Meridian Digital Centrex

Network Termination 1 (NT1)

Description

BCS31 Draft 01.02 April 1991

northern telecom

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Publication number: 297-2451-107
Product release: BCS31
Document release: Draft 01.02
Date: April 1991

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About this guide

This guide describes the ANSI standard 2B1Q version of the ISDN Network Termination 1 (NT1).

This guide

This guide is organized into four sections:

- *The NT1 in the network* briefly describes the NT1 in the ISDN network and its compliance with ANSI standards
- *Packaging and interfaces* describes the packaging configurations of the NT1 and its interfaces to associated equipment
- *NT1 functions* is a functional description of the NT1
- *Specifications* lists the NT1's performance specifications
- the *List of terms* defines terms used in the guide.

Related guides

There are three guides related to this one, which can all provide you with information you need if you are planning the network and the customer premises equipment:

- the *NT1 and S/T Bus Installation Guide* (NTP297-2451-207) explains how to install the NT1
- the *ISDN S/T Bus and U Loop Engineering Guide* (NTP297-2451-182) helps you plan and engineer the network
- the *IBDN Implementation Guide* is used to plan and implement the ISDN network.

A corresponding set of documents is provided for the AMI version of the NT1:

- the *Network Termination 1 (NT1) Description* (NTP297-2451-106)
- the *NT1 and S/T Bus Installation Guide* (NTP297-2451-206)
- the *ISDN S/T Bus and U Loop Engineering Guide* (NTP297-2451-181)
- the *IBDN Implementation Guide.*

The NT1 in the network

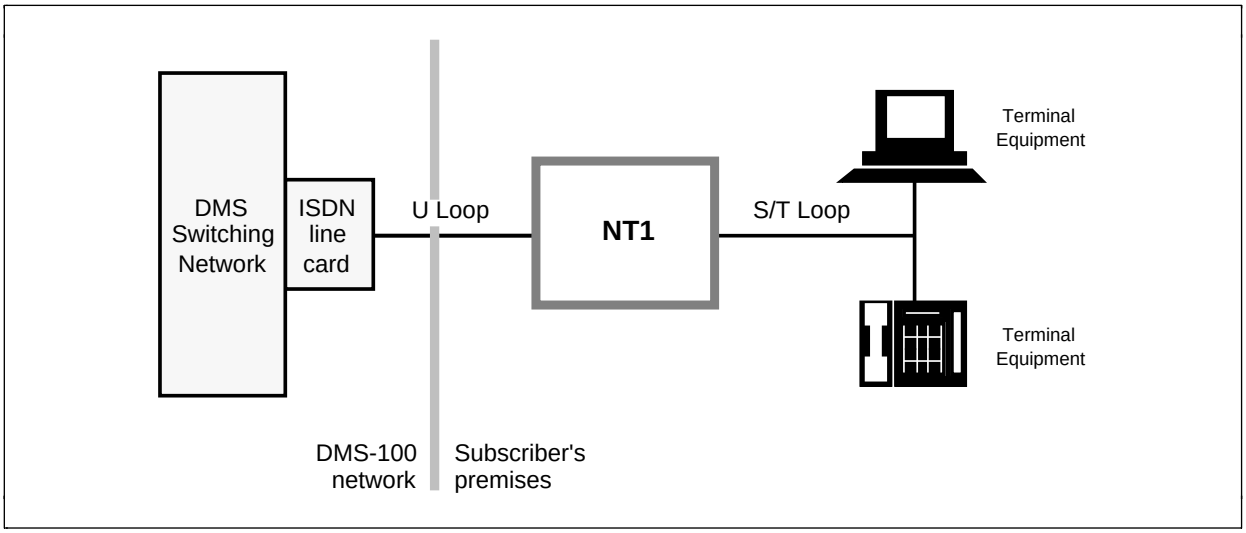
As shown in Figure 1-1, the NT1 is the link between the central office equipment and the customer premises equipment in the ISDN network, terminating the subscriber loop and providing basic rate services to the customer. The NT1 is located at the customer premises, and supports the basic rate interface (BRI) ISDN service by providing two ANSI standard interfaces:

- one for the subscriber loop, or U loop, which connects the NT1 to the ISDN line card in the telephone network
- one for the customer interface bus, known as the S/T bus, which connects the NT1 to the customer's terminal equipment (TE).

The NT1 unit, which is a single printed circuit card, is provided in two different types of packaging:

- the stand-alone packaging version of the NT1 (NTBX80XX) contains one NT1 unit, and is typically wall-mounted or placed on the desk at the user's workstation
- the modular version of the NT1 (NTBX83XX) contains up to 12 NT1 units, and is typically wall- or rack-mounted in the central equipment room.

Figure 1-1
NT1 in the network



ISDN service

ISDN basic rate access (BRA) service provides the customer with clear transmission of user data channels to his terminals, the channels being transparent through the ISDN line card (ISLC) and the NT1. BRA service is designated as 2B+D (two 64 kb/s B channels and one 16 kb/s D channel), with the two B channels each providing full-duplex transmission at a rate of 64 kb/s, and the D channel providing a rate of 16 kb/s. Either of the two B channels can be used for circuit-switched voice, circuit-switched data, or packet-switched data, with the associated signaling performed on the D-channel. The D-channel can also carry low-speed packet data, together with its associated signaling.

2B1Q coding

The NT1 supports the ANSI standard ISDN 2B1Q U-loop interface. The 2B1Q transmission code specifies a four-level pulse amplitude modulation (PAM) code with 2 binary to 1 quaternary symbol coding. The NT1 allows ISDN terminals to access ISDN BRA services offered by the DMS-100 switch (or any other 2B1Q standard ISDN switch), and is compatible with any terminal equipment that meets the 2B1Q standards.

NT1 interfaces

The NT1 is connected to the ISDN line card with a 2-wire, non-loaded central office loop, known as the U loop, which simultaneously transmits and receives 2B+D data using 2B1Q coding. An additional 8-kb/s channel (the M channel) provided between the NT1 and the network equipment is used for the transfer of maintenance messages.

The customer's TEs communicate with the NT1 via the S/T bus, which is a 4-wire loop consisting of transmit and receive pairs. Up to eight TEs can be connected to the S/T bus in a number of different configurations. The S/T wiring includes two channels used for maintenance messaging: the S channel for messages to the TEs, and the Q channel for messages from the TEs.

The NT1 converts and reformats the data from the S/T bus to a form that can be transmitted on the U loop, and vice versa. However, data transmitted and received between TEs and the network is transparent to the NT1, as it processes only the first of the three layers defined in the OSI model of layered protocols. The higher layers of the model, which are user and application dependent, are not affected by the NT1. Similarly, the features provided to the user are dependent only on TE and network capabilities, and are unaffected by the NT1.

Maintenance and testing features

For ease of maintenance and testing, both from the network perspective and the customer perspective, the NT1 supports the following features:

- transmission performance monitoring by the network
- subscriber loop (U loop) maintenance by the network
- testing by the network to the NT1
- testing by the customer to the NT1.

NT1 packaging and interfacing

The NT1 unit, which is a single printed circuit card, is provided in two different types of packaging:

- the stand-alone packaging version of the NT1 (NTBX80XX) contains one NT1 unit, and is typically wall-mounted or placed on the desk at the user's workstation
- the modular version of the NT1 (NTBX83XX) contains up to 12 NT1 units, and is typically wall- or rack-mounted in the central equipment room.

The stand-alone version has a optional, companion power supply unit (NTBX81XX) which converts ac power to the -48 V dc used by the NT1 unit. The modular version has an optional power supply module (NTBX86XX), and an optional battery module (NTBX89XX) for back-up power during ac power failure.

For the modular version of the NT1 packaging, the NT1 unit itself (NTBX84XX) comes in two versions: the NT1 basic unit, and the star unit, which has two S/T bus interfaces.

