NORTHERN TELECOM

PRACTICE 297-1001-103
ISSUED: 920724
RELEASE: 14.03 STANDARD

DIGITAL SWITCHING SYSTEMS

DMS-100* FAMILY

PERIPHERAL MODULES

* DMS is a trademark of Northern Telecom

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1. INTRODUCTION

GENERAL

This Practice describes Peripheral Modules (PMs), and how they are interfaced with the DMS-100 Family of switching systems (DMS-100 Family). This Practice also describes the PMs of the Signaling Transfer Point DMS-SuperNode[1] application.

APPLICABILITY OF THIS DOCUMENT

1.01 Northern Telecom (NT) software releases are referred to as batch change supplements (BCS) and are identified by a number, for example, BCS26.

1.02 This document applies to DMS-100 Family offices that have BCS30. Unless the document is revised, it also applies to offices that have software releases greater than BCS30.

1.03 To determine if this document has been revised, check the release information in the Master index of publications, 297-1001-001.

How to identify the software in your office

1.04 The Office feature record D190 lists your current BCS and the NT feature packages which it comprises.

1.05 To view similar information on screen, enter the following command string at a MAP (maintenance and administration position).

```
>PATCHER;INFORM LIST;LEAVE
```

[1] Trademark of Northern Telecom

REVISION HISTORY

BCS	DATE	REVISIONS
BCS30	June 1992	The following changes were made to existing text: * page 174 - modified to correctly identify physical location of cards NT6X68AC and NT6X68AD in shelf ST7G * page 166 - Fig.61 modified to correct physical location of MSB6 Unit-1 and MSB6 Unit-0
	April 1991	Updated information on XPM Power Converters
	March 1990	Added information on the TOPS Message Switch (TMS)
BCS29	September 1989	* References to the International LGC and DTC were expanded to include the PLGC and the PDTC, for PMs using PCM30. * Reference to the Link Peripheral Processor (LPP) cabinet was added to the hardware configurations for the LIM and LIU7 of the STP. * The NTP numbers for references to the STP were changed.
BCS28	May 1989	The following information was added: * optional V.35 capability for STP * NT9X78BA DS-0A paddleboard * XPM broadcast loading of LCMs.
BCS27	December 1989	The following information was added: * the CLASS modem resource card (CMR) in the LGC, LTC, and RCC for Calling Number Delivery (CND)

Table Continued

BCS	DATE	REVISIONS
		* Calling Number Delivery (CND) and the Line Concentrating Module (LCM) * the NT6X51AB processor card in the expanded memory Line Concentrating Module (XLCM)
BCS26	September 1988	The following information was added: * a new chapter entitled "Extended Multiprocessor System PMs" describing common XPM functions and hardware * information on XPM Inter-Peripheral Message Links used for parallel loading several XPMs simultaneously * information on XPM Inter-Module Communication * information on the Remote Switching configuration employing a Dual Remote Cluster Controller

WHERE TO FIND INFORMATION

1.06 Documents that you require to understand the content of this document, or to perform the procedures it describes, are referred to in the appropriate places in the text.

1.07 These documents, and others that contain related information, are listed in this section.

Note: More than one version of these documents may exist. To determine which version of a document applies to the BCS in your office, check the release information in the Master index of publications, 297-1001-001.

DOCUMENT	TITLE
297-1001-001	Master Index of Practices
297-1001-100	System Description
297-1001-102	Network Description Types NT0X48 and NT5X13
297-1001-106	Maintenance System DMS 100/200
297-1001-110	Maintenance and Administration Position (MAP)
297-1001-114	Operational Measurements (OM)
297-1001-120	Equipment Identification
297-1001-122	Alarm System Description
297-1001-129	Input/Output System Reference Manual
297-1001-130	Synchronous Clock System Description
297-1001-137	Common Channel Signaling CCIS6 and CCITT6 System Description
297-1001-141	Common Channel Signaling 7 Description
297-1001-151	Distributing Frame Layout
297-1001-152	Trunk Selection and Compatibility
297-1001-450	Provisioning
297-1001-451	Common Customer Data Schema
297-1001-510	Log Report Manual BCS30
297-1001-515	Peripheral Modules Maintenance Reference Manual
297-1001-527	Digital Recorded Announcement Machine Maintenance Reference Manual
297-2101-101	Line Module Description
297-2101-102	Remote Line Module (RLM) Description
297-2101-516	Line Maintenance Reference Manual

Table Continued

DOCUMENT	TITLE
297-2401-516	ISDN Line Maintenance Reference Manual
297-2401-503	Lines Maintenance Performance Oriented Practice
297-5101-100	STP System Description
297-5101-102	STP OA&M Manual
GS0X29	Frame Supervisory Panels (Line Frames)
GS1X90	Test Signal Generator Card
GS2X12	Digital Echo Suppressor Module
GS2X14	Line Module Controller and Remote Line Controller
GS2X31	Digital Carrier Module
GS2X58	Maintenance Trunk Module, Office Alarm Unit, and Remote Service Module
GS2X96	PCM Level Meter Card
GS3X65	Digital Echo Suppressor
GS6X05	Line Concentrating Module Drawer
GS6X17	Standard Line Circuit Type A With Cutover
GS6X18	Line Card Type B
GS6X35	Frame Supervisory Panel Line Concentrating Module
GS6X53	Power Converter 5V/15V
GS6X71	Data Line Card (DLC)
GS6X99	Integrated Bit Error Rate Tester

2. PERIPHERAL MODULE INTERFACE

GENERAL

PMs are shelf or frame-mounted units providing an interface between the DMS-100 Family and the analog or digital transmission facilities, service circuits, or subsidiary PM.

Note: The Link Interface Module (LIM) and the Link Interface Unit 7 (LIU7) are PMs in the Signaling Transfer Point DMS-SuperNode[2] application and do not share interface characteristics with any other of the PMs described in this Practice. For information on the LIM and LIU7 see Part 18 on page 190 and Part 19 on page 203.

The PM translates the characteristics of these different sources into the 32-channel, 2.56 megabits/sec (Mb/s), time division multiplex format used by the DMS-100 Family. See 297-1001-102 for a description of the network modules and how they interface with PM. See also 297-1001-100 for a system description of the DMS-100 Family of switching systems.

In the DMS-100 system channel format, 30 of the 32 channels are used for speech paths between the PM and the network. One of the remaining two channels (one unused) provides paths for an internal message system, providing control and communication interfaces between the PM and the Central Control Complex (CCC) of the DMS-100 System. Each 32-channel connection between a PM and the network consists of separate transmitting and receiving paths (4-wire). Each set of 32-channel, 4-wire, transmit and receive paths, is referred to as a speech link. The point at which the speech link connects to the PM or network is called a port. This transmission format is designated DS30.

DS30 links are duplicated, with an equal number of links between a PM and each plane (0 or 1) of the duplicated network modules (NM). See 297-1001-102 for details of NM configurations. All references to the quantity of DS30 links required by a PM type are per-plane unless otherwise specified.

Each PM has a Peripheral Processor (PP) function which performs local processing action within its PM, and controls the flow of messages between itself and the call processing software in the CCC. This action by the PP relieves the CCC of routine local processing, enabling the CCC to concentrate on higher level activities.

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[2] Trademark of Northern Telecom

TYPES OF PERIPHERAL MODULES

Signaling Transfer Point PMs

The Signaling Transfer Point PMs do not have interface characteristics that are similar to the other PMs described in this chapter. Consequently, they are not discussed further here. For information on the STP PMs see Part 18 on page 190 and Part 19 on page 203.

Each of the PM types in the various categories is described in detail in a separate part of this Practice. A DMS-100 Family system may contain a mixture of any of the following types of PM.

PM USING ONE DS30 LINK PER PLANE TO NM

See Figure 1 on page 21.

* Trunk Module (TM). Interfaces with up to 30 trunk transmission facilities. See Part 4 on page 51.

* Maintenance Trunk Module (MTM) Interfaces with up to 24 test or service circuits. See Part 5 on page 57.

* Office Alarm Unit (OAU). Interfaces with up to 24 circuits of the DMS-100 alarm system. See Part 6 on page 64.

* Digital Recorded Announcement Machine (DRAM). Provides access to up to 30 voice announcements, recorded in digital format and stored in memory circuits. See Part 7 on page 66.

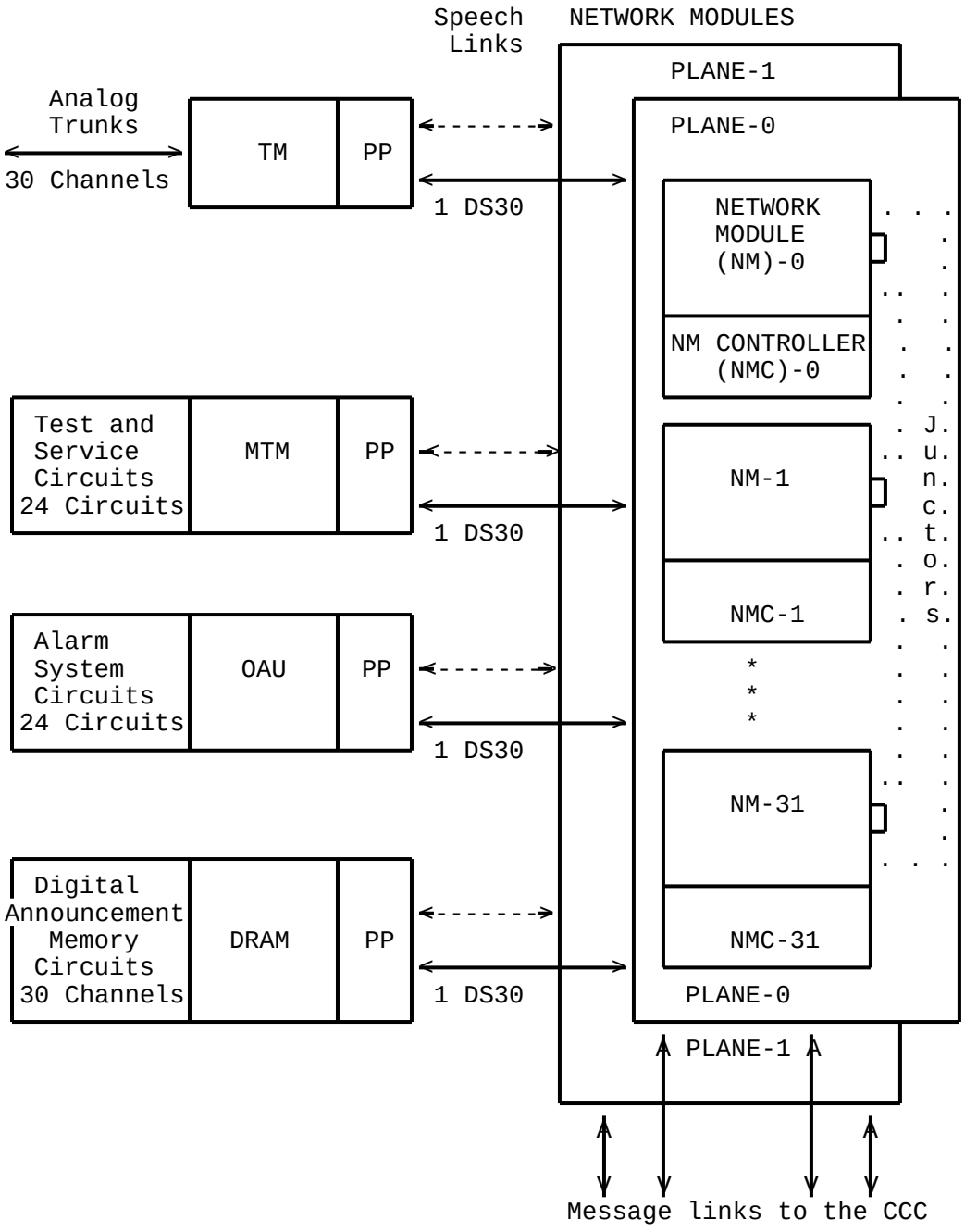

Fig. 1 - PM Using 1 DS30 Link to NM. I/F Analog DS1s or Service Circuits

PM USING UP TO FOUR DS30 LINKS PER PLANE TO NM

DCM, DCM-R, DES

The PM to Network module connections for these three peripheral modules are shown in Figure 2 on page 23. Details of the connections for each PM are as follows:

* Digital Carrier Module (DCM). Interfaces four DS30 links (120 speech channels) with five 24-channel DS1 digital trunks (5 X 24 = 120 channels). Available in two versions: basic (DCM-B), and DCM with synchronized clock (DCM-S). See DCM Operation on page 69.

* Digital Carrier Module - Remote (DCM-R). Interfaces with four DS1 links (96 channels max.) to Remote Line Modules (RLM) and one DS1 digital trunk. Various other configurations of DS1 links between DCM-R and RLM are also possible. See DCM-R Operation on page 73.

* Digital Echo Suppressor (DES). Applies digital echo suppression to digital trunk circuits. Interfaces three DS30 links (90 channels) with 45 digital send and receive speech paths (90 channels) to digital echo suppression circuits. The fourth DS30 link is not required in the DES application. See Digital Echo Suppressor (DES) on page 74.

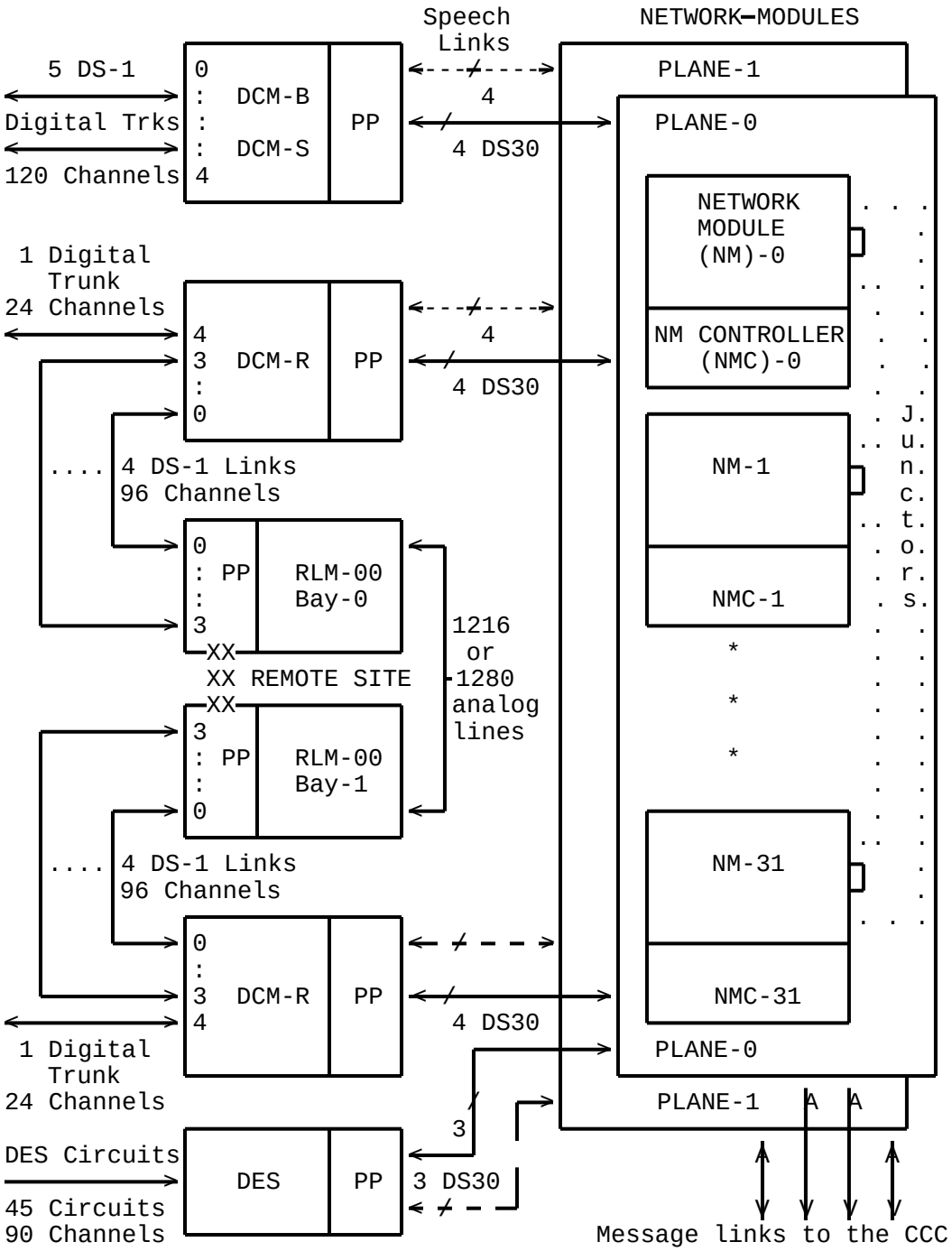

Fig. 2 - PM Using Up to 4 DS30 Links to NM. I/F with DS1

Subscriber Module SLC-96 (SMS)[3]

The PM to Network module connections for the Subscriber Module SLC-96 (SMS) are shown in Figure 3 on page 25. The SMS interfaces up to four DS30 links (up to 120 channels) with up to 20 DS-1 links (480 channels). These DS-1 links connect to up to six Remote Concentrator SLC-96 Terminals (RCS). RCS is the DMS-100 name for the Remote Terminal of the SLC-96 carrier system. The number of DS-1 links connecting an RCS and an SMS depends on the mode of operation of the RCS.

The RCS consists of four line shelves labelled A, B, C, and D. Shelves A and B form the upper shelfgroup, AB; shelves C and D form the lower shelf group, CD. Each shelf group operates independently in one of three modes:

mode I (see Figure 4 on page 26)
mode II (see Figure 5 on page 27)
mode III (see Figure 6 on page 28)

A-shelfgroup's mode depends on the control cards installed in the RCS; this mode cannot be changed under program control. The mode of each shelf group of an RCS is datafilled in the MODE field of the RCSINV table. This table is described in 297-2101-451, Section 144. Mixed modes are not allowed in an RCS.

The DS-1 links coming from the RCS first terminate at an Office Repeater Bay, located in the Central Office, and connect to an SMS through a DS-1 Cross-Connect (DSX) frame or equivalent. The SMS has 20 ports for DS-1 links, enabling it to support up to four Mode I RCS modules that have five DS-1 links connected, six Mode II, or six Mode III RCS modules. The SMS can support up to six Mode I RCS modules when these modules contain fewer than the maximum five links.

[3] SLC-96 is a trademark of AT&T Technologies, Inc

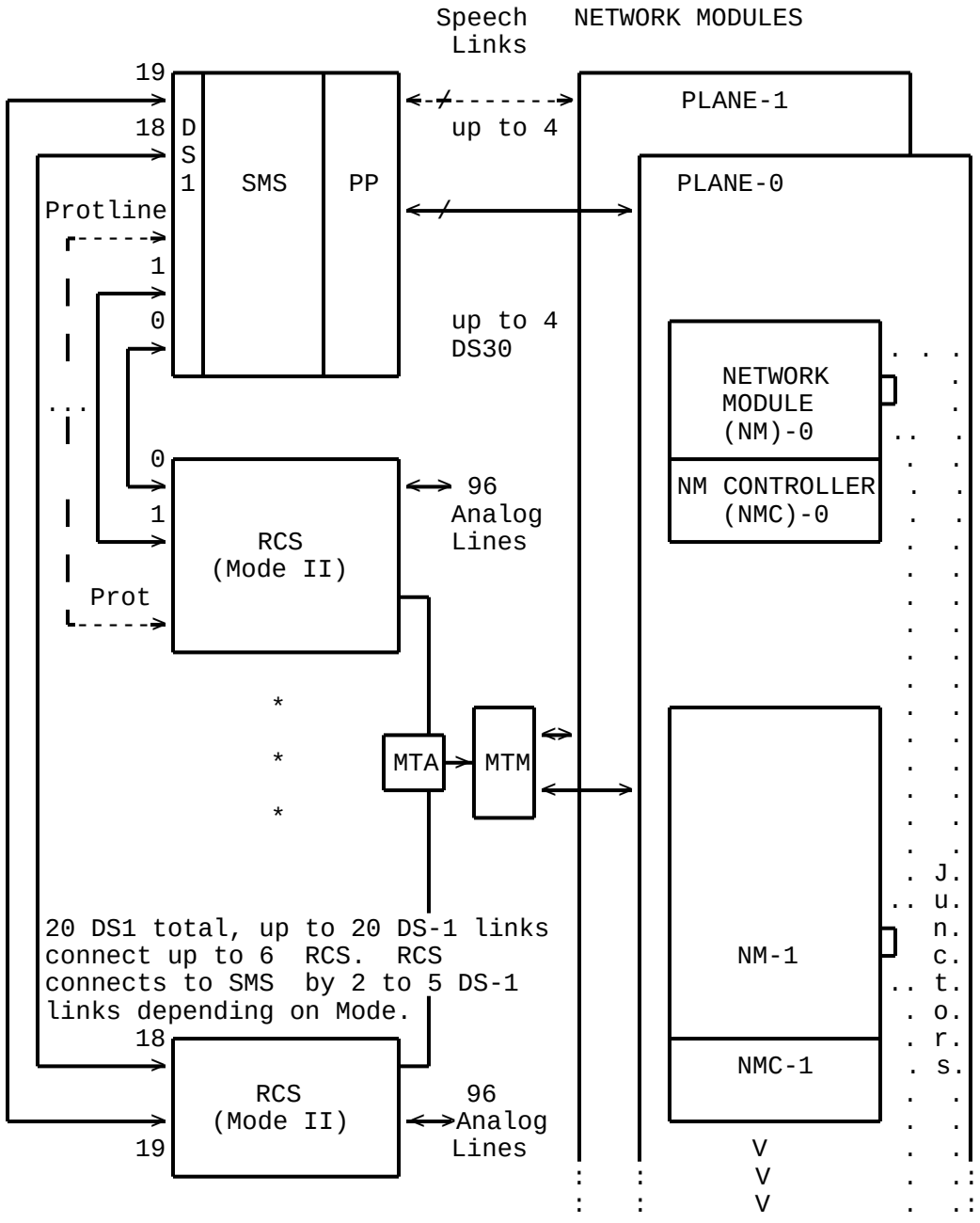

Fig. 3 - PM Using Up to 4 DS30 Links to NM. I/F with RCS

Mode I

Mode I, shown in Figure 4, has non-concentrated shelf groups. This mode contains a dedicated DS-1 link for each shelf, so that every line circuit has a dedicated channel on the DS-1 link. One or two shelves exist per shelfgroup, depending on whether one or two shelves are equipped. Mode I is used primarily for single- and multi-party lines, with both types of line using dual-circuit, message line cards. Single-circuit line cards, including coin and special service, may be mixed with dual-circuit line cards without restriction but leave one time slot on the DS-1 link unused.

In Mode I, the RCS supports up to 96 subscriber lines and connects to the SMS through up to five DS-1 links. One of these links is a protection link and is activated automatically to carry calls when one of the normal links fails. The switch operator can also manually activate a protection link. This mode uses fixed assignments of remote terminal circuit numbers to DS-1 time slots. This means that every subscriber loop, which is associated with a circuit number, has a dedicated channel on a DS-1 link.

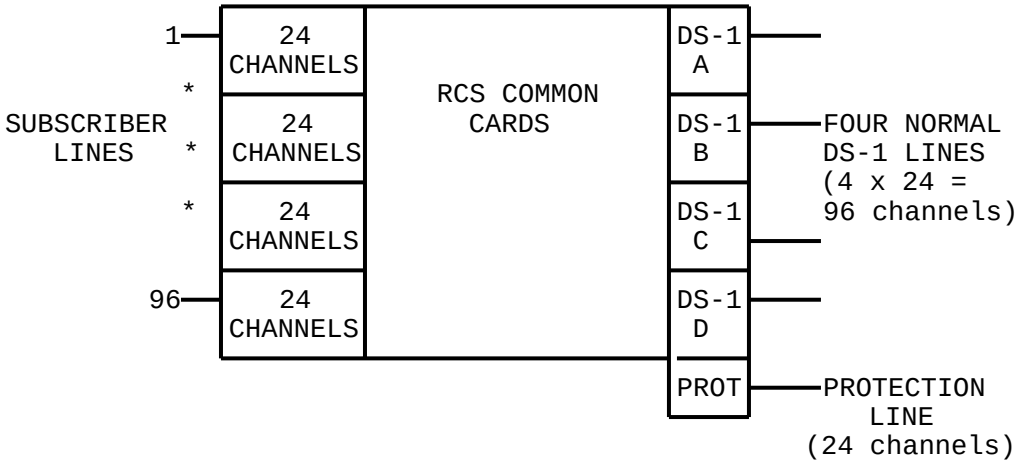

Fig. 4 - RCS in Mode I

Mode II

An RCS in Mode II, shown in Figure 5, has concentrated shelf groups. This mode operates with one DS-1 link per shelf group, forcing 48 subscribers to compete for 24 time slots on the DS-1 link. To achieve this two-to-one concentration, a Time Assignment Unit (TAU), must be used. Single-circuit line cards and dual-circuit line cards can be mixed in Mode II, but special-service and coin cards can be placed only in the four rightmost slots of each shelf. Up to eight single-circuit line cards are allowed per Mode II shelfgroup.

In Mode II, an RCS supports up to 96 subscriber lines or a combination of 64 subscriber lines and 16 special service and coin cards. A mode II RCS connects to the SMS through up to three DS-1 links (one is a protection link) and uses dynamic mapping of circuit numbers to DS-1 time slots.

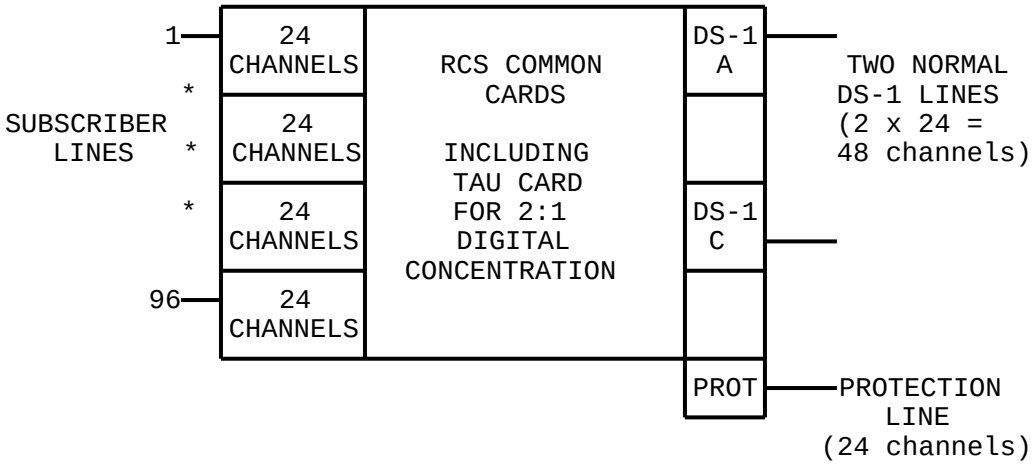

Fig. 5 - RCS in Mode II

Mode III

A Mode III RCS, shown in Figure 6, uses non-concentrated shelf groups. This mode normally supports special services, but it can also support coin cards.

This mode operates with one DS-1 link per shelf group and uses a Multiplexer (MXU) card to multiplex channels from the two shelves on a shelf group onto one DS-1 link. Shelves are equipped with only single-circuit line cards and therefore have dedicated, non-concentrated lines. A Mode III RCS supports up to 48 special service and coin cards. This mode uses fixed assignments of remote terminal circuit numbers to DS-1 time slots.

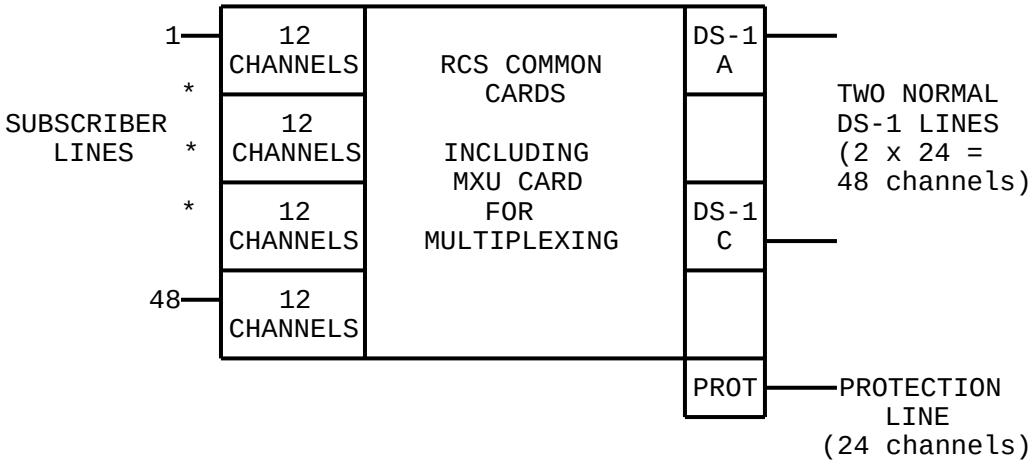

Fig. 6 - RCS in Mode III

PM USING 3 TO 16 DS30 LINKS PER PLANE TO NM

This category of PM interfaces with other PM via 32-channel balanced speech links (max. range 50 ft), designated DS30A; or with DS1 equipment. Various configurations of links are possible, other than the typical configurations described. See Part 10 on page 101 and Part 16 on page 156 for details.

* Line Group Controller (LGC). See Figure 7 on page 30. Interfaces 3 to 16 DS30 links (90 to 480 channels) with up to 20 DS30A links (600 channels) to up to 10 Line Concentrating Modules (LCM), or alternatively via DS1 links to Remote LCM (RLCM).

* Digital Trunk Controller (DTC). See Figure 10 on page 33. Interfaces 4 to 16 DS30 links with up to 20 DS1 digital trunk circuits (480 channels).

* Line Trunk Controller (LTC). A hybrid version of the LGC and DTC, equipped to interface with both DS30A and DS1 links.

* Message Switch and Buffer (MSB). See Figure 10 on page 33. Interfaces from three to six of the up to sixteen DS30 links per plane and with up to nine groups of eight Signaling Terminals (ST). The ST are connected to Common Channel Signaling (CCS) transmission links, carrying multiplexed inter-office signaling messages. MSB configurations can be arranged to handle various types of CCS formats by provisioning the appropriate hardware and software. See Part 16 on page 156 for details of the MSB.

* Subscriber Module Remote (SMR). See Figure 8 on page 31. Interfaces 3 to 16 DS30 links (90 to 480 channels) with up to 18 DS-1 links (432 channels). These DS-1 links connect to up to 6 Remote Concentrator Terminals (RCT). RCT is the DMS-100 name for the Remote Terminal of the DMS-1R[4] carrier system. Up to 3 DS-1 links connect an RCT to an SMR. One of these DS-1 links is a backup link called a protection link, which is manually or automatically switched into service should an in-service DS-1 link fail. The SMR has the capacity to support 20 DS-1 links.

* Subscriber Module Urban (SMU). See Figure 9 on page 32. Interfaces 3 to 16 DS30 links (90 to 480 channels) with up to 20 DS-1 links to multiple Remote Carrier Urban (RCU) modules. Two to eight DS-1 links connect to each RCU. RCU is the DMS-100 name for the Remote Terminal of the DMS-1U[5] carrier system The RCU can be configured in several ways, and more information on these configurations is located in 363-2051-100.

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[4] DMS-1R is a trademark of Northern Telecom

[5] DMS-1U is a trademark of Northern Telecom

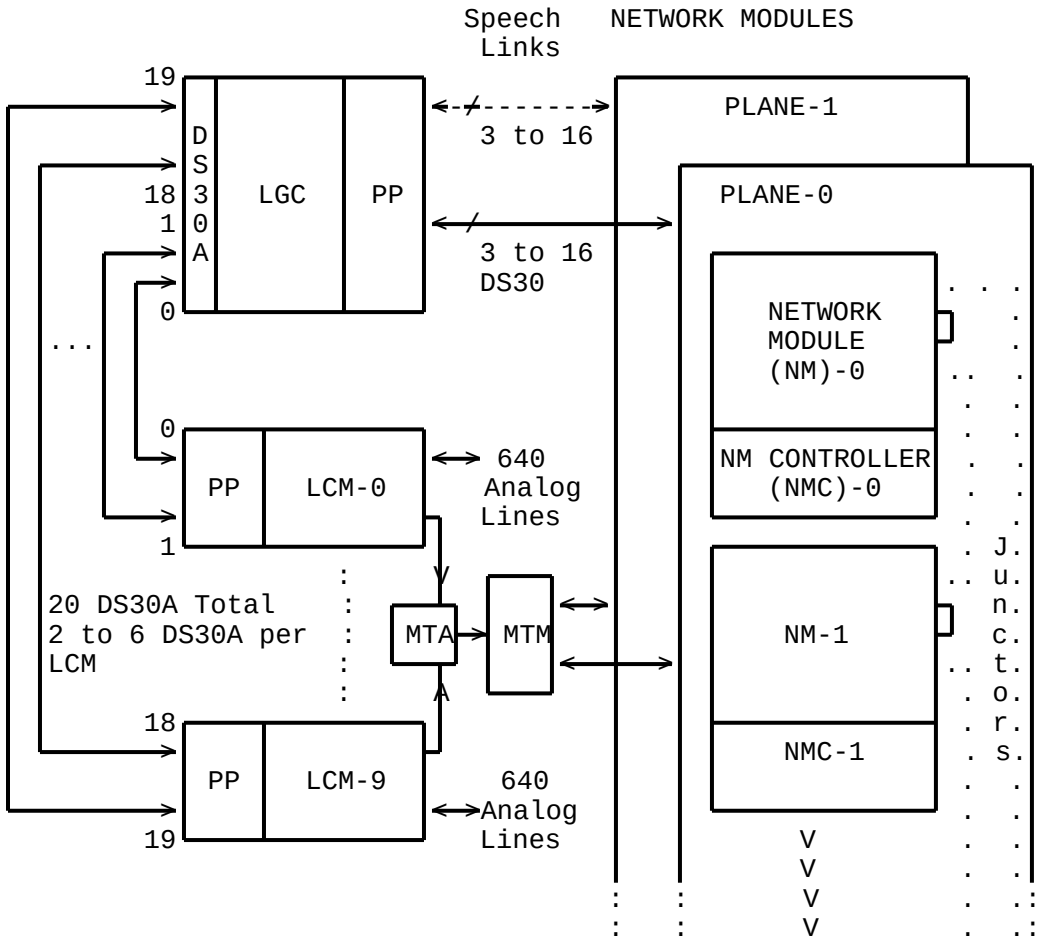


Fig. 7 - PM Using 3 to 16 DS30 Links to NM. I/F with LCM

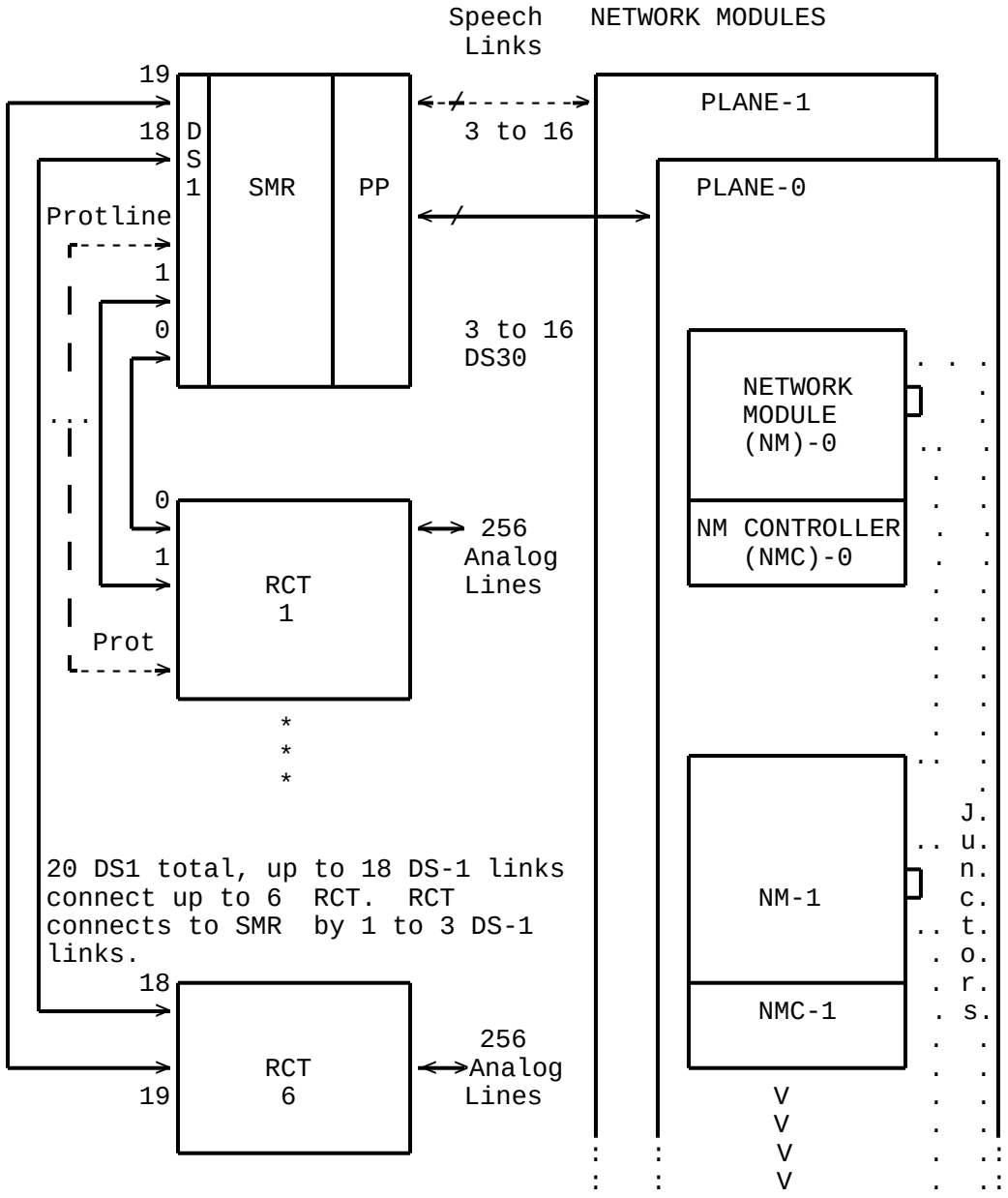


Fig. 8 - PM Using 3 to 16 DS30 Links to NM. I/F with RCT

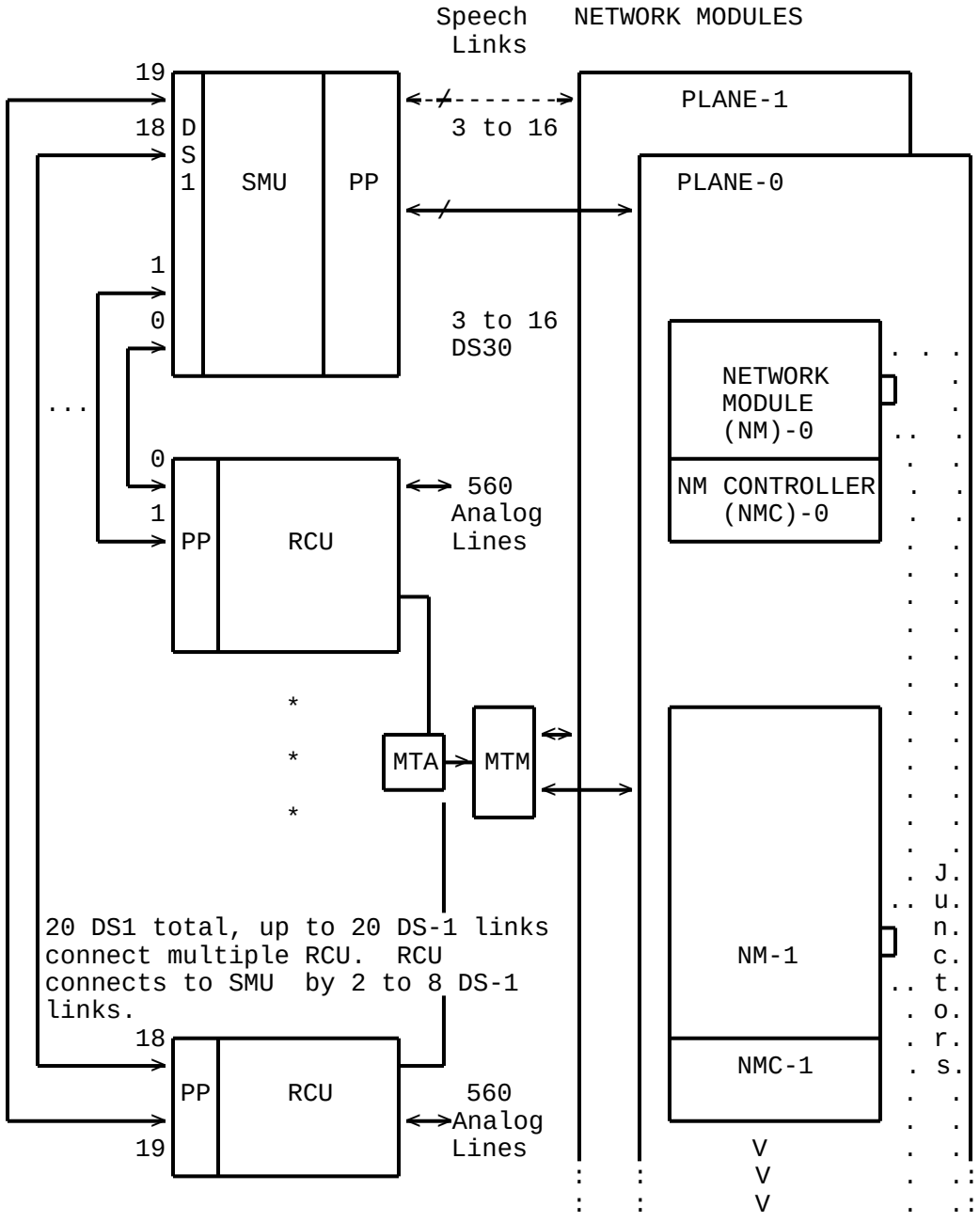


Fig. 9 - PM Using 3 to 16 DS30 Links to NM. I/F with RCU

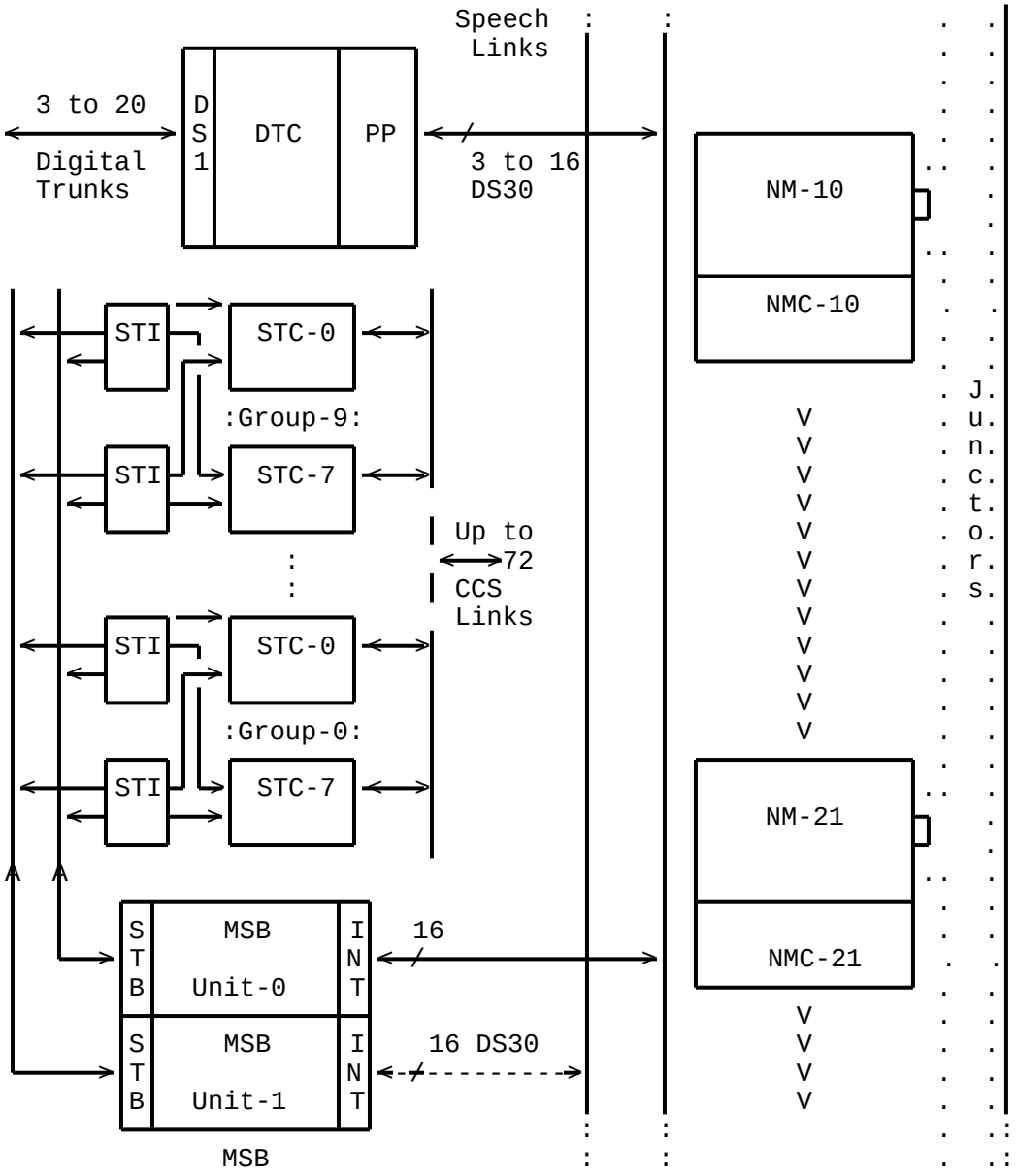


Fig. 10 - PM Using 3 to 16 DS30 Links to NM. I/F to DS1s or CCS

PM USING DS30A AND/OR DS1 LINKS TO LGC AND/OR LTC

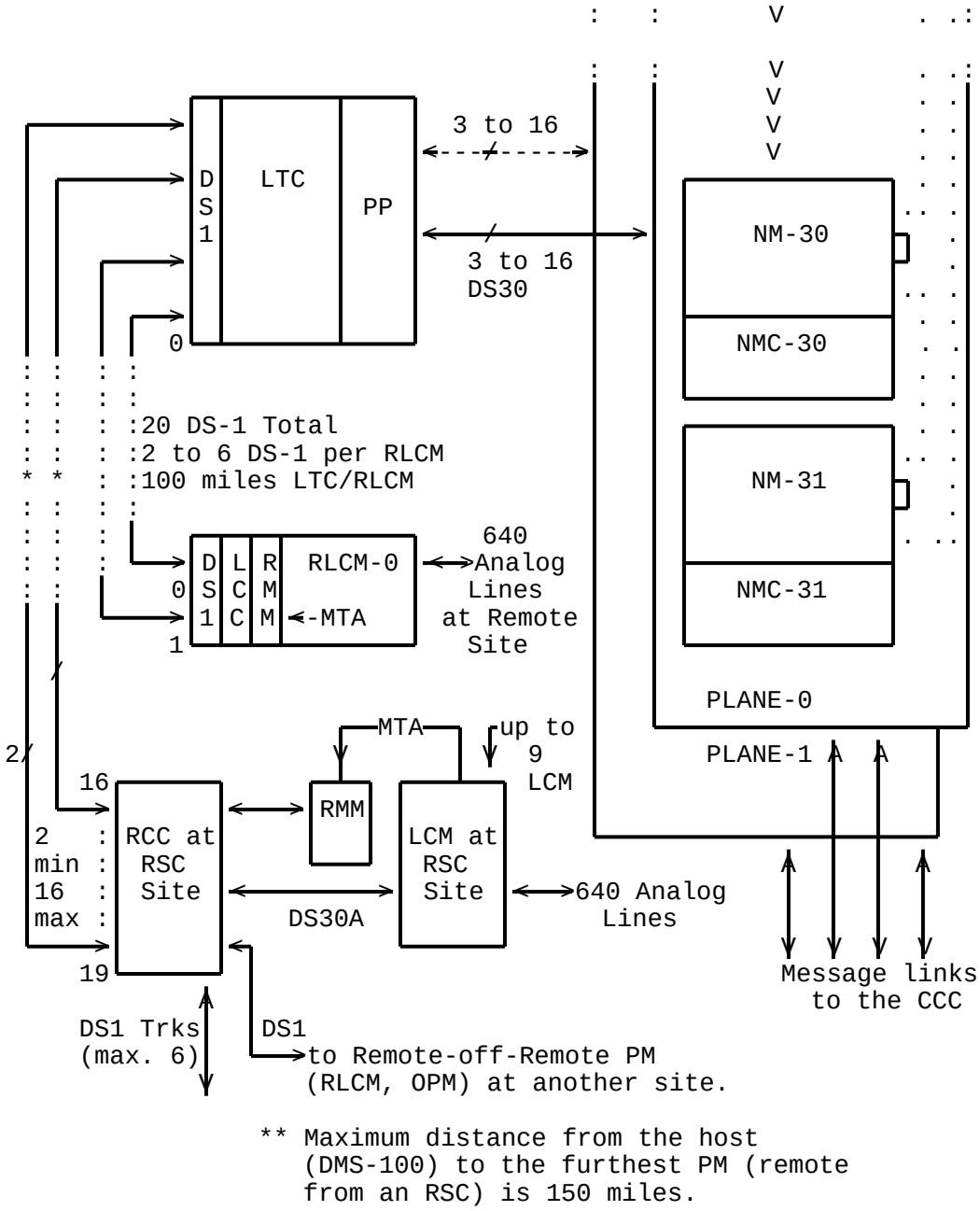
* Line Concentrating Module (LCM). See Figure 7 on page 30. Interfaces with 2 to 6 DS30A links (60-180 channels), serving up to 640 analog lines. Figure 7 on page 30 shows an example where ten, two-port LCM are handling a total of 20 DS30A links. Other possible configurations of DS30A links and LCM are described in Part 20 on page 215.

* Remote LCM (RLCM). See Figure 11 on page 35. An RLCM has two to six C-side DS1 links (48 to 144 channels) which connect to an LGC (or LTC) or Remote Switching Center. An RLCM is an enhanced LCM, equipped with DS1 interface circuits and Link Control Cards (LCC). Like the LCM, the RLCM can service up to 640 analog lines. An RLCM can be located up to 100 miles from and LGC (or LTC). For more details, including details of the RLCM-off-RCC configuration, see Part 20 on page 215.

* Remote Switching Center (RSC). See Figure 11 on page 35. Connected to the host office via 2 to 16 DS1 links (48 to 384 channels). The RSC consists of a Remote Cluster Controller (RCC) which provides up to 20 DS30A or DS1 links (or a combination of DS1 and DS30A links up to a total of 20 links) to:

  - LCM at the RSC site (DS30A links)
  - RLCM (or OPM) (DS1 links)
  - CDO or PBX (DS1 digital trunks).

  The RCC is similar to an LTC, but is equipped for remote operation. Remote-off-remote equipment can consist of RLCM or Outside Plant Modules (OPM). See Part 21 on page 243 for details of the RSC.



** Maximum distance from the host (DMS-100) to the furthest PM (remote from an RSC) is 150 miles.

Fig. 11 - PM Using 3 to 16 DS30 Links to NM. I/F to RLCM OR RSC

PM USING 2 TO 4 DS30 LINKS PER PLANE TO NM

See Figure 12 on page 37.

* Line Module (LM). Interfaces with 2 to 4 DS30 links (60-120 channels) serving up to 640 analog lines. LM are housed in adjacent bays, and operate in pairs with mutually-supportive PP. In the event of a PP failure in one bay of a pair, the PP in the other bay is capable of handling calls on the whole 1280-line group with slightly-reduced efficiency. See Part 24 on page 274.

* Remote Line Module (RLM). Operates in conjunction with the DCM-R at the remote HOST office (see also Figure 2 on page 23). Concentrates up to 96 digital channels in DS1 format onto 640 analog lines. RLM operate in paired bays similarly to the LM with mutually-supportive PP. For remote maintenance the RLM are grouped into five (00 to 04) pairs, referred to as a "cluster". One RLM pair (00) of the cluster uses 32 of its internal channels to control the Remote Service Module (RSM). The RSM handles remote Metallic Test Access (MTA) to the tip and ring leads of all the analog lines connected to the cluster of five RLM. The first "prime" RLM pair (00) therefore handles only 608 lines (640-32) per bay. See Part 24 on page 274 for more details of the RLM, its associated modules, and alternative DS1 link configurations.

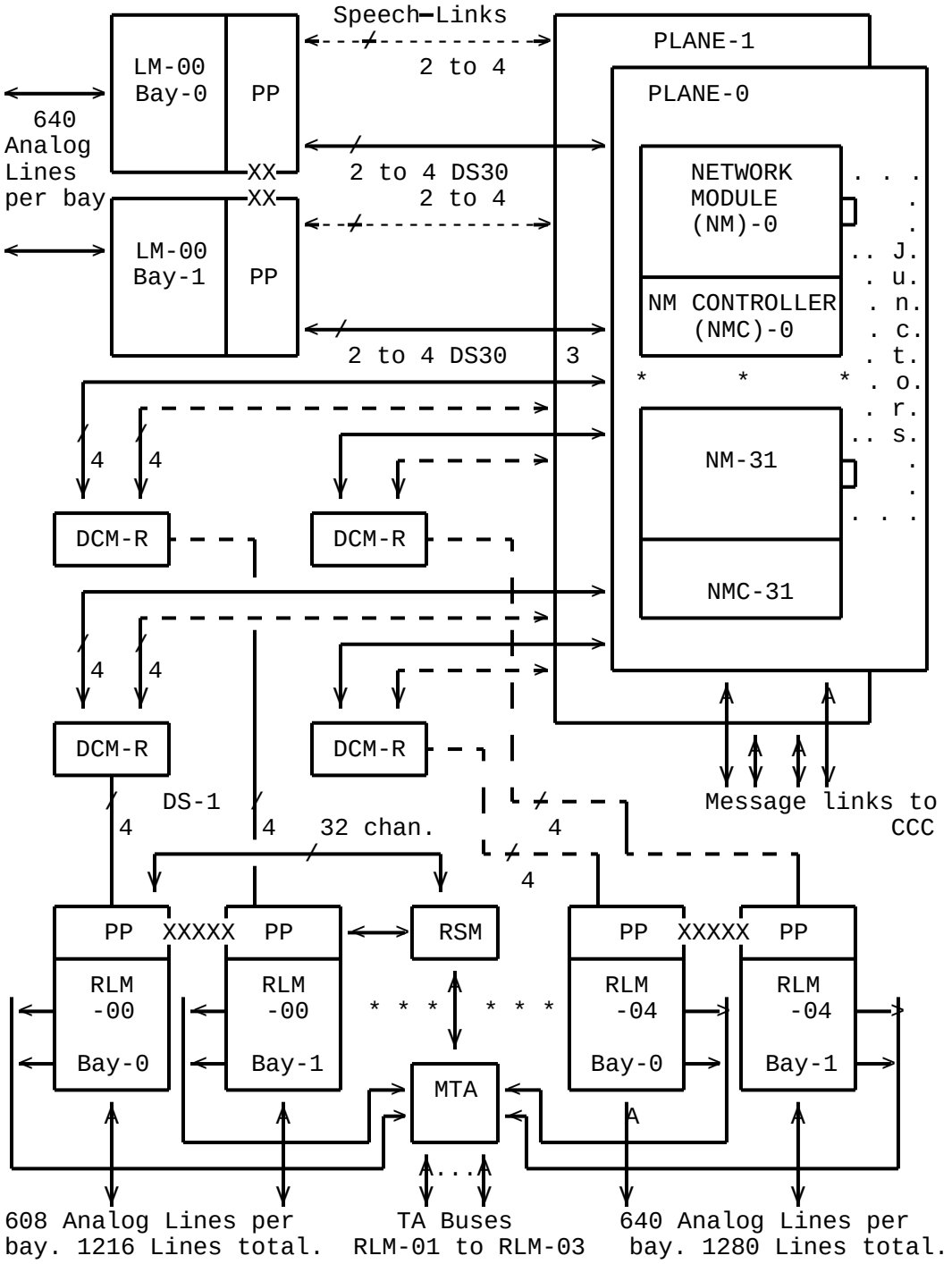


Fig. 12 - PM Using 2 to 4 DS30 Links to NM. I/F to Analog Lines

SUMMARY OF PM CHARACTERISTICS

The link characteristics of all the PM types in the foregoing descriptions are summarized in Table A on page 39. The side of a PM which is connected, either directly or through another PM, to the network is referred to as the C-side (towards the CCC). The side of a PM which is connected to lines, trunks, or to a subsidiary PM, is referred to as the P-side (peripheral side). This nomenclature is used in references to links and channels.

CELL SITE CONTROLLER (CSC)

The PM-type CSC is part of the Mobile Telephone Exchange (MTX) system, and is not described in this Practice. The MTX system is covered by the series of supplementary Practices, numbered 297-2131-nnn. See 297-2131-103 for a general description of the CSC, and 297-2131-515 for details of CSC maintenance displays and commands.

SCM-100 FAMILY OF PM

The SCM-100 Family of PM provide interfaces between DMS-100 Family systems and non-DMS-100 remote equipment.

The SCM-100 Family of PM comprises:

* the Subscriber Module Urban (SMU) - refer to Part 13 on page 136.

* the Subscriber Module SLC-96 (SMS) - refer to Part 14 on page 144.

* the Subscriber Module Remote (SMR) - refer to Part 15 on page 152.

TABLE A
DMS-100 FAMILY PERIPHERAL MODULES LINE CHARACTERISTICS

PM	C-SIDE LINKS	TYPE	CHAN	P-SIDE LINKS	TYPE	CHAN	REMARKS
DCM-B	4	DS30	120	5	DS1	120	See Note.
DCM-R	4	DS30	120	2	DS1	48	Min.Qty.DS1
	:			:		:	links to RLM
	4	DS30	120	4	DS1	96	Max.Qty.DS1 links to RLM
Note:	Quantity of DS30 links is per-plane.						
DES	3	DS30	90	-	-	90	45 ch. rec. 45 ch. trans
DRAM	1	DS30	30	-	-	30	Digital recorded announce-ments
DTC	3	DS30	90	20	DS1	72	24-channel
	:					:	digital
	16	DS30	480	20	DS1	480	trunks.
IDTC	3	DS30	90	16	PCM30	480	30-channel
	:					:	internation-
	16	DS30	480	16	PCM30	480	al digital trunks.
ILGC	3	DS30	90	20	DS30A	600	International
	:		:				LGC
	16	DS30	480	20	DS30A	600	
LCM						640 lines/LCM	
Qty.							
3	6	DS30A	540	-	-	1920	Analog lines
4	5	DS30A	600	-	-	2560	Analog lines
5	4	DS30A	600	-	-	3200	Analog lines
6	3	DS30A	540	-	-	3840	Analog lines
10	2	DS30A	600	-	-	6400	Analog lines

Table Continued

TABLE A (Continued)
DMS-100 FAMILY PERIPHERAL MODULES LINE CHARACTERISTICS

PM	C-SIDE LINKS	TYPE	CHAN	P-SIDE LINKS	TYPE	CHAN	REMARKS
LGC	3	DS30	90	20	DS30A or	600 or	DS30A<->LCM or DS1 (to
	:		:				
	16	DS30	480	20	DS1	480	RLCM/RCC) or combinations max 20 ports
LM	2	DS30	60	-	-	640	Analog lines
	3	DS30	90	-	-	640	(640 lines
	4	DS30	120	-	-	640	per LM bay)
LTC	3	DS30	90	20	DS30A or	600 or	DS30A (to LCM) or DS1
	:		:				
	16	DS30	480	20	DS1	480	trunks or DS1 (to RLCM/RCC or combinations max 20 ports
MSB6	3	DS30	90	8 or 64	RS232C (CCIS6) RS232C (CCITT6)		16 C-side links is theoretical max- CCS6 only requires 3-4.
	:		:				
	16	DS30	480				
MSB7	3	DS30	90	Note 1: IPML connections (from DTC serving CCS voice trunks) and NUC connections (to PM servicing CCS transmission links all use C-side links Note 2: 16 C-side links is hardware max. CCS7 application requires 3-6.			
	:		:				
	16	DS30	480				
MTM	1	DS30	30	-	-	24	Service circuits

Table Continued

TABLE A (Continued)
DMS-100 FAMILY PERIPHERAL MODULES LINE CHARACTERISTICS

PM	C-SIDE LINKS	TYPE	CHAN	P-SIDE LINKS	TYPE	CHAN	REMARKS
OAU	1	DS30	30	-	-	24	Alarm circuits
RCC	2 : 16	DS1 DS1	48 : 384	20 20	DS30A or DS1	600 or 480	DS30A (to LCM or DS1 (to CDO or PBX) or combinations max 20 ports
RLM	2 3 4	DS1 DS1 DS1	48 72 96	- - -	- - -	608 or 640	Prime RLM has 608 analog lines Others have 640
RLCM						640 lines/RLCM	
Qty.							
3	6	DS1	432	-	-	1920	Analog lines
4	5	DS1	480	-	-	2560	Analog lines
5	4	DS1	480	-	-	3200	Analog lines
6	3	DS1	432	-	-	3840	Analog lines
10	2	DS1	480	-	-	6400	Analog lines
RMM	2	DS30A	30	-	-	24	2 MTA buses + service circuits
RSM	2	RLM Buses	30	-	-	24	2 MTA buses + service circuits
SMR	3 : 16	DS30 DS30	90 : 480	20 20	DS1	480	

Table Continued

TABLE A (Continued)
DMS-100 FAMILY PERIPHERAL MODULES LINE CHARACTERISTICS

PM	C-SIDE LINKS	TYPE	CHAN	P-SIDE LINKS	TYPE	CHAN	REMARKS
SMS	up to 4	DS30	up to 120	20	DS1	480	
				20			
SMU	3 : 16	DS30	90 : 480	20	DS1	480	
				20			
STM	1	DS30	30	-	-	10	Service circuits
	1	DS30	30	-	-	10	Service circuits Two reduced-sized MTM functions).
TM	1	DS30	30	-	-	30	Analog trunk circuits.

3. COMMON PM CHARACTERISTICS

Note: The Link Interface Module (LIM) and the Link Interface Unit 7 (LIU7) do not have interface characteristics that are similar to other PMS described in this chapter. For information on the LIM and the LIU7 see Part 18 on page 190 and Part 19 on page 203.

The interfaces between the PM, the network, and the external facilities have the following common characteristics, although each type of PM has a different technique for implementing them.

NETWORK ACCESS

The DS30 speech links between the ports on the NM and the PM are completely duplicated by having separate sets of NM, referred to as Plane-0 and Plane-1. Only Plane-0 speech links are shown in detail. Each channel on each speech link in Plane-0 has a counterpart in Plane-1, and speech signals travel on both speech links simultaneously. The number of speech links required per plane for each PM type varies (as described in Part 1 on page 14). Also, for PM using a variable number of links per plane, the number of speech links required is selected based on estimates of light, medium, or heavy traffic on a particular PM.

FACILITY INTERFACES

Each type of PM contains several interface cards which are selected to match each channel of the PM to the signaling and speech characteristics of the trunk, digital link or subscriber line to which it is connected. Other interface cards provide special functions, such as: MF detection; user access to the network; access to recorded announcements or test circuits. Methods of provisioning PM and their facility interface cards are described in 297-1001-450/32.

DS30 DATA FORMAT

See Figure 13 on page 47. Data on the speech links between PM and NM is organized into frame-times of 125-microsecond (us) duration. A frame consists of 32 channel times of 3.9 us, with each channel further divided into 10 bit-times of 390 nanoseconds (ns). The characteristic DS30 data transmission rate of 2.56 Mb/s is derived from these values thus:

10 bits X 32 channels = 320 bits
320 bits/125 X 10^{-6} = 2.56 Mb/s
Channel 0 is transmitted first.

One channel time is enlarged to show its composition in more detail. The 10 bits of the channel are identified as bits 0 through 9, with bit 9 transmitted first. Eight of the 10 bits (2 through 9) carry either Pulse-Code Modulated (PCM) samples of voice signals or digital data. Bit 1 is the Channel Supervision Bit (CSB) which forms part of the Channel Supervision Message (CSM) , and bit 0 provides parity over the ten channel bits. Together, bits 1 and 0 provide a per-channel fault detection capability.

Thirty of the 32 channels carry PCM or data as just described. One of the remaining two channels carries control messages between the PM and CCC, via the Network Message Controller (NMC, one per NM). The other channel is used for maintenance.

On the channel carrying control messages, the data format is different to a speech channel. Bits 2 through 9 represent message data, bit 1 is not used, and bit 0 is used as a frame synchronizing pulse during channel 0 time only. Full details of the structure and protocol of the message system are contained in 297-1001-104.

CHANNEL SUPERVISION MESSAGE (CSM)

See Figure 14 on page 48. The CSB (bit 1) in each speech channel appears once every frame time (125 us), and, over a sequence of 40 frames (5 milliseconds), is used to compose a 40-bit Channel Supervision Message (CSM).

The CSM is sent and received between connected PM via the network as a continuous check of the integrity of the transmit and receive paths of a connected call.

In the example, the value of bit 1 in channel 2 during frame-time 0 is read at channel time 2, when it becomes bit 0 of the CSM for channel 2. This process continues, during subsequent frame times up to CSM bit 39, each time reading the value of channel 2, bit 1, until the CSM for channel 2 is complete. Similar action occurs during the channel times of the other connected speech channels up to channel 31, until CSM have been composed for all connected channels, and sent to the far-end PM on the transmit path.

During the same period, the PM is receiving CSM from the corresponding channels of the connected PM, thus providing a complete check of the transmit and receive paths of connected channels.

A complete 40-bit CSM contains 24 synchronization bits (23 ones followed by zero) and a 16-bit data word. The data word is divided into two bytes (8 bits), a connection data byte and an integrity byte. The connection data byte is used to carry inter-peripheral messages between connected PM. The integrity byte is a maintenance function which monitors call-path integrity by checking values transmitted from a PM against values received

back from the connected PM. If an error is detected, the alternative channel in the other plane is placed in service. If the error persists, the CCC reroutes the call to another channel.

PM/NM COMMUNICATION

See Figure 15 on page 49. Speech and supervision information from the network to the PM is carried in duplicate on the speech links of both planes of the network, and appears simultaneously at the plane-0 and plane-1 ports on the PM. Instructions which select the plane to be used for each speech channel, are sent to the PM from the CCC via the message channel.

Initially the speech channels are assigned so that the load is shared equally between planes, allowing the channels of both to be exercised. If a fault is detected the PM selects the alternative plane. Minimum CCC action is thus required unless the fault persists.

When the PM transmits to the NM, plane selection depends on the type of data being transmitted and its destination. Speech PCM and CSM destined for another PM are transmitted on both planes. Messages destined for the CCC are transmitted on the message channel via one selected plane. The selected plane is part of a preferred path which is determined by CCC on a per-PM basis. The plane selection is sent to each PM via its message channel.

PERIPHERAL PROCESSORS

Each of the various types of PM contains a peripheral processor (PP) function, which performs routine tasks such as signaling, supervision and handling messages between the PM and the CCC.

By performing routine processing functions, the PP relieves the load on the CCC and enables it to concentrate on higher-level activities. The PP function is performed by one or more microprocessors and associated control circuitry.

MAINTENANCE

Parity

Bit-0 of each speech channel provides a parity check over each 10-bit speech sample on the speech links. An incorrect parity condition interrupts the PP, and initiates automatic maintenance action.

Loop-around

See Figure 16 on page 50. When initiated by a maintenance program from the CCC, the receive paths of a PM can be looped around into the transmit paths, enabling test signals to be applied, the results to be analyzed, and maintenance action to be taken if necessary. A tone generator test card, located in an MTM, is accessed via network connections, and feeds known PCM samples to the PM under test. The loop-around logic returns the PCM, on the transmit path of the PM, via the network to a tone measurement card in the MTM. A comparison of the original and loop-around signals provides a test of all circuits en route. The CCC interrogates the MTM to obtain the results of the loop-around test.

Man-Machine Interface (MMI)

Communication between maintenance personnel and the DMS-100 Family system is provided by the MAP. The MAP consists of a keyboard for entering commands and a Visual Display Unit (VDU) where responses from the system are displayed on a video screen. See 297-1001-110 for details of the MAP. Non- automatic PM maintenance procedures are applied and controlled through sequences of commands and responses referred to as MMI. The MAP also displays the maintenance status of all PM in the system, or the display can be "telescoped" to concentrate on a single PM. The general principles of the DMS-100 Family maintenance system are described in 297-1001-106, while detailed MMI instructions for PM maintenance are contained in 297-1001-515.

Operational Measurements

All PM contain hardware and software elements which monitor and provide indications of the performance of all major aspects of PM operation.

Operational measurements (OM) data are provided in PMs for maintenance events. The OM Groups which provide this information are PM, PMTYP, PM1, PM2, DCM, TM, and LM. See 297-1001-114 for descriptions of these groups.

OM data can be scheduled to be printed via the logs subsystem.

Logs

The log subsystem provides reports of events occurring within the PM which are significant for maintenance or administrative purposes. The log reports are recorded, stored, and routed to selected output devices by the routing and reporting subsystem. Log reports are either printed immediately on occurrence or at specified times and intervals, depending on their urgency and priority. Alarms of various degrees of severity are also triggered when certain critical logs are output. See 297-1001-129 for details of the logs and routing and reporting subsystems. The contents of all log reports are listed in the output report

manual 297-1001-510. Log reports of PM events are identified by the letters PM followed by three digits.

