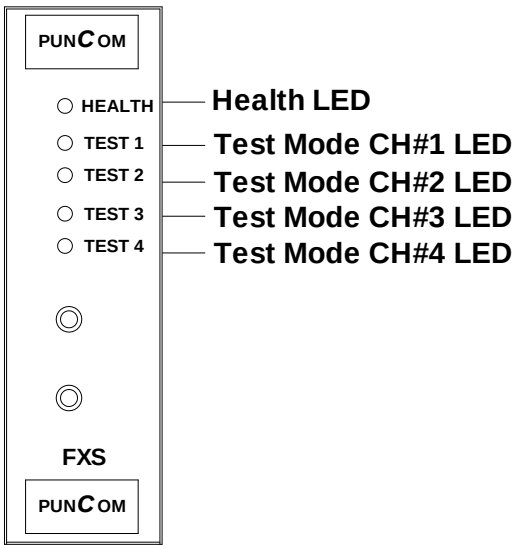


Fig 5.10

The following table describes the front panel of FXS card.

ITEM	LED STATUS	LED FUNCTION
HEALTH	Green ON Red ON Blinking	Card is working OK Card hardware has gone faulty Card's hardware is OK but it is not configured by main TME card.
Test-1	ON	Channel-1 is in test and diagnostic mode
Test-2	ON	Channel-2 is in test and diagnostic mode
Test-3	ON	Channel-3 is in test and diagnostic mode
Test-4	ON	Channel-4 is in test and diagnostic mode

Table 5.20

Header settings

There are no user selectable headers. All the headers are factory set. The setting of these headers should not be changed otherwise equipment may malfunction. The function of these headers is tabulated below.

S. No.	Header name	Position	Remarks
1.	H3	2-3	SPROM program enable/disable
2.	H2	1-2	Watchdog strobe selection
3.	H4	1-2	System resetting
4.	H8,9,10,11	Open	For future use
5.	H7	1-2	IP control
6.	H18	1-2	Programming supply selection
7.	H1	1-2	Ringer mode selection for CH-1
8.	H5	1-2	Ringer mode selection for CH-2
9.	H6	1-2	Ringer mode selection for CH-3
10.	H16	1-2	Ringer mode selection for CH-4

Table 5.21

Signalling codes

The various signalling states and signalling codes for the FXS card are as given below.

a) Call originated by exchange

Signalling condition	Status of subscriber	Status of subscriber interface card	Transmitted bits				Received bits			
			a	b	c	d	a	b	c	d
Idle	High resistance Loop	Normal potential	1	1	0	1	1	1	X	X
Ring	High resistance Loop	Ringing voltage 75V rms	1	1	0	1	1	1/0	X	X
Ring Tip	Low resistance Loop	Normal potential	0	1	0	1	1	1	X	X

Table 5.22

b) Call originated by subscriber

Signalling condition	Status of subscriber	Status of subscriber interface card	Transmitted bits				Received bits			
			a	b	c	d	a	b	c	d
Idle	High resistance Loop	Normal potential - ve on ‘a’ limb +ve on ‘b’ limb	1	1	0	1	1	1	X	X
Seizure	Low resistance Loop	-do-	0	1	0	1	1	1	X	X
Dialing	Loop Make/Break	-do-	0/1	1	0	1	1	1	X	X
Answer by called Subscriber	Low resistance Loop	Reverse potential + ve on ‘a’ limb - ve on ‘b’ limb (Only in case of CB/PBX otherwise Normal potential)	0	1	0	1	1 0	1 OR 1	X X	X X
Clear forward	High resistance Loop	Reverse or Normal potential	1	1	0	1	0 1	1 OR 1	X X	X X

Table 5.23

Installation

- Slide the card in the required slot and lock in position with the help of ejectors
- Configure the card and ports using either NMS or NMT, if already not configured.
- Route the ports, if already not routed

vii) G. 703 CARD

The front panel of the G .703 card is shown below.

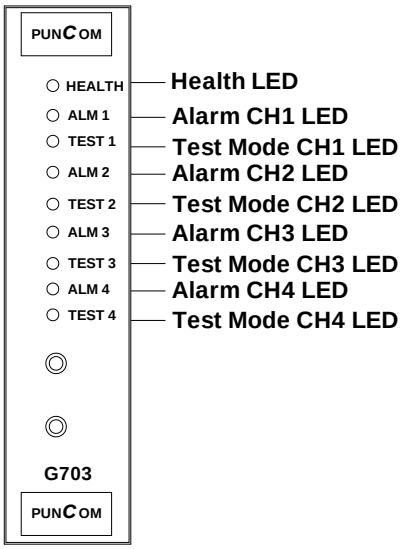


Fig 5.11

The following table describes the front panel of G. 703 card.

ITEM	LED Status	LED Function
Health	Green On Red ON Blinking	Card is working OK Card hardware has gone faulty Card's hardware is OK but it is not configured by main TME card.
ALM1	ON	LOS or Bipolar violation on CH1
Test1	ON	Channel 1 is in test and diagnostic Mode
ALM2	ON	LOS or Bipolar violation on CH2
Test2	ON	Channel 2 is in test and diagnostic Mode
ALM3	ON	LOS or Bipolar violation on CH3
Test3	ON	Channel 3 is in test and diagnostic Mode
ALM4	ON	LOS or Bipolar violation on CH4
Test4	ON	Channel 4 is in test and diagnostic Mode

Table 5.24

Header settings

There are no user selectable headers. All the headers are factory set. The setting of these headers should not be changed otherwise equipment may malfunction. The function of these headers is tabulated below.