About the stand-alone NT1

The stand-alone NT1 product, which is typically installed at the user's work area, consists of the following units:

- the NT1 unit (NTBX80XX)
- the optional NT1 power supply (NTBX81XX)
- a mounting plate (PO706571).

Stand-alone NT1 unit

As shown in Figure 2-1, the stand-alone NT1 unit is a two-part molded housing of 210 mm (8.27 inch) by 108 mm (4.25 inch), its depth tapering from about 50 mm (2 inches) to about 32 mm (1.25 inch). On the unit's housing are four LED status indicators and three connectors. The bottom of the unit holds four rubber feet for desk-mounting the unit, and four slides that are used to attach the unit to the mounting plate. The unit contains the single NT1 circuit pack assembly.

Status indicators

As shown in Figure 2-1, the NT1 has four LED status indicators at the lower end of its front panel:

⎓ the green power LED is on to indicate that power is available to the NT1

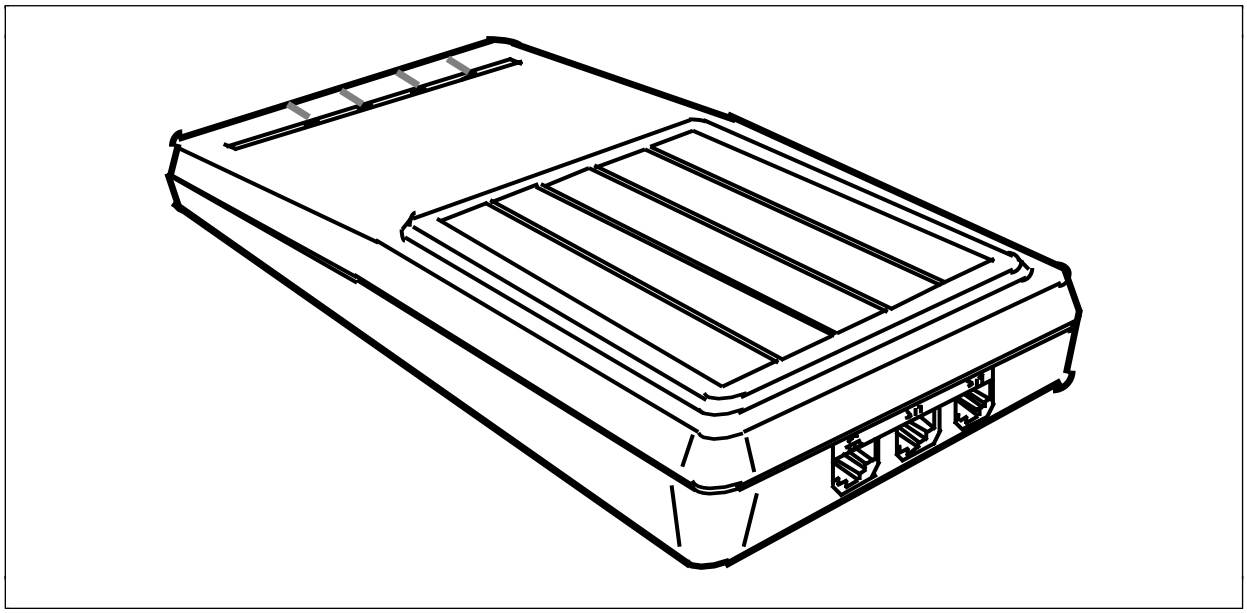
S/T the red S/T sync LED indicates the S/T interface operating status as follows:

- the light is off during normal operation.
- the light is on to indicate loss of synchronization with the TEs
- the light flashes to show excessive data errors on the S/T interface.

U the red U sync LED indicates the U interface operating status as follows:

- the light is off during normal operation
- the light is on to indicate loss of synchronization with the network
- the light flashes to indicate excessive data errors on the U interface.

Figure 2-1
Stand-alone NT1



the red test LED indicates the NT1's test status for either network- or customer-initiated tests or the self-test initiated on power-up:

- the light is on to indicate that a test is in progress
- the light flashes to indicate failure of the self-test (the self-test is automatically initiated when the NT1 is powered up)
- the light is off to indicate a self-test pass or normal operation of the NT1.

Connectors

The NT1 is provided with three 8-pin teladapt external connectors:

the U interface connector provides the connection for the U loop and the NT1's -48 V dc input power. Table 2-1 shows the pin assignment of the U loop connector.

the S/T interface connector provides the S/T bus connection. Table 2-2 shows the connector's pin assignment.

the auxiliary S/T connector is provided as a convenience, and is typically used when the customer has a telephone and a terminal to be connected at his workstation. (Refer to Table 2-2 for the connector's pin assignment.)

Table 2-1
U interface teladapt pin assignment

Pin Number	Function	Notes
1	No connection	No connection
2	No connection	No connection
3	No connection	Reserved for future standardization
4	Tip or ring	Tip or ring of pair to/from network
5	Tip or ring	Tip or ring of pair to/from network
6	No connection	Reserved for future standardization
7	-48 V dc	-48 V dc input
8	-48 V gnd	-48 V ground

Table 2-2
S/T interface teladapt pin assignment

Pin number	Function	
	NT1	TE
1	No connection	No connection
2	No connection	No connection
3	Receive +	Transmit +
4	Transmit +	Receive +
5	Transmit -	Receive -
6	Receive -	Transmit -
7	Power source 2 -	Power sink 2 -
8	Power source 2 +	Power sink 2 +

Cables

A 2-metre (7-foot) teladapt cable (A0361365) is provided with the NT1 unit for connection to the U loop service jack.

The other cables used in the installation of the NT1 are teladapt cables.

NT1 power supply unit

The stand-alone NT1 is powered by one of two methods:

1. The NT1 power supply unit (NTBX81XX), which converts 110 V ac input to provide -48 V dc for the NT1, and optionally for the TEs on the S/T bus.
2. A customer-provided -48 V dc supply rated at 2 W minimum for NT1 powering. Additional power may be provided to power the TEs on the S/T bus.

As shown in Figure 2-2, the NT1 power supply unit is virtually identical to the NT1 unit. It is a two-part molded housing of 210 mm (8.27 inch) by 108 mm (4.25 inch), its depth tapering from about 50 mm (2 inches) to about 32 mm (1.25 inch). On the unit's housing are three connectors, one of which is a captive power cord. The bottom of the unit holds four rubber feet for desk-mounting the unit, and four slides that are used to attach the unit to the mounting plate. The unit contains a single circuit pack assembly.

Connectors

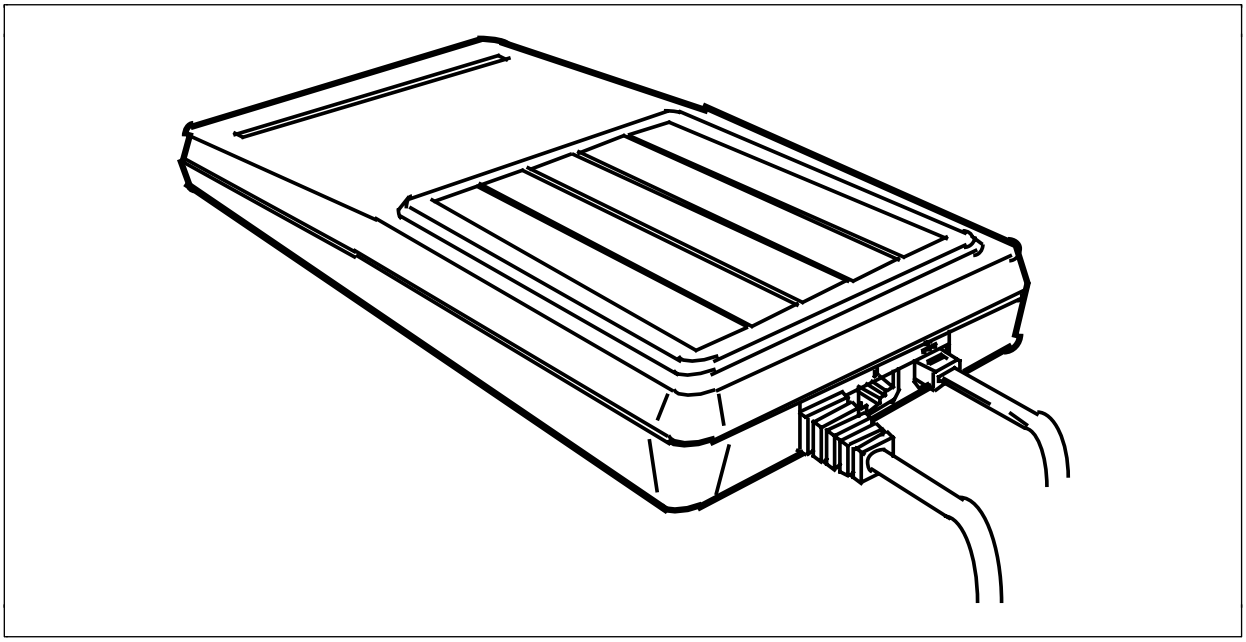
The NT1 power supply has two connectors and a captive power cord:

captive cord the 2.12 m (6-foot) captive power cord is provided for connection to ac power.

U the U interface connector is an 8-pin teladapt connector which provides the connection to the U loop service jack.

U + ⎓ the NT1 interface connector is an 8-pin teladapt connector which provides the connection to the NT1. It provides the U interface as well as the pair for NT1 power. Table 2-3 shows the connector's pin assignment.

Figure 2-2
NT1 power supply unit



Cables

Two cables are provided with the NT1 power supply unit:

- a 178-millimetre (7-inch) cable (A0346581) for connection between the power supply and the NT1 unit.
- a captive power cord for connection to an ac power outlet.

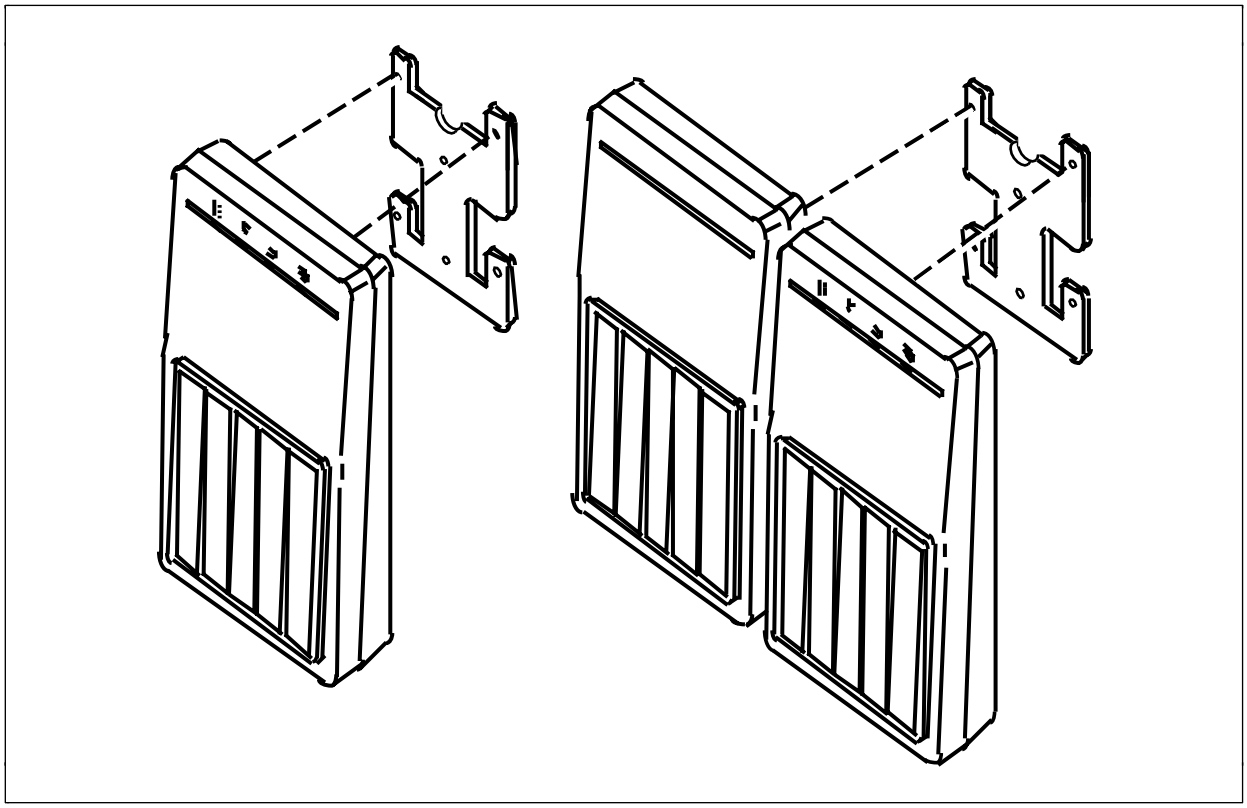
Mounting plate

The mounting plate (PO706571) shown in Figure 2-3 is used for wall-mounting the NT1, or both the NT1 and the power supply unit. For desk-top use, the mounting plate interlocks the NT1 and the power supply unit.

Table 2-3
U+ interface teladapt pin assignment

Pin Number	Function
1	No connection
2	No connection
3	No connection
4	Tip or ring
5	Tip or ring
6	No connection
7	-48 V dc
8	-48 V gnd

Figure 2-3
Mounting the NT1 and power supply unit



About the modular NT1 system

The modular NT1 product, which is typically mounted on the wall or in a rack in the central equipment room, consists of the following units:

- the NT1 module (NTBX83AA), which can contain up to 12 NT1 units (cards):
  - the basic NT1 unit (NTBX84AA), which has one S/T bus interface
  - the NT1 star unit (NTBX84BA), which has two S/T bus interfaces
- the optional NT1 power module (NTBX86AA)
- the optional NT1 battery module (NTBX89AA)
- the optional rack-mount shelf (NTBX82AA).

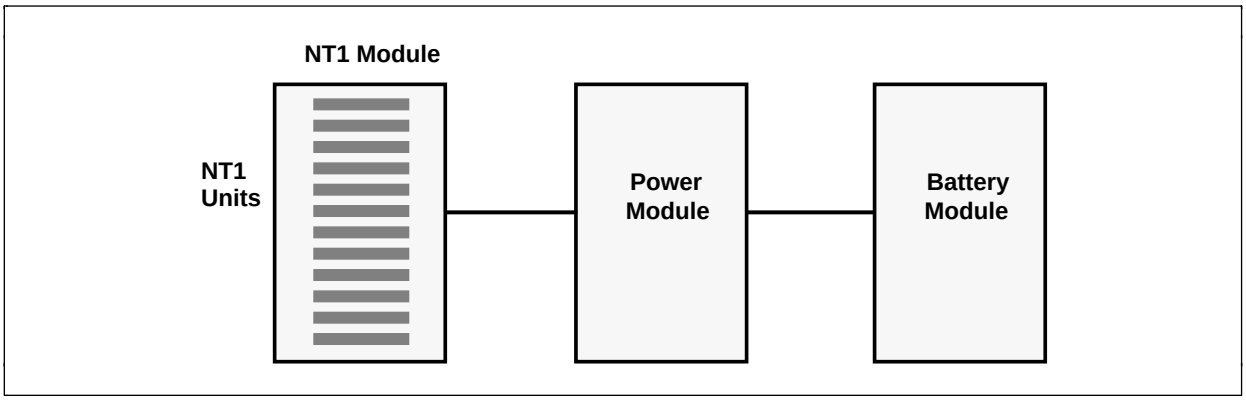
Due to their modular construction, the units can be installed in a number of configurations. For instance, the typical basic system represented in Figure 2-4 consists of an NT1 module containing up to 12 NT1 units (any of which may be basic or star units), a power supply unit, and a battery unit for back-up power. (In fact, as both the power module and the battery module are optional, the customer may provide his own method of powering the NT1 module.)