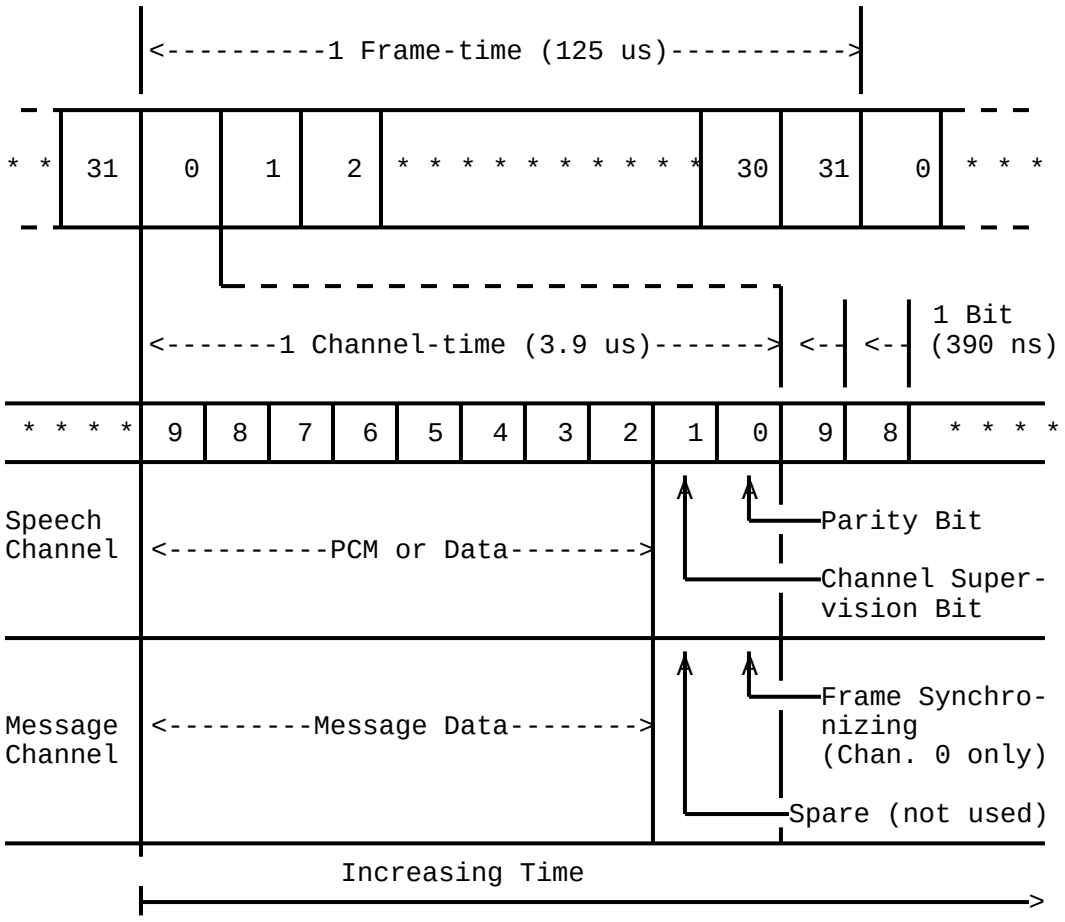


Fig. 13 - Speech and Message Data Format

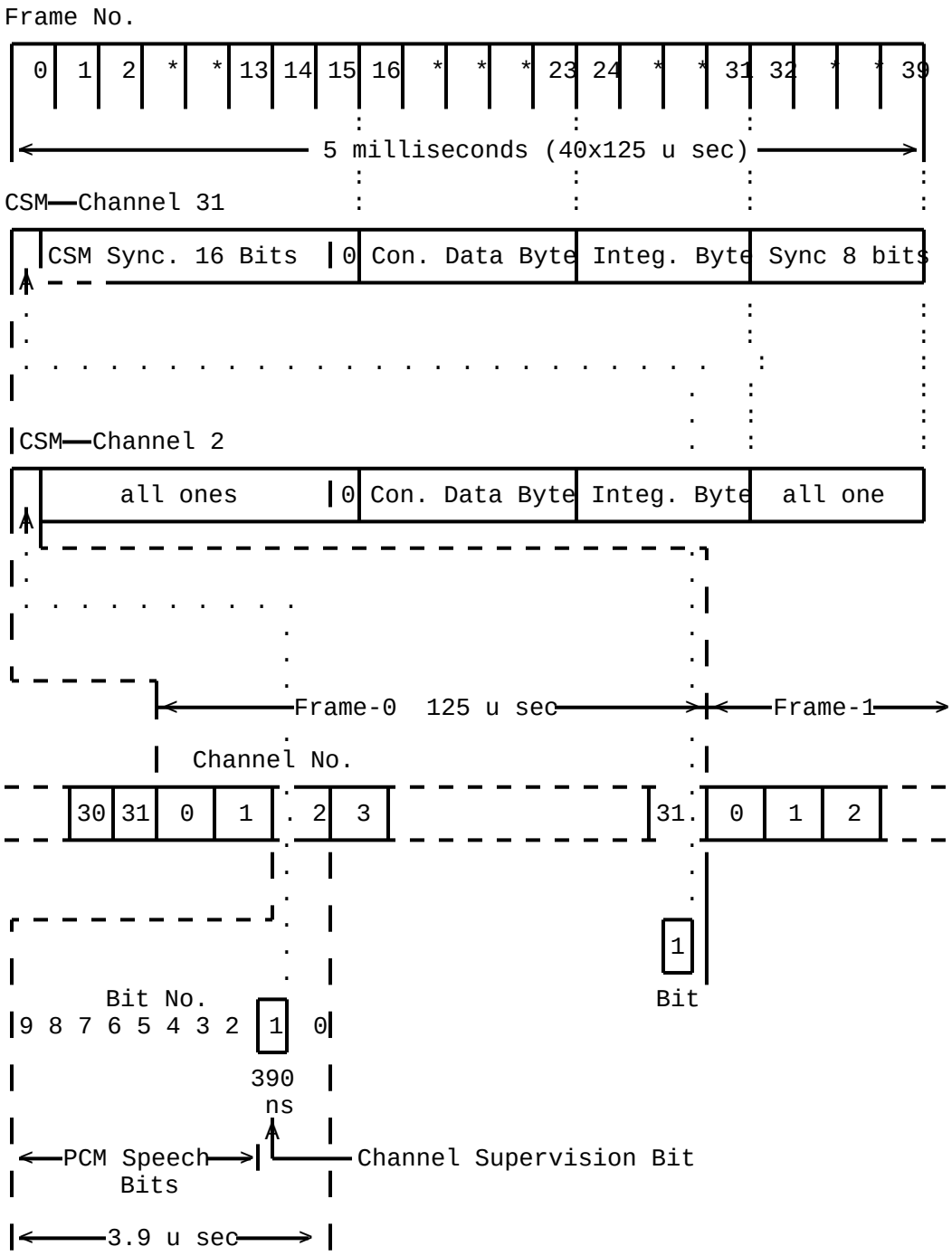


Fig. 14 - Channel Supervision Message (CSM)

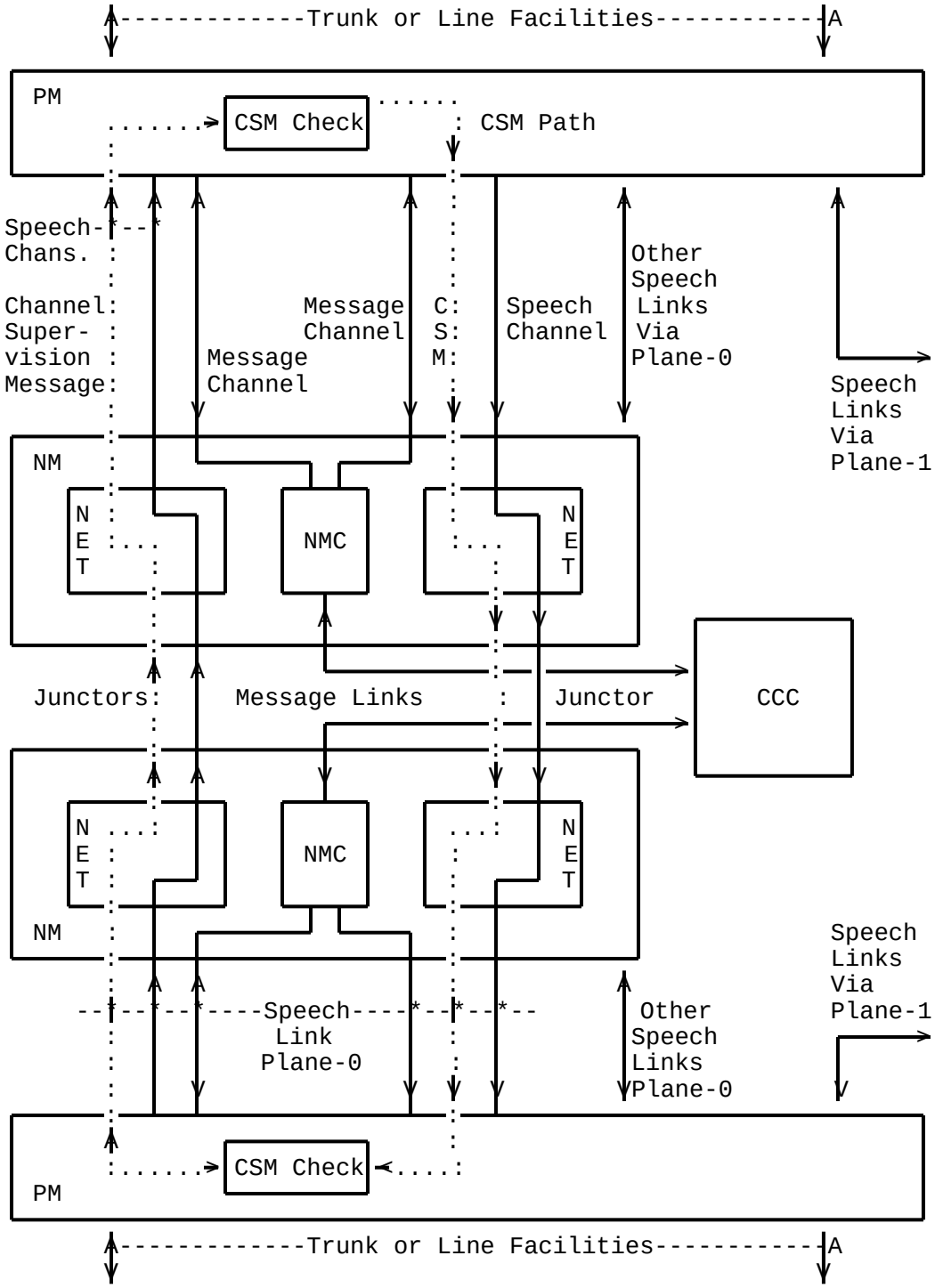


Fig. 15 - PM/NET Communication Paths

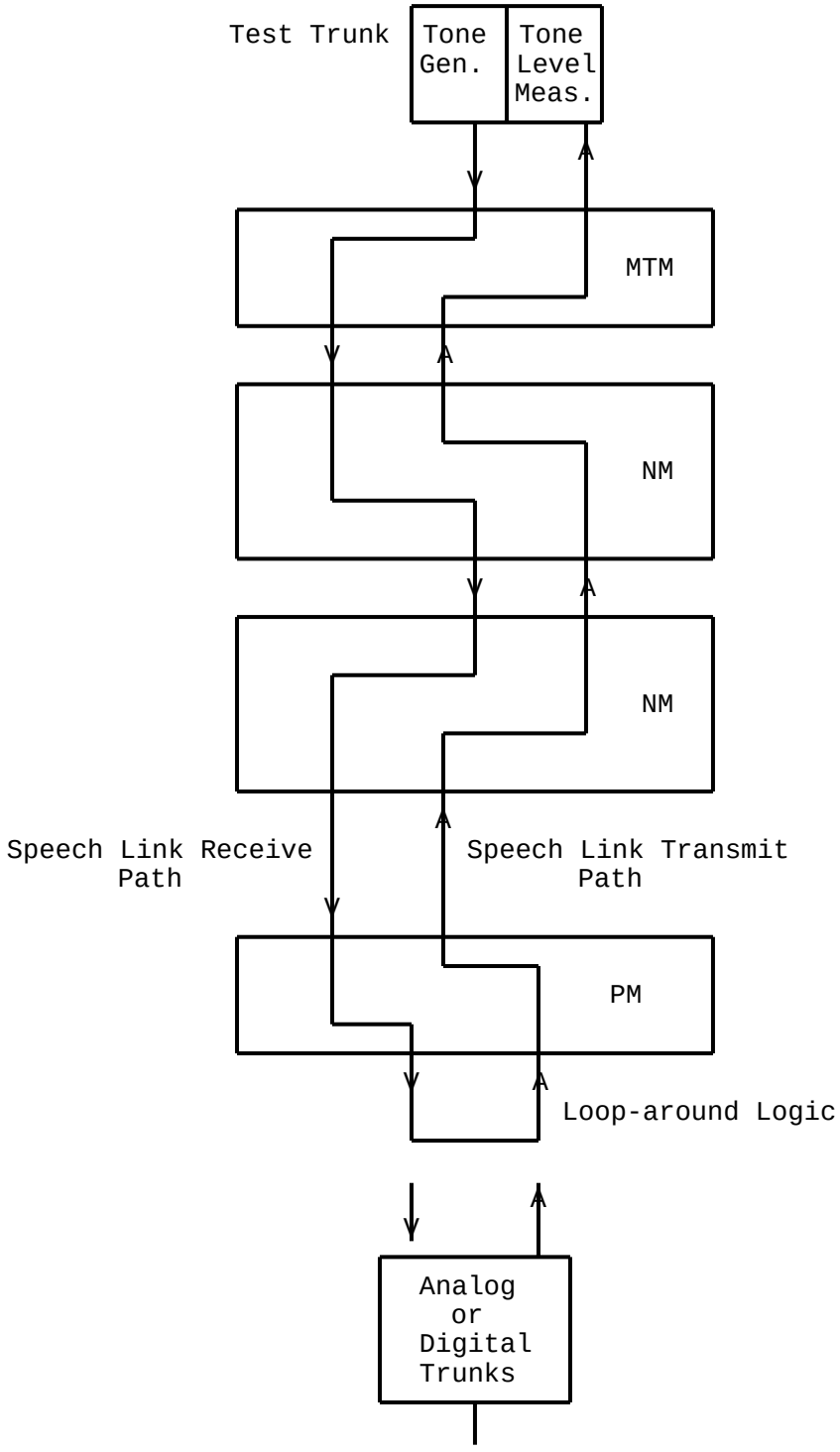


Fig. 16 - PM/NET Path for Loop-around Tests

4. TRUNK MODULE (TM)

TM OPERATION

See Figure 17 on page 52. The Trunk Module (TM) contains a common control section and up to 15 interchangeable trunk interface cards of various types. Each trunk card contains one or two trunk interface circuits, which are selected to match the speech transmission characteristics and signaling methods of the trunk facility connected to it. The various configurations of TM hardware are identified by PEC NT2X52, with a variable two character suffix.

The common control and the trunk interface circuits are linked within the TM by two pairs of common buses, one pair (XDAT/RDAT) carrying digital data, and the other pair (XPAM/RPAM) carrying Pulse Amplitude Modulated (PAM) analog speech samples. Both pairs of buses provide 30, two-way, time-division multiplexed, transmission paths.

The common control section performs four functions: network interface (with the DS30 speech links to plane-0 and plane-1 of the network); processor (PP); control; group CODEC (PCM/PAM coder/decoder). In some TM (NT2X52AE to AG), the network interface, processor, and control functions are performed by three separate circuit cards. In subsequent TM (NT2X52AM to AR), these functions are combined on a single card. In both configurations the group codec function is performed by a separate circuit card, but the principles of operation of the common control section are the same, regardless of the configuration.

The operation of the TM is described by following the path of data arriving on a speech link 'receive' channel from the NM or CCC, through to its destination in either the trunk interface circuit or PP. See Receive Path on page 53.

On the 'transmit' path, data is traced from its point of origin in the trunk interface card or PP to its transmission on a speech link 'transmit' channel to either the NM or CCC. See Transmit Path on page 53.

More detailed descriptions of the TM, and its cards is contained in 297-1001-152 which contains a complete tabulation of all available trunk interface cards with their functions, characteristics, and compatibility with other switching systems.

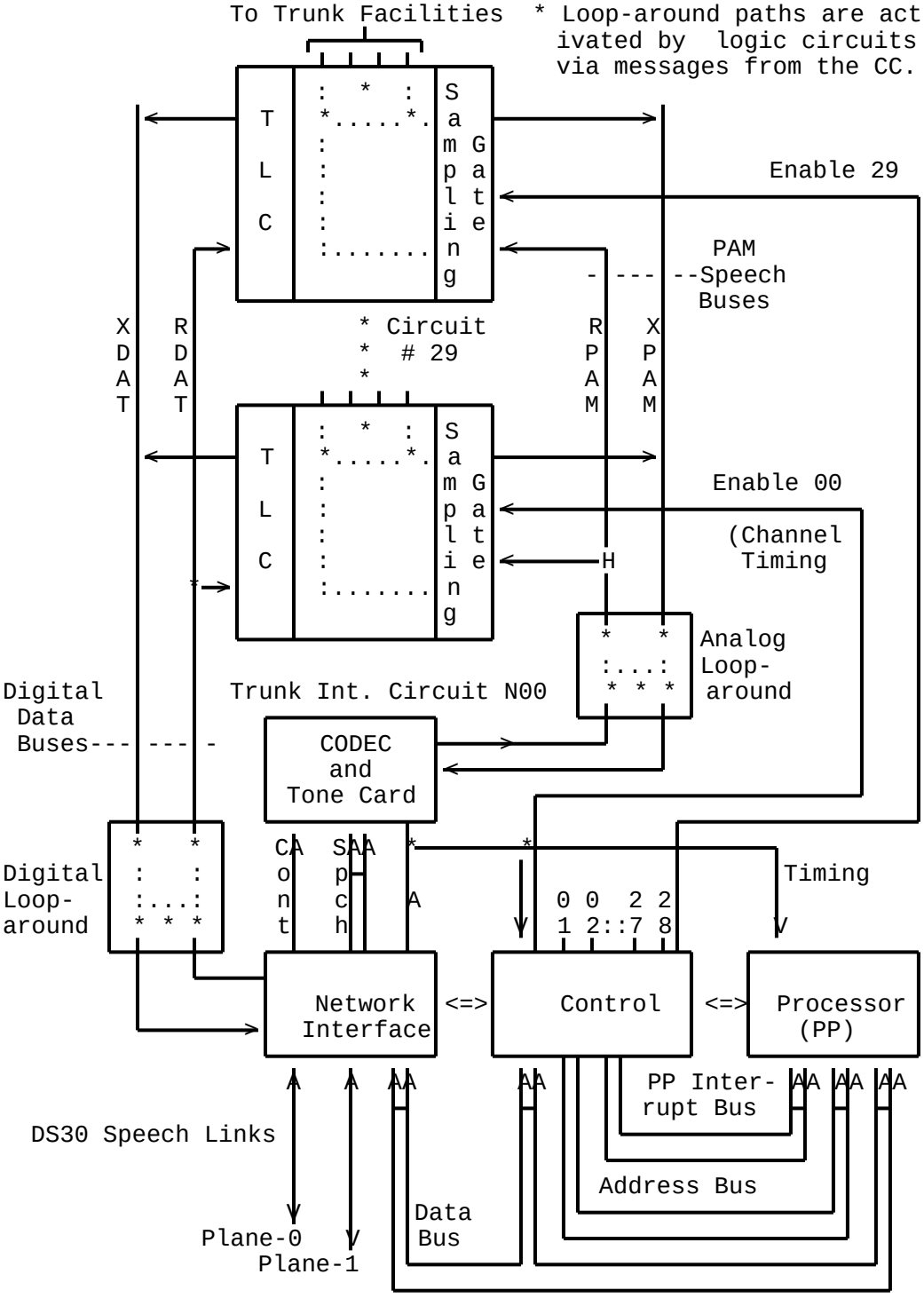


Fig. 17 - Trunk Module Block Diagram

Receive Path

Data on the 'receive' channels of the speech links from NM Plane-0 or Plane-1 enters the TM via the network interface where one of the two planes is selected for service. Data is aligned and re-formatted, and PCM speech samples are separated from control messages.

PCM speech samples undergo automatic level adjustment and are directed via the speech bus to the CODEC and Tone card, where the PCM is decoded to PAM and placed on the RPAM bus. Digital tones are inserted instead of PCM, as required. The PAM samples are applied to the sampling gate of the addressed trunk interface circuit at the appropriate channel time, as determined by the channel timing ('enable') signal from the control circuit. After filtering and level control, the original analog signal is reconstructed from the PAM samples and passes to the trunk transmission facilities.

Control messages addressed to a trunk interface circuit are placed on the digital data (RDAT) bus, and are directed to the Trunk Logic Circuit (TLC) of the addressed trunk interface circuit at the appropriate channel time reserved for data transfer. The trunk interface circuit translates the data in the TLC, referred to as Signal Distributions (SD), into supervisory signals compatible with the signaling method of the associated trunk facility.

Transmit Path

Analog speech signals from the trunk transmission facilities enter the analog side of the trunk interface circuit and, after level control and filtering, are converted to PAM samples by the sampling gate. The PAM samples from the enabled trunk circuit are multiplexed onto the XPAM bus and passed to the CODEC where they are encoded into PCM samples. Digital tones are inserted if required. The PCM samples are passed via the speech bus to the network interface.

Data for transmission from a trunk interface circuit is translated from the signaling method of the associated trunk facility into digital data which is entered into the TLC. At the appropriate channel time reserved for data transfer, these data are read out onto the XDAT bus. Data on the XDAT bus are referred to as 'Scans'.

The PCM samples and their associated data are combined and reformatted into a data stream which is placed on the speech link 'transmit' path.

Message Handling. The 'receive' message channel of the speech links carries instructions from the CCC to the Peripheral Processor (PP) of the TM, while the 'receive' speech channels carry the CSM. These messages are separated from the speech samples and SD data, and routed to the control circuit and PP via the Data bus.

Responses from the PP to messages from the CCC, and transmission of the CSM are handled by the control circuit and passed via the data bus to the network interface for insertion on to the speech link 'transmit' message channel. The CSM is inserted into the appropriate speech 'transmit' channel.

The control circuit organizes the flow of incoming and outgoing messages in accordance with the DMS-100 Family I/O message protocol, and ensures that the PP capability is properly allocated. Communication between the control circuit and PP is via the data and address buses. The PP interrupt bus is used to stop routine processor operation when priority operations such as call processing are required.

Operation of the common control is coordinated via the control bus linking the four functions, and by a timing signal derived from the DS30 speech link, which is distributed to all common control circuits.

Loop-around Facilities. Both digital and analog loop-around facilities are provided in a TM. For digital loop-around, the RDAT bus is looped into the XDAT bus,while the RDAT/XDAT connections to the TLC in the interface circuits are opened. For analog loop-around, the RPAM bus is similarly looped into the XPAM bus. Loop-around circuits are also provided in each trunk circuit so that per-channel loop-around tests can be applied by addressing the appropriate trunk circuit via its TLC. Loop-around paths are activated by messages from the CCC acting on the logic circuits in the appropriate card.

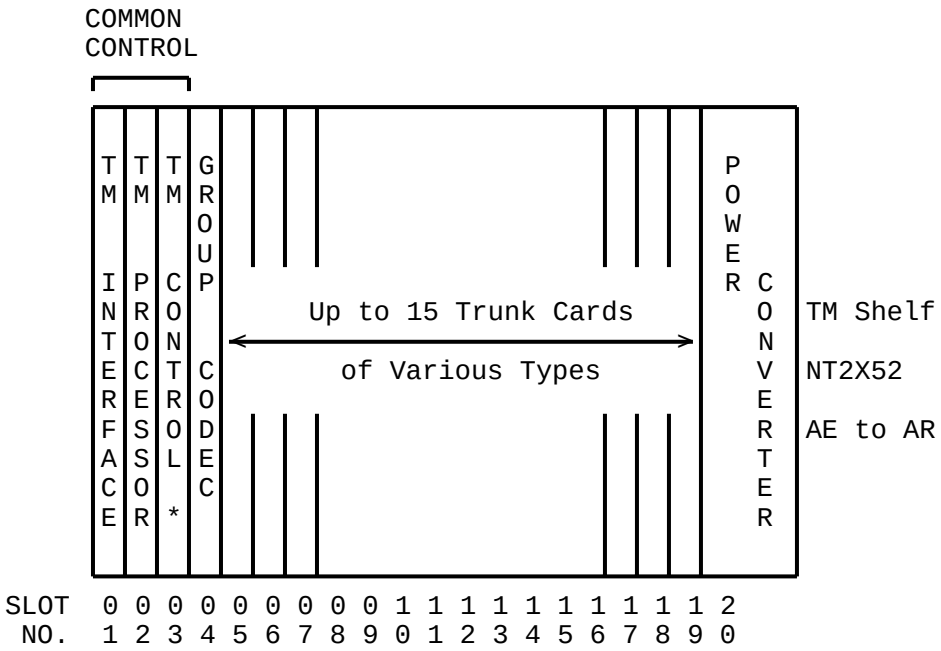
SHELF LAYOUT

See Figure 18 on page 56. Viewed from the front, a TM shelf has a number of vertical slots into which cards are inserted, and plugged into connectors at the back panel of the shelf. The vertical slots are identified by card position numbers from 01 at the left. The first four card positions are assigned to the common control and the next 15 positions to the trunk interface cards. The last positions are occupied by a power converter card.

If the TM product code is NT2X52AE to AG, the common control section card configuration is as shown in Figure 18 on page 56. If the TM product code is NT2X52AM to BD, there are no cards in slots 01 and 02, and slot 03 contains the combination TM control card.

Trunk interface cards usually contain two trunk interface circuits per card, although some cards may have only one circuit or more than two. Details of the identification scheme used to relate card positions to the trunk interface circuits are contained in 297-1001-120.

Trunk modules are also identified by the number of wires required to connect each trunk interface circuit to the trunk facilities. Thus, a TM whose connections to the trunk facilities are cabled for 2-wire trunks, is referred to as a TM2. Designations TM4 and TM8 are given to 4-wire and 8-wire trunk modules respectively. Typical connections to various types of TM are contained in 297-1001-151.



Slot	NT PEC	Remarks
01	2X45AB	TM Interface (to Network)
02	0X70AA	TM Processor
03	2X53AA	TM Control
03	4X65AB	* TM Control Card. For TM NT2X52AM to AR, slots 01 and 02 are vacant, and this card is installed in slot 03.
04	2X59AA	Group CODEC
05 to 19	—	Trunk Circuit Cards. Selected as required. See 297-1001-152 for details of trunk circuit selection.
20	2X09AA	Power Converter, Multi-Output

Fig. 18 - Trunk Module: Shelf Layout and Card Complement (Front View)

5. MAINTENANCE TRUNK MODULE (MTM)

GENERAL

The Maintenance Trunk Module (MTM) connects speech link channels from the Network Modules (NM) through to channels on one of the test circuit cards or service circuit cards installed in the MTM. In addition the MTM acts as a switching center for control messages exchanged between the DMS Central Control Complex (CCC) and individual test or service circuit cards.

Internally the MTM provides:

- direct data exchange between test circuit cards
- the low voltage feeds required to power the test and service circuit cards.

The various configurations of MTM hardware are identified by PEC NT2X58 with a variable two character suffix.

MTM CONFIGURATION

The MTM contains:

* the same network interface, processor and control card(s) and the circuits used in the TM (to make and maintain connections)

* two buses (Maintenance 1 and 2) to permit direct data exchange between test circuit cards without using XDAT or RDAT buses

* two power converter cards (one more than the TM)

* up to twelve service or test circuit cards

The internal configuration of the MTM is shown in Figure 19 on page 59. Additional technical information about the MTM is given in GS2X58.

MTM OPERATION

All MTM circuits except for the MAINT buses operate in the same way as those of the TM (see Part 4 on page 51). The configuration of the MTM shelf has two versions identified by the PEC suffix:

* MTM having PEC NT2X58AC use three separate cards for the common control functions in slots 01, 02 and 03.

* MTM having PEC NT2X58AL use the single combination control card in slot 01 enabling slots 04-16 to be relocated two positions to the left (as slots 02-14). Slots 15 and 16 become extra slots allowing two extra test or service cards to be provisioned.

Typical test circuit cards making use of the MAINT buses are the PCM Level Meter (PLM) card and the Test Signal Generator (TSG) card. The PLM card contains circuits for measuring the level and frequency of PCM samples of analog voice frequencies or tones. The level meter and frequency meter circuits in the PLM operate in conjunction with the TSG card, which contains separate signal generator and filter circuits.

Details of these test circuit cards are contained in GS2X96 (PLM) and GS1X90 (TSG). To use the test circuits within these cards, and to apply them in various combinations to the RDAT, XDAT and MAINT buses, control codes are sent to the SD points in the TLC of each card. Also, cards used in such a combination, share the same 'enable' signal instead of being separately enabled as for an individual trunk circuit.

The proper combinations of control codes at the SD points and 'enable' signals, are provided by maintenance programs in DMS software acting through messages from the CCC via the message channel and common control cards in the MTM.

The MTM shelf layout and circuit card complement is illustrated in Figure 20 on page 60.

SERVICE TRUNK MODULE

General

The Service Trunk Module (STM) is a reduced-size MTM. One shelf can contain two STM. Each STM operates independently of the other, and is actually a separate PM with its own set of common control cards and speech links to the network.

There are two STM configurations:

* the configuration used in the DMS-250 (identified by PEC numbers commencing with NT7X30) where the power to both STM in a shelf is supplied from two "shared" power converters (one with multiple outputs and one supplying +/-5 volt and +/-12 volt power)

* the configuration used in the DMS-100 (identified by PEC numbers commencing with NT1X58) where each configuration has its own power converter supplying +/-5 volt and +/-12 volt power.

The function and operation of the STM duplicate those of the MTM with some limitations.

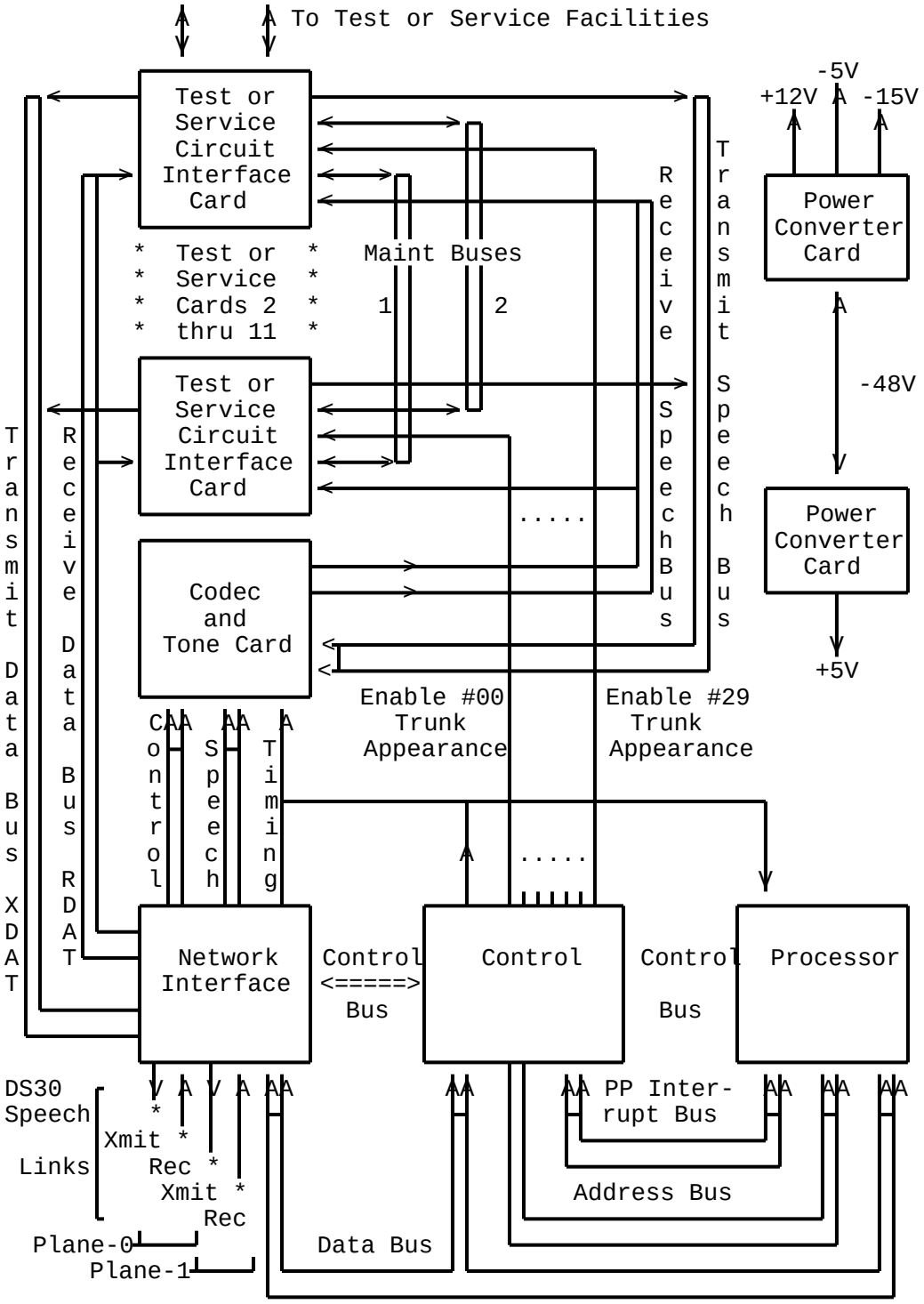
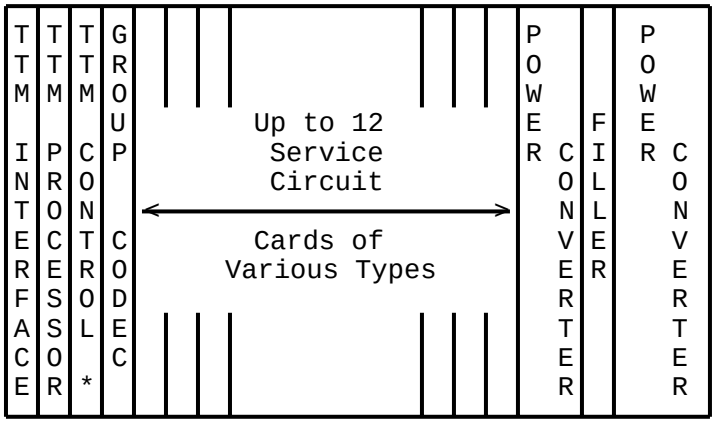
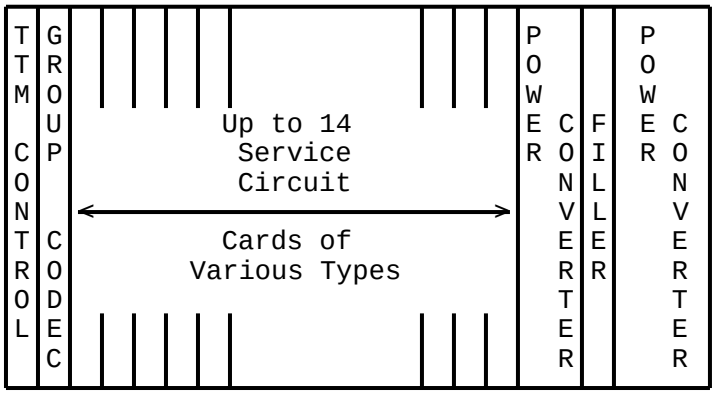


Fig. 19 - Maintenance Trunk Module (MTM) Block Diagram



SLOT NO.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20

Slot	NT PEC	Remarks	
01	2X45AB	TM Interface (to Network)	COMMON CONTROL
02	0X70AA	TM Processor	
03	2X53AA	TM Control	
04	2X59AA	Group Codec	
05 to 16	—	Service Circuit Cards. Selected as required. See 297-1001-450/33 for details of trunk service circuit provisioning.	
17,18	2X09AA	Power Converter	
19	0X50AA	Filler Panel	
20	2X06AB	Power Converter.	



SLOT NO.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20

In the AL version, a single TM control card (4X65AB) is used

Fig. 20 - Card Locations in Maintenance Trunk Module Shelf

The limitations on the provisioning of the STM are:

* a maximum of 5 service cards in the NT7X30 configuration and a maximum of 6 or 7 in the NT1X58 configuration.

* only service cards (without external connections)

* only service cards with +/-5 volt and/or +/-12 volt power requirements (applies to NT1X58 configuration only)

STM Shelf Layout (NT1X58 version)

The NT1X58 version of the STM shelf is divided into two STM modules, each module being a separate STM. Slots 01-11 contain STM-0 (max. 7 test or service cards). Slots 12-20 contain STM-1 (max. 6 test or service cards)

The arrangement of the circuit cards in the NT1X58 version of the STM shelf is (from left to right) as follows:

* Slots 01 to 03.

  Contain the power converter for STM-0 supplying +/-5 volt and +/-12 volt power to the STM-0 test and service cards in slots 04-08.

* Slot 04.

  Contains the combination control card which performs the Interface (to the network), Processor and Control functions for STM-0.

* Slots 04 to 11.

  Contain up to seven service circuit cards which are operated by the control card in slot 04.

* Slots 12.

  Contains the combination control card which performs the Interface (to the network), Processor and Control functions for STM-1.

* Slots 13 to 18.

  Contain the set of six STM-1 service circuit cards which are operated by the control card in slot 12.

* Slot 19.

  Contains a filler panel (not used)

* Slots 20 to 22.

Contain the power converter for STM-1 supplying +/-5 volt and +/-12 volt power to the STM-1 test and service cards in slots 13-18.

Standard Card Fill for STM (NT1X58 Version)

NT PEC	QTY	POSITION	FUNCTION
4X65	2	4,12	TM Controller
2X70	2	1,20	Power Converter +/-5V, +/-12V

Provisional Cards for STM (NT1X58 Version)

The NT1X58 version of the STM can be provisioned with any of the cards in the following list. The position column indicates the card slots into which each card may be inserted.

NT PEC	POSITION	FUNCTION	
2X48	5-13,13-18	4-Channel DTMF or MF Receiver	
3X67	5-8,10,13-16,18	6-Port Conference Circuit	
3X68	5-11,13-18	Tone Generator - PRMT/PST/CONF	
5X29	5,13	Digital Tone Detector and sender	
1X31	5-8,10,13-16,18	3-Port Conference Circuit	
1X00	5-11,13-18	102 Test Trunk or Receiver Off-hook Tone	
1X90	6,8,10,14,16	Test Signal Generator	
2X96	7,9,11,15,17	PCM Level Meter	
2X47	6,8,10,14,16	Transmission Test Controller	Transmission Test Unit
2X56	7,9,11,15,17	TTM Digital Filter	
2X75	5-11,13-18	Loop Around Test Line	
3X02	6,8,10,14,16	Control Processor	TOPS Control
3X03	7,9,11,15,17	Digital Signal Processor	

STM Shelf Layout (NT7X30 Version)

The arrangement of the circuit cards in the NT7X30 version of the STM shelf is (from left to right) as follows:

* Slots 01 to 03.

  Contain a set of three common control cards, similar to those in the MTM shelf layout (Figure 20 on page 60). In some versions, slots 01 and 02 are vacant, and the combination control card which performs all three functions is installed in slot 03.

* Slots 04 to 08.

  Contain up to five service circuit cards which are operated by the control cards in slots 01 to 03.

* Slots 09 to 11.

Contain another set of common control cards for the second MTM function.

* Slots 12 to 16.

  Contain a second set of five service circuit cards which are operated by the control cards in slots 09 to 11.

* The remainder of the shelf is occupied by two power converters which supply various regulated power supplies for both MTM functions in the STM.

PACKAGED TRUNK MODULE

The Packaged Trunk Module (PTM), PEC NT7X3501, is a repackaged version of the MTM. The PTM is used in packaged DMS switches, especially the DMS-250, functions the same as the MTM, and runs on present MTM maintenance software.

6. OFFICE ALARM UNIT (OAU)

GENERAL

The Office Alarm Unit (OAU) has the same basic circuitry as the MTM (see Part 4), but is equipped with circuit cards to interface with office alarm circuits of various types, instead of test or trunk circuits.

SHELF LAYOUT

Figure 21 on page 65 shows an example of a typical OAU shelf containing:

* SD cards, which provide an interface between SD points on the TLC and external relay-controlled equipment

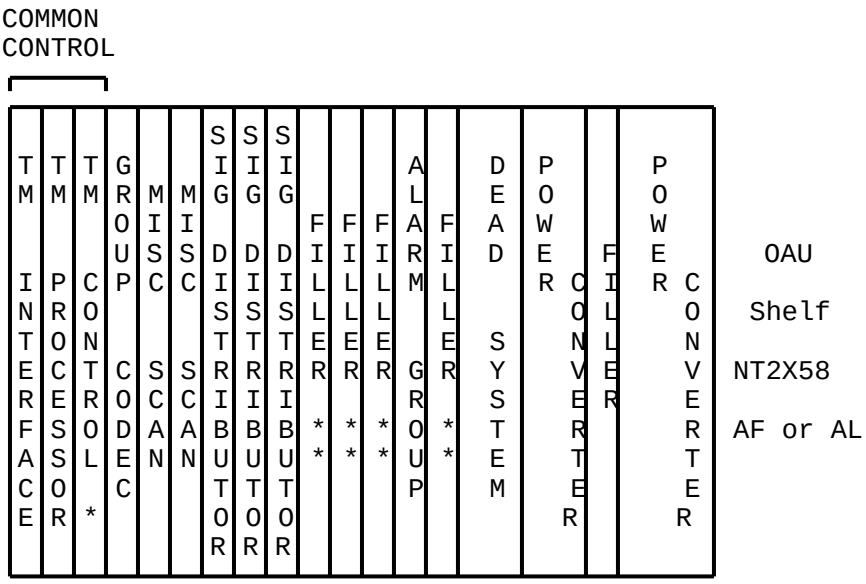
* Scan cards, which detect external contact states and convert them to TLC scan states and

* office alarm circuits, which interface with visual and audible alarms.

The selection of OAU cards to fill slots 05 to 16 is a function of the office engineering process. The rules for provisioning an OAU shelf are described in 297-1001-450/33. The card complement for this part of the OAU shelf varies to suit individual office requirements.

For details of the function of the OAU and MTM within the DMS-100 alarm system, refer to 297-1001-122.

Circuit/card position identification methods peculiar to the OAU are described in 297-1001-120.



Slot	NT PEC	Remarks
01	2X45AB	TM Interface (to Network)
02	0X70AA	TM Processor
03	2X53AA	TM Control
03	4X65AA	* TM Control Card. For OAU NT2X58AL, slots 01 and 02 are vacant, and this card is installed in slot 03.
04	2X59AA	Group Codec
05,06	0X10AA	Miscellaneous Scan Card.
07-09	2X57AA	Signal Distributor Card I.
10-12, 14	0X50AC	** Filler Panels. May be replaced by service circuit or alarm cards as required. See 297-1001-450/33 for details of OAU provisioning.
13	3X85AA	OAU Alarm Group
15,16	3X82AA	OAU Dead System
17,18	2X09AA	Power Converter
19	0X50AA	Filler Panel
20	2X06AB	Power Converter.

Fig. 21 - Office Alarm Unit: Typical Shelf Layout and Card Complement

7. DIGITAL RECORDED ANNOUNCEMENT MACHINE (DRAM)

GENERAL

The Digital Recorded Announcement Machine (DRAM) is a specially-equipped MTM. In the DRAM the service circuit cards are replaced by a special group of cards referred to as a DRAM unit. Also the inter-card bus links the first ten card slots instead of the odd-even slot inter-card connections on the MTM.

There are two versions of the DRAM corresponding to the two versions of the MTM described in Part 5 on page 57:

* the DRAM identified by PEC NT2X58AG (corresponds to MTM NT2X58AC)

* the DRAM identified by PEC NT2X58AM (corresponds to MTM NT2X58AL)

There is also a reduced size version of the DRAM which corresponds to the STM described in Service Trunk Module on page 58. The STM version of the DRAM is identified by PEC NT1X58AC and corresponds to STM NT1X58AA. Two STM are configured in a single MTM shelf. Only the left-most STM (STM-0) can be provisioned as a DRAM.

The shelf layout and card complement for the NT2X58 versions of the DRAM is shown in Figure 22 on page 68.

DRAM CONTROL SECTION

The same TM control section (Interface, Control, Processor and Codec) used in the corresponding version of the MTM, makes and maintains the connections to/from the network in the DRAM implementation.

DRAM UNIT

Configuration

The DRAM unit consists of one DRA controller card, and a number of Programmable Read-Only Memory (PROM), Electronically-Erasable PROM (EEPROM), and random access memory (RAM) cards. The DRA controller card, and at least one PROM and RAM card are the minimum complement. The maximum number of PROM and RAM cards can never exceed eight, but can be mixed in any manner. An MTM for DRAM service is also equipped with a special configuration of its MAINT buses which allows maximum interface between the DRA controller and a full complement of eight memory cards.

Cards and Operation

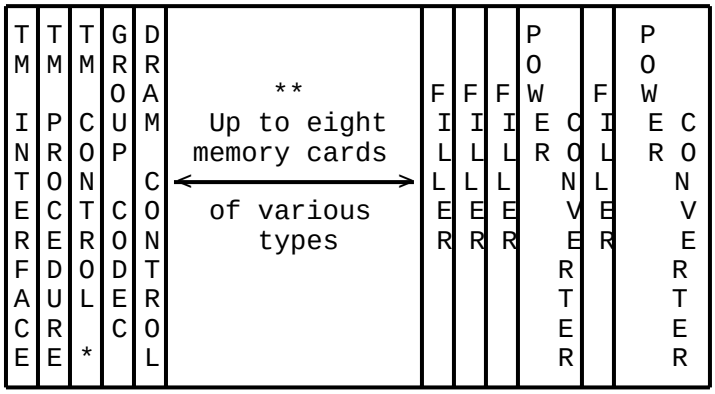
DRA Controller. This card controls reception and transmission of CCC messages addressed to the DRAM unit via the MTM common control. It also selects and retrieves recorded announcements and phrases from the PROM or RAM cards and transmits them on designated speech link channels. It handles the recording of new announcements, and assigns them to an appropriate section of memory. The controller is configured manually by switches to function as a 8, 16, 24 or 30 - channel speech interface.

PROM Card. The PROM card contains standard pre-recorded announcements in digital form, which are programmed into the PROM during the manufacturing process. These announcements cannot be altered, extended or erased. The card identification code indicates the type of announcements in the PROM, and the language of the recorded speech.

RAM Card. The RAM card provides storage for on-site recording of announcements directly via a network connection and a PCM speech channel.

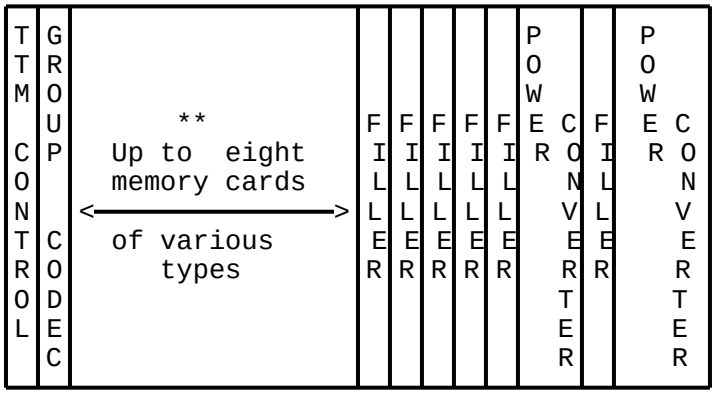
EEPROM Card. Provides storage for on-site recording of announcements, but retains memory, even if the card is removed, until electrically erased.

Control. Each ROM or RAM card has sufficient memory storage for up to 31 seconds of speech. The selection of announcements and phrases from the memories and their coordination into complete announcement messages is performed automatically by the DRA controller on instructions from the CCC. Manual control for maintenance purposes or for making new recorded announcements is performed via the MAP, using MMI procedures. Detailed instructions for the proper commands necessary to run diagnostic tests, and to record or erase speech are contained in the DRAM Maintenance Reference Manual 297-1001-527.



SLOT NO. 0 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 1 0 1 1 1 2 1 3 1 4 1 5 1 6 1 7 1 8 1 9 2 0

Slot	NT PEC	Remarks	
01	2X45AB	TM Interface (to Network)	CONTROL COMPLEX
02	0X70AA	TM Processor	
03	2X53AA	TM Control	
04	2X59AA	Group Codec	
05	1X75BA	DRA Controller	
06	1X76aa	PROM Card. Suffix aa selects announcement type.	
to	1X77AA	RAM Card	
13	1X79AA	EEPROM Card. ** See 297-1001-527 DRAM reference manual, and 297-1001-450/33 DRAM provisioning	
14-16	0X50AC	Filler Panel	
17,18	2X09AA	Power Converter	
19	0X50AA	Filler Panel	
20	2X06AB	Power Converter.	



SLOT NO. 0 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 1 0 1 1 1 2 1 3 1 4 1 5 1 6 1 7 1 8 1 9 2 0

In the AM version, a single TM control card (4X65AB) is used

Fig. 22 - DRAM: Shelf Layout and Card Complement

8. DIGITAL CARRIER MODULE (DCM)

GENERAL

The purpose of the Digital Carrier Module (DCM) is to convert the 8-bit 24-channel DS1 digital signal to the 10-bit, 32 channel DS30 digital format, and vice-versa. The DCM also interfaces the A/B bits signaling method of the DS1 links with the SD/Scan methods of the DMS-100 System. The various configurations of DCM hardware are identified by PEC NT2X31 with a variable suffix (aa).

DCM TYPES

Three configurations of DCM are available. The DCM-B configuration (NT2X31AH,AJ) provides the basic functions described in the previous paragraph. The DCM-S configuration (NT2X31AE) provides the basic functions, but also contains additional circuitry for a clock synchronization feature. The DCM-R configuration (NT2X31AF,AG) is specially equipped to interface, via up to four DS1 carrier systems, with a Remote Line Module (RLM), or with various combinations of RLM links and digital trunks, or with digital trunks only, up to a total of five systems. The DCM-R can also support the clock synchronization feature, if suitably equipped. Refer to Part 12 for details of the RLM.

DCM OPERATION

This description is applicable to all DCM configurations. See Figure 23 on page 70. The DS1 speech channels on the DS1 links are assigned to an equal number of DS30 channels according to an algorithm which distributes the channels evenly over the four speech links to the network.

Up to five DCM interface cards provide interfaces between the five DS-1 facilities and the DCM, while the network card interfaces with the four speech links (per plane) to the DMS network. The DCM interface cards and the network interface card are interconnected via a bi-directional, 2.56 Mb/s speech bus, having four paths in each direction. Each 2-way path is associated with one of the four duplicated speech links.

Common control for the DCM is performed by the control, PP message processor, tone, and signaling cards, which are themselves under control of the DCM processor.

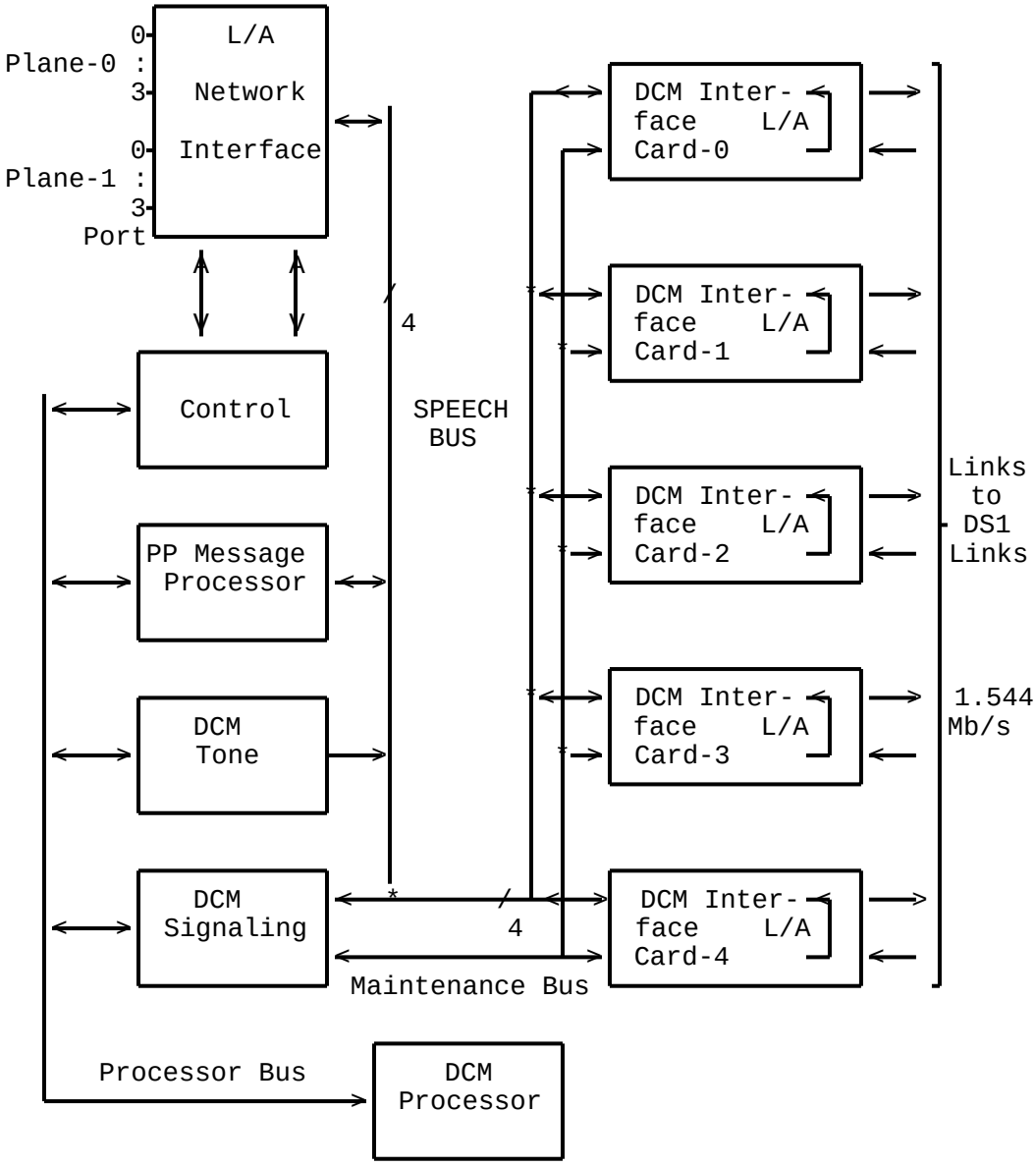


Fig. 23 - Digital Carrier Module (Basic) (DCM-B) Block Diagram

The speech bus provides access for the insertion and extraction of tones (tone card), A/B bits (signaling card), CSM (PP message processor card), on the appropriate paths and channels in accordance with the assignment algorithm and bit mapping.

The maintenance bus, linking the DCM interface cards and the signaling card provides a separate path for monitoring the performance of the DS1 channels. Conditions detected are: slips, re-framing, sustained loss of synchronization, bipolar violations

and remote alarms. A 'card present' signal is also provided for each DS1 line card. This maintenance information is communicated to the DCM processor via the signaling card. Abnormal conditions and alarms are reported via a message to the DMS maintenance system.

Two loop-around (L/A) functions are provided, one in the network interface card and the other in the DCM interface cards. The network L/A loops the eight speech bits of each 'receive' channel into the corresponding 'transmit' channels, and includes the speech bus, tone and signaling circuits in its path. The DCM interface L/A loops all 24 channels within each card, thus checking the internal transmit and receive paths, and isolating the circuits to the DS-1 facilities.

Detailed descriptions of the functions of each card in the DCM, and illustrations of the channel assignment algorithm and bit mapping between DS30 and DS1 are contained in GS2X31.

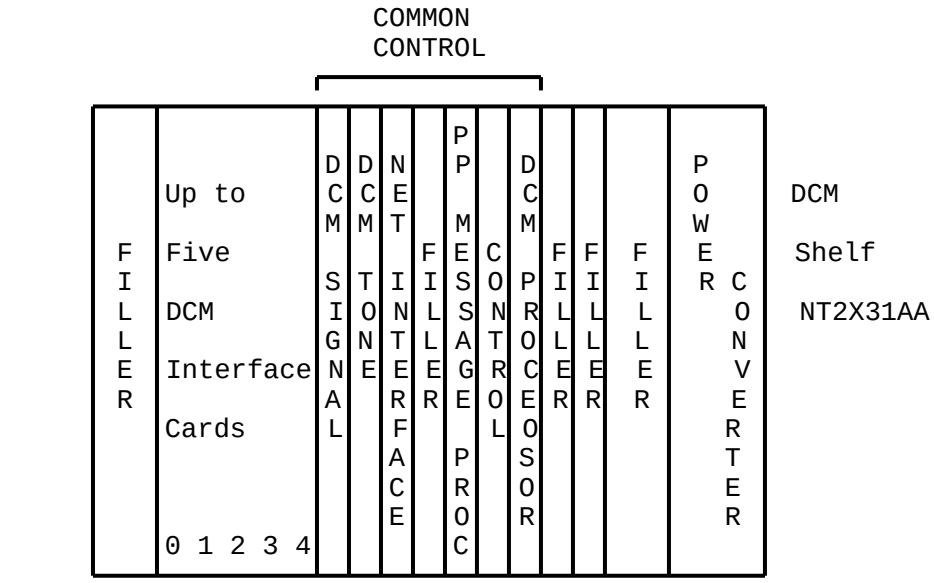
DCM SHELF LAYOUT

See Figure 24 on page 72. In the DCM shelf, the DCM interface cards occupy slot positions 03 through 07, the five common control cards positions 08, 09, 12, 13 and 14 and the network interface card, position 10. The power converter occupies position 19.

Methods of identifying a DS1 channel with respect to a circuit number and card position number in a DCM are described in 297-1001-120.

DCM-S OPERATION

In addition to the circuitry previously described for the DCM-B operation, the DCM-S contains other circuits which compare the internal DCM-S frame pulses with those derived from another DCM in an office equipped with a master clock. Any slip between the two frame pulses is used to keep the "slave" synchronized to the master clock.



Slot	NT PEC	Remarks
01,02	0X50AE	Filler Panels
03 to 07	2X35AB	DCM Interface (DS1 Line Cards)
08	2X38AB	DCM Signaling
09	2X37AB	DCM Tone
10	2X36AA	Network Interface
	2X36AB	Network Interface with XPCM suppression facility.
11	0X50AC	Filler Panel
12	2X34AA	PP Message Processor
13	2X33AB	Control
14	2X32AA	DCM Processor
15,16	0X50AC	Filler Panels
17,18	0X50AE	Filler Panel
19	2X70AA	Power Converter, Multi-Output.

Fig. 24 - DCM: Shelf Layout and Card Complement

Refer to Figure 25 on page 73. The master office clock consists of a specially-equipped and wired Central Message Controller (CMC). The master office is provided with a DCM-B, one of whose DS1 links, is used to transmit the master clock signal to a DCM-S in the slave office. The slave office, in turn can pass the synchronized clock signal, via another of its DCM to a second slave

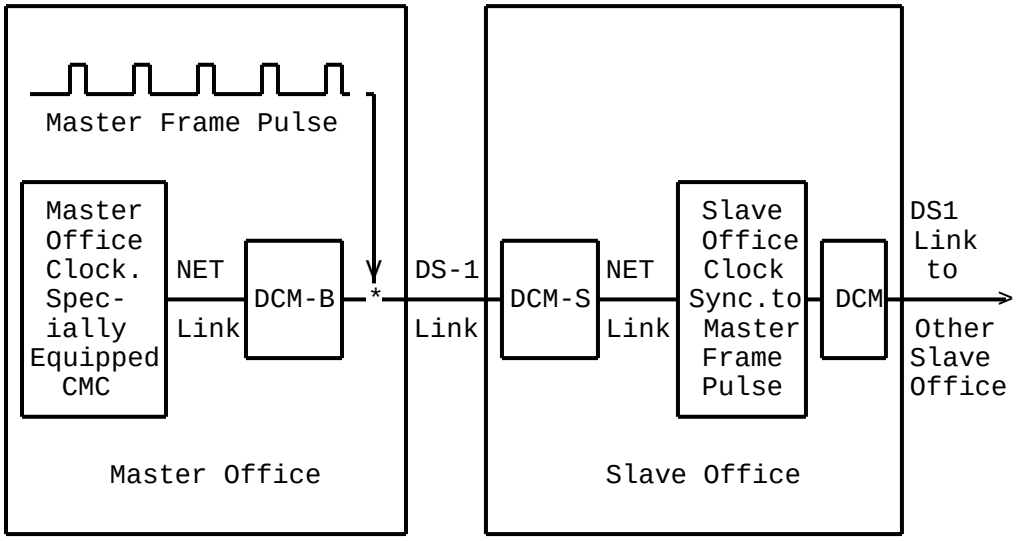


Fig. 25 - DCM-S: Master/Slave Clock Signal Flow

office. The master clock synchronization feature is activated when the appropriate software for this feature is loaded. When the software is not present, the feature is not activated, and the DCM-S operates independently (like a DCM-B) using its own clock. See 297-1001-130 for details of the synchronous clock system.

DCM-R OPERATION

Figure 23 on page 70 is also applicable to the DCM-R, with respect to the flow of signals on the speech, maintenance and processor buses. The difference is in the signaling and tone cards which, in addition to the circuitry previously described for the DCM-B and DCM-S, contain other circuits used when operating with an RLM (see Part 12).

Refer to Figure 26 on page 76. DCM-R are provisioned in pairs, each DCM-R is assigned to operate with one of the two PP in an RLM double-bay frame. This description refers to either one of the pair of DCM-R. All DS1 links between one bay of an RLM and a DCM-R must terminate on the same DCM-R.

The DCM-R provides paths for the High-Level Data Link Control (HDLC) Common Channel Signaling required to interface with the HDLC message processor in the PP of the RLM. See GS2X14 for details.

Slot position 03 is reserved for DCM interface card-0, with one channel assigned to be the primary HDLC message path between the DCM-R and the associated PP in the RLM bay. The other 23 channels on this DS1 line carry PCM speech samples. The DCM interface card-1 (in slot position 04), if used as an RLM link, has a

channel assigned to be the spare HDLC message path. The spare path is automatically switched in if the primary path does not function. The other 23 channels carry PCM speech samples.

DCM interface cards 2, 3 and 4 are located in slot positions 05, 06, and 07 respectively. Each carries 24 PCM channels between either an RLM bay or channel or DS1 channel bank equipment, depending on office requirements.

In RLM operation, the DCM processor in the DCM-R handles command interpretation of CCC messages addressed to the DCM itself in the same way as in a DCM-B. CCC messages addressed to the RLM, however, are not interpreted but are routed to the signaling card, where they are embedded in their entirety as the information portion of a message signaling unit to the associated RLM. The HDLC circuits route the message signaling unit via the primary or spare DS1 link to the HDLC processor in the RLM PP, where the command is interpreted and appropriate action taken within the RLM. HDLC message units in the reverse direction from RLM to CCC travel via the same route.

Since the HDLC path is used for RLM/DCM-R communication, the A and B bit signaling, used by the DS1 channel banks, is not required and is suppressed whenever a DS1 system is assigned to RLM service. Any DS1 systems assigned to channel bank service do not have A and B bits suppressed, and function the same as a DCM-B.

The CSM bits, between the CCC and the DCM-R, are received and sent continuously by the DCM processor card. On DS1 lines in RLM service, the CSM information is not communicated to the RLM as long as no change occurs in the CSM bits. If any of the CSM bits change (e.g. integrity set-up or failure, changes in signaling status), the occurrence is communicated to the RLM on the HDLC path.

DIGITAL ECHO SUPPRESSOR (DES)

See Figure 27 on page 77. The Digital Echo Suppressor (DES) module is a voice-operated device which monitors the levels of digital speech signals on the transmit and receive paths between interconnected trunk circuits. The DES automatically applies attenuation whenever necessary, to reduce echo effects on long distance trunk circuits.

The DES is physically a DCM-B shelf, using the same common control card configuration and circuitry, but the five DS1 line cards have been replaced by six DES service circuit cards, located in slot positions 02 to 07. DES hardware is identified by PEC NT2X12AD.

Refer to Figure 28 on page 78. The DES service circuits are connected as required between near and and far trunks, via network connections set up by the CCC. The set of receive and send paths

between the DES and the far trunks are referred to as the FAR channels. The corresponding set of receive and send paths between the DES and the near trunks are referred to as the NEAR channels.

The DES service circuits sense when echo suppression loss for each channel should be applied, and insert attenuation between the associated FAR and NEAR channels. FAR receive (incoming) channels pass through the DES to NEAR receive (outgoing) channels. NEAR send (incoming) channels pass through the DES to FAR send (outgoing) channels. The channels are delayed as they pass through the DES, to allow for processing time. A similar delay occurs between FAR and NEAR channels on the receive side.

Two classes of digital echo suppression are available, full (duplex) or split (half duplex). In the duplex mode of operation, attenuation is inserted in the send and receive paths between the near and far trunks. In the half-duplex mode, the send path only is attenuated. Duplex operation is used on trunks where the total round-trip delay is less than 70 msec. Half-duplex operation is used for applications where the total round-trip delay exceeds 70 msec. Full or half-duplex operation is selected on a per-channel basis by manual switches on each DES service circuit card. Refer to GS3X65 for details of the DES card and to GS2X12 for details of the DES shelf.

A fully-equipped DES module can provide echo suppression for up to 45 two-way transmission paths (90 channels). DES cards located in even-numbered slot positions are assigned to handle eight receive and eight send channels per card. DES cards located in odd-numbered shelf positions are assigned to handle seven receive and seven send channels per card. When all DES cards are provisioned, the total channel capability is: 24 (3 X 8) + 21 (3 X 7) = 45 channels-send, and 45 channels-receive. See Figure 29 on page 79 for details of the relationship between the three network ports, the DES shelf and the channels assigned to each of the six DES cards. The fourth network port,normally used by a DCM, is not required for DES operation.

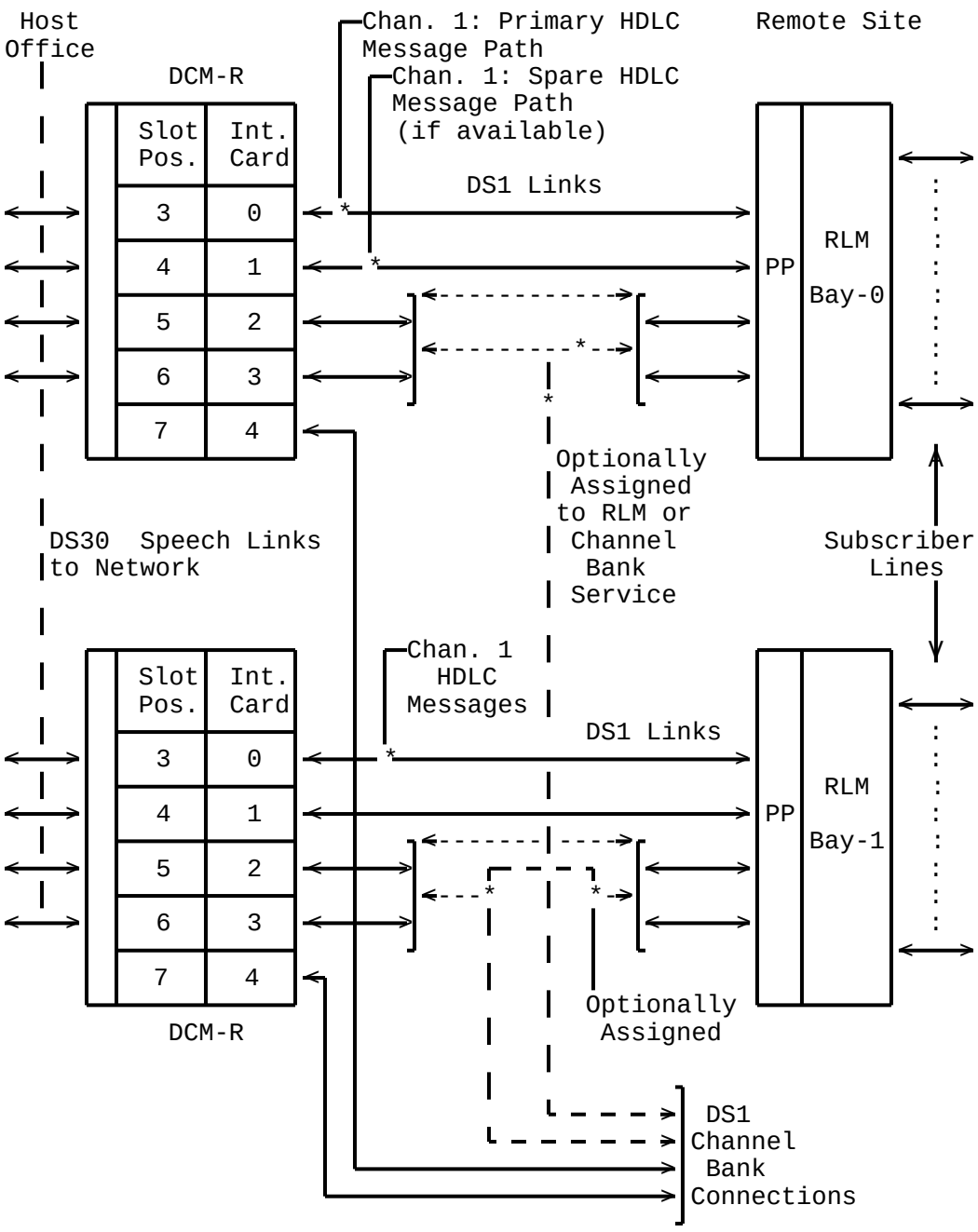
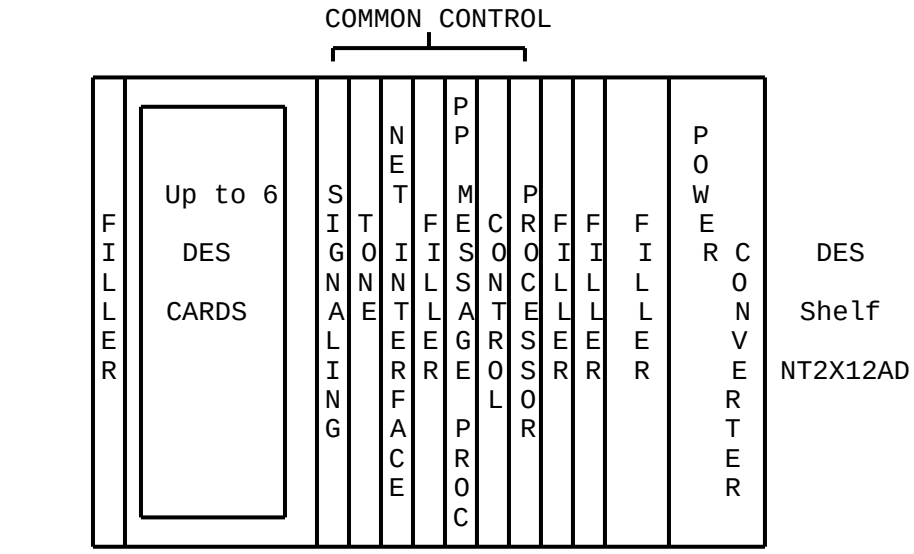


Fig. 26 - DCM-R to RLM: DS1 Link Connections



Slot	NT PEC	Remarks
01	0X50AE	Filler Panel
02 to 07	3X65AA	Digital Echo Suppressor (DES)
08	2X38AD	Signaling
09	2X37AB	Tone
10	2X36AA	Network Interface
11	0X50AC	Filler Panel
12	2X34AA	PP Message Processor (Supervision)
13	2X33AB	Control
14	2X32AA	Processor
15,16	0X50AC	Filler Panels
17,18	0X50AE	Filler Panel
19	2X70AA	Power Converter

Fig. 27 - DES: Shelf Layout and Card Complement

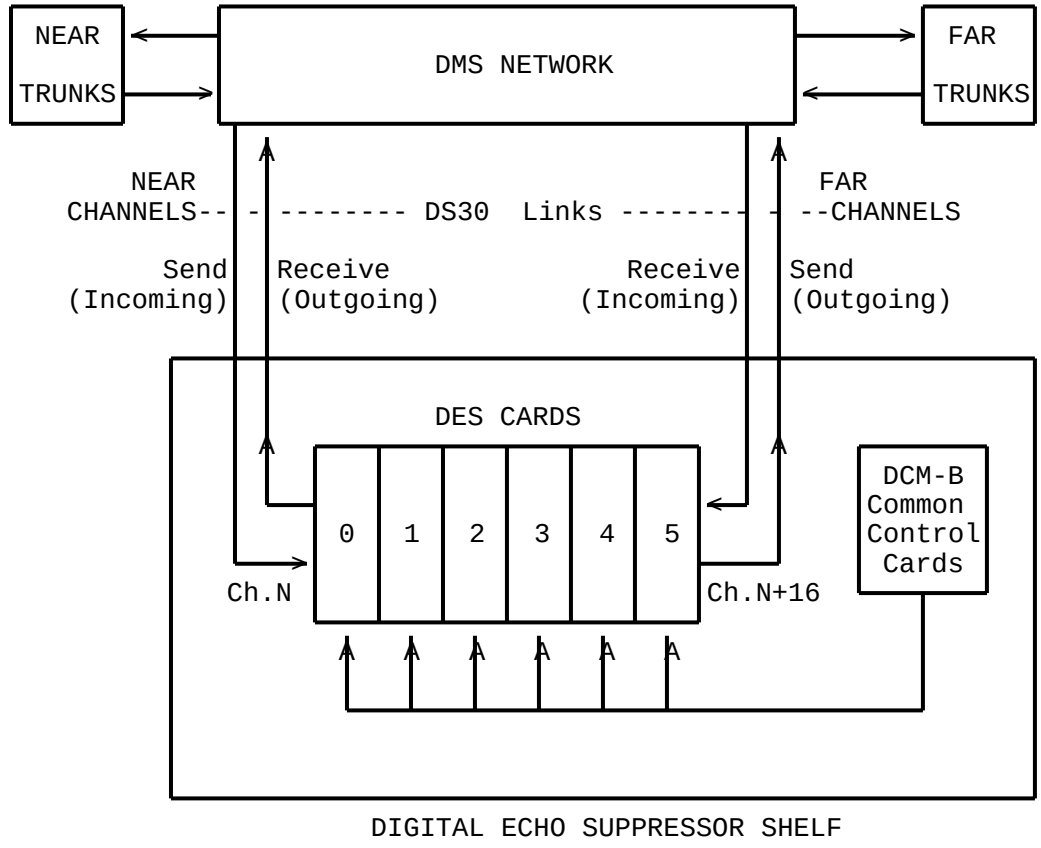


Fig. 28 - DES: Operation with DMS Network

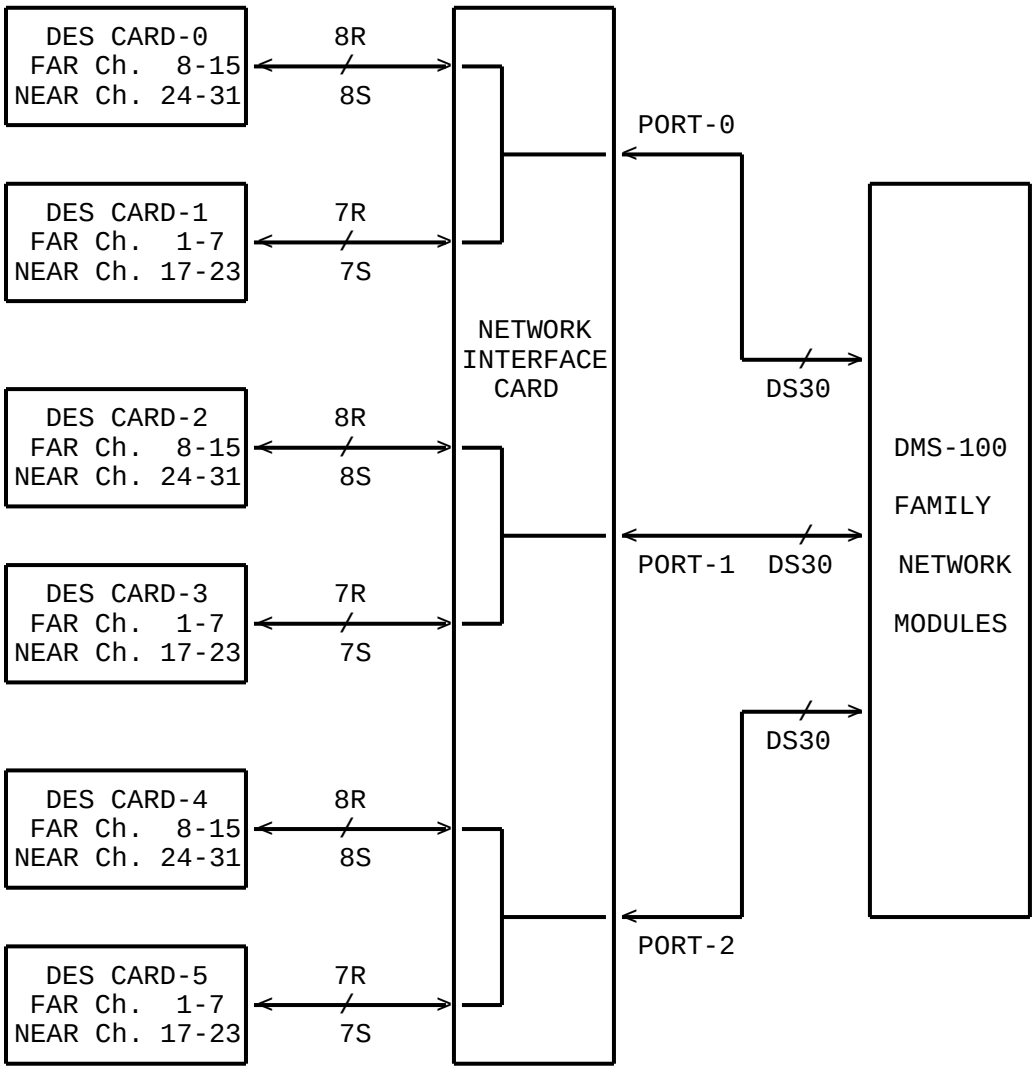


Fig. 29 - DES Card: Channel and Port Assignments

9. EXTENDED MULTIPROCESSOR SYSTEM PMS

XPM is a term applied to Peripheral Modules (PMs) based on the Extended Multiprocessor System (XMS). XPMs are Series 2 PMs that perform medium processing functions using the Motorola 68000 microprocessor. An XPM consists of dual units, each unit occupies a single shelf. For reliability, the XPM contains two control complexes, one in each unit (or shelf). One control complex is active and controls both units. The mate control complex is held in hot standby mode.

