SL-1

2-Mb/s Remote Peripheral Equipment

Description and engineering guidelines

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Contents

General

The 2-Mb/s Remote Peripheral Equipment (RPE) increases the 50-ft. (15-m) range of the multiplexed loop between the Common Equipment (CE) and the Peripheral Equipment (PE) shelves by using a 2.048 Mb/s carrier span. The increased range of the multiplexed loop, in turn increases the serving range of the SL-1.

Carrier systems for the span must be land-based links, which meet CCITT recommendation G703 for interface at 2.048 Mb/s.

This Northern Telecom Publication (NTP) provides a description of the 2-Mb/s RPE feature required by the SL-1 Generic X11 Supplementary Features, Group F (Phase 6). Also provided is a description of the hardware unique to the 2-Mb/s RPE feature and any pertinent ordering information. The required characteristics of the span facility are provided in the Engineering Guidelines section.

Refer to 553-2931-200 for installation and acceptance tests for the RPE feature. Publication 553-2931-500 provides fault-clearing and maintenance information. Also refer to Appendix 1 to 553-2741-100/200/500 for RPE cabinets and shelves for the ST machines/System Option 21, and SN machines.

Feature description

General

The 2-Mb/s RPE feature increases range of the multiplexed loop between the CE and PE. Increased range is accomplished by employing a 2.048 Mb/s carrier span between the local and remote sites.

Span options

The carrier span shall consist of a land-based 2.048 Mb/s carrier system. Refer to the Engineering Guidelines for further information regarding the carrier.

Note: All spans should meet CCITT recommendation G703 for interface at 2.048 Mb/s.

Equipment configuration

Figure 2-1 shows a 2-Mb/s RPE group block diagram. One RPE group consists of up to four RPE loops. Each group is declared via service change overlay program 52.

Each RPE group is housed in a single RPE shelf at both the local and remote sites. Each RPE group can be equipped with up to four network loops for RPE use.

The 2-Mb/s design gives customers the option of defining one loop in each group as a spare loop. The spare loop is not connected to PE shelves at the remote site, and is switched into service when a serious fault is detected in one of the active loops. When the spare loop is activated the PE assigned to the faulty loop is connected to the spare via the path switch circuit pack as shown in Figure 2-1.

N The network terminating capacity of the SL-1 is decreased by the number of *ote:* spare loops equipped.

If the spare loop option is used, three loops are active while the fourth loop is spare (idle). The spare loop when in service (due to a fault condition or manual switchover by a maintenance technician), remains active until the faulty loop is repaired and is manually switched back into service from a maintenance terminal. It could also switch back by itself.

Note: Calls in progress on a loop are disconnected by the switchover. Two-way established calls remain established.

If the spare loop option is not chosen, all four loops can be connected to PE. Each RPE loop can serve four PE shelves at the remote site.

Every network loop in the SL-1 has an address which is determined by the location of the network circuit pack in the network shelf. Any network address can be assigned via service change overlay program 52 to any RPE group. An RPE group (1-31) can consist of up to four loops, called members (LM0, LM1, LM2, and LM3) which are assigned through the service change facility. The network address is assigned to a member number in overlay program 52.

Note: The correlation of RPE shelf connector designations and service change assignments is shown in Figure 3-1.

To increase reliability, loops from different network shelves should be assigned to an RPE group.

A typical configuration for one RPE group is shown in Figure 2-2. Each RPE group requires an RPE shelf (QSD21 or QSD22) at both the local and the remote sites. RPE shelves can only be located in Peripheral Equipment cabinets. At both the local and the remote site, an RPE shelf must be within 50 cable feet (15 m) of the the network circuit packs and the PE it serves.There is no physical difference between RPE shelves for remote or local sites. The shelf used at the local and remote end are identified to the SL-1 as such by the Bus Terminating Unit (BTU) connected to the shelf backplane.

Each network circuit pack is connected to the local RPE shelf by an NE-A18QA cable (Figure 2-2). The local site RPE shelf is connected to the span facility by two 75-ohm coaxial cables per loop (Figure 2-3). At the remote site the span facility is connected to the remote RPE shelf by two 75-ohm coaxial cables per loop. As shown in Figure 2-2, the remote shelf is connected to the PE it serves by one NE-A18QA cable per loop.

The coaxial cables are connected to the shelf by BNC connectors supplied with each shelf. The coaxial cable used for connection to the span is not supplied by Northern Telecom.

PE shelves at the remote site are connected to the cross-connect terminal in the same manner as PE shelves at the local site. Refer to 553-YYY1-210 for PE shelf connecting information.

Refer to 553-YYY1-215 for telephone set connecting information.

Power

Power required for the RPE shelves is supplied from the cabinet -48 V supply via the QBL14 Power Distribution Box (Figure 2-4). The QBL14 box can distribute power for up to four shelves. Provided with each RPE shelf (QSD21/QSD22) is a cable assembly, required for connecting the shelf to the QBL14 unit.

Each RPE shelf (local and remote) must be equipped with a QPC190 5/12 V converter circuit pack. The converter circuit pack provides voltages required by RPE circuit packs, from the regulated -48 V received from the QBL14. No additional power supply is required at either the local or the remote sites. Cabinets containing RPE shelves are provided with power in the normal manner as described in the associated installation publication (553-YYY1-210).

Note: Line terminating units and line repeaters cannot be powered by the SL-1 power supply.

Maintenance

Many features are provided with the 2-Mb/s RPE feature to ease the effort of the maintenance technician. Preventative maintenance is carried out by the SL-1 automatically by the resident RPE alarm handler program. This program runs continually, monitoring the status of the RPE. The RPE maintenance diagnostic overlay program 53 may be included as part of the daily routines to perform tests on the RPE system on a daily basis. It can also be a background (BKGD) Program. Carrier (span) maintenance should follow the carrier manufacturer specifications.