Figure 2-5 shows a typical expanded system, consisting of three NT1 modules, each containing a mixture of basic and star NT1 units, a power module, and a battery module.

There are many variations possible in the modular NT1 configuration, which depend on the requirements of the user. For example, some users require the NT1 modules to provide TE powering in addition to NT1 powering. Other users may provide a separate power source for the TEs.

The NT1 modules can be mounted on walls or in equipment racks. Up to four modules can be mounted side-by-side on the NT1 rack-mount shelf for installation in a standard 19-inch rack.

Figure 2-4
NT1 modular configurations (1)



NT1 module

As shown in Figure 2-6, the NT1 module is a three-part molded housing of 483 mm (19 inch) by 345 mm (13.6 inch), its depth about 105 mm (4.12 inches). The housing consists of a base and a chassis, which are screwed together, and a removable lid, which snaps into place.

Housing

The housing has louvres on the front and back panels, which provide air cooling for the unit, and six holes for the screws that are used to attach the base and chassis. There are four keyholes on the back of the base for hanging the unit on the wall when wall-mounting the unit. At the bottom of the unit are a drawer-style plastic latch and metal clip used to latch the unit into the rack when rack-mounting it.

As well as the NT1 unit circuit pack assemblies, the NT1 module contains :

- the maintenance panel, consisting of membrane switches and a LED display indicator card
- the power converter card, including the module monitor, which provides maintenance control communications between the NT1 units and the maintenance panel
- a ribbon cable connecting the maintenance panel to the module monitor
- the backplane assembly, including connectors for the NT1 units, power and U and S/T loops, and velcro cable ties.

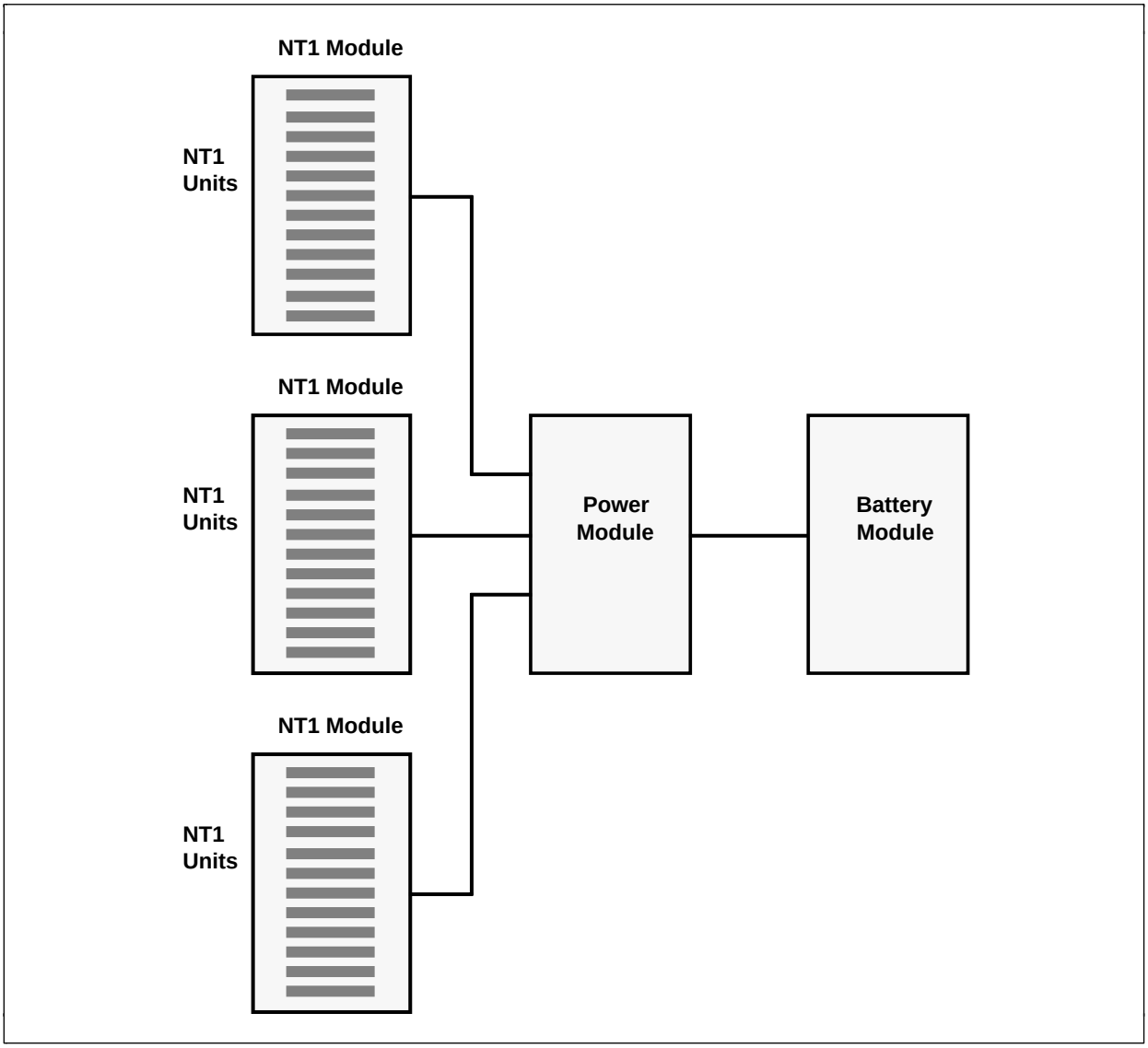
The module is shipped complete with the maintenance panel, the power converter card, the ribbon cable, and the backpanel assembly. The ribbon cable between the power converter and the maintenance panel is installed at the factory, and the power cable is shipped loose with the module.

Maintenance panel

The module's maintenance panel contains:

- two power status indicator LEDs, which indicate the status of input power to the module (ac and battery)
- four status indicator LEDs, which indicate the status of the selected NT1, or the module monitor if no NT1 is selected
- twelve selection indicator LEDs, which indicate which of the twelve NT1 units is selected (if no NT1 is selected, selection defaults to the module monitor)
- two selection control switches, which allow the user to select one of the twelve NT1s or the module monitor
- a self-test switch, which initiates the local self-test for the selected NT1 or the module monitor.

Figure 2-5
NT1 modular configurations (2)



Status indicators

As shown in Figure 2-7, the NT1 maintenance panel has six LED status indicators at the top of the panel:

the green power LED indicates the power status of the NT1 module as follows:

- the light is on during normal operation, indicating that power is available to the module
- the light is off to indicate that there is no power
- the light flashes to indicate that ac power is unavailable and that power is being provided to the NT1 power module from the battery module

the red battery LED indicates the status of the battery module as follows:

- the light is off to indicate that the battery condition is good (if the installation does not include a battery module, the LED also remains off)
- the light is on to indicate that the battery is bad or has degraded capacity.

S/T — the red S/T sync LED indicates the S/T interface status of the selected NT1:

- the light is off during normal operation.
- the light is on to indicate loss of synchronization with the TEs
- the light flashes to show excessive data errors on the S/T interface.