XPM List

The XPMs that are described in this Practice are:

* Line Group Controller (LGC)
* Line Trunk Controller (LTC)
* Digital Trunk Controller (DTC)
* Message Switch and Buffer 6, 7(MSB6, 7)
* Remote Cluster Controller (RCC)
* Link Interface Module (LIM)
* Link Interface Unit 7 (LIU7)
* Subscriber Carrier Module-100R (SMR)
* Subscriber Carrier Module-100U (SMU)
* Subscriber Carrier Module-100S (SMS)

This chapter describes XPM functions and cards that are common to the following XPMs:

* Line Group Controller (LGC)
* Line Trunk Controller (LTC)
* Digital Trunk Controller (DTC)
* Remote Cluster Controller (RCC)

Consult the Table of Contents to find the chapters in this Practice that describe the functions and hardware of specific XPMs.

INFORMATION FLOW TO AND FROM AN XPM

Information is exchanged between the XPM and three other node types:

* Central Control Complex (CCC)
* P-side nodes (either XPM or other PM)
* other XPMs (connected through the network)

The information exchange between the XPM and the three node types is accomplished using the following link types:

* DS30 (C-side)
* DS1 (P-side, C-side)
* DS30A (P-side)
* inter-peripheral message links (IPML) (C-side)

Data Exchange Between the CCC and the XPM

The Central Control Complex (CCC) and the XPM exchange messages over channel zero of the DS30 message link. The CCC to XPM control messages contain:

* requests to start and stop monitoring for call originations

* requests to use selected DS30 channels on specific planes for speech connections through the network

* subscriber data used to determine tone selection and the method of digit collection

* requests for the XPM to supply ring back or busy tones

* requests for the XPM to monitor speech channel integrity by transmitting and receiving integrity values in the channel supervision Message

* downloaded software destined for the XPM or other nodes

Messages from the XPM to the CCC include:

* call origination messages
* digit information
* change of subscriber status (on-hook, off-hook)

(See Figure 30 on page 82.)

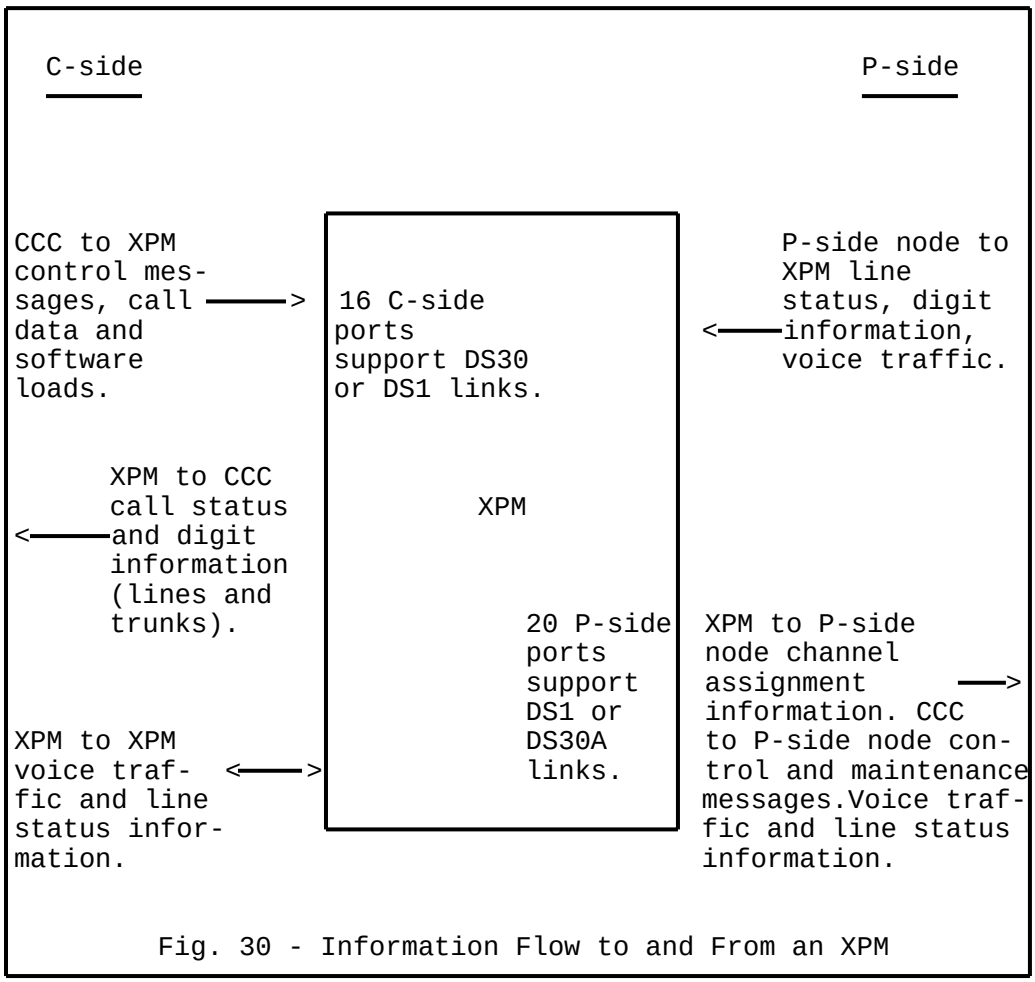


Fig. 30 - Information Flow to and From an XPM

Data Exchange Between the XPM and P-side Nodes

The XPM exchanges messaging, maintenance and encoded speech information with P-side nodes over DS30A and or DS1 links. Messaging between the XPM and P-side nodes is transmitted over dedicated message channels using DMSX protocol. When the XPM interfaces with P-side DS1 trunks, the XPM receives and transmits signaling information using A and B signaling bits (C and D bits are also used in extended frame format). The XPM receives the following information from P-side nodes:

* encoded speech signals
* digits
* subscriber terminal status (on-hook, off-hook)

The XPM sends the following information to P-side nodes:

* control messages from the CCC
* encoded speech signals
* digital tones (re-order and busy)

* terminal display messages (for subscriber display terminals)
* requests to supply ringing voltage to subscriber lines
* requests to associate C-side channels with subscriber lines
* outpulsed digits (over trunks)
* software loads and associated data

Simultaneous Loading of P-side Nodes

The XPM is capable of loading several P-side nodes, of the same type, simultaneously (LCMs, RLCMs, ESAs, and RCCs). The XPM performs simultaneous loading by:

* copying a software load received from the CCC

* sending a copy of the load plus related data simultaneously to several P-side nodes of the same type

Note: The simultaneous loading of P-side nodes by an XPM is aborted if a switch of activity (SWACT) occurs in the XPM. In addition to loading of multiple P-side nodes, the XPM is capable of performing the following related functions:

* storage of P-side node loads in the Master Processor memory of the active unit of the XPM if memory space is available

* auditing of XPM memory to ensure that any P-side node software stored there is not corrupted (in the event of corruption the XPM state will be set to in-service-trouble (INSTB) at the MAP)

* sending identical loading messages (reset, status, load and run) to multiple P-side nodes of the same type after receiving a single request from the CCC

* simultaneous processing of several independent load and data distribution requests for different P-side node types (for example LCMs and RMMs)

Data Exchange Between XPMs Over DS30 Links

Information is exchanged between XPMs by means of C-side DS30 channels that are connected through the network. The following information is exchanged between XPMs:

* digitally encoded speech signals

* voice channel integrity messages in the channel supervision message (CSM)

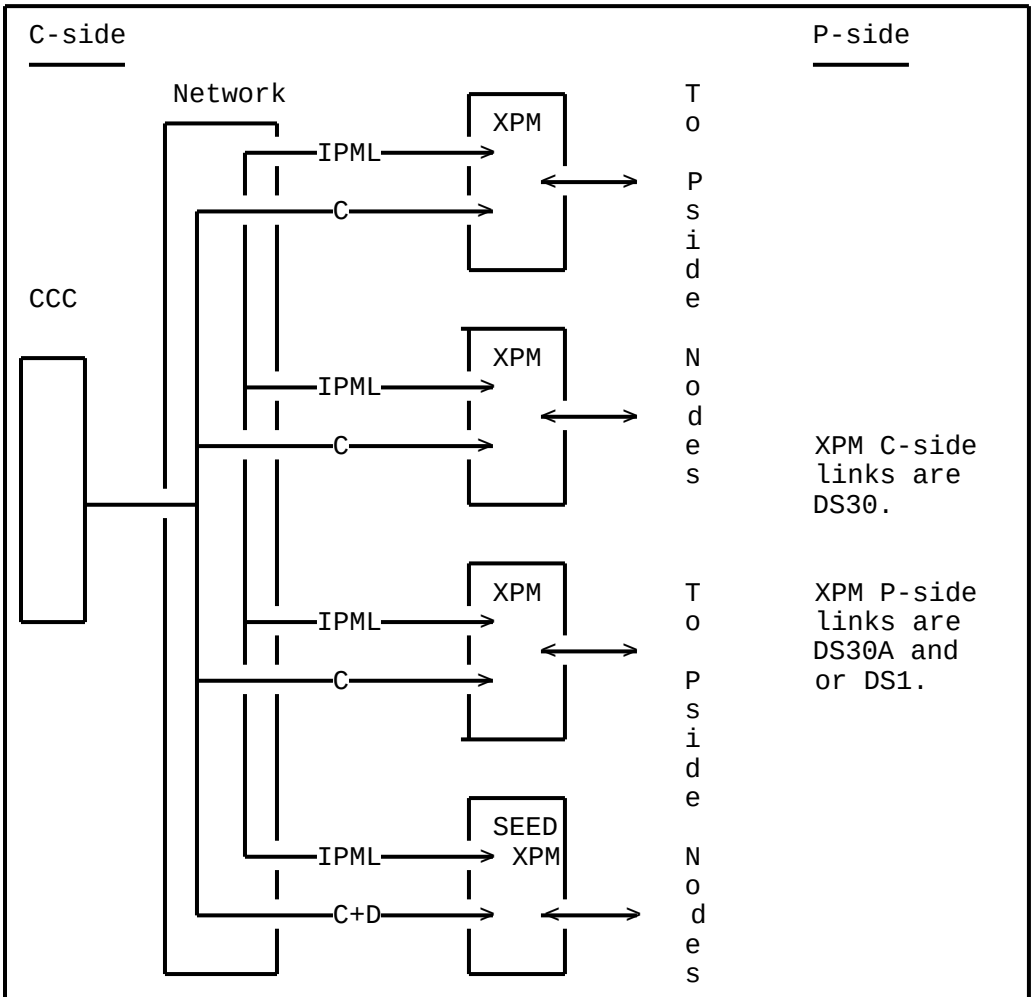
* terminal status (on-hook and off-hook) in CSM

XPM Inter-Peripheral Message Links

The inter-peripheral message link (IPML), used for parallel loading of multiple XPMs, is a temporary network connection between two or more active XPM units (see Figure 31 on page 85).

Note: The MSB6/7 IPML is a permanent network connection between the MSB6/7 and the DTCs that interface with trunks carrying the speech part of calls (see Part 16 on page 156).

The temporary IPML consists of a 64 kilo bit per second C-side channel that provides a messaging connection through the network between active XPM units. The message protocol card (NT6X69) provides the interface to the IPML in the active XPM units and supports six IPML links or five IPML links plus one inter-module communication link (IMC).



ABBR	EXPANSION
IPML	Inter-Peripheral Message Link
C	CCC control messages
C+D	CCC control message and downloaded software

Fig. 31 - XPM Inter-Peripheral Message Links

Temporary IPMLs are used by the CCC to:

* parallel load the active units of many XPMs of the same type over a broadcast IPML network

* parallel load the inactive units of many XPMs of the same type over an IPML broadcast network (using IMC links between XPM units)

* load any number of XPM P-side nodes from a load supplied by the CC or stored in XPM memory

* send static data or messages to many XPMs simultaneously

The use of IPMLs for loading and data distribution reduces:

* CCC involvement during XPM and P-side node loading
* CCC involvement in data distribution
* the time required for dead office recovery

The CCC sets up parallel loading of XPMs by:

* sending reset messages to the XPMs that are to be loaded

* setting up parallel IPML connections through the network between XPMs that will receive the software load

* informing the XPMs about the IPML network connections (which nodes to accept messages from, which nodes to reply to, which nodes to forward messages to)

* sending the load to the seed node (the seed node loads its own memory and broadcasts the load to the other XPMs on the IPML network)

* verifying that all nodes are loaded

Note: XPMs equipped with NT6X45 processor cards with versions earlier than BA cannot perform IPML parallel loading of active XPM units at ROM level and cannot perform loading of inactive units using IPML and IMC links.

INFORMATION FLOW WITHIN AN XPM

XPM Internal Channel Connections

The XPM makes internal connections between C-side DS30 (or DS1) channels and P-side DS30A (and or DS1) channels (see Figure 32 on page 87).

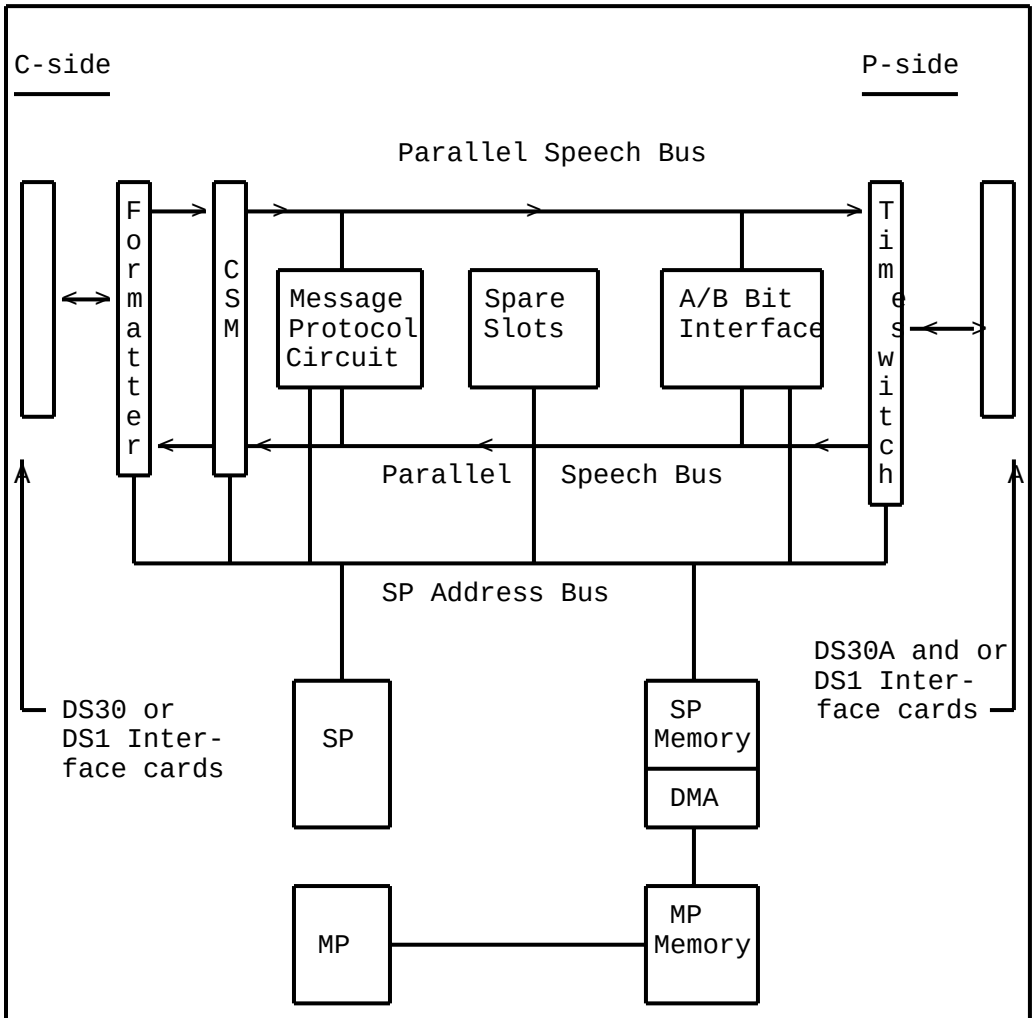


Fig. 32 - XPM Internal Speech Connections

The list that follows outlines the C-side to P-side speech path connections that are made by the XPM during call processing:

* The DS30 interface card receives the incoming C-side DS30 serial bit stream, and converts it from the bipolar line code to the TTL signal type used by the XPM. The DS30 interface card sends the information in DS30 format to the formatter card.

* The formatter card accepts the incoming voice signals from either plane zero or one, on a channel by channel basis, and converts the serial bit stream into a ten bit wide parallel stream. Each ten bit serial channel from the DS30 frame is given a time slot on the parallel speech bus. Five hundred and twelve of the 640 time slots on the Parallel Speech Bus

are used for speech. The remaining time slots are used for tones, DMSX messaging to P-side peripherals and maintenance.

* The channel supervision message (CSM) interface card receives the parallel bit stream from the formatter card and performs the following functions: checks for parity errors, extracts the channel supervision bits from each time slot and builds the 40-bit CSM for each channel (or time slot), examines the CSM integrity byte to ensure speech path integrity from the originating XPM to the terminating XPM.

* The message protocol card interfaces with the parallel speech Bus and performs the following functions: extracts control messages received on channel zero from the CCC, sends messages to nodes located on the P-side of the XPM, supports DS30 and DMSX protocols, and provides tones if equipped with a tone circuit.

* The A/B bit interface circuit is used when the XPM is equipped with P-side DS1 interface cards and performs A/B bit signaling functions. A/B bit signaling can be enabled on a port-by-port and channel-by-channel basis. The A/B bit interface maps the Supervision bit onto the A/B bits in the appropriate outgoing channel.

* The time switch receives the encoded speech signals from the parallel speech bus and performs the following functions: converts the parallel bit stream on the Parallel Speech Bus to a serial bit stream and outputs the serial bit stream to either a DS1 or DS30A Interface card, performs concentration of the channels on the 20 P-side ports to the channels on the 16 C-side ports, makes connections between any of the 640 parallel speech bus time slots to any of the 640 P-side channels,

* The P-side DS30A and or DS1 interface cards are connected to the time switch and convert the TTL signal output from the time switch to the bipolar encoded signal which is transmitted over P-side DS30A and or DS1 links.

XPM Inter-Module Communication

inter-module communication links are used in the XPM to exchange call processing, and diagnostic messages and to transmit software loads and related data between the active and inactive units. There are two IMC links used in the XPM:

* the message protocol card IMC
* the signaling processor card (SP) IMC

The message protocol card IMC is the primary IMC link in the XPM and is used for all types of IMC messaging between XPM units. The SP IMC is used exclusively for maintenance and diagnostics.

Message Protocol Card IMC

The message protocol card IMC is an IMC link, operating at 64 kilo bits per second, which connects the message protocol cards in each XPM unit. This IMC link is used for exchanging:

* link status and connection information between the active unit and the inactive unit (this data allows the inactive unit to maintain stable calls if a switch of activity (SWACT) occurs

* software loads and related data from the active unit to the inactive unit (used primarily when the C-side links on the inactive unit are down)

* maintenance and diagnostic messages from the CCC to the inactive unit when message links to the inactive unit are not functioning

* the results of diagnostic tests that have been performed on the inactive unit and are transmitted to the CCC by way of the active unit

Signaling Processor IMC Link

The signaling processor (SP) IMC link is a universal asynchronous receive transmit (UART) link that operates at 19.2 kilo bits per second. The SP IMC link connects the SPs in both units and is used for:

* loading small diagnostic programs from the in-service active unit to the out-of-service inactive unit

* providing information which is used for diagnosing faults in the mate unit when the message protocol card IMC link is not functioning

Note: XPMs equipped with NT6X45 processor cards with versions earlier than BA cannot perform IPML parallel loading of active or inactive units at ROM level.

XPM TASKS

Task List

The primary XPM tasks are:

* interfacing to DS30, DS30A and DS1 links
* connecting P-side and C-side channels
* informing the CCC of call originations
* collecting and sending digit information to the CCC
* supplying tones to subscriber terminals
* transmitting and receiving integrity messages

* transmitting and receiving the CSM supervision bit
* performing a switch of activity (SWACT)
* performing audits of hardware and internal records
* executing internal diagnostics

Interfacing to DS30, DS30A and DS1 Links

C-side Interface

The XPM supports a maximum of 16 C-side links, either DS30 (see Figure 33 on page 91) or DS1. When the XPM is connected directly to the network, four DS30 Interface cards provide the XPM C-side interface, two DS30 cards in each XPM unit. The two DS30 cards in unit zero provide port connections for links to network plane zero (unit one DS30 cards provide port connections for links to network plane one). The active XPM unit receives speech and messaging information over both planes simultaneously but accepts the information, carried on each channel, from only one plane. Each DS30 card supports a maximum of eight equipped ports. XPMs at remote sites (Remote Cluster Controllers) are equipped with C-side DS1 interface cards that support a maximum of 16 C-side DS1 links to a controlling XPM at the switching office.

P-side Interface

The XPM supports a maximum of 20 P-side links, either 20 DS30A links or 20 DS1 links or a combination of both DS30A and DS1 links that totals 20 (see Figure 34 on page 92). DS30A cards are duplicated in the XPM. The equipped ports on a DS30A card in unit zero are connected to the same DS30A links as the equipped ports on the duplicate DS30A card in unit one. The control section in either XPM unit cannot access the DS30A cards in the mate unit. Each DS30A card supports a maximum of ten equipped DS30A ports. Each XPM unit supports a maximum of two DS30A cards (for a total of 20 duplicated DS30A ports per XPM unit). DS1 cards are not duplicated in the XPM. Each DS1 card contains two port circuits and all DS1 cards are controlled by the active XPM unit. Each XPM unit can support a maximum of five DS1 cards (a maximum of ten DS1 ports per unit and a maximum of 20 DS1 ports per XPM).

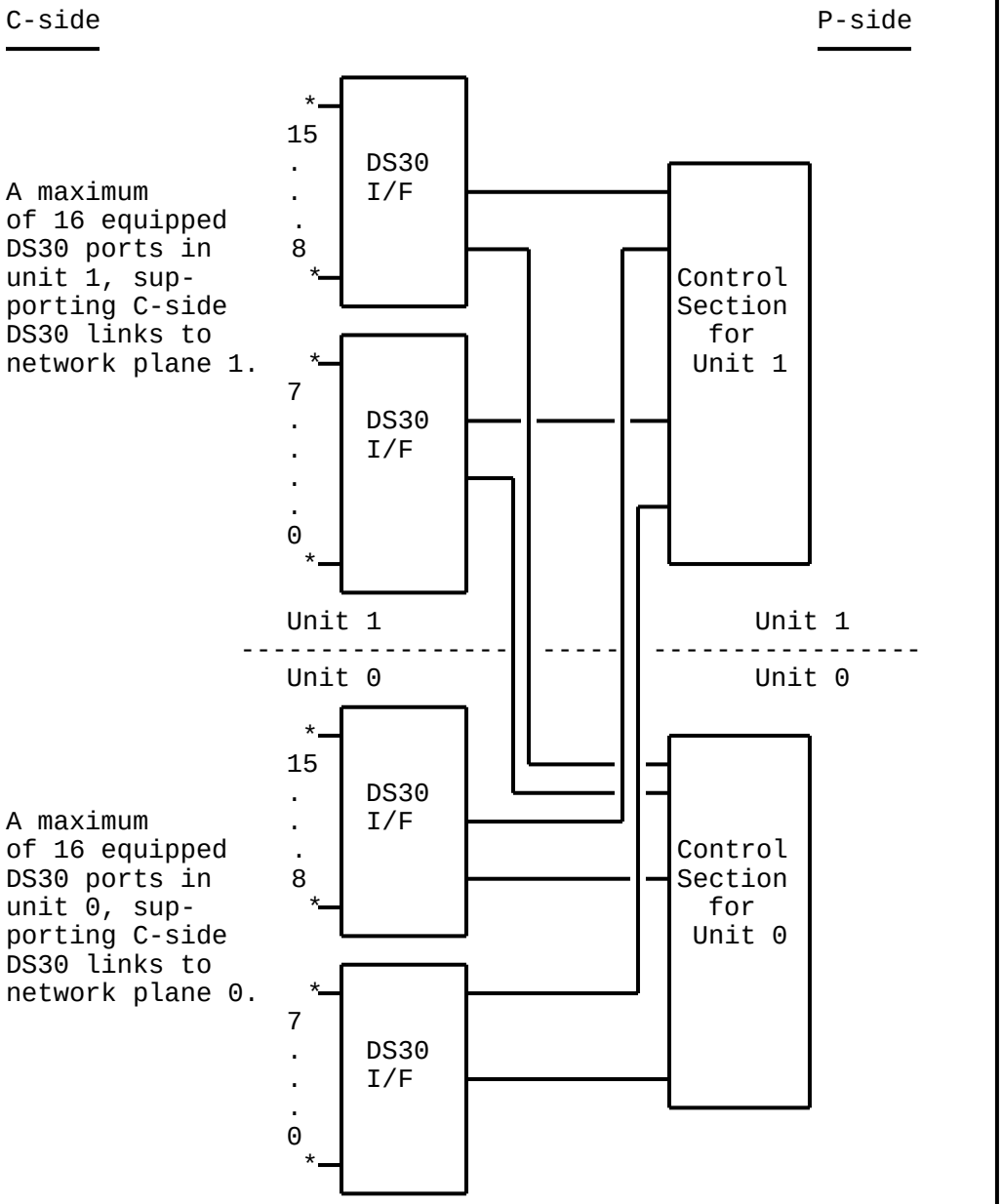


Fig. 33 - XPM C-side DS30 Interface

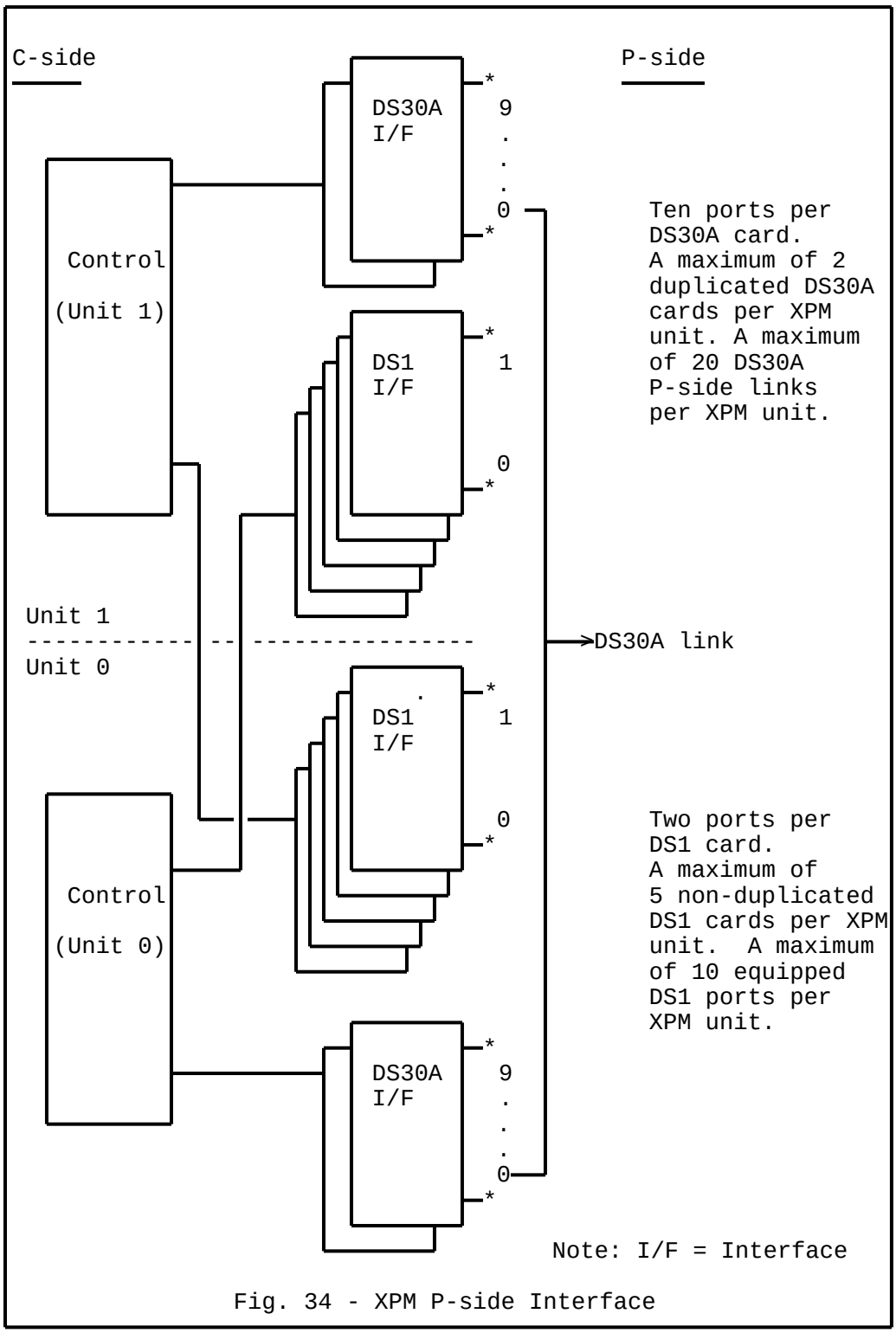


Fig. 34 - XPM P-side Interface

Connecting P-side and C-side Channels

During call processing, the XPM is informed by P-side nodes of off-hook conditions on idle lines. Upon receiving off-hook information, the XPM sends a call origination message to the CCC. In response, the CCC specifies the network plane and the C-side channel that the XPM must use for transmitting encoded speech signals across the network. The XPM then makes internal time switch connections and connects P-side and C-side channels.

Informing CCC of Call Originations

Call Originations for Lines

The XPM scans for hook state change messages from P-side nodes that service subscriber lines. After receiving such a message, the XPM translates the message from the DMSX messaging format to the DS30 messaging format and sends the origination message to the CCC.

Call Originations for Trunks

The XPM scans the trunks that it interfaces and notifies the CCC if one of these trunks is seized.

Collecting and Sending Digit Information to the CCC

After receiving a call origination message, the CCC instructs the XPM to stop scanning for originations and to collect the digits that are sent from the subscriber terminal. If the XPM is equipped with a universal tone receiver (UTR), the XPM makes the internal connection between the P-side channel carrying the digits and an available UTR channel. If the XPM is not equipped with a UTR, the CCC sets up a channel through the network to a Maintenance Trunk Module which is equipped with a Digitone Receiver. The CCC informs the XPM to use the specified network plane and C-side channel to connect to the Digitone Receiver. After receiving the digits from the UTR (or Digitone Receiver) the XPM sends the digit information to the CCC in one or more messages.

Supplying Tones to Subscriber Terminals

The XPM can supply digital tones such as reorder and busy tones to subscriber lines. To supply the tones, the XPM is either equipped with a specialized tone card or the tone circuit found on the message interface card or message protocol card is used.

Transmitting and Receiving Integrity Messages

During call processing, the originating and terminating XPMs transmit and receive an integrity byte that is supplied to each XPM by the CCC. The integrity byte is transmitted between the XPMs in the channel supervision message and is used by the XPMs to monitor call-path integrity.

Transmitting and Receiving CSM Supervision Bit

During call setup and takedown the XPMs monitor the terminal status of the originating and the terminating subscriber. Terminal status changes from on-hook to off-hook or off-hook to on-hook are relayed to the XPMs by P-side nodes which interface with subscriber lines. The XPMs inform each other of status changes by changing the channel supervision bit, as required, and sending the information to the other XPM in the Channel Supervision Message. The status change information is used by the XPMs to determine when to connect and disconnect PCM voice transmission.

Note: The monitoring and insertion of the CSM bit by XPMs is optional and depends on the call type.

Performing a Switch of Activity (SWACT)

A switch of activity occurs in the XPM if a fault is detected in any of the following cards in the active unit:

* master processor
* master processor memory
* signaling processor
* signaling processor memory
* formatter
* time switch
* CSM interface
* A/B bit interface and time switch
* message protocol (or message interface)
* DS30A interface

In addition, a switch of activity occurs if the software in either the master processor or the signaling processor:

* traps during the processing of a non-recoverable task

* traps more often than is allowed in a predetermined period of time.

Performing Audits of Hardware and Internal Records

The XPM runs audits that check the integrity of hardware and ensure consistency between internal records.

Executing Internal Diagnostics

When a fault is detected in an XPM unit or when an XPM is tested or returned to service from the MAP, a series of internal tests are run that check both software and hardware.

XPM CARDS

Each unit of the XPM occupies one shelf and consists of the following cards:

Card List

DS1 interface	NT6X50AB/AA
DS30A interface	NT6X48AA
DS30 interface	NT6X40AA/AC
master processor	NT6X45BA/AF/AE/AD/AC/AB
master processor memory	NT6X47AB
signaling processor	NT6X45BA/AF/AE/AD/AC/AB
signaling processor memory	NT6X46BA/AB/AC
A/B bit interface and time switch	NT6X44AA
message protocol	NT6X69AB/AA
or message interface	NT6X43AA
tone generator	NT6X79AA
CSM interface	NT6X42AA
formatter	NT6X41AA
power converter	NT2X70
universal tone receiver (optional)	NT6X92AA
filler panel	NT0X50AA

DS1 Interface Card

The DS1 interface card (NT6X50) contains two separate ports. Each port provides a two-way voice, data, and signaling interface and carries a 24-channel, 1.54 mega bit per second bit stream. The DS1 Interface card provides:

* loop-around paths for each DS1 port to allow isolation of faults

* transmission of local alarms and the detection of remote alarms

* detection of error conditions such as loss of synchronization, bipolar error, and slip

The card is available in two versions:

* NT6X50AA
* NT6X50AB

The AA version of the card supports the A/B bit signaling format. The AB version supports the extended frame format and can use

either A/B bit or A/B/C/D bit signaling. Each DS1 port contains a loop-around circuit for fault isolation.

DS30A Interface Card

The DS30A interface card (NT6X48AA) contains ten separate ports. Each port provides a two-way voice and data interface and carries a 32-channel, 2.56 mega bit per second bit stream. In the XPM, DS30A cards are duplicated for reliability with a maximum of two DS30A cards per unit and a maximum of four per XPM. Each DS30A port contains a loop-around circuit for fault isolation.

DS30 Interface Card

The DS30 interface card (NT6X40) is available in two versions:

* NT6X40AA Eight ports
* NT6X40AC Sixteen ports

The DS30 interface card is mounted in an LGC/LTC/DTC to provide a C-side interface for DS30 links to the network. A maximum of four, eight-port NT6X40AA cards can be equipped in the XPM (two AA cards in slots 22 and 23 in each unit) for a total of 16 ports in each unit. Alternatively, two sixteen port NT6X40AC cards can be equipped in the XPM (one AC card in each unit in slot 22) for a total of 16 ports in each unit. Both units of a single XPM must contain the same type of DS30 interface card, either AA or AC but never AA and AC. Each port of DS30 interface card provides a two-way voice and data interface and carries a 32-channel, 2.56 mega bit per second bit stream. In addition, each DS30 port contains a loop-around circuit for fault isolation. The DS30 cards in unit zero of an XPM terminate DS30 links to plane zero of the network while the DS30 cards in unit one terminate DS30 links to plane one.

Master Processor Card

The master processor (MP) card (NT6X45) in each unit uses a 68000 based CPU which performs the following functions:

* digit collection
* channel assignment
* interpretation of CCC messages
* interpretation of PM messages

Note: XPMs equipped with processor cards with versions earlier than BA cannot perform ROM level functions such as IPML parallel loading and IMC ROM level messaging; however, processor cards with versions earlier than BA do support task level IPML and IMC functions such as data distribution (see XPM Inter-Peripheral Message Links on page 84 and XPM Inter-Module Communication on page 88).

Master Processor Memory

The master processor memory (NT6X47) consists of RAM used to store data and software applications for both the master processor and the signaling processor. The signaling processor has access to a portion of the MP memory using its memory management unit. The AB version of the master processor XPM memory card (NT6X47) consists of two mega bytes of RAM. The master processor supports a maximum of four mega bytes of RAM which is obtained by equipping each XPM unit with two NT6X47AB memory cards.

Signaling Processor

The signaling processor (SP) Card (NT6X45) in each unit uses a 68000 based CPU which performs the following real-time critical functions:

* message transmission and reception
* A/B bit scanning
* time switch control
* channel supervision message transmission and reception

The MP and SP communicate using direct memory access (DMA) which allows the SP to read and write to portions of the MP memory; however, the MP cannot access the SP memory.

Note: XPMs that are equipped with processor cards with versions earlier than BA cannot perform ROM level functions such as IPML parallel loading and IMC ROM level messaging; however, processor cards with versions earlier than BA do support task level IPML and IMC functions such as data distribution (see XPM Inter-Peripheral Message Links on page 84 and XPM Inter-Module Communication on page 88).

Signaling Processor Memory

The signaling processor (SP) memory (NT6X46) consists of RAM used to store data and software applications. SP RAM is located on one card and exists in three versions:

* NT6X46AB (512 kilo bytes of RAM)
* NT6X46AC (1 mega byte of RAM)
* NT6X46BA (1 mega byte of RAM)

Note: Only one memory card is allowed for each SP regardless of the memory card version.

A/B Bit Interface and Time Switch

A/B Bit Interface

The A/B bit interface circuit, on the NT6X44AA card, performs A/B bit signaling functions when the XPM is equipped with P-side DS1 interface cards. The A/B bit interface consists of memory locations used for A/B bit insertion and extraction. C/D bits are also used when extended frame format is supported by the AB version of the DS1 Interface card.

Time Switch

The time switch performs the following functions:

* connects any P-side channel with any C-side channel.
* converts the incoming serial data stream to a parallel stream
* provides serial output to either a DS1 or DS30A interface card
* concentrates 20 P-side ports to 16 C-side ports

Message Protocol Card

The message protocol card (NT6X69AB/AA) performs the following functions:

* providing both a P-side and C-side messaging interface

* extracting CCC control messages from channel zero

* sending messages to nodes located on the P-side of the XPM

* providing a message rate of one hundred 64-byte messages per second per link

* supporting DS30 and DMSX protocols

* supporting IPML and message protocol card IMC link messaging

The P-side port and channel connections on the message protocol card provide the interface for the XPM C-side IPML links and the message protocol card IMC link. The message protocol card can support a maximum of six processes: five IPMLs and one IMC or six IPMLs and no IMC. The AB version of the card contains a tone generator that provides tones such as re-order and busy tones. The AA version does not contain a tone generator and must be used with tone generator card NT6X79.

Message Interface Card

The message interface card (6X43AA) is an earlier card design that does not have all of the capabilities of the message protocol card but performs the same function in the XPM. The functions of the message interface card are:

* providing the interface for both P-side and C-side messaging

* extracting CCC control messages from channel zero
* sending messages to nodes located on the P-side of the XPM
* providing tones
* providing a message rate of 100 messages per second

Note: The message interface card does not support IPML messaging or message protocol card IMC functions.

Tone Generator Card

A tone generator card is included on the message protocol card NT6X69AB and the message interface card NT6X43AA but the tone Generator card NT6X79AA must be equipped in the XPM if the AA version of the message protocol card is used. The tone generator card provides tones such as re-order and busy tones.

CSM Interface Card

The channel supervision message (CSM) interface card (NT6X42) performs the following functions:

* extracts the CSM bit from the C-side channels
* assembles the CSM for each channel
* performs parity checking on all incoming bytes
* inserts the CSM into the outgoing C-side PCM
* performs parity generation on all outgoing bytes

Formatter Card

The formatter card (NT6X41) consists of two sections: the formatting section and the clock section. The clock section generates the 10.24 mega hertz shelf clock. The formatting section of the card performs the following functions:

* parallel-to-serial conversion of the encoded voice signals received from the CSM Interface card and destined for the C-side links

* serial-to-parallel conversion of the encoded voice signals received from the C-side interface cards

* network plane selection

* parity error generation for test purposes

* T1 clock generation

Power Converter

The XPM contains two power converters, one on each shelf. Each Power Converter (NT2X70) supplies plus or minus 5v or 12v direct current and provides power for all cards on the shelf. Power to the DS1 cards (NT6X50) is provided to prevent loss of these unduplicated cards during a power failure. Power is not provided to the remainder of the LGC/DTC control complex.

Universal Tone Receiver

The universal tone receiver (UTR) (NT6X92) is an optional card in the XPM. If the UTR is not included in a specific XPM, the CCC can establish a network connection between the XPM and a different PM that has a UTR. The UTR is a 32-channel tone receiver that detects a variety of tones, including dual-tone multifrequency (DTMF) and multifrequency (MF). Tone samples are switched onto the parallel speech bus by the time switch and are collected by the UTR at the appropriate time slots. The UTR analyzes the samples and identifies the tones. The results are sent to the signaling processor.

Filler Panel

The filler panel (NT0X50AA) is used to fill empty card slots in the XPM shelves. There are a maximum of five spare card slots in each XPM shelf. Three of the slots (15, 16, and 17) have access to the SP address bus and parallel speech bus; the remaining spare slots (13 and 19) do not.

XPM HARDWARE CONFIGURATION

The specifications and shelf and frame layouts are different for each XPM and are described in various chapters in this practice. Consult the Table of Contents for the pages in this Practice where this information can be found.

10. LINE GROUP CONTROLLER (LGC)/LINE TRUNK CONTROLLER (LTC)/DIGITAL TRUNK CONTROLLER (DTC)

GENERAL

All the PMs in this group are built around a common "core".

The common ("core") characteristics for all members of this group are:

* a duplicated (dual-shelf) configuration allowing either control complex to control all processing in the PM

* DS30 interface processing enabling the 3-16 C-side ports to service DS30 links to the network

* a control complex (identified as PEC NT6X02AA) comprising : master processor, message and signaling processors and associated memory

* a standard shelf and panel arrangement and naming convention (see Figure 37 on page 109 for details).

Additional features can be added to produce a PM that is tailored for a specific function. The features that can be added are:

1. DS1 interface processing to allow the P-side ports to service DS1 trunks

2. DS1 interface processing to allow the P-side ports to service DS1 links to a remote PM

3. DS30A interface processing to allow the P-side ports to service DS30A links (duplicated for extra reliability) to a local PM

4. digit collection processing to allow the PM to collect and report digits to reduce the call processing load on the Central Control Complex

5. ring processing to provide a remote PM with PCM ringing instructions

6. pad processing to attenuate speech samples before they are passed to a remote PM

7. additional signaling processing to maintain a DS1 link with remote subscriber carrier equipment

8. special tone detection, to allow the PM to detect and report: re-originations, special information tones (SIT), audio tone detection (ATD), and call progress tones.

The main role, of the PMs that can be built by combining the core features with additional features, is to provide an interface between C-side and P-side links. The LGC and LTC provide an interface between C-side DS30 links to the network and P-side DS30A links and or DS1 links to subsidiary PMs. The DTC provides an interface between C-side DS30 links to the network and P-side DS1 digital trunks.

COMMON CHARACTERISTICS

Hot Standby Capability

Figure 35 on page 104 illustrates the duplicated configuration of the PM. Unit-1 is physically located in the shelf immediately above Unit-0. Each unit has its own control complex, but only one control is active at a time and provides control for both units. The inactive control in the mate unit is held in "hot" standby mode.

C-side Interface

The C-side ports can support up to 16 pairs of DS30 links (32 links, 16 to plane 0 and 16 to plane 1) to the network. Four DS30 interface (I/F) cards (two in unit-0, and two in unit-1) support the C-side links, each card handling up to eight DS30 ports. Link assignments are distributed over the four DS30 cards so that the even-numbered links are connected to plane-0 of the network, and the odd-numbered links to plane 1. A minimum of three link pairs (6 links, 3 to plane 0 and 3 to plane 1) is required for proper interface with the NM and CC.

Formatter

Each DS30 card outputs 256 (8 X 32) channels per plane to the formatter cards in both shelves 0 and 1, thus providing a duplicated path through whichever control complex is currently active. Each formatter handles a total of 512 channels (256 channels from each shelf) per plane. The two network planes are combined in the formatter where one plane or the other is selected on a per-channel basis.

The 512 speech channels are added to 128 internal service channels and are converted to a 640-channel (512 + 128) bus to the control complex.

Control Complex

The control complex contains a CSM card, to handle integrity and parity messages; processors and associated memories to perform the PP function; and a Time Switch card. The Time Switch enables any DS30 speech link channel to be connected to any DS1 or DS30A channel.

Shelf Layout

Figure 37 on page 109, shows the location of all the cards required to configure the PM as a LGC, LTC or DTC. The most recent PEC card numbers are indicated in the figure. Older numbers that still apply are also shown.

The number of DS30A and DS1 interface cards included in any unit depends on the equipment configurations.

Each shelf contains a power converter card. Power for the DS1 interface cards can be provided by either converter if one converter fails.

Frame Layout

See Figure 38 on page 110 and Figure 46 on page 135 . The LGC/LTC/DTC pairs of shelves are housed in a standard DMS-100 Family single-bay frame. The frame is referred to as

* a LGC equipment (LGE) frame, if provisioned for LGC service

* a LTC equipment (LTE) frame, if provisioned for LTC service

* a DTC equipment (DTE) frame, if provisioned for DTC service

For hardware identification purposes the frame is generally referred to as a Common Peripheral Controller Equipment (CPCE) frame, and has PEC NT6X01AA.

The frame contains two pairs of shelves, each pair referred to as a module. Module-0 is located on the lower two shelves of the frame, and module-1 on the upper two shelves. The frame supervisory panel (FSP) which provides power control and alarm circuits is located between the two modules. The fan unit provides a cooling air flow.

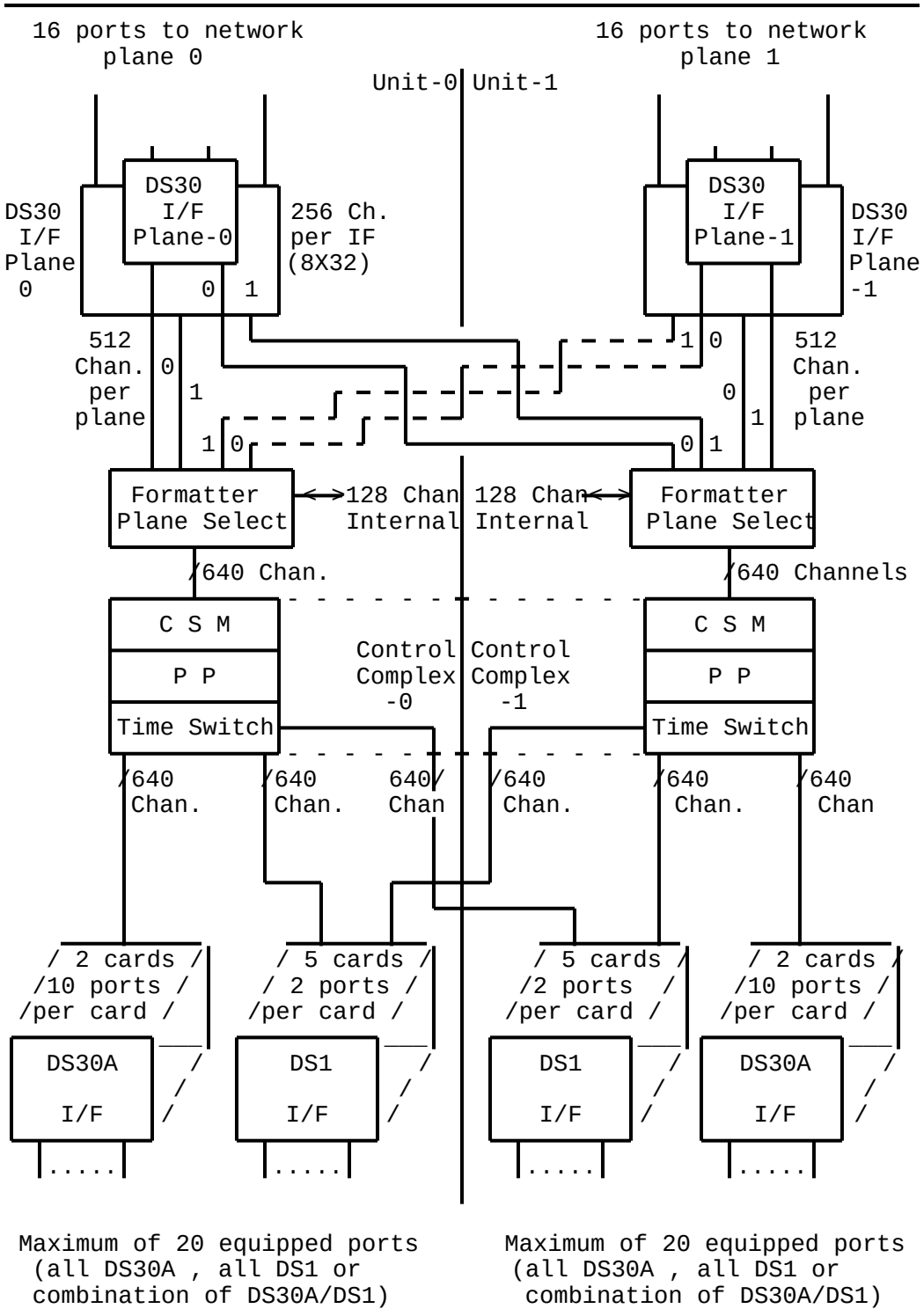


Fig. 35 - LGC/LTC/DTC Block Diagram

LINE GROUP CONTROLLER

The Line Group Controller (LGC) consists of the common "core" (see General on page 101) with the addition of:

* DS1 Interface cards to allow the LGC to service DS1 links to remote PM (RLCM or RCC/LCM)

* DS30A Interface cards to allow the LGC to service DS30A links to local PM

* Universal Tone Receiver (UTR) cards (optional) to allow the LGC to collect and report digits. Each UTR can collect digits from up to 30 channels at one time. An LGC can include up to two UTR cards. The UTR can be provisioned in either slot 15 or 16, one UTR on each shelf.

* CLASS Modem Resource Card (CMR) is an optional card used to implement the CLASS Calling Number Delivery (CND) feature for residential enhanced services (RES) customers. For more information on CND see CLASS Calling Party Identification (297-1401-122). The CND feature delivers the calling party's directory number plus the date and time of the call to the called party's customer premises equipment (CPE). For interoffice calls, the calling number information is transmitted between the originating and the terminating offices by means of Common Channel Signaling 7 (CCS7).

  The CMR card is located in the host LGC of the LCM or RLCM that terminates the called party's subscriber line. The CMR card monitors the LCM or RLCM's looped-back ringing code and transmits the calling party information to the called party's CPE between the first and second ring (see CLASS Calling Number Delivery in the LCM on page 218).

  Two CMR cards must be equipped in an LGC in order to provide the CND feature. One card is located in slot 13 of unit 0 and the other card is located in slot 13 of unit 1 (see Figure 37 on page 109). For datafill information see Table LTCINV, Section 064, in 297-1001-451. The CMR card has the resources to monitor 32 CND calls for ringing while simultaneously transmitting CND information for another 32 CND calls (a total of 64 CND calls).

The link assignments when the LGC is equipped to service 20 DS1 links (or 20 DS30A links) is shown in Figure 36 on page 108.

The 20 P-side ports of the LGC can be configured to support links to a variety of subsidiary PMs. The subsidiary PMs and the number of links required to connect them to the LGC are listed below:

* Line Concentrating Modules (LCMs) - two to six DS30A links to each LCM

* Remote Line Concentrating Modules(RLCMs) - two to six DS1 links to each RLCM

* Remote Switching Center (RSC) - two to 16 DS1 links to an RSC

DIGITAL TRUNK CONTROLLER

The Digital Trunk Controller (DTC) consists of the common "core" (see General on page 101) including:

* DS-1 Interface cards to allow the DTC to service DS1 trunks

* Specialized Tone Receiver (STR) card (optional) to allow the DTC to detect and report specified tones on one or all channels (up to 480). An STR can scan up to 480 channels at one time. Each unit in a DTC can include one STR card. This card is used in the DMS-250 to enable a subscriber in the "talking" state to depress # or * and dial out digits to "re-originate" a call (make a new connection without re-dialing the carrier's access and authorization codes).

  The STR is provisioned in slot 17 in both unit-1 and 0 (see Figure 37 on page 109).

  The STR can only be provisioned in a DTC with an extended SP Memory (6X47AB) and a Message Protocol card (6X69AB). Note : The earlier version of the Message Protocol card (6X69AA) can also be used if the Tone card (6X79AA) is present.

* Universal Tone Receiver (UTR) cards (optional) to allow the DTC to collect and report digits. Each UTR can collect digits from up to 30 channels at one time. A DTC can include up to two UTR cards. The UTR can be provisioned in either slot 15 or 16, one UTR on each shelf.

The DTC can service a maximum of 20 DS1 trunks by means of its 20 P-side ports.

LINE TRUNK CONTROLLER

The Line Trunk Controller (LTC) consists of the common "core" (see General on page 101) with the addition of

* DS-1 Interface cards to allow the LTC to service DS1 trunks and DS1 links to remote PM

* DS30A Interface cards to allow the LTC to service DS30A links to local PM

* Universal Tone Receiver (UTR) card (optional) to allow the LTC to collect and report digits. Each UTR can collect digits from up to 30 channels at one time. An LTC can include up to

two UTR cards. The UTR can be provisioned in either slot 15 or 16, one UTR on each shelf.

* CLASS Modem Resource Card (CMR) is an optional card used to implement the CLASS Calling Number Delivery (CND) feature for residential enhanced services (RES) customers. For more information on CND see CLASS Calling Party Identification (297-1401-122). The CND feature delivers the calling party's directory number plus the date and time of the call to the called party's customer premises equipment (CPE). For interoffice calls, the calling number information is transmitted between the originating and the terminating offices by means of Common Channel Signaling 7 (CCS7).

  The CMR card is located in the host LTC of the LCM or RLCM that terminates the called party's subscriber line. The CMR card monitors the LCM or RLCM's looped-back ringing code and transmits the calling party information to the called party's CPE between the first and second ring (see CLASS Calling Number Delivery in the LCM on page 218).

  Two CMR cards must be equipped in an LTC in order to provide the CND feature. One card is located in slot 13 of unit 0 and the other card is located in slot 13 of unit 1 (see Figure 37 on page 109). For datafill information see Table LTCINV, Section 064, in 297-1001-451. The CMR card has the resources to monitor 32 CND calls for ringing while simultaneously transmitting CND information for another 32 CND calls (a total of 64 CND calls).

The link assignments when the LTC is equipped to service 20 DS1 links (or 20 DS30A links) are shown in Figure 36 on page 108.

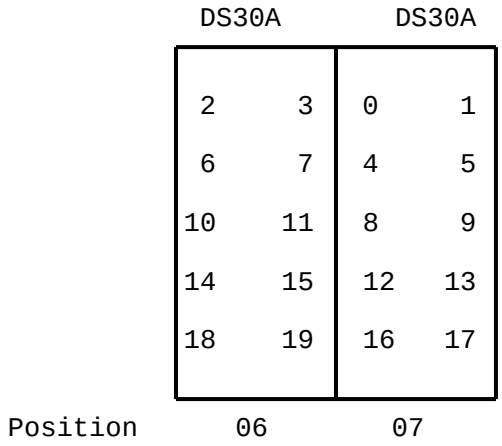
The 20 P-side ports of the LTC can be configured to support DS1 trunks as well as links to a variety of subsidiary PMs. The trunks and subsidiary PMs supported by the LTC are

* Line Concentrating Modules (LCMs) - two to six DS30A links to each LCM

* Remote Line Concentrating Modules(RLCMs) - two to six DS1 links to each RLCM

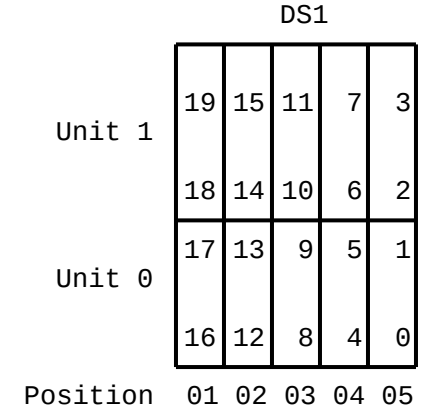
* Remote Switching Center (RSC) - two to 16 DS1 links to an RSC

* DS1 trunks - two to 20 DS1 trunks



DS30A links are duplicated in unit-0 and unit-1

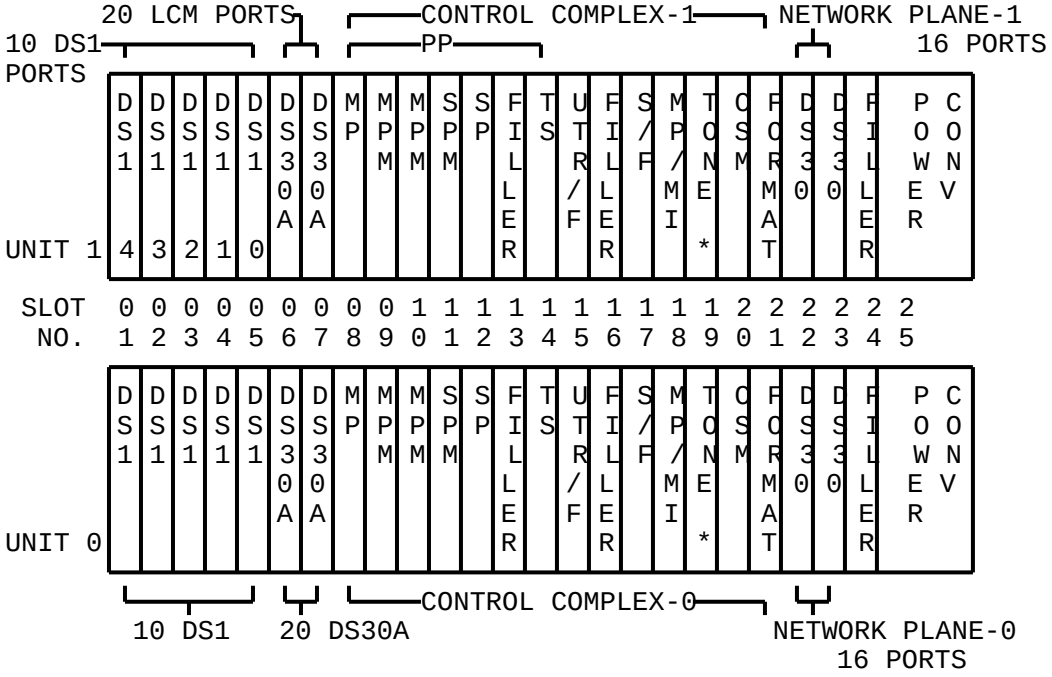
Link Assignments when all ports on LGC/LTC are used for DS30A links



DS1 links are not duplicated

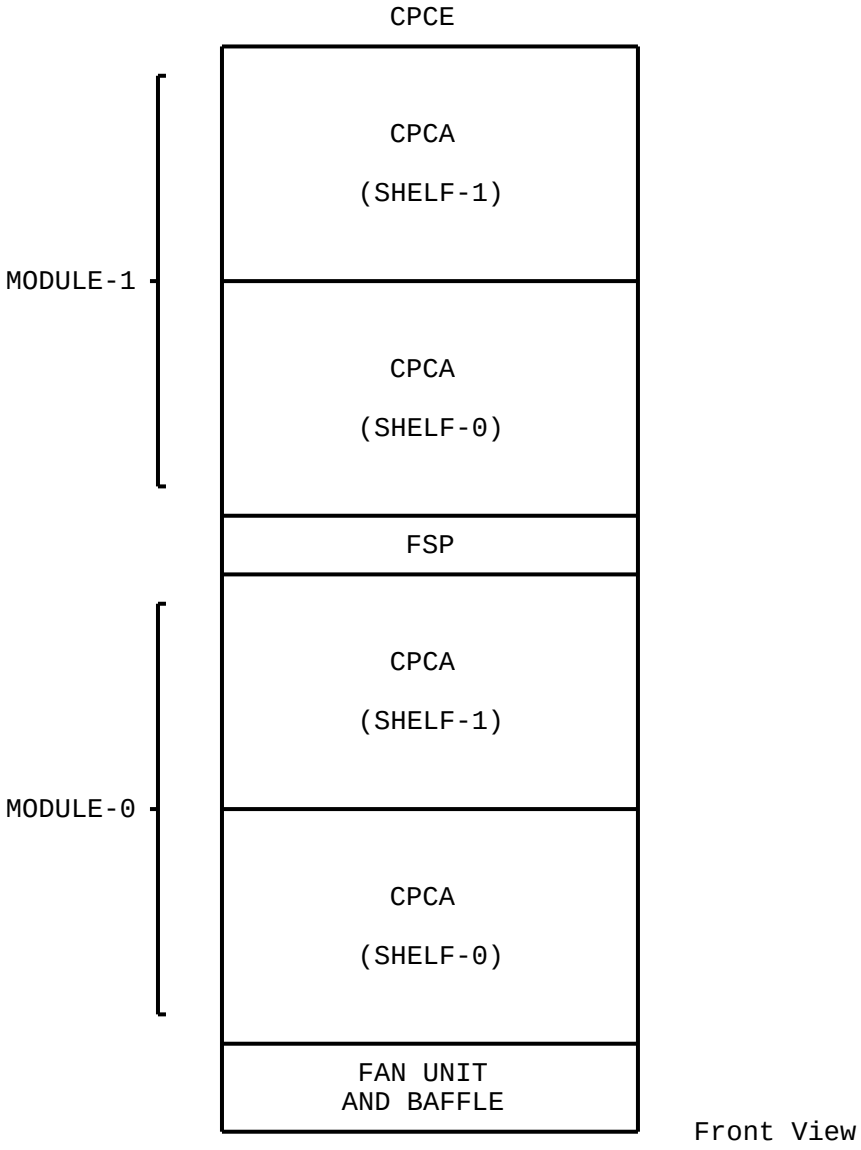
Link Assignments for DTC (and LGC/LTC when all ports are used for DS1 links)

Fig. 36 - Links Assignment for LGC/DTC/LTC



Slot	ABBR	NT PEC	Remarks
01-05	DS1	6X50AA	DS1 Interface (max. 5 cards)
	or	6X50AB	
06-07	DS30A	6X48AA	DS30A Interface (max. 2 cards, in LTC/LGC only)
08	MP	6X45BA	Master Processor (or AF/AE/AD/AC/AB)
09,10	MPM	6X47AB	MP Memory
11	SPM	6X46BA	SP Memory (or AB/AC versions)
12	SP	6X45BA	Signaling Processor (or AF/AE/AD/AC/AB)
13	——	0X50AA	Filler Panel or NT6X70AA Continuity Tone Detector (CCS only) or NT6X78AA CLASS Modem Resource card
14	TS	6X44AA	Time Switch
15-16	UTR/F	6X92AA	Universal Tone Receiver (slot 15 or 16, max. 2 per XPM) or 0X50AA Filler Panel
17	S/F	6X62AA	Specialized Tone Receiver (STR - max. 2 per DTC only) or Filler Panel
18	MP/MI	6X69AB	Message Protocol Circuit (or 6X69AA or 6X43 Message Interface card)
19	TONE	6X79AA	Tone Generator *(required if slot 18 contains a 6X69AA) or Filler Panel
20	CSM	6X42AA	Channel Supervision Message
21	——	6X41AA	Formatter
22,23	DS30	6X40AA	DS30 Interface (8-port)
22	DS30	6X40AC	DS30 Interface (16-port). If this card is provisioned, slot 23 is not used.
24	——	0X50AA	Filler Panel
25	——	2X70AB	Power Converter

Fig. 37 - LGC/LTC/DTC: Shelf Layout and Card Complement (T6X02)



ABBR	NT PEC	Remarks
CPCA	6X0201	Common Peripheral Controller Array. General term for one shelf of an LGC/LTC/DTC type of PM.
CPCE	6X01AA	Common Peripheral Controller Equipment. General term for LGE/LTE/DTE frame.
FSP	0X28AM	Frame Supervisory Panel

Fig. 38 - LGE/LTE/DTE Frame: Shelf and Panel Arrangement

11. INTERNATIONAL LGC/INTERNATIONAL DTC

International LGC (ILGC)

The International Line Group Controller (ILGC) is used in countries outside North America, and runs in conjunction with the standard LCM.

The ILGC is similar to the LGC (see Line Group Controller on page 105) but has the following differences.

* The ILGC uses the international Message Interface card (PEC NT6X43BA) and firmware. For United Kingdom implementations another version (PEC NT6X43CA) is used.

* The ILGC supports DS30 diagnostics rather than DS1 diagnostics.

* The ILGC uses the Universal Tone Receiver (UTR) (PEC NT6X92AA) rather than the standard Dual-Tone Multifrequency (DTMF) receivers.

* The ILGC uses the Turkish dialing plan digit analysis logic.

With several PCM types available, an ILGC datafilled for PCM30 is identified as a PLGC.

International DTC (IDTC)

The International DTC (IDTC) is similar to the DTC (see Digital Trunk Controller on page 106), but operates with international digital trunks instead of North American DS1 digital trunks. International digital trunks may use the PCM30 transmission format.

With several PCM types available, an IDTC datafilled for PCM30 is identified as a PDTC.

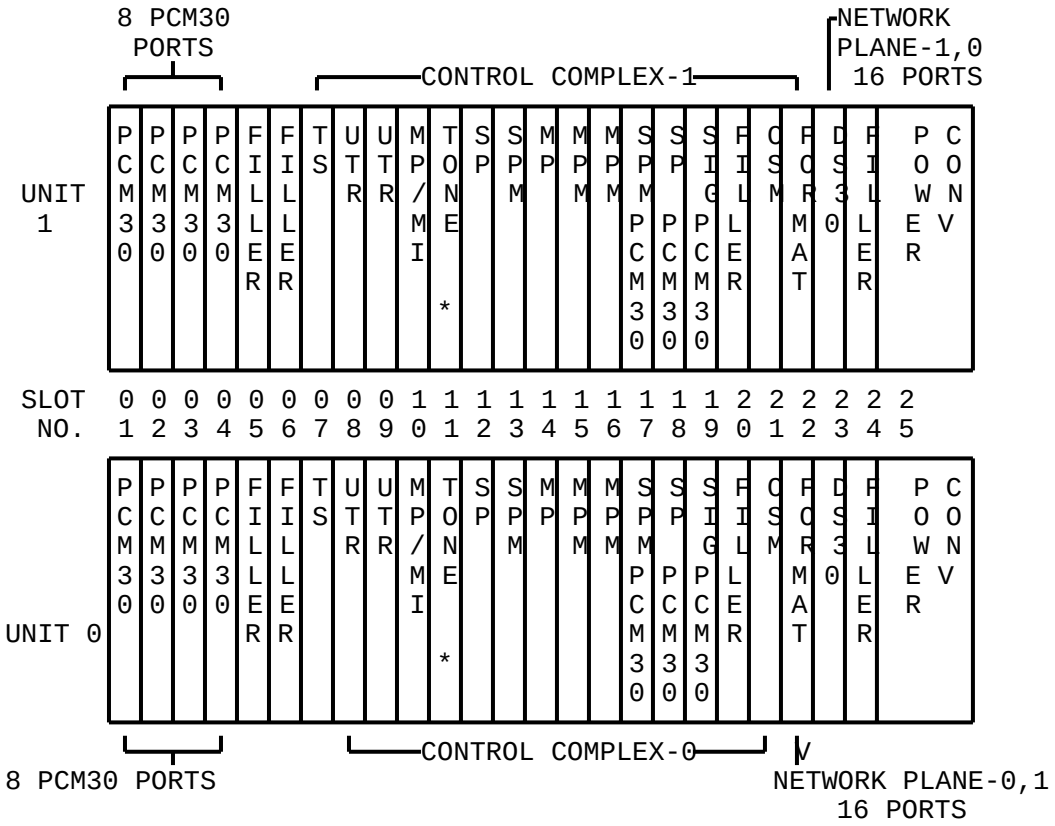
Shelf Layout

The control complex and DS30 interfaces of the IDTC operate similarly to the DTC but no DS30A and DS1 interfaces are required. Instead of the DS1 interfaces, PCM30 interface cards are used. The IDTC shelf also has different interconnection arrangements between the circuit cards. See Figure 39 on page 113, which shows the location of all cards in an IDTC.

Each shelf of the IDTC is referred to as an International Common Peripheral Controller Array (ICPCA), and is identified by PEC NT6X0211. The set of common circuit cards has PEC NT6X02BA.

Frame Layout

The frame housing the IDTC is similar to the CPCE frame (see Figure 38 on page 110), and is referred to as a International CPCE (ICPCE) frame. It is identified by PEC NT6X01BA.



Slot	ABBR	NT PEC	Remarks
01 to 04	PCM30	6X27AA	PCM30 Interface (D30). Adapts DMS-100 DS30 format to international format.
05,06	——	0X50AA	Filler Panels.
07	TS	6X44AA	Time Switch
08,09	UTR	6X92AA	Universal Tone Receiver
10	MP/MI	6X69AA	Message Protocol (or 6X43AA Message I/F)
11	TONE	6X79AA	Tone Generator *(or 0X50AA Filler Panel if slot 10 contains a 6X43AA)
12	SP	6X45AA	Signaling Processor
13	SPM	6X46AA	SP Memory (PCM30)
14	MP	6X45AA	Master Processor
15,16	MPM	6X47AA	MP Memory
17	SPM	6X46AA	SP Memory (PCM30)
18	SP	6X45AA	Signaling Processor (PCM30)
19	SIG	6X28AA	Signaling Card (PCM30)
20	——	0X50AA	Filler Panel
21	CSM	6X42AA	Channel Supervision Message
22	——	6X41AA	Formatter
23	DS30	6X40AB	DS30 Interface (16-port)
24	——	0X50AA	Filler Panel
25	——	2X70AA	Power Converter

Fig. 39 - IDTC: Shelf Layout and Card Complement (NT6X02BA)

12. SUBSCRIBER CARRIER MODULE

BACKGROUND

Introduction of Subscriber Carrier Systems

One of the first applications of digital transmission systems between a Central Office and a subscriber phone was a Subscriber Carrier System.

The Subscriber Carrier System (refer to Figure 40) consisted of a Control Terminal (CT) or Central Office Terminal (COT) (located at the Central Office with the analog switching equipment) and a Remote Terminal (located at a Remote Site). Analog speech and signalling were digitally encoded for transmission over DS1 links connecting the Control Terminal and the Remote Terminal. The receiving Terminal converted the digital signaling back to analog.