Figure 2-1
2-Mb/s RPE group block diagram

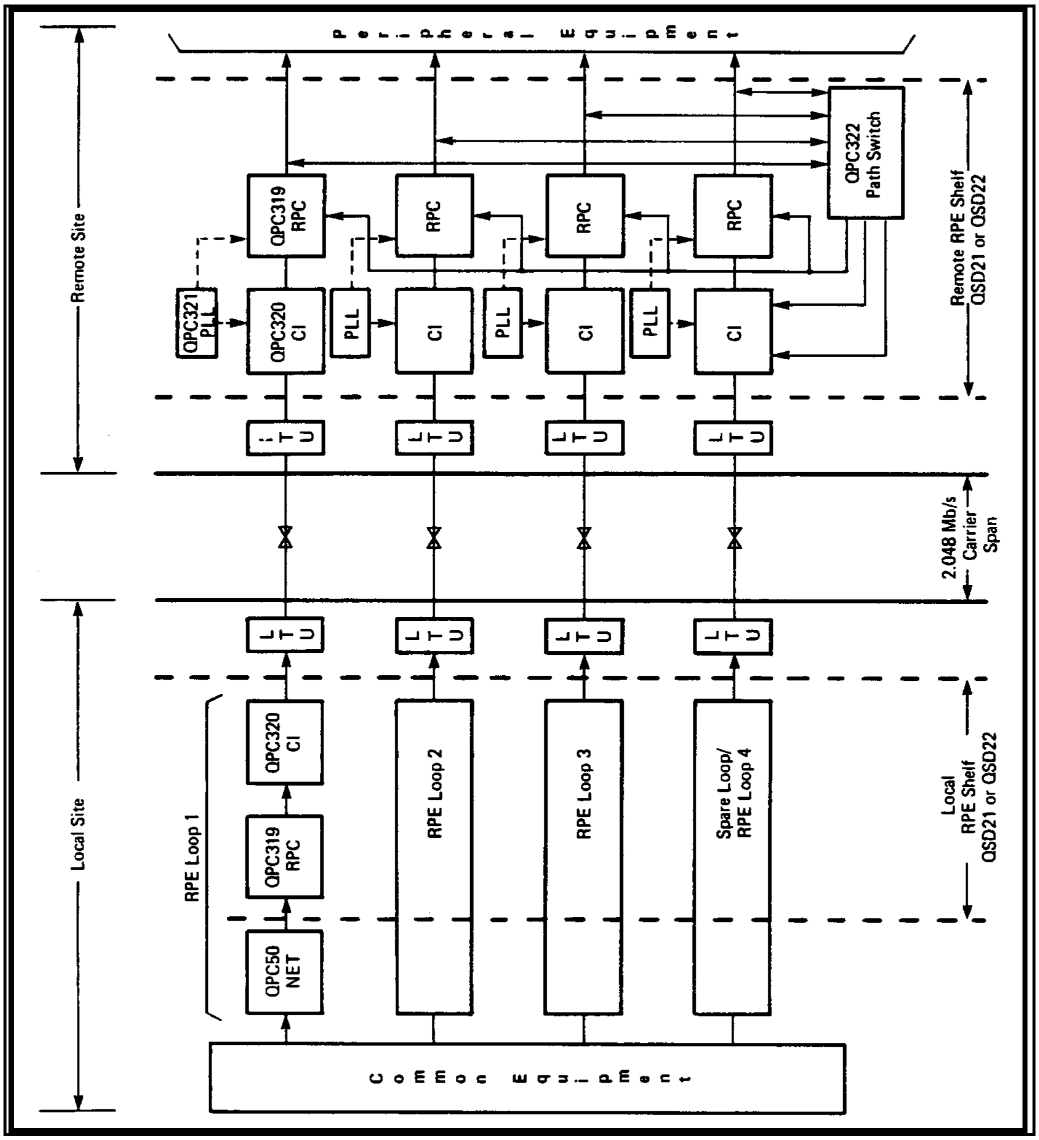


Figure 2-2
Typical group configuration

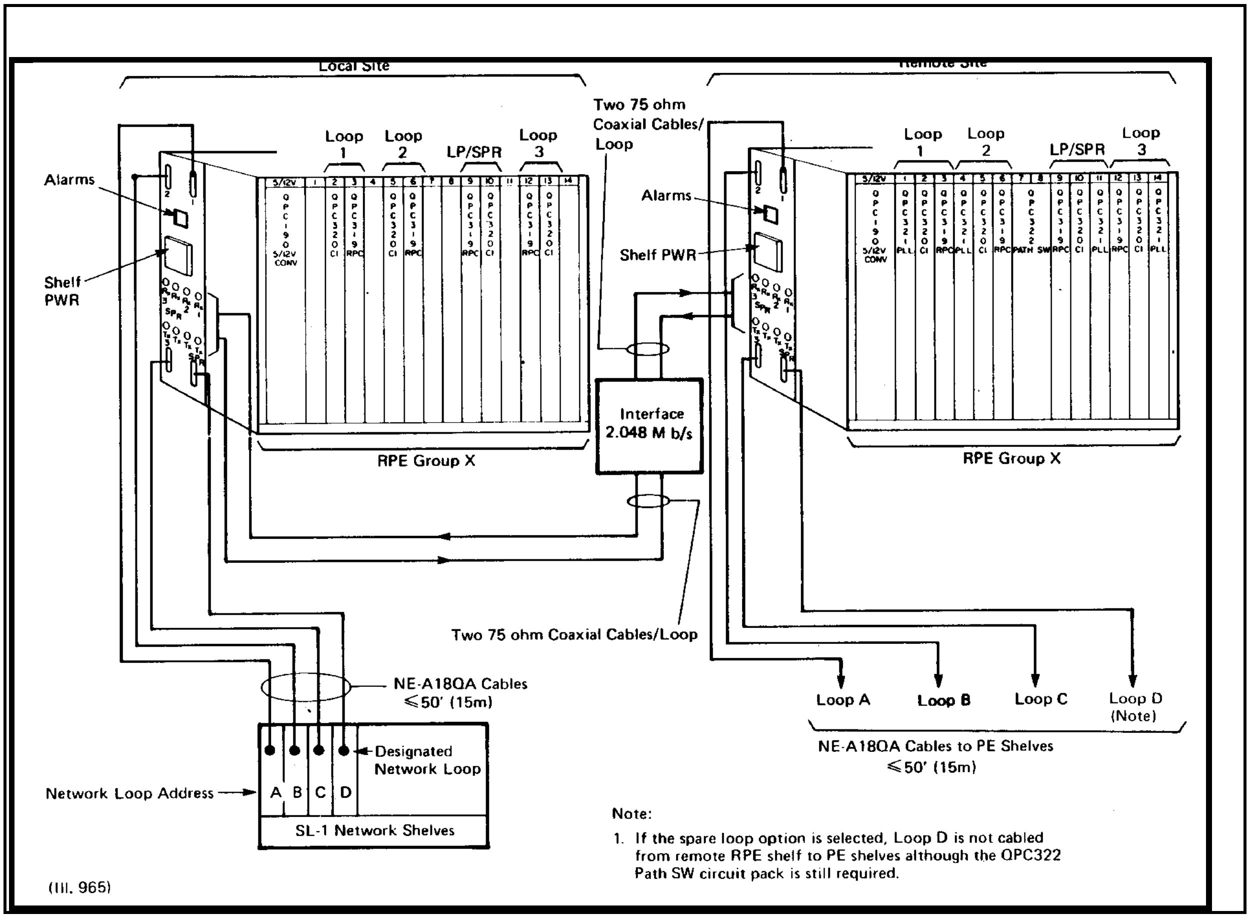
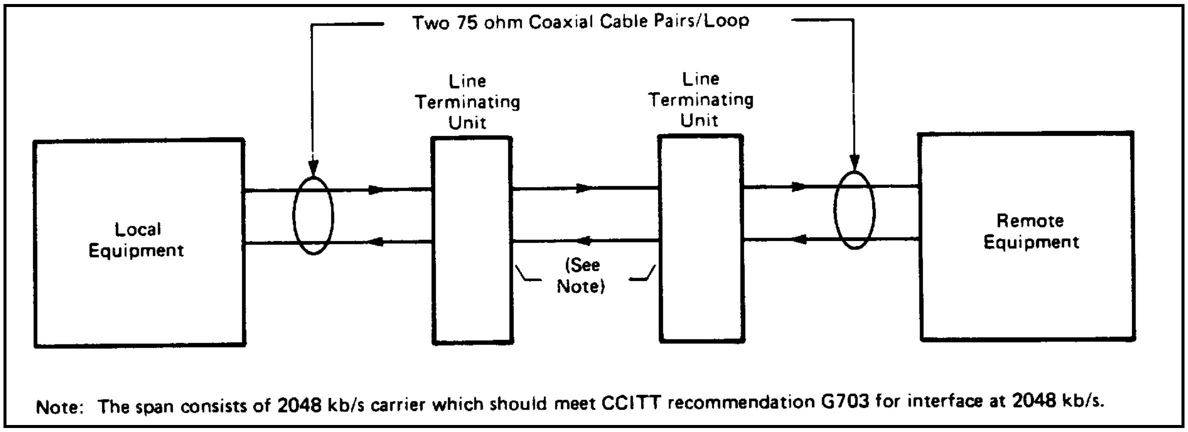


Figure 2-3
RPE span with interface circuits



Visual fault indicators

RPE hardware (circuit packs) design provides the technician with a visual indication as to the status of the RPE. Light Emitting Diodes (LEDs) on circuit pack faceplates provide fault and status indicators for RPE circuits. Refer to Table 2-A and Figure 2-5 for information regarding LED indicators.