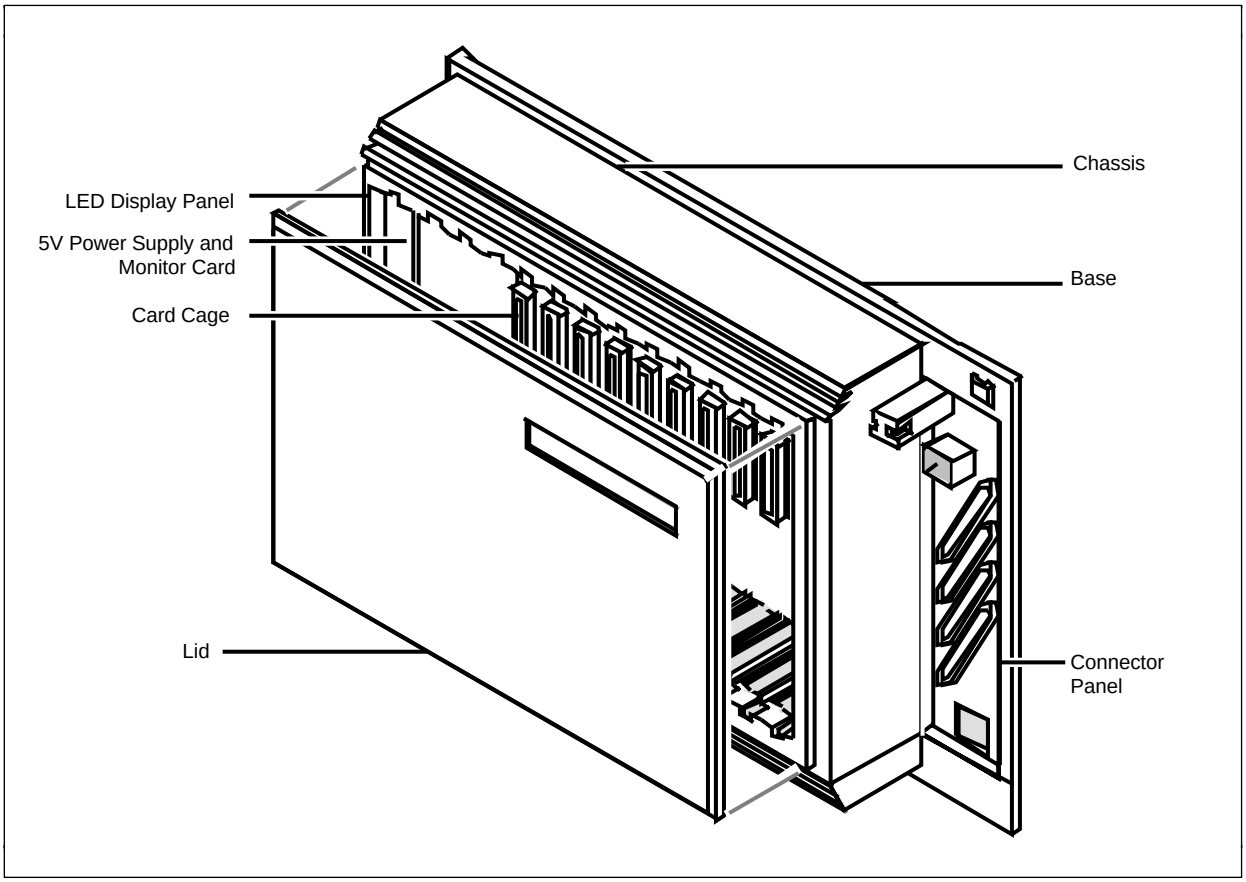
U — the red U sync LED indicates the U interface status of the selected NT1:

- the light is off during normal operation
- the light is on to indicate loss of synchronization with the network
- the light flashes to indicate excessive data errors on the U interface.

the red test LED indicates the selected NT1's test status (or the module monitor's test status if no NT1 is selected) for either network- or customer-initiated tests or the self-test:

- the light is on to indicate that a test is in progress
- the light flashes to indicate failure of a self-test
- the light is off to indicate a self-test pass or normal operation of the NT1.

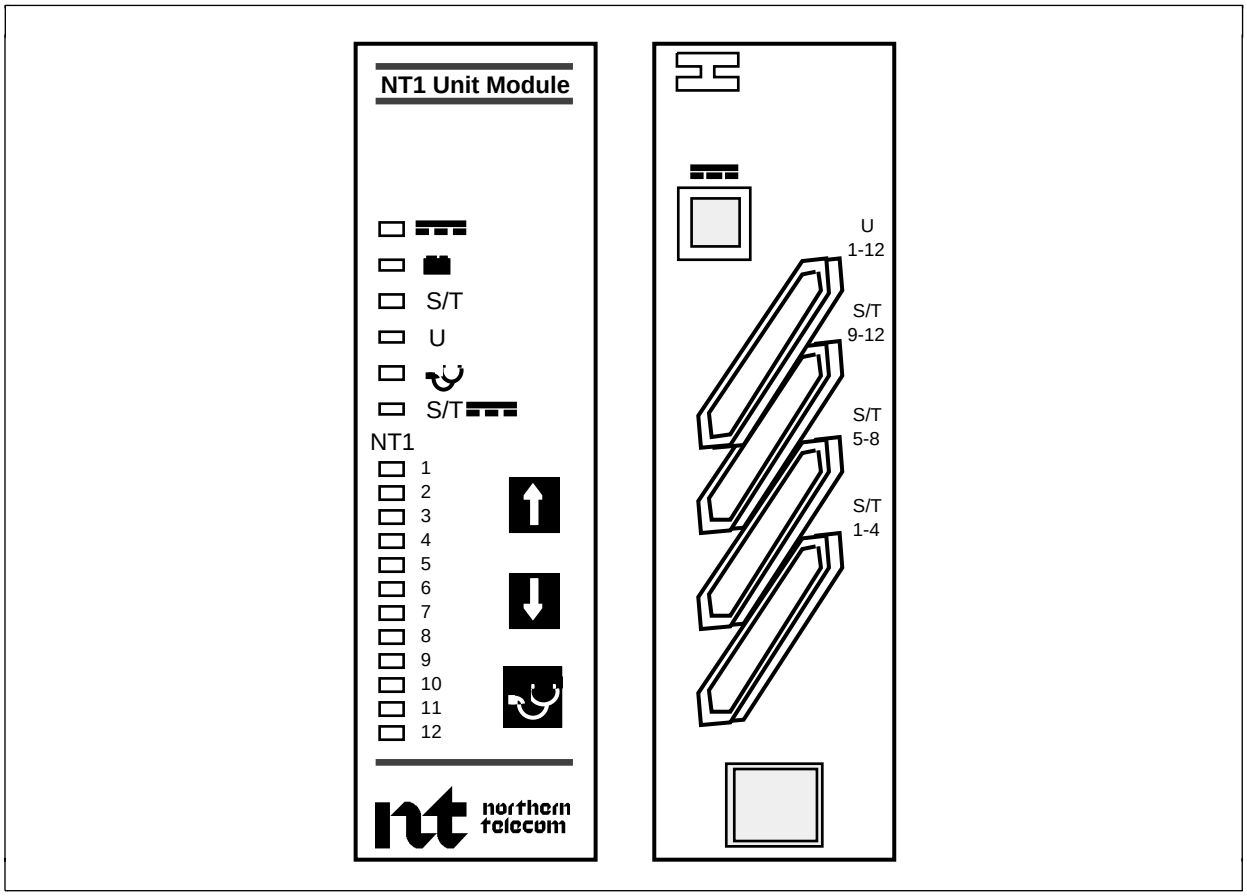
Figure 2-6
NT1 module



S/T⎓ the red S/T power LED indicates the status of TE powering for the selected NT1:

- the light is off during normal operation
- the light is on to indicate that the TEs on the S/T bus are current-limited due to an overload condition.

Figure 2-7
NT1 display and connector panels



Selection indicators

Each of the 12 selection indicator LEDs corresponds to the NT1 unit in the card cage slot marked with the same number. If there is no NT1 selected, the module monitor is selected by default. The selection light indicates the status of the selected NT1 as follows:

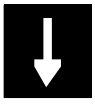
- the light is flashing to indicate that the NT1 is selected and its status conditions are indicated by the status LEDs
- the light is on to indicate a status alert (that is, at least one status LED is indicating an abnormal condition)
- the light is off to indicate normal operation (all status LEDs off).