S. No.	Header name	Position	Remarks
1.	H1	1-2	IP control
2.	H2	2-3	DCLK testing
3.	H3	1-2	System resetting
4.	H4	1-2	Watchdog strobe selection
5.	H5	2-3	SPROM program enable/disable
6.	H8,9,10,11	Open	For future use
7.	H14	1-2	Programming supply selection

Table 5.25

Termination Signal details

When installed in designated slot, the terminations are available on the various connectors available on the rear of the motherboard. The signal detail of these connectors is as under.

Connector designation: J7, 9, 11, 13, 15, 17, 19, 21, 23, 29
Connector Type: 96-Pin Euro male

Pin	A	B	C
1	----	----	----
2	RX1 A (IN)	NC	RX1 B (IN)
3	TX1 A (OUT)	NC	TX1 B (OUT)
4	NC	NC	NC
5	RX2 A (IN)	NC	RX2 B (IN)
6	TX2 A (OUT)	NC	TX2 B (OUT)
7	NC	NC	NC
8	NC	NC	NC
9	----	----	----
10	RX3 A (IN)	NC	RX3 B (IN)
11	TX3 A (OUT)	NC	TX3 B (OUT)
12	NC	NC	NC
13	RX4 A (IN)	NC	RX4 B (IN)
14	TX4 A (OUT)	NC	TX4 B (OUT)
15	NC	NC	NC
16	All other pins are not connected		

Table 5.26

Installation

- Slide the card in the required slot and lock in position with the help of ejectors
- Configure the card and ports using either NMS or NMT, if already not configured.
- Route the ports, if already not routed

5.7 INITIAL POWERING UP OF THE SYSTEM

Following procedure may be followed for general powering of the system

- Insert the common cards viz. PSU and TME into the respective slots and power up the system. See the normal functioning of the health LED on the TME CARD. Connect the NMT to the port marked ‘NMT’ and get the opening menu on the screen.
- Insert the user Interface cards into desired slots and go to display hardware through NMT to see that the same has been updated to show the enhanced configuration.
- Finally insert the optional common cards (LPC), if required and again check up the display on the NMT.
- Configure the PCM trunks using hardware set-up screens on the NMT for PCM trunks. Also configure the network clock as per the desired priority. Now connect the PCM trunks and watch the PCM trunk status on the NMT display as well as from LEDs on TME card.
- Now program one routing table as per desired cross-connect plan and make it active.

- Program all the VF and data interface ports to desired settings.
- Program the types of all alarms in the system as **major or minor or none**.
- VMUX-100 is now fully configured for user ports. Check for correct flow of traffic between each of the user ports and its destination on the network.
- Program alternate routing tables if required and also the power on routing table and time of Day routing tables as desired.
- Set up and program the omnibus Conferencing channels. Configure the local E & M VF Conferencing ports. Connect the conferencing phones through the adapter unit to the defined E & M conferencing ports and test for the proper operation of omnibus channels.
- Program the conditions under which bypass action is to be automatically activated (if required).
- Finally change the factory-defined password to the user defined password.

5.8 MAINTENANCE

The following maintenance options have been provided in the VMUX-100 which can be used to identify network or MUX faults as well as to activate network configurations.

a) **LOOP BACKS:** VMUX-100 provides local and remote loop backs at both trunk and channel level which can be activated from NMT.

b) **MUX BYPASS:** In case of critical hardware failure, the MUX automatically bypasses itself by physically shorting PCM1 trunk to PCM2 trunk through bypass relays. This bypass can also be activated from NMT.

c) **STATISTICS COLLECTION:** MUX can be programmed to collect error and slip statistics on the PCM1 and PCM2 trunks. The statistics collection can be started / stopped for a specified period or can be done on continuous basis. In latter case, thresholds can be specified for error performance and Major/Minor alarms can be raised in case error performance deteriorates.

d) **ALARM HISTORY:** The VMUX-100 maintains a 100 deep alarm history file, which contains of all times the most recent 100 past and present alarms including their generation and clear time. This display can be used to see in one place, a chronological sequence of last 100 alarms. In case the history file overflows, with new alarms, older, minor and major alarms, in order, are deleted from display.

5.9 PROGRAMMING OF VMUX-100

Operating VMUX-100 requires two distinct steps of setting up and programming MUX for the desired environment and of monitoring its operation for status of trunks, user lines and other network parameters. VMUX-100 comes with a Non-volatile RAM (NVRAM) which holds at all times the running configuration or programming of VMUX-100. This NVRAM comes pre-programmed from the factory to a default typical configuration. This default programming can be viewed by the operator on the NMT/NMS and can be altered by him to meet installation specific requirements.