Table 2-A
RPE circuit pack states

LED Indicator	Interpretation
—CCLK	Loss of carrier clock
—FA	Loss of frame synchronization with carrier
RPC FAIL	Associated RPC pack failed or initializing
OUT OF LOCK	Faulty PLL pack or clock cannot be locked on
LOOP 1	Loop member 0 has been replaced by the spare
LOOP 2	Loop member 1 has been replaced by the spare
LOOP 3	Loop member 2 has been replaced by the spare
LPDN	Loop is inactive or faulty
LPBK	Loop is in loopback maintenance mode

Maintenance diagnostic program

The RPE maintenance diagnostic overlay program 53 can be used in two different ways. The program can be loaded automatically by the SL-1 as part of the daily routines,run in the background, or run manually when testing or performing fault-location or fault-clearing procedures. The options are Midnight, Background, or Manual. When loaded by the SL-1 as part of the daily routines the program:

- Performs a LOOP test on each configured RPE loop.
- Resets all alarm counters in the RPE system.
- Tests all enabled 'stand by' SPARE loops and all (not manually) spared PRIMARY loops by running the following commands:
  TSTL
  TSTR
  LOCL
  REML
  ENLL
- Performs an unsparing attempt for each one of the primary loops that passed the above tests by running the UNSP command.

Note: If the TRLL option is turned off, no LOCL testing is performed.

Figure 2-4
QBL14 power distribution box

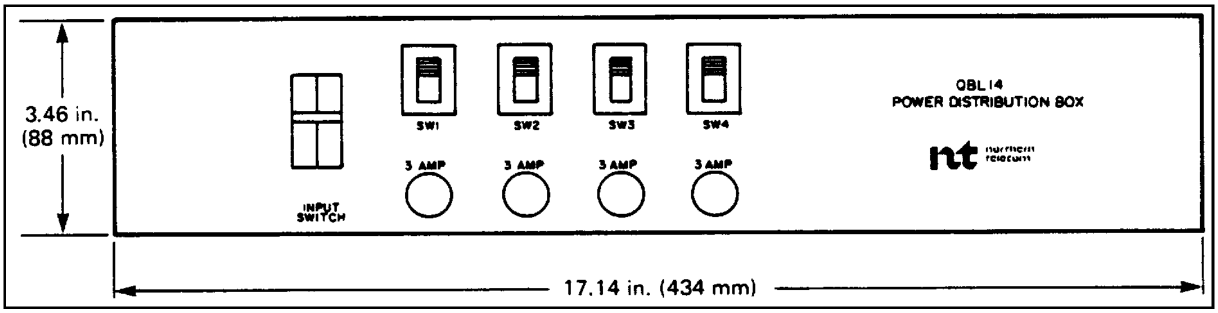
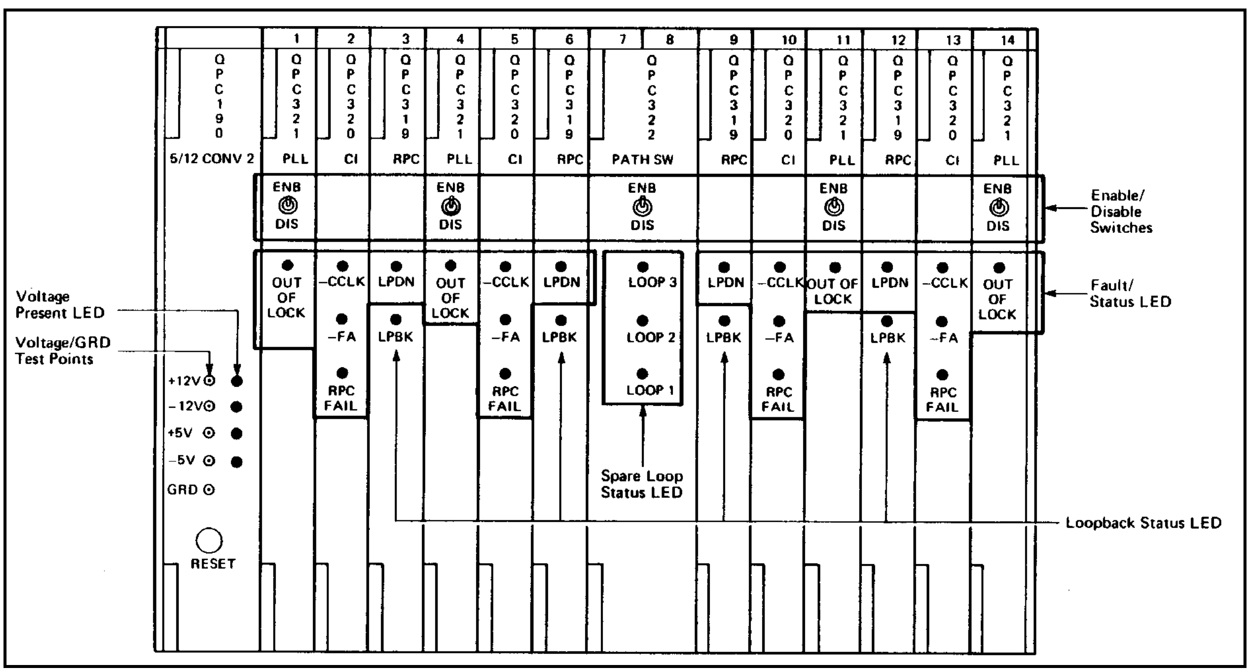


Figure 2-5
RPE circuit pack faceplate layout



When loaded manually the RPE diagnostic program can perform all of the functions previously mentioned for automatic loading and the following may be performed:

- Force the loop into local and remote loopback mode
- Disable and enable RPE loops/shelves
- Switch the spare loop in and out of service
- List current alarm counter content
- List status of the RPE loops/shelves
- Provide the sparing status of the group
- Provide the status of the Path Switch pack
- Unspare previously spared loops
- Clear maintenance display
- List configured RPE loops.
- List disabled and replaced RPE loops
- Make a complete test of RPE loop L by performing combined local and remote testing (TRPL command).

Loop-around tests

The following tests are performed when a loop-around test is completed.

- Test registers within local site RPC circuit pack
- Test the continuity of speech channels
- Test network connection memory
- Test the continuity of signaling channels

Loop-around tests can be performed for both the local and remote sites. The loop-around test facility can be used to isolate faults to local, remote, or carrier equipment. As illustrated in Figure 2-6 local loop-around tests verify the equipment at the local site, while the remote test verifies carrier equipment and local equipment.

Alarms

Customer-defined alarms

The 2-Mb/s RPE design provides customers with the option of defining three alarms for each RPE group installed. The alarms defined could be, for example, loss of commercial power, intrusion door closure, or temperature. The alarms are connected to the RPE shelf alarm connector at the remote site.