After a time-out period of 10 minutes, the selection LED stops flashing and reverts to the off (NT1 normal) or on (NT1 status alert) state, and the module monitor becomes selected by default.

Selection and test switches

Three membrane switches allow you to select the NT1 units or the module monitor and initiate the self-test:

press the up-arrow switch to select the next NT1 on the display panel in the upward direction



press the down-arrow switch to select the next NT1 on the display panel in the downward direction

press the test switch twice within a 2-second period to begin the local self-test for the selected NT1 or the module monitor.

Only installed NT1 units can be selected; if an NT1 is not installed in a particular card cage slot, the corresponding LED is skipped when a selection switch is pressed.

Connector panel

As shown in Figure 2-7, the NT1 has five connectors:

⎓ the 9-pin power connector provides the connection to the power supply module (or the customer-provided -48 V supply rated at 3 A minimum). Table 2-4 shows the pin assignment of the power connector.

U 1-12 the 50-pin U interface connecter provides the U loop connections for the 12 NT1s. Table 2-5 shows the pin assignment of the U loop connector.

S/T 9-12 the 50-pin S/T interface connector provides the S/T bus connection for the NT1 units in slots 9 to 12 of the card cage. Table 2-6 shows the connector's pin assignment.

S/T 5-8 the 50-pin S/T interface connector provides the S/T bus connection for the NT1 units in slots 5 to 8 of the card cage. Table 2-7 shows the connector's pin assignment.

S/T 1-4 the 50-pin S/T interface connector provides the S/T bus connection for the NT1 units in slots 1 to 4 of the card cage. Table 2-8 shows the connector's pin assignment.

Table 2-4
Power interface pin assignment

Pin Number	Function	Description
1	-48 V	Power
2	-48 V ret	Power return
3	No connection	
4	No connection	
5	Battery status	Open - battery fail Closed - battery good Toggle - no battery
6	Battery status ret	
7	Pwr mode	Open - ac power Closed - battery power
8	Pwr mode ret	
9	No connection	

Table 2-5
U interface pin assignment

BIX pair	Wire colour	Pin	Function
1	Blue-White / White-Blue	1 / 26	Ring / Tip U loop 1
2	Orange-White / White-Orange	2 / 27	No connection
3	Green-White / White-Green	3 / 28	Ring / Tip U loop 2
4	Brown-White / White-Brown	4 / 29	No connection
5	Slate-White / White-Slate	5 / 30	Ring / Tip U loop 3
6	Blue-Red / Red-Blue	6 / 31	No connection
7	Orange-Red / Red-Orange	7 / 32	Ring / Tip U loop 4
8	Green-Red / Red-Green	8 / 33	No connection
9	Brown-Red / Red-Brown	9 / 34	Ring / Tip U loop 5
10	Slate-Red / Red-Slate	10 / 35	No connection
11	Blue-Black / Black-Blue	11 / 36	Ring / Tip U loop 6
12	Orange-Black / Black-Orange	12 / 37	No connection
13	Green-Black / Black-Green	13 / 38	Ring / Tip U loop 7
14	Brown-Black / Black-Brown	14 / 39	No connection
15	Slate-Black / Black-Slate	15 / 40	Ring / Tip U loop 8
16	Blue-Yellow / Yellow-Blue	16 / 41	No connection
17	Orange-Yellow / Yellow-Orange	17 / 42	Ring / Tip U loop 9
18	Green-Yellow / Yellow-Green	18 / 43	No connection
19	Brown-Yellow / Yellow-Brown	19 / 44	Ring / Tip U loop 10
20	Slate-Yellow / Yellow-Slate	20 / 45	No connection
21	Blue-Purple / Purple-Blue	21 / 46	Ring / Tip U loop 11
22	Orange-Purple / Purple-Orange	22 / 47	No connection
23	Green-Purple / Purple-Green	23 / 28	Ring / Tip U loop 12
24	Brown-Purple / Purple-Brown	24 / 49	No connection
25	Slate-Purple / Purple-Slate	25 / 50	No connection

Table 2-6
S/T interface pin assignment, S/T9-12 connector

BIX pair	Wire colour	Pin	Function
1	Blue-White / White-Blue	1 / 26	Tx- / Tx+ S / T loop 9, output A
2	Orange-White / White-Orange	2 / 27	Rx- / Rx+ S / T loop 9, output A
3	Green-White / White-Green	3 / 28	PS2- / + S / T loop 9, output A
4	Brown-White / White-Brown	4 / 29	Tx- / Tx+ S / T loop 9, output B
5	Slate-White / White-Slate	5 / 30	Rx- / Rx+ S / T loop 9, output B
6	Blue-Red / Red-Blue	6 / 31	PS2- / + S / T loop 9, output B
7	Orange-Red / Red-Orange	7 / 32	Tx- / Tx+ S / T loop 10, output A
8	Green-Red / Red-Green	8 / 33	Rx- / Rx+ S / T loop 10, output A
9	Brown-Red / Red-Brown	9 / 34	PS2- / + S / T loop 10, output A
10	Slate-Red / Red-Slate	10 / 35	Tx- / Tx+ S / T loop 10, output B
11	Blue-Black / Black-Blue	11 / 36	Rx- / Rx+ S / T loop 10, output B
12	Orange-Black / Black-Orange	12 / 37	PS2- / + S / T loop 10, output B
13	Green-Black / Black-Green	13 / 38	Tx- / Tx+ S / T loop 11, output A
14	Brown-Black / Black-Brown	14 / 39	Rx- / Rx+ S / T loop 11, output A
15	Slate-Black / Black-Slate	15 / 40	PS2- / + S / T loop 11, output A
16	Blue-Yellow / Yellow-Blue	16 / 41	Tx- / Tx+ S / T loop 11, output B
17	Orange-Yellow / Yellow-Orange	17 / 42	Rx- / Rx+ S / T loop 11, output B
18	Green-Yellow / Yellow-Green	18 / 43	PS2- / + S / T loop 11, output B
19	Brown-Yellow / Yellow-Brown	19 / 44	Tx- / Tx+ S / T loop 12, output A
20	Slate-Yellow / Yellow-Slate	20 / 45	Rx- / Rx+ S / T loop 12, output A
21	Blue-Purple / Purple-Blue	21 / 46	PS2- / + S / T loop 12, output A
22	Orange-Purple / Purple-Orange	22 / 47	Tx- / Tx+ S / T loop 12, output B
23	Green-Purple / Purple-Green	23 / 28	Rx- / Rx+ S / T loop 12, output B
24	Brown-Purple / Purple-Brown	24 / 49	PS2- / + S / T loop 12, output B
25	Slate-Purple / Purple-Slate	25 / 50	No connection