5.91 PARAMETERS PROGRAMMABLE IN VMUX-100

The following major parameters are programmable in VMUX-100 and may be modified from NMT/NMS.

i) Parameters related to PCM trunks

- Framing format CRC4/Standard
- Enable/Disable trunk
- Time slot cross-connection
- 75/120 Ohm line impedance

ii) Parameters related to VF

- VF Port type
- Trans gain
- Receive gain
- Time slot mapping

iii) Parameters related to Data

a) When data card is G. 703
   - Time slot mapping

b) When data card is UDT
   - Baud rate
   - Sync/Async.
   - Point to point / Multidrop
   - Handshaking
   - Time slot mapping
   - Interface selection

c) When data card is N64
   - Time slot mapping
   - Value of N

d) When data card is FE1
   - Time slot mapping
   - Interface enable/Disable
   - NMS Enable/Disable

iv) Parameters related to Network Clocks

- Programming of network clock sources in order of priority

v) Miscellaneous Parameters

- Defining all alarms in MUX as Major/Minor/None
- Setting up Omnibus Conferencing channels
- Defining conditions for activating MUX bypass
- Defining alarm thresholds for BER, CRC errors, slip counts
- Setting up and defining alternate route configurations in case of major network failures

5.10 SYSTEM SPECIFICATIONS

General

Number of PCM trunks	:	2
Number of user ports	:	40 Max., modularity of 4 in most cases
Number of configurable user ports	:	30 Max.
Type of VF interfaces supported	:	E & M 2W and 4W Loop Incoming Loop Outgoing Subscriber Interface Exchange Interface Hot Line
Types of data interfaced supported	:	64 Kbps G.703 co directional 1200 t0 19200 baud sync 1200 t0 19200 baud Async NX64 Kbps sync Fractional E1
Power supply	:	-36 to -72 V, -48V Nominal
Network clock Synchronization	:	Selected from Extracted PCM1 clock Extracted PCM2 clock Data interface Clock 2.048 MHz External Clock 2.048 MHz Internal Clock
Other Synchronization features	:	2.048 MHz network clock out available
Omnibus Conferencing	:	Eighteen 3/4 party conferencing, of which maximum 8 conferences can be 4 party
Alarms	:	All alarms user programmable for threshold and type as Major/Minor/None
Network Management	:	A PC based application available for network control and management

5.10.1 PCM trunk interface specifications

Multiplexing	:	As per recommendation G.732
Framing Structure	:	As per recommendation G.706
Interface	:	As per recommendation G.703
Clock Rate	:	2048 Kbps ± 50 ppm
Output impedance	:	75 Ω unbalanced/120Ω balanced
Input impedance	:	75 Ω unbalanced/120Ω balanced

5.10.2 VF INTERFACE

i) E & M 4W

Coding	:	A-Law, Rec. G.711
Normal Impedance	:	600Ω at input and output ports
Return loss	:	Better than 20 dB in range 300-3400 Hz
Quantization distortion	:	Meets Rec. G.712

Linearity	:	Meets Rec. G.712
Frequency distortion	:	Meets Rec. G.712
RX level	:	-11 to +4 dBr adjustable in steps of 0.1dB
TX level	:	-14 to 1 dBr adjustable in steps of 0.1dB

ii) E & M 2W

Coding	:	A-Law, Rec. G.711
Normal Impedance	:	600Ω
Return loss	:	12 dB, 300-600 Hz 115 dB, 600-3400 Hz
Quantization distortion	:	Meets Rec. G.712
Linearity	:	Meets Rec. G.712
Frequency distortion	:	Meets Rec. G.712
RX level	:	-15 to 0 dBr adjustable in steps of 0.1dB
TX level	:	-11 to+4 dBr adjustable in steps of 0.1dB

iii) Loop Incoming

Open loop resistance	:	More than 10 K
Closed loop resistance	:	1200 Ohms Max.
Line reversal detection	:	Provided
Line potential disconnection detection	:	Provided
Trunk offering	:	Provided
Dial Pulse speed	:	8-12 pps
VF Specs	:	Same as for 2W, E & M

iv) Loop Incoming

Max. loop resistance	:	800Ω
Battery reversal capability	:	Provided
Trunk offering detection	:	Provided
Blocking	:	Provided (Reverse potential applied on limbs)
Dial Pulse speed	:	8-12 pps
VF Specs	:	Same as for 2W, E & M

v) FXS Interface

Max. loop resistance	:	1200Ω
Battery reversal capability	:	Provided
Ring Voltage	:	75 V rms ± 5 V
Ring frequency	:	17-25 Hz
Dial Pulse speed	:	8-12 pps
VF Specs	:	Same as for 2W, E & M

vi) FXO Interface

Open loop resistance	:	More than 10 K
Closed loop resistance	:	1200 Ohms Max
Minimum ring voltage detection	:	15 V rms
Dial Pulse speed	:	8-12 pps
VF Specs	:	Same as for 2W, E & M

vii) HOT LINE

Max. loop resistance	:	1200Ω
Ring Voltage	:	75 V rms
Ring frequency	:	17-25 Hz
VF Specs	:	Same as for 2W, E & M

5.10.3 DATA INTERFACE

64 Kbps G.703 Data interface

Interface	:	Co-directional as per Rec. G.703
Nominal output impedance	:	120 Ω
Nominal input impedance	:	120 Ω
Return loss at inputs ports	:	12 dB for 4-13 KHz 18dB for 13-256 KHz 14 dB for 256-384 KHz