Alarm inputs are received at the remote RPE shelf alarm connector as shown in Figure 2-7. The inputs are provided to the shelf by the closure of contacts. The contacts should meet the following electrical specifications.

- Maximum current contact closed 50 mA
- Minimum current contact closed 5 mA
- Maximum contact Resistance 2 ohm
- Maximum voltage contact open 50 V
- Minimum impedance contact open 1.0 Mohm
- Maximum voltage to ground 100 V dc
- Minimum impedance to ground 10.0 Mohm

The input to the shelf should be a clean ground (logic ground). The ground supplied on pin 8 of the alarm connector is recommended. The following also applies to alarm inputs at the remote shelf connector:

- maximum voltage 5 ±0.5 V
- maximum voltage to ground 5 ±0.5 V

When an alarm such as door closure occurs, a customer supplied relay operates or releases. The operation or release of the relay causes the contact closure. On one side of the relay contact the ground is connected, on the other side of the contact the appropriate alarm lead is connected. The ground placed on the alarm lead by the contact closure causes an SSD message to be generated at the remote site.

The software responds to messages (SSD) from the remote site by printing an RPE alarm message that corresponds to the required alarm assignment. The RPEXXX message is accompanied by the loop address of each equipped loop in the RPE group (shelf) and is printed up to four times (one line of output for each loop assigned to the shelf where the alarm is connected).

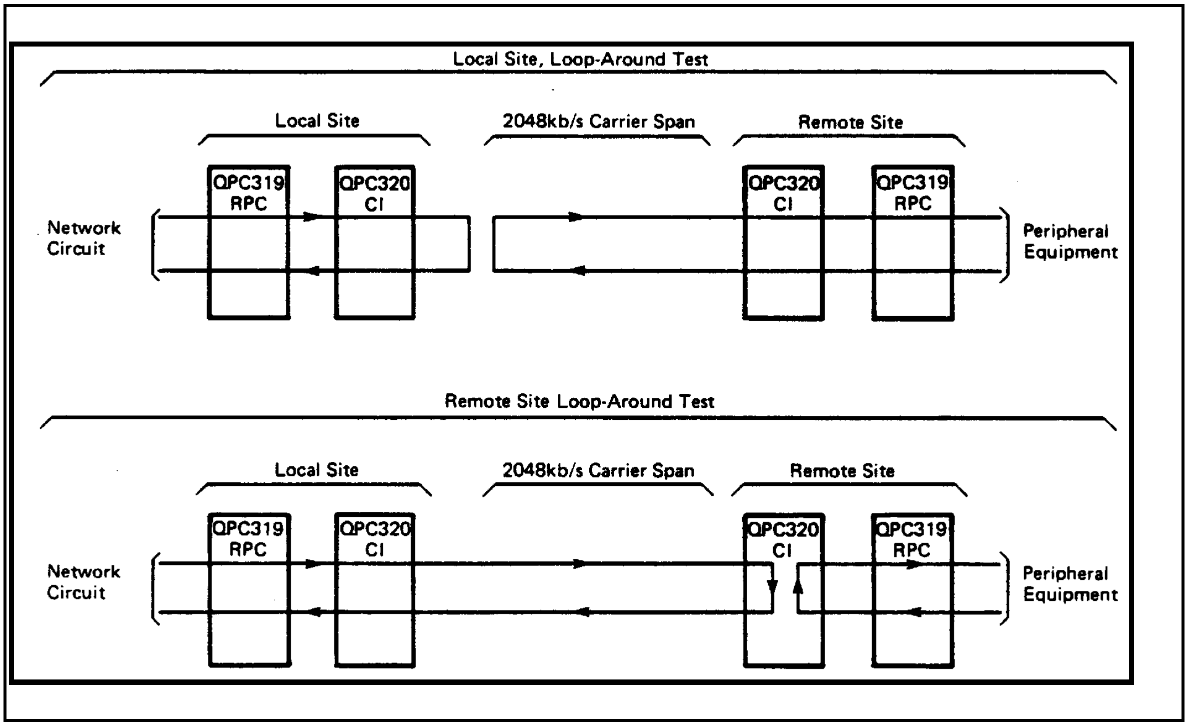
Alarm 1 should be connected to the alarm that requires the highest priority. Alarm 1 is connected directly to the Carrier Interface circuit pack by shelf backplane wiring. Alarms 2 and 3 are processed by the RPC circuit pack before being passed to the CI, a fault in an RPC could conceivably inhibit alarms 2 and 3.

Power failure alarm

A power failure, at the remote site, releases a relay in the power monitor circuit located on the power converter shelf. The release of this relay closes a contact between REMALMA and REMALMB leads.

Refer to Figure 2-8 for typical wiring connections. As shown, the ground on REMALMA is transmitted over the released relay contacts to REMBLMA and then to any one of ALM1, ALM2 or ALM3 leads. A ground on anyone of these leads causes an alarm message printout on the teletype at the local site, indicating a power failure at the remote site.

Figure 2-6
Local and remote loop-around tests



Resident RPE Alarm Handler

A resident program called the RPE Alarm Handler is provided when the RPE feature is equipped. The following alarms and the customer defined alarms are reported and monitored by the resident alarm handler program.

- Frame alignment signal error rate local/remote sites
- PCM error rate exceeds 1 in 10^4 at local/remote sites
- Loss of frame alignment local/remote sites
- Remote site RPC circuit failure
- Local site RPC initialization

This program runs at all times monitoring and reporting RPE alarm signals. Alarm thresholds can be specified by the customer by service change overlay program 52. Two types of thresholds can be specified; timing thresholds and counting thresholds. A counter threshold is the maximum number of occurrences of a particular alarm that is allowed before an attempt to spare the faulty loop is made. A timing threshold is the maximum length of time allowed for a failure before sparing of the faulty loop is attempted.