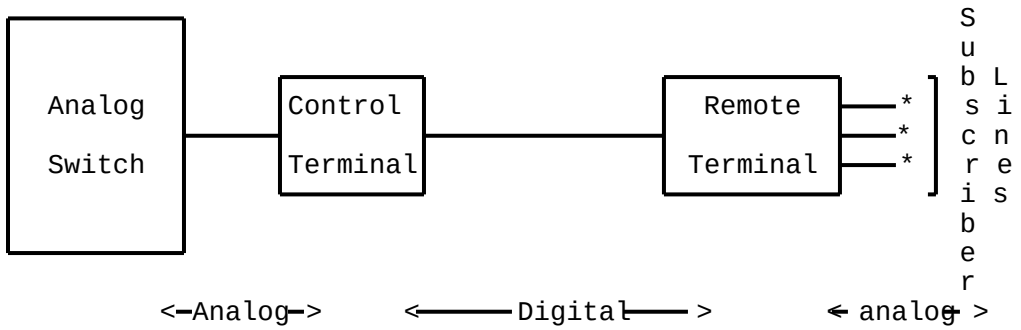


Fig. 40 - Subscriber Carrier System

Subscriber Carrier Systems in the DMS-100 Family

To enable the Remote Terminals to be retained when the analog switch was replaced by a DMS-100 family digital switch, new digital-to-digital Peripheral Modules called Subscriber Carrier Modules (SCM) were introduced to replace the Control Terminals. Subscriber Carrier Module is a generic term that describes all peripheral modules of this type. The three types of Subscriber Carrier Module, as well as the remotes that they support, are included in the list that follows:

SCM TYPE	REMOTE CARRIER
Subscriber Carrier Module-100R (SMR) (also called Subscriber Module Remote)	DMS-1 Rural Remote Terminal (RCT)
Subscriber Carrier Module-100U (SMU) (also called Subscriber Module Urban)	DMS-1 Urban Remote Terminal (RCU)
Subscriber Carrier Module-100S (SMS) (also called Subscriber Module SLC 96)	SLC 96 Remote Terminal (RCS)

This chapter describes the functions and elements that are common to all three types of Subscriber Carrier Module. The SMU, SMS, and SMR chapters, that follow this chapter, describe the functions and elements that are unique to each Subscriber Carrier Module.

When integrated with a DMS-100 family switch, the original Remote Terminals are retained and are renamed "Remote Carrier Modules" (refer to Figure 41 on page 116). In this section, the Remote Carrier Modules are often called Remotes.

Unlike the original implementation of the Subscriber Carrier Systems, where one Control Terminal was required to service one Remote Terminal, each Subscriber Carrier Module can service several Remote Carriers Modules.

By integrating the Remote Carrier Modules with the DMS-100, the Subscriber Carrier Module gives subscribers the full resources of a digital switching system for call processing and maintenance. Moreover, one SCM can support multiple Remote Carrier Modules and, with SCMs, individual line cards for each subscriber line are eliminated. This reduces Main Distribution Frame (MDF) wiring and activity and saves much office space. A system with an SCM, therefore, becomes less expensive and easier to maintain.

[6] SLC is a registered trademark of AT&T Technologies, Inc.

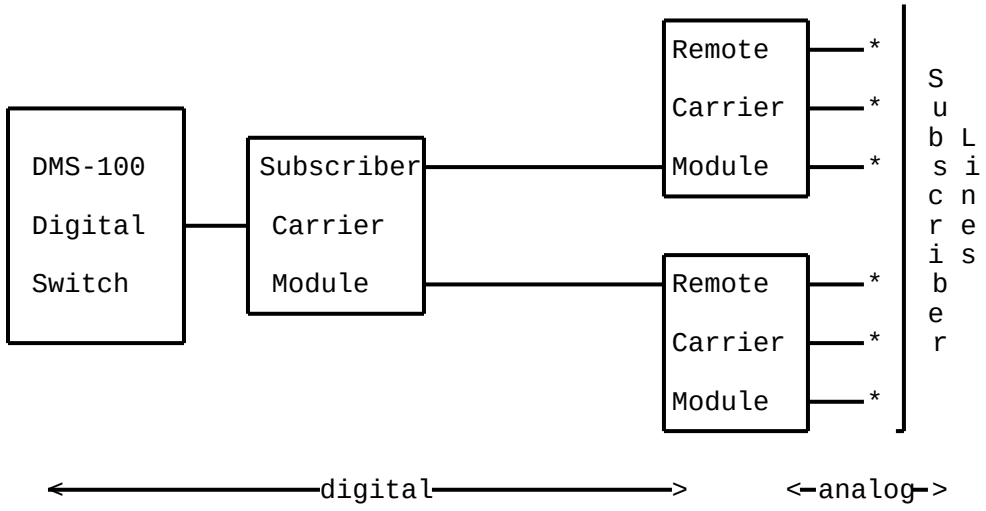


Fig. 41 - DMS-100 Subscriber Carrier System

INFORMATION FLOWS TO/FROM THE SCM

Information flows are transmitted between the SCM and three nodes types:

the Remote Carrier Module (control and speech/status)
the Central Control Complex (control)
the other Peripheral Modules (speech/ supervision).

Figure 42 shows the three types of information flows and how they relate to the CCC,the network, the SCM and Remote Carrier Modules.

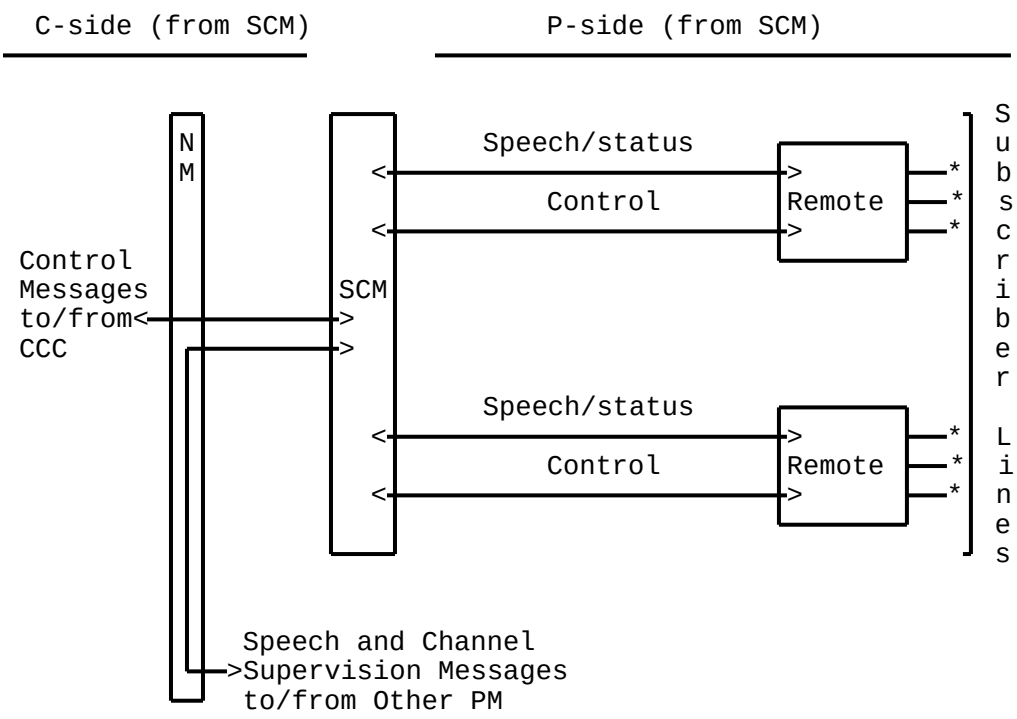


Fig. 42 - SCM-Remote Configuration and Information Flows

SCM<=>Remote Control Messages

The SCM and Remote exchange control messages over one or more DS1 links. The CCC constructs control messages destined for the Remote and the SCM reformats these messages for the Remote. After receiving the control message over a DS1 link, the Remote takes appropriate action and usually returns a control message response to the CCC through the SCM.

The control information exchanged includes

* messages from the CCC to the Remote

  - to set up or to take down connections (between a line card and a speech channel)

  - to update provisioning data records

  - to initiate Common Equipment, DS1 link, line card, or subscriber loop maintenance.

* messages from the Remote to the CCC

  - to indicate subscriber hook status

  - to acknowledge CC messages

  - to return test results

  - to signal fault conditions (with alarms).

SCM<->Remote Signaling

Speech and signaling information is exchanged between an SCM and a Remote over speech channels. A speech channel is used primarily to exchange digitally encoded speech samples.

The protocol used to exchange speech samples also allows two status indicators to be transmitted, called an A bit and a B bit, for each speech channel. The A bit is the Least Significant Bit (LSB), in each channel of frame 6, and the B bit is the LSB in each channel of frame 12 (see Figure 43 on page 119). When used as signaling bits, the A and B bits send

* subscriber-line-status information and dial pulse digits from the Remote Terminal to the SCM

* subscriber-line-control information from the SCM to the Remote, including ringing requests, and, for some remotes, coin commands

  Sometimes system control information is also exchanged, using signaling bits that are assembled into strings, but this depends on the type of SCM.

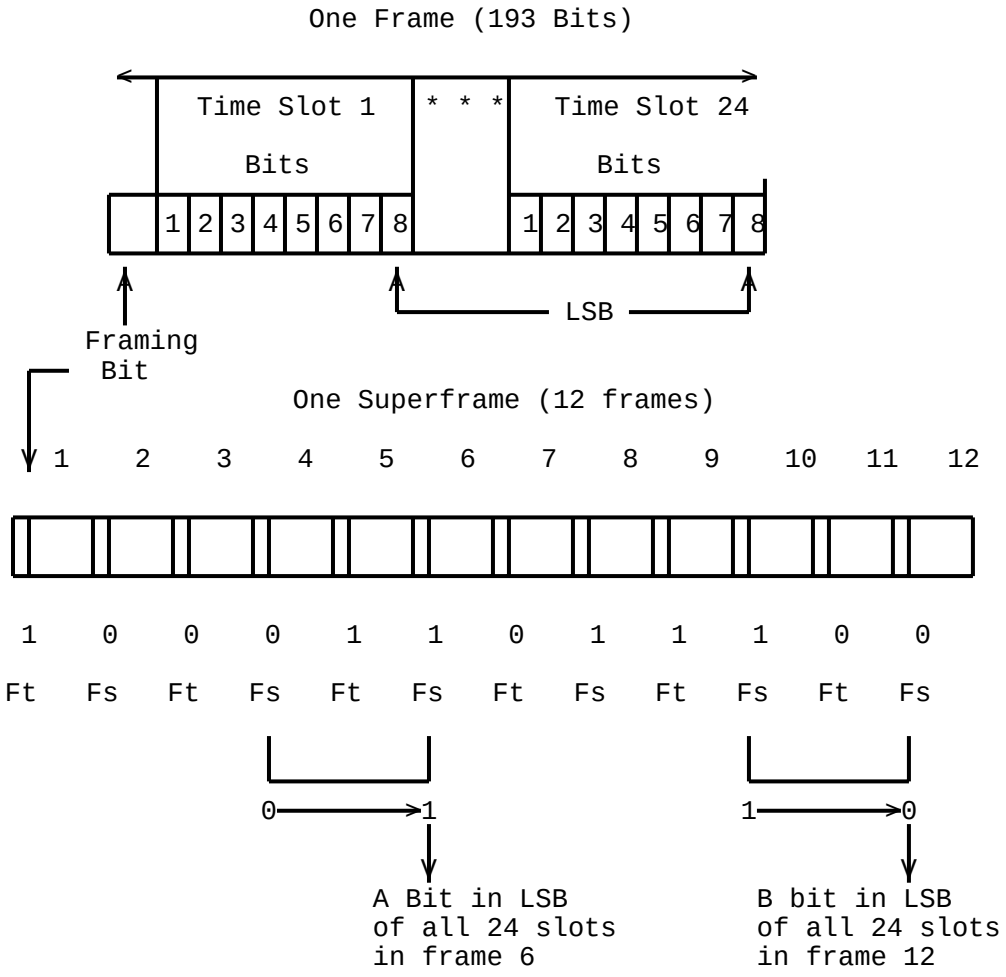


Fig. 43 - Location of A and B Bits

SCM<–>CCC Control Messages

An SCM and the central control complex (CCC) exchange control messages over dedicated control channels (channel 0, on links 0 and 2) on DS30 links.

The control information includes:

* messages to the CCC including:

  – change of subscriber status (for example, a subscriber has gone off-hook)

- dialed digits
- maintenance information.

* messages from the CCC including:
  - speech channel allocation for SCM-to-Remote or SCM-to-other PM connection
  - integrity values for supervision of SCM-to-other PM connections
  - provisioning data for the SCM
  - maintenance operation.

SCM<—>Other PM Speech/Supervision

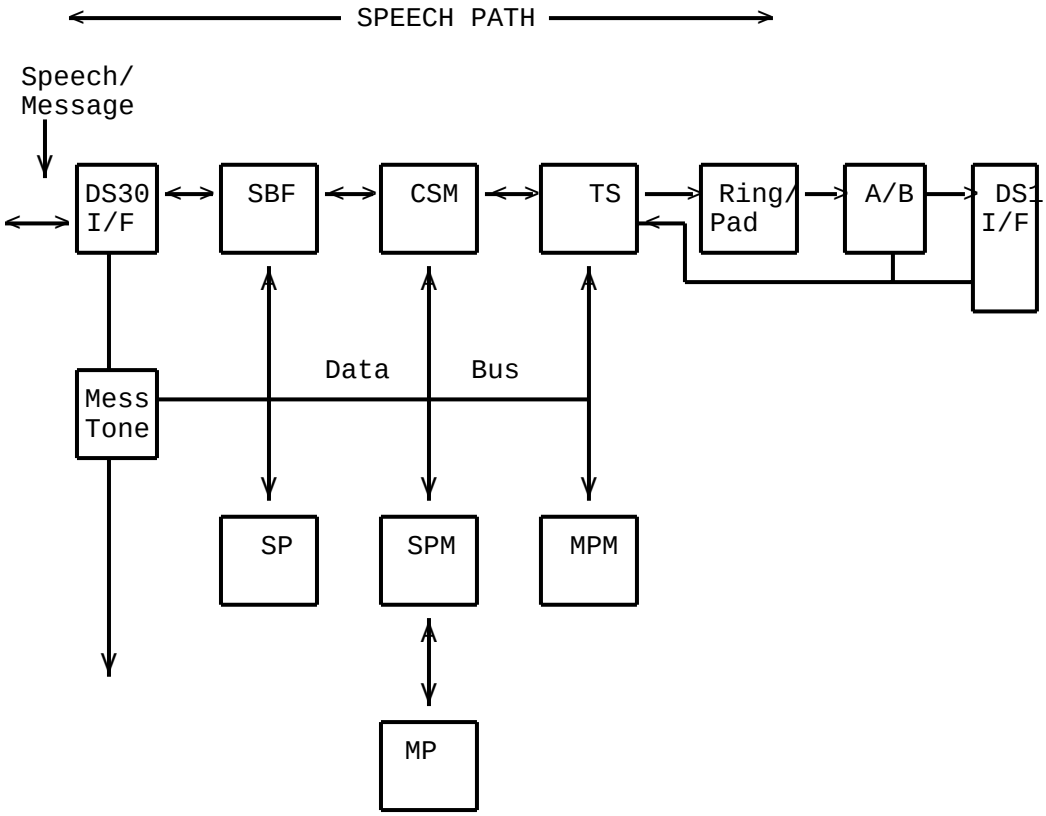
An SCM exchanges speech and Channel Supervision Messages with another PM over a speech channel connected via the Network Modules. The CCC establishes these connections as part of the call set up procedures.

The protocol used to exchange speech samples also allows for the transmission of supervision bits across the channel. The SCM transmits and receives 40-bit sequences called Channel Supervision Messages which contain:

* the integrity value allocated to the connection
* other PM-to-PM control messages.

DATA PATHS WITHIN THE SCM

The data paths between the cards in the SCM are shown in Figure 44 on page 121.



ABBR	REMARKS
CSM	Channel Supervisory Message
DS30 I/F	DS30 Interface
DS1 I/F	DS1 Interface
MP	Master Processor
MPM	Master Processor Memory
SBF	Speech Bus Formatter
SP	Signal Processor
SPM	Signal Processor Memory
TS	Time Switch
AB	A-Bit/B-Word (present for SMR and SMS)

Fig. 44 - Data Paths Within an SCM

INFORMATION FLOWS WITHIN THE SCM

The message and data flows between the cards of an SCM are described in this section. The internal configuration for an SCM is included in Figure 44 on page 121

The SP interfaces with certain cards over the data bus. The SP polls each card and sends or receives messages by Direct Memory Access (DMA). The memory access protocol is card specific.

The MP formulates messages destined for the CCC. The SP directs the messages, sending them from the Message and Tone card through the DS30 cards. CCC messages are placed on channel 0 of DS30 links 0 and 2. Messages from the CCC are extracted from the DS30 Interface card by the Message and Tone card. The SP scans the Message and Tone card, accesses the messages, and sends them to the MP for interpretation.

The Message and Tone card exchanges C-side messages with the DS30 card over a wired link. The Message and Tone card also enables message exchange between the active and inactive SCM units. These messages are sent over a wired link using Inter-Module Communication (IMC) protocol.

The DS30 cards and the Time Switch exchange control messages over a wired link.

Control and status messages to and from the DS1 cards are sent using a message channel through the Time Switch. The Time Switch exchanges one message channel per DS1 link with each DS1 card. Since each DS1 card handles two links, there are two message channels per card.

The SP and MP communicate by DMA of MP memory. The SP has access to both its own memory and that of the MP. The MP cannot access SP memory.

SCM TASKS

The primary SCM tasks are:

* Interfacing to DS30 and DS1 Links
* Connecting P-side and C-side Channels
* Connection Set Up for RCM Originating Call
* Reporting Call Originations to the CCC
* Connection Set Up and Ringing Control for RCM Destination Call
* Supplying Tones to RCM-Subscriber
* Taking Down of Connections to/from RCM-Subscriber
* Recording Dial Pulse Digits
* Detecting Use of "Flash" Feature
* Message Forwarding (RCM-to-CC and CC-to-RCM)
* Receiving and Issuing Coin Service Control Messages
* Loss Padding
* SWitch ACTivity (SWACT)
* Downloading Provisioning Data
* Auditing Hardware and Internal Records
* Executing Internal Diagnostics.

Interfacing to DS30 and DS1 Links

The SCM provides the P-side interfaces needed to send and receive data over DS1 links to/from a Remote. The SCM monitors signals transmitted over the DS1 links and ensures they meet transmission specifications. If too many errors occur or the frame or signal is lost, alarms are raised and links are sometimes automatically removed from service.

The SCM also provides the C-side interface needed to send and receive data over DS30 links (to/from the Network Modules).

Connecting C-side and P-side Channels

Network<->SCM<->Remote: The SCM sets up DS30 channels to/from the network and DS1 channels to/from the Remote for the duration of a call.

Special-Service Hairpin Connections: The SCM also sets up special-service hairpin (non-switched) connections. This type of connection is used for special service lines, where special-services include all services provided by an operating company other than residence, coin, and non-Private Branch Exchange (PBX) business services.

In a special-service hairpin connection, information is not switched through the Network. Rather, the information path goes from a Remote Carrier Module or other piece of digital equipment, over a DS1 link, through the SCM, over another DS1 link, and terminates on a Remote Carrier Module or other piece of digital equipment.

These connections are nailed up or permanently set up. The connections can be set up to use A-bit and B-bit signaling, and, during special-service connection failure, various types of trunk conditioning can be applied, or no trunk conditioning may be used at all.

Maintenance Test Connections: The SCM and the DMS switch set up maintenance test connections (for example, a metallic bypass to test subscriber loops). (Refer to Table B on page 128).

Connection Set Up for Remote Originating Call

When a subscriber goes off-hook, the SCM receives either an off-hook message or off-hook signal. The SCM allocates a DS1 channel and requests the Remote associate the DS1 channel with the appropriate internal loop and time slot. Once a speech connection is established between the Remote line card and the SCM, the SCM monitors status of the line using the A and B bits sent by the line card (refer to Figure 43 on page 119).

Reporting Call Originations to the CCC

After the subscriber has remained off-hook for a specific time interval (360 ms in SMU-RCU subsystem; 400 ms in SMS-RCS subsystem; 200 ms in the SMR-RCT subsystem) the SCM reports the origination to the CCC. The CCC allocates the necessary SCM-to-network channel(s) to program the call setup.

Supplying Tones to Remote-Subscriber

On instruction from the CCC, the SCM supplies the tones used in the setup of a call from an Remote-Subscriber. The tones supplied are:

* Dial Tone - to request dialed digits

* Busy Tone - to indicate that the called party is already busy

* Reorder Tone - to indicate that a connection cannot be established to the switch serving the called party.

* Ringback Tone - to indicate to the calling party that the line of the party being called is ringing.

Set Up and Ringing Control for Terminating Call

On receipt of an incoming call notification from the CCC, the SCM sends a "Set Up Connection" message to the Remote. Once the SCM-to-Remote speech path has been set up, the SCM sends a ringing signal to the Remote. The SCM controls the cadence of the ringing by transmitting different A and B bit patterns.

Different SCM-RCM subsystems supply different types of ringing, including superimposed, Frequency Selective Ringing (FSR), Coded, and single-party 20 Hz.

Taking Down of Connections to/from Remote-Subscriber

The SCM monitors the A bits received from the Remote for each active call. If the Remote subscriber goes on-hook for more than 480 ms in the SMU-RCU subsystem; 400 ms in the SMS-RCS subsystem; or 200 ms in the SMR-RCT subsystem (1140 ms for the SMU-RCU subsystem, 1550 ms for the SMS-RCS subsystem, or 1450 ms in the SMR-RCT subsystem, where the subscriber has a flash feature), the SCM interprets this as a disconnect.

When a disconnect occurs, the SCM sends:

* a disconnect message to notify the CCC

* a take-down-connection message to the Remote.

If the far-end subscriber disconnects, the CCC informs the SCM, and the SCM sends a take-down-connection to the Remote.

Recording Dial Pulse Digits

For subscribers using dial pulse equipment, the SCM detects the dialed digits using A and B bit signaling information. Dial pulses are transmitted from a subscriber phone set to its associated line card as a series of makes and breaks (on-hooks and off-hooks). The Remote line card detects these hook changes and uses the A signaling bit, which it transmits to the SCM, to indicate a make (A=1) or a break (A=0).

The SCM scans incoming A bits, collects the digits into a string in its call processing software area, and forwards the digits to the CC.

The SCM uses specific time intervals while scanning A bits. These intervals determine intra-digit timeouts, breaks, and related digit-collection variables.

Detecting Use of "Flash" Feature

As mentioned under Taking Down of Connections to/from Remote-Subscriber on page 125, the SCM detects flashing. When an Remote subscriber goes off-hook for a certain time interval (480 ms to 1440 ms in the SMU-RCU subsystem; 400 to 1550 ms in the SMS-RCS subsystem; or 200 to 1450 ms in the SMR-RCT subsystem), the SCM interprets this as a flash.

Message Forwarding (CCC->RCM)

The SCM forwards control messages and data that the CCC is sending to the Remote. The SCM reformats these messages into an appropriate format for the Remote.

The SCM collects return messages from the Remote, reformats them, and sends the reformatted messages to the CCC.

Receiving and Issuing Coin Service Control Messages

The SCM supports three types of coin service:

* Coin First Pay Stations (CCF service, dial tone is given after an off-hook and coin deposit)

* Dial Tone First Pay Stations (CDF service, dial tone is given after an off-hook but the connection is completed only after coin deposit)

* Semi-Post Pay Stations (CSP service, dial tone and dialing before coin deposit but speech is enabled after coin deposit).

All coin operations are initiated by the CCC (with the exception of coin return). Upon receiving a call origination message, the CCC issues coin control commands to the SCM. The SCM, in turn sends coin commands to the Remote over the voice channel set up for the coin call.

SCM coin commands consist of A and B bit signals or A and B bit signals coupled with Pulse Coded Modulation (PCM) values (see Figure 49 on page 140). The SCM coin commands (A/B bit, PCM, or both) instruct the Remote to initiate five main coin operations:

* coin collect

* coin presence

* coin return

* partial coin presence check

* ringing.

The SCM issues the previous coin commands before or after subscribers receive voice communication. The Remote places line voltages on the coin line tip and ring in compliance with the SCM commands and sends line status signals (using A and B bits) to the SCM.

The SCM monitors the line status signals from the Remote and forwards messages to the CCC to indicate if the original CCC coin commands have been completed.

Loss Padding

Padding or attenuation of PCM samples is needed to compensate for signal loss in the network. The CCC directs the SCM to apply padding for specific lines.

SWitch ACTivity (SWACT)

The active and standby units of the SCM are in constant communication. If a fault occurs in the active unit, the standby unit takes over full control. The system maintains calls in the talking state.

Downloading Provisioning Data

The SCM downloads provisioning data to its subtending Remote Carrier Modules when the Remotes are returned to service. Provisioning data can include Common Equipment hardware present on the Remote Carrier Module, types of line cards present, line card options, system options, and related data.

Auditing Hardware and Internal Records

The SCM runs audits that check the integrity of some hardware and ensure consistency between internal records.

Executing Internal Diagnostics

When the SCM is tested or returned to service from the MAP, a series of internal tests are run that check both software and hardware. Table B on page 128 lists the kinds of diagnostics that are performed and the hardware components that are involved.

TABLE B
SCM INTERNAL DIAGNOSTICS

NAME	CAPABILITIES TESTED	COMPONENTS INVOLVED.
A/B	Loop-around ability of Time Switch CSM loop-around ability of the Formatter card Time switching function of the Time Switch Time Switch generation of A/B bits	6X85 DS1 card 6X44 Time Switch 6X69 Message and Tone 6X41 Speech Bus Formatter Speech Bus
CSM	Memory of the CSM and Formatter Channel Data byte transmission and reception logic	6X42 CSM 6X41 Formatter Speech Bus
DS1	Loop-around circuitry of the DS1 card DS1 control register Looping of A/B bits to and from the 6X85	6X85 DS1 6X44 Time Switch 6X69 Message and Tone Speech Bus
Message	Transmit messages from P-side to C-side Message card memory Frame Interrupt required to communicate with the network	6X43 Message and Tone 6X44 Time Switch 6X41 Speech Bus Formatter 6X85 DS1 Speech Bus
Speech	Integrity of speech channels	6X41 Formatter 6X69 Message and Tone 6X44 Time Switch 6X85 DS1 Speech Bus

Table Continued

TABLE B (Continued)
SCM INTERNAL DIAGNOSTICS

NAME	CAPABILITIES TESTED	COMPONENTS INVOLVED.
Time Switch	Memory and time switching function of the Time Switch	6X44 Time Switch 6X69 Message and Tone
Tones	Ensures that all channels carrying tones are enabled onto the speech bus	6X43 Speech Bus

SCM CARDS

The following cards are used in an SCM:

* DS30 Interface
* DS1 Interface
* Speech Bus Formatter
* Channel Supervisory Message
* Master Processor
* Master Processor Memory
* Signaling Processor
* Signaling Processor Memory
* Time Switch
* Message and Tone
* Ring/Pad
* A/B (SMR and SMS)

Note: The locations of these cards in the different SCM and the PEC for each card are shown in Figure 51 on page 143, Figure 54 on page 151 , and Figure 56 on page 155.

Note: More detailed information on each cards can be found in the associated General Specification (GS) documents.

DS30 Interface

* transmits speech to and receives speech from the Network

* converts the signals from bipolar to Transistor Transistor Logic (TTL) and back, synchronizes the signals with the SCM, and passes these signals to the Speech Formatter card.

DS1 Interface

* provides a loop-around circuit for each DS1 port to allow for isolation of faults

* generates the framing bit for outgoing PCM

* detects errors that can lead to alarms being produced.

Speech Bus Formatter

* converts PCM speech from the DS30 card from serial to parallel format

* converts PCM speech from the CSM card from parallel to serial format

* provides Network and CSM loop-around.

Channel Supervisory Message

* extracts and buffers the CSM for each outgoing speech channel

* generates the CSM for each incoming speech channel

* detects and flags parity errors for each outgoing speech channel

* passes the Supervision bit (the most significant bit of the Channel Data Byte) to the Time Switch.

Master Processor

* collects digits

* administers call control

* assigns channel

* interprets CCC messages.

The Signal Processor and Master Processor communicate with each other through the Dynamic Memory Access (DMA) of the Master Processor Memory

Signaling Processor

* forwards messages exchanged between the CCC and RCM

* scans for A and B bits

* controls the Time Switch

* receives and transmits CSM

* controls the A-BUS (internal messaging).

Master and Signaling Processor Memory

* provide the software used in call processing, maintenance, and administrative tasks.

Time Switch

* provides non-blocking switching to connect any C-side port and channel from the parallel speech bus to any P-side port and channel

* replaces the Least Significant Bit of the appropriate channels with the signaling bits, as directed by the Signal Processor.

Message and Tone

* exchanges C-side messages with the DS30 card over a wired link.

* provides multiple tones, which are passed to the Time Switch as PCM samples on specified control links. These samples, firmware encoded, include the following:

  - busy tone
  - dial tone
  - reorder tone
  - audible ringback
  - special tones.

Ring/Pad

* attenuates PCM 0 to 7 decibels (all outgoing speech passes through a Ring/Pad card), with the exact amount determined on a per channel basis by software.

* provides PCM-encoded frequencies for Frequency Selective Ringing.

A/B

* inserts A and B bits into the PCM stream and extracts A and B bits from the PCM stream.

  These per-channel signaling bits are used for ringing, hook status detection, and, in some cases, ANI and coin functions.

HARDWARE CONFIGURATION

SCM Structure and Specification

An SCM consists of:

* a C-side interface comprising DS30 Interface cards

* a duplicated Processor Complex comprising:

  - a Master Processor card containing the programs that direct most of processing functions performed by the SCM

  - a Signaling Processor card that accesses the ancillary cards in the Processor Complex to control the flow of messages to/from (and through) the SCM and moves messages to and from memory that can be accessed by the MP.

* ancillary cards to handle the reception and transmission and temporary storage of data and the switching of data within the SCM.

* a P-side interface comprising DS1 Interface cards.

The basic specification of the SCM is detailed in Figure 45 on page 133.

CLASSIFICATION		
PM NAME	PM TYPE	REMARKS
Subscriber Carrier Module (SCM)	XPM	A DMS-100 PM that emulates a Control Terminal or Central Office Terminal for communication with a Remote Carrier Module.

C-SIDE LINKS			
MIN. MAX.	TYPE	CHAN/LINK	REMARKS
3 16	DS30	32	Links are duplicated to other (duplicated) network plane. SMS has up to 4 DS30 links.

P-SIDE LINKS			
MIN. MAX.	TYPE	CHAN/LINK	REMARKS
2 20	DS1	24	Number of DS1 channels should be equal to or less then the number of C-side DS30 channels.

BASIC STRUCTURE OF SCM

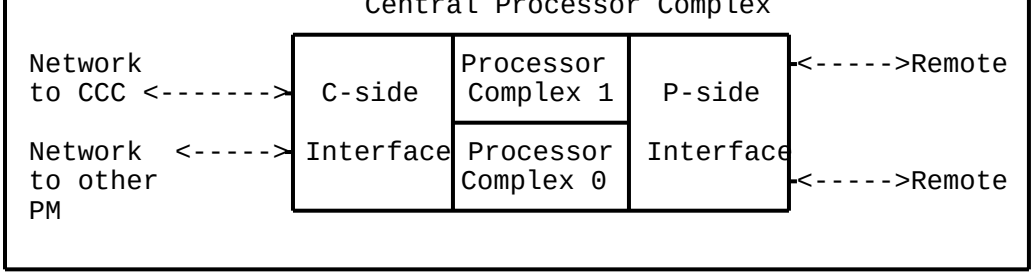


Fig. 45 - SCM Specification

Physical Configuration

SCM Shelf

Subscriber Carrier Modules are redundant, with two units, an active and a standby (mate). Each unit can support call processing and system control. While one unit is operating as the main processor, the other unit is in "hot" standby; when a fault occurs on the active unit, the standby unit takes over full control of the links until the failure is corrected.

Unit 0 occupies the lower shelf of an SCM, while Unit 1 occupies the upper shelf. Figure 51 on page 143, Figure 54 on page 151 , and Figure 56 on page 155show the unit layouts of the different SCMs and include for each card on the unit the slot number and NT PEC identification.

Frame

SCMs are housed in a standard DMS-100 single-bay frame, called a Subscriber Module Equipment (SME) frame. This frame (NT6X01AA) contains two pairs of shelves, each pair referred to as a module. The lower module is numbered 0 while the upper module is numbered 1.

Because an SME frame is designed to accommodate combinations of SMR, LGC, DTC, LTC, SMS, and SMU modules, any pair of these modules can be provisioned in one frame. Refer to Figure 46 on page 135 for an example of an SME frame layout.

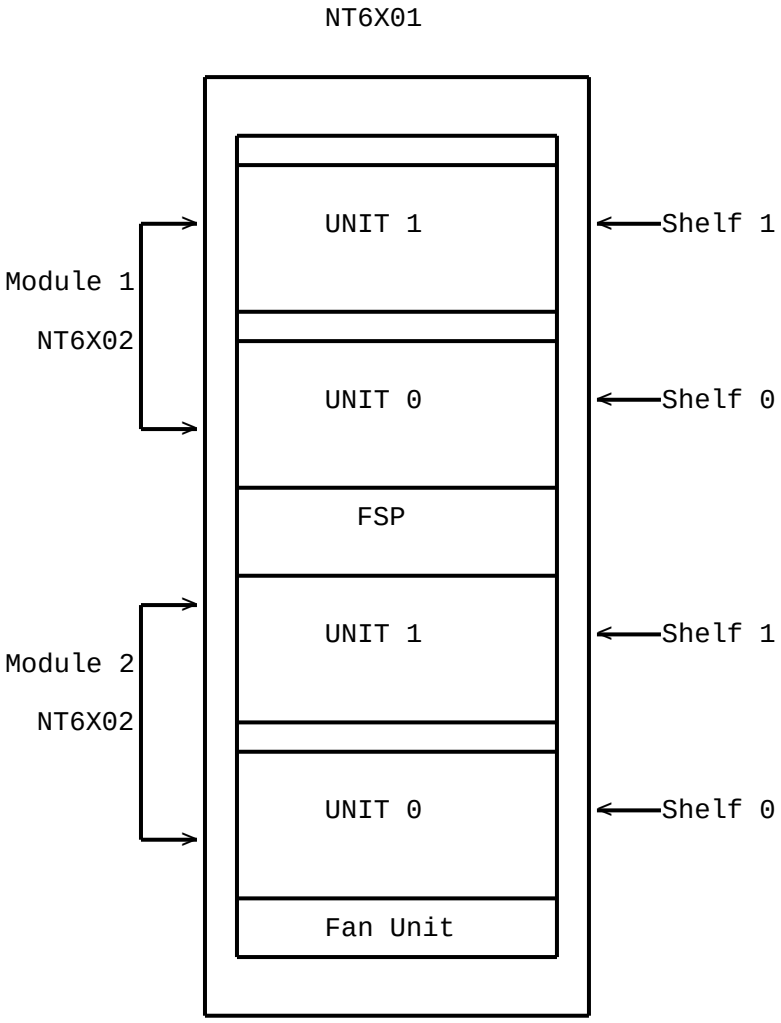


Fig. 46 - SCM Frame

13. OVERVIEW OF THE SMU-RCU SUBSYSTEM

The Subscriber Module Urban (SMU) is one of the three types of Subscriber Carrier Modules currently available. Subscriber Carrier Module is a generic term used to describe all peripheral modules of this type. This chapter describes the Subscriber Carrier Module functions and elements that are unique to the SMU. Those functions and elements in the SMU that are common to all Subscriber Carrier Modules are described in the Subscriber Carrier Module chapter.

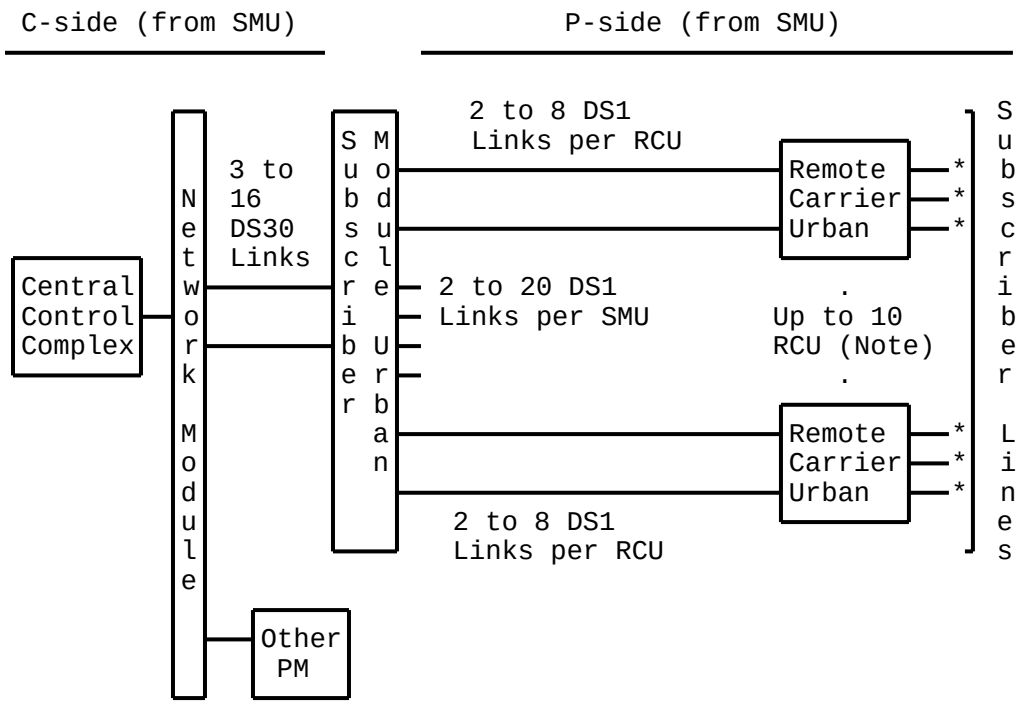
The Subscriber Module Urban (SMU) enables existing DMS-1U Remote Terminal Equipment, previously serviced from an analog switch, to be connected to a DMS switch.

The SMU and one or more DMS-1U Remote Terminals become a subsystem of the DMS switch. The DMS-1U Remote Terminal is renamed "Remote Carrier Urban" (RCU) and the complete subsystem is called the SMU-RCU subsystem.

Figure 47 on page 137 shows:

* the position of the SMU-RCU subsystem in relation to the central components of a DMS-100 switch

* the connections between the SMU and the DMS Network Module (these connections are duplicated to both planes of the network).



Note: Based on the number of SMU p-side ports, up to 10 RCUs can connect to an SMU. The actual number supported depends on traffic through the RCU modules and SMU real time capacity.

Fig. 47 - SMU-RCU Configuration

INFORMATION FLOWS TO/FROM THE SMU

The information flows to and from the SMU are identical to the information flows in all the other Subscriber Carrier Modules. Subscriber Carrier Module is a generic term used to describe the family of peripheral modules of this type. For information on this subject see Information Flows to/from the SCM on page 117.

SMU<=>RCU Control Messages

The SMU-RCU Subsystem differs from other SCMs in the message protocol used to transfer information. The SMU and the RCU exchange messages over a dedicated control channel using DMSX protocol. Channel 0 on DS1 link 3 is the primary control channel. Channel 0 on DS1 link 4 is used as the secondary control channel. If link 3 fails, link 4 assumes transmission of control messages. The types of control messages exchanged were previously described in SCM<=>Remote Control Messages on page 117.

Figure 48 on page 138 shows the basic format of control messages that the SMU and RCU exchange. Messages usually comprise 15 bytes.

DESTINATION IDENTIFICATION (ID)	BYTE 0
SOURCE IDENTIFICATION (ID)	BYTE 1
OPERATION CODE	BYTE 2
FILLER AND MARKER	BYTE 3
DATA	BYTE 4 to BYTE 9
RESERVED DATA FIELD	BYTE 10 to BYTE 12
CHECKSUM (CRC-16)	BYTE 13 & BYTE 14

Fig. 48 - DMSX Message Format

The fields of the data packet are described in the following list:

Destination ID — Byte 0 is an 8-bit field that identifies the functional area or tasks to which the data packet is addressed. Examples of functional areas are RCU Call Processing (which has a Destination ID of 3), RCU Common Equipment (CE) Maintenance (which has a Destination ID of 17), and SMU Line Maintenance (which has a Destination ID of 12).

Source ID — Byte 1 is an 8-bit field that identifies the functional area or task in the SMU or RCU that originates the message. When the RCU replies to SMU messages, it switches the Destination ID and the Source ID of the original SMU message.

Operation Code — Byte 2 is an 8-bit field that defines the operation the Destination ID must execute. Examples

of operations are aborting a local line test (for RCU Line Maintenance) and executing a 24-hour switchover from one set of CE cards to another.

Filler — Byte 3 is a 7-bit field containing all zeros and is reserved for future use.

Marker — This single bit is set to 1 for single data packet messages. When a message contains several data packets, it is set to 0 for all but the last data packet, which has the bit set to 1 to indicate the last message of the data pack is coming.

Data Field — Bytes 4 through 9 each contain 8 bits. The information contained in these bytes varies with the Destination and Operation Code fields. They can contain logical addresses of subscriber lines, test results, and equipment status.

Reserved Data — Data bytes 10, 11,and 12 are reserved. Unless otherwise specified, the RCU copies the last three collocated bytes (10, 11, and 12) from the message it receives from the SMU into bytes 10, 11, and 12 of the data packet it is transmitting.

Checksum — Data bytes 13 and 14 contain a 16-bit check sum value. The module that receives this value uses it to ensure data packet integrity. The check sum value is compared to the data packet sum value (or a variation of the sum).

SMU<—>RCU Speech/Signaling

This section describes coin operations signaling between the SMU and RCU. This form of signaling is unique to the SMU. All other forms of speech and signaling between the SMU and RCU are common to the other types of Subscriber Carrier Modules. Common information is described in the Subscriber Carrier Module chapter (see SCM<—>Remote Signaling on page 118).

During coin operations, the SMU coin commands consist of A and B bit signals plus Pulse Coded Modulation (PCM) values which are issued by the SMU before or after subscriber voice communication is provided (refer to Figure 49 on page 140). The RCU responses are indicated by A and B bit signals.

SIGNALS SENT FROM SMU		SIGNALS SENT TO THE SMU BY THE RCU			
A and B bit Signals	Coin Control Patterns (PCM value)	Idle	Off-hook	Coin Ground	Off-hook and Coin Ground
Normal Battery		X	X		X
Reverse Battery		X	X		X
Coin Control	Coin Check Positive (11101100)	X		X	
Coin Control	Coin Check Negative (11101000)	X		X	
Coin Control	Coin Collect (11110000)	X			X
Coin Control	Coin Return (11110100)	X			X
Coin Control	Ringing (11111000)	X	X		X

Fig. 49 - Signals and Control Patterns for Coin Lines

SMU-CCC control messages and supervision between the SMU and another PM were described previously in SCM↔>CCC Control Messages on page 119 and SCM↔>Other PM Speech/Supervision on page 120, respectively.

SMU TASKS

This section describes two SMU tasks: channel reassignment and setup of special-service hairpin connections. The SMR-RCT subsystem also supports channel reassignment, and the SMS-RCS subsystem supports special-service hairpin connections. All other tasks described for the SMU are common to other types of Subscriber Carrier Modules. Common information of this type is described in the Subscriber Carrier Module chapter (refer to SCM Tasks on page 123).

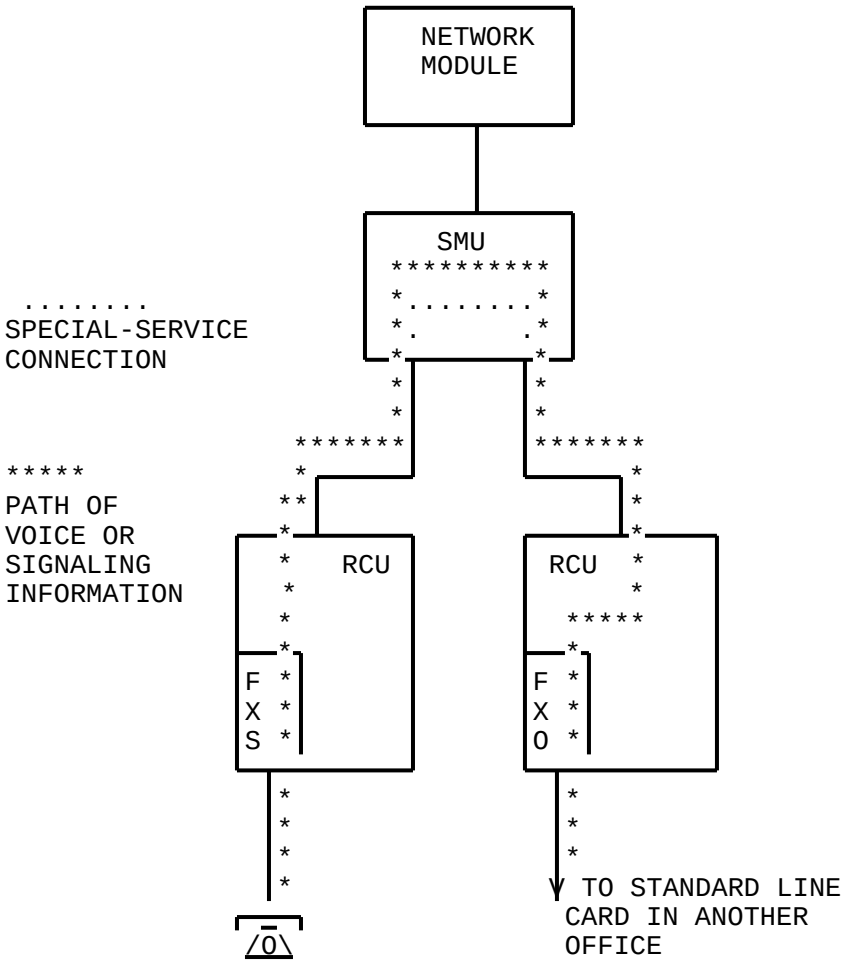
Message and Speech Channel Reassignment

If a problem occurs on the primary message link (SMU to RCU), the SMU switches to the secondary link to maintain continuous communication with the RCU. If both links fail, then all messaging is lost. The RCU enters Total Operation Failure and is removed from service.

If any message or non-message DS1 link fails, calls in the talking or ringing states are reassigned to free channels on a properly functioning DS1 link. Calls in other states, such as dial tone or digit collection, are dropped. Special-service calls are reassigned before POTS calls, and calls in the talking state are reassigned before calls in the ringing state. Sometimes special-service calls are allowed to "bump" POTS calls when too few free DS1 channels exist to handle calls from a failed DS1 link.

Special-Service Hairpin Connections

The SMU-RCU subsystem supports special-service hairpin connections. Such connections are not switched through the network; rather, the information path is from an RCU or other piece of digital equipment (channel bank, another switch, or related equipment) over a DS-1 link to the SMU. Information passes through the SMU and is sent over another DS-1 link, which leads to an RCU or other piece of digital equipment. Foreign exchange and data services are examples of special services that use hairpin connections (refer to Figure 50 on page 142 for an example of a foreign exchange hairpin connection).



SMU = SUBSCRIBER MODULE URBAN
RCU = REMOTE CARRIER URBAN
FXS = FOREIGN EXCHANGE STATION END
FXO = FOREIGN EXCHANGE OFFICE END

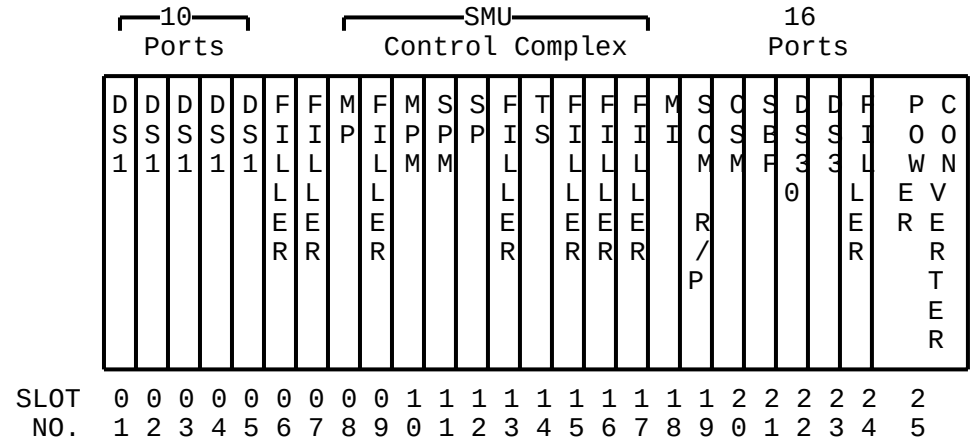
Fig. 50 - Foreign Exchange Hairpin Cross Connection

HARDWARE CONFIGURATION

Physical Configuration

An SMU is provisioned in an NT6X01 frame called an SME frame (refer to Figure 46 on page 135). Two SMU modules can occupy an SME frame, with each SMU consisting of two units.

Each SMU has two identical units, which contain Common Equipment cards. These cards are shown in Figure 51 on page 143 and were described previously under SCM Cards on page 129.



Slot	ABBR	NT PEC	Remarks
01-05	DS1	6X85AB	DS1 Interface
06-7,	-	0X50AA	Filler
08	MP	6X45AC	Master Processor
09	-	0X50AA	Filler
10	MPM	6X47AB	Master Processor Memory
11	SPM	6X46AB	Signal Processor Memory
12	SP	6X45AC	Signal Processor
13	-	0X50AA	Filler
14	TS	6X44CA	Time Switch
15-17	-	0X50AA	Filler
18	MI	6X69AB	Message and Tone
19	R/P	6X80BA	Ring/Pad
20	CSM	6X42AA	Channel Supervisory Message
21	SBF	6X41AA	Speech Bus Formatter
22,23	DS30	6X40AA	DS30 Network Interface
24	-	0X50AA	Filler
25	-	2X70AD	Power Converter

Fig. 51 - Card Locations in SMU Shelf

14. OVERVIEW OF THE SMS-RCS SUBSYSTEM

The Subscriber Module SLC 96 (SMS) enables existing SLC 96 Remote Terminal Equipment, previously serviced from an analog switch, to be connected to a DMS switch.

The SMS and one or more SLC 96 Remote Terminals become a subsystem of the DMS switch. The SLC 96 Remote Terminal is renamed "Remote Carrier SLC 96" (RCS) and the complete subsystem is called the SMS-RCS subsystem.

See Figure 52 for:

* the position of the SMS-RCS subsystem in relation to the central components of a DMS-100 switch

* the connections between the SMS and the DMS Network Module (these connections are duplicated to both planes of the network).

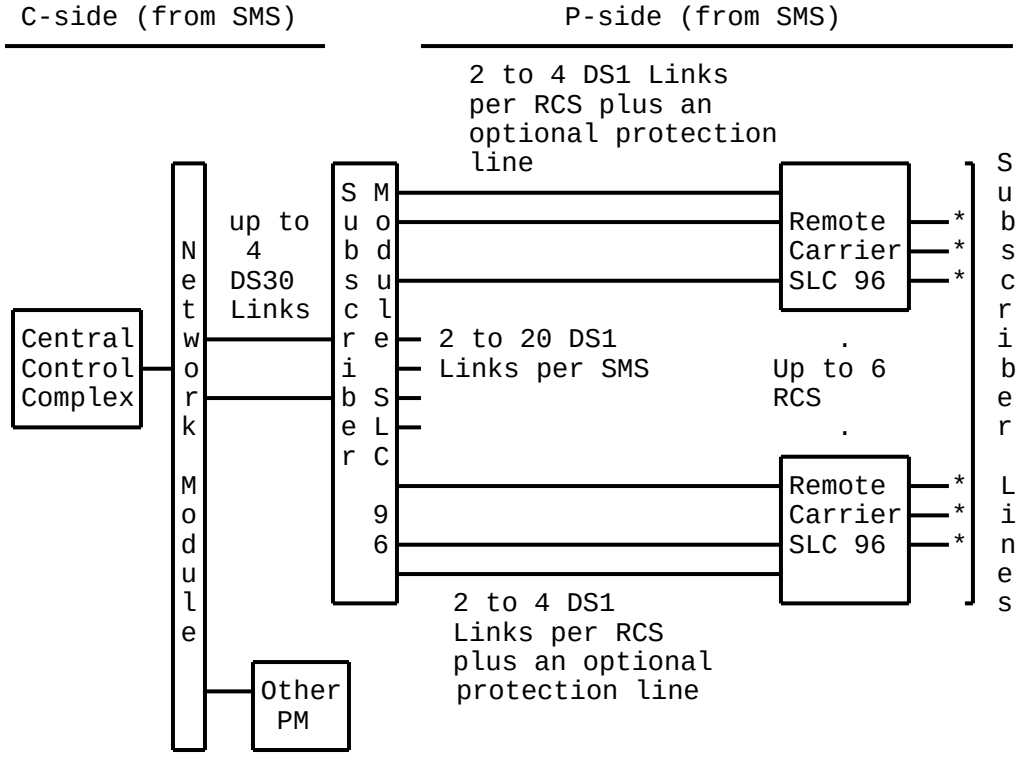


Fig. 52 - SMS-RCS Configuration

INFORMATION FLOWS TO/FROM THE SMS

This section describes information flows that are unique to the SMS. Additional information flows to and from the SMS that are common to other peripheral modules of this type are described in the Subscriber Carrier Module chapter. Subscriber Carrier Module is a generic term used to describe the family of peripheral modules of this type. See Information Flows to/from the SCM on page 117.

SMS<—>RCS Control Messages

The SMS-RCS subsystem differs from other SCMs in the message protocol used to transfer information. The SMS and RCS exchange messages over a special data link called a Derived Data Link (DDL). The DDL is a 2.2 Kilobit/second data path formed by robbing Fs framing bits. As shown in Figure 43 on page 119, an SCM superframe consists of 12, 193-bit frames. Each frame is preceded by a framing bit. These framing bits are either Ft of Fs bits. In the SMS-RCS subsystem, two superframes pass unaltered, but the next four are robbed of their Fs bits, and these bits are replaced with DDL bits. Thus, the DDL link consists of 24 bits. The Fs bits are robbed at either a card in the RCS or the Time Switch card in the SMS.

DDL Messaging

The 8085 Microprocessor of the A-bit/B-word DDL card sends DDL messages to the Time Switch that are included in the DS1 PCM data stream, and it extracts the DDL message from incoming PCM. Software in the SP, called the DDL Facility, processes DDL messages.

The DDL message consists of 24 consecutive bits that are grouped as shown in Table C on page 146.

TABLE C
DERIVED DATA LINK BITS

DDL BITS	FIELD NAME
Bits 1 through 11	Concentrator Field (C-Field)
Bits 12 through 14	Spoiler Bits (fixed pattern of 010)
Bits 15 through 17	Maintenance Field (M-Field)
Bits 18 and 19	Alarm Data Link Field (A-Field)
Bits 20 through 23	Protection Line Switch Field (S-Field)
Bit 24	Spoiler Bit Field (fixed pattern of 1)

The SMS-RCS subsystem uses the C-Field only when the RCS operates in Mode II. This is a mode used for special-service and coin operation, although POTS is also supported. The C-field carries information that includes control of assignment of subscribers to DS1 channels, hook transitions, and activation of the PCM Looping Test. The PCM Looping Test is a loop-around test on a DS1 link from the SMS to the RCS and back. It ensures the integrity of DS1 channels.

A list follows of five field types and the information that is contained in each field:

1. The M-Field carries information for all shelves and controls card and customer loop testing.

2. The A-Field carries alarm and system control information for all shelves.

3. Spoiler bits are inserted at preassigned positions in the DDL to ensure that a signaling pattern is never duplicated by the DDL.

4. The S-Field controls the switching of the DS1 protection link.

5. When no C-Field is available to send on the DDL link, the 8085 Microprocessor sends an idle pattern on the DDL link. The RCS also sends an idle pattern when no new C-Field exists.

If the M-, A-, or S-Fields remain unchanged between messages, the 8085 Microprocessor sends the previous field patterns. The RCS, at the other end, also sends the same patterns. The 8085 Micro-

processor sends information to the SP only when a DDL field changes; idle patterns are not transmitted.

SMS<—>RCS Speech/Signaling

This section deals with signaling that is unique to the SMS. Signaling between the SMS and RCS, that is common to other Subscriber Carrier Modules, is described in the Subscriber Carrier Module chapter.

Refer to SCM<—>Remote Signaling on page 118 for general information on signaling used between the SMS and the RCS.

A and B bits are either 1 or 0, and the possible A- and B-bit patterns are steady state 0, steady state 1, and modulated 0 and 1. These patterns signify different signaling states. The SMS sends the following signaling information to the RCS on a per-channel basis

* Start or stop ringing

* Start or stop forward disconnect

* Scan for on-hook and off-hook

* Collect ANI/Coin information

* Collect channel maintenance information.

The SP collects return signaling information from the RCS that includes the following data:

* Call Origination

* Call Disconnect

* Digit Collection

* ANI/Coin

* Answer

* Flash.

The RCS never sends modulated 1 and 0 messages to the SMS. It sends only a steady 1 and 0. The SMS can send modulated 1 and 0 to the RCS.

A- and B-bit messages are decoded in a unique way for each type of RCS line card. A specific pattern for a single-party line card, for example, may indicate something different than the same pattern for a coin card.

The SP contains a software section called the A/B Bit Facility (AB_BIT Facility), which ensures that the 8085 Microprocessor is

operating correctly and scans incoming RCS signaling information on a per-channel basis for origination, answer, flash, disconnect, and other subscriber telephone states. These states are defined as follows:

Origination	Subscriber line goes off-hook from on-hook and stays off-hook for at least 400 ms.
Digit Collection	Pulses at 7.5 to 12 every second, percent break of 58 to 64, intra-digit time out of 300 ms.
Answer (to ringing)	Subscriber line goes off-hook from on-hook and stays off-hook for at least 200 ms.
Flash	Subscriber line goes from off-hook to on-hook and stays on-hook for at least 400 ms but not more than 1550 ms and returns to off-hook for at least 200 ms.
Disconnect	Subscriber goes on-hook from off-hook and stays on-hook for at least 1550 ms (flash option allowed). When the flash option is not allowed, disconnect occurs when a subscriber line goes on-hook from off-hook and stays on-hook for at least 400 ms.

Another part of the SP, called the DIGC_ROUTINE, detects and collects digits, counting and reporting them to the A/B Bit Facility.

SMU-CCC control messages and supervision between the SMU and another PM were described previously in SCM=>CCC Control Messages on page 119 and SCM=>Other PM Speech/Supervision on page 120, respectively.

SMS TASKS

This section describes protection switching, a task that is unique to the SMS and SMR. SMS tasks, that are common to other Subscriber Carrier Modules, are described in the Subscriber Carrier Module chapter.

Refer to SCM Tasks on page 123 for information on tasks that are common to all Subscriber Carrier Modules.

Protection Switching

Protection switching ensures continued communication between an SMS and RCS if a DS1 line connecting the two fails or must be put out of service by the switch operator.

A protection line occupies one DS1 p-side port of a SMS and connects a single RCS. Each RCS has from one to four primary lines

and at most one protection line. Each protection line serves only the RCS to which it connects. Figure 53 on page 149 shows a typical protection line configuration.

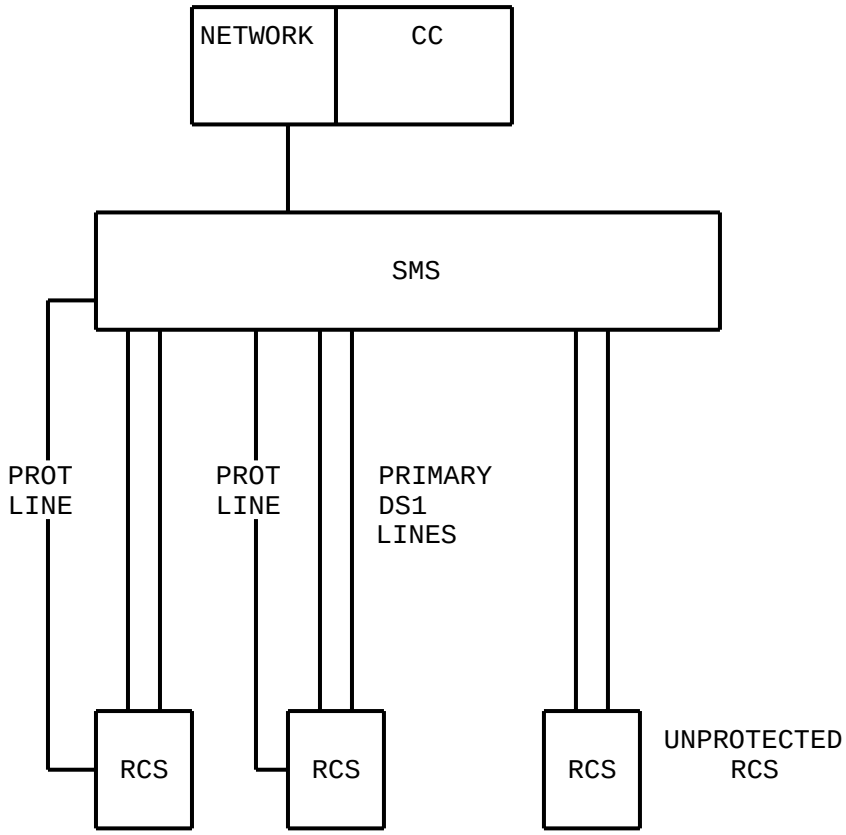


Fig. 53 - Protection Line Configuration

Protection switches are initiated automatically by the RCS or SMS, or manually by the switch operator.

When a protection switch occurs, calls in the talking state are maintained. For POTS and coin lines, calls in the ringing state are also maintained. The protection line carries voice, signaling, and system control information.

Causes Of Automatic Protection Switching

Either an SMS or an RCS may initiate a protection switch after detecting a DS1 link failure. The module that detects the failure initiates the protection switch.

Switches occur for the following faults:

* Bipolar violations (BpV) exceeding the threshold datafilled in the CARRMTC Table

* Loss of signal persisting for a time greater than the threshold datafilled in the CARRMTC Table

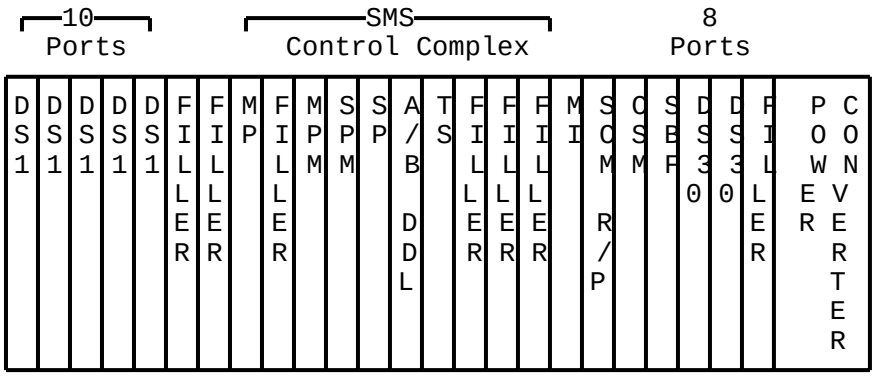
* Removal of a DS1 Interface card.

HARDWARE CONFIGURATION

Physical Configuration

An SMS is provisioned in an NT6X01 frame called an SME frame (refer to Figure 46 on page 135). Two SMS modules can occupy an SME frame, with each SMS consisting of two units.

Each SMS has two identical units, which contain Common Equipment cards. These cards are shown in Figure 54 on page 151 and were described previously under SCM Cards on page 129.



Slot	ABBR	NT PEC	Remarks
01-05	DS1	6X85AB	DS1 Interface
06-7,	-	0X50AA	Filler
08	MP	6X45CA	Master Processor
09	-	0X50AA	Filler
10	MPM	6X47AB	Master Processor Memory
11	SPM	6X46AB	Signal Processor Memory
12	SP	6X45CA	Signal Processor
13	-	6X86AA	A-bit/B-word DDL Message
14	TS	6X44AB	Time Switch
15-17	-	0X50AA	Filler
18	MI	6X43AA	Message and Tone
19	SCM R/P	6X80BA	SCM Ring/Pad
20	CSM	6X42AA	Channel Supervisory Message
21	SBF	6X41AA	Speech Bus Formatter
22,23	DS30	6X40BA	DS30 Network Interface
24	-	0X50AA	Filler
25	-	2X70AD	Power Converter

Note:
6X40BA Network Interface card has four network ports and must be used with 6X45CA processors.

Fig. 54 - Card Locations in SMS Shelf

15. OVERVIEW OF THE SMR-RCT SUBSYSTEM

The Subscriber Module Remote (SMR) enables existing DMS-1 Rural Remote Terminal Equipment, previously serviced from an analog switch, to be connected to a DMS switch.

The SMR and one or more DMS-1 Rural Remote Terminals become a subsystem of the DMS switch. The DMS-1 Rural Remote Terminal is renamed "Remote Concentrator Terminal" (RCT) and the complete subsystem is called the SMR-RCT subsystem.

See Figure 55 for:

* the position of the SMR-RCT subsystem in relation to the central components of a DMS-100 switch

* the connections between the SMR and the DMS Network Module (these connections are duplicated to both planes of the network).

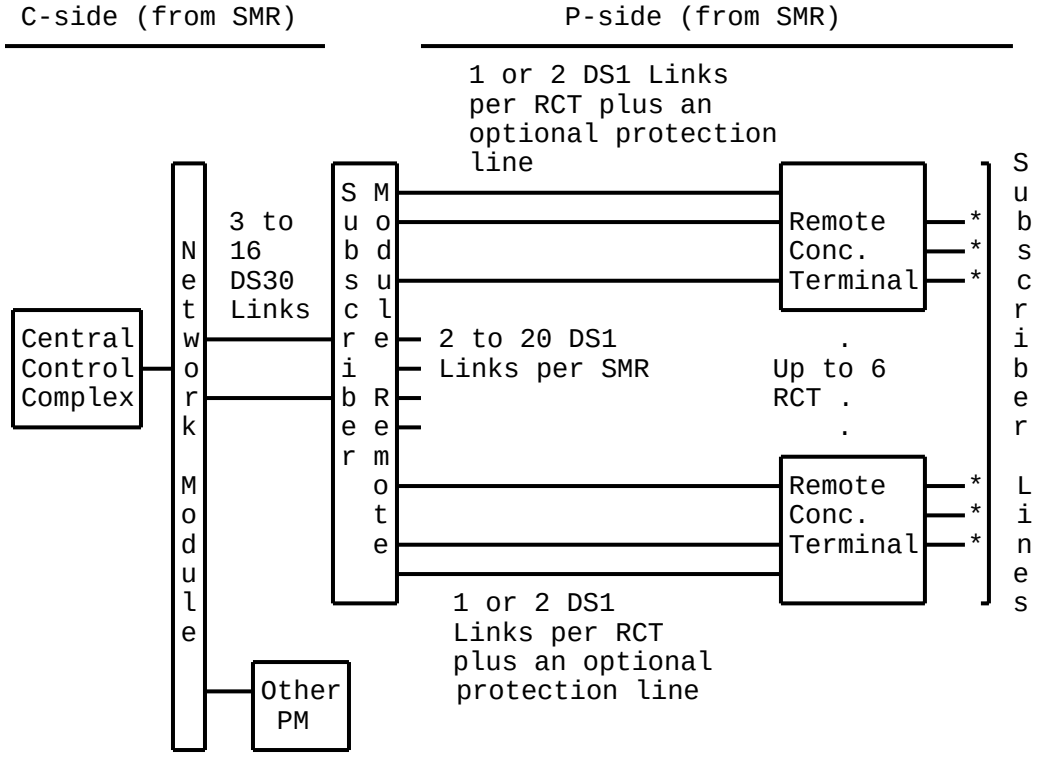


Fig. 55 - SMR-RCT Configuration

INFORMATION FLOWS TO/FROM THE SMR

This section describes information flows that are unique to the SMR. Additional information flows to and from the SMR that are common to other peripheral modules of this type are described in the Subscriber Carrier Module chapter. Subscriber Carrier Module is a generic term used to describe the family of peripheral modules of this type. See Information Flows to/from the SCM on page 117.

SMR<—>RCT Control Messages

The SMR-RCT subsystem differs from other SCMs in the message protocol used to transfer information. The SMR and RCT exchange messages over DS-1 links using B words. B words consist of 24 B bits, assembled by "robbing" the least significant bit from every twelfth frame channel (refer to Figure 43 on page 119 for framing information).

Three eight-bit bytes comprise B words. The function byte instructs the RCT on the type of operation to execute and the type of memory or register to access. The address byte contains the address on which the operation is to be executed. The data byte contains return information from the RCT. B words are used in the SMR-RCT subsystem for system control functions, such as exchange of alarm and maintenance information, and channel assignment.

SMR<—>RCT Speech/Signaling

The SMR and RCT exchange A bits, which are the least significant bits "robbed" from every sixth frame, to notify each other of changes on specific channels to which the A bits belong. A bits are used for the following functions:

* To start or stop ringing
* To scan for on-hook and off-hook
* To collect ANI/Coin information
* To pass dial pulses.

SMR TASKS

SMR tasks, that are common to other Subscriber Carrier Modules, are described in the Subscriber Carrier Module chapter. Subscriber Carrier Module is a generic term used to describe the family of peripheral modules of this type.

Refer to SCM Tasks on page 123 for information on tasks that are common to all Subscriber Carrier Modules. The SMR also supports channel reassignment and protection switching. These tasks were previously described in SMU Tasks on page 140 and SMS Tasks on

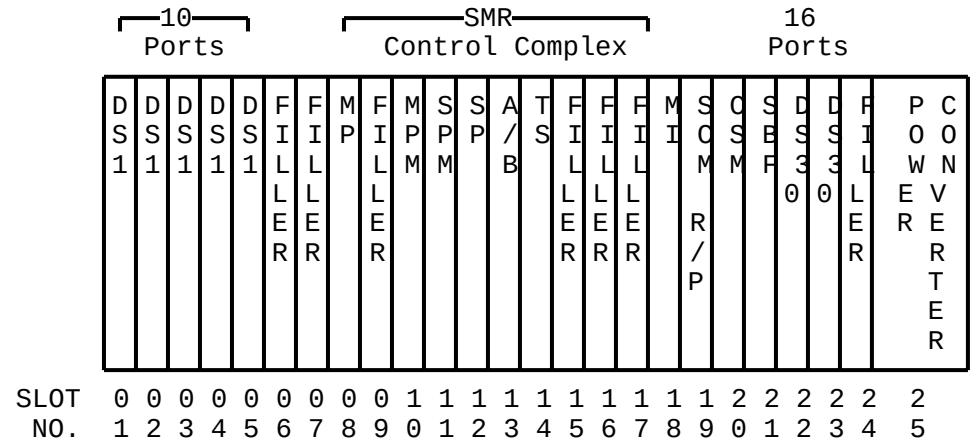
page 148, respectively. The SMR-RCT subsystem handles both tasks in a similar way to the SMU-RCU and SMS-RCS subsystems.

HARDWARE CONFIGURATION

Physical Configuration

An SMR is provisioned in an NT6X01 frame called an SME frame (refer to Figure 46 on page 135). Two SMR modules can occupy an SME frame, with each SMR consisting of two units.

Each SMS has two identical units, which contain Common Equipment cards. These cards are shown in Figure 56 on page 155 and were described previously under SCM Cards on page 129.



Slot	ABBR	NT PEC	Remarks
01-05	DS1	6X50AA	DS1 Interface
06-7,	-	0X50AA	Filler
08	MP	6X45AC	Master Processor
09	-	0X50AA	Filler
10	MPM	6X47AB	Master Processor Memory
11	SPM	6X46AB	Signal Processor Memory
12	SP	6X45AC	Signal Processor
13	-	6X81AA	A-bit/B-word DDL Message
14	TS	6X44AA	Time Switch
15-17	-	0X50AA	Filler
18	MI	6X43AA	Message and Tone
19	SCM R/P	6X80BA	SCM Ring/Pad
20	CSM	6X42AA	Channel Supervisory Message
21	SBF	6X41AA	Speech Bus Formatter
22,23	DS30	6X40AA	DS30 Network Interface
24	-	0X50AA	Filler
25	-	2X70AD	Power Converter

Fig. 56 - Card Locations in SMR Shelf

16. MESSAGE SWITCH AND BUFFER (MSB)

GENERAL

In Common Channel Signaling (CCS) implementations separate paths are provided between switching offices for the signaling part and the voice part of a call. See the NTPs (listed below) for a more comprehensive description of CCS6 and CCS7 subsystems and formats:

* 297-1001-137 CCIS6 and CCITT6 System Description

* 297-1001-141 Common Channel Signaling 7 Description

The Message Switch and Buffer (MSB) is a PM which controls the movement of the interoffice messages which form the signaling part of a call. Different types of MSB (MSB6 or MSB7) are used for the CCS6 and CCS7 implementations of Common Channel Signaling.