5.10.4 CLOCK INTERFACES

2.048 MHz Clock Input

Termination	:	75 Ω unbalanced/120Ω balanced
Rate	:	2048 KHz ± 50 ppm
Signal wave shape	:	As per figure 21/G.703
Maximum line attenuation	:	6 dB

2.048 MHz Clock output

Nominal impedance	:	75 Ω unbalanced/120Ω balanced
Rate	:	Synchronized to system clock
Signal wave shape	:	As per figure 21/G.703

Troubleshooting chart for Puncom Mux

Alarm Condition	Possible Cause	Action Suggested
PSU's "PWR" LED ON & "O/P FAIL" LED off	Normal condition of the card	No action required.
PSU's "PWR" LED off	The power cable for the PSU on the motherboard is not connected / corresponding MCB on BTP is off.	Connect the power cable/ switch on the MCB/check the connections on BTP.
PSU's "O/P FAIL" LED red	One or more of the PSU's output has failed	Replace the PSU.
TME's "Health" LED blinking Red-Green & all other LEDs off (except TDNMS blinking)	Normal condition of the card	No action required.

P1 / P2 “Local” LED ON	Problem in STM	See the Rx port of STM. If it’s red, the fiber has broken or cross connects not configured in STM. Check STM / fiber.
	Mux has hanged	Reset the Mux by switching it OFF & then ON & wait for few minutes. The alarm should go. If it doesn’t go to next step.
	Wiring between Mux & STM (via DDF) has become loose or has broken up.	Check wiring between Mux & STM. Correct it, if found loose. Still problem persists, change TME card.
P1 / P2 “Remote” LED glows	Problem at remote site i.e. next station to which P1 / P2 (as the case may be) is connected or fiber break.	Check other station for faults / rectify fiber break.
P1 / P2 “Local” LED blinking	Errors at the local site	Wiring may be loose between STM & Mux
P1 / P2 “Remote” LED blinking	Errors at the remote site	Wiring may be loose between STM & Mux on the other site to which P1/P2 is connected.
Clock LED blinking / permanently glowing	Blinking implies slips & permanently glowing means clock has failed	Check clock settings through NMS. Settings may be wrong or primary clock has failed
Test LED glowing	Card in diagnostics or Loop back Mode	Remove the loopback
TDNMS LED blinking	NMS is working	No action required
LPC Health LED green	LPC is working ok	No action required
LPC “P1 fail” LED glows	P1 has broken & system is working on protection if TME is normal	Correct the primary link connected to P1 as early as possible. (If TME is normal)
LPC “P2 fail” LED glows	P2 has broken & system is working on protection if TME is normal	Correct the primary link connected to P2 as early as possible. (If TME is normal)
Health LED of any line card like E&M,FXO,FXS blinking	Card’s hardware is OK but it is not configured by main TME card	Configure the card through NMS

Health LED of any line card like E&M,FXO,FXS green	Card is working OK	No action required
Health LED of any line card like E&M,FXO,FXS red	Card has gone faulty	Replace the card
Test LED of any line card like E&M,FXO,FXS green	The respective port is in loopback mode	Remove the loopback through NMS for normal working of the port

REVIEW QUESTIONS

OBJECTIVE

1. VMUX-100 provides _____ Voice/Data ports in the 19” sub-rack.
   a) 30 b) 40 c) 50 d) 60

2. In VMUX-100 a maximum of _____ conferences can be configured as 4-party.
   a) 18 b) 30 c) 12 d) 08

3. Number of slots provided in the motherboard of VMUX-100 system is _____
   a) 13 b) 14 c) 12 d) 15

4. TME card of VMUX-100 can be located in slot no. _____ of VMUX-100.
   a) 1 b) 2 c) 3 d) Any slot

5. User Interface cards of VMUX-100 can be installed in _____ of VMUX-100.
   a) All slots b) Slot 1 to Slot4 c) Slot 5 to Slot 14 d) None

6. Redundant power supply card can be installed in _____ of VMUX-100.
   a) 1 b) 1 and 2 c) 2 d) 3

7. _____ card is used to protect the P1 and P2 streams carrying the traffic in case of any major FAILURE IN THE NETWORK OF VMUX-100.
   a) TME b) DAC c) LPC d) None

8. An eight position DIP switch has been provided on _____ to set the equipment ID of VMUX-100.
   a) TME card b) DAC card c) FXO card d) Motherboard

9. The ID of the equipment is required for the NMS operation and forms the address of the _____ basic frame of VMUX-100.
   a) NMS b) NMT c) E1 d) None

10. NMS Ethernet and RS-232 connectors are located in _____ card of VMUX-100
    a) LPC b) PSU c) TME d) None

SUBJECTIVE

1. Briefly describe the function of VMUX-100
2. Explain the function of TME card,
3. Explain the function of LPC card,
4. Explain Network synchronization in VMUX-100.
5. Explain how the VMUX-100 can be managed.
6. Explain the function of various LEDs that are provided on the TME card of VMUX-100.