Figure 2-7
Customer-defined alarms

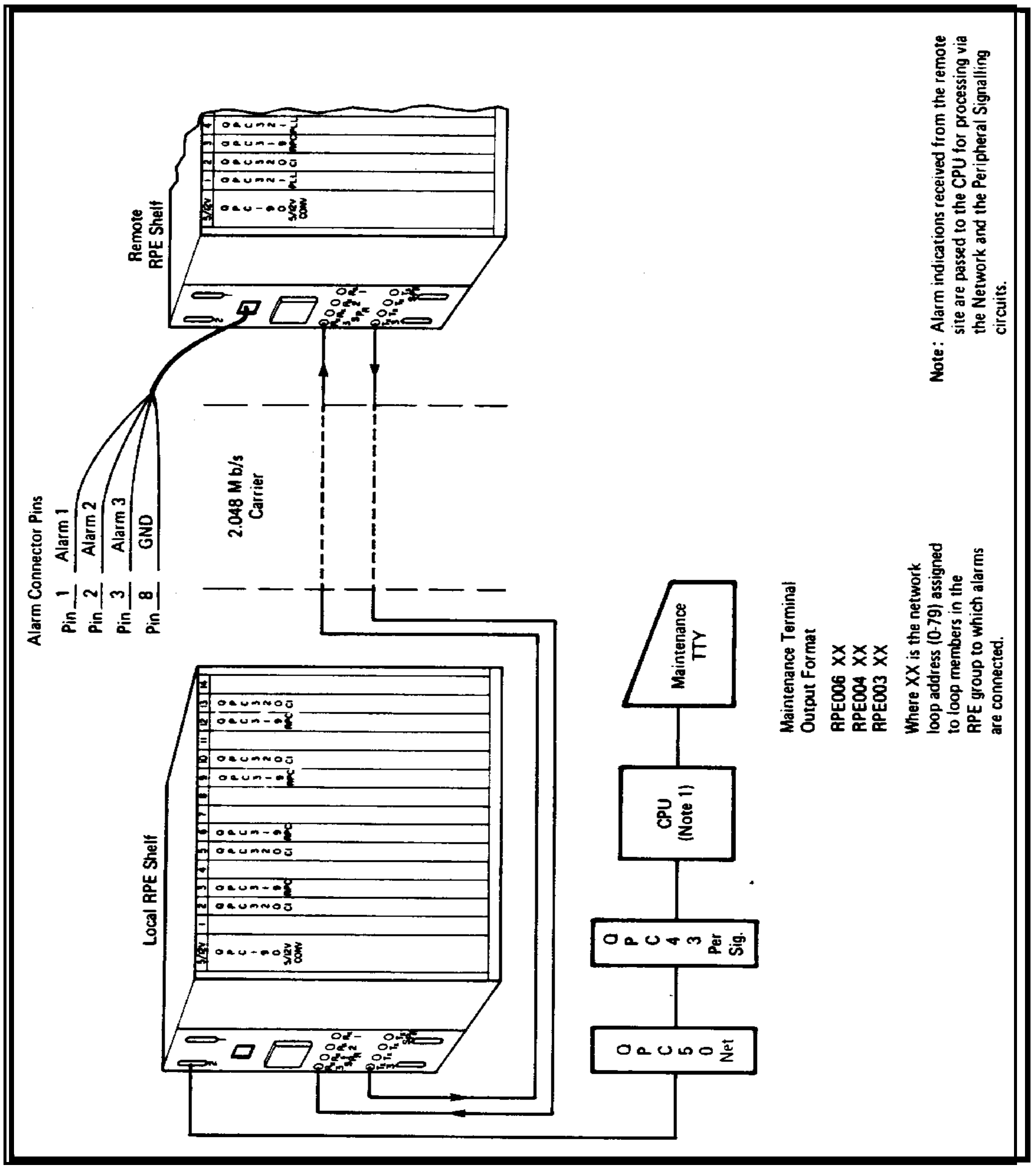
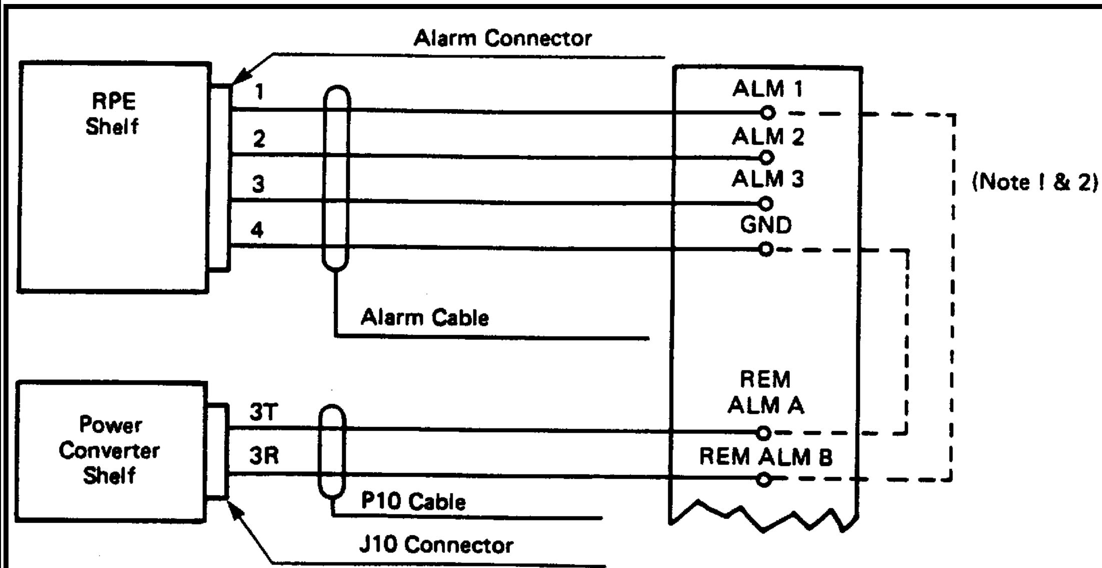


Figure 2-8
Typical wiring connections of power failure alarm at remote site



Note 1: ——— indicates X-connect wiring at distributing frame
Note 2: REM ALM B lead may be X-conn to any one of ALM 1, ALM 2 or ALM 3, as required

Emergency transfer

Emergency transfer units will not work on 2-Mb/s RPE remote sites.

Feature administration

Refer to 553-2931-200 for data administration (service change) information.

Description and ordering information

This part provides a description of unique hardware items required with the 2-Mb/s RPE feature. The description contains the purpose, the quantity required, the location where the equipment is used, and any features relevant to the particular item. From the information given in this part the quantity of hardware items required can be determined for an RPE installation.

Cabinets

Standard SL-1 PE cabinets are used to house RPE equipment at both the local and remote sites.

Shelves

Two shelf types are available for mounting RPE circuit packs. The shelves are:

- QSD21 right-hand mount RPE shelf
- QSD22 left-hand mount RPE shelf

Included with the RPE shelf are 8 BNC connectors for the coaxial cable, and one 12.5-ft. (3.5-m) cable assembly for connection to the QBL14 Power Distribution Box.

Purpose

The RPE shelf accommodates the RPE circuit packs listed in Table 3-A. An RPE shelf can house one RPE group which consists of up to four loops. An RPE group cannot be located in more than one shelf at either site.

Quantity

For each RPE group, one shelf is required at the local site and one shelf is required at the remote site.

Location

Local Site - Any PE shelf location within 50 cable ft. (15 m) of the network circuits assigned to the RPE group in the shelf. Remote Site - Any PE shelf location within 50 cable ft. (15 m) of associated PE shelves.

Features

- Fully connectorized connection
- International Rack mounting standards: 19 in (483 mm)
- Printed circuit backpanel
- Approximate weight: 35 lb (15.9 kg) fully equipped

Circuit Pack Vintages

The QPC43L and later vintage peripheral signaling circuits with improved clock signaling are recommended for 2-Mb/s RPE and digital trunk facilities.

QPC319 Remote Peripheral Equipment Controller

Purpose

Interfaces the network circuit at the local site and the PE buffers at the remote site. The Remote Peripheral Equipment Cabinet has two LED on its faceplate.

- LPDN - When lit indicates that the loop is either not active or faulty
- LPBK - When lit indicates that the CI is in a loopback maintenance mode

Table 3-A
RPE circuit packs

Code	Description	Location	Quantity
QPC355	5/12 V Converter	local and remote	1 per shelf
QPC319	Controller	local and remote	2 per shelf
QPC320	Carrier Interface	local and remote	2 per loop
QPC321	Phase Lock Loop	remote site	1 per loop
QPC322	Path Switch	remote site	1 per remote shelf when sparing option is used
QPC164*44	BTU Local	local site	2 per local shelf
QPC164*45	BTU Remote	remote site	2 per remote shelf

* indicates the vintage of the BTU such as A, B, C, etc.