Permanent connections are maintained through the network between the MSB and:

* the DTC servicing the interoffice CCS trunks which carry the voice part of the call

* the PM which services the interoffice CCS transmission links which carry the signaling part of the call.

See Figure 57 on page 157. The MSB has a dual-shelf configuration with duplicated control complexes, referred to as unit-0 and unit-1. One unit is active, and the other is inactive but in standby mode. MSB functions are divided into three areas: Signaling Terminals (ST or STC) and Interfaces (STI); MSB Control Complex; and DS30 interfaces to the network.

ST (or STC) and STI. ST are arranged in up to 10 groups called:

* Signaling Terminal Controller Modules (STCM) in CCS6 applications and

* Signaling Terminal Groups (STG) in CCS7 applications

Each group of ST is connected to a pair of signaling terminal interfaces (STI), which can be operated by whichever MSB control unit is active. The number of groups required, and the type of path used between the ST and the CCS transmission links depends on the CCS configuration being used.

Notes:

1. A Signaling Terminals (ST) may also be called a Signaling Terminal Controller (STC). In the MSB description only the name Signaling Terminal and the abbreviation "ST" is used.

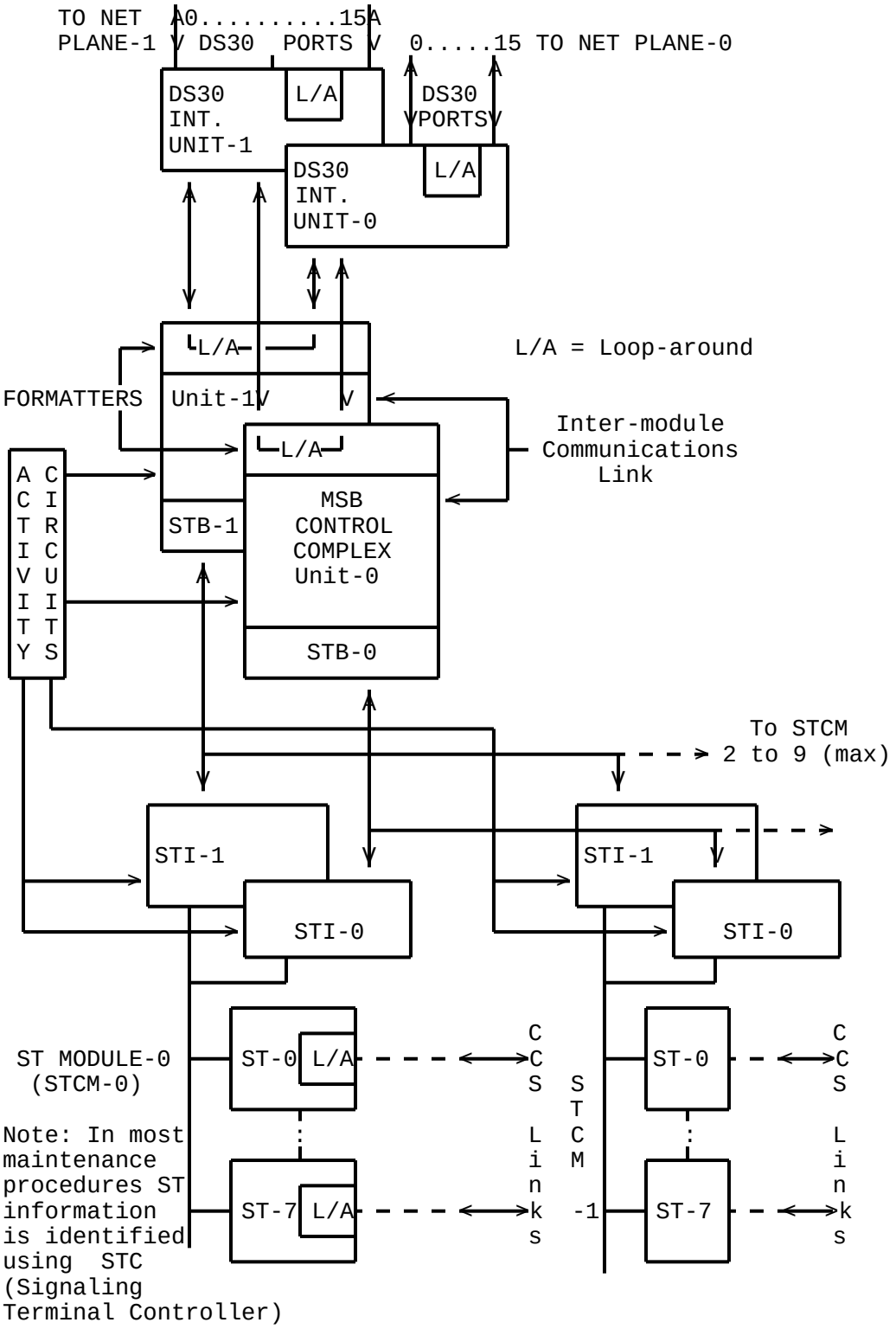


Fig. 57 - MSB: Simplified Block Diagram

2. In most of the maintenance displays (see 297-1001-515) ST information is identified using the abbreviation "STC".

MSB Control Complex. The duplicated control complexes are identified as Unit-0 and Unit-1. Each unit is associated with a DS30 interface but either unit is capable of operating both the DS30 interfaces.

Only one of the two units is designated active by the MSB activity circuit. Operation of the two units is coordinated via the inter-module communication link. The active unit is connected to the DS30 interfaces on one side via the formatter, and to the ST on the other side via the Signaling Terminal Buffers (STB).

The functions of the active unit are as follows:

* Scans the ST for incoming messages from CCS transmission links.

* Determines if incoming messages on an ST are destined to a DTC or to the CCC.

* Transmits messages via the formatter and DS30 interfaces to the proper destination.

* Scans DS30 link channels for incoming messages from the DTC, to be routed to ST; or CCC messages for internal use.

* Transmits messages via the STB and STI to the appropriate ST and CCS link.

* Verifies transmission and reception of messages.

* Monitors the ST and reroutes CCS messages if an ST fails.

* Monitors its own performance, and transfers activity (via the activity circuit) to the standby unit if required.

DS30 Interfaces to Network The DS30 interfaces provide up to 16 ports per plane for the DS30 links to the network but only up to 6 ports are used. The number of ports used by a MSB is dependent on whether a CCS6 or a CCS7 configuration is being utilized, the number of DTC using CCS and the number of ST associated with the MSB. Communication between the MSB control units and the CCC is carried on channel 0 of port 0 and channel 0 of port 2. Ports 0 and 2 therefore are always provided. An MSB unit always has access to the message channel regardless of its activity state. The other channels are available for CCS messages. The DS30 interfaces in both planes are accessible from either MSB unit (whichever is active), thus maintaining operation, even if one unit fails.

CCS CONFIGURATIONS

MSB can be equipped with appropriate hardware and software to operate in several CCS configurations. This Practice describes:

* the MSB6 which handles:
  - Common Channel Interoffice Signaling No.6 (CCIS6), and
  - International Common Channel Signaling System No.6 (CCITT6).
* the MSB7 which handles Common Channel Signaling System No.7 (CCS7).

In all configurations, call processing messages are exchanged between the Central Control Complex and the DTC (duplicating the situation found in non-CCS call processing where the signaling part and the voice part of a call are exchanged between switching offices over voice trunks serviced by the DTC). When operating in a CCS configuration, the DTC sends and receives the signaling part over signaling links via an MSB and only utilizes the CCS voice trunks it services for the voice part of a call.

Assignment of CCS Trunks (Voice)

CCS trunks can only be assigned to a DTC equipped with the MSB messaging and trunk continuity circuits necessary for CCS implementation.

CCS SIGNALING LINKS

The CCS signaling link comprises:

1. an intraoffice link between the DTC (servicing the voice trunks to the next switching office) and the MSB.
2. an intra-MSB link between the MSB control unit and a Signaling Terminal (ST).
3. an intraoffice link between the ST (which implements the CCS link protocol and error checking) and the CCS transmission links to the next switching office.

Connection Between the DTC and the MSB

An Inter-Peripheral Message Link (IPML) through the network connects the DTC and the MSB (through which the DTC sends and receives the signaling part of a CCS call).

The IPML is set up by the system software in the DMS Central Control Complex (CCC). The IPML consists of two Inter Peripheral Connections (IPC), one through each plane of the network. The

load is normally shared between the two IPC, but each IPC is capable of carrying all messages if the other connection fails.

The terms IPML and IPC are used in commands and displays during maintenance procedures. See 297-1001-515, for details of IPML configuration and MSB maintenance.

Connection Between the MSB Processor and the ST

Within the MSB messages are passed via a control bus connecting:

* the Signaling Terminal Buffer (STB) which interfaces with the MSB processor.

* the Signaling Terminal Interfaces (STI) each of which interface with up to eight ST.

The connection between the MSB processor and the ST is completely duplicated for reliability.

Connection Between the ST and CCS Transmission Links

The ST associated with the MSB implement the CCS link protocol and error checking for signaling messages exchanged between the MSB and the next switching office over the CCS transmission links.

The intraoffice connection between the ST and the CCS transmission link involves another PM (a DCM, DTC, LTC or TM) which services the CCS transmission links to the next switching office.

The type and operation of this connection and the type of PM which can be used to service the CCS transmission links varies depending on the type of CCS messaging being used. See Connection Between the ST and CCS6 Links and Connection Between the ST and the Transmission Link on page 170 for further details.

CCS6 (CCIS6 AND CCITT6) CONFIGURATIONS

Connection Between the ST and CCS6 Links

In a CCS6 configuration, the transmission links are served by DCM,DTC or TM. These DCM,DTC or TM are connected to the ST in the MSB6 using:

1. nailed up connections (NUC) through the network between:

    * the DCM, DTC or TM and

    * a TM (incorporating Modem Interface Cards - MIC)

2. a direct connection, via a modem, between:

    * the MIC in the TM and

    * a RS232C port on the MSB6 Signaling Terminal (ST)

The minor differences between the CCIS6 and the CCITT6 connections are shown in Figure 58 on page 162 and Figure 59 on page 163 .

Routing of CCS6 Signaling Messages

An incoming CCS6 message travels from the transmission link along the following path:

Transmission Link-> DCM/DTC/TM-> NUC-> TM(MIC)-> modem-> ST

Messages correctly received by the ST are transferred into the MSB for routing to the proper DTC via the IPML assigned to each DTC.

Messages from the DTC are similarly routed, first to the MSB via the IPML, then to the ST for forwarding along the following path:

ST-> modem-> TM(MIC)-> NUC-> DCM/DTC/TM-> Transmission Link

CCIS6 and CCITT6 Configuration Overview

The two CCS6 configurations differ as follows:

* in the CCIS6 configuration (see Figure 58 on page 162):

    - the MSB6 contains two STCM (16 ST total).

    - a set of active and inactive (reserve) nailed up connections between the TM (containing the MIC) and separate DCM/DTC/TM servicing two groups of CCIS6 transmission links ensures the reliability of the TM-to-Far End Switching Office signaling connection.

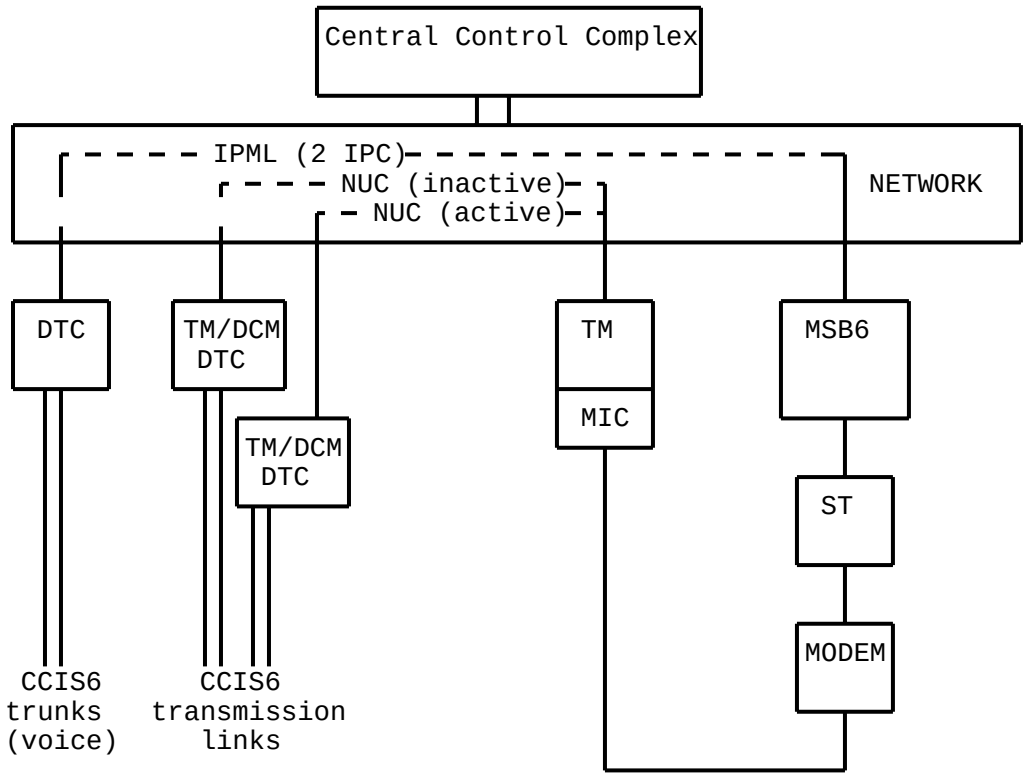


Fig. 58 - CCIS6 System Configuration

Note: In most of the maintenance displays (see 297-1001-515) ST information is identified using the abbreviation "STC".

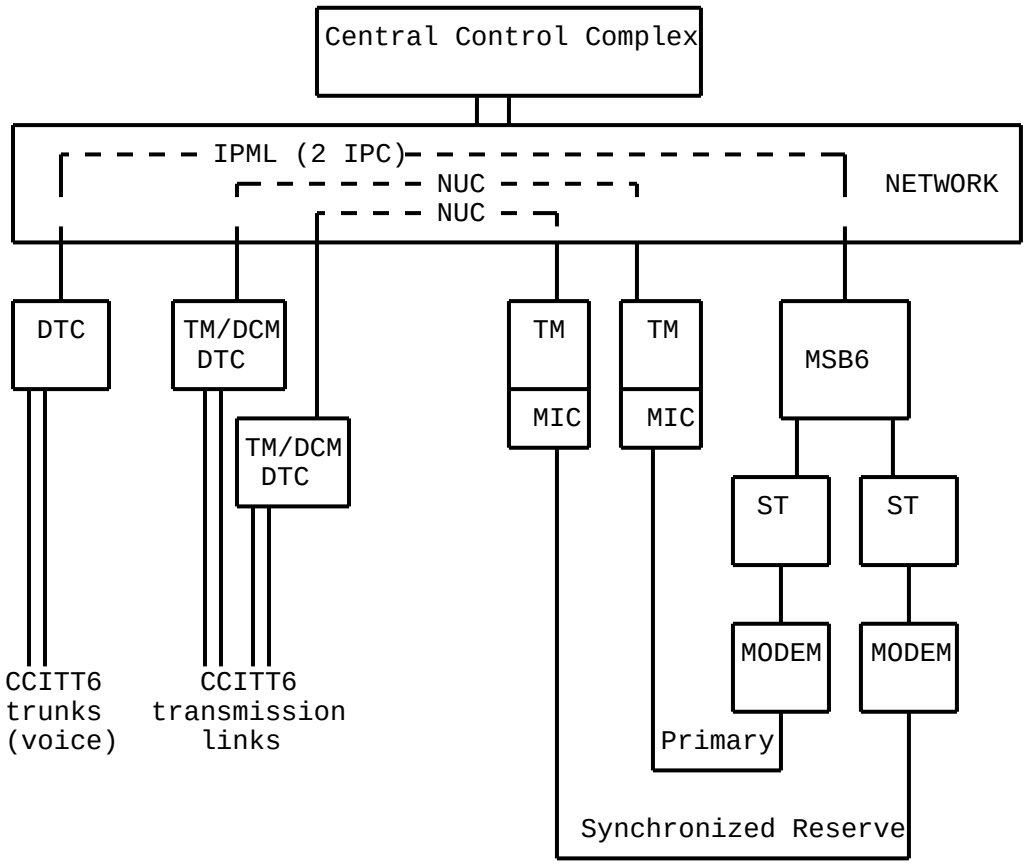


Fig. 59 - CCITT6 System Configuration

* in the CCITT6 configuration (see Figure 59):

- one MSB can be associated with up to eight STCM (maximum sixty-four ST but current usage only sixty (0 to 59) ST).In addition to the two STCM accommodated on the MSB shelf, up to 6 STCM can be accommodated in separate Signaling Terminal Shelves (STS) as shown in Figure 63 on page 168

- the use of pairs of Primary and Reserve Links from the MSB through to separate DCM/DTC/TM servicing two sets of CCITT6 transmission links ensures reliability of the total MSB-to-Far End Switching Office signaling connection. These links can also be used in a load sharing mode with each link being capable of carrying the full signaling load in the event of failure of the other link

CCIS6 SHELF AND FRAME LAYOUT

Shelf Layout

See Figure 60 on page 165. The two MSB6 control units, the two Signaling Terminal Buffers (one servicing each MSB6 control unit), the DS30 interfaces, the two modules (STCM) of 8 ST, and the two pairs of Signaling Terminal Interfaces (STI) are housed in two identical shelves, each referred to as an ST array (6STA). 6STA-1 is mounted above 6STA-0.

Each 6STA contains two power converters, one for the ST power supply (left) and the other for the MSB6 control units and DS30 interface (right).

ST-0 to ST-7, STI-0 and STI-1 occupy the left half of the shelf, while the MSB control unit cards occupy the right half of the shelf.

Each STI pair services one STCM. One STI (STI 0) is used when the MSB6 unit-0 control complex is active. The second STI (STI 1) is used when the MSB6 unit-1 control complex is active.

Frame Layout

See Figure 61 on page 166. The upper part of the CCSI6 equipment frame (MS6E) contains the two shelves, previously described which comprise the MSB6 (including sixteen ST). The lower part of the frame contains the 16 modems which are connected to the ST, and two modem power units. The FSP provides power control and power alarm circuits for all shelves in the frame. Below the FSP is located the cooling unit and the inverters which convert office battery to AC power for use by the cooling unit and modems.

CCITT6 SHELF AND FRAME LAYOUT

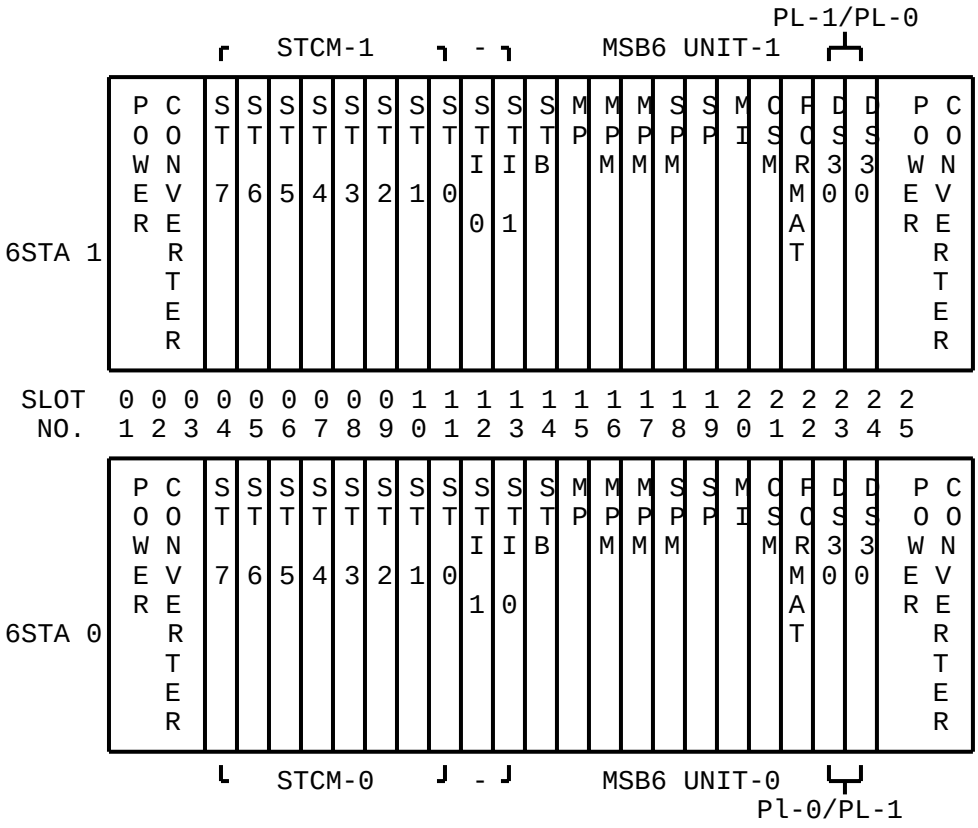
Shelf Layout

Two types of shelf are used for the CCITT6 implementation:

1. the same Signaling Terminal Array (6STA) Shelf as used in the CCIS6 implementation (see Shelf Layout and Figure 60 on page 165)

2. the Signaling Terminal Shelf (STS). See Figure 62 on page 167. STS are used in CCITT6 applications which require more than the two STCM contained in the two 6STA shelves of the MSB6. An STS shelf houses two power converters, two STCM, and two pairs of STIs. All STS shelves are controlled by the active MSB6 control complex.

   Each STI pair services one STCM. One STI (STI 0) is used when the MSB6 unit-0 control complex is active. The second



Slot	ABBR	NT PEC	Remarks
01	–	2X70AB	Power Converter (supplies STCM)
04-11	ST	6X65AA	Signaling Terminal (8 max.)
12,13	STI	6X68AC	Signaling Terminal Interface (or 6X68AA, 6X68AB, 6X68AD)
14	STB	6X67AA	Signaling Terminal Buffer
15	MP	6X45AA	Master Processor
16,17	MPM	6X47AA	MP Memory
18	SPM	6X46AA	Signaling Processor Memory
19	SP	6X45AA	Signaling Processor
20	MI	6X43AA	Message Interface
21	CSM	6X42AA	Channel Supervision Message
22	–	6X41AA	Formatter
23,24	DS30	6X40AA	DS30 Interface
25	–	2X70AB	Power Converter (supplies MSB6 and DS30)

Fig. 60 - No. 6 Signaling Terminal Arrays (6STA) Shelf Layout and Card Complement

MS6E Frame NT6X06AB

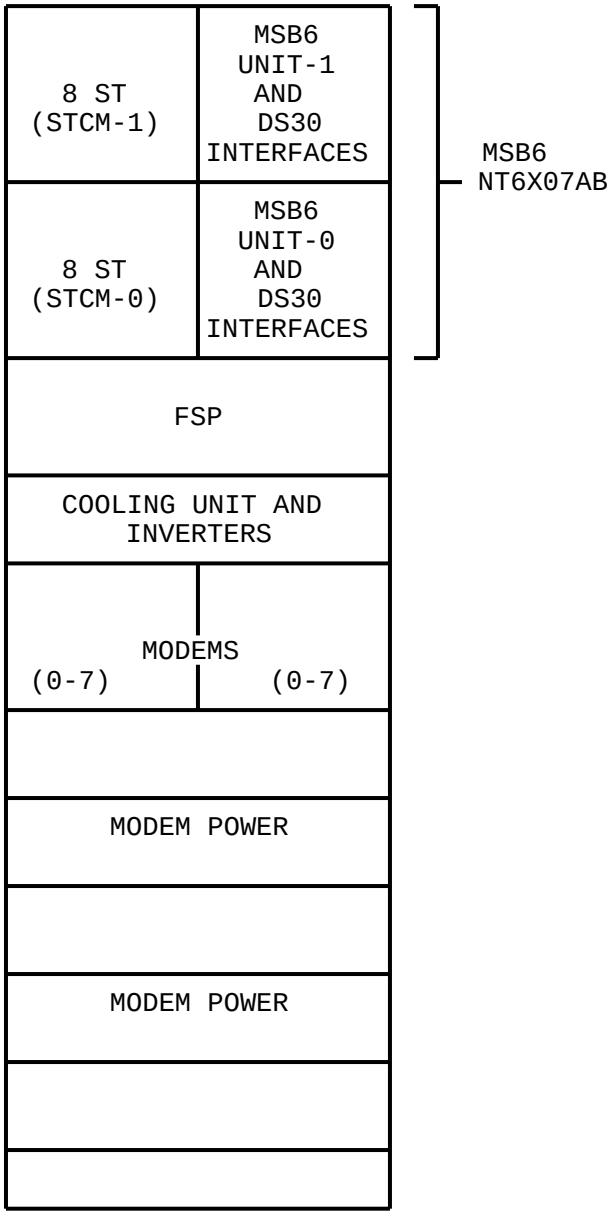


Fig. 61 - MSB/Modems: CCIS6 Frame Layout (MS6E)

STI (STI 1) is used when the MSB6 unit-1 control complex is active.

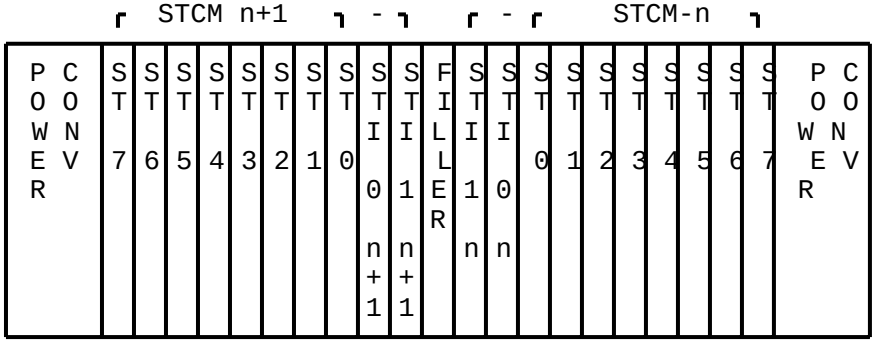
Frame Layout.

Two types of frame are used in for the CCITT6 implementation:

1. the same Message Switching 6 Equipment frame as used in the CCIS6 implementation (see Frame Layout on page 164 and Figure 61 on page 166).

2. the No.6 Signaling Terminal Equipment (STE6) frame (see Figure 63 on page 168) which houses up to three STS (containing a total of 48 ST). When added to the up to 16 ST located in the MS6E frame, the total of sixty-four ST (16 plus 48), the maximum for CCITT6 service, is achieved.

STS NT6X08AA



Slot	ABBR	NT PEC	Remarks
01	–	2X70AB	Power Converter (left STCM).
04-11	ST	6X65AA	Signaling Terminal (8 max.)
12,13	STI	6X68AC	Signaling Terminal Interface (or 6X68AA)
		6X68AD	This type of STI (or 6X68AB) terminates the STB bus when the associated STCM is electrically furthest from the STB.
14	–	0X50AA	Filler Panel.
15,16	STI	6X68AC	Signaling Terminal Interface.
		6X68AD	STI with STB bus termination.
17-24	ST	6X65AA	Signaling Terminal (8 max.)
25	–	2X70AB	Power Converter (right STCM).

Fig. 62 - Signaling Terminal Shelf (STS) CCITT6 Layout

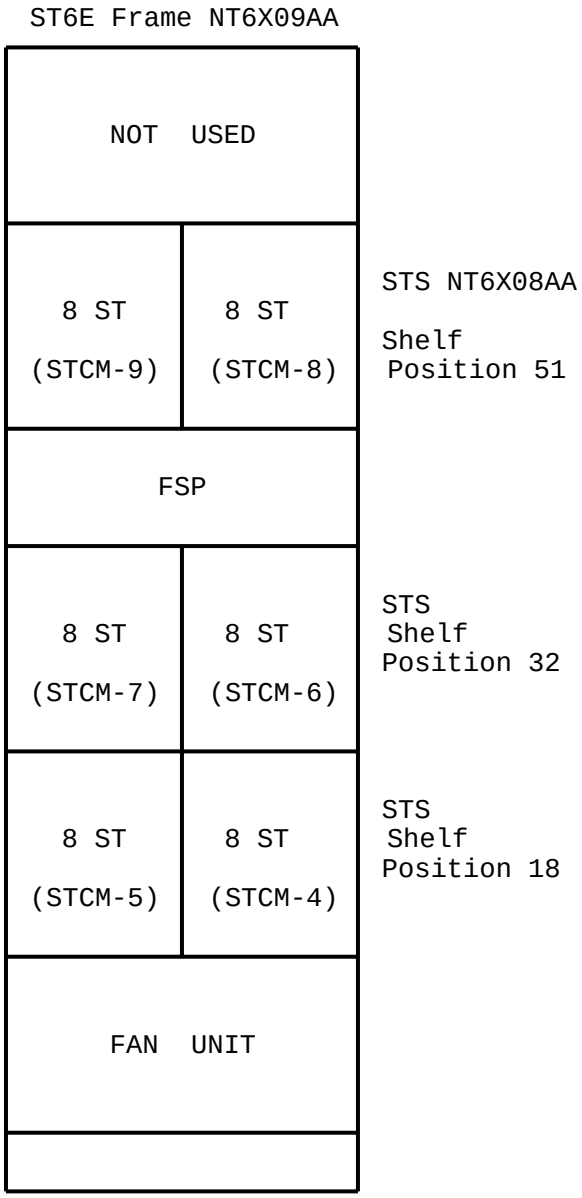


Fig. 63 - No 6 Signaling Terminal Equipment Frame Layout (STE6)

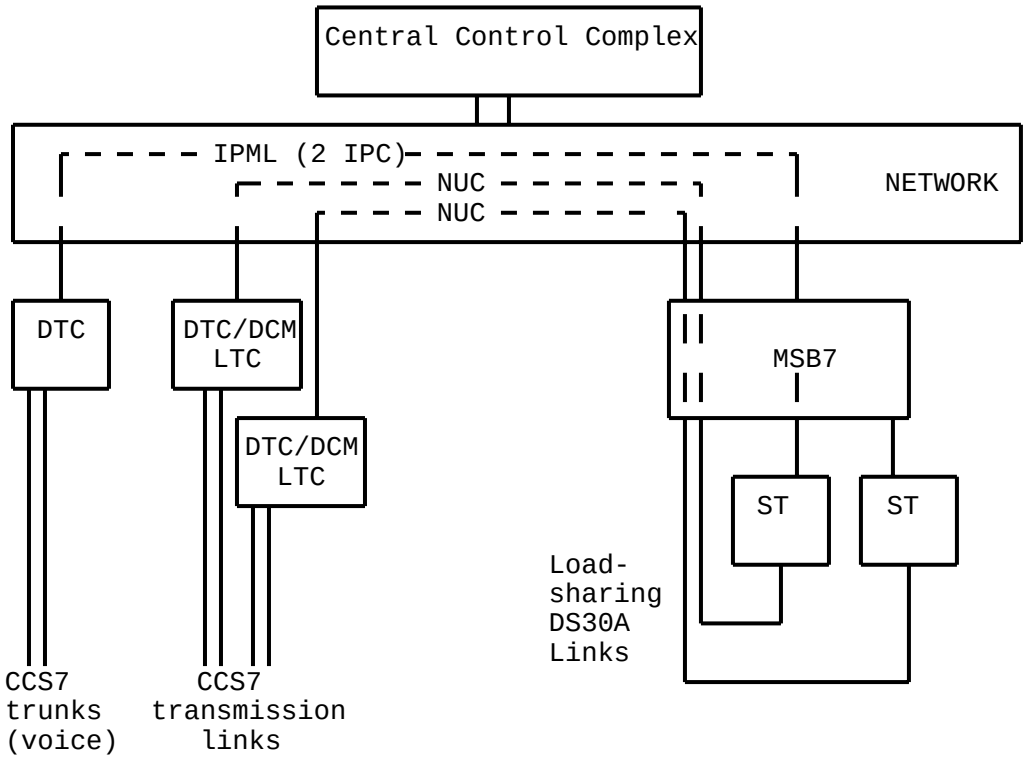


Fig. 64 - CCS7 System Configuration

CCS7 Configuration Overview

See Figure 64 for a diagram of the CCS7 configuration.

In the CCS7 configuration:

* the dual shelf MSB7 contains eight Signaling Terminals (ST)

* an MSB7 can control up to seventy-two ST. The additional sixty-four ST are added to the basic configuration using Signaling Terminal Group shelves (STG7), each of which contains sixteen ST.

* the DS30 links from the network to the MSB7 are used to terminate:

  - the IPML from the DTC servicing the CCS7 voice trunks

  - the NUC from the DCM/DTC/LTC servicing the CCS7 transmission links.

* within the MSB7, the ST is accessed through two separate paths:

  - a path via the STB used for messages received on or to be sent on the IPML

  - a path via a DS30A interface used for messages received from or to be sent on the NUC (CCS7 transmission link messages).

* the use of load sharing pairs of connections (each of which can carry the complete signaling load) between the DTC and the MSB7 and between the MSB7 and the Far End Switching Office ensures the reliability of the signaling connection.

Connection Between the ST and the Transmission Link

In a CCS7 configuration the CCS7 transmission links are served by DCM,DTC or LTC. These DCM,DTC or LTC are connected to the ST in the MSB7 using:

1. nailed up connections (NUC) through the network between:

   * the DCM, DTC or LTC and

   * the MSB7

2. a DS30A link between:

   * the MSB7

   * the MSB7 Signaling Terminal (ST)

The CCS7 connections are shown in Figure 64 on page 169.

Routing of CCS7 Signaling Messages

An incoming CCS7 message travels from the transmission link along the following path:

Transmission Link-> DCM/DTC/LTC-> NUC-> MSB7(DS30->DS30A)-> ST

Messages correctly received by the ST are transferred into the MSB7 via the Signaling Terminal Buffer (STB) for routing to the proper DTC via the IPML assigned to each DTC.

Messages from the DTC are similarly routed, first to the MSB7 via the IPML, then via the STB to the ST for forwarding along the following path:

ST-> MSB7(DS30A->DS30)-> NUC-> DCM/DTC/LTC-> Transmission Link

CCS7 SHELF LAYOUT

MSB7 Shelves

The MSB7 consists of:

* two Signaling Terminal Array (STA7) shelves (see Figure 65 on page 173)

* (optionally) one or more Signaling Terminal Group (ST7G) shelves (see Figure 66 on page 174).

STA7 Shelves

The two STA7 shelves (STA7 1 and STA7 0) each contain:

* the MSB7 control complex

* a DS30 interface

* a DS30A interface

* two Signaling Terminal Interfaces (STI)

* four Signaling Terminals (ST)

* two power converters (one to supply power to cards in slots 04-13 and one to supply cards in slots 14-24).

STA7-1 Shelf

The MSB7 control complex in the STA7-1 shelf is designated MSB7 unit-1. The four Signaling Terminals in the STA7-1 shelf are designated STG-1.

The STI in slot 09 is designated STI-1. STI-1 provides the interface between the four STs in STG-1 and the unit-1 data bus (used when the MSB7 unit-1 control complex is active).

The STI in slot 08 is designated STI-0. STI-0 provides the interface between the four STs in STG-1 and the unit-0 data bus (used when the MSB7 unit-1 control complex is active).

Note: If no ST7G shelves are provisioned, an STI incorporating a bus terminator is used as STI-0 to terminate the unit-0 data bus.

STA7-0 Shelf

The MSB7 control complex in the STA7-0 shelf is designated MSB7 unit-0. The four Signaling Terminals in the STA7-0 shelf are designated as STG-0.

The STI in slot 09 is designated STI-0. STI-0 provides the interface between the four STs in STG-0 and the unit-0 data bus (used when MSB7 unit-0 control complex is active).

The STI in slot 08 is designated STI-1. STI-1 provides the interface between the four STs in STG-0 and the unit-1 data bus (used when the MSB7 unit-1 control complex is active).

Note: If no ST7G shelves are provisioned, an STI incorporating a bus terminator is used as STI-1 to terminate the unit-1 data bus.

STG7 Shelf

The ST7G shelf consists of:

* two pairs of Signaling Terminal Interfaces (one pair of STI services one Signaling Terminal Group)

* two Signaling Terminal Groups (STG) of eight ST .

* two power converters (one to supply power to cards in slots 04-13 and one to supply power to cards in slots 14-24)

One ST7G shelf may be provisioned in the Message Signaling frame. The STGs contained in this shelf are designated STG 2 and STG 3 (see Figure 67 on page 176).

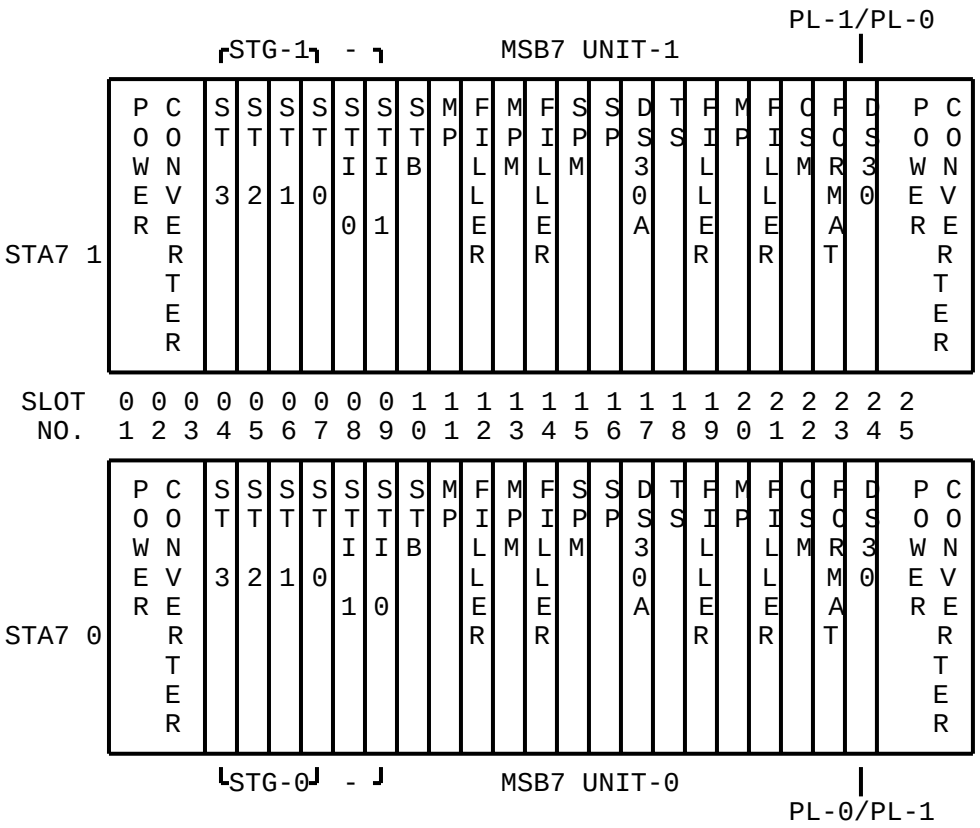
Up to three additional ST7G shelves may also be provided in an extension frame. The STGs contained in these additional shelves are numbered STG 4 through STG 9 (see Figure 68 on page 177).

Each odd numbered STG consists of up to eight STs in slots 04 through 11. The pair of STI in slots 12 (STI-1) and 13 (STI-0) are connected to the STs in the odd numbered STG.

STI-1 provides the interface between the STs and the unit-1 bus (used when the MSB7 unit-1 control complex is active). STI-0 provides the interface between the STs and the unit-0 bus (used when the MSB7 unit-0 control complex is active).

Similarly, the even numbered STG consists of up to eight STs in slots 17 through 24. The STI in slots 15 (STI-0) and 16 (STI-1) provide the interface to the unit-0 data bus and the unit-1 data bus.

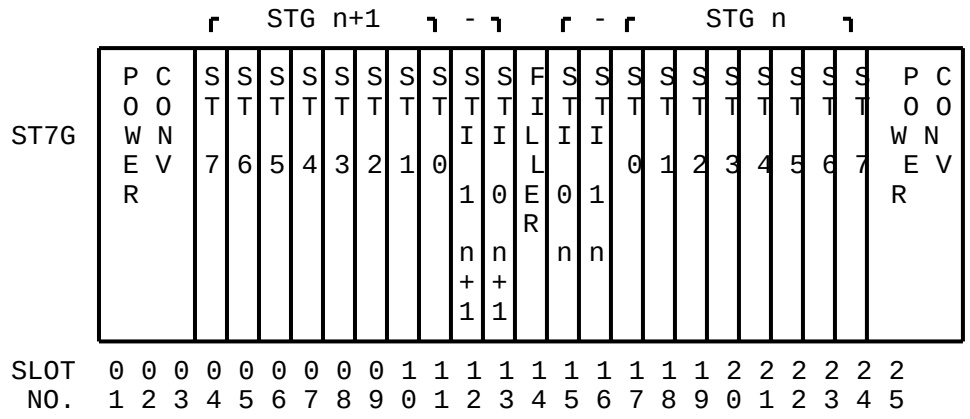
Note: The two STI associated with the highest numbered STG both incorporate a bus terminator. STI-0 terminates the unit-0 bus and the STI-1 terminates the unit-1 bus.



Slot	ABBR	NT PEC	Remarks
01	–	2X70AC	Power Converter (supplies slots 04-13).
04-07	ST	6X66AA	CCS7 Signaling Terminal (4 max.)
08	STI	6X68AC	Signaling Terminal I/F (or STI 6X68AD)
09	STI	6X68AC	Signaling Terminal Interface.
10	STB	6X67AA	Signaling Terminal Buffer.
11	MP	6X45AE	Master Processor.
12	–	0X50AA	Filler Plate.
13	MPM	6X47AB	MP Memory Plus.
14	–	0X50AA	Filler Plate.
15	SPM	6X46AB	Signaling Processor Memory Plus.
16	SP	6X45AE	Signaling Processor.
17	DS30A	6X48AA	DS30A Interface.
18	TS	6X44AB	Time Switch.
19	–	0X50AA	Filler Plate.
20	MP	6X69AA	Message Protocol.
21	–	0X50AA	Filler Panel
22	CSM	6X42AA	Channel Supervision Message.
23	–	6X41AA	Formatter.
24	DS30	6X40AB	DS30 Interface.
25	–	2X70AC	Power Converter (supplies slots 14-24).

Fig. 65 - Signaling Terminal Array 7 (STA7) Shelf Layout and Card Complement

ST7G NT6X08AA



Slot	ABBR	NT PEC	Remarks
01	–	2X70AB	Power Converter (left STG).
04-11	ST	6X66AA	Signaling Terminal CCS 7 (8 max.)
12,13	STI	6X68AD	STI with bus termination. See note 2
		6X68AC	Signaling Terminal Interface. See note 1
14	–	0X50AA	Filler Panel.
15,16	STI	6X68AD	STI with bus termination. See note 2
		6X68AC	Signaling Terminal Interface. See note 1
17-24	ST	6X65AA	Signaling Terminal CCS 7 (8 max.)
25	–	2X70AB	Power Converter (right STG).

NOTES
1. Two STI are provided for each Signaling Terminal Group (STG). STI 0 interfaces with MSB7 unit-0 over one data bus and STI 1 interfaces with MSB7 unit-1 over a second data bus.

2. The two STI provided for the highest numbered Signaling Terminal Group are of type 6X68AD to terminate the data buses.

Fig. 66 - Signaling Terminal 7 Group (ST7G) Shelf Layout and Card Complement

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Frame Layout

The main CCS7 equipment frame (MS7E) is illustrated in Figure 67 on page 176

The lower part of the MS7E contains the two STA7 shelves which comprise the MSB7 (including eight ST)

Where more than eight ST are required, an additional sixteen can be added in a ST7G shelf in the upper part of the MS7E frame.

Where more than twenty-four ST are required an extension ST7E frame (see Figure 68 on page 177) can be equipped with up to

three ST7G shelves. The two frames can therefore include a total of seventy-two ST (24 plus 48) linked through 20 STI to the MSB7.

The Frame Supervisory Panel (FSP), located in the center of the (MS7E) frame, provides power control and power alarm circuits for all shelves in the frame.

The cooling unit located at the base of the MS7E frame includes the inverters which convert office battery to AC power for use by the cooling unit.

MS7E Frame NT6X31AA

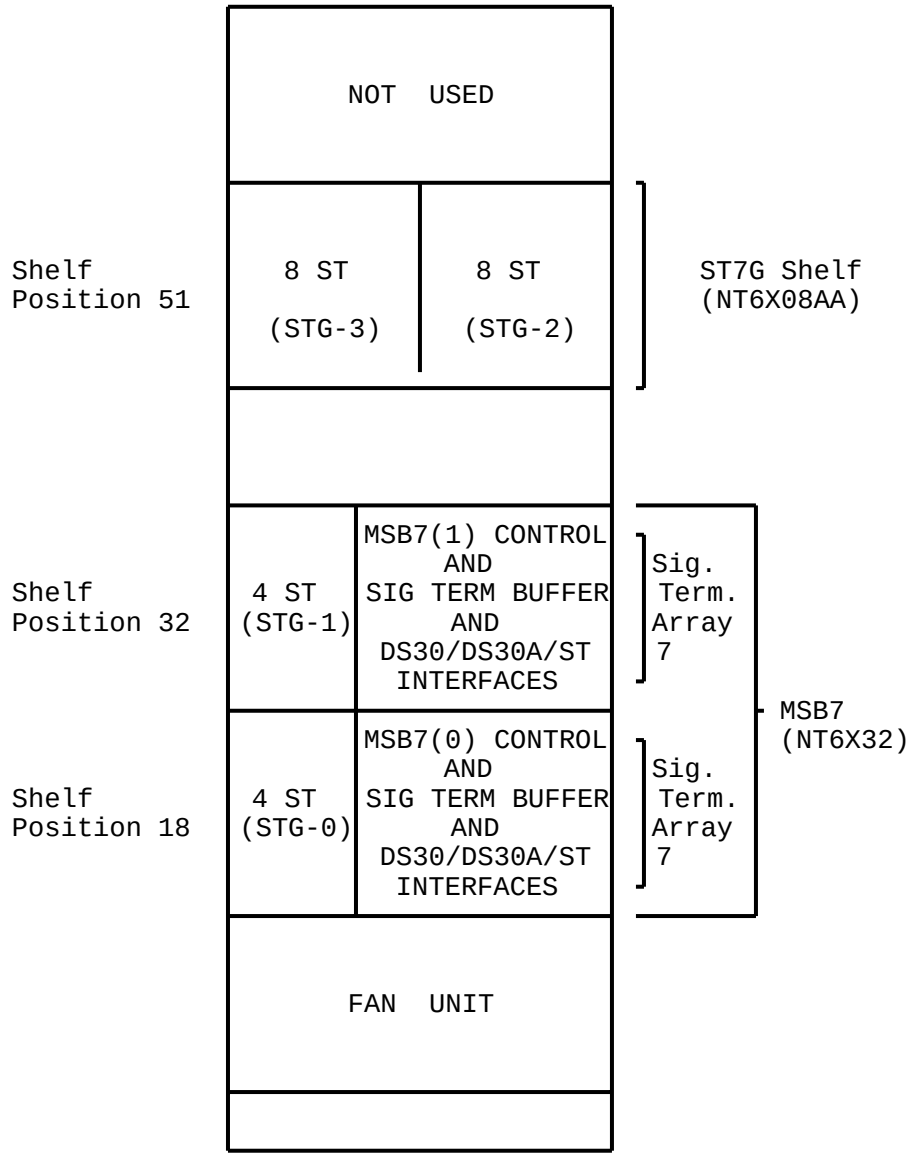


Fig. 67 - Message Signaling 7 Frame Layout (MS7E)

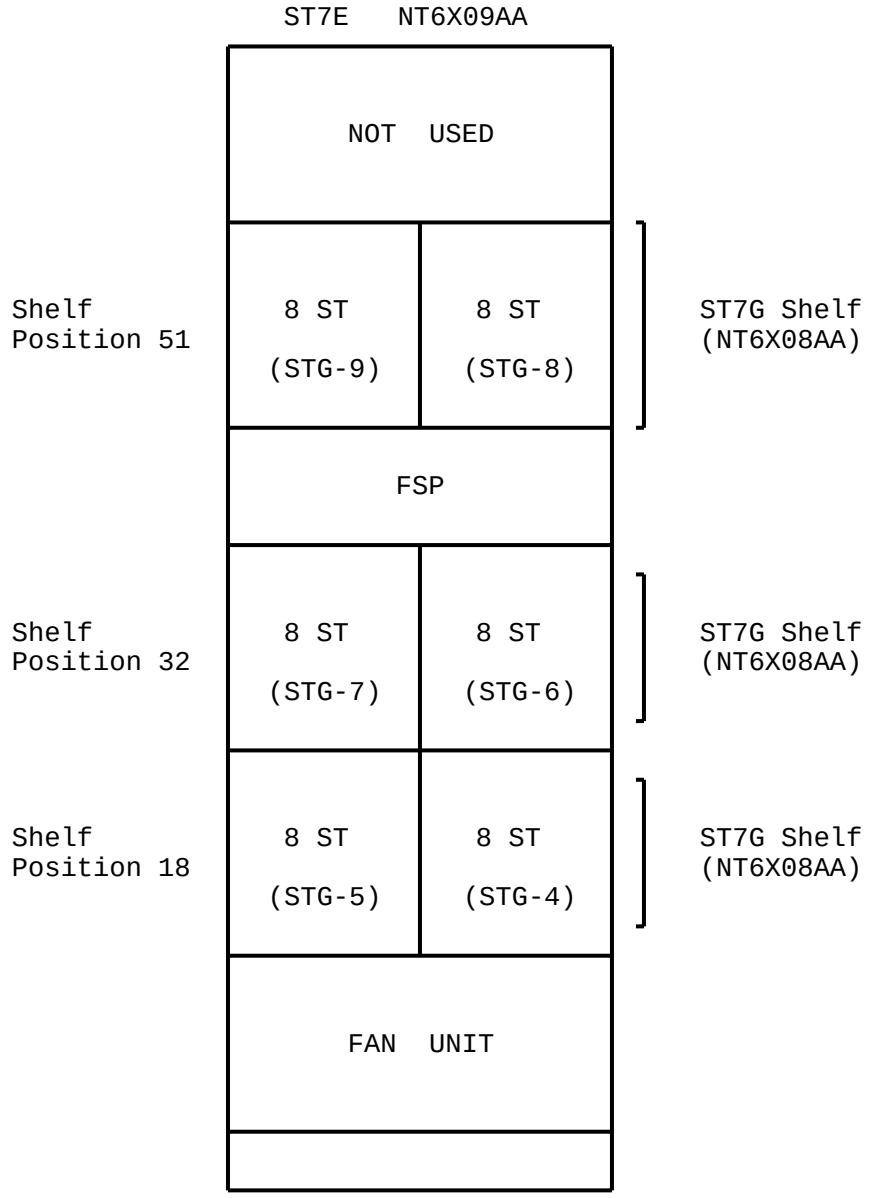


Fig. 68 - Signaling Terminal Extension Frame for CCS7 Applications

17. TOPS MESSAGE SWITCH (TMS)

GENERAL

17.01 The TOPS Message Switch (TMS) is a DMS peripheral that is used in the TOPS Multi-purpose Position (TOPS MP) Integrated system as a link concentrator and message switching device. The TOPS MP Integrated system is offered as an enhancement to an earlier offering of the TOPS MP system that is now referred to as the TOPS MP Standard system. For a complete description of the TOPS MP system offerings, refer to 297-2291-010. This section addresses only the TMS peripheral in the TOPS MP Integrated system.

TOPS MESSAGE SWITCH IN THE TOPS MP INTEGRATED SYSTEM

17.02 Figure 69 on page 179 illustrates how the TMS fits into the TOPS MP Integrated system. Basically, the TMS provides message switching between the DMS Central Control (CC), the TOPS Position Controllers (TPCs), and the external operator services data bases, such as the Operator Reference Data Base (ORDB) and the Computer Consoles, Incorporated (CCI) data base. The TMS uses the Consultative Committee on International Telegraphy and Telephony (CCITT) 1980 recommendations for X.25 protocol for message switching between all nodes attached to it.

17.03 A set of T1 links connects the external data bases to the TMS. A software-controlled time switch in the TMS dynamically connects the TPCs connected to the TMS to the data bases also connected to the TMS.

TMS FRAME AND SHELF LAYOUT

17.04 The TMS peripheral is an ISDN Line Trunk Controller (LTCi) shelf with a TMS packfill. The TMS packfill includes:

* NTX6X40 DS-30 Interface card
* NT6X45 Master Processor/Signaling Processor card
* NT6X47 Master Processor card
* NTBX01 ISDN Signaling Processor (ISP) card
* NT6X46 Signaling Processor Memory card
* NT6X44 Time Switch card
* NT6X41 Formatter card
* NT6X42 Channel Supervisory Module
* NT6X69 Message/Tone card
* NT6X50 DS1 Interface card
* NTBX02 D-Channel Handler (DCH) card.

Note: Although the TMS uses ISDN hardware, the TMS neither uses nor implements ISDN interfaces in the TOPS MP Standard system environment.

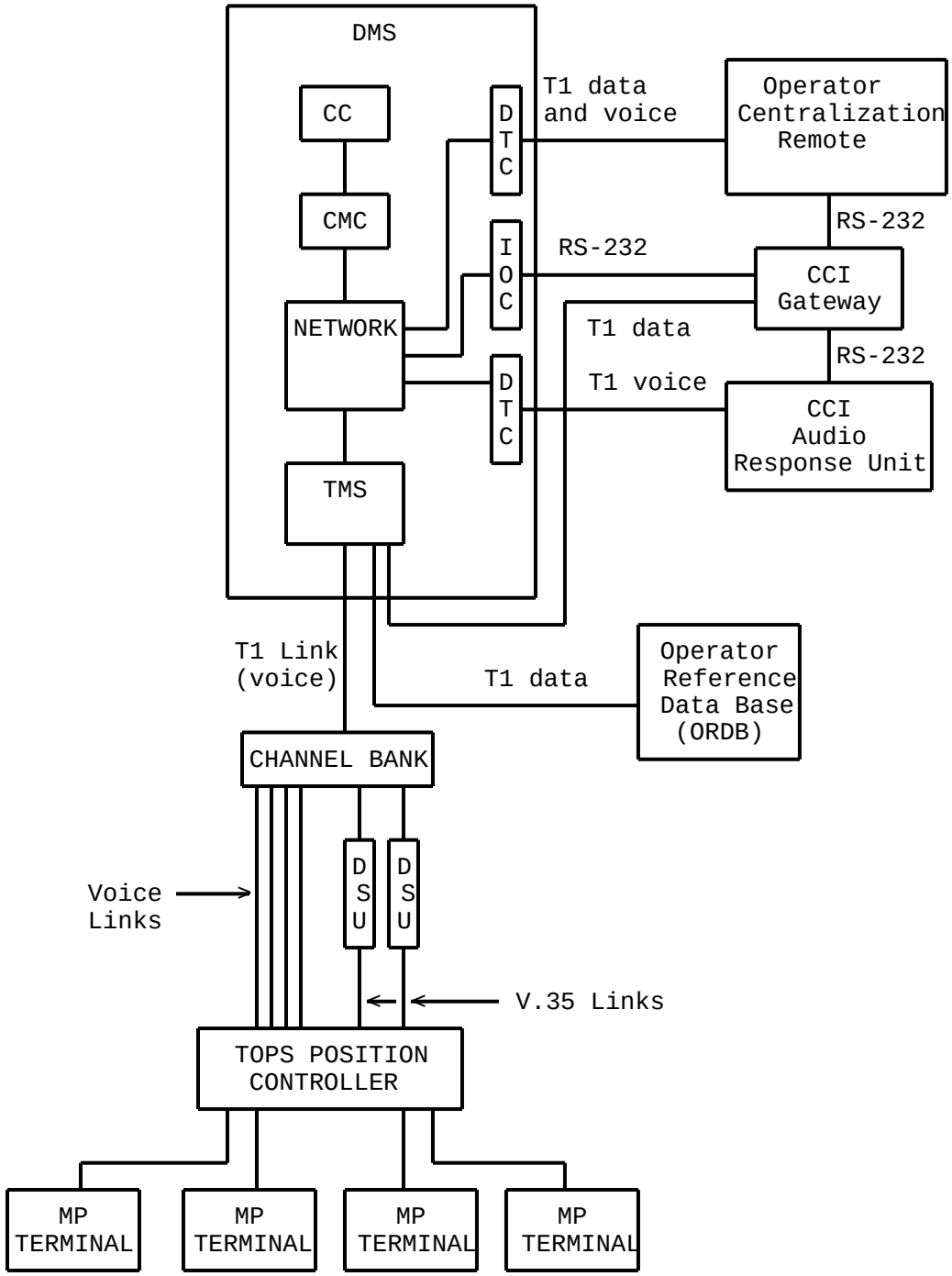


Fig. 69 - TOPS MP Integrated Configuration - TMS

17.05 The TMS is mounted in a NT0X25 TMS Frame mounted in the DMS lineup in the central office. The TMS frame includes two TMS modules, a FSP, and a cooling unit. A diagram of the TMS frame layout is in Figure 70 on page 181. A diagram of the TMS module shelf layout is in Figure 71 on page 182.

TMS BLOCK DIAGRAM

17.06 A functional block diagram of the TMS is shown in Figure 72 on page 183. Figure 72 on page 183 shows the functional relationships between each card in the TMS. This diagram serves as a point of reference for the description of the TMS cards following.

TMS CARDS

17.07 Following is a brief description of each of the cards in the TMS.

DS-30 Card (NT6X40)

17.08 The DS-30 card provides the interface between the TMS and DMS CC. Two DS-30 cards are included in the TMS packfill, providing 16 duplicated C-side links. Only two links are used, one on Port 0 and the other on Port 2. Each link provides 32 channels, two of which, channels 0 and 16, are used for messaging and maintenance respectively. The remaining channels, 30 per link, are used for voice connections to the DMS network.

Formatter (NT6X41)

17.09 The Formatter card converts the serial bit stream from the DS-30 card to parallel format for the internal speech bus, and the parallel data on the internal speech bus to a serial bit stream for the DS-30 links.

Channel Supervision Module (NT6X42)

17.10 The Channel Supervision Module (CSM) manages the speech link between the TMS and other DMS peripheral modules. The CSM reports any errors detected on the bus to the TMS Signaling Processor.

Signaling Processor (NT6X45)

17.11 The Signaling Processor card controls the Formatter, Channel Supervision Module, and the Time Switch. The Signaling Processor receives incoming control messages from the Master Processor, sends all outgoing messages to the Master Processor, and returns all DMS CC-to-TMS and TMS-to-DMS CC messages to the Master Processor.

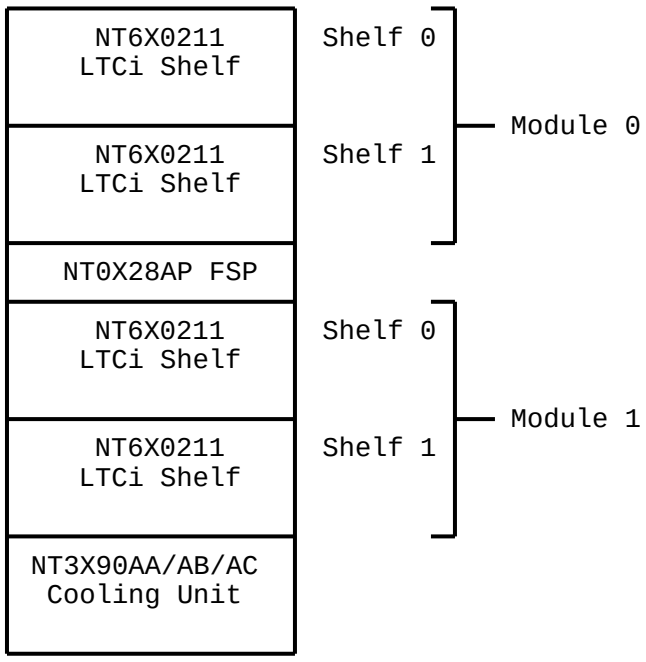


Fig. 70 - TMS Frame Layout

Signaling Processor Memory (NT6X46)

17.12 The Signaling Processor Memory card provides Random Access Memory (RAM) read/write memory for the Signaling Processor card and a direct memory access area to provide access to the Master Processor card memory.

Master Processor (NT6X47)

17.13 The Master Processor card serves as the main processor for the TMS. The Master Processor executes the TMS software to control the operation and maintenance of the TMS.

Master Processor Memory (NT6X47)

17.14 The Master Processor Memory card provides RAM read/write memory for the Master Processor card.

Message/Tone Card (NT6X69)

17.15 The Message/Tone card supervises the exchange of all control messages between the TMS and DMS CC through the DS-30 cards and between the TMS and external nodes through the DS1 cards.

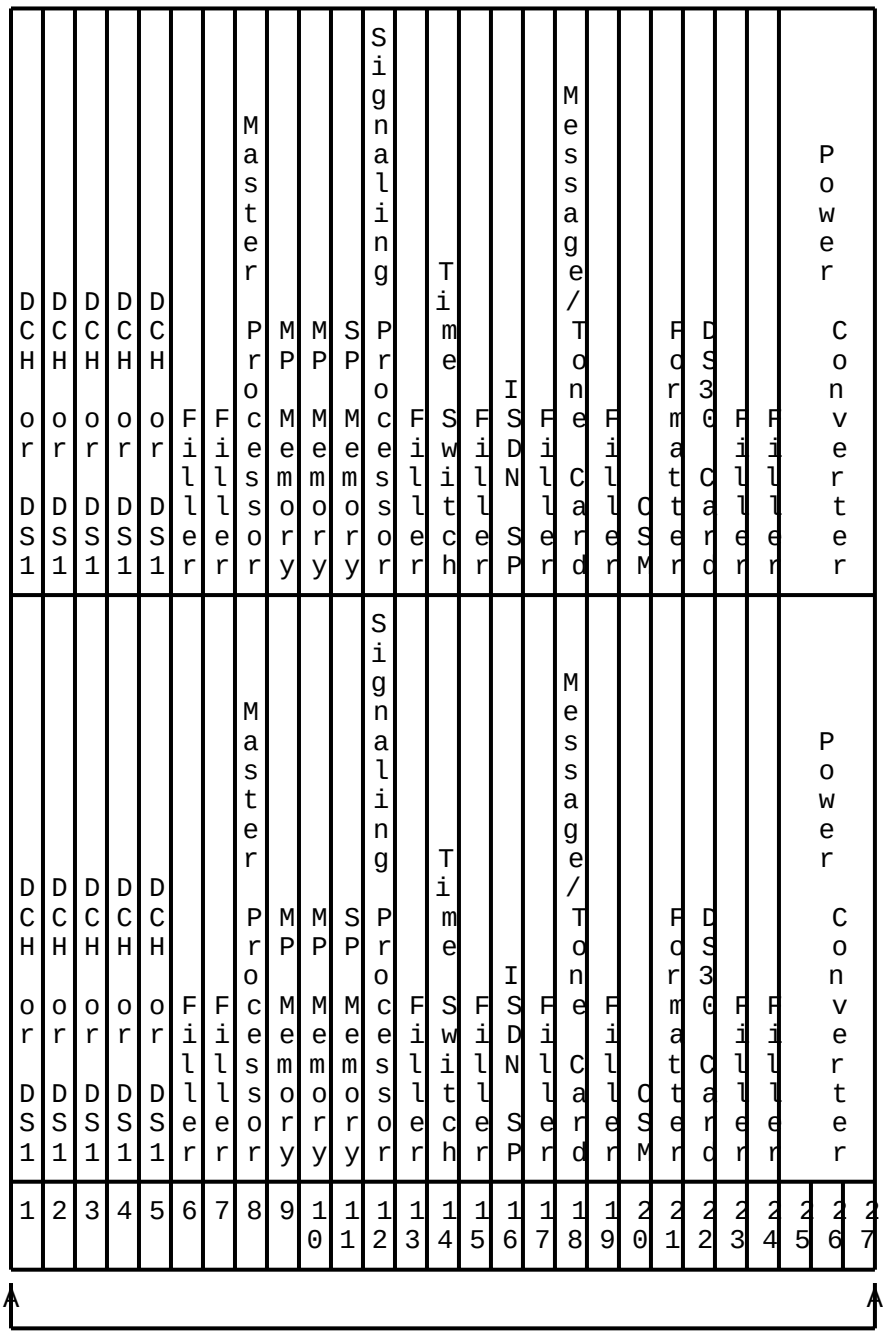


Fig. 71 - TMS Module Shelf Layout

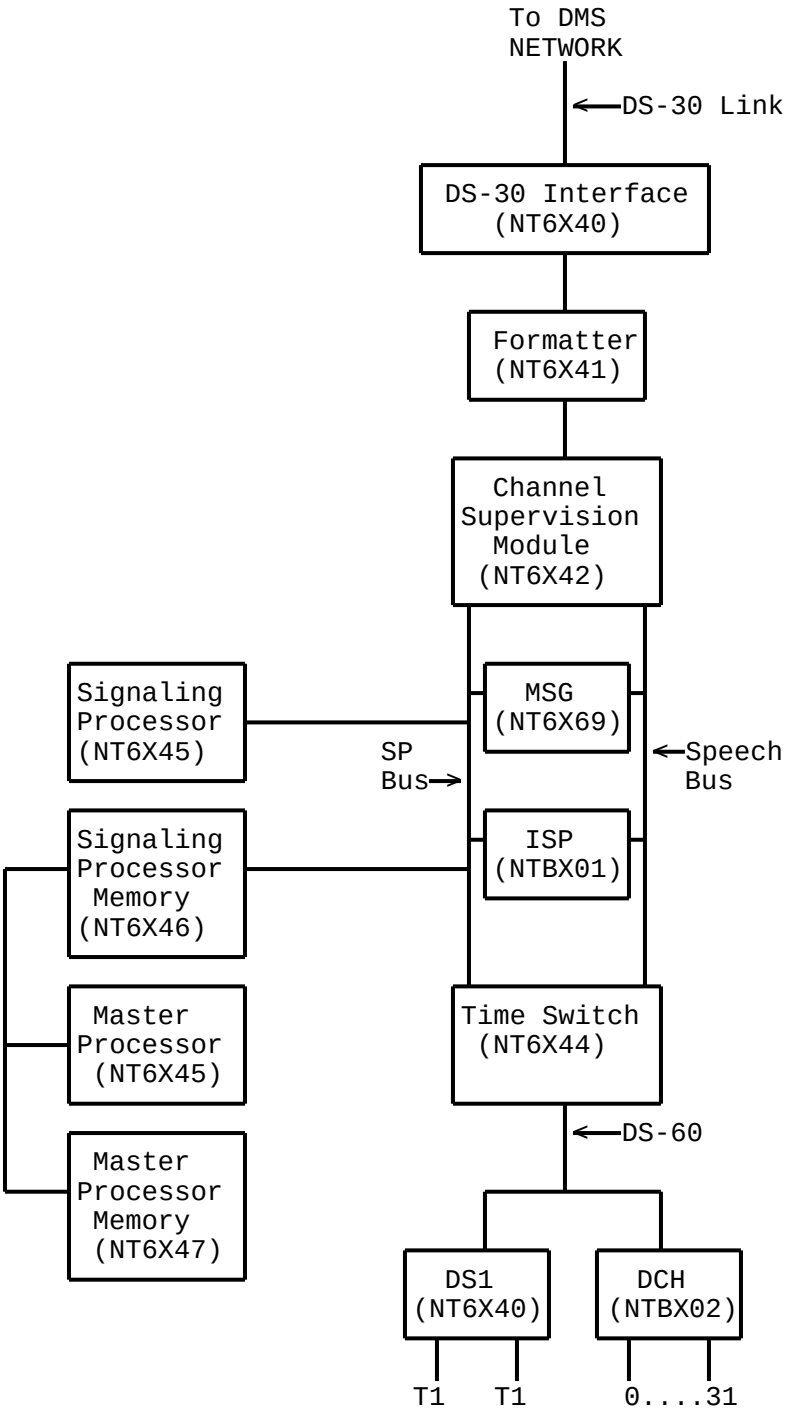


Fig. 72 - Block Diagram of the TMS

ISDN Signaling Pre-processor (NT6X01)

17.16 The ISDN Signaling Pre-processor (ISP) card provides call control messaging functions and DCH maintenance functions, and acts as an interface between the DCH cards and the Signaling Processor and Master Processor in the TMS. The ISP receives information from the DCH cards over the speech bus, processes the information, then forwards the information to either the Master Processor or the Signaling Processor over the Signaling Processor Bus. Information from the Master Processor or Signaling Processor to a DCH card follows the reverse path.

Time Switch (NT6X44)

17.17 The Time Switch performs the actual message switching in the TMS. Under control of the ISP, the Time Switch associates a DS-30 channel, T1 channel, or DCH channel with a timeslot on the speech bus and transfers data between the associated channel and timeslot.

DS1 (NT6X50)

17.18 The DS1 cards provide the interface between the TMS and the T1 links to the nodes on the TMS. Each T1 link provides 24 56 kb/s channels for use by the nodes on the TMS.

D-Channel Handler (DCH) (NTBX02)

17.19 The DCH card routes messages incoming on T1 channels either to other T1 channels terminating on the same DCH card, or to the ISP for routing. The DCH card performs interchannel switching on all channels terminating on it. If a DCH receives a message over one of its channels that must be connected to another one of its channels, that DCH can connect the two channels itself without using the TMS Time Switch. However, if a DCH receives a message that must be connected to a channel that is not terminated on itself, that DCH must forward the message to the ISP for routing through the Time Switch.

Power Converter (NT2X70)

17.20 The power converter converts the -48V Battery from the central office power plant to the appropriate voltage and power levels for the TMS shelf. Each shelf has its own power converter, which has the capability to take over its mate’s shelf should its mate power converter fail.

TMS TASKS

17.21 Under direction of the TMS software, the TMS performs the following tasks in the TOPS MP Integrated system:

* connects operator voice links to the DMS Network

* routes messages between nodes

* implements X.25 protocol

* performs maintenance.

17.22 Following is a brief description of each of these functions.

CONNECTING OPERATOR VOICE LINKS TO DMS NETWORK

17.23 In addition to performing message routing functions in the TOPS MP Integrated system, the TMS also provides connectivity to the DMS network for the TPC operator positions. Refer to Figure 69 on page 179 and Figure 72 on page 183. The voice link from each operator position connects to a channel bank, where it is multiplexed onto a 56 kb/s channel on the T1 link leaving the channel bank. At the TMS, data from the T1 channel carrying voice information from an operator position is connected by the TMS Time Switch to one of the voice channels on the DS-30 cards in the TMS. The voice path through the TMS to the DMS network for each operator position is nailed up; that is, remains intact at all times.

17.24 The voice channels on the DS-30 cards in the TMS connect the operator position voice channel to the DMS network. The basic TMS configuration provides a maximum of 60 voice channels through two DS-30 links. Each DS-30 link provides up to 30 channels each and terminate on different planes of the DMS network. Additional DS-30 links can be provisioned as needed to achieve the maximum configuration of 96 operator positions per TMS.

MESSAGE ROUTING

17.25 Message routing in the TMS includes messages between the DMS CC and nodes attached to the TMS, and messages between nodes on the TMS. The TMS nodes are referred to as TOPS Services Nodes (TSNs), and include the TPCs and external operator services data bases.

17.26 Message routing in the TMS is performed by the ISP and DCH cards in the TMS. Messages to the TMS from its TSNs are in the form of X.25 data packets, which contain address information on both the source of the data and the destination of the data, and the data itself, as well as some other information. The TMS software contains routing information for the source and destination addresses. The TMS ISP and DCH use the routing information in the TMS software and the address information contained in the messages to route each message.

Messaging Path Between DMS CC and TPC

17.27 Messages between the DMS CC and a TSN are routed by the TMS ISP. It must be noted that the DMS CC can only communicate with TPCs. Communication between the DMS CC and other TSNs through the TMS is not supported at this time. Messages from the DMS CC to the TPCs pass over the messaging channels of each TMS DS-30 link to the TMS ISP. The ISP then routes the message through the TMS Time Switch to the DCH card that terminates the T1 link over which the message is to be sent. The DCH card then forwards the message to its destination over the appropriate T1 link and channel.

17.28 Messages from the TPCs to the DMS CC are received by a DCH card over a T1 link. The DCH card then forwards the message through the TMS Time Switch to the ISP, which forwards the message through the TMS Time Switch to the DMS CC through a DS-30 link messaging channel. Figure 73 on page 187shows the messaging path of a message from the DMS CC through the TMS to a TPC.

Message Path Between TSNs

17.29 Messages between TSNs are routed by the TMS DCH or ISP cards. If the message is bound for another TSN on the same DCH card, the DCH card routes the message to the destination TSN. If the destination TSN is not on the same DCH card, the DCH forwards the message to the ISP for routing. Figure 74 on page 188 shows the messaging path of a message between a TPC and an external operator services data base that are on the same DCH.