CHAPTER 6

Control Circuit Protection Scheme in PD- MUX

6.1 Introduction: The control circuits are worked on 64 kbps channels configured in conference mode and multiplexed by PD-MUX and resultant E1 is carried on STM1 on OFC backbone. This E1 thread extends to the control section boundary/ division boundary. Time-slots other than those carrying omnibus control circuits carry point-to-point circuits. The PD-MUXes are in linear topology, with E1 level ring protection on STM backbone on OFC network at the end of the thread.

6.2 Protection of control circuits on OFC sections: Ring/loop protection mechanism is in general implemented in two different ways.

1. Use of LPC (Loop protection card) and 2 E1s at every station for all time-slots protection
2. Ring protection mechanism using spare time slots in working E1

These are discussed below

6.2.1. Use of LPC and 2 E1s at every station for all time-slots protection: This scheme is used by PUNCOM PD-MUX VMUX -0100.

Features: The scheme has following features.

1. It offers protection to all the 30 channels.
2. The switching to alternate E1 takes place simultaneously at two stations. (On either side of the cable cut section). Therefore the switching can be made very fast.
3. The protected sections can be subdivided into smaller sections to take care of multiple cable faults without the use of additional PD-MUX.

Please refer figure 6.1

In this approach, the E1 carrying 30 time-slots and designated as ‘working’ E1 is taken from P2 of LPC (Loop Protection Card) of PD-MUX. This is carried over STM1 Add-drop MUX to next station and connected to P1 of LPC card of PD-MUX. Like-wise the E1 thread continues.

Another E1, designated as ‘protection’ E1, taken from P4 of LPC of PD-MUX is also carried via the same Add-Drop STM1 to next station and connected to P3 of LPC of the PD-MUX. Like-wise, the second thread of E1 continues.

From the terminal station, E1 from loop-forward port (P6) of LPC is carried via protection path on STM back-bone on different route to the originating station and connected on loop back Port (P5) of LPC

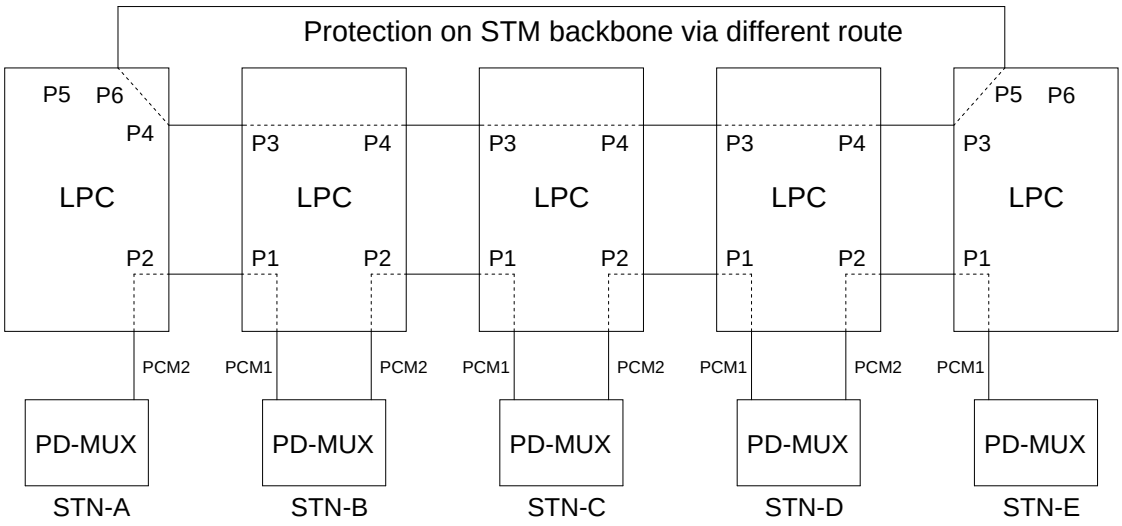


Fig.6.1 Use of LPC and 2 E1s at every station for all time-slots protection

In the above figure, STM1 Add-Drop muxes are not shown to keep the diagram simple.

In case of failure of E1 due to port failure/OFC cut between terminal station and immediate next station (for example between station-A and station-B) switching in LPC takes place as shown in fig.6.2

a. At station-A, PCM2-to-P2 and LF (P6) -to- P4 connections are interrupted; instead, P6 -to - PCM2 is connected in LPC
b. At station-B, P1-to-PCM1 and P3 -to- P4 connections are interrupted; instead, PCM1-to-P4 is connected in LPC