The QPC319 also performs the following:

- Filters alarm messages from the remote site and reports them to system software
- Receives enables from the network at the local site and performs remote TN update transparent to SL-1 software
- Buffers messages from the network and retransmits them at 2 bits per frame for redundancy across the span
- Interprets control messages from SL-1 software at the local site and transmits the messages to the remote in timeslot 1 with alarm signals

Quantity

Two circuit packs per RPE loop.

Location

See Figures 3-1 and 3-2.

QPC320 Carrier interface circuit

Purpose

This circuit pack formats alarm control and voice data from the local and remote sites into a 2.048 Mb/s bit stream. The carrier interface (CI) circuit monitors the span (carrier) and reports fault conditions to the RPC for transmittal to the CPU. The CI pack contains three LEDs:

- CCLK. When lit indicates the carrier clock signal has been lost
- FA. When lit indicates that the CI has lost frame synchronization with the carrier
- RPCFAIL. When lit indicates that the associated RPC circuit pack is initializing, missing or has failed.

Quantity

Two circuit packs are required for each remote loop.

Location

See Figures 3-1 and 3-2.

QPC321 Phased Lock Loop (PLL)

Purpose

The Phased Lock Loop (PLL) circuit pack removes jitter from the clock signal recovered from the CI pack at the remote site. When lit, the LED labelled OUT OF LOCK on the faceplate indicates that the PLL is faulty or the clock signal cannot be locked on.

Quantity

One PLL circuit pack is required for each remote loop equipped.

Location

See Figures 3-1 and 3-2.

QPC322 Path Switch

Purpose

When a fault in an active loop is detected by SL-1 software all signals destined for the faulty loop are redirected to the spare loop. At the remote site the Path Switch (PATH SW) receives all the single ended signals from the spare loop. RPC disables the drivers on the loop to be spared and drives the differential signals to the peripheral buffer. Similarly the PATH SW intercepts the signals returning from the peripheral buffer and relays them back to the spare loop RPC. At the local site the signals coming back from the spare loop are interpreted by software as arriving from the faulty loop. The circuit pack has three LEDs and an enable/disable switch on the faceplate. An LED, when lit, indicates the loop number that is replaced by the spare loop. The enable/disable switch is used to hardware enable and disable the circuit pack.

Quantity

One PATH SW is required for each RPE group where the spare loop option is applied.

Location

See Figures 3-1 and 3-2.

QPC164 Bus Terminating Unit Local

Purpose

The Bus Terminating Unit provide the shelf wiring options that identify the RPE shelf to the system as a local or remote shelf.

QPC164 Bus Terminating Unit Remote

Quantity

Two QPC164*44 are required for each local RPE shelf equipped. Two QPC164*X*45 are required for each remote RPE shelf equipped. Where * indicates the vintage of the BTU, for example A, B, C.

Location

Connected to the backpanel of local and remote RPE shelves.

QPC190 (QPC355) 5/12-V Converter

Purpose

This unit converts 48 V dc to +12 V and +5 V dc required by the RPE shelves.

Quantity

One for each RPE shelf (QSD21/QSD22) equipped.

Location

See Figures 3-1 and 3-2.

QBL14 Power Distribution Box

Purpose

Distributes -48 V to a maximum of 4 RPE shelves. The QBL14 unit is equipped with circuits to provide low voltage shutdown (-42 V) disconnect. The unit also contains circuit protection (3 A fuses) and power ON/OFF switches for 4 outputs (shelves).

Quantity

One for every 4 RPE shelves.

Note: This unit is required at both the local and remote sites, and should only distribute power to RPE shelves located in the QCA8/QCA7 cabinet pair that it is mounted in.

Location

Above QUX3 or QBL10 unit in QCA8 cabinets.

Cables

The following cables are used in RPE installations. One NE-A18QA cable is used to interconnect each network circuit pack to the local RPE shelf and one per loop to interconnect the remote RPE shelf to the first PE shelf served by each loop.

Note: The 75-ohm computer grade coaxial cable used to interconnect the span with local and remote shelves is customer-supplied.