Table 2-7
S/T interface pin assignment, S/T5-8 connector

BIX pair	Wire colour	Pin	Function
1	Blue-White / White-Blue	1 / 26	Tx- / Tx+ S / T loop 5, output A
2	Orange-White / White-Orange	2 / 27	Rx- / Rx+ S / T loop 5, output A
3	Green-White / White-Green	3 / 28	PS2- / + S / T loop 5, output A
4	Brown-White / White-Brown	4 / 29	Tx- / Tx+ S / T loop 5, output B
5	Slate-White / White-Slate	5 / 30	Rx- / Rx+ S / T loop 5, output B
6	Blue-Red / Red-Blue	6 / 31	PS2- / + S / T loop 5, output B
7	Orange-Red / Red-Orange	7 / 32	Tx- / Tx+ S / T loop 6, output A
8	Green-Red / Red-Green	8 / 33	Rx- / Rx+ S / T loop 6, output A
9	Brown-Red / Red-Brown	9 / 34	PS2- / + S / T loop 6, output A
10	Slate-Red / Red-Slate	10 / 35	Tx- / Tx+ S / T loop 6, output B
11	Blue-Black / Black-Blue	11 / 36	Rx- / Rx+ S / T loop 6, output B
12	Orange-Black / Black-Orange	12 / 37	PS2- / + S / T loop 6, output B
13	Green-Black / Black-Green	13 / 38	Tx- / Tx+ S / T loop 7, output A
14	Brown-Black / Black-Brown	14 / 39	Rx- / Rx+ S / T loop 7, output A
15	Slate-Black / Black-Slate	15 / 40	PS2- / + S / T loop 7, output A
16	Blue-Yellow / Yellow-Blue	16 / 41	Tx- / Tx+ S / T loop 7, output B
17	Orange-Yellow / Yellow-Orange	17 / 42	Rx- / Rx+ S / T loop 7, output B
18	Green-Yellow / Yellow-Green	18 / 43	PS2- / + S / T loop 7, output B
19	Brown-Yellow / Yellow-Brown	19 / 44	Tx- / Tx+ S / T loop 8, output A
20	Slate-Yellow / Yellow-Slate	20 / 45	Rx- / Rx+ S / T loop 8, output A
21	Blue-Purple / Purple-Blue	21 / 46	PS2- / + S / T loop 8, output A
22	Orange-Purple / Purple-Orange	22 / 47	Tx- / Tx+ S / T loop 8, output B
23	Green-Purple / Purple-Green	23 / 28	Rx- / Rx+ S / T loop 8, output B
24	Brown-Purple / Purple-Brown	24 / 49	PS2- / + S / T loop 8, output B
25	Slate-Purple / Purple-Slate	25 / 50	No connection

Table 2-8
S/T interface pin assignment, S/T1-4 connector

BIX pair	Wire colour	Pin	Function
1	Blue-White / White-Blue	1 / 26	Tx- / Tx+ S / T loop 1, output A
2	Orange-White / White-Orange	2 / 27	Rx- / Rx+ S / T loop 1, output A
3	Green-White / White-Green	3 / 28	PS2- / + S / T loop 1, output A
4	Brown-White / White-Brown	4 / 29	Tx- / Tx+ S / T loop 1, output B
5	Slate-White / White-Slate	5 / 30	Rx- / Rx+ S / T loop 1, output B
6	Blue-Red / Red-Blue	6 / 31	PS2- / + S / T loop 1, output B
7	Orange-Red / Red-Orange	7 / 32	Tx- / Tx+ S / T loop 2, output A
8	Green-Red / Red-Green	8 / 33	Rx- / Rx+ S / T loop 2, output A
9	Brown-Red / Red-Brown	9 / 34	PS2- / + S / T loop 2, output A
10	Slate-Red / Red-Slate	10 / 35	Tx- / Tx+ S / T loop 2, output B
11	Blue-Black / Black-Blue	11 / 36	Rx- / Rx+ S / T loop 2, output B
12	Orange-Black / Black-Orange	12 / 37	PS2- / + S / T loop 2, output B
13	Green-Black / Black-Green	13 / 38	Tx- / Tx+ S / T loop 3, output A
14	Brown-Black / Black-Brown	14 / 39	Rx- / Rx+ S / T loop 3, output A
15	Slate-Black / Black-Slate	15 / 40	PS2- / + S / T loop 3, output A
16	Blue-Yellow / Yellow-Blue	16 / 41	Tx- / Tx+ S / T loop 3, output B
17	Orange-Yellow / Yellow-Orange	17 / 42	Rx- / Rx+ S / T loop 3, output B
18	Green-Yellow / Yellow-Green	18 / 43	PS2- / + S / T loop 3, output B
19	Brown-Yellow / Yellow-Brown	19 / 44	Tx- / Tx+ S / T loop 4, output A
20	Slate-Yellow / Yellow-Slate	20 / 45	Rx- / Rx+ S / T loop 4, output A
21	Blue-Purple / Purple-Blue	21 / 46	PS2- / + S / T loop 4, output A
22	Orange-Purple / Purple-Orange	22 / 47	Tx- / Tx+ S / T loop 4, output B
23	Green-Purple / Purple-Green	23 / 28	Rx- / Rx+ S / T loop 4, output B
24	Brown-Purple / Purple-Brown	24 / 49	PS2- / + S / T loop 4, output B
25	Slate-Purple / Purple-Slate	25 / 50	No connection

Cables

Two cables are shipped with the NT1 module:

- the LED display / power supply ribbon cable (NTBX8307) connects the LED display card to the 5 V power supply; this cable is connected at the factory
- the 1.8-metre (6-foot) power cable (NTBX8306) connects the NT1 module with the power supply module; this cable is shipped loose with the module.

NT1 power module

The NT1 power module converts 110 V ac input to -48 V dc for the NT1 modules (and optionally for the TEs on the S / T bus). As shown in Figure 2-8, the NT1 power supply module is a two-part molded housing of 483 mm (19 inch) by 345 mm (13.6 inch), its depth about 105 mm (4.12 inches). The housing consists of a base and chassis, which are screwed together. Although it doesn't have a removable lid, the power supply module housing is otherwise almost identical to that of the NT1 module.

Power requirements can be calculated from Table 2-9 based on equipment installed and the TE powering jumper setting on the NT1 cards. Power module capacity and battery back-up capacity determine the quantity of modules required. (Refer to Table 2-10.)

As shown in Figure 2-8, the power module has five connectors:

the two 6-pin battery connectors permit connection of the power module to two battery modules; Table 2-11 shows the pin assignment of the battery connector.

the three 9-pin power connectors provide the connections to three NT1 modules; Table 2-12 shows the pin assignment of the NT1 connector.

The power module has a captive power cord which plugs into a grounded ac outlet.

Table 2-9
Power load factors

NT1 card	Low TE powering	High TE powering
1.6 W	2.5 W	10 W

Table 2-10
Back-up power capacity

NT1 Power Module	One battery module	Two battery modules
150 W	5.1 hours at 50 W	11.1 hours at 50 W
	2.2 hours at 100 W	5.1 hours at 100 W
	1.2 hour at 150 W	3.2 hours at 150 W