Routing Messages

17.30 TOPS Services Nodes (TSNs) are identified by a physical link number, a logical link number, and a Permanent Virtual Circuit (PVC) number. A physical link is a T1 link connected to the TMS. Each T1 link terminates on a DS1 card in the TMS. A logical link is one of the 24 channels on a T1 link. Each channel terminates on a specific DCH card in the TMS. Each channel can carry several conversations between TSNs. Each conversation on a channel, or logical link, is identified by a PVC number. A PVC is essentially a nailed-up connection; that is, all data packets exchanged during a conversation between two TSNs follow the same path. The PVC number identifies this logical path on the T1 channel.

17.31 Messages passing through the TMS are routed based on information contained within each message. Each message passing over a physical link to the TMS includes information on the message source. The source information contains the address of the node that transmitted the message, which includes the physical link number (DCH card and link number), logical link number, and PVC number over which the address was received. To route the message, the TMS uses the source address contained in the message and routing information contained in tables in the TMS software to map the source address with a destination

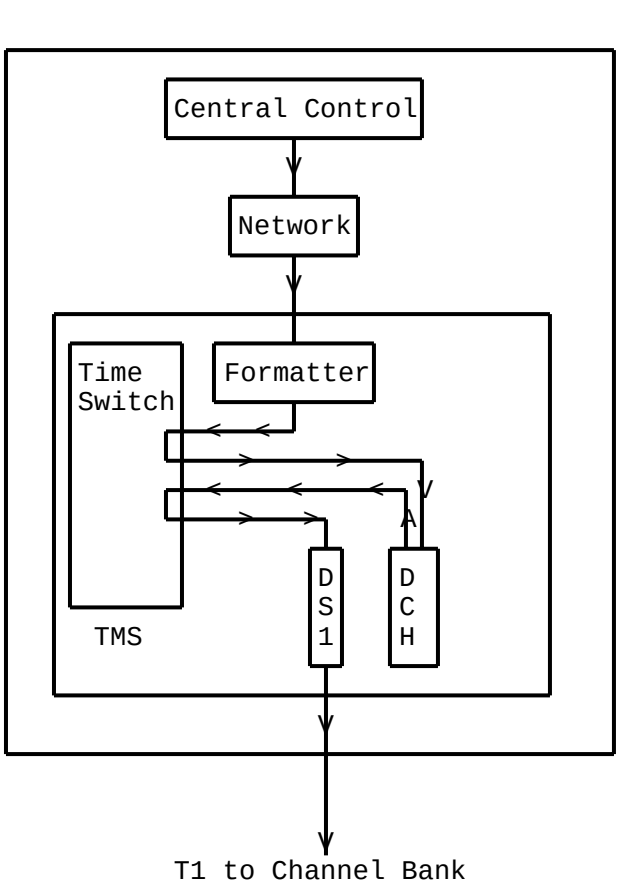


Fig. 73 - Messaging Between DMS CC and TPC Through TMS - CC-to-TPC

address. The destination address, like the source address, includes the physical link number, logical link number, and PVC number. Switching in the TMS is done such that PVCs on different physical and logical links can be interconnected.

17.32 A TMS TSN in the DMS CC is represented by a Terminal Identifier (TID), which consists of a node number and terminal number. For messages from the DMS CC to a TPC, the TMS maps TIDs, included in the DMS CC message as the terminating address, to a DCH number, link number, and PVC number of the terminating node.

PROTOCOL IMPLEMENTATION

17.33 The TMS software supports CCITT 1980 recommendations for X.25 protocol (PVCs only), which is used between the TMS and all of its TSNs. Software from the Multi-Protocol Controller (MPC) is used to implement Levels 1, 2 and 3 of the 7-layer model

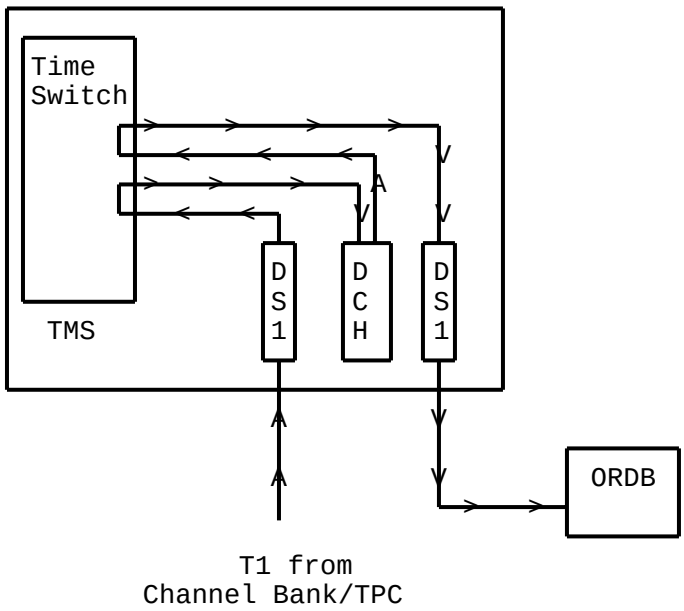


Fig. 74 - Messaging Path Between TSNs Through the TMS - TPC-to-TSN

for Open System Interconnect for X.25 communications in the TMS. For information on the implementation of X.25 in the TMS, refer to 297-1001-139.

17.34 The implementation of X.25 in the TMS is environment-independent, which means that it can operate on any system.

MAINTENANCE

17.35 Maintenance in the TMS is performed automatically by TMS software. Standard XPM maintenance routines are used to monitor TMS operation and report any failures detected to the DMS CC. Switch Activity (SWACT) is also supported in the TMS to allow the mate TMS shelf to take over should a major fault occur in the active unit.

17.36 Manual maintenance is performed on the TMS from the TMS MAP level accessed from the PM or CARRIER menu of the DMS MAP. Maintenance of the data channels terminating on a TMS is performed from the ISG MAP level accessed from the TMS MAP menu.

17.37 A complete description of the TMS and ISG MAP levels is in 297-1001-515. Manual maintenance procedures for the TMS is in 297-2291-520.

TMS Logs

17.38 The TMS uses the same logs as the LTCi; however, the log names are TMSnnn. The TMS logs indicate various events, state changes, and error conditions in the TMS. For information on TMS logs, refer to 297-1001-510.

Operational Measurements

17.39 The TMS uses two OM groups, TDCPROT and TDCROUT. The TMS OM groups monitor the operation of the TMS ISP and DCH routers, and the DCH protocol. Statistics accumulated on the ISP and DCH routers includes messages sent through the router, the average size of messages sent over a link, and the number of messages discarded.

17.40 Statistics on the DCH protocol include message transfer and error information for Layers 1, 2, and 3 of the X.25 protocol.

17.41 For information on the TMS OM groups, refer to 297-1001-814.

TMS Administration

17.42 Administration of the TMS is included in the documentation for TOPS MP. For information on TMS administration, refer to 297-2291-320.

18. LINK INTERFACE MODULE

BACKGROUND

A Link Interface Module (LIM) is a peripheral module in a Signaling Transfer Point (STP) DMS-SuperNode application (see 297-1001-141 and 297-5101-100).

It is physically located in the cabinet of the Link Peripheral Processor (LPP), along with Link Interface Units 7 (LIU7s).

A Link Interface Module provides a messaging connection, within the STP, between Link Interface Units 7 (LIU7s), and the DMS-Bus. (see Figure 75 on page 191).

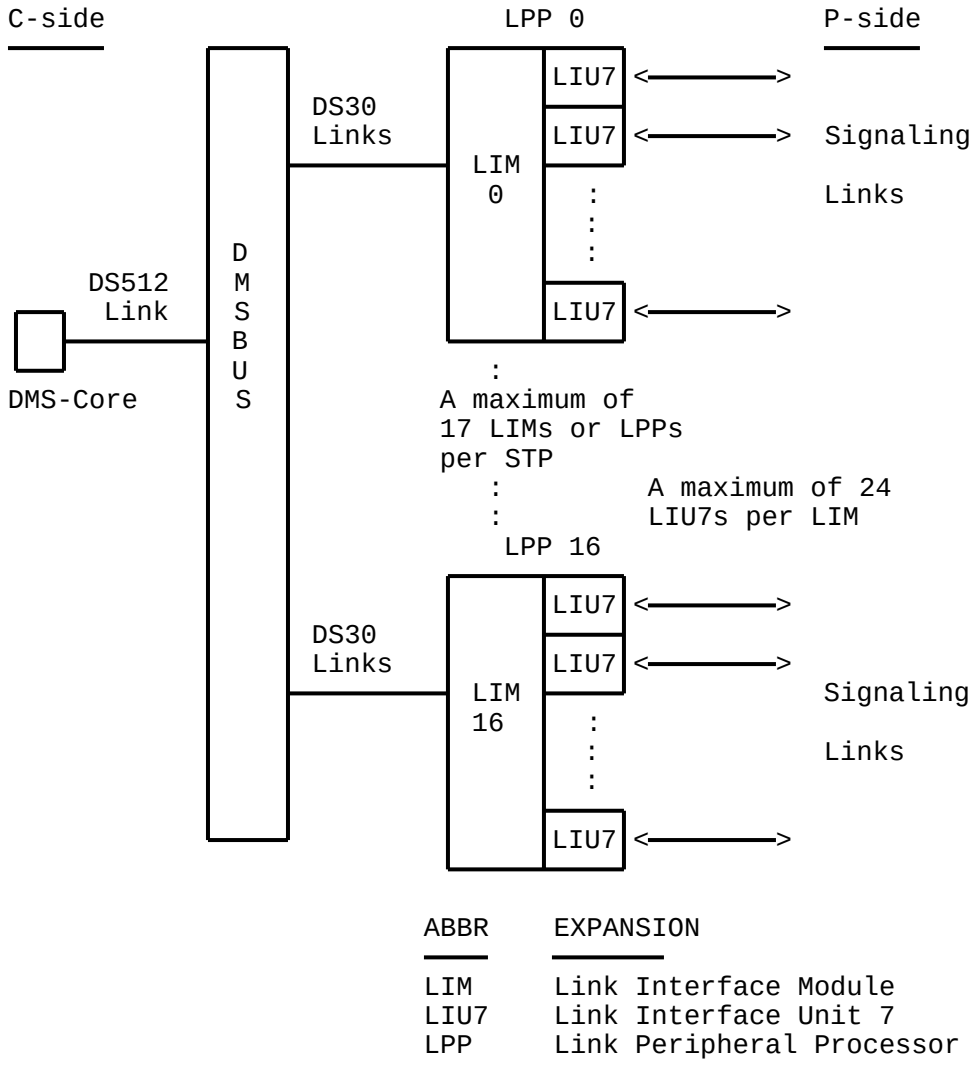
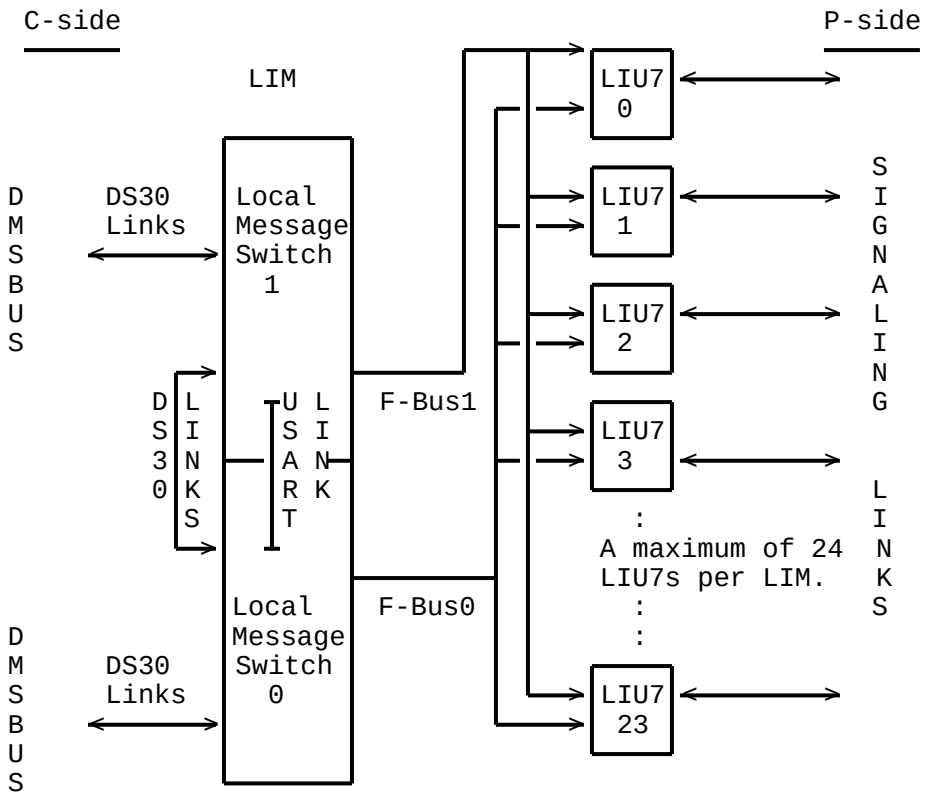


Fig. 75 - Signaling Transfer Point Configuration

The LIM consists of a pair of local message switches (LMS 0 and LMS 1) plus two frame transport buses (F-Buses). The frame transport buses connect the local message switch pair to up to 24 LIU7s. The pair of local message switches (LMS 0 and 1) occupy a single shelf and operate in a load sharing mode; one unit is capable of taking over the message traffic of the mate unit. One STP can support a maximum of 17 Link Interface Modules (LIMs) (see Figure 76 on page 192).



ABBR	EXPANSION
LIU7	Link Interface Unit 7
F-Bus	Frame Transport Bus
LIM	Link Interface Module
LMS	Local Message Switch

Fig. 76 - Link Interface Module Configuration

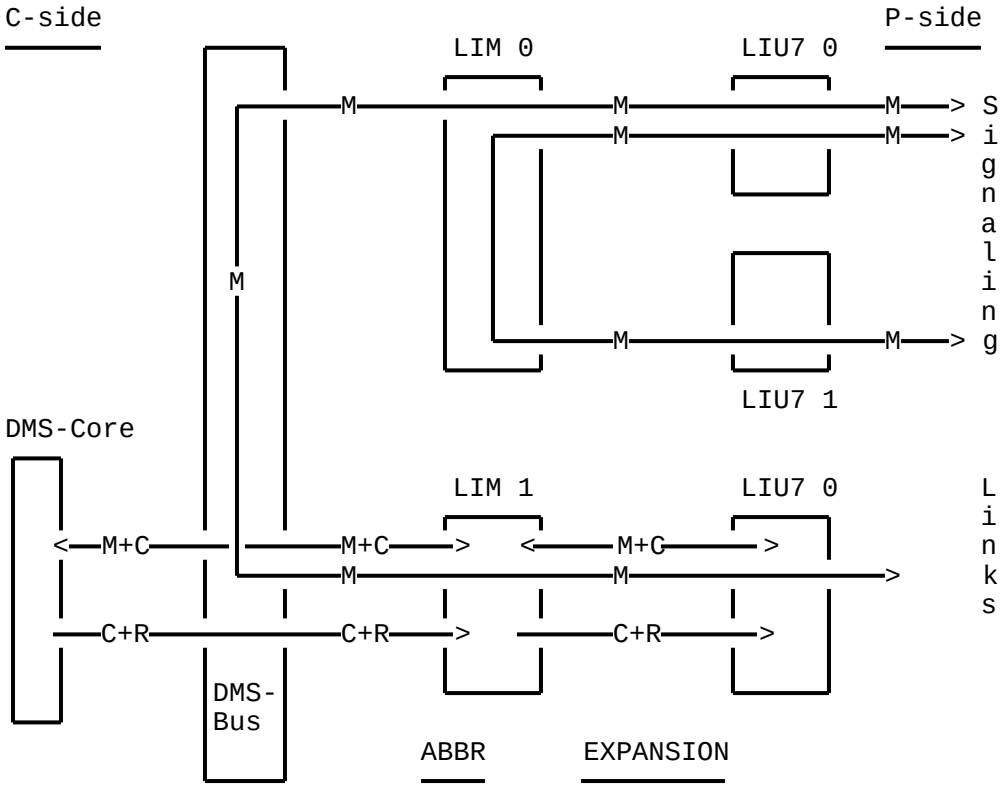
DATA PATHS THROUGH THE LIM

The local message switch pair (LMS 0 and LMS 1) of the LIM provide messaging connections for

* signaling link message traffic (LIU7<->LIU7 and LIU7<->DMS-Core)

* maintenance and control data (LIU7<->DMS-Core and LIM<->DMS-Core)

* downloaded configuration and routing data (DMS-Core-->LIM and DMS-Core-->LIU7) (see Figure 77 on page 193).



ABBR	EXPANSION
LIM	Link Interface Module
LIU7	Link Interface Unit 7
M+C	Maintenance and control data
M	Signaling Link Message Traffic
C+R	Downloaded Configuration and Routing Data

Fig. 77 - Data Paths Through the LIM

LIM TASKS

Task List

The Link Interface Module (LIM) performs the following functions:

* DS30 interface
* F-Bus interfaces with LIU7s
* transfer of messages
* local message switch takeover
* maintenance message exchange with the DMS-Core
* F-Bus hardware fault detection and isolation
* card fault detection

* maintenance for LIM<->DMS-Bus DS30 links
* reaction to loss of communication to the DMS-Core

DS30 Interface

On the C-side, a LIM supports the following DS30 connections:

* eight DS30 links between a LIM and the DMS-Bus (two DS30 links connect each local message switch with each plane of the DMS-Bus)

* two DS30 links between the two local message switches

F-Bus Interfaces with LIU7s

Two F-Buses link LMS 0 and 1 with all the LIU7s in the LPP cabinet (up to 24 LIU7s). The F-Buses provide 8-bit data paths for message traffic between the LIU7s and the LIM. The F-Buses operate in load sharing mode; if one F-Bus fails the other F-Bus can handle the message traffic for the entire LPP.

Transfer of Messages

A LIM transfers messages between LIU7s and the DMS-Bus. Incoming messages to an STP are processed by LIU7s. The LIU7s perform discrimination functions to determine the destination of the messages. A message is either addressed to another node in the network or to the STP that received it. Incoming messages that are addressed to other nodes are transferred, by the LIM, from the LIU7 that terminated the incoming link to the LIU7 that terminates the outgoing link. Local LIU7 to LIU7 message traffic within the same LIM is transferred directly on an F-Bus from the incoming LIU7 to the outgoing LIU7. Message traffic between LIU7s that are in different LPPs of an STP is

* placed on an F-Bus by an LIU7
* transferred by a local message switch to the DMS-Bus
* routed to the LIM associated with the outgoing signaling link
* placed on an out going signaling link by an LIU7

The LIM also provides message transfer for

* incoming messages addressed to the STP

* maintenance and application messages between the LIU7s and DMS-Core

* downloaded configuration data, software and routing information from the DMS-Core to the LIU7s

Local Message Switch Takeover

Local message switches (LMS 0 and 1) of a LIM operate in load sharing mode; one LMS is capable of taking over the message traffic for the entire LIM.

Maintenance Message Exchange with the DMS-Core

The LIM sends status information to the DMS-Core. This status information indicates current states as well as state transitions in the LIM. The DMS-Core uses the LIM status information to generate the following man machine interface output:

* MAP displays and alarms (see 297-1001-515)
* log reports (see 297-1001-510)
* operational measurements (see 297-1001-114)

For LIM table control see 297-1001-451.

F-Bus Hardware Fault Detection and Isolation

Both the LIM and the LIU7 perform F-Bus maintenance. They provide notification of faults to the DMS-Core and perform tests (loop-back) to isolate faults within the F-Bus.

Card Fault Detection

Cards in the Link Interface Module are equipped with a firmware controlled processor called a card maintenance unit (CMU). The CMU provides card level control for fault detection. If a fault condition occurs diagnostics are performed and (if necessary) the card is taken out-of-service.

Maintenance for LIM<->DMS-Bus DS30 Links

C-side DS30 links on the LIM are maintained by both the LIM and the DMS-Bus. The LIM tests and monitors the DS30 links.

Reaction to Loss of Communication with the DMS-Core

If the LIM detects a loss of communication to the DMS-Core, the LIM suspends messages to the DMS-Core and continues LIM functions that do not require communication with the DMS-Core.

If a Link Interface Module loses communication with the DMS-Bus, the LIM goes out-of-service. When communication between the LIM and the DMS-Bus is reestablished, the LIM resumes normal operation.

LIM CARDS

Card List

The LIM cards consist of all the cards on the top shelf (front and rear) of an LPP cabinet plus the following cards on the link interface shelves (LIS):

* +5V power converters (a total of six) (NT9X30AA)

* F-Bus repeater/terminators (NT9X74AA) (a total of six)

* F-Bus extension paddleboards with (NT9X79BA) and without (NT9X79AA) termination (a total of six)

Half of the LIM cards on the top shelf of the LPP cabinet (front and rear) form local message switch 0 and the other half make up local message switch 1. Each local message switch consists of the following cards:

CARD NAME	
local message switch processor (LMSP)	NT9X13DA
memory	NT9X14BB
remote terminal interface paddleboard (RTIF PB)	NT9X26AA
clock	NT9X53AA
mapper	NT9X15AA
4-port (interface controller)	NT9X17AA
DS30 4-port paddleboard	NT9X23BA
processor bus (P-Bus) terminator	NT9X49CA
T-Bus access	NT9X52AA
F-Bus extension paddleboard	NT9X79AA/BA
F-Bus repeater/terminator	NT9X74AA
F-Bus rate adapter (RA)	NT9X73AA
+5V power converter	NT9X30AA

(See Figure 79 on page 201.)

Local Message Switch Processor

There are two local message switch processor (LMSP) (NT9X13DA) cards in the front LIM shelf, one LMSP card in each local message switch. The LMSP card performs the processing in the local message switch.

Memory

There are two memory cards (NT9X14BB) in the front LIM shelf, one memory card in each local message switch. The memory card provides software storage for the central processing unit.

Remote Terminal Interface Paddleboard

There are two remote terminal interface paddleboards (RTIF PBs) (NT9X26AA) located in the rear LIM shelf, one RTIF PB in each local message switch. The remote terminal interface paddleboard (RTIF) monitors and decodes commands and passes them to the processor card in the form of control signals. The RTIF also monitors processor signals and relays them to the remote terminal or remote scanning system. In addition the RTIF supports a serial link between the two local message switches in the LIM. This link consists of an RS-232 universal synchronous asynchronous receive transmit (USART) link which is used for messaging between the two LMS units.

Clock

There are two clock cards (NT9X53AA) in the front LIM shelf, one clock card in each local message switch. The local message switch clock is slaved to/from the DMS-Bus clock by DS30 links. The clock card is the system time source for the local message switch.

Mapper

There are two mapper cards (NT9X15AA) located in the front LIM shelf, one mapper card in each local message switch. The mapper card performs logical to physical address translation for primary and secondary routes in the local message switch. It also provides route status information.

4-Port Interface Controller

There are four 4-port interface controller cards (NT9X17AA) in the front LIM shelf with two 4-port interface controller cards in each local message switch. Each 4-port interface controller card controls one DS30 4-port paddleboard. Each local message switch has eight DS30 ports.

DS30 4-Port Paddleboard

There are four DS30 4-port paddleboards (NT9X23BA) in the rear LIM shelf, two DS30 4-port paddleboards in each local message switch (LMS). Together they provide eight C-side DS30 ports in each LMS.

Processor Bus (P-Bus) Terminator

There are two P-Bus terminator cards (NT9X49CA) in the front LIM shelf, one in each local message switch. The P-Bus terminator cards provide passive terminations for bus signals.

T-Bus Access

There are two T-Bus access cards (NT9X52AA) in the front LIM shelf, one in each local message switch. The T-Bus access cards provide passive terminations for bus signals as well as LMSP access to the T-Bus.

F-Bus Extension Paddleboard

There are two F-Bus extension paddleboards (NT9X79AA/BA) in the rear of each shelf in the LPP cabinet (a total of eight per LPP). F-Bus extension paddleboards with termination (NT9X79BA) are used on the top and bottom shelves of the LPP (two per shelf, a total of four). F-Bus extension paddleboards without termination are used on the middle two shelves in the cabinet (two per shelf, a total of four). F-Bus extension paddleboards are used to extend the F-Bus to all four shelves of the LPP. F-Bus extension PBs with termination provide passive termination for the F-Bus signals.

Note: The F-Bus extension paddleboards with termination on the top shelf of the LPP cabinet provide the composite clock input required to synchronize the DS-0A terminator paddleboards on the link interface shelves. The F-Bus extension paddleboards on the link interface shelves relay the clock signal to the lower three shelves.

F-Bus Repeater/Terminator

There are two F-Bus repeater/terminator cards (NT9X74AA) in the front of every link interface shelf (LIS) assembly (a total of 6 F-Bus repeater/terminator cards per LPP cabinet). The F-Bus repeater/terminator cards are used to extend the LIM F-Bus to the link interface shelves.

F-Bus Rate Adapter (RA)

There are two F-Bus rate adapter cards (NT9X73AA) in the front LIM shelf, one in each local message switch. The rate adapter (RA) card converts signals from the 32-bit T-bus to the 8-bit F-Bus.

+5V Power Converter

There are two +5V power converter cards (NT9X30AA) in the front LIM shelf, one in each local message switch. In addition, there are two +5V power converters on each LIS shelf (a total of six) which are owned and maintained by the LIM. Each power converter card provides the required operating voltage to the cards in one half of the shelf.

LIM HARDWARE CONFIGURATIONS

LIM Specifications

The basic specification and structure of the Link Interface Module is shown in Figure 78.

CLASSIFICATION

PM NAME	PM TYPE	REMARKS
Link Interface Module (LIM)	LIM	Uses DMS-SuperNode architecture

C-SIDE LINKS

MIN.	MAX.	TYPE	CHAN/LINK	REMARKS
8	12	DS30	32	Each local message switch is linked by two DS30 links to each of the two planes of the DMS-Bus. A total of 8 DS30 links (LIM<->DMS-Bus).
2	-	DS30	32	Two DS30 links connect local message switch 0 with local message switch 1 in the LIM.

P-SIDE LINKS

MIN.	MAX.	TYPE	CHAN/LINK	REMARKS
2	-	F-Bus	1	Two 8-bit F-Buses. Each F-Bus connects one local message switch in the LIM to up to 24 LIU7s located in the bottom three shelves of the LPP cabinet.

C-side Links — BASIC STRUCTURE OF A LIM — P-side Links

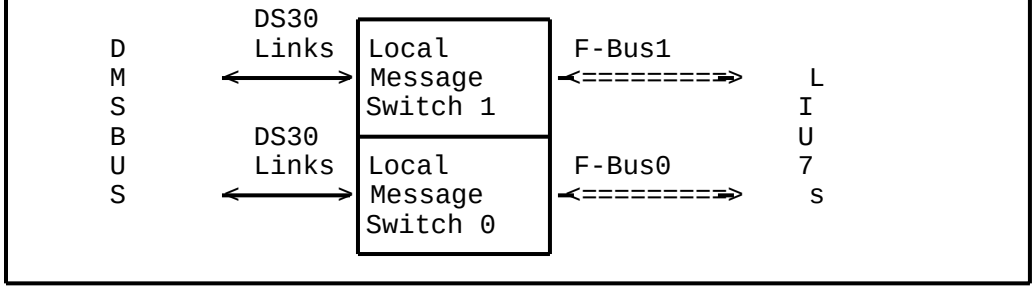


Fig. 78 - LIM Specification

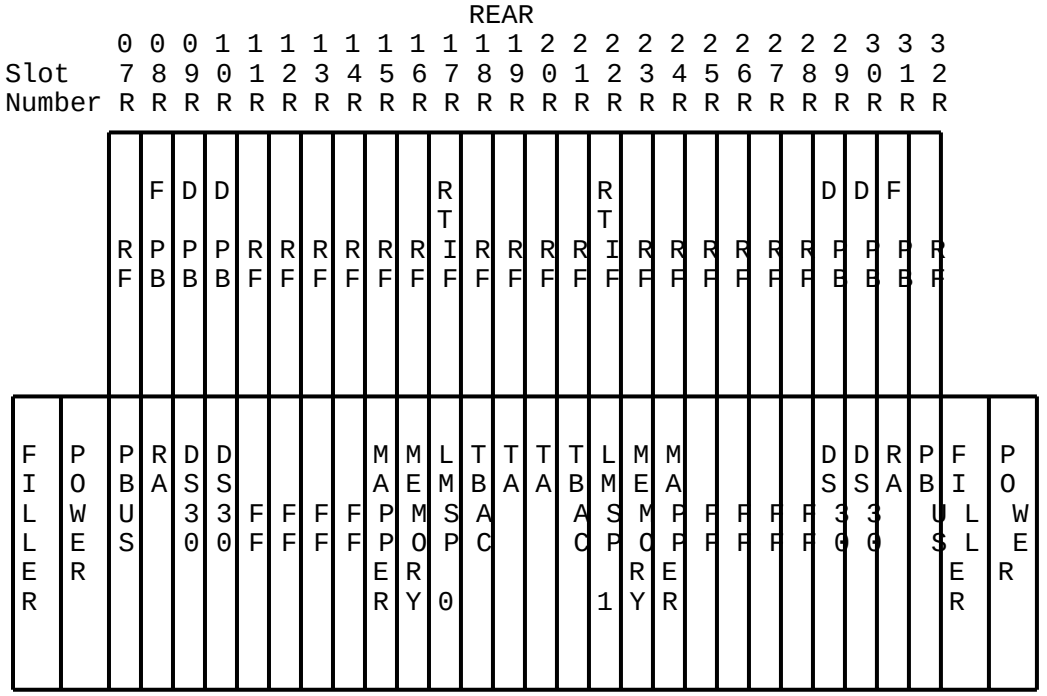
LIM Physical Configuration

LIM Shelf

The local message switch shelf is the top shelf in an LPP cabinet. Each local message switch of the LIM occupies one half of the shelf (front and rear).

Note: There are fixed LIM cards which are located on each link interface shelf assembly: +5V power converters (NT9X30AA), F-Bus repeater/terminators (NT9X74AA), F-Bus extension paddleboards with (NT9X79BA), without (NT9X79AA) termination. The shelf position of these cards is shown in LIU7 Physical Configuration on page 212.

Figure 79 on page 201 shows the front and rear LIM shelf when viewed from the top of the frame.



Slot	ABBR	NT PEC	EXPANSION
------	LMS	------	Local Message Switch
------	-----	9X7101	Local Message Switch Shelf Assembly
1F,33F	FILLER	9X19EA	Filler Face Plate
4F,36F	POWER	9X30AA	+5V Power Converter
7F,32F	P-Bus	9X49CA	P-bus Terminator
8F,31F	RA	9X73AA	F-Bus Rate Adapter
9F,10F,29F,30F	DS30	9X17AA	4-Port
FRONT FILLER	FF	9X19AA	8 Filler Face Plates
15F,24F	MAPPER	9X15AA	Mapper
16F,23F	MEMORY	9X14BB	Memory
17F,22F	LMSP	9X13DA	Local Message Switch Processor
18F,21F	TBAC	9X53AA	Clock
19F,20F	TA	9X52AA	T-Bus Access
REAR FILLER	RF	9X19BA	18 Paddleboard Filler Face Plates
8R,31R	F PB	9X79BA	F-Bus Extension Paddle-board with Termination
9R,10R,29R,30R	D PB	9X23BA	DS30 4-Port Paddleboard
17R,22R	RTIF	9X26AA	Remote Terminal I/F PB

Fig. 79 - Front and Rear Card Locations in LIM

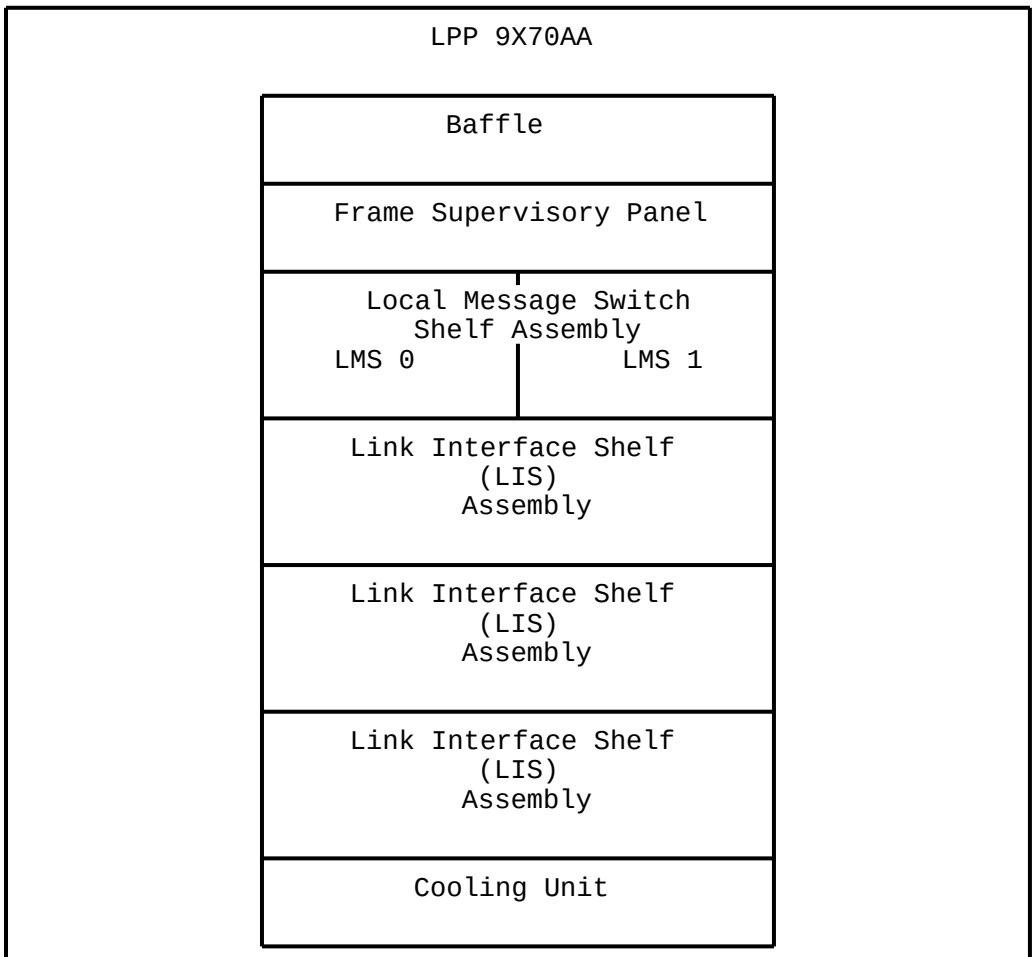
LPP Cabinet

A LIM and up to 24 LIU7s share a six-foot-high cabinet which consists of two shelf assembly types:

* local message switch shelf assembly

* link interface shelf assembly

(see Figure 80).



Note: The cabinet doors are not shown.

Fig. 80 - LIM Shelf in an LPP Cabinet

19. LINK INTERFACE UNIT 7

BACKGROUND

A Link Interface Unit 7 (LIU7) is a peripheral module in a Signaling Transfer Point (STP) DMS-SuperNode application (see 297-1001-141, 297-5101-100, and Figure 81 on page 204).

It is physically located in the Link Peripheral Processor (LPP) cabinet, along with the LIM.

In the STP, LIU7s terminate signaling links and provide the following message handling functions: message discrimination, message distribution and message routing.

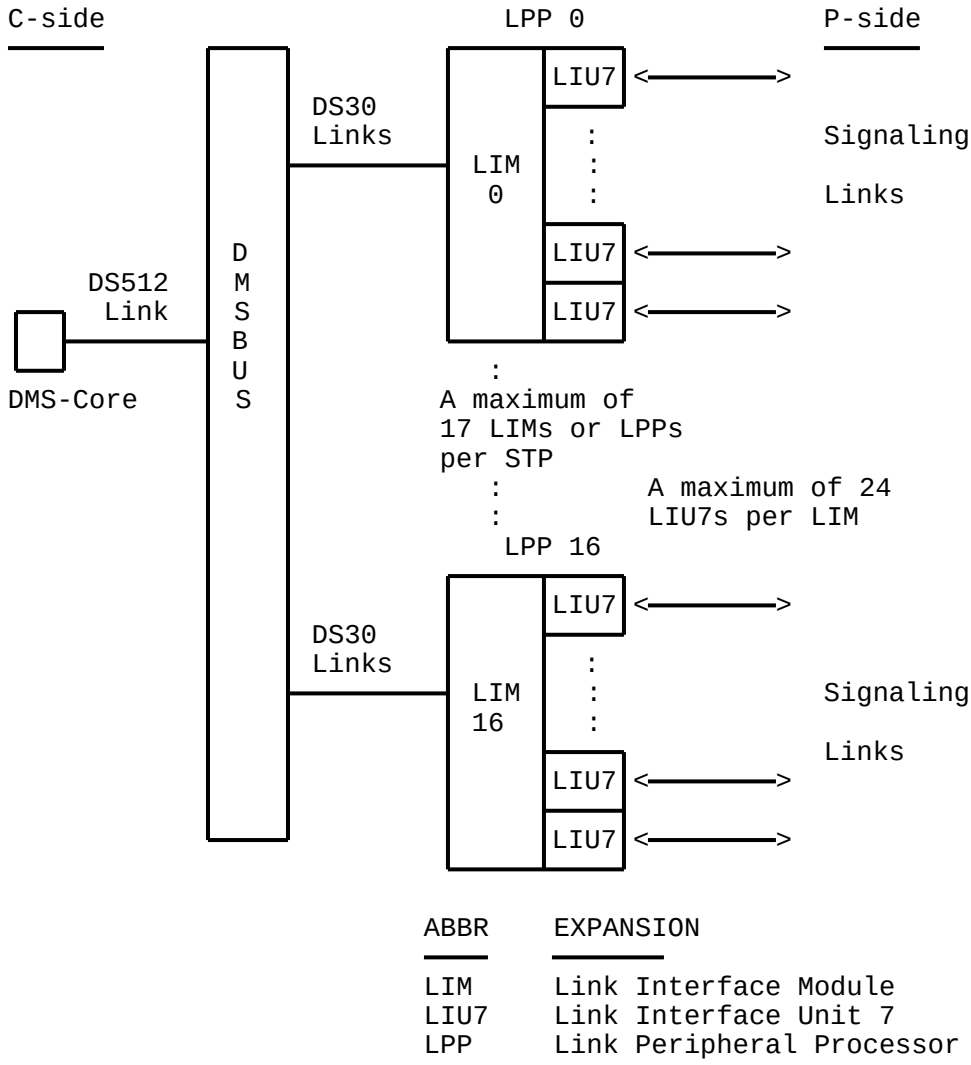
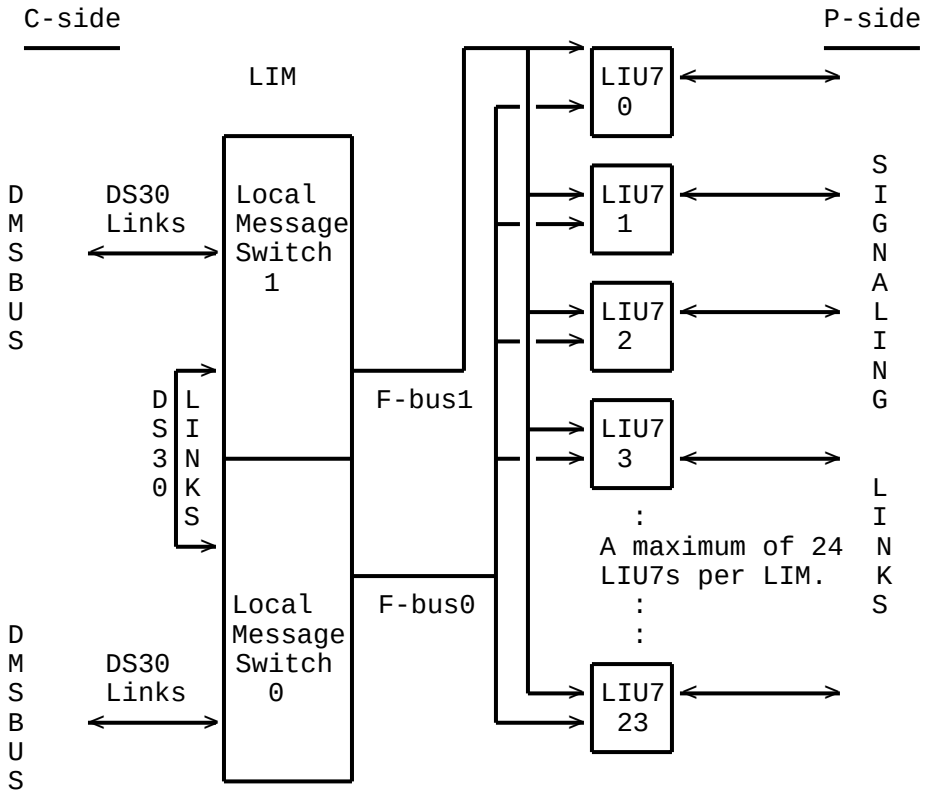


Fig. 81 - Signaling Transfer Point

Up to 24 LIU7s can be equipped in one LPP cabinet. On the P-side an LIU7 terminates one signaling link. On the C-side an LIU7 is connected to two F-Buses (F-Bus 0 and 1). The F-Buses provide 8-bit data paths to the two local messages switches (LMS 0 and 1) of the LIM. (See Figure 82 on page 205.)



ABBR	EXPANSION
LIU7	Link Interface Unit 7
F-bus	Frame Transport Bus
LIM	Link Interface Module
LMS	Local Message Switch

Fig. 82 - LIU7 and LIM Configuration

DATA PATHS THROUGH THE LIU7

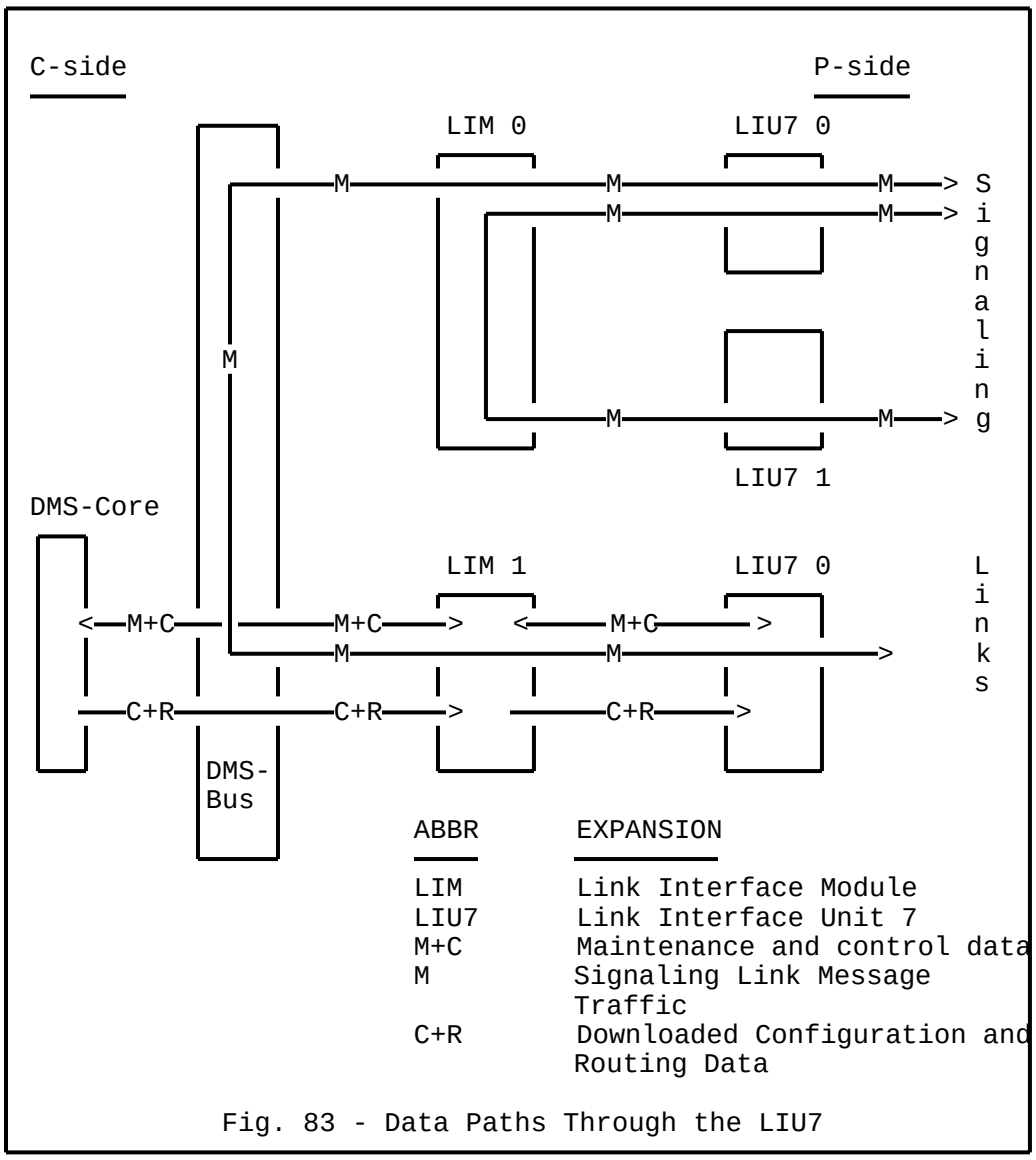
The data paths through the LIU7 consist of

* signaling link message traffic (LIU7<->LIU7 and LIU7<->DMS-Core)

* maintenance and control data (LIU7<->DMS-Core)

* downloaded configuration and routing data (DMS-Core-->LIU7)

(See Figure 83 on page 206.)



ABBR	EXPANSION
LIM	Link Interface Module
LIU7	Link Interface Unit 7
M+C	Maintenance and control data
M	Signaling Link Message Traffic
C+R	Downloaded Configuration and Routing Data

Fig. 83 - Data Paths Through the LIU7

LIU7 TASKS

Task List

An LIU7 provides

* signaling link termination
* F-Bus interfaces
* message handling
* routine audits and diagnostics
* global title translations (GTTs)

Signaling Link Termination

An LIU7 provides

* a P-side DS-0A (or, optionally, V.35) interface for the signaling link that it terminates.

* monitoring of the signaling link

Since there is no duplication of cards in the LIU7, a signaling link goes out-of-service if an LIU7 card fails.

F-Bus Interfaces

Each LIU7 in an LPP cabinet is connected to both local message switches of the LIM by means of two LIM F-Buses. F-Bus 0 connects the LIU7 to local message switch 0 and F-Bus 1 to local message switch 1. The LIU7 interfaces with both F-buses by means of the processor bus frame transport bus interface (PFI) card.

Message Handling
An LIU7 performs the following message handling functions:

* supports CCS7 protocols

* performs error checking on incoming messages and assembles outgoing messages

* decodes incoming messages to determine their destination

  - routes them to an outgoing link if they are destined for another node in the network

  - routes them to the correct internal address if they are destined for the STP

  - discards any incoming messages if their destination is not known to the system

  sends/receives maintenance messages to/from the DMS-Core

* receives downloaded configuration and routing data from the DMS-Core

Routine Audits and Diagnostics

The LIU7 performs the following maintenance functions:

* maintains the status of the LIU7 and notifies the DMS-Core of status changes

* responds to maintenance requests from the DMS-Core and the maintenance and administration position (MAP)

* provides a mechanism for handling faults or error conditions that are detected by the LIU7 or other STP modules

* provides a mechanism to carry out in and out-of-service diagnostics on cards

The DMS-Core uses the LIU7 status information to generate the following man machine interface output:

* MAP displays and alarms (see 297-1001-515)
* log reports (see 297-1001-510)
* operational measurements (see 297-1001-114)

For LIU7 table control see 297-1001-451.

Global Title Translation

The LIU7 performs the translation of CCS7 application addresses to the specific point codes associated with actual CCS7 network nodes and the services at those nodes. This translation is called global title translation (GTT).

LIU7 CARDS

Card List

There are three link interface shelf (LIS) assemblies in an LPP cabinet and each shelf has a front and rear (see Figure 85 on page 213 and Figure 86 on page 214). Each link interface shelf contains the following LIM cards which are fixed and are owned and maintained by the LIM:

* +5V power converters NT9X30AA
* F-Bus repeater/terminators NT9X74AA
* F-Bus extender paddleboards NT9X79BA/AA

Note: The power converters, F-Bus repeater/terminators and the F-Bus extender paddleboards are LIM cards and are discussed under LIM Cards on page 196. Each LIU7 that is equipped on a link interface shelf assembly consists of three cards and a paddleboard:

* link general processor NT9X13CA
* P-Bus F-Bus interface (PFI) NT9X75AA
* STP signaling terminal (ST) NT9X76AA
* DS-0A terminator paddleboard NT9X78AA/BA or
* V.35 interface paddleboard NT9X77AA (optional)

Link General Processor

One link general processor (LGP) (NT9X13CA) card is placed in the front of a LIS shelf for each equipped LIU7 (a maximum of eight per shelf). The link general processor (LGP) is the master processor in the LIU7.

P-Bus F-Bus Interface

One P-Bus F-Bus interface (PFI) card (NT9X75AA) is placed in the front of a LIS shelf for each equipped LIU7 (a maximum of eight per shelf). The PFI interface connects the LIU7 to both of the LIM F-Buses.

STP Signaling Terminal

One STP signaling terminal (ST) (NT9X76AA) is placed in the front of a LIS shelf for each equipped LIU7 (a maximum of eight per shelf). The STP ST supports the signaling link message protocols.

DS-0A Terminator Paddleboard

One DS-0A terminator paddleboard (NT9X78AA or BA) is placed in the rear of a LIS shelf for each equipped LIU7 (a maximum of eight per shelf). The DS-0A paddleboard provides the physical interface between the signaling link and LIU7. The 9X78BA is an enhanced version of the 9X78AA; it provides the LIU7 with the ability to respond to imbedded control signals, as well as to operate at both 56 and 64kb/s data rates.

V.35 Interface Paddleboard

The optional V.35 interface replaces the DS-0A paddleboard, and occupies the same slot-positions in the LIS. The NT9X77AA can operate in either a data communications equipment (DCE) or data terminal equipment (DTE) configuration. When configured as a DCE, it provides the 56kb/s clock source; when configured as a DTE, it receives clock from the modem or data unit and can operate at the following rates (in kb/s): 2.4, 4.8, 9.6, 19.2, and 56.

LIU7 HARDWARE CONFIGURATIONS

LIU7 Specifications

An LPP cabinet can be equipped with a maximum of 24 LIU7s (8 per LIS). A maximum of 408 LIU7s can be supported by a single STP. The basic specification and structure of the Link Interface Unit 7 is shown in Figure 84 on page 211.

CLASSIFICATION

PM NAME	PM TYPE	REMARKS
Link Interface Unit 7	LIU7	

C-SIDE LINKS

MIN.	MAX.	TYPE	CHAN/LINK	REMARKS
2	2	F-bus	1	Each LIU7 is connected to both local message switches of the LIM by means of two F-Buses. F-Bus 0 connects the LIU7 to LMS 0 and F-Bus 1 connects the LIU7 to LMS 1.

P-SIDE LINKS

MIN.	MAX.	TYPE	CHAN/LINK	REMARKS
1	1	DS-0A (or V.35)	1	Each LIU7 terminates only one CCS7 signaling link.

BASIC STRUCTURE OF A LIU7

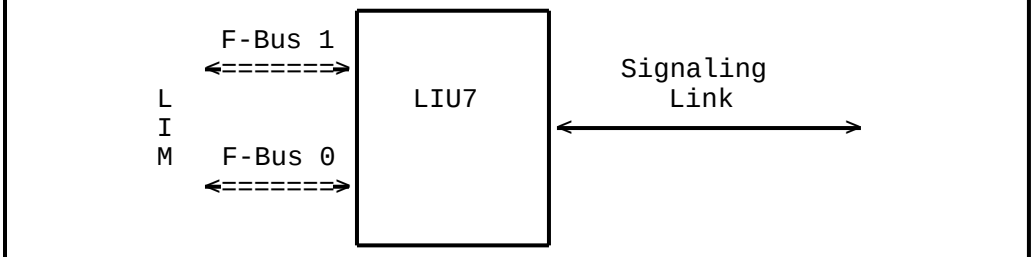
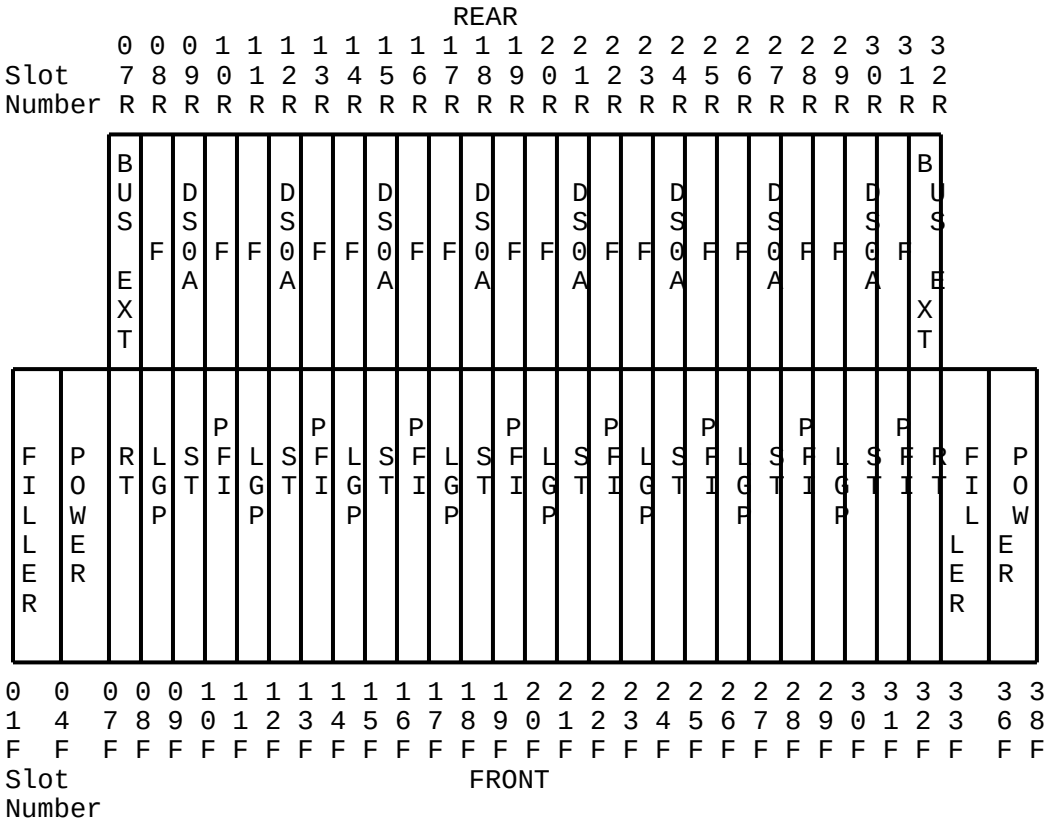


Fig. 84 - LIU7 Specification

LIU7 Physical Configuration

LIU7 Shelf

Each LPP cabinet is always provisioned with three link interface shelf (LIS) assemblies. The LISs occupy the lower three shelves (front and rear) of the cabinet. (See Figure 85 on page 213 for card positions within the link interface shelf assemblies and Figure 86 on page 214 for the position of the LIS in the LPP cabinet.



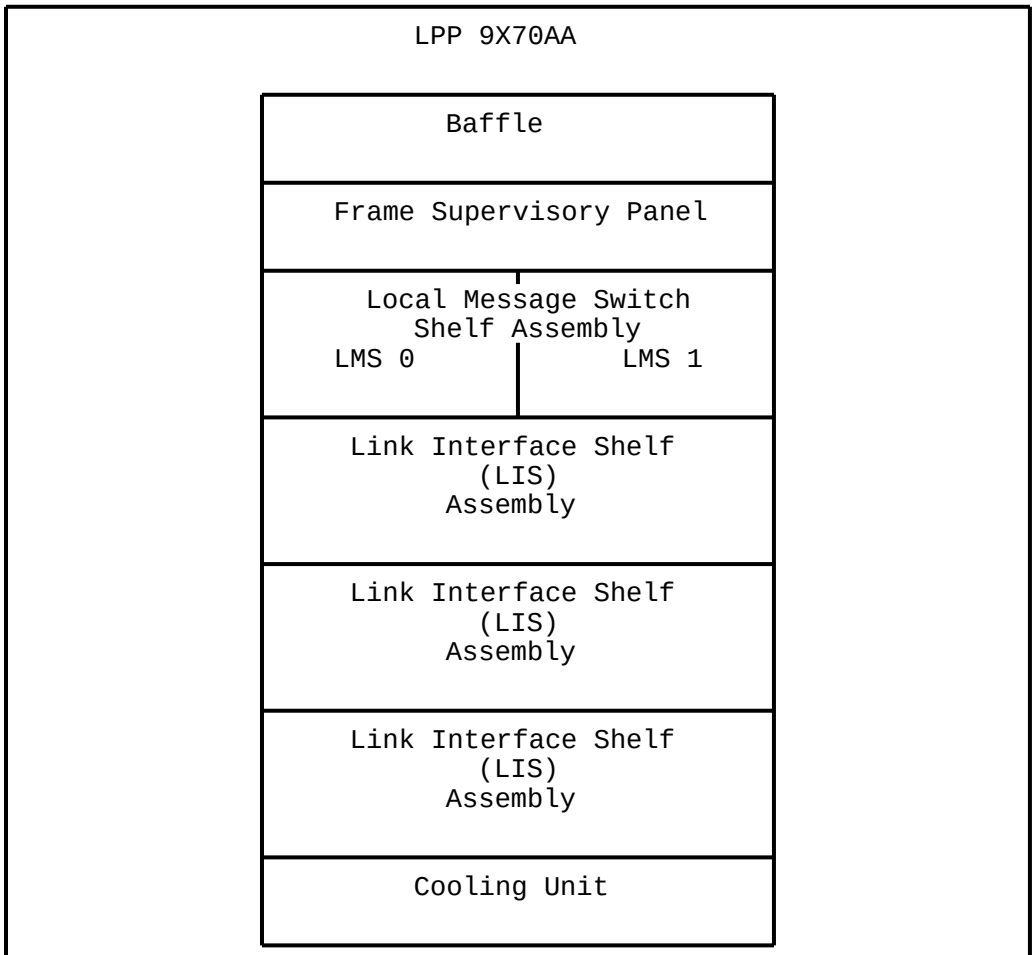
NOTE: When equipped with the optional V.35 interface, the 9X77AA paddleboard resides in those slots shown for the DS-0A.

Slot	ABBR	NT PEC	REMARKS
-----	LIS	9X7201	Link Interface Shelf Assembly
1F,33F	FILLER	9X19EA	Filler Face Plate (LIM card)
4F,36F	POWER	9X30AA	+5V Power Converter (LIM card)
7F,32F	RT	9X74AA	F-bus Repeater/Terminator (LIM card)
(see above)	LGP	9X13CA	Link General Processor
(see above)	ST	9X76AA	STP Signaling Terminal
(see above)	PFI	9X75AA	P-Bus F-Bus Interface
7R,32R	BUS EXT	9X79AA	F-bus Extender Paddleboard (LIM card) 'AA' without termination shelf 1,2 'BA' with termination shelf 0,3
Rear Filler	F	9X19BA	Paddleboard Filler Face Plate.
(see above)	DS-0A	9X78AA/BA	DS-0A Terminator Paddleboard
Front Filler	-----	9X19AA	Filler Face Plate (unequipped LIU7s)

Fig. 85 - Front and Rear Card Locations in LIU7

LPP Cabinet

Link interface units 7 (LIU7s) are located in link interface shelf assemblies (LISs) in an LPP. Three LIS assemblies are always provided in a single LPP cabinet (see Figure 86). A fully equipped link interface shelf assembly can house eight LIU7s. One LPP cabinet can be equipped with a maximum of 24 LIU7s.



Note: Cabinet doors are not shown.

Fig. 86 - LIU7 Shelves in an LPP Cabinet

20. LINE CONCENTRATING MODULES (LCM & RLCM & OPM)

GENERAL

A line concentrating module (LCM) is a PM to which the switch ends of up to 640 subscriber lines are connected. The C-side of the LCM is connected to a "controller" PM using DS30A links. The controller PM is placed within 50 feet of the LCM and can be any of the following:

* a line group controller (LGC)
* a line trunk controller (LTC)
* a remote cluster controller (RCC)

On instruction from the LGC (LTC or RCC), the LCM associates a DS30A channel with a subscriber line to enable an outgoing call to be made or an incoming call to be received.

The LCM can support digital or analog lines. All signals between the LCM and the LGC (LTC OR RCC) are digital. The LCM converts analog signals to digital and digital signals to analog.

A remote line concentrating module (RLCM) is a special version of the LCM to which the switch ends of up to 640 subscriber lines are connected. The C-side of the RLCM can be connected over DS1 links to the following peripherals:

* to a controller PM (an LGC or LTC). The RLCM can be located at a remote site, up to 100 miles from the LGC (or LTC).

* to a remote switching center (which is in turn connected to an LGC or LTC). The RLCM can be located at a remote site up to 50 miles from the RSC (to permit full use of ESA and intraswitching at the RSC).

Note: Fiber links can be used to link an RLCM with a host office. For information on the use of fiber links with the RLCM see Part 22 on page 263.

An outside plant module (OPM) is an RLCM, housed in a weather-proof cabinet. The OPM cabinet also contains its own power supply and power control equipment.

LCM CONFIGURATION

The LCM configuration is illustrated in Figure 87 on page 217. The LCM is a dual-shelf peripheral. Each shelf (called a Line Concentrator Array - LCA) has its own control complex (LCM processor and digroup control) and power converter.

The two control complexes are often called Unit-0 (the control complex in the lower shelf) and Unit-1 (the control complex in the upper shelf).

Each digroup control has eight C-side ports. Six of these ports are connected by means of DS30A links (three in active mode and three normally inactive - only used if one control complex fails) to the "host" LGC. The other two ports (connected to the digroup control in the other shelf) are used for link sharing (enables unused DS30A channels to be accessed by either control complex).

Each shelf (LCA) also contains five line drawers. Each line drawer contains a pair of line subgroups (LSG) and a single bus interface card (BIC). Each LSG pair consists of an even-numbered LSG and an odd-numbered LSG. The drawer identification reflects the identification of the two LSGs contained therein (for example: LSG 01/00)

An LSG consists of up to 32 line cards, one for each subscriber line serviced by the LSG.

The bus interface card (BIC) in each line drawer services the links between

* the unit-0 and unit-1 digroup control cards
* each (of the two) LSG contained in the line drawer.

When both units of the LCM are "active", the unit-1 control complex controls the ten odd-numbered LSG using the ten digroups (ten 32-channel P-side ports) available on the unit-1 digroup control card. Similarly the ten even-numbered LSG are controlled by the unit-0 control complex.

A fully equipped LCM interfaces six DS30A C-side links (180 speech channels) with 640 analog subscriber lines using:

* two control complexes
* two power converters
* 20 LSG (20x32 line cards) contained in ten physical drawers

If one control complex fails, the remaining control complex can "takeover" and support all six DS30A links and all 20 LSG. Calls in process of connection at the time of take over are terminated and must be redialed, but calls already connected and in progress are maintained.

If one power converter fails, the remaining power converter is capable of

* supplying power to all 20 LSG

* distributing the ringing and ANI/coin control voltages (supplied by one of the two ringing generators located in the LCE frame) to all 20 LSG.

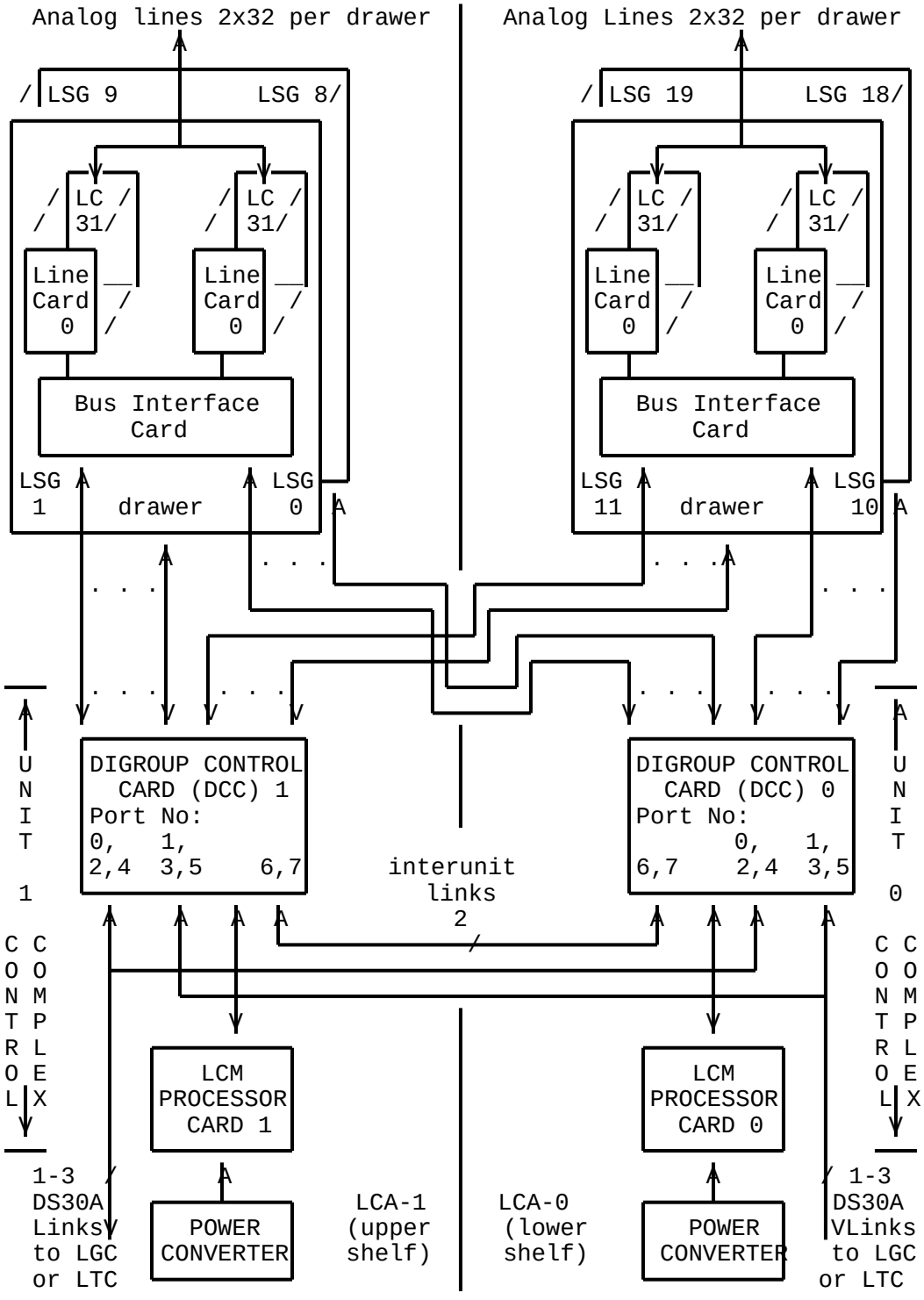


Fig. 87 - LCM Block Diagram

If an LSG fails, the LSG is set to system busy status and a minor alarm is reported. The operation of the other 19 LSGs is unaffected. The status of each LSG is shown as part of the LCM-level MAP display.

Port Configurations The minimum number of DS30A ports for the two shelves comprising the LCM is two, because each of the two links carries one message channel to the LGC (or LTC). Other ports up to a total of six ports (60 to 180 speech channels) per LCM can be accommodated depending on traffic capacity and concentration ratio required. Two additional DS30A ports are used for inter-unit links.

An LGC (or LTC) has 20 P-side ports. These 20 ports can be provisioned for

* (LGC and LTC) links to LCMs, RLCMs and Remote Cluster Controllers (RCC)

* (LTC only) digital trunks

CLASS Calling Number Delivery in the LCM

Calling Number Delivery (CND) is one of the optional Custom Local Area Signaling (CLASS) features that is offered to residential enhanced services (RES) customers. For more information on CND, see Class Calling Party Identification, (297-1401-122). The CND feature delivers the calling party's directory number to the called party's customer premises equipment (CPE) along with the date and time of the call. For interoffice calls, the calling number information is transmitted between the originating and the terminating offices by means of Common Channel Signaling 7 (CCS7).

The calling party information is transmitted to the called party CPE during the ringing phase of the call by a CLASS modem resource (CMR) card. The CMR card is located in the host LGC, LTC or RCC of the LCM or RLCM that terminates the called party's subscriber line. For more information on the CMR card see Line Group Controller on page 105.

In order to implement the CND feature, the terminating LCM or RLCM performs the following functions:

* receives a ringing request message from the terminating LGC/LTC/RCC that indicates a CND call

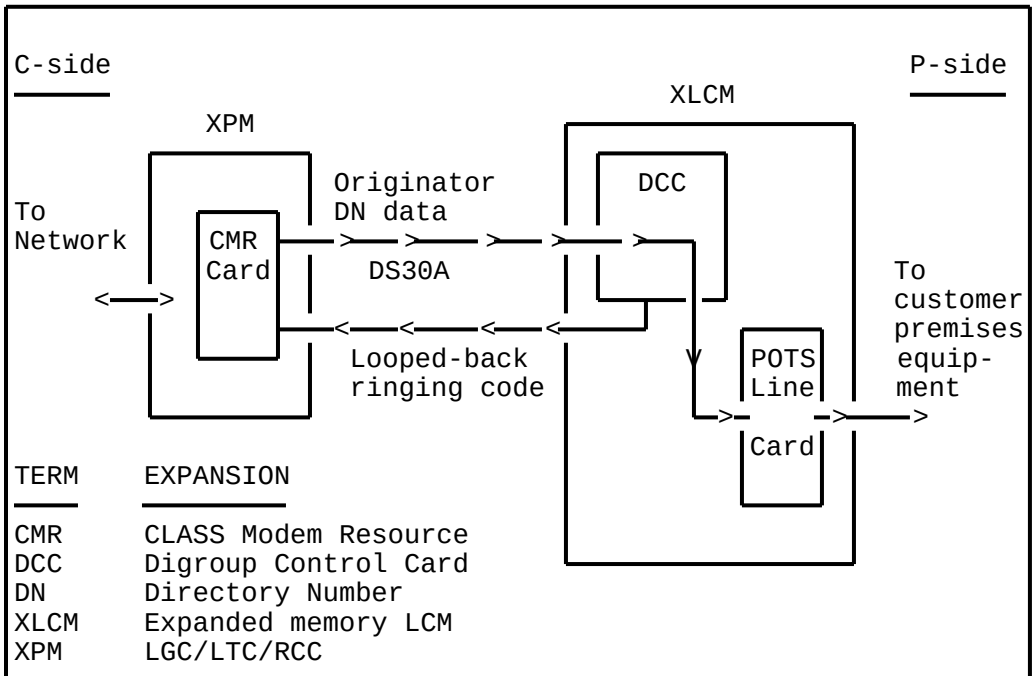
* sets up the C-side DS30A speech path connection to the CMR card in the terminating LGC/LTC/RCC (See Figure 88 on page 219.)

* sends a PCM ringing code for the first ring to the line card that terminates the CLASS subscriber set

* loops back the line card PCM ringing code to the CMR card in the host LGC/LTC/RCC by means of the DS30A speech path

* during the silent interval between the first and second ring, the LCM receives the calling party information from the CMR card and delivers it to the line card that services the called party's line

The CLASS CND capability is available in all expanded memory LCM (XLCM) loads but must be enabled by the optional RES and CLASS feature packages (see 297-1401-122 for feature package information). For information on the XLCM Processor card (NT6X51AB) see LCM/XLCM Processor on page 220.



TERM	EXPANSION
CMR	CLASS Modem Resource
DCC	Digroup Control Card
DN	Directory Number
XLCM	Expanded memory LCM
XPM	LGC/LTC/RCC

Fig. 88 - Calling Number Delivery to a RES Subscriber

LCM CARDS

Card List

Each line concentrating array (LCA) shelf in the LCM consists of three common cards plus five line Drawers. The common cards in each LCA consist of:

* LCM/XLCM processor	NT6X51AA/AB
* digroup control	NT6X52AA
* power converter	NT6X53AA

Each line drawer consists of one common bus interface card (NT6X54AA) plus a maximum of 64 line cards. The following line card types can be equipped in the LCM:

* A type standard (POTS) NT6X17AA/AB
* B type (Coin) NT6X18AA
* B type (Coin) NT6X18AB
* power converter (+48V) NT6X23AA
* C type (P-Phone) NT6X21AA/AB
* D type (Data) NT6X71AA/AB
* E type (Message-Waiting) NT6X19AA
* message-waiting converter NT6X20AA
* integrated bit error rate tester (IBERT) NT6X99AA

LCM/XLCM Processor

One NT6X51 processor card is provisioned on each LCA shelf (see Figure 90 on page 227). The NT6X51 processor card is available in two versions:

* LCM Processor NT6X51AA
* Expanded Memory LCM (XLCM) Processor NT6X51AB

Some characteristic features of the LCM Processor Card NT6X51AA include:

* an Intel 8085 microprocessor
* 64 kilobytes of random access memory (RAM)
* 8 kilobytes of read only memory (ROM)
* the ability to use standard LCM software loads only

The NT6X51AA processor performs the following functions in the LCM:

* controls LCA activity and sanity checking
* collects dial pulse digits
* handles DMSX message protocol on DS30A links to the LGC/LTC/RCC
* monitors the power supply, and ringing generator
* monitors ANI/coin functions

Some characteristic features of the XLCM NT6X51AB processor card include:

* an Intel 8085 microprocessor
* 256 kilobytes of RAM in four memory banks
* 32 kilobytes of ROM
* the ability to use either LCM or XLCM software loads
* the ability to perform all functions of the LCM Processor (AA)
* full backward compatibility with existing LCM software loads
* functions as a replacement card for the LCM Processor (AA)

Datafill of the MEMSIZE field in Table LCMINV allows the XLCM Processor NT6X51AB card to function as either an AA or AB processor card (see Table LCMINV in 297-1001-451 Section 159).