Figure 3-1
Local shelf circuit pack location

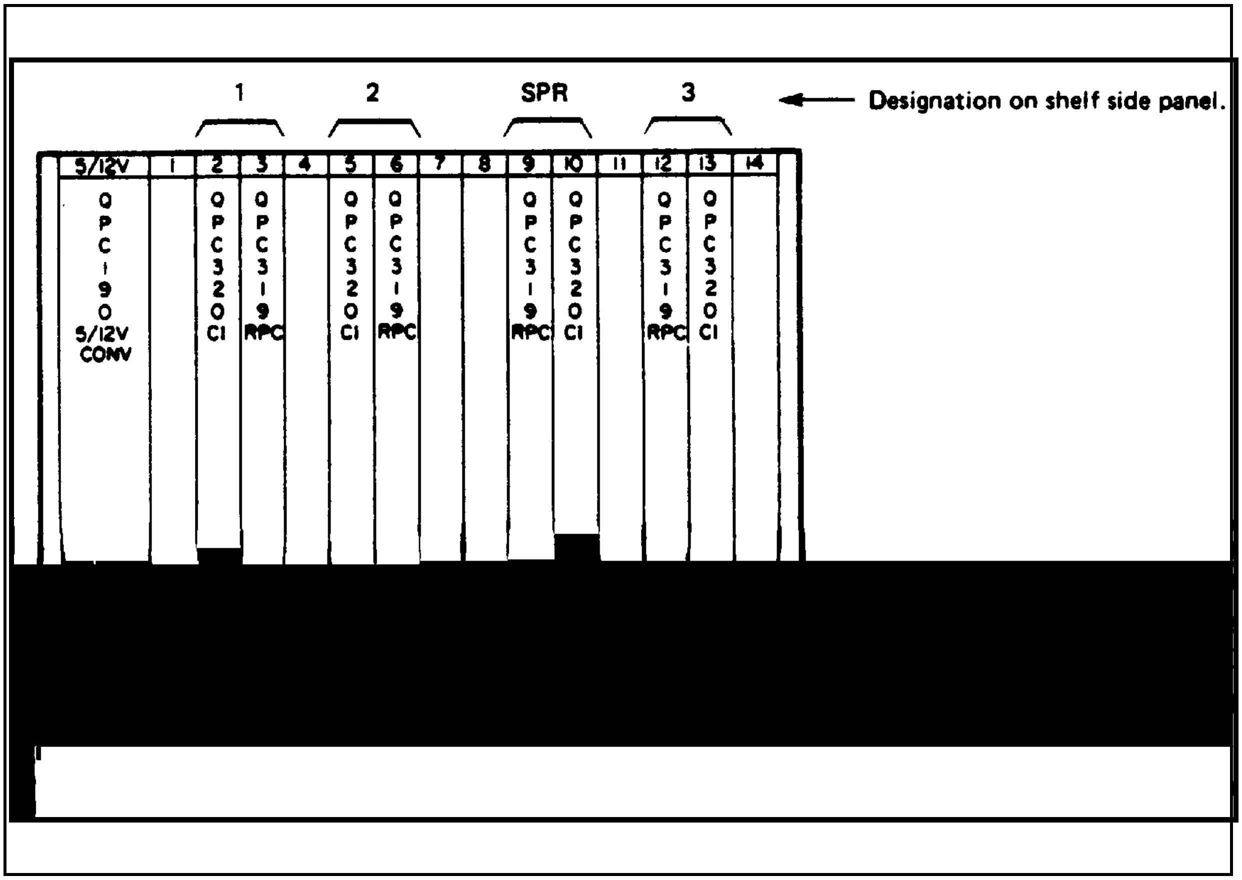
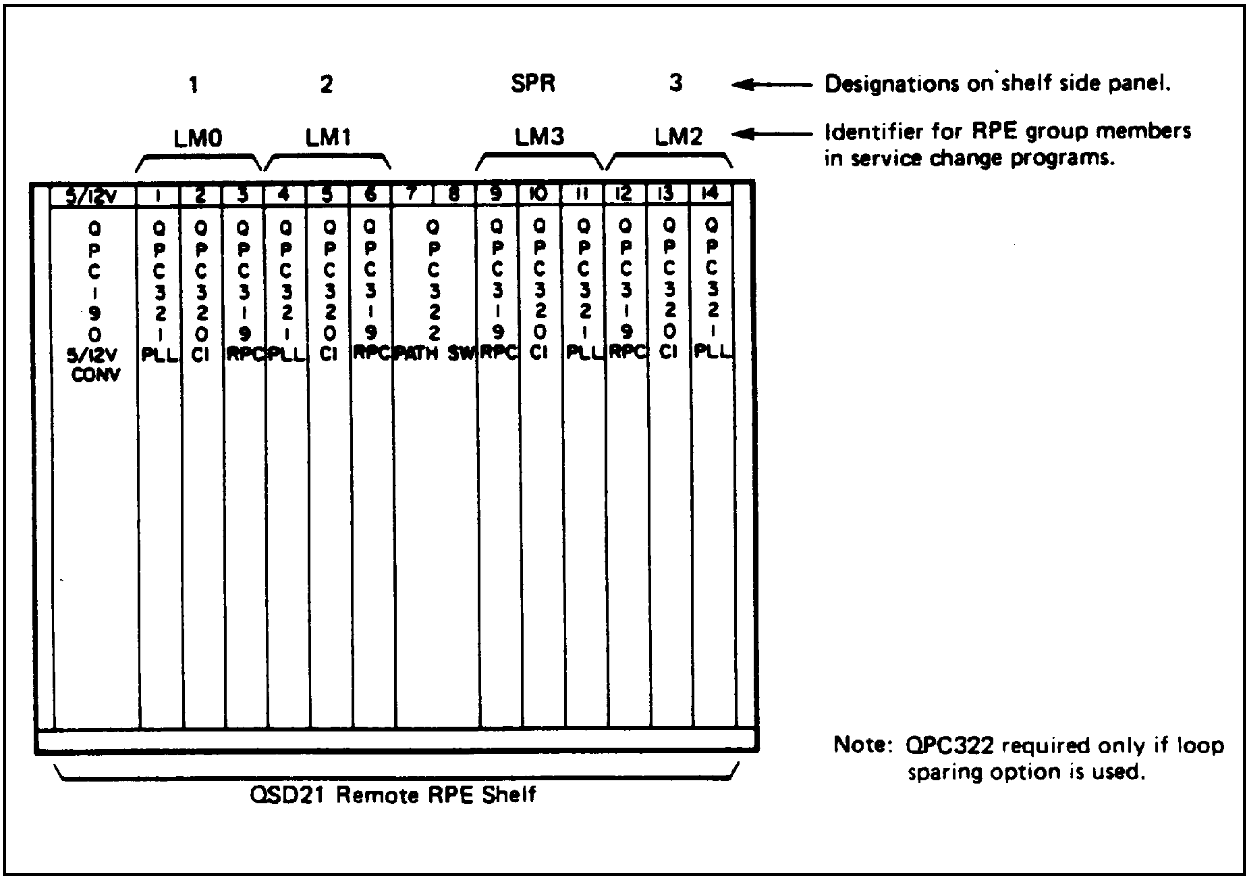


Figure 3-2
Remote shelf circuit pack location



Engineering guidelines

Interface circuits

The 2-Mb/s RPE hardware has been designed to interface with systems which meet CCITT recommendation G703 for interface at 2.048 Mb/s. Any system which meets the CCITT recommendation should be able to interface with SL-1 2-Mb/s RPE equipment.

Carrier

The 2-Mb/s RPE is compatible with carrier systems having the following characteristics.

Table 4-A
Carrier specifications

Characteristics	Specifications
Line rate	2.048 Mb/s ±50 ppm
Code	HDB3 (see HDB3 explanation)
Pairs in each direction	One coaxial pair
Pulse shape	See Figure 4-1
Test load impedance	75 ohms at 1.024 MHz
Nominal peak voltage of a mark (pulse)	2.37 V ±10
Peak voltage of a space	0 ±0.237 V
Nominal pulse width	244 ns
Ratio of the widths of positive and negative pulses at the midpoint of the pulse width	0.95 to 1.05

Ratio of widths of positive and negative pulses at the nominal half amplitude	0.95 to 1.05

Explanation of HDB3

The coding of a binary signal into an HDB3 signal is done according to the following rules:

- The HDB3 signal is pseudo-ternary the three states are B+, B- and 0
- Spaces in the binary signal are coded as spaces in the HDB3 signal. For strings of four spaces special rules apply (see Note)
- Marks in the binary signal are coded alternately as B+ and B- in the HDB3 signal (alternate mark inversion). Violations of the rule of alternate mark inversion are introduced when coding strings of four spaces (see Note)

Note: The first space of a string is coded as a space, if the preceding mark of the HDB3 signal has a polarity of the preceding violation and is not a violation by itself; it is coded as a mark, not a violation (i.e. B+ or B-), if the preceding mark of the HDB3 signal has the same polarity as that of the preceding violation or is by itself a violation. This rule ensures that successive violations are of alternate polarity so that no dc component is introduced; the second and third spaces of a string are always coded as spaces. The last space of a string of four is always coded as a mark, the polarity of which is such that it violates the rule of alternate mark inversion. Such violations are denoted V+ or V- according to their polarity.

Loop extension

The purpose of the 2-Mb/s RPE is to extend the range of the SL-1 network loops from 15 meters to any (economically motivated) distance by transmitting the loops' control and voice signals over multiplexed PCM connections.

Jitter

Jitter is defined as the short term variation of pulses from their ideal position in time, and is a form of random pulse width and position modulation. In a 2-Mb/s RPE, jitter arises from imperfections in the equalization and clock recovery process in the repeaters.

The maximum peak-to-peak jitter found on PCM lines is shown in Figure 4-2. A 2-Mb/s RPE system operates in the area under the line when equipped with a PLL circuit pack. The horizontal axis displays the jitter frequency modulating the 2.048 M Hz carrier. The vertical axis indicates the maximum jitter amplitude (peak-to-peak).

Protection

On exposed cables, gas tube protectors must be installed on the cable pairs to protect the carrier system.