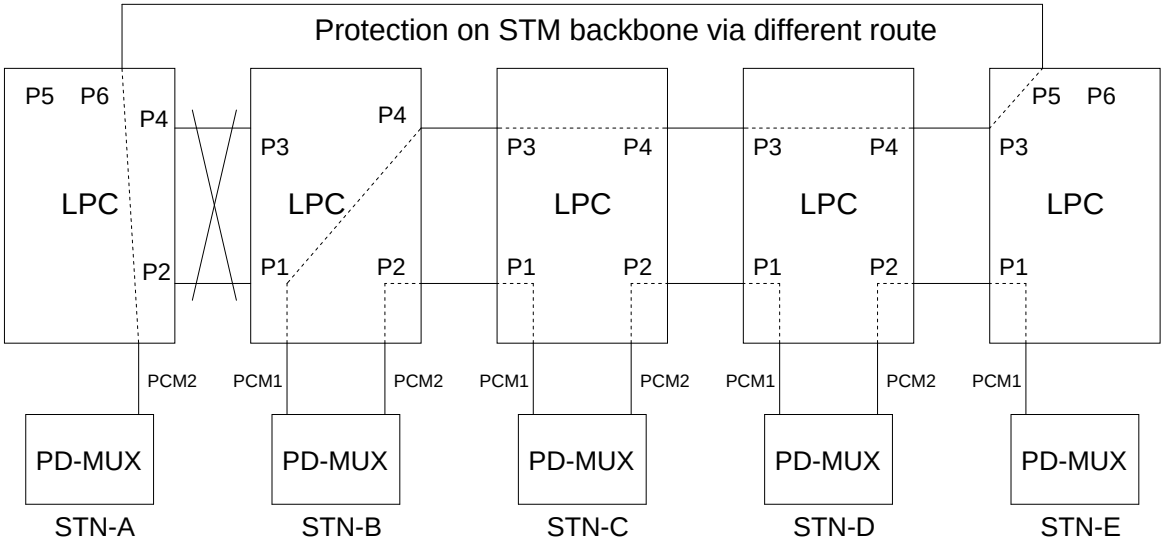


Fig. 6.2 Switching in LPC in case of failure of E1/ OFC cut between terminal station and immediate next station

In case of failure of E1 due to port failure/OFC cut between two intermediate stations, (for example between station-C and station-D) switching in LPC takes place as shown in fig.6.3

a. At station-C, PCM2-to-P4 and P3 – to –P4 connections are interrupted; instead, P3-to-PCM2 is connected in LPC
b. At station-D, PCM1-to-P1 and P3 – to –P4 connections are interrupted; instead, PCM1-to-P4 is connected in LPC

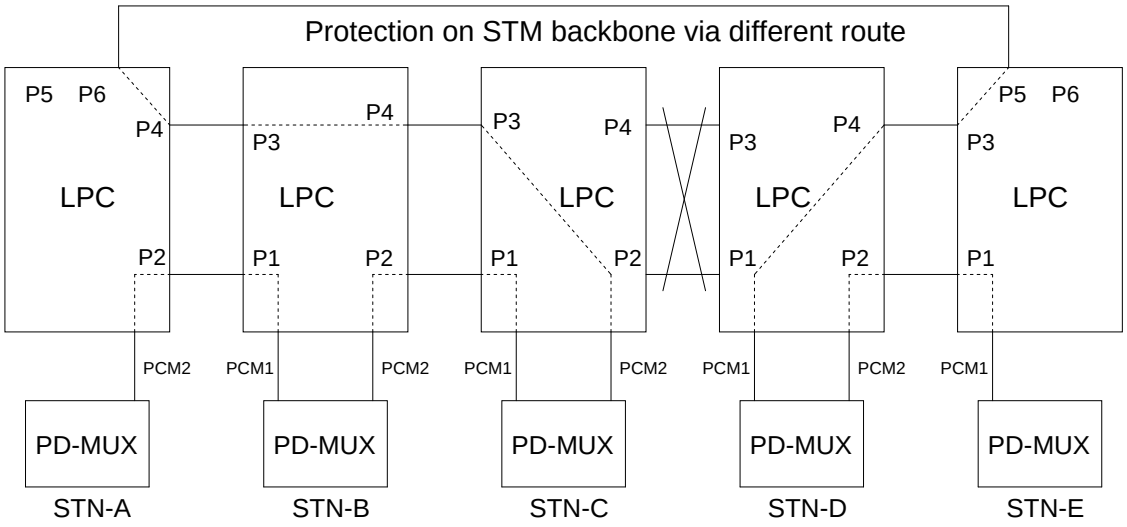


Fig.6.3 Switching in LPC in case of failure of E1/ OFC cut between two intermediate stations

Thus, in this arrangement of using LPC and 2 E1s at every station, all time-slots of the E1-thread is protected. Loop-back protection is end to end on STM back-bone via different route.

Problem of overreach:

In case of multiple cable cuts in a single protected section, the stations on either side of the isolated section (section isolated by two cable faults) get directly connected.

This will cause extension of point to point circuits between these two non-adjacent stations which were meant between adjacent stations only.

Figure 6.4 shows how station-C and station-D get isolated and also over-reach of timeslots from station-B to station-E

Consider time slot 10 is used for working point to point telephone between stations A and B, and the same time slot is used for working point to point telephone between station C and D, and also between D and E then in case of faults between station B and C & between stations C and D, direct connection between point to point telephones at stations B and E will be established.