Digroup Control

A single digroup control NT6X52AA card is provisioned on each LCA shelf (see Figure 90 on page 227). Each digroup control card is responsible for

* terminating one to three C-side DS30A links to an LGC/LTC
* controlling ten serial 32-channel digroups, one to each line drawer in the LCM
* associating digroup channels from line drawers to DS30A channels by means of time switching
* providing its associated LCM/XLCM processor with access to all ten line drawers (LD) through a 32-channel digroup to each LD
* providing its associated LCM/XLCM processor with access to all six LCM C-side DS30A links
* providing digital loop-around paths for fault isolation

Power Converter

A single power converter (NT6X53AA) is provisioned on each LCA shelf (see Figure 90 on page 227). Normally, each power converter supplies +5 and +15 outputs to the cards in the LCA where it is located; however, if one power converter fails, the mate is capable of supplying power to all cards of the LCM.

The multiplexer circuit on the NT6X53AA card is used to select which ringing voltage generators on the LCE frame will supply ringing voltage to an LCA shelf.

Bus Interface Card

The bus interface (BIC) NT6X54 card is located at the front of the line drawer, behind the front faceplate (see Figure 91 on page 228 and Figure 92 on page 229). The BIC is responsible for

* providing an interface between two 32-channel digroups and a maximum of 64 line cards
* scanning line cards for a hook switch change or message present state
* sending signals through a ringing multiplexer to control the relays in the power converter which select ringing and ANI/coin voltages

* monitoring line drawer activity

* performing digital loop-around (for fault isolation) on command from the maintenance system

See GS6X05 for details of the LD and the BIC card.

A Type Standard (POTS) Line Card

The A type line card (NT6X17AA/AB), operates with lines connected to single-line analog telephone sets (type 500 or 2500). It also has a cutover control circuit. See GS6X17.

B Type Coin Line Card (AA)

The B type coin line card (NT6X18AA) provides all the features of the A type line card and, in addition, operates with analog pay telephone sets, requiring coin control, plus single-party, two-party, or multiparty analog sets. See GS6X18.

B Type Coin Line Card (AB)

The B type coin line card (NT6X18AB) provides all of the features of the NT6X18AA card plus a +48V interface for use with coin lines that require coin pad disabling.

Note: The B Type Coin Line card (NT6X18AB) must be equipped with a +48V Power Converter card (NT6X23AA) in order to provide coin pad disabling (see Power Converter (+48V)).

Power Converter (+48V)

The +48V power converter (NT6X23AA) is used with the B type coin line card (NT6X18AB) when coin pad disabling is required. This card must occupy two vertical slots (0 and 16) in a line drawer within the odd LSG (see Figure 90 on page 227 and Figure 91 on page 228).

C Type P-Phone Line Card

The C type P-Phone line card (NT6X21AA/AB) operates with electronic multiline telephone sets and operator consoles. See GS6X21.

D Type Data Line Card

The D type data line card (NT6X71AA/AB) provides data transmission interfaces for lines equipped with DMS-100 data units. The DLC occupies two adjacent slot positions in a line drawer (for example slots 1 and 17, see Figure 91 on page 228). The DLC is described in GS6X71.

E Type Message-Waiting Line Card

The E type message-waiting line card (NT6X19AA) provides all the features of the A Type Line Card, plus the message-waiting lamp driver circuit. This circuit, when activated, causes the message waiting lamp on the associated telephone set to flash at 1 Hz, thus informing the subscriber that a message is being held.

Message-Waiting Converter Line Card

The Message-Waiting Converter Line card (NT6X20AA) provides a -150 V synchronized pulse for the message-waiting lamp circuit. The converter is synchronized from the 2.56 MHz clock pulse in the LCM. This card must occupy two vertical slots (0 and 16) in a line drawer within the odd LSG (see Figure 90 on page 227 and Figure 91 on page 228).

Integrated Bit Error Rate Tester Line Card

The integrated bit error rate tester (IBERT) line card (NT6X99AA) provides a bit-error-rate-test (BERT) pattern for testing the transmission quality of data loops in a DMS office. The IBERT occupies two vertically adjacent line card positions in a line drawer of an LCM or RLCM. The IBERT line card is always placed in the lower numbered line subgroup of the line drawer (see Figure 90 on page 227). The IBERT line card is used as a testing tool in ISDN, Datapath, and bit error rate performance (BERP) testing. As an engineering recommendation, no more than one IBERT line card should be allocated per LCM or RLCM. For more information on IBERT see the following documents:

* 297-2401-516 (ISDN) Line Maintenance Reference Manual
* 297-2101-516 Line Maintenance Reference Manual
* 297-2401-503 (ISDN) Lines Maintenance Performance Oriented Practice
* GS6X99 Integrated Bit Error Rate Tester

INTERNATIONAL LCM

The international line concentrating module (ILCM), PEC NT6X05BA, is an LCM designed for international applications. The ILCM operates the same as the LCM and uses the following hardware in place of the standard LCM hardware.

International Digroup Controller Card, PEC	NT6X52AB- replaces NT6X52AA
International Bus Interface CP, PEC	NT6X54BA- replaces NT6X54AC
International Type A Line Card, PEC	NT6X93AA- replaces NT6X17AA

LCM FRAME AND SHELF LAYOUT

LCM Frame Layout

See Figure 89 on page 226. LCMs are housed in a standard DMS-100 single-bay frame, referred to as a line concentrating equipment (LCE) frame. Each frame contains two LCM consisting of two shelves per LCM, as previously described. The LCM shelves are referred to as line concentrating arrays (LCA). The baffle and fuse panels above each LCA permit air circulation for convection cooling, and carry sets of five +5V and -48V fuses (one set for each LSG pair) and a pair of fuses for the ringing voltage outputs.

The LCE frame also contains a frame supervisory panel (FSP) which provides power control and alarm circuits for both LCMs, and for two ringing generators (RG-0, RG-1) located within the FSP. See GS6X35 for details of the FSP. The RGs also generate ANI/coin control voltages. Normally, the bottom LCM (LCM-0) uses RG-0, and the top LCM (LCM-1) uses RG-1. In the event of a failure of the ringing voltage from either RG, the remaining RG can supply ringing voltage to both LCM. The ANI/coin control voltage circuits are, however, not shared like the RG circuits, and the LCM goes into takeover mode if the ANI/coin voltage from an RG fails (or if a complete RG fails).

LCM Shelf Layout

See Figure 90 on page 227. All LCA shelves have the same layout, with the power converter card at the left (slots 01-03), the control complex cards next (slots 04, 05), and the five line drawers filling the remainder of the shelf.

The power converter contains circuits for converting -48V office battery to regulated +5V, +15V outputs for the shelf circuitry, also relay circuits which control the application of ringing and ANI/coin voltages from the RG to the LCM line circuits. See GS6X53 for details of the LCM power converter. Power connections to the two shelves of an LCM are arranged so that one converter can supply both shelves if the mate converter fails.

Line Drawer (LD) Layout

See Figure 91 on page 228 and Figure 92 on page 229 which shows a side and front view of a typical LCM line drawer (LD). The LD can be withdrawn from the frame to obtain access to the circuit cards, yet remain operative because of flexible cables connected to the rear receptacles.

The bus interface (BIC) card (NT6X54) is located at the front of the LD, behind the front faceplate. In addition to providing an

interface between two 32-channel digroups and the 64 line circuits, the BIC card performs the following functions:

* scans line circuits for hook switch change or message present

* sends signals through a ringing multiplexer to control the relays in the power converter which select ringing and ANI/coin voltages

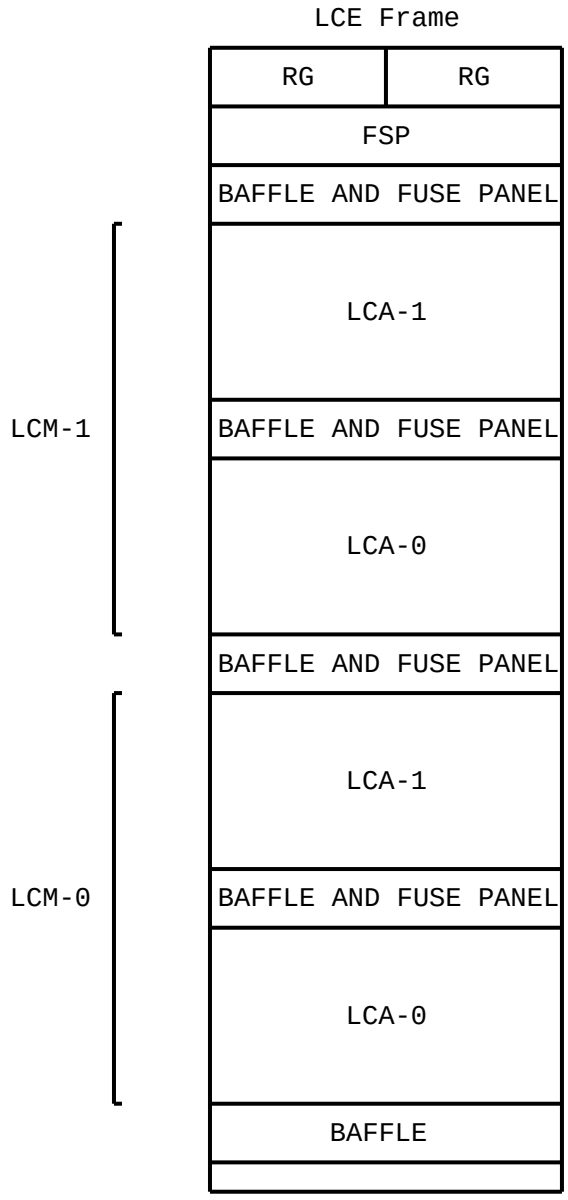
* monitors LD activity circuit for maintenance purposes

* performs digital loop-around on command from the maintenance system

See GS6X05 for details of the LD and the BIC card.

The line circuit cards (LC) are located behind the BIC card in four rows of up to 16 LCs. The top two rows form the odd numbered LSGs and the bottom two rows form the even numbered LSGs.

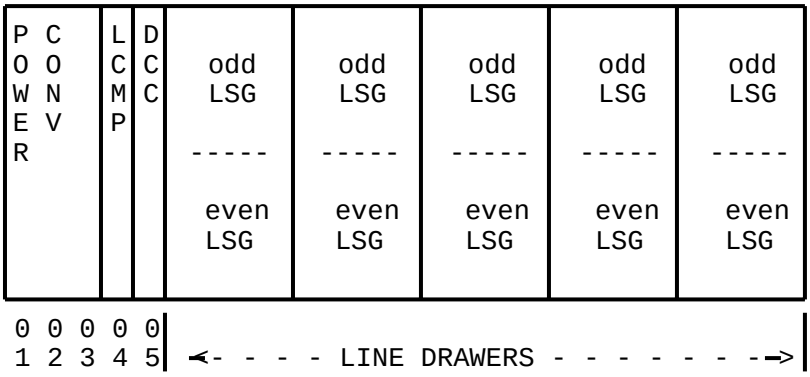
For circuit identification the individual circuits are numbered by LC within LSG. LSG numbers in a LCM range from LSG-00 (lower two rows of LC in the bottom left line drawer) to LSG-19 (upper two rows of LC in top right line drawer). LC numbers range from 00 to 31. The position for LC-00 is assigned to a type A line circuit, which is used for analog ringing test purposes, and is therefore not available for assignment to a subscriber line.



Slot	NT PEC	Remarks
FSP	6X35AA	Frame Supervisory Panel
LCA	6X0401	Line Concentrating Array (shelf) See Figure 87 on page 217
LCE	6X03AA	Line Concentrating Equipment (frame)
LCM	6X04AA,AB	line concentrating module
RG	6X30AA	Ringing Generators

Fig. 89 - LCE Frame, Shelf and Panel Arrangement

LCA: NT6X04AA



Slot	Abbr	NT PEC	Remarks
01-03	-	6X53AA	Power Converter. Also contains ringing and ANI voltage switching circuits.
04	LCMP	6X51AA/AB	LCM Processor (6X51AB is the XLCM Processor)
05	DCC	6X52AA	Digroup Control Card
-	-	6X05AA	Line Drawer See Figure 91 on page 228 and Figure 92 on page 229.
	LSG	-	Line Subgroup.

Fig. 90 - Line Concentrating Array (LCA), Shelf Layout and Card Complement

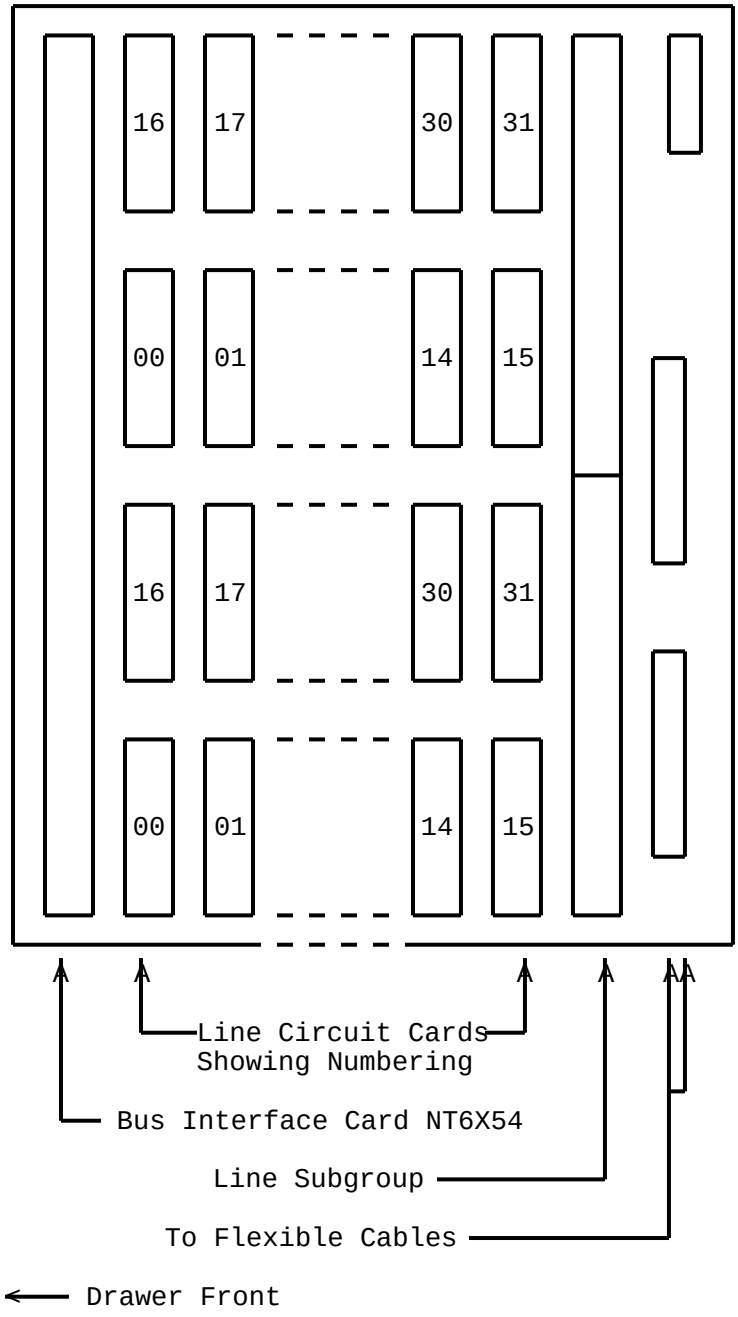


Fig. 91 - LCM Line Drawer NT6X05AA, Card Location

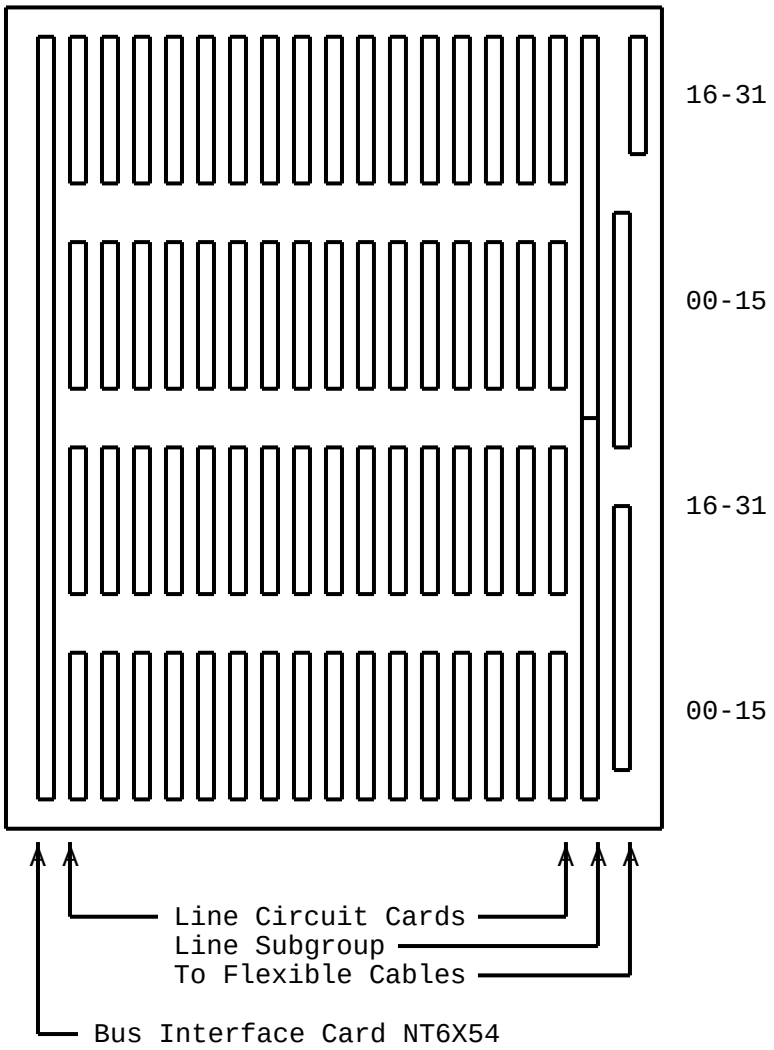


Fig. 92 - LCM Line Drawer NT6X05AA. Packaging of Circuit Cards

RLCM CONFIGURATION

The RLCM configuration consists of four modules:

* the Line Concentrating Module (LCM)
* the host interface equipment (HIE)
* the Remote Maintenance Module
* emergency-stand-alone cards

LINE CONCENTRATING MODULE (IN RLCM)

The LCM two-shelf configuration and shelf layout is as described in LCM Configuration on page 215, LCM Shelf Layout on page 224, and Figure 87 on page 217.

HOST INTERFACE EQUIPMENT

The host interface equipment (HIE) is the additional equipment required to enable the RLCM to support DS1 C-side links. The HIE converts between DS1 links (to and from the LGC or LTC, located in the "host" office) and DS30A links (to and from the LCM, which forms a part of the RLCM).

Note: For information on fiber links between an RLCM and a host office see Part 22 on page 263.

The host interface equipment is housed in an HIE shelf (see Figure 96 on page 242), and consists of

* two or three DS1 interface cards connected to the DS1 links to and from the host LGC (or LTC)

* two link Control cards (LCC-0 and LCC-1). The DS30A links from LCA-0 (LCM Unit-0) are connected to the P-side of LCC-0. The DS30A links from LCA-1 (LCM Unit-1) are connected to the P-side of LCC-1.

Connections also exist between the C-side of each LCC and

* each DS1 card
* the other LCC
* the RMM

As part of the set up of the RLCM, a configuration parameter is passed to each LCC which causes each DS30A channel to or from the LCA to be connected (in the LCC) to

1. a channel to and from the mate LCC (interswitched), or

2. a channel to and from a DS1 interface card, or

3. another channel to and from the same LCA (intraswitched), or

4. a channel to and from the RMM

LINKS WITHIN AN RLCM CONFIGURATION

The links that can be provisioned, in an RLCM configuration, are shown in Figure 93 on page 239. Each DS1 interface card services two DS1 links from the distant host office LGC or LTC and is connected to LCC-0 and LCC-1.

When both LCCs are active:

* the traffic to and from the even-numbered DS1 links (0, 2, 4) is passed, through LCC-0, to and from the LCA-0 shelf in the LCM

* the traffic to and from the odd-numbered DS1 links (1, 3, 5) is passed, through LCC-1 to and from the LCA-1 shelf in the LCM.

Each LCC can only pass traffic to and from the corresponding LCA. If LCA-0 becomes inactive, a takeover is triggered in the LCM so that all traffic is handled by LCA-1 and LCC-1. Similarly, if LCA-1 becomes inactive, all traffic is handled by LCC-0 and LCA-0.

Each LCC is connected to the corresponding LCA through eight DS30A ports (0-7). The purpose of the ports is as follows:

* Port-0 "primary" port. Carries the LCA shelf message channel (1) which is mapped on to the channel 1 of each of the two primary DS1 links to the host office. A minimum of two DS1 interface cards must be provisioned with one primary DS1 link terminated on each card for reliability. Port-0 also carries 30 speech channels which are:

  - mapped on to channels 2 to 24 of the primary DS1 link

  - looped around to another DS30A channel back to the same LCA (for intraswitched calls)

  - connected, through the mate LCC, to a DS30A channel into the mate LCA (for interswitched calls)

* Ports 1 and 2 Used to carry speech channels for mapping onto the other two DS1 links (if provisioned), and for intraswitched or interswitched calls or both.

* Ports 3, 4, 5 Normally inactive, these ports become active if the mate LCA and LCC are inactive, and takeover occurs. Port 3 takes over mate port 0, port 4 takes over mate port 1, and port 5 takes over mate port 2. The mapping of all channels

on to the DS1 links is maintained, and the active LCM controller takes control of all DS1 links.

* Port 6 Provides a DS30A link for intershelf connections. During call processing the channels on this port are used for two purposes:

  - Interswitching: providing intershelf connections between subscriber lines on different shelves of the same RLCM, without using the host network. Connections between subscribers on the same shelf are handled by intrashelf links within each LCC.

  - Link sharing; allowing a subscriber line on one LCA to have access to a DS1 channel to the host office, when the channel is controlled by the mate LCA and LCC.

* Port 7 Provides duplicate DS30A links for access (one per LCA) to the RMM. If the RMM is not provisioned, this port is not used. By means of the RMM ports, individual line circuits can be selected and metallic test access (MTA) connections can be made to their tip and ring leads for test purposes.

REMOTE MAINTENANCE MODULE (IN RLCM)

The Remote Maintenance Module (RMM) provides the LCM with access to test and service circuit cards at the remote site (thus reducing the load on the RLCM-to-"host" DS1 links).

The RMM is similar in configuration to the MTM (see Part 5 on page 57 and Figure 19 on page 59) and occupies one shelf. However the RMM C-side interface uses a pair of DS30A links, one to each LCC in the HIE shelf. This ensures that the RMM is operable regardless of which LCC is active. There are also differences in the control and processor cards.

Like the MTM, the RMM can accommodate up to 14 service circuit cards which are selected from a variety of types to meet the office requirements. Some of the service cards in an RMM, however, are dedicated to performing the MTA function, and consist of

* Metallic Test Interface. Applies operating signals to the remote MTA card, as instructed by commands from the host, through port 7 of the LCC.

* Remote MTA Consists of a two-wire metallic matrix with four horizontal and eight vertical buses. One horizontal bus is connected to the MTA bus for the 320 line circuits in LCA-0, while another is connected to a similar MTA bus in LCA-1. Two horizontal buses are unused. The verticals are connected to service circuits or spare line circuits.

* Line Test Position (LTP) Monitor Provides an interface to an analog test trunk to an LTP where talk monitoring and other tests can be performed. See 297-2101-116 for details of the LTP.

Connections for selecting a line circuit, applying tests to it, and displaying the results, are made through the DS30A links to the LCC, and hence by the DS1 links to the host office, where PM maintenance is performed using the MAP (see Man-Machine Interface (MMI) on page 46).

RLCM INTRACALLING

Intracalling Feature

Intracalling is a feature which allows calls between subscribers on the same RLCM to be connected without using the host network. Intracalling has two components:

* intraswitching - the ability to connect calls from subscribers served by the same LCA in an RLCM

* interswitching - the ability to connect calls between subscribers served by different LCA within the same RLCM

Intracalling Hardware

The intracalling connections are made within the LCC. When configured for intracalling, the LCC sets up a number of

* loop-around connections between pairs of DS30A channels to and from the LCA (used for intraswitched calls)

* connections between the LCA-to-LCC DS30A channels and LCC-to-LCC DS30A channels (used for interswitched calls)

The intracalling connections use the spare capacity available within the LCC. This capacity comes from the following differences between the internal capabilities of the LCC and the external requirements to support the links to the "host" PM:

* the LCC can support 30 speech channels on each of its six ports, but the DS1 links to the host only use 24 speech channels

* for each of the unequipped C-side ports, 30 speech channels are used

Intracalling Operation

All calls from subscribers served by an RLCM are set up through two speech paths:

1. from the RLCM to the LGC (or LTC)

2. from the LGC (or LTC) to the called party

When the DMS call processing software recognizes that the calling and called party are served from the same RLCM, it instructs the RLCM to

* intraswitch the call (if the lines are served by the same LCA)

* interswitch the call (if the lines are served by different LCAs within the same RLCM)

If the intracalling connection is successful, the original path through the LGC is released.

A speech path through the LGC can be re-established. This can be necessary when a business set at one end of an intracalling connection is used to

* activate a feature which requires LGC intervention

* send a DTMF tone which must be generated by the DTMF tone generator associated with the LGC.

Once a speech path is re-established through the LGC (or LTC), it is never changed back to an intracalling connection.

RLCM INTRACALLING WHEN HOSTED BY RSC

Intracalling Operation

When an RLCM is "hosted" by an RSC, RSC intracalling may be used to extend the intracalling capabilities.

In all cases, RLCM intracalling is attempted as described in RLCM Intracalling on page 233. If intracalling at the RLCM is unsuccessful, RSC intracalling is then attempted.

If intracalling at the RSC is successful, the original speech path through the LGC is released.

Distance Limitation

In order to use RSC intracalling, an RLCM (remote from an RSC) must be within 50 miles of the RSC.

EMERGENCY STAND-ALONE (IN RLCM)

Emergency Stand-Alone Description

Emergency Stand Alone (ESA) is an optional emergency service feature (NTX154AA) which permits local calling within an RLCM in the event of loss of communication with the "host" peripheral module (LGC or LTC or RSC). Special ESA hardware takes over enough of the call processing control functions to enable calls to be made on a "no charge" basis between subscribers supported by the same RLCM.

NOTE: A Convertible RLCM does not support ESA.

While the RLCM is in ESA, subscribers receive Plain Ordinary Telephone Service (POTS) on all types of telephone and data sets. Special features are suspended in ESA.

Subscriber line types supported during ESA are:

single party
two party
multiparty
four party fully selective
eight party semi-selective
PBX loop or ground-start
Electronic Business Set (POTS subset)
data line card (POTS subset)
Automatic Lines

Other features supported during ESA are:

* DP, DIGITONE[7] dialing from lines (DIGITONE requires a digitone receiver to be equipped in the RMM)

* all ringing types supported by the LCM

* ground and loop start

* line to line calling, including Electronic Business Set and DDU

* line to line hunting (sequential only)

* a range of local dialing plans, for POTS and business services.

During ESA, the following services are not supported:

* billing, including CAMA and message rate charging (all lines are treated as flat rate lines)

* coin control functions (coin always returned to the caller)

* speed calling, call waiting, three way calling and the majority of business service features (only the primary directory number and the release keys are supported on Electronic Business Sets)

* line restriction features

* multiple appearance directory number groups (the primary numbers are treated as regular business service lines)

* calling party identification (Automatic Number Identification is disabled in ESA)

* maintenance and administration features

* recorded announcements

* Teletypewriter Exchange Service

* operator consoles (in ESA calls to the operator can be routed for special termination).

Emergency Stand-Alone Hardware

RLCMs equipped for ESA operation are provided with an ESA processor, tone and clock card, and an additional memory card in the host interface equipment shelf; also, if DIGITONE[8] service is required, a DIGITONE receiver service card is added to the RMM shelf.

Emergency Stand-Alone Entry

ESA operation occurs automatically when:

* loss of communication, on the message channels of the primary DS1 links to the "host" PM (LGC, LTC or RCC) is detected

* the CC fails to respond to loop-around messages.

ESA-Entry delay periods (default 30 seconds for communications loss and 15 minutes for non-response to loop-around messages) are stored as office parameters. These delays ensure that the ESA is not entered if restart or other maintenance procedures being carried out on host equipment causes a temporary loss of communication.

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[7] DIGITONE is a Trademark of Northern Telecom.

[8] DIGITONE is a Trademark of Northern Telecom.

ESA-Entry involves enabling the messaging link between the LCM processor(s) and the ESA processor, through the LCC and ESA processor bus.

When ESA-Entry occurs, all calls are lost.

Emergency Stand-Alone Operation

During ESA, all call control messages which would normally have been exchanged with the CC (through the LGC or LTC) are now exchanged with the ESA processor.

The ESA processor uses copies of the CC translation tables, stored in the ESA memory, to identify calls between lines served by the RLCM. The intracalling facility (see RLCM Intracalling on page 233) is used to connect these calls. All other calls are routed to reorder tone.

During ESA, the C-side ports of the RLCM are temporarily reconfigured to show all but ports 0 and 1 as unequipped.

As a result, the spare capacity in the LCC is increased and used to make intracalling connections between lines serviced by the RLCM (see also Intracalling Hardware on page 233).

Emergency Stand Alone Exit

When the links to the host LGC (or LTC) are restored, the CC starts either a system ESA-exit or a manual ESA-exit process. A control table entry indicates whether the system or manual ESA-exit is appropriate.

A system ESA-Exit is initiated after the expiry of a time-out period. During the time-out period, a countdown is displayed, and it is then possible to override the system action by placing the RLCM in the Manual Busy state.

A manual ESA-exit is initiated after the CC reports that the links to the host LGC (or LTC) have been restored. When the Return to Service (RTS) command is entered, the number of current calls in ESA is displayed and confirmation is requested. If the ESA-exit confirmation is given, the exit process is started immediately.

All calls are lost during the exit from ESA mode.

RLCM EMERGENCY STAND-ALONE WHEN HOSTED BY RSC

When an RLCM is "hosted" by an RSC, two levels of ESA are provided:

* RLCM ESA, in the event of loss of communication between the RLCM and the RSC. This is described in RLCM Intracalling on page 233.

* RSC ESA used in the event of loss of communication between the RSC and the LGC (or LTC). This is described in Emergency Stand-Alone (in RSC) on page 251.

RLCM FRAME AND SHELF LAYOUT

RLCM Frame Layout

See Figure 94 on page 240. Each RLCM is housed in a standard DMS-100 single-bay equipment frame. The lower part of the frame contains one LCM, consisting of two LCAs (with baffle and fuse panels), as described in LCM Frame Layout on page 224. Lower and upper baffles permit air circulation for convection cooling.

The upper part of the frame contains the host interface equipment (HIE) shelf, the RMM shelf, and the frame supervisory panel FSP. The FSP provides power control and alarm circuits for the LCM, host interface, and RMM shelves, and for the ringing generators in the HIE shelf.

Shelf Layout - LCA Shelves

The layout of the LCA shelves and line drawers (LD) is the same as illustrated in Figure 90 on page 227, Figure 91 on page 228 and Figure 92 on page 229.

Shelf Layout - HIE Shelf.

The HIE shelf (see Figure 96 on page 242) contains the DS1 interface cards, the two LCC, and the optional ESA cards (marked *). A minimum of two DS1 cards are required (four DS1 links) so that the two primary message channels can be carried on different cards for reliability backup. The third DS1 card is optional and is required only if six DS1 links are to be used. The shelf also contains two power converters, and two RG.

Shelf Layout - RMM Shelf

The RMM shelf layout is similar to the MTM, except that only one power converter is used. The four card locations at the left are assigned to the DS30A interface and control cards. The remainder of the shelf is assigned to whatever service circuit cards are provisioned to meet office engineering requirements. Figure 95 on page 241 illustrates a complement of these cards for a typical RMM.

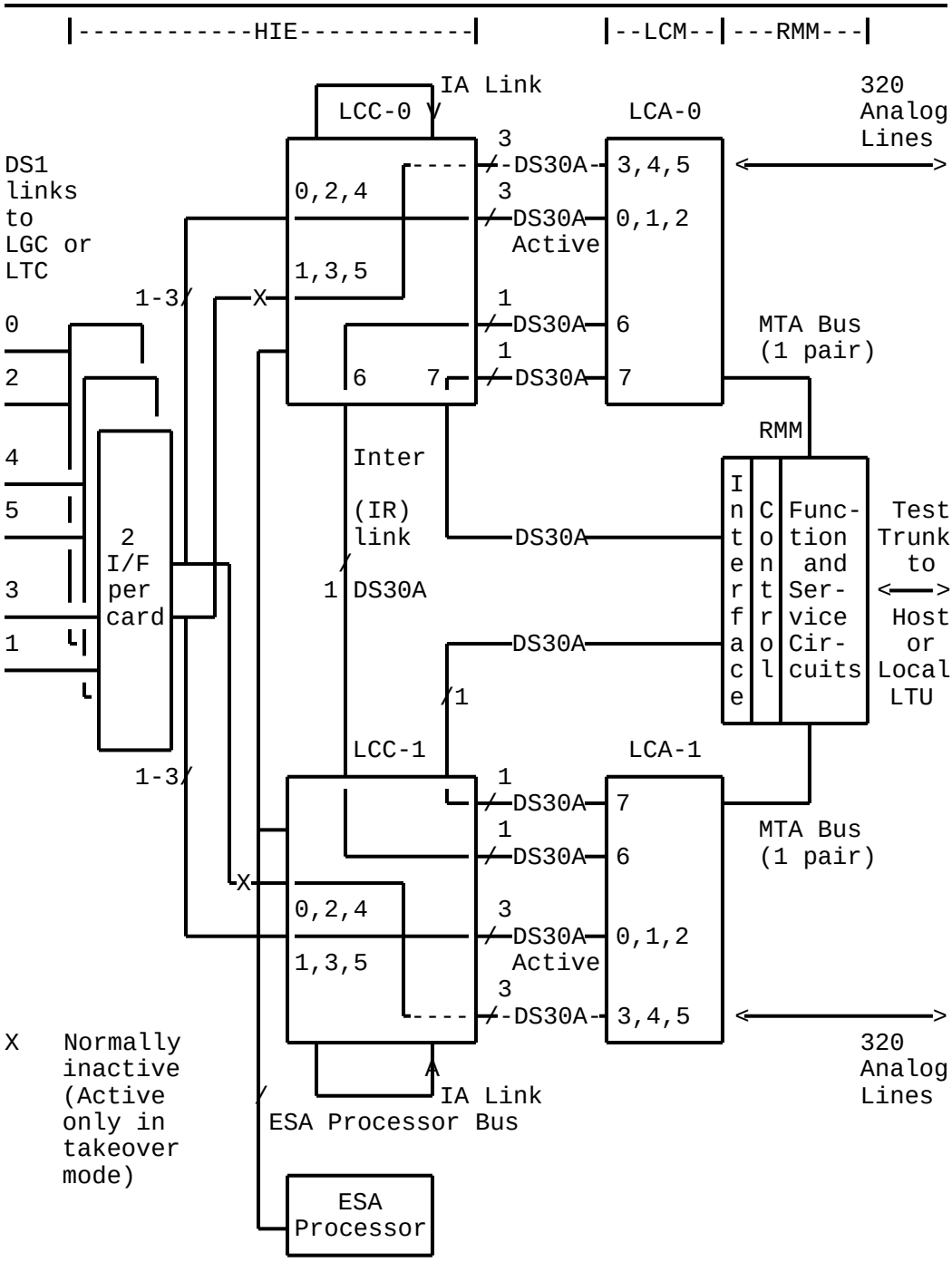
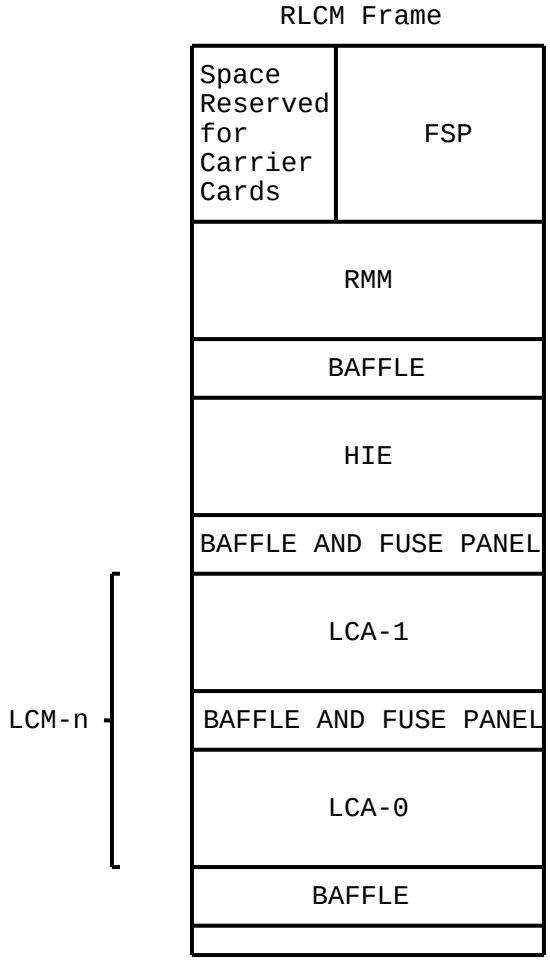
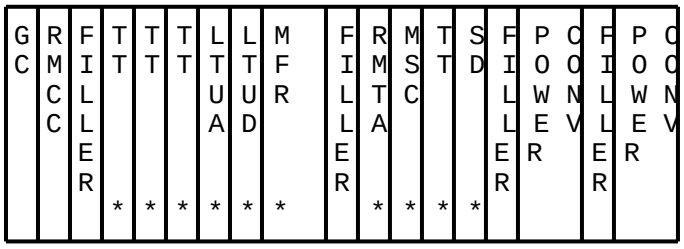


Fig. 93 - RLCM Block Diagram



Slot	NT PEC	Remarks
FSP	6X25AA	Frame Supervisory Panel, Remote
HIE	6X11AA	Host Interface Equipment (shelf) See Figure 96 on page 242
LCA	6X0401	Line Concentrating Array. See Figure 87 on page 217
LCM	6X04AA,AB	line concentrating module. See Figure 89 on page 226
RMM	6X13AA	Remote Maintenance Module See Figure 95 on page 241

Fig. 94 - RLCM Frame. Shelf and Panel Arrangement (Front View)



Slot	ABBR	NT PEC	Remarks
01	GC	2x59AA	Group Codec
02	RMCC	6X74AA	RMM Control Card
03	-	0X50AC	Filler Panel
04-06	TT	2X90AB	Test Trunk Circuit
07	LTUA	2X10AA	Line Test Unit, Analog
08	LTUD	2X11AA	Line Test Unit, Digital
09,10	MFR	2X48AB	Digital 4-Chan. MF Receiver
11	-	0X50AC	Filler Panel
12	RMTA	3X09AA	Remote Metallic Test Access
13	MSC	0X10AA	Miscellaneous Scan Card
14	TT	2X90AB	Test Trunk Circuit
15	SD	2X57AA	Signal Distribution Card 1 * Slots 04 to 15 show a typical complement of RMM test and service circuits This complement varies depending on office requirements. See 297-1001-450/33 for provisioning rules)
16	-	0X50AC	Filler Panel
17,18	-	2X09AA	Power Converter
19	-	0X50AA	Filler Panel
20	-	2X06AB	Power Converter

Fig. 95 - RMM Shelf Layout and Card Complement

Slot No.	0 1	0 2	0 3	0 4	0 5	0 6	0 7	0 8	0 9	1 0	1 1	1 2	1 3	1 4	1 5	1 6	1 7	1 8	1 9	2 0	2 1	2 2	2 3	2 4	2 5

Slot	ABBR	NT PEC	Remarks
01-04	RG0	6X60AA	RLCM Ringing Generator
05-08	RG1	6X60AA	RLCM Ringing Generator
09-13	-	0X50AA	Filler Panel
14	ESAM	6X47AB	*Emergency Stand-Alone (ESA) Memory
15	ESAP	6X45AA	*ESA Processor
16	ETC	6X75AA	*ESA Tone/Clock Card * These cards provisioned for ESA option only. Closed by filler panels 0X50AA otherwise
17,18	LCC	6X73AA	Link Control Card (LCC-0, LCC-1)
19,20	DS1	6X50AA	DS1 Interface (2 DS1 links per card)
21	-	0X50AA	Filler Panel ** If additional DS1 links required (to give a total of 6 DS1 links), filler panel is replaced by NT6X50AA
22-24	-	2X70AA	Power Converter
25	-	2X70AA	Power Converter

Fig. 96 - HIE Shelf Layout and Card Complement

21. REMOTE SWITCHING CENTER (RSC)

GENERAL

The Line Trunk Controller (LTC) is a PM which controls lines and trunks connected to a DMS switch. The LTC forms part of the switch complex located at the Central Office. The LTC "hosts" Line Concentrating Modules (LCM - also located in the Central Office) and Remote Line Concentrating Modules (RLCM - located at a remote site) through which subscribers lines are connected.

The Remote Switching Center (RSC) enables the functionality of the LTC, its associated PM and the services obtained from an MTM to be transferred to a remote site. The farthest PM hosted by the RCC can be up to 100 miles from the host central office.

The Remote Switching Center (RSC) provides facilities for supporting a large number of analog lines and/or digital trunking at a remote location.

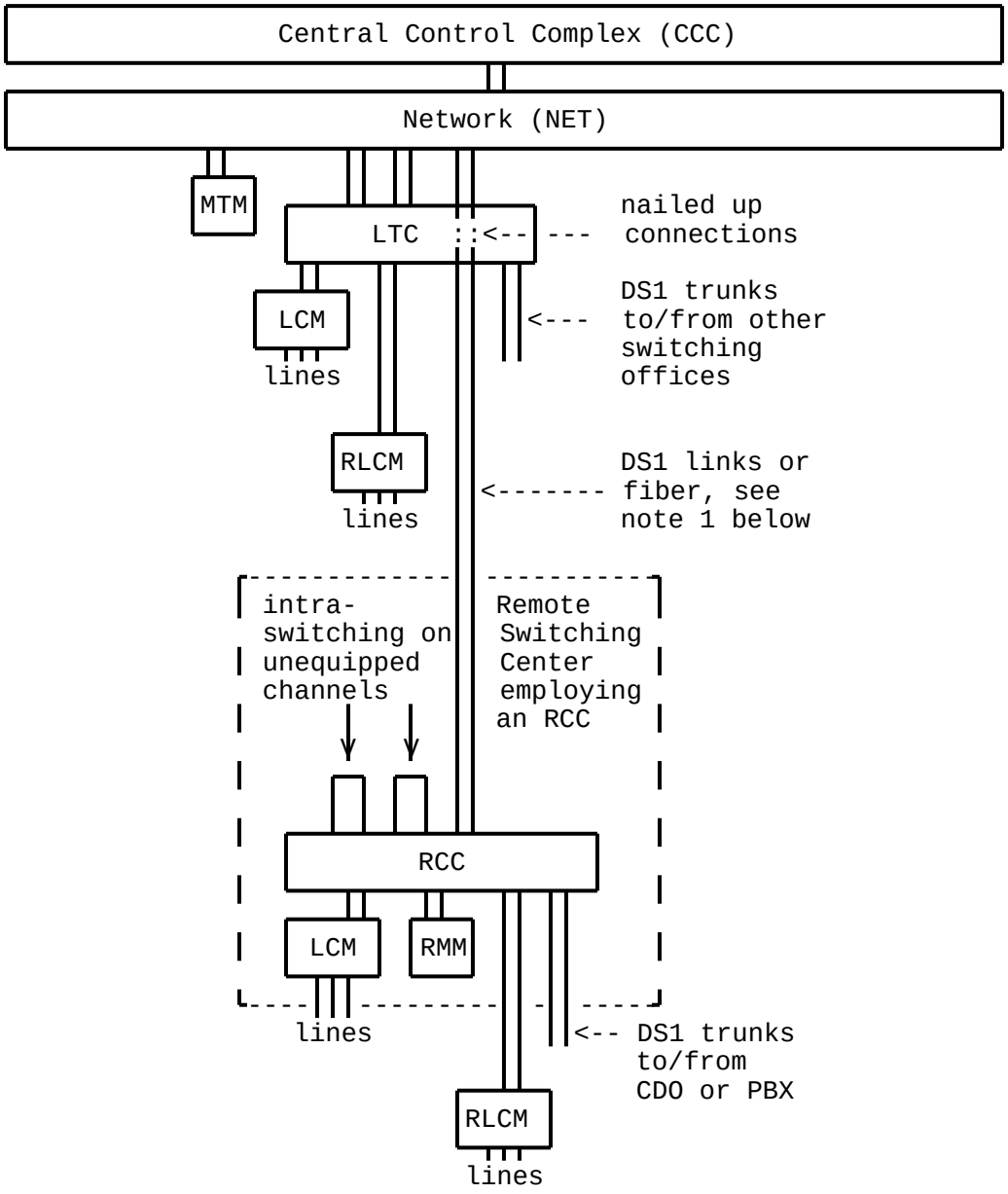
Interface between the host office and its RSC is via DS1 links, a Remote Cluster Controller (RCC) subsidiary PM at the remote site, and the LTC at the host office.

Note: A fiber transmission system can be used to link an RSC with its host office. For information on use of fiber links with an RSC see Part 22 on page 263.

Note: A LGC may be used in place of the LTC (at the host office). using

The Remote Cluster Controller (RCC) is an LTC, enhanced to enable it to stand alone in a remote location. The nailed up (dedicated) connections through the host LTC allow direct communication between the Central Control (CC) and the RCC. Thus, most of the CC/LTC call processing software can be used in CC/RCC call processing. Figure 97 on page 244 presents a configuration overview of a host office employing an RSC that is equipped with an RCC.

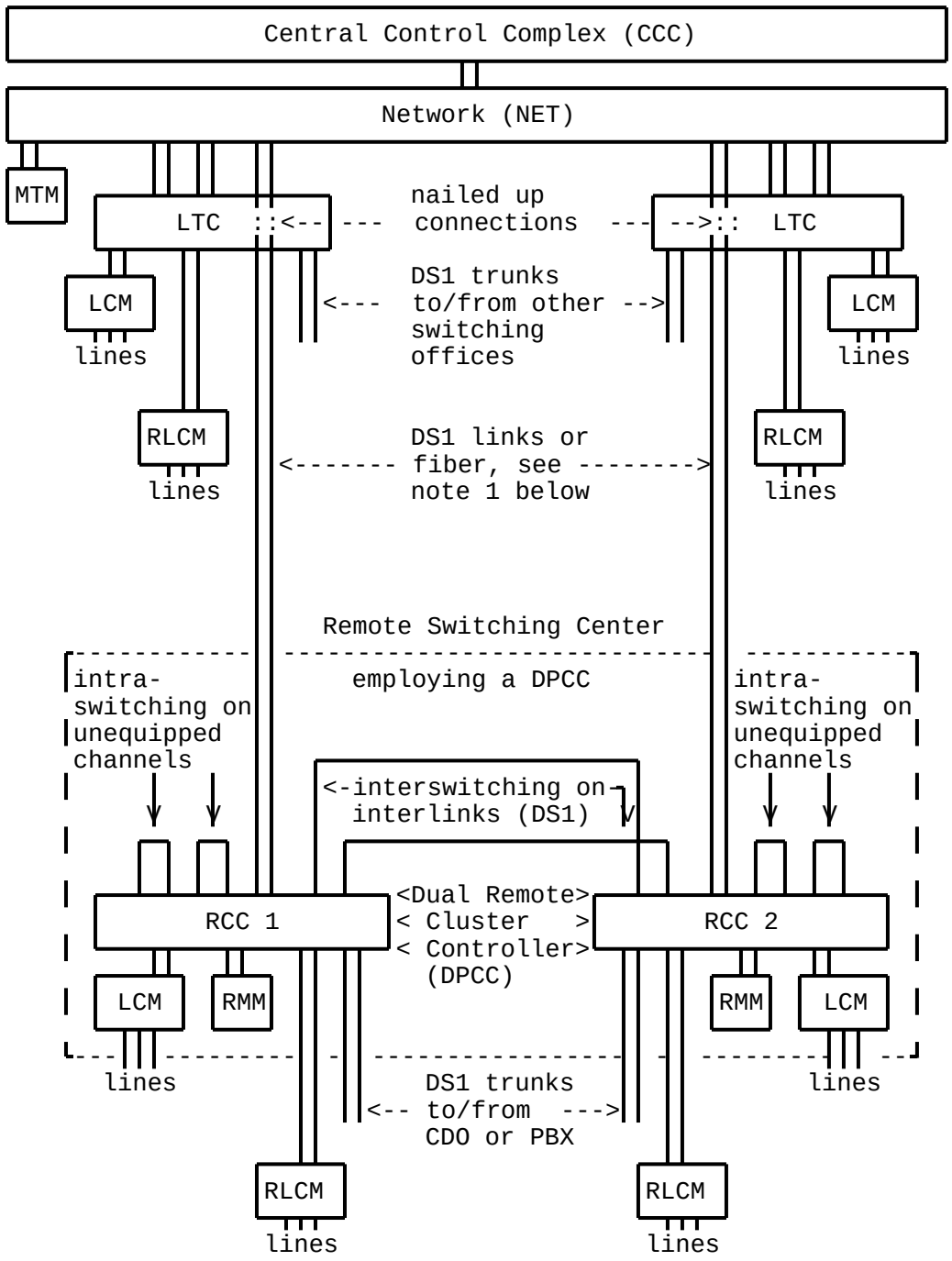
The Dual Remote Cluster Controller (DRCC) is similar in concept and operation to an RCC, but has near double the traffic-handling capacity. It is essentially two sets of RCC hardware installed at the same location and interconnected by DS1 links called interlinks. The interlinks (and associated software) enable two RCCs to operate essentially as one. Figure 98 on page 245 presents a configuration overview of a host office employing an RSC that is equipped with a DRCC.



Notes:

1. A fiber transmission system can be used to link an RSC with its host, see fiber links chapter of this practice.
2. RLCM perform intraswitching via unequipped c-side channels similar to those shown on the RCC.

Fig. 97 - Configuration Overview of CCC/RSC Employing an RCC



Notes:
1. A fiber transmission system can be used to link a DRCC with its host, see fiber links chapter of this practice.
2. RLCM perform intraswitching via unequipped c-side channels similar to those shown on RCC 1 and RCC 2.

Fig. 98 - Configuration Overview of CCC/RSC Employing a DRCC

RSC CONFIGURATION

RSC Modules

See Figure 99 on page 259. The major modules located at an RSC are:

* a Remote Cluster Controller (RCC)
* one or more Line Concentrating Modules (LCM)
* a Remote Maintenance Module (RMM)

Note: Two sets of the above-listed hardware are required if the RSC employs a DRCC configuration.

Remote Cluster Controller (RCC)

The RCC provides a master controller for all units at the RSC, and is in turn controlled by the host LTC. The RCC is a dual-shelf PM, similar in configuration to the LTC, and using many of the same components. The RCC shelves are referred to as Remote Controller Arrays (RCA).

The RCC provides an interface by means of two to 16 DS1 links to matching DS1 interfaces in the host office LTC. Within the RSC, the RCC provides up to 20 ports that can be configured to provide various combinations of DS30A and/or DS1 links. The Universal Tone Receiver card (UTR) gives the RCC the ability to collect and report digits.

The Intracalling (IAC) and Emergency Stand Alone (ESA) options enable calls between subscribers served by the same RSC to be intra-connected (or intraswitched) at the RCC with only minimum CC involvement (or, in the case of ESA, with no CC involvement). More details on these options is given in Intracalling (IAC) on page 250 and Emergency Stand-Alone (in RSC) on page 251.

Dual Remote Cluster Controller (DRCC)

Each RCC of a DRCC provides a master controller for all units subtended from it, and it is in turn controlled by the host LTC. Each RCC of a DRCC is a dual-shelf PM, similar in configuration to the LTC, and using many of the same components. The RCC shelves are referred to as Remote Controller Arrays (RCA).

A DRCC is two RCCs interconnected on the c-side by DS1 links called interlinks. Interlinks may be up to 200 meters long. The DRCC configuration requires a minimum of two interlinks, and the required interlinks must connect port 1 and 3 of RCC 1 to port 1 and 3 of RCC 2, respectively.

All of the functionality of an RCC is retained by both RCCs of a DRCC configuration. In addition, a capability called inter-switching supports calls between an originator serviced from one RCC (of a DRCC) to a terminator serviced from the other RCC (of the same DRCC). Interswitched calls are initially set up by the

host using channels through the network. If directory lookup shows that the call can be interswitched and if an interlink channel is available, a new connection is established via an interlink channel. The host is no longer needed, its involvement with that call ends, and host resources are freed for other tasks.

If custom calling features (such as 3-way calling) are invoked, an interswitched call will revert from an interlink channel to a network channel. That call will continue to use the network channel for the duration of the call. Note that a call is not interrupted when the call path is changed.

The Universal Tone Receiver card (UTR) gives the RCC the ability to collect and report digits.

The Intracalling (IAC) and Emergency Stand Alone (ESA) options enable calls between subscribers served by the same RSC to be intra-connected (or intraswitched) at the RCC (or DRCC) with only minimum CC involvement (or, in the case of ESA, with no CC involvement). More details on these options is given in Intra-calling (IAC) on page 250 and Emergency Stand-Alone (in RSC) on page 251.

Line Concentrating Module (LCM)

The LCM at an RSC is identical to the LCM used at the host office (see Part 20 on page 215). Up to nine two-port LCM can be provisioned using 18 of the 20 DS30A ports provided by the RCC, and leaving two ports available for RMM. The RSC can therefore service up to 5760 (9 X 640) remote subscriber lines. The DRCC has near double the traffic capacity of an RCC. (Traffic capacity is slightly less than double because two ports are employed to support interlinks.) In a smaller configuration where six three-port LCM are used, the RSC can service up to 3840 lines. The RCC is sometimes called "the 3000-line remote".

Remote Maintenance Module (RMM)

The RMM is identical to the module used by the RLCM (see Remote Maintenance Module (in RLCM) on page 232) and performs the MTA function for the LCM. The RMM also contains service circuit cards which are provisioned to meet office engineering requirements. The RMM uses one of the DS30A ports provided by the RCC. Up to two RMM can be provisioned.

RSC Remote Modules

The following modules can be located remote from the RSC:

* a Remote Concentrating Module (RLCM)
* an Outside Plant Module (OPM)

Remote Line Concentrating Module (or OPM)

An RLCM is an enhanced LCM which can operate at a site remote from an RSC. From two to six DS1 speech links interconnect an RLCM with an RSC. One RLCM can service a maximum of 640 remote subscriber lines.

Up to five RLCMs or OPMs (or a combination of both) can be remotely linked to the P-side of an RSC. This arrangement makes it easier for small offices to convert to DMS-100. In combination with intracalling, this arrangement minimizes the use of DS1 links. For a full description of the RLCM, see pages 230 to 242.

Outside Plant Module

An Outside Plant Module (OPM) is an RLCM, housed in a weatherproof cabinet. The OPM cabinet also contains its own power supply and control equipment.

Remote Digital Trunking

Remote Digital Trunking is available on DS1-equipped ports on the RCC, up to a maximum of eight ports, can be assigned to interface with DS1 digital trunk groups. Each trunk group contains a maximum of 24 trunks (24 transmit and 24 receive).

The remote trunking facility has applications for:

* Trunking to a Community Dial Office (CDO) or Private Branch Exchange (PBX) collocated with the RSC or within the extended service area range of the RSC.

* Usage as a Remote Trunk Switch (RTS), where the RCC supports DS1 trunks exclusively. This is a specialized application for use with the DMS-250[9] switching system, and requires special features not described in this Practice.

RCC CONFIGURATION

See Figure 100 on page 260. Like the LTC, the RCC has a dual-shelf configuration with duplicate processing and control functions. Only one processor/speech bus complex is active at a time and provides control for both RCA. If a fault occurs on the active RCA, the 'hot' standby processor/speech bus complex in the mate RCA takes over.

The 2-16 DS1 interfaces to the host LTC (host face) are divided between the two RCA shelves. Complex-0 in RCA-0 handles eight DS1 interfaces from its own interface cards, and eight DS1 interfaces from the interface cards in RCA-1. RCA-1 has a similar

[9] DMS-250 is a trademark of Northern Telecom.

configuration for complex-1. Each RCA is therefore capable of carrying all 16 interfaces, regardless of which RCA is active.

The processor/speech bus complexes in each shelf consist of the following elements:

* A processor function with associated memories for controlling the internal speech buses within the complex, the application of signaling, and the time switch (TS).

* A message interface to handle internal messages from the host LTC via the primary DS1 links message channels. Note that the CSM is handled by the CSM card in the host LTC, and is not extended to the RCC.

* A time switch for establishing channel connections between any host face DS1 channel and any of the PM face DS30A or DS1 channels.

* Host link formatter. Handles the transition from DS1 format on the host face DS1 links to the internal speech buses within the complex.

* Tone and signaling interfaces which handle the insertion and extraction of these signals to the appropriate channels on the internal speech busses.

On the PM face, the DS1 cards interface to a CDO or PBX, or remote PM (RLCM, OPM) while the DS30A cards interface to local subsidiary PM (LCM, RMM). The DS1 interfaces operate in "hot" standby configuration, with the active processor controlling two groups of ten DS1 cards numbered 0-9. The DS30A interfaces are completely duplicated to provide the equivalent of plane-0 and plane-1 speech links to the LCM. Each DS30A card provides ten ports.

The quantities of interface cards that are provisioned depend on the traffic requirements of the office. In order to provide primary and standby message links to the host LTC, however, the number of host face DS1 links cannot be less than two (one DS1 card in RCA-0 and one card in RCA-1).

The PM face can be provisioned with:

* all DS30A interface cards (two per RCA), providing 20 duplicated links to/up to nine two-port LCM and two RMM

* or all DS1 interface cards (five per RCA), providing 20 links to digital trunks or remote-off-remote equipment. However, it is recommended that no more than eight P-side DS1 links be configured.

Alternatively, any other combination can be selected provided that the total number of links does not exceed 20.

INTRACALLING (IAC)

IAC consists of two optional features which enable the CC to set up calls which originate and terminate in the RSC using connections within the RCC. Once the intra-RCC connection is made the host face DS1 channel used during the call set up is released.

Feature package NTX150AA enables line-to-line intra-RCC connections to be made for calls between subscriber's lines connected to any LCM controlled by the RCC. Feature NTX150AA also supports line-to-line intracalling for subscriber lines served by an RLCM remote from an RCC. However, for intracalling, an RLCM must be within 50 miles of its "host" RCC. On all line-to-line intracalling at the RCC, a 0-db loss insertion is used.

The combination of feature package NTX150AA and NTX152AA extends the intra-RCC connection facility to include line-to-line, line-to-trunk, and trunk-to-trunk calls between a subscriber's line connected to any LCM controlled by an RCC and digital trunks connecting that RCC to a CDO or a PBX.

To implement the IAC feature, host face channels not used for messaging or signalling connections to the LTC are used as IAC channels to "loop back" calls as part of the intra switching process. Thus the IAC capacity of an RCC is reduced as more DS1 channels on links to the host LTC are utilized. Selection of the quantity of host-DS1 channels versus IAC channels depends on traffic requirements and is determined during the RSC and office engineering process.

INTERCALLING

Intercalling is an inherent function of feature package NTX380AA. It enables the CC to set up calls which originate on one RCC and terminate on the other RCC (of the same DRCC) using connections via DS1 links between the RCCs (called interlinks). Once the interconnection is made, the host face channel used during the call setup is released.

To implement the intercalling feature, twisted-pair DS1 links must be run from the c-side ports of RCC 1 to the c-side ports of c-side ports of RCC 2. Wire-run lengths up to 200 meters are acceptable. All DRCCs require a minimum of two interlinks. Those required interlinks must be connected from RCC 1 ports 1 and 3 to RCC 2 ports 1 and 3, respectively. The remainder of the implementation of interlinks consists of datafill and software configuration.

Host face channels not used for messaging or signalling connections to the LTC are used as interlink channels to "loop back" calls as part of the interswitching process. Thus the interlink capacity of an RCC is reduced as more DS1 channels on links to the host LTC are utilized. Selection of the quantity of

host-DS1 channels versus interlink channels depends on traffic requirements and is determined during the RSC and office engineering process.

EMERGENCY STAND-ALONE (IN RSC)

Introduction

ESA operation provides the capability for line subscribers terminating off the same RSC or its subtending peripheral modules to complete calls when the RSC loses communication with the host. An RSC automatically enters ESA operation when communication with the host fails and automatically exits ESA operation (returning to normal operation) when communication with the host is restored.

There are some differences in ESA operation of an RSC dependent upon whether it is equipped with an RCC or a DRCC. This is due to the fact that the DRCC is actually two cooperating, but essentially independent, functional entities. The important similarities and differences are as follows:

* an RCC can operate in normal mode or in ESA mode

* A DRCC can operate in normal mode, single ESA mode (one RCC in normal mode and the other in ESA mode), or dual ESA mode (both RCCs in ESA mode)

* when a DRCC is in single ESA mode; the RCC in ESA mode operates in the same manner as a single RCC in ESA mode, the RCC in normal mode operates in the same manner as a single RCC in normal mode, and intercalling is inoperative

* when a DRCC is in dual ESA mode, the RSC operates in the same manner as it would operate with a single RCC in ESA mode.

Description of ESA Operation

The RSC implementation of Emergency Stand Alone (ESA) is an optional emergency service feature which provides local calling within an RSC in the event of the loss of communication with the Host office equipment. The RSC ESA feature has two implementations:

* ESA lines option (NTX149AA), which provides for line to line calls between subscribers serviced by the RSC

* ESA lines and trunks option(NTX149AB), which provides line to line, line to trunk, trunk to line, and trunk to trunk calls between the lines and trunks serviced by the RSC.

No additional hardware is required. During ESA, the RCC processors will continue to control the subsidiary and remote PM (LCM, RMM, RLCM, OPM) and trunks using the same interfaces as in normal

operation. At the same time, the RCC processors invoke additional ESA software to carry out many of the functions normally performed by the host office LTC and CCC.

During ESA, a basic service is provided between subscribers and trunks supported by the RSC. Calls which require connections via the host office network are routed to:

* operating company specified lines or trunks (for emergency or operator calls)
* reorder tone (120 ipm)

Subscriber Line Service in ESA

While the RSC is in ESA, subscribers receive Plain Ordinary Telephone Service (POTS) on all types of telephone and data sets. Special features are suspended in ESA.

Subscriber line types supported during ESA are:

single party
two party
multi-party
4 party fully selective
8 party semi-selective
PBX loop or ground-start
Business Set and Data Unit (POTS subset)
DLC (POTS subset)
Automatic Lines.

Other features supported during ESA are:

* DP and DTMF dialing

* all ringing types supported by the LCM

* ground and loop start

* line to line calling, including Business Set and Data Unit

* line to line hunting (sequential only)

* a range of local dialing plans, for POTS and business services

During ESA, the following services are not supported:

* billing including Centralized Automatic Message Accounting (CAMA) and message rate charging (all lines are treated as flat rate lines)

* coin control functions (coin always returned to the caller)

* speed calling, call waiting, three way calling and the majority of business service features (only the Primary Directory Number, the Release, and the Hold keys are supported on a Business set)

* line restriction features

* Multiple Appearance Directory Number groups (the primary numbers are treated as regular business service lines)

* calling party identification (Automatic Number Identification is disabled in ESA except for calls to an Emergency Service Bureau)

* maintenance and administration features

* recorded announcements

* Teletypewriter Exchange Service

* operator consoles (in ESA calls to the operator can be routed for special termination).

Trunk Service in ESA

The following trunk type/signaling combinations are supported in ESA:

POTS End Office trunks (incoming, outgoing and two way)

* Multifrequency with wink or delay dial start signals,
* Dial pulse with:
  - wink, delay dial, immediate and dial tone start signals on incoming trunks
  - wink, delay dial, and immediate start signals on outgoing trunks.

Integrated Business Network (incoming, outgoing and two way)

* Multifrequency with wink or delay dial start signals,
* Digitone with wink, delay dial and immediate start signals,
* Dial pulse with wink, delay dial and immediate start signals,
* Nil pulse with:
  - immediate start signal on incoming trunks
  - wink, delay dial and immediate start signals on outgoing trunks.

Digital PBX (two way)

* Multifrequency with wink or delay dial start signals,
* Digitone with:

  - wink, delay dial, immediate and dial tone start signals on incoming trunks
  - wink, delay dial and immediate start signals on outgoing trunks,

* Dial pulse with:
  - wink, delay dial, immediate and dial tone start signals on incoming trunks
  - Dial pulse with wink, delay dial and immediate start signals on outgoing trunks,
* Nil pulse with immediate start signal on outgoing trunks

Emergency Service Bureau (outgoing)

* Multifrequency with wink or delay dial start signals,
* Digitone with wink, delay dial and immediate start signals,
* Dial pulse with wink, delay dial and immediate start signals,
* Nil pulse with immediate start signal on outgoing trunks

The following trunk types and services are not supported in ESA:

two way trunks:

* operator trunks
* superCAMA trunks

outgoing trunks:

* Autovon access
* CAMA trunks
* operator services

Trunk services

* overlap outpulsing
* ground start signaling.
* Automatic Number Identification (except for calls to an Emergency Service Bureau)

DRCC in ESA mode

The following are special considerations, restrictions, and limitations applicable to DRCC operation in ESA mode:

* When a hunt group is split across both RCCs of a DRCC, the hunt process tries all line-group members subtending the RCC from which the call originates before trying the line-group members subtending the other RCC.

* Each RCC of a DRCC supports 200 hunt groups. One hunt group split across both RCCs of a DRCC counts as a total of two groups, one group for each RCC.

* Each RCC of a DRCC supports 4000 hunt-group members. This number is reduced by the number of members in split hunt groups.

* POTS lines are supported by a maximum of 16 prefix translations, and 8 for each group.

* Trunk groups can not be split between the RCCs of a DRCC.

* Before ESA trunk-routes originating and terminating on different RCCs of the same DRCC can be datafilled, the affected interlinks must be datafilled.

Emergency Stand-Alone Entry

ESA operation occurs automatically when:

* loss of communication, on the message channels of the primary DS1 links to the host LGC (or LTC), is detected

* the CC fails to respond to loop-around messages.

ESA-Entry delay periods (default 30 seconds for communications loss and 15 minutes for non-response to loop-around messages) are stored as office parameters. These delays ensure that the ESA is not entered if a restart or another maintenance procedure being carried out on Host equipment causes a temporary loss of communication.

ESA-Entry involves enabling a set of ESA control programs within the RCC.

When ESA-Entry occurs all calls are lost.

Emergency Stand-Alone Operation

During ESA all call control messages which would normally have been exchanged with the CC (via the LGC (or LTC)) are handled within the RCC.

The RCC uses information from the CC translation tables and special ESA translation tables, to identify:

* calls between lines and/or trunks served by the RSC
* operator and emergency service calls.

The intracalling facility (see Intracalling (IAC) on page 250) is used to connect these calls. All other calls are routed to reorder tone.

In ESA a check is done to ensure that a channel is available before a call is serviced. If no channel can be found, two more attempts are made (at one second intervals) before the call is

abandoned. If a channel is found, supervision continues normally.

During ESA, the C-side ports of the RCC are temporarily reconfigured to show all but ports 0 and 1 as unequipped. This increases the spare capacity in the RCC which can be utilized to make intracalling connections between lines serviced by the RCC (see also Intracalling Hardware on page 233).

Emergency Stand Alone Exit.

When the links to the Host LGC (or LTC) are restored, either a ESA-Exit or a manual ESA-Exit process is started by the CC. A control table entry indicates whether the system or manual ESA-Exit is appropriate. system

A system ESA-Exit is initiated after the expiry of a time out period. During the time-out period, a countdown is displayed and an operator at the MAP may override the system action by placing the RCC in the Man-Busy state.

A manual ESA-Exit can be initiated after the CC reports that the links to the Host LGC (or LTC) have been restored. When the Return to Service (RTS) command is entered, the number of current calls in ESA is displayed and confirmation is requested. If the ESA-Exit confirmation is given the exit process is started immediately.

All calls are lost during the exit from ESA mode.

CLASS CALLING NUMBER DELIVERY

Calling Number Delivery (CND) is one of the optional Custom Local Area Signalling (CLASS) features that is offered to residential enhanced services (RES) customers. For more information on CND, see Class Calling Party Identification, (297-1401-122). The CND feature enables the directory number of the calling party to be delivered to the customer premises equipment of the called party along with the date and time of the call. For interoffice calls, the calling number information is transmitted between the originating and the terminating offices by means of Common Channel Signaling 7 (CCS7). The calling party information is transmitted to the called party during the ringing phase of the call by a CLASS Modem Resource (CMR) card.

The CMR card is an optional card located in the host RCC of the LCM or RLCM that terminates the called party’s subscriber line. The CMR card monitors the LCM or RLCM’s looped-back ringing code and transmits the calling party information to the LCM or RLCM line card between the first and second ring (see CLASS Calling Number Delivery in the LCM on page 218). The CMR card has the resources to monitor 32 CND calls for ringing while simultaneously transmitting CND information for another 32 CND calls (a total

of 64 CND calls). For datafill information see Table RCCINV, Section 177, in 297-1001-451.

Note: Two CMR cards must be equipped in an RCC, in order to implement the CND feature. One card is located in slot 18 of unit 0 and the other card is located in slot 18 of unit 1. To make room for the CMR card, the tone generator card (NT6X79AA) must not be used in slot 18. Instead, the functions of the tone generator card must be provided by the message protocol card (NT6X69AB) which includes a tone circuit (see Figure 102 on page 262).

RSC FRAME AND SHELF LAYOUT

Frame Layout

See Figure 101 on page 261. The RCC and RMM are housed in a standard DMS-100 single-bay frame. The frame consists of four equipment shelves, a FSP, and a cooling unit. It is referred to as the Remote Controller Equipment (RCE) frame.

The lower two shelves contain the components (RCA-0, RCA-1) of the dual-shelf RCC function. Power converters are located at the ends of both shelves, and the cards for the interfaces and processor/speech bus functions are located between the converters.

The upper part of the RCE frame contains one or two RMM (if provisioned). The layout of the RMM shelf is the same as used by the RLCM (see Part 20 on page 215), and illustrated in Figure 95 on page 241.