Example

The maximum jitter amplitude, indicated by the graph (Figure 4-2), is 3.5 dB for a carrier system being modulated at a jitter frequency of 200 Hz. To convert to jitter in nanoseconds (peak-to-peak):

Jitter dB = (20 log 10 x n units) ÷ 1 unit
n = 10 (jitter DB) ÷ 20

jitter in ns (peak-to-peak) = n units x 488 ns

Figure 4-1
Mask of a pulse at the interface

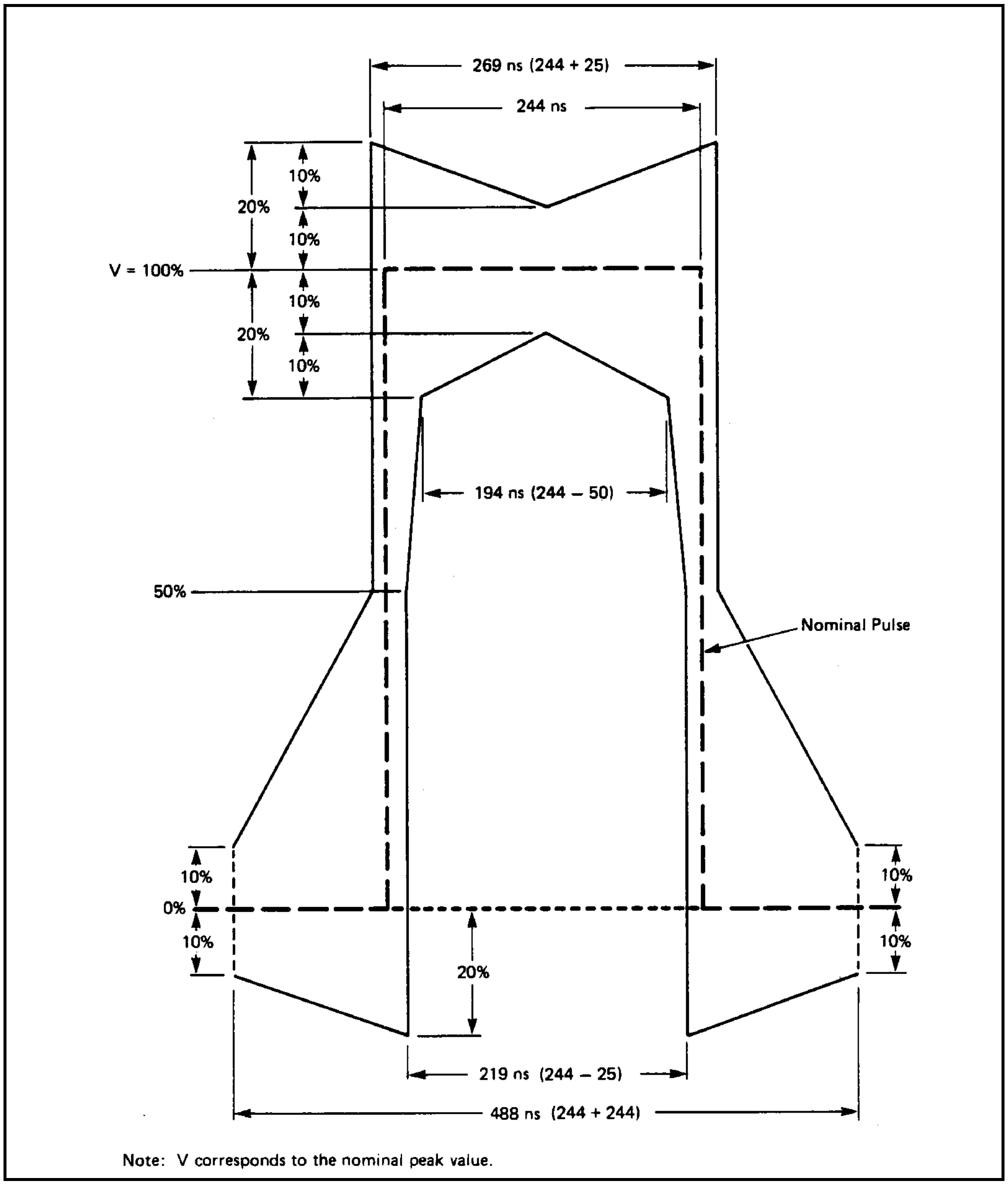
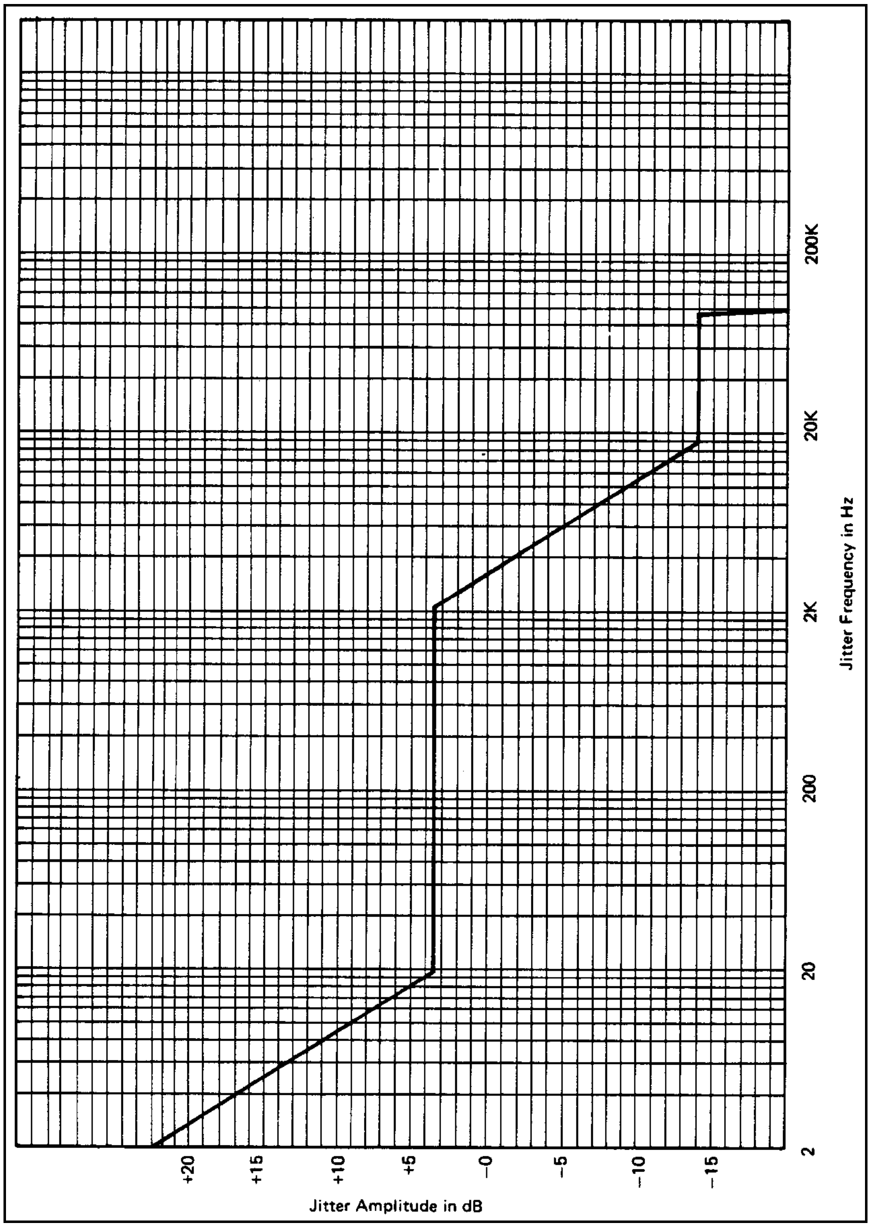


Figure 4-2
Maximum peak-to-peak jitter found on PCM lines



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2-Mb/s Remote Peripheral Equipment

Description and engineering guidelines

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