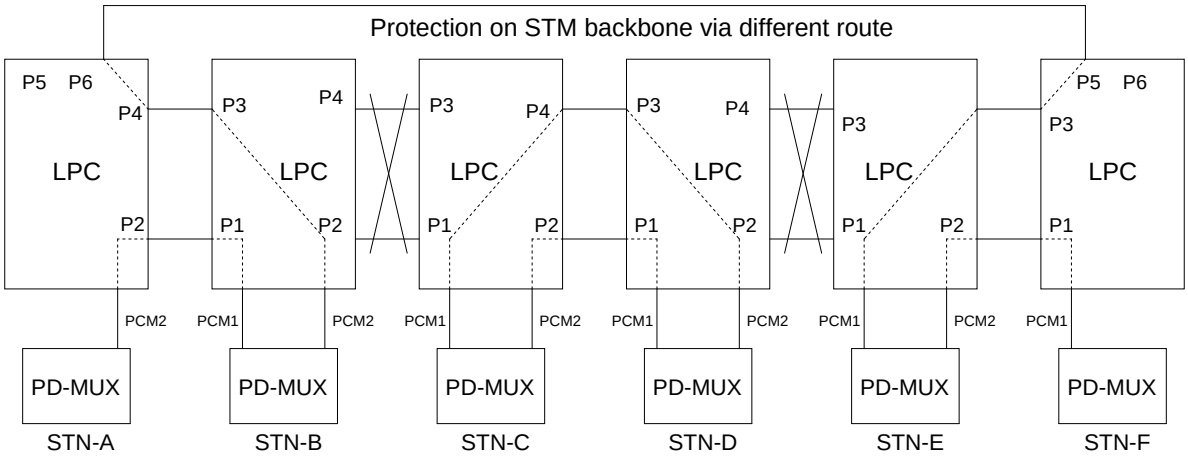


Fig.6.4 Multiple Cuts Scenario: Isolation and overreach problems

This fact has to be considered if such telephones are being used for train working.

Similar problem shall occur on other point to point circuits. Special precaution needs to be taken if on point to point circuits, axle counters channels are worked. To avoid this, either the time slot or the address setting for modem to modem communication must be different for axle counters in a section. For example if two axle counters are using same time slot 11, then they must not use the same address

6.2.2. Ring protection mechanism using spare time slots in working E1

Please refer Fig.6.5. In this approach, all the conference circuits are always protected whereas only those point-to-point circuits get protected which are mapped to spare time slots in E1 for protection purpose. Therefore, in this approach, the protection has to be planned at time slot level for point to point circuits.

This approach is followed in Webfil PD-MUX and Nokia PD-MUX having loop protection module. In case of older versions of Nokia/ Webfil where automatic loopback is not supported, protection E1 is kept ready for patching at test-room

Problem of over reach:

This scheme shall also lead to overreach in case of multiple cable cuts. However, this scheme allows for protection of selected time slots only. Therefore the overreach in sensitive circuits like station to station hot line telephone can be avoided by disabling automatic protection for those circuits while continue to have automatic protection for control circuits. In case of applications like axle counter which require automatic protection switching for improved reliability purpose, judicious time slot allocation can prevent such problem.

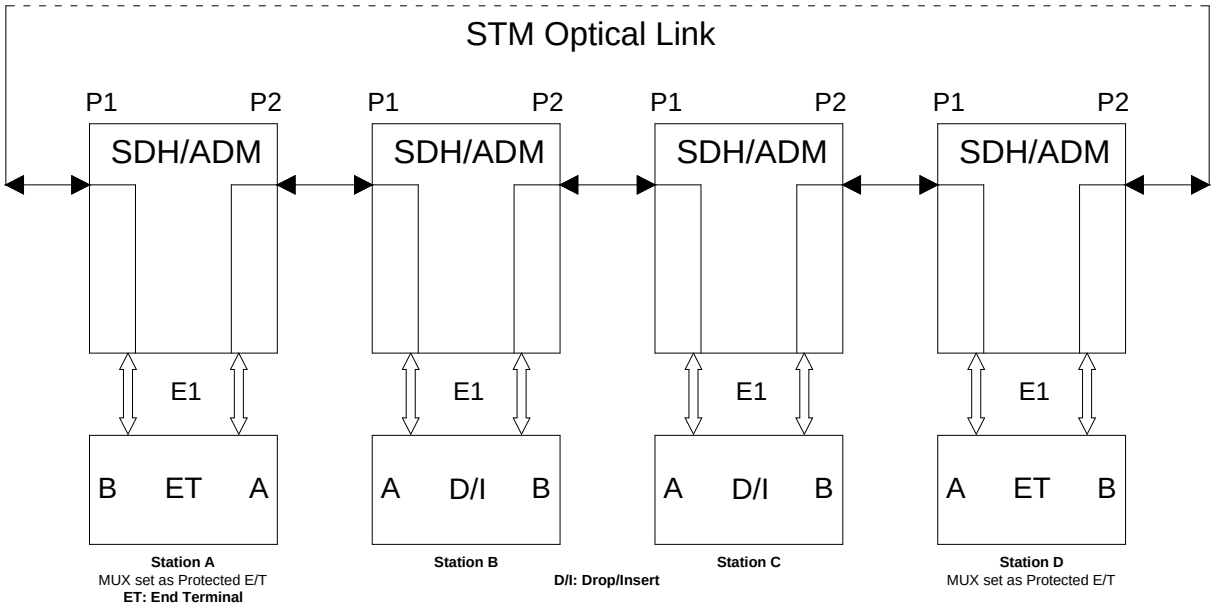


Fig.6.5 Ring-protection using spare time-slots in Working E1

6.3 A committee was formed by Railway Board vide letter No. 2010/Tele/9 (1) dated 19.01.2012. It has given a report, suggesting features of most suitable protection scheme and migration to the scheme for all existing types and versions of PD-MUXes