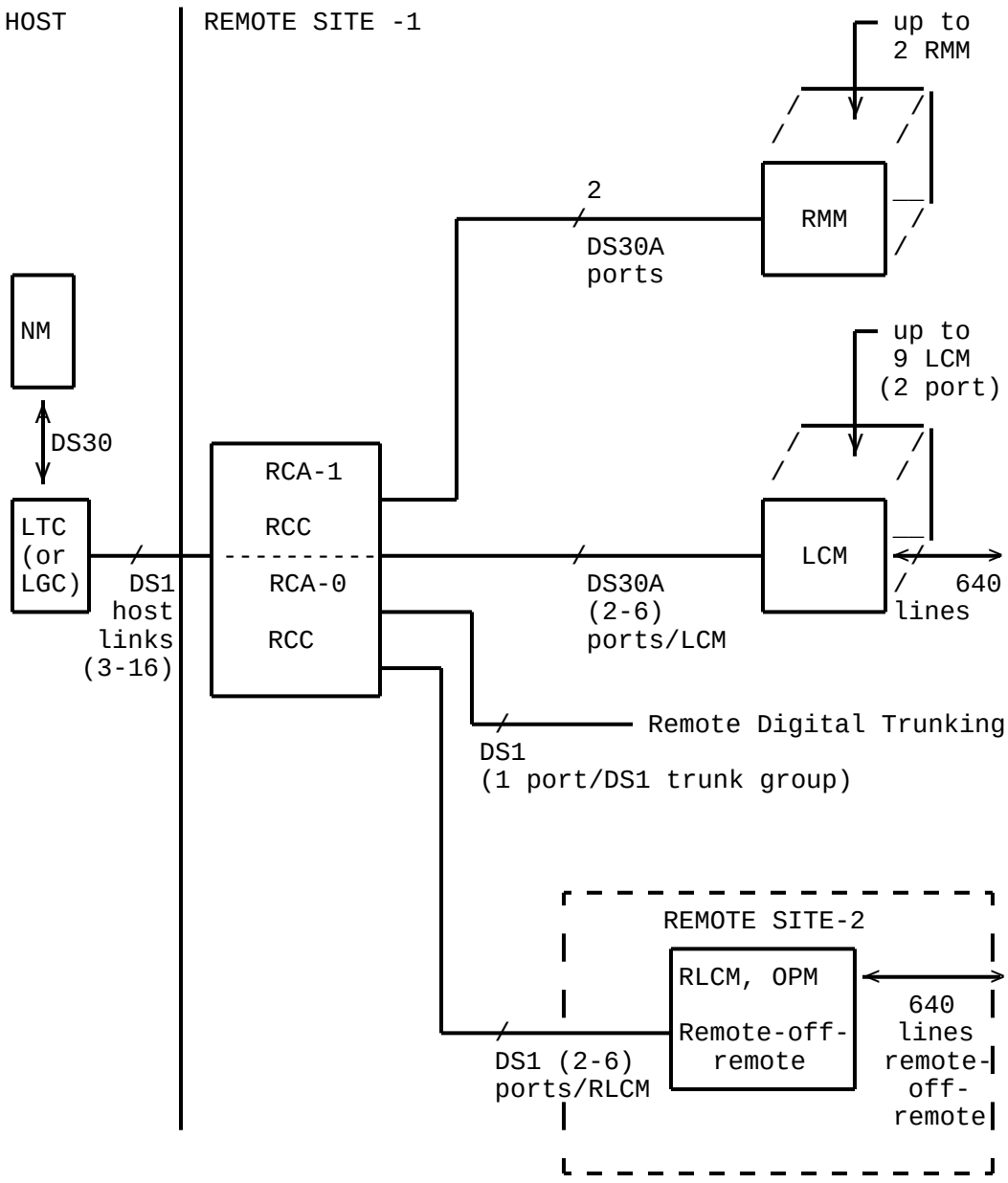
Adjacent to the RCE frame are LCE frames containing standard dual-shelf LCM, as described in Part 20 on page 215, and illustrated in Figure 89 on page 226. The number of LCE frames required depends on their type (number of ports) and the engineering requirements for the RSC. Since a maximum of 18 ports on the RCC are available for LCM usage, the configuration of three LCE illustrated accommodates a maximum of six 3-port LCM (0-5).

RCA Shelf Layout

See Figure 102 on page 262, which illustrates one RCA shelf of the dual-shelf RCC configuration, and the locations of all possible cards. In actual practice, not all DS1 or DS30A interface cards are provided. The quantity of host-face DS1 interface cards (1 min., 4 max. per shelf) depends on the number of host office links required to meet traffic requirements. Likewise, the number of PM-face DS1 interface cards (up to 5) depends on the number of digital trunks in use, or if remote-off-remote links are required.

The two DS30A cards are required if one or more LCM (up to a maximum of 9) are hosted from the RCC. Each LCM is connected to both cards to ensure high reliability.

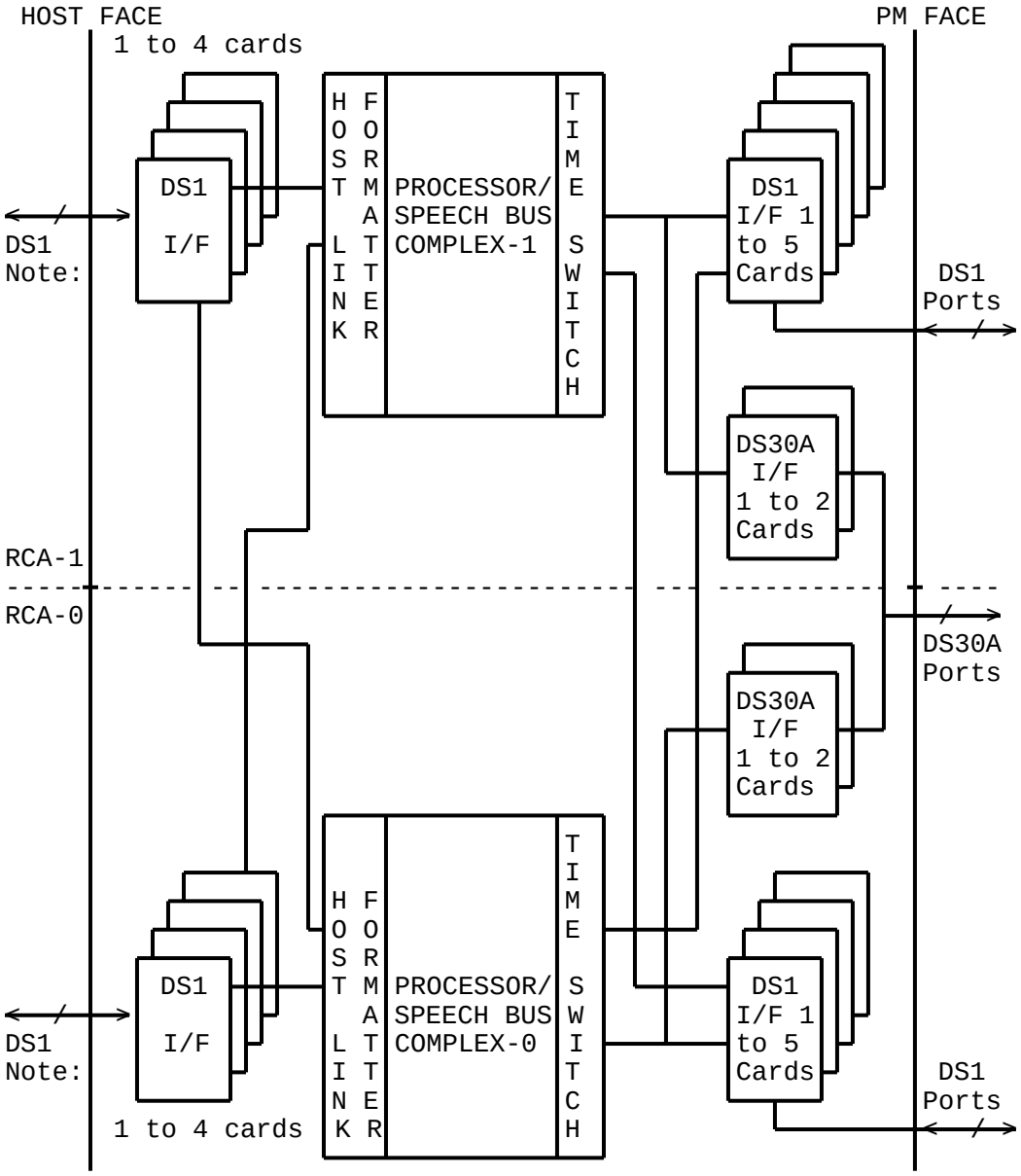
The cards comprising the processor/speech bus complex are located between the interface cards.



NOTE:

A typical RCC is shown above. A DRCC configuration employs two sets of RCC hardware, and those RCC must be interconnected by two or more DS1 links called interlinks. See Intercalling.

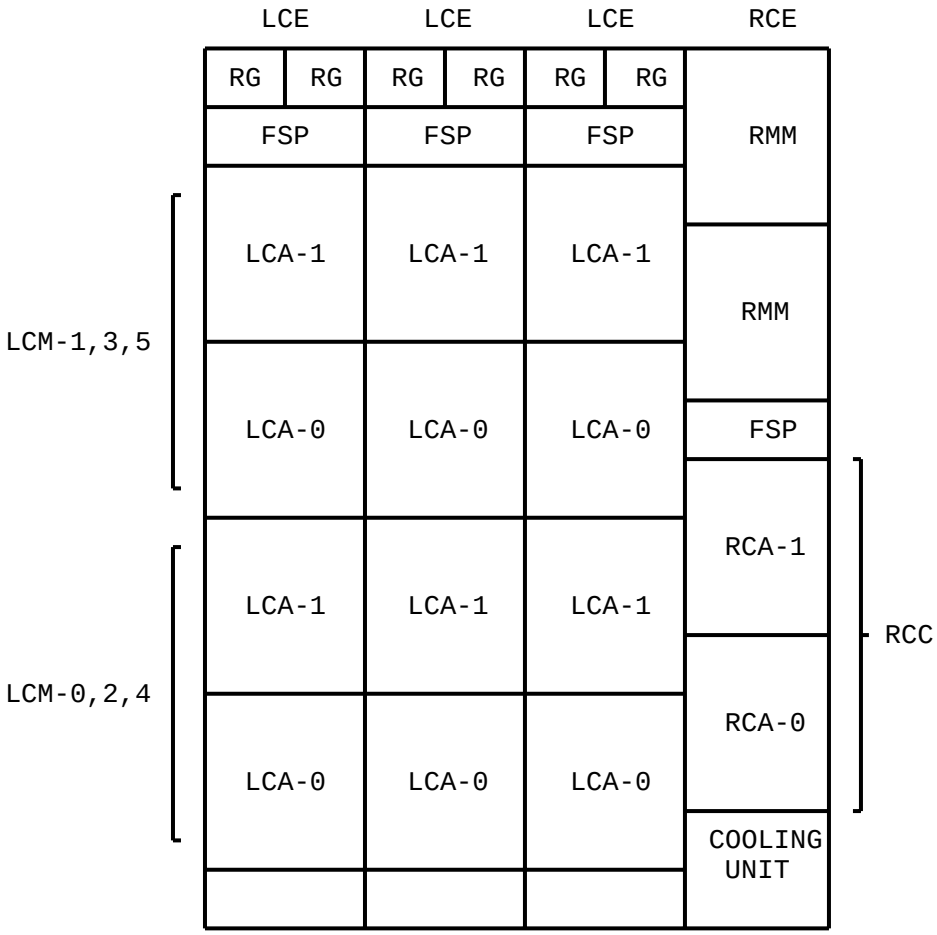
Fig. 99 - RSC Module Structure



NOTES:

1. Minimum of 2 DS1 links, maximum of 16 DS1 links overall.
2. A typical RCC is shown above. A DRCC configuration employs two sets of RCC hardware, and those RCC must be interconnected by two or more DS1 links called interlinks. See Intercalling.

Fig. 100 - RCC Structure

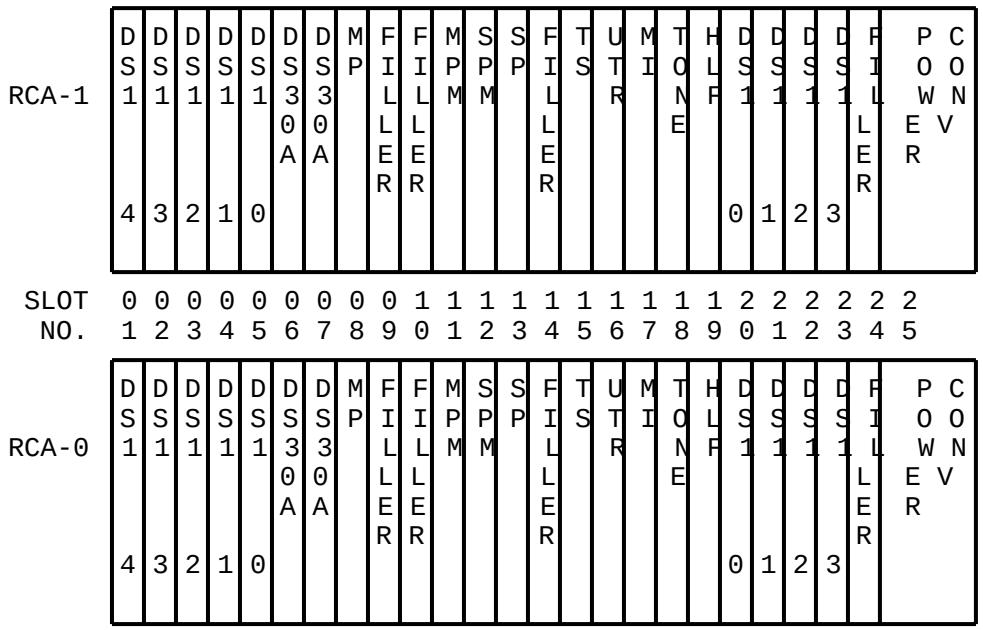


ABBR	NT PEC	Remarks
FSP	0X28AS	Frame Supervisory Panel, Remote.
LCE	6X03AA	Line Concentrating Equipment (frame). See Figure 89 on page 226.
RCA	6X1201	Remote Concentrating Array (shelf)
RCC	6X12AB	Remote Cluster Controller. See Figure 102 on page 262.
RCE	6X10AC	Remote Controller Equipment (frame)
RMM	6X13AB	Remote Maintenance Module. See Figure 95 on page 241.

NOTE:

A typical RCC is shown above. A DRCC configuration employs two sets of RCC hardware, and those RCC must be interconnected by two or more DS1 links called interlinks. See Intercalling.

Fig. 101 - RSC Frames (Front View)



Slot	ABBR	NT PEC	Remarks
01-05	DS1	6X50AA	DS1 Interfaces (PM Face)
06,07	DS30A	6X48AA	DS30A Interfaces (LCM)
08	MP	6X45AE	Master Processor
09-10	-	0X50AA	Filler Panel
11	MPM	6X47AB	Master Processor Memory
12	SPM	6X46AB	Signaling Processor Memory
13	SP	6X45AE	Signaling Processor
14	-	0X50AA	Filler Panel (or 2nd Universal Tone Receiver 6X92AA)
15	TS	6X44AA	Time Switch
16	UTR	6X92AA	Universal Tone Receiver
17	MI	6X69AB	Message Protocol (AB version includes tone generator - AA version does not)
18	TONE	6X79AA	Tone Generator or 6X78AA CLASS Modem Resource card
19	HLF	6X72AA	Host Link Formatter
20-23	DS1	6X50AA	DS1 Interfaces (Host Face) - Minimum one 6x50AA in position 20.
24	-	0X50AA	Filler Panel
25	-	2X70AD	Power Converter.

NOTE:

A typical RCC is shown above. A DRCC configuration employs two sets of RCC hardware, and those RCC must be interconnected by two or more DS1 links called interlinks. See Intercalling.

Fig. 102 - RCC Shelf Layout and Card Complement

22. FIBER LINKS FOR RLCM AND RSC

BACKGROUND

Remote Line Concentrating Modules (RLCMs) and Remote Switching Centers (RSCs) can be linked to a host office using either

* DS1 links
* fiber links

DS1 links between an RLCM (or RSC) and a host office are described in RLCM Configuration on page 230 and Part 21 on page 243.

The fiber link configuration between an RLCM (or RSC) and a host office is engineered using an NT FMT-150 fiber multiplexing system (see Figure 103). An NT Fiber Multiplex Terminal 150 (FMT-150) is installed in both the host office and the remote site. Fiber links interface with the FMT-150s and provide a data link between the two sites. An FMT-150 is a fiber transmission system which multiplexes DS1 links at the host and remote sites onto fiber links.

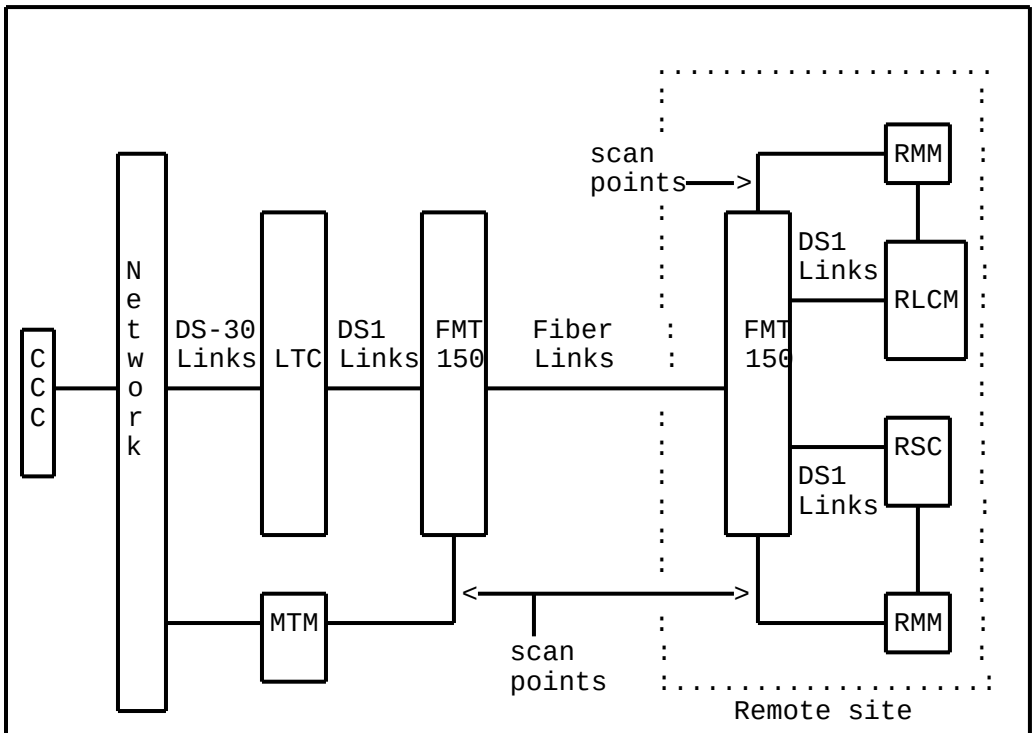


Fig. 103 - Fiber Link for RLCM and RSC

The two versions of the FMT-150 system and the transmission rates they support are

FMT-150 VERSION	TRANSMISSION RATE
FMT-150A	45 Mbps
FMT-150B	150 Mbps

Both the FMT-150A and B versions include standby cards and links which serve as backups (protection). These standby cards and links add robustness to the FMT-150 system.

FIBER MULTIPLEX TERMINAL 150A

The FMT-150A system multiplexes information from a maximum of 28 DS1 links onto duplicated fiber links. A protected FMT-150A system occupies one shelf and consists of

* one DM-13 digital multiplexer (with standby DS1 and DS3 cards)
* a DMI-F45 fiber interface (duplicated for protection)
* fiber links (duplicated for protection)
* a maintenance controller unit
* a service channel unit (for voice communication between sites)
* a monitor and control panel
* four power supply units (includes two standby power supply units)

FIBER MULTIPLEX TERMINAL 150B

The single shelf FMT-150B configuration with one DM-13 digital multiplexer multiplexes 28 DS1 links onto fiber links with a transmission rate of 150 Mbps. A protected single shelf FMT-150B system consists of

* one DM-13 digital multiplexer (with standby DS1 and DS3 cards)
* four power supply units (includes two standby power supply units)
* a fiber transport unit (duplicated for protection)
* fiber links (duplicated for protection)

* a service channel unit (for voice communication between sites)

* a monitor and control unit

* a maintenance controller unit

ALARMS

The FMT-150A and B systems include a microprocessor based maintenance and control unit which can detect service and non-service affecting faults in FMT-150 system components. In the FMT-150 system a major alarm indicates a service affecting fault and a minor alarm indicates a non-service affecting fault.

Note: An FMT-150 major alarm signal is interpreted as a critical alarm by the DMS-100 and an FMT-150 minor alarm is interpreted as a major alarm by the DMS-100.

Major and minor alarm conditions in the FMT-150 trigger the closing of relay points. The relay point closures are detected by scan cards in a maintenance trunk module (MTM) and a remote maintenance module (RMM).

The alarm information collected by the scan cards is communicated to the DMS-100 host office and is routed to an office alarm unit (OAU). The OAU then activates the appropriate visual and audible alarms while maintenance software in the DMS-100 implements the necessary alarm indications for the MAP.

MTM and RMM Alarm Scan Cards

Relay contacts generated by the alarm circuits of the FMT-150 are detected by alarm scan cards (NT0X10). The alarm scan cards are located in the maintenance trunk module (MTM), at the host site, and in the remote maintenance module (RMM) at the remote site.

Note: The alarm scan cards (NT0X10) occupy service circuit slot positions within the MTM and RMM (see Part 5 on page 57 and Remote Maintenance Module (RMM) on page 247 and 297-1001-450 for more information).

Each alarm scan card (NT0X10) consists of two circuits, and each circuit has seven scan points (see Figure 104 on page 266). Since each circuit is assigned a terminal ID (TID), an entire circuit must be dedicated to a single application. All seven scan points of an alarm scan card, which are used for the FMT-150 application, are reserved for that application. Both alarm points from a single FMT-150 node must be connected to the same circuit. The seven scan points on a single scan card circuit can be shared by three different FMT-150s (two scan points each). In special cases, an FMT-150 with one scan point can use the seventh scan point.

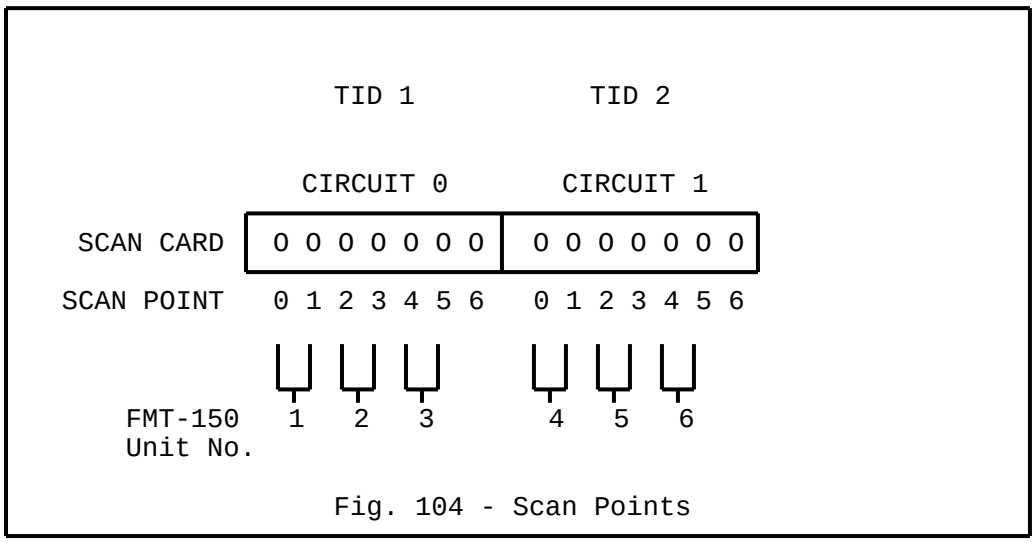


Fig. 104 - Scan Points

Note: The existing signal distribution cards (NT2X57) in the office alarm unit (OAU) are used in the FMT-150 application. No new cards are required. For more information see Part 6 on page 64 and 297-1001-122 and 297-1001-120.

DMS-100 maintenance software provides the following maintenance support for the FMT-150 system:

* an inventory list of equipped FMT-150 modules (see 297-1001-451)

* a unique MAP level for display of FMT-150 alarm status and for translation of FMT-150 DS1s to peripheral module DS1s (see 297-1001-515)

* log reports to reflect event changes or failures in the FMT-150 system (see 297-1001-510)

SERVICE RANGE FOR FIBER LINKS

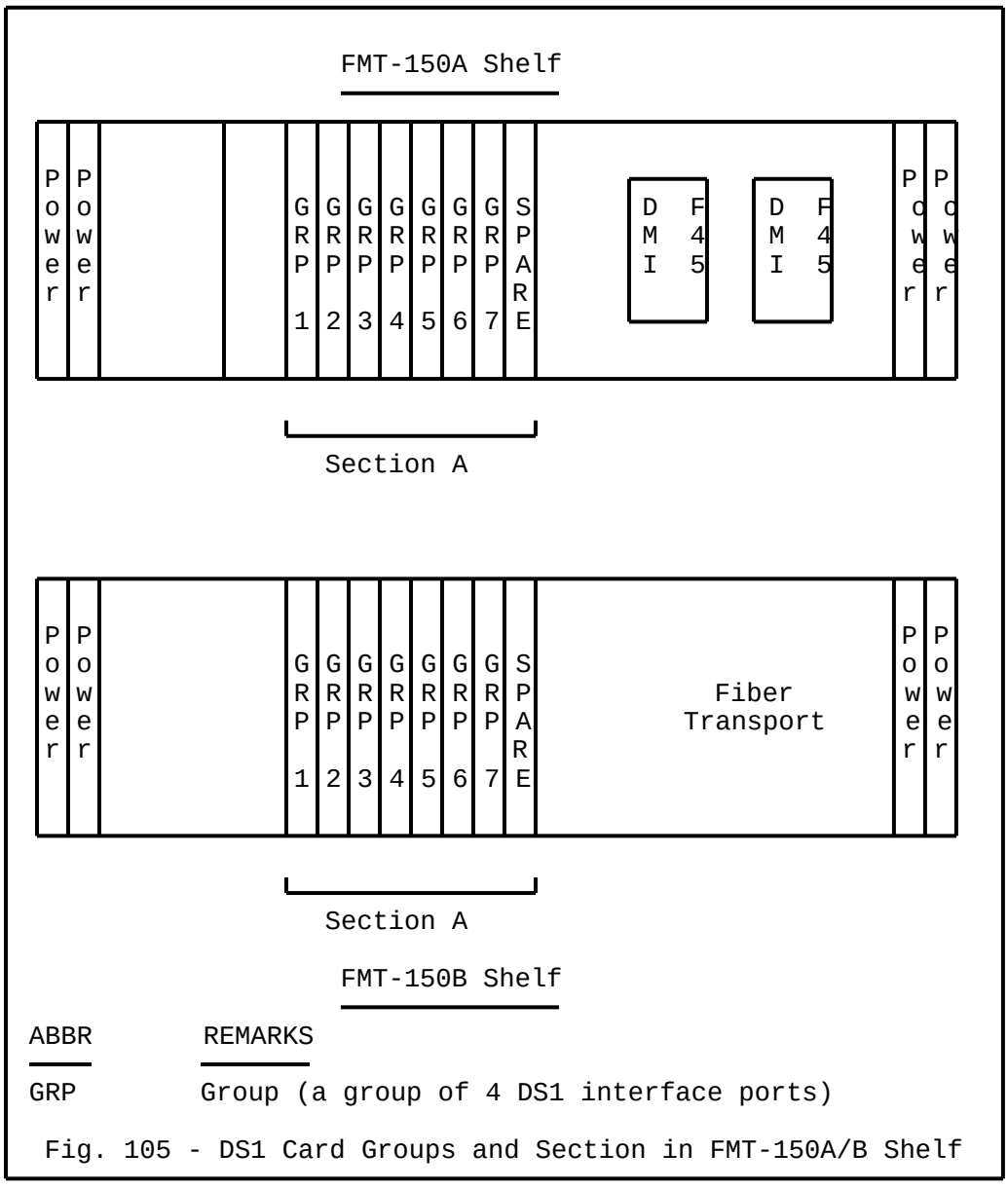
The service range for the FMT-150A system is 31 miles between the host office and remote site. The service range for the FMT-150B system can be extended with repeaters (FMT-150Ds), but cannot exceed the existing service range of the RLCM and RSC. The service range restrictions for the RLCM and RSC are

* 100 miles between an RLCM and a host LGC or LTC

* 150 miles between a host LGC or LTC and the furthest peripheral which is remote from an RSC

DS1 INTERFACE CARDS

Both the FMT-150A and FMT-150B (with single multiplexer) can be equipped with up to 28 DS1 interface circuits. There are four DS1 interface circuits on each GRP (group) DS1 card and up to seven GRP cards in an FMT-150A or B. Each DS1 circuit is numbered from one-to-four. A maximum of seven GRP cards (numbered one-to-seven) make up a section. The section type is always "A" for FMT-150A and FMT-150B (with single multiplexer). (see Figure 105).



ABBR	REMARKS
GRP	Group (a group of 4 DS1 interface ports)

Fig. 105 - DS1 Card Groups and Section in FMT-150A/B Shelf

FMT-150 FRAME

The FMT-150A and FMT-150B (with single multiplexer) are both single shelf units. A miscellaneous frame can be equipped with a maximum of seven FMT-150 single shelf units (either FMT-150As or Bs). (see Figure 106).

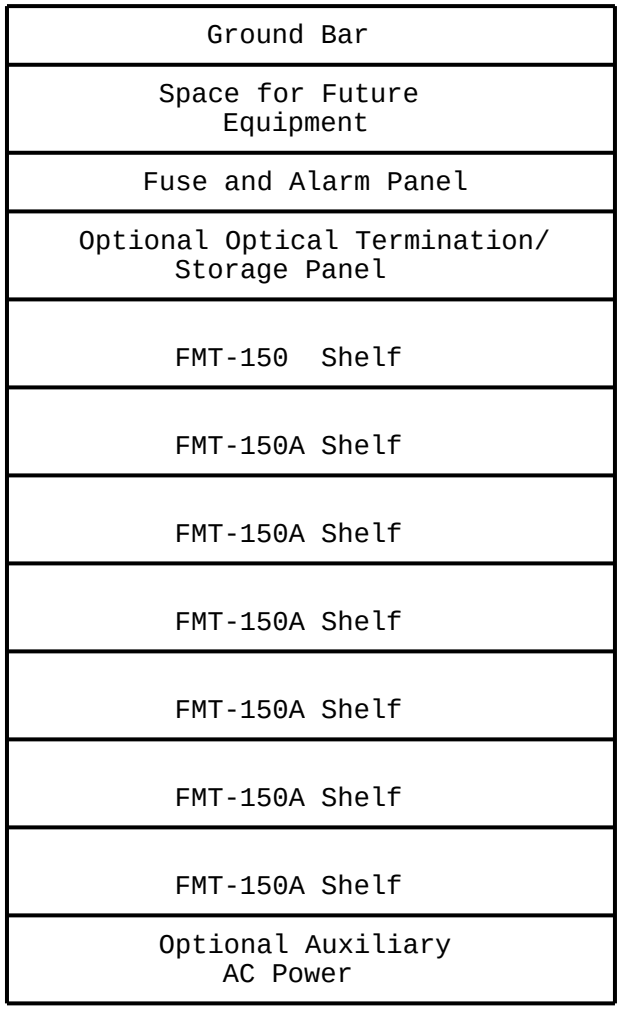


Fig. 106 - Miscellaneous Frame Equipped with FMT-150A Shelves

23. CONVERTIBLE RLCM

GENERAL

The Convertible RLCM provides a temporary alternative to the Remote Switching Center. The Convertible RLCM facilitates later conversion of the equipment to a RSC, since the Line Controller Equipment (LCE) frames and their associated LCM to DF cabling remain unaltered. The Convertible RLCM provides facilities for interfacing up to 1920 subscriber lines, or the equivalent of 3 LCM. The Convertible RLCM is operationally identical to the RLCM with the exceptions that ESA is not available and that the Ringing Generators (RG) are located on the LCE frames, not in the HIE.

Interface between the host office and the Convertible RLCM is via 6 to 18 DS1 links (2 to 6 links per HIE shelf) and a LGC/LTC at the host site. Links are provisioned on a traffic basis.

If Intra-calling is requested, this facility is restricted to calls within the LCM associated with a particular HIE, not the entire remote site.

CONVERTIBLE RLCM CONFIGURATION

See Figure 107 on page 271. The Convertible RLCM is comprised of a Remote Control and Maintenance Equipment (RCME) frame and its associated LCE frames. The RCME frame is composed of up to four units; three (HIE) and one RMM. Two RLCMs can be located at the same remote site and can share a single RMM.

Each HIE shelf consists of 2 to 3 DS1 interface cards and 2 Link Controller Cards (LCC) which control the DS30A links to its associated LCM shelf. Each HIE interfaces to only one LCM and is functionally independent of the other HIE/LCM pairs.

Each DS1 interface card accepts 2 DS1 links from the Host office LGC/LTC and multiplexes them onto all 6 links to the LCC. DS1-CP0 (position 19) uses C-side ports 0 and 2, DS1-CP1 (position 20) uses C-side ports 1 and 3, and DS1-CP2 (position 21) uses C-side ports 4 and 5. C-side ports 0 and 1 are used as messaging links back to the host LGC/LTC. Should either DS1-CP0 or DS1-CP1 becomes inactive, messaging is handled by the remaining interface card.

Both LCC are normally active, with LCC-0 operating LCA-0 and LCC-1 operating LCA-1. See Figure 108 on page 272 LCC-0 serves the even-numbered links (0, 2, 4) from the DS1 interfaces and LCC-1 serves the odd-numbered links (1, 3, 5) from the DS1 interfaces. If either LCC becomes inactive, the mate LCC takes over and serves all 6 links via the duplicated paths from the inactive LCC.

Each LCC is connected to its LCA via eight DS30A ports numbered 0-7 in the same way as the RLCM (see Links Within an RLCM Configuration on page 231).

The Remote Maintenance Module (RMM) used in the convertible RLCM configuration is identical to the module used by the RLCM (see Part 20 on page 215) and performs the MTA functions for the LCM. The RMM also contains service circuit cards which are provisioned to meet office maintenance requirements. Two RLCMs can be located at the same remote site and can share a single RMM.

Frame Layout. See Figure 109 on page 273. Each RCME is housed in a standard DMS-100 single-bay equipment frame. The frame supports up to 3 HIE, 1 RMM and a Frame Supervisory Panel (FSP). Baffles permit air circulation for convection cooling.

The FSP provides power control and alarm circuitry for the three HIE shelves and the RMM shelf.

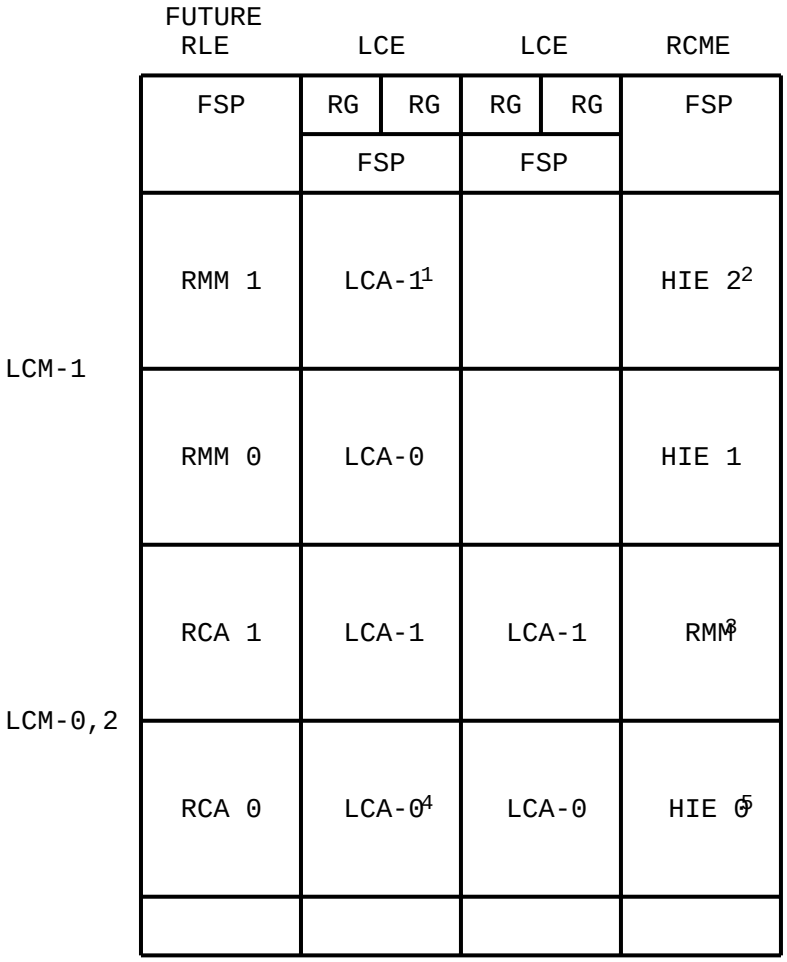
SPECIAL LCE CONFIGURATION

One LCE frame is a standard DMS-100 single-bay frame, housing two LCM while the other LCE is similar, but houses only one LCM. The LCE frame also houses a FSP which provides power control and alarm circuitry for both of the LCM, and for the two ringing generators (RG-0, RG-1) located within the FSP. The RG provide ringing current and generate ANI/coin control voltages. Normally one HIE/LCM pair use RG-0 and the other pair uses RG-1. In the event of failure of either RG, the remaining RG becomes available for use by both of the HIE/LCM pairs. If control voltage failure should occur the LCM will go into takeover mode until the RG can be returned to service.

The LCM that are supported by Convertible RLCM are identical to the LCM that are supported by the standard RLCM with the exception that there is an additional cable between the LCA shelves. This cable is only connected when the Convertible RLCM configuration is converted to an RSC. The cable provides the intra-channels and duplicated paths required in a LCM/RSC configuration.

The LCA shelves, power converters, and line drawer layouts are identical to the equipment described in Part 20 on page 215.

The Convertible RLCM uses the standard line cards (LC) which are available for all DMS line applications, see Part 20 on page 215.



1 See Figure 90 on page 227.
2 See Figure 96 on page 242.
3 See Figure 95 on page 241.
4 See Figure 89 on page 226.
5 See Figure 109 on page 273.

Fig. 107 - Convertible RLCM (Front View)

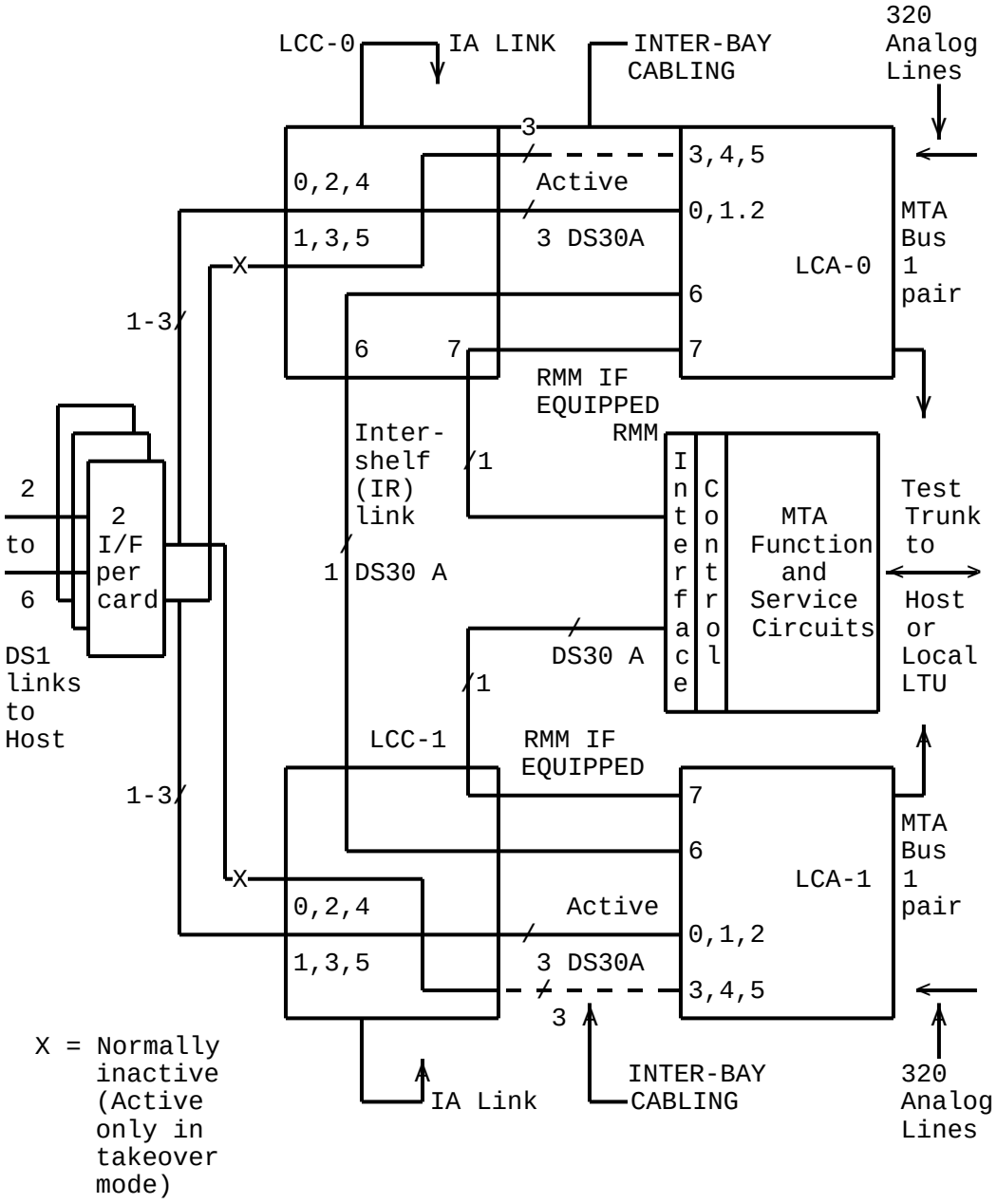


Fig. 108 - RCME HIE Block Diagram

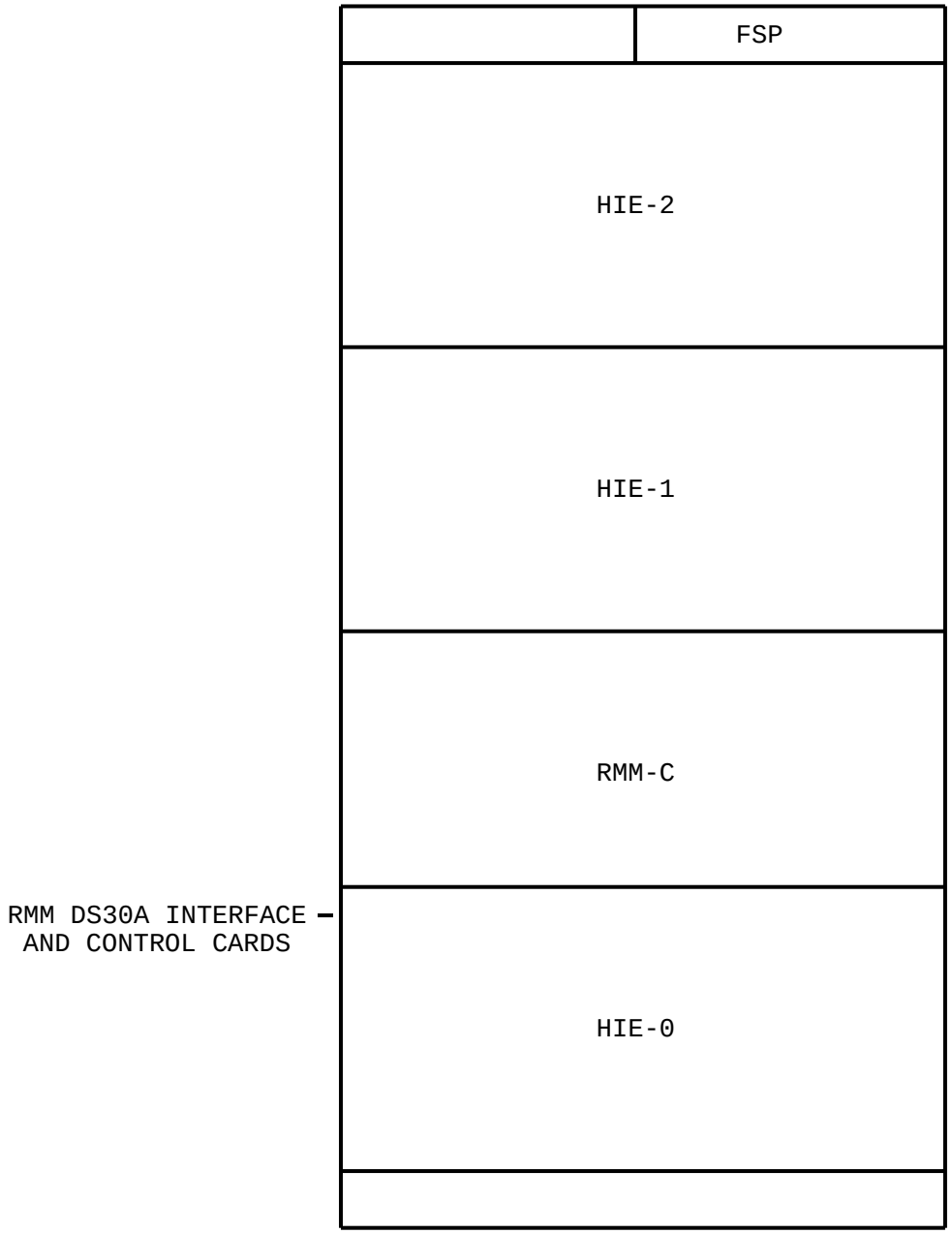


Fig. 109 - RCME Shelf and Frame Layout (Front View)

24. LINE MODULES (LM & RLM)

GENERAL

Line Modules (LM) use 2 to 4 speech links to the NM, and operate either at the DMS-100 office site (LM), or as a remote LM (RLM) at a remote site.

The LM and RLM are housed in double-bay frames which are structurally similar. Each bay provides voice and signaling interfaces between digital multiplexed speech channels and up to 640 analog lines.

The LM Equipment (LME) frame operates as a direct PM of the DMS-100 office via DS30 speech link, but the RLM operates via the DCM-R (as described in Part 8 on page 69) and is connected to the host office NM by up to four DS1 carrier links. The RLM can be located up to 50 miles (80 Km) from the host office.

LM CONFIGURATION

See Figure 110 on page 276. The double-bay LME frame contains two complete LM bays, which have the same configuration. A LM bay comprises a LM controller (LMC) shelf, four line shelves, and a FSP (see GS0X29).

The LMC controls the speech and signaling channels between 2 to 4, duplicated DS30 links to planes-0 and -1 of the NM, and twenty terminal groups (0-19) to the line drawers (LD). Each line shelf contains five LD, for a total of twenty LD (4x5). The LMC contains a master processor and three subsidiary processors which perform the PP function. Two processors handle CC messages, and one handles signaling and ringing.

Each LD accommodates 32 line circuit (LC) cards which provide bidirectional analog-to-digital and digital-to-analog interfaces between the subscriber lines and the terminal groups. LD-0 accepts connections from the first group of 32 lines via LC-00 to LC-31. Similarly LD-01 through LD-04 each accept 32 lines, totaling 160 lines for the first line shelf. The other three line shelves each accept 160 lines totaling 640 lines (4X160) for the whole bay.

Each LD also contains two bus interfaces (BI) (primary and secondary) which collect 32 sets of bidirectional digital signals from their associated LC, and multiplexes them onto the 20 terminal groups to the LMC. Normally, the primary BI is active, but if the LMC in one bay fails, the secondary bus interface is activated and routes the 20 terminal groups to the LMC in the mate bay. This mutual support between mate LM bays enables the traffic load from all 1280 lines to be handled by one LMC until the other LMC is restored to service.

Any one of the 640 analog lines can be associated with any one of the 32 paths in each terminal group, and any channel in any one of the up to 120 speech channels (4 speech links) to the network. In addition to speech path organization, the LMC generates and controls the application of ringing, signaling, and tones to the LC. The LM scans its lines for on/off hook status, and continuously checks each connected line for integrity of the network connections.

Metallic Test Access. Each LC card has a metallic test connection to its analog circuits and to the subscriber's tip and ring leads, via a test access relay in each line circuit. The Test Access (TA) connections from each LC are collected onto two test access buses (per LM bay). One bus collects TA connections from LD-00 through LD-09, while the other serves LD-10 through LD-19 (320 LC per TA bus). Individual LC cards are selected for connection to the TA buses when their TA relays are operated by control signals from the DMS-100 system. The TA buses are cabled to the Metallic Test Access (MTA) Unit. The MTA handles distribution of TA connections to the Main Distribution Frame (MDF) and from thereto line testing equipment. See 297-2101-116 for details of the MTA unit and associated line test procedures.

LM FRAME AND SHELF LAYOUT

Figure 111 on page 277 illustrates the physical appearance of a double-bay LME frame. The LD are identified as LD-00 in the left side of the lowest shelf to LD-19 in the right side of the top line shelf. The LMC is in the upper shelf, and in addition to processors and memories handling the PP functions, contains power converters, programmable ringing generators, standard tone generators, and DS30 interfaces.

For detailed descriptions of LM features, operation, and hardware, refer to 297-2101-101.

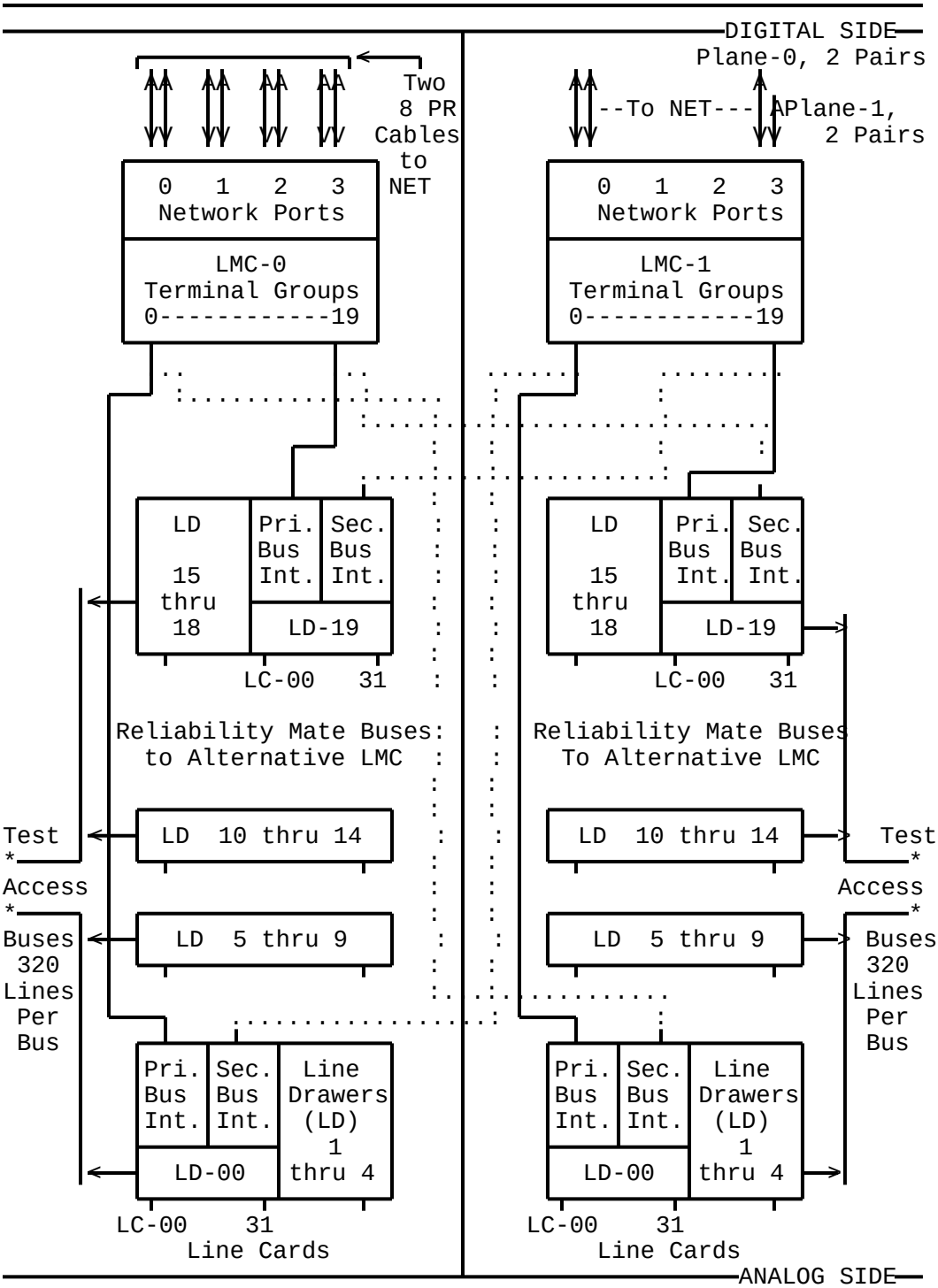


Fig. 110 - LM Equipment Frame Block Diagram

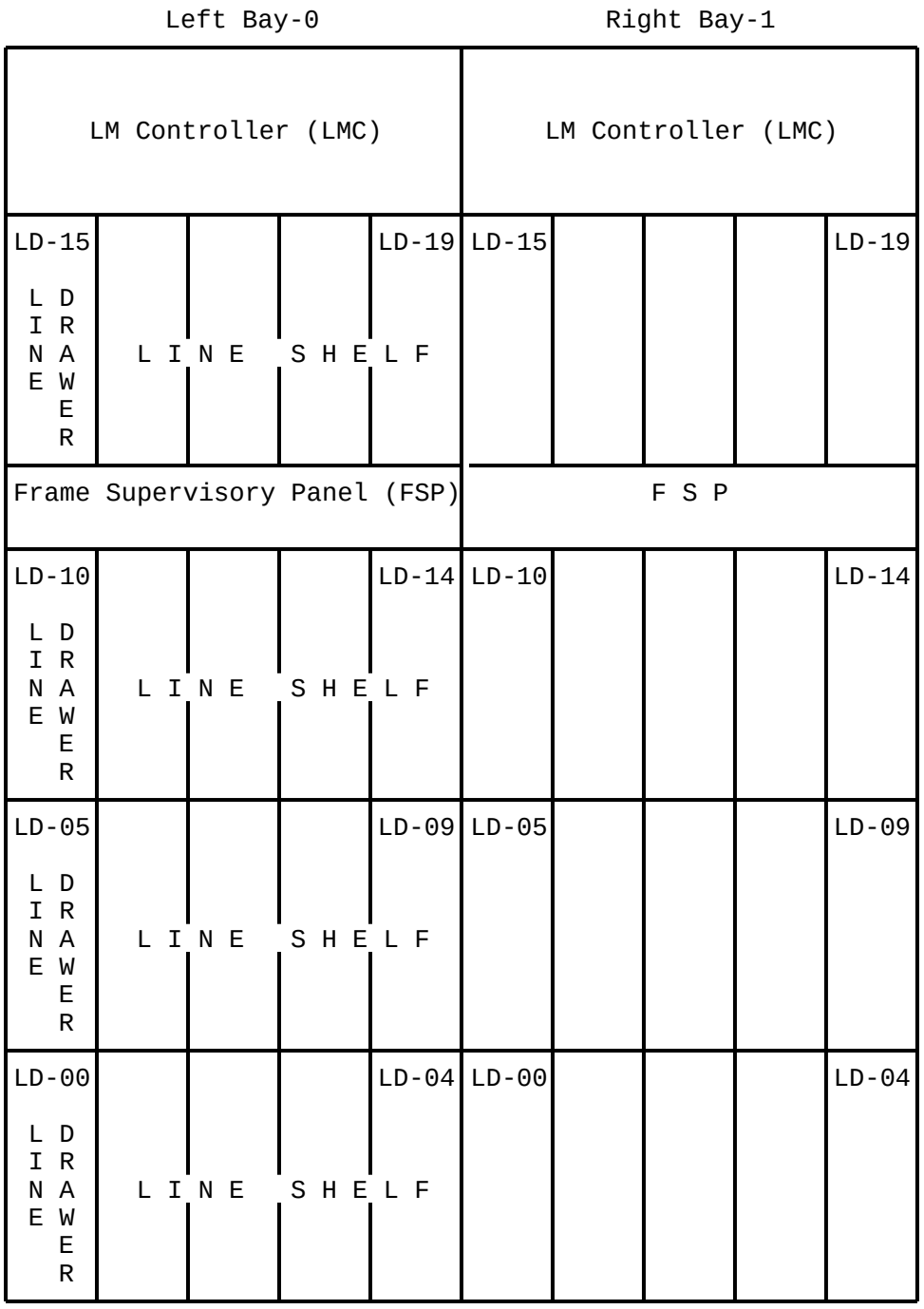


Fig. 111 - Double-Bay LM Equipment Frame Layout (Front View)

RLM CONFIGURATION

See Figure 112 on page 280. The configuration of the RLM frame is very similar to that of the LME frame, except as follows:

* The Remote Line Controller (RLC) circuitry (which replaces the LMC) interfaces with up to four two-way DS1 links to the host office. The RLC circuitry converts the 32-channel, 2.56 Mb/s format used within the RLM to the 24-channel, 1.544 Mb/s format used by the DS1 carrier equipment. The DS1 links are not duplicated.

* The RLC in mate RLM bays operates in the same mutual support configuration as the LMC.

* In the 1280-line RLM frame configuration (640 lines per bay), the RLC terminal group assignment and LD arrangement is the same as in the 640-line LM bay.

* In the 1216-line RLM frame configuration (608 lines per bay), terminal groups 0 through 18 are assigned to LD-00 through LD-18. Terminal group 19 on each bay, however, is used to provide control buses to the Remote Service Module (RSM) circuits.

RLM are available in a basic configuration and two optional configurations, either or both of which can be added to the basic package. Available configurations are as follows:

* Basic RLM Package. 1216-line RLM frame with RSM (see GS2X58). Up to 608 subscriber lines per bay. Controls an RSM which handles metallic test access bus connections for itself, and a cluster of up to four other 1216 or 1280-line RLM frames.

* RLM with Intra-Calling (IAC) IAC enables calls between subscribers connected to the same double-bay RLM frame to be completed locally via the RLM circuits thus relieving the load on the DS1 links and host office network. Various combinations of intra-bay (IA), inter-bay (IR), and DS1 (host) links are possible to meet RLM traffic requirements.

* RLM With Emergency Stand-Alone (ESA) Option. In the event of a failure of the DS1 carrier links to the host office, ESA enables Plain Ordinary Telephone Service (POTS) to be provided between subscribers connected to the same 1216-line frame.

  NOTE: When ESA Entry or Exit occurs, all calls that are currently in progress are lost (including stable calls).

Metallic Test Access (MTA). MTA buses have two configurations, as follows:

* In the 1280-line RLM frame configuration, the TA buses are arranged the same as in the LME frame.

* In the 1216-frame RLM frame configuration, one TA bus handles TA connections from LD-00 through LD-09 (320 lines), while the other handles TA connections from LD-10 through LD-18 (288 lines).

RLM FRAME AND SHELF LAYOUT

Figure 113 on page 281 illustrates the physical appearance of a double-bay RLM frame, which is similar to the LME frame, except as follows:

* In the 1280-line RLM frame configuration (640 lines per bay), the LD arrangement is the same as in a LME frame.

* In the 1216-line RLM frame configuration (608 lines per bay), only 19 LD (LD 00 through 18) are used. The lower three line shelves have the same configuration as those in an LME bay, but the top line shelf contains only four LD (LD-15 through 18). The twentieth LD position is used to accommodate connectors which interface with the RSM.

For detailed descriptions of RLM features, options, IAC link combinations, operation, and RLM and RSM hardware, refer to 297-2101-102.

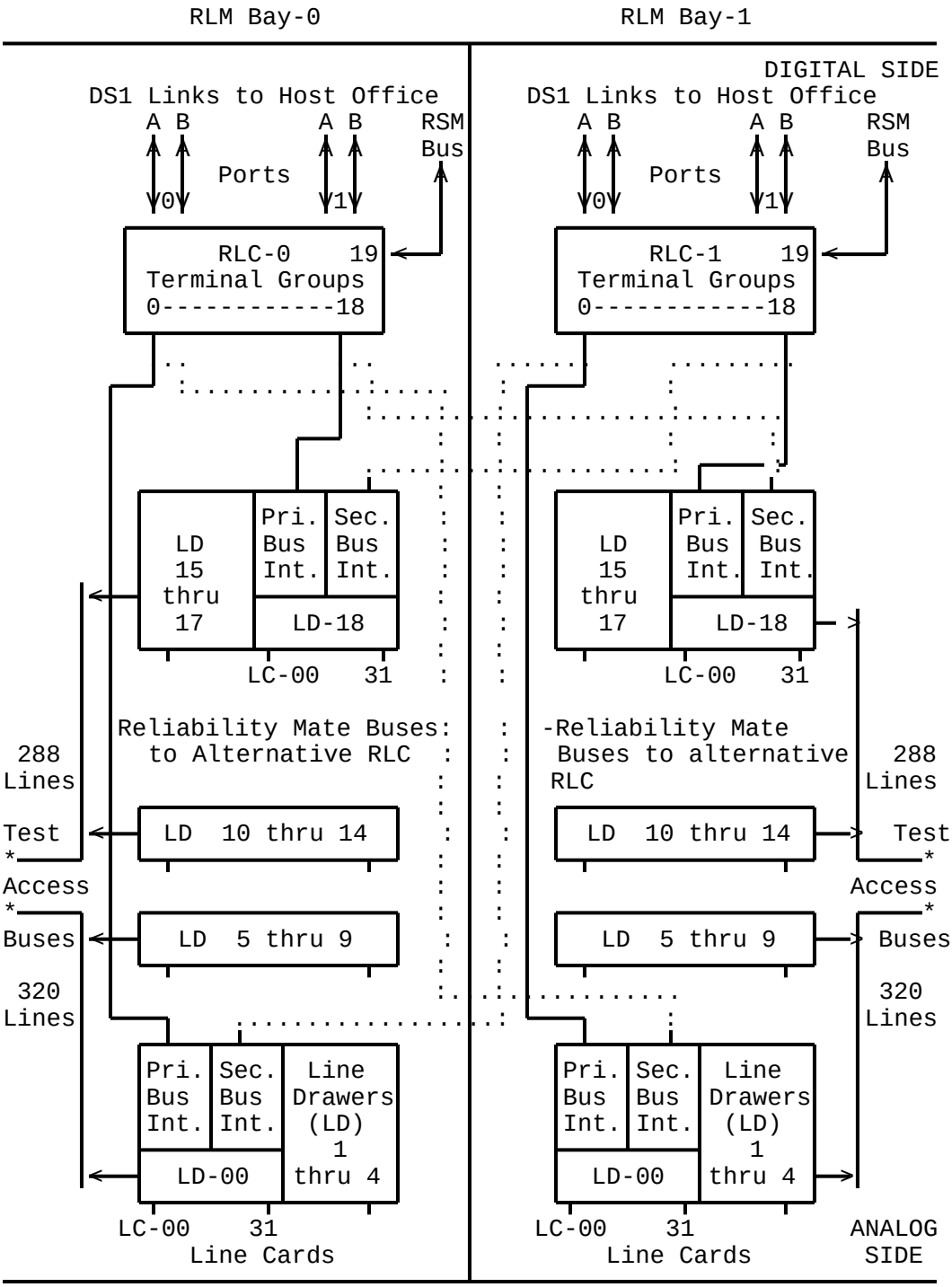
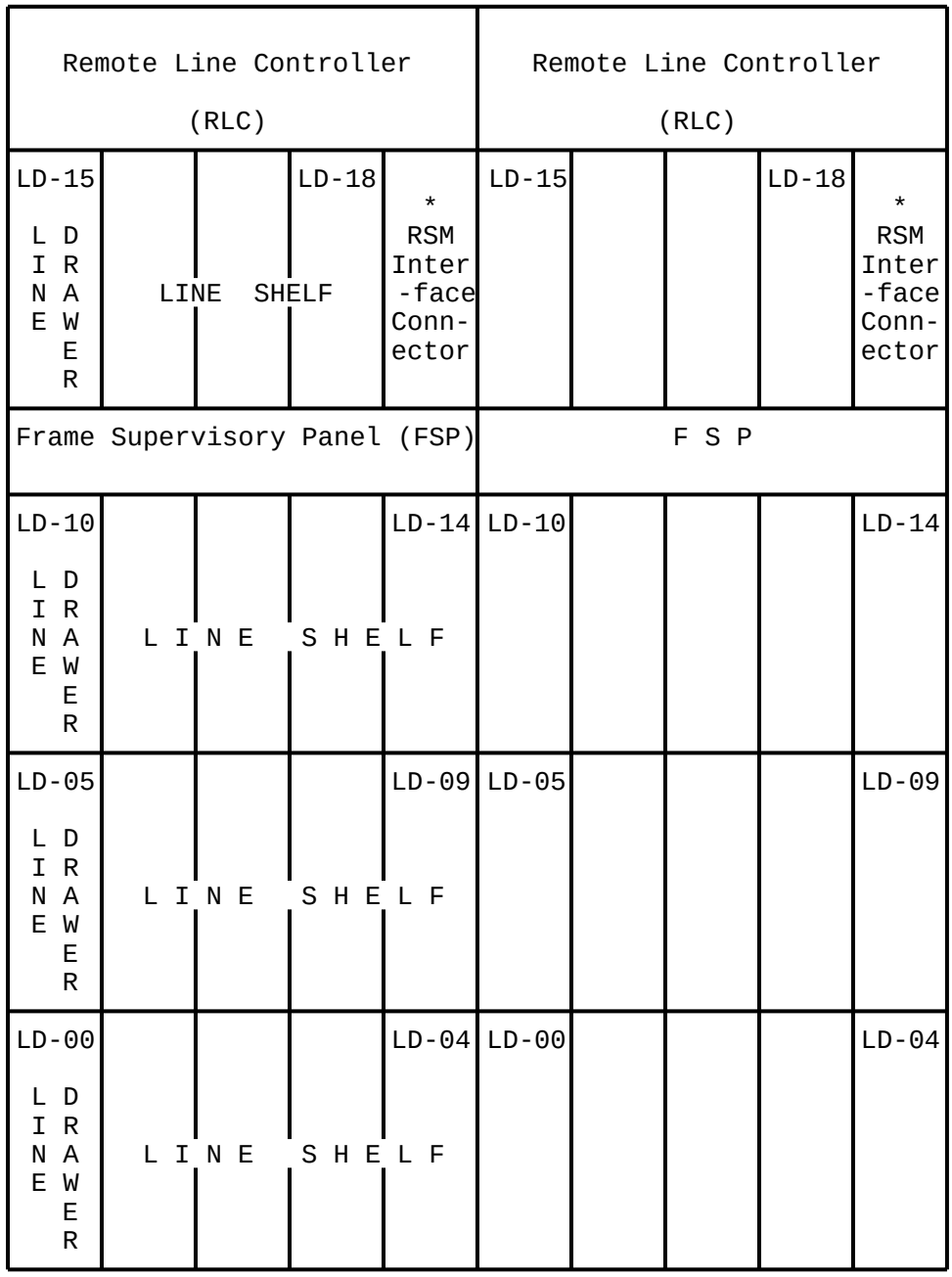


Fig. 112 - RLM Equipment Frame (Block Diagram)



* is LD-19 if 1280-line RLM frame; RSM interface connectors if 1216-line RLM frame.

Fig. 113 - Double-Bay RLM Equipment Frame Layout (Front View)

25. ABBREVIATIONS

ANI	Automatic Number Identification
AT&T	American Telephone and Telegraph Company
BCS	Batch Change Supplement
BIC	Bus Interface Card
CCITT	Consultative Committee for International Telephone and Telegraph
CC	Central Control
CCC	Central Control Complex
CCIS	Common Channel Interoffice Signaling
CCIS6	Common Channel Interoffice Signaling No.6, the application of CCS6 to handle Plain Ordinary Telephone Service (POTS) calls
CCITT6	CCITT Signaling System No.6, the application of CCS6 to handle national and international service calls
CCS	Common Channel Signaling
CCIS6	Common Channel Interoffice Signaling No 6
CCS7	Common Channel Signaling No 7
CDO	Community Dial Office
CLASS	Custom Local Area Signaling Services
CMC	Central Message Controller
CMU	Card Maintenance Unit
CMR	CLASS Modem Resource
CND	Calling Number Delivery
CODEX	Coder-Decoder
CPCA	Common Peripheral Controller Array
CPCE	Common Peripheral Interoffice Signaling
CSB	Channel Supervision Bit
CSC	Cell Site Controller
CSM	Channel Supervision Message or Channel Supervision Module
DCH	D-Channel Handler
DCM	Digital Carrier Module
DDL	Derived Data Link
DES	Digital Echo Suppressor
DLC	Data Line Card
DMS	Digital Multiplex Switch
DMSX	A link control protocol used with DS30A or DS1 links for messaging between Peripheral Modules
DP	Dial Pulse
DRA	Digital Recorded Announcement (controller)
DRAM	Digital Recorded Announcement Machine
DRCC	Dual Remote Cluster Controller
DTC	Digital Trunk Controller
DTMF	Dual-Tone Multifrequency
EEPROM	Electrically-Erasable PROM
ESA	Emergency Stand-Alone
F-Bus	Frame Transport Bus
FMT	Fiber Multiplexing Terminal
FSP	Frame Supervisory Panel
GFD	General Feature Description
GRP	Group
GS	General Specification
GTT	Global Title Translation

HDLC	High-level Data Link Control
HIE	Host Interface Equipment (shelf)
IA	Intra (link)
IAC	Intra Calling (feature)
IBERT	Integrated Bit Error Rate Tester
ICPCE	International CPCE (frame)
IDTC	International DTC
ILCM	International Line Concentrating Module
ILGC	International Line Group Controller
IMC	Inter-Module Communication
IPC	Inter Peripheral Connection
IPM	Impulses per Minute
IPML	Inter-Peripheral Message Link
IR	Inter (link)
ISDN	Integrated Services Digital Network
ISP	ISDN Signalling Pre-processor
I/F	Interface
LC	Line Circuit
LCA	Line Concentrating Array
LCC	Line Control Card
LCE	Line Concentrating Equipment (frame)
LCM	Line concentrating Module
LD	Line Drawer
LGC	Line Group Controller
LGP	Link General Processor
LIM	Link Interface Module
LIS	Link Interface Shelf
LIU7	Link Interface Unit 7
LM	Line Module
LMC	Line Module Controller
LME	Line Module Equipment (frame)
LMS	Local Message Switch
LMSP	Local Message Switch Processor
LPP	Link Peripheral Processor
LSG	Line Subgroup
LTC	Line Trunk Controller
LTCi	ISDN Line Trunk Controller
LTU	Line Test Unit
L/A	Loop-around
MAINT	Maintenance (bus)
MAP	Maintenance and Administrative Position
MDF	Main Distribution Frame
MF	Multifrequency
MIC	Modem Interface Card
MMI	Man-Machine Interface
MS	Message Switch
MSB	Message Switch and Buffer
MSB6	Message Switching Buffer equipped for CCS6
MSB7	Message Switching Buffer equipped for CCS7
MTA	Metallic Test Access
MTM	Maintenance Trunk Module
NM	Network Module
NMC	Network Message Controller
NT	Northern Telecom
NTP	Northern Telecom Practices

NUC	Nailed-up Connection
OAU	Office Alarm Unit
OM	Operational Measurements
OPM	Outside Plant Module
PAM	Pulse Amplitude Modulation
PB	Paddleboard
P-Bus	Processor Bus
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PDTC	PCM30 Digital Trunk Controller
PEC	Product Engineering Code
PFI	Processor Bus Frame Transport Bus Interface
PLGC	PCM30 Line Group Controller
PLM	PCM Level Meter
PM	Peripheral Module
POTS	Plain Ordinary Telephone Service
PP	Peripheral Processor
PROM	Programmable Read-Only Memory
PTM	Packaged Trunk Module
PVC	Permanent Virtual Circuit
RA	Rate Adapter
RAM	Random Access Memory
RCA	Remote Concentrating Array
RCC	Remote Cluster Controller
RCE	Remote Controller Equipment (frame)
RCME	Remote Control and Maintenance Equipment
RCS	Remote Carrier SLC-96
RCT	Remote Concentrator Terminal
RCU	Remote Carrier Urban
RDAT	Receive Data (bus)
RES	Residential Enhanced Services
RPAM	Receive PAM analog speech (bus)
RG	Ringing Generator
RLC	Remote Line Controller
RLCM	Remote Line Concentrating Module
RLM	Remote Line Module
RMM	Remote Maintenance Module
ROM	Read Only Memory
RSC	Remote Switching Center
RSM	Remote Service Module
RTIF	Remote Terminal Interface
RTS	Remote Trunk Switch
SCM	Subscriber Carrier Module
SD	Signal Distribution
SLC	Subscriber Line Carrier
SME	Subscriber Module Equipment
SMR	Subscriber Module Remote
SMS	Subscriber Module SLC-96
SMU	Subscriber Module Urban
ST	Signaling Terminal
6STA	Signaling Terminal Array shelf (CCS6)
STA7	Signaling Terminal Array shelf (CCS7)
STB	Signaling Terminal Buffer
STC	Signaling Terminal Controller (alternative name for Signaling Terminal (ST)).

STG	Signaling Terminal Group
STG7	Signaling Terminal Group shelf (CCS7)
STCM	STC Module
STI	Signaling Terminal Interface
STM	Service Trunk Module
STP	Signaling Transfer Point
STP ST	Signaling Transfer Point Signaling Terminal
STR	Specialized Tone Receiver
STS	Signaling Terminal Shelf in (CCS6)
SWACT	SWitch ACTivity
TA	Test Access
T-Bus	Transport Bus
TID	Terminal Identification
TLC	Trunk Logic Circuit
TM	Trunk Module
TMS	TOPS Message Switch
TPC	TOPS Position Controller
TOPS MP	Traffic Operator Position System Multi-purpose Position
TSN	TOPS Subtending Node
TSG	Test Signal Generator
USART	Universal Synchronous Asynchronous Receive Transmit
UTR	Universal Tone Receiver
XDAT	Transmit Data (bus)
XLCM	Expanded Memory Line Concentrating Module
XPAM	Transmit PAM analog speech (bus)
XPM	Extended Multiprocessor System Peripheral Module

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