6.3.1 Features of most suitable protection scheme

1. E1 thread carrying control circuits on work-path shall terminate at control section boundary; it shall not be continued on adjacent control section.
2. However, other omnibus circuits like EC, SCADA etc. are to be patched at VF level across control section boundaries and picked-up in the fresh E1 thread.
3. E1 level ring protection on STM backbone on OFC network at the end of the thread shall be via different path.
4. Also, wherever feasible, additional protection path (3rd path) shall be provided on STM backbone to ensure availability of circuits in case of simultaneous cuts on Working Path and Protection Path.
5. Protection has to be automatic through PD-MUX NMS
6. Overreach problem is to be avoided in case of PD-MUX failures/switch-off/KLM pass through on STM1
7. Overreach problem is to be avoided in case of multiple OFC cuts
8. Smaller sections for loop protection to be implemented to the extent possible so that multiple cuts' scenarios have better availability of control circuits
9. Uniformity of PD-MUXes on all segments to be ensured on multi-segment control section. Since there is large installation base of PD-MUXes of various types/versions and no further technical developments are taking place in this segment, migration to the above scheme of most suitable protection is discussed in the next section for all existing types/versions of PD-MUXes

6.3.2 Migration to Most Suitable Protection Scheme

1. Sections with PUNCOM PD-MUX or WEBFIL PD MUX or Nokia PD MUX as per IRS TC 68/04

The protection scheme followed in these MUXes creates overreach problem of point- to-point circuits in case of multiple OFC cuts. Hence, channeling plan with enough spare slots and judicious staggering of channels should be followed. If numbers of channels are more, 2nd PD-MUX chain can be planned.

2. Sections with old versions of MUXes which does not support automatic loop protection

In case of old version of Webfil MUX as per (IRS TC 68/97), automatic protection scheme can be implemented by replacing NIM and TRIB cards in the terminal MUXEs only. The NIM and TRIB cards of Webfil make are to be taken as per newer version of MUX i.e. as per IRS TC 68/2012.

OR

External LPM (Loop protection module) can be procured and protection implemented as shown in Fig.6.6. Such modules are available with M/s PUNCOM and M/s Webfil. However, as this scheme provides complete time-slot protection, which can cause overreach of point-to-point circuits, time-slots shall be programmed leaving spare slots to avoid overreach.

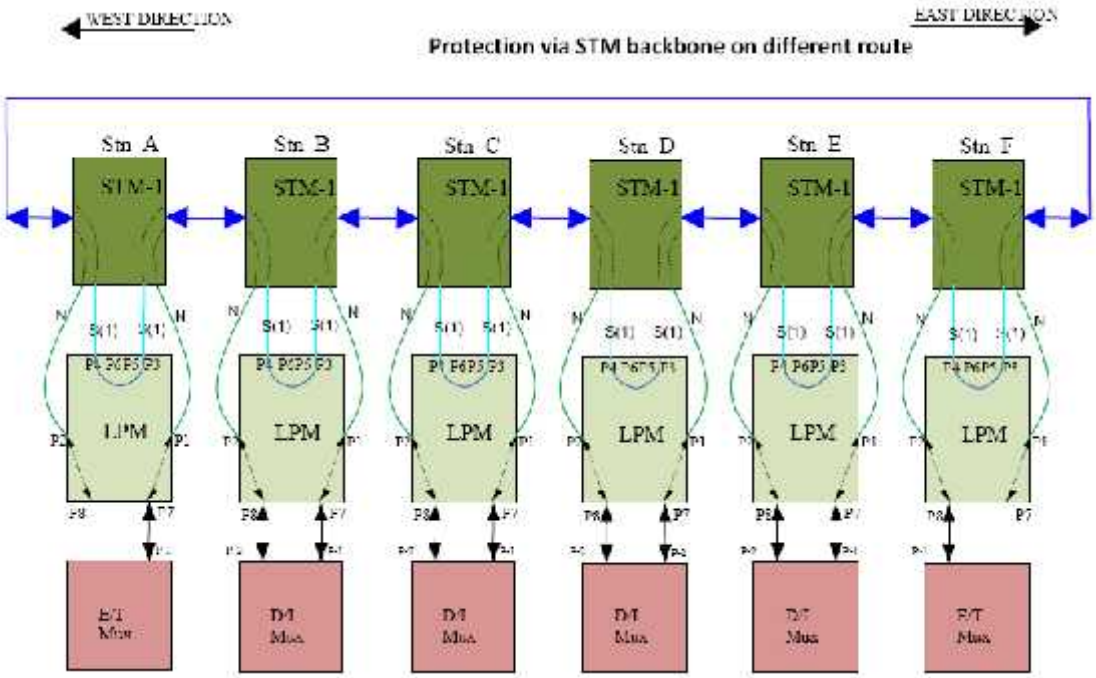


Fig. 6.6 Use of External LPM Module on PD-MUX

3. Sections with Coral PD-MUX

As mechanism for loop protection is not available in Coral PD-Mux, external LPM module of Webfil or LPC module of PUNCOM can be procured and protection implemented as shown in Fig 6.6. However, as this scheme provides complete time-slot protection, which can cause overreach of point-to-point circuits, time-slots shall be programmed leaving spare slots to avoid overreach.