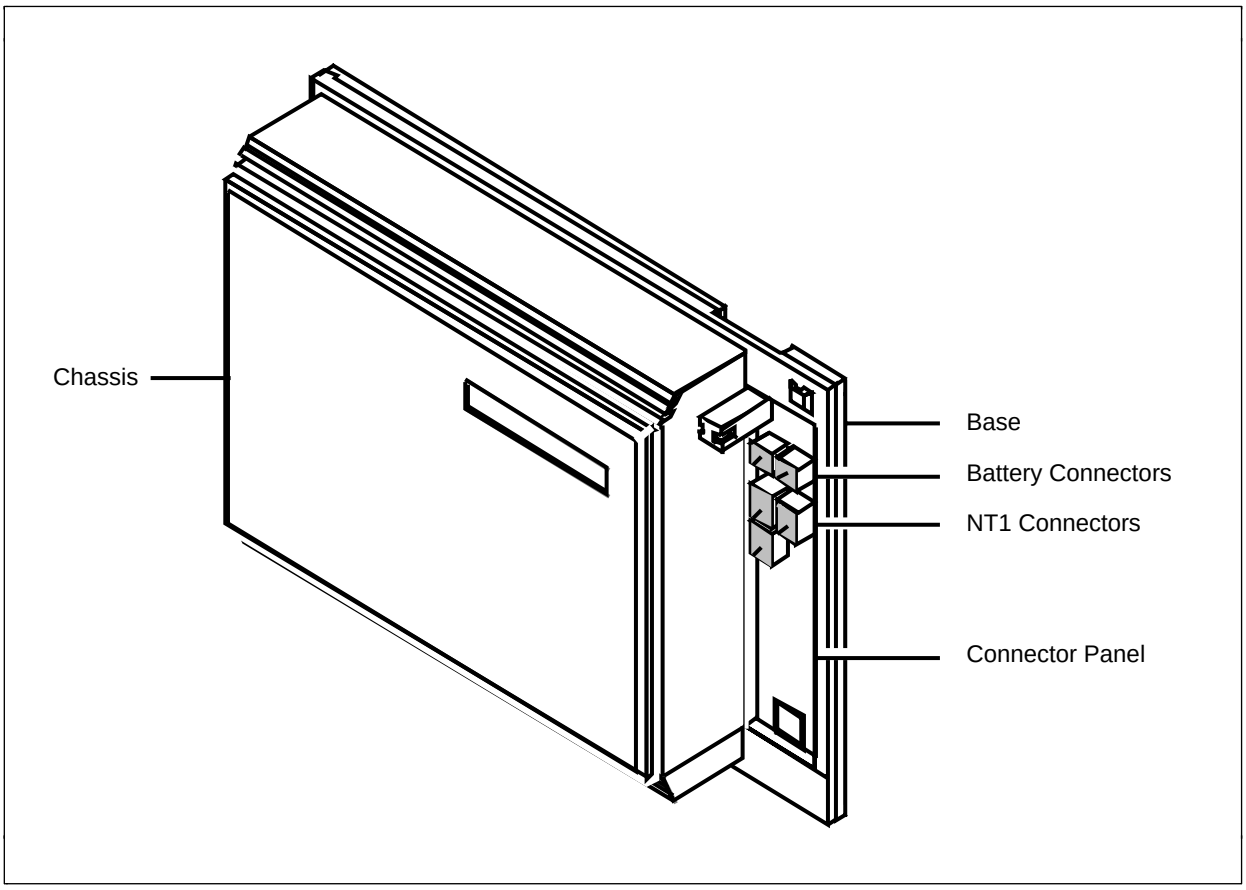
Table 2-11
Battery interface pin assignment

Pin Number	Function	Description
1	No connection	
2	Battery +	24 V
3	Battery +	24 V
4	Battery presence	
5	Battery -	return
6	Battery -	return

Table 2-12
NT1 interface pin assignment

Pin Number	Function	Description
1	-48 V	Power
2	-48 V return	Power return
3	No connection	
4	No connection	
5	Battery status	Open - battery fail Closed - battery good Toggle - no battery
6	Battery status return	
7	Pwr mode	Open - ac power Closed - battery power
8	Pwr mode return	
9	No connection	

Figure 2-8
NT1 power module



NT1 battery module

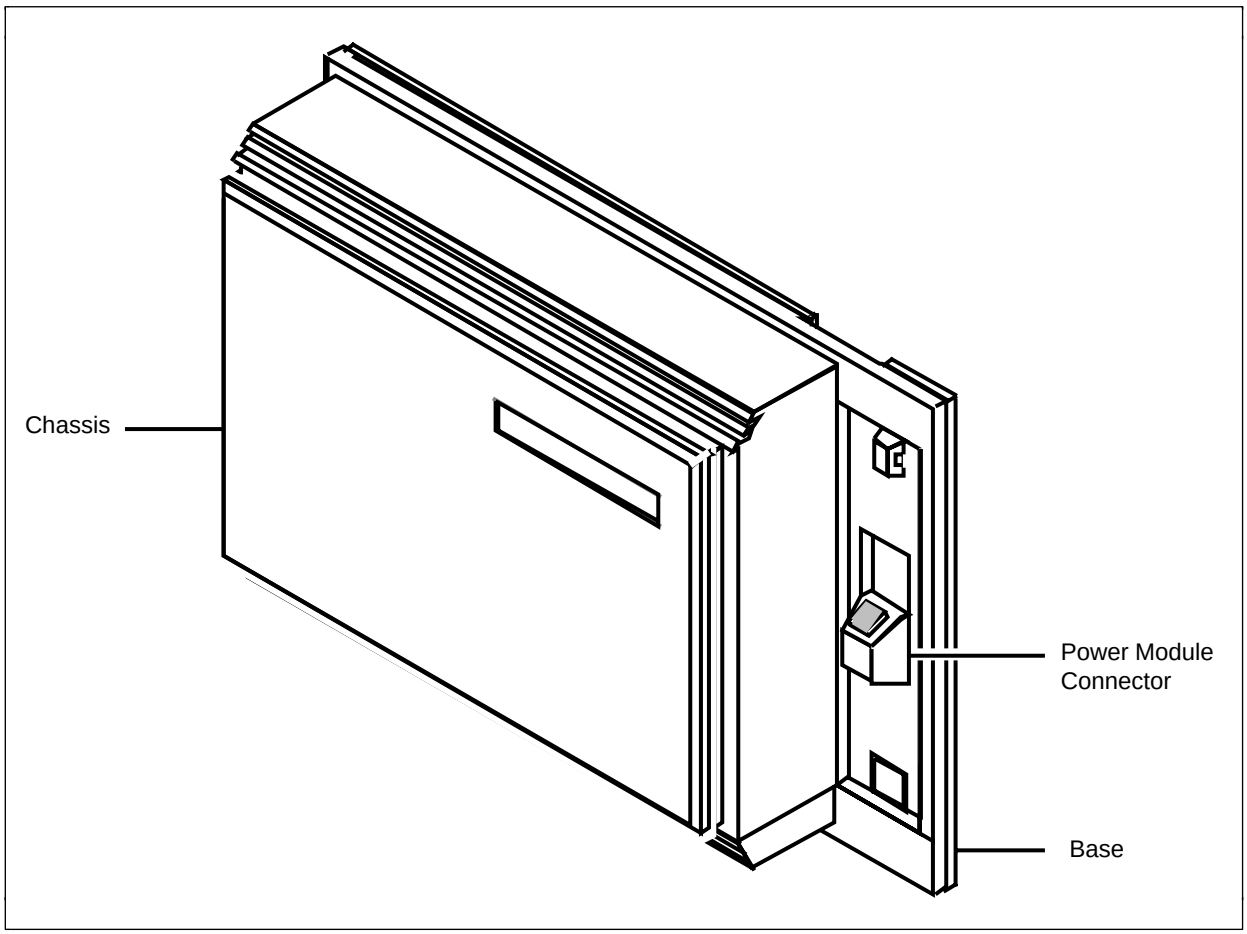
The NT1 battery module, which contains two 'GEL CEL' technology batteries, provides a battery back-up for the power module in cases of ac power failure. The batteries are sealed containers which require no maintenance. As shown in Figure 2-9, the module housing is almost identical to that of the power module, except that there is only one connector:

- the 6-pin battery / power connector permits connection to the power module; Table 2-11 shows the pin assignment of the battery connector.

The battery module has three cable assemblies:

- two internal cable assemblies, the battery cable (NTBX8903) and the battery fused cable (NTBX8904) are connected at the factory
- the 0.9-metre (3-foot) battery / power module cable (NTBX8902) connects the battery module to the power module, and is shipped loose with the battery module.

Figure 2-9
NT1 battery module



NT1 rack-mount shelf

The rack-mount shelf is a 483-mm (19-inch) shelving unit used to mount up to four NT1 modules side-by-side in a standard 1.8-m (6-foot) rack. The shelf is shipped fully assembled, and weighs about 16.3 kg (26 lb). The air intake grill at the bottom front of the unit provides for hot air exhaust from the NT1 modules.

NT1 functions

Figure 3-1 illustrates the breakdown of the NT1 into seven functional blocks:

1. U front-end.
2. U transceiver.
3. S/T front-end.
4. S/T transceiver.
5. Star S/T.
6. Maintenance processor.
7. Power converter (stand-alone NT1 version). The power converter for the modular NT1 version resides on a separate card.

U front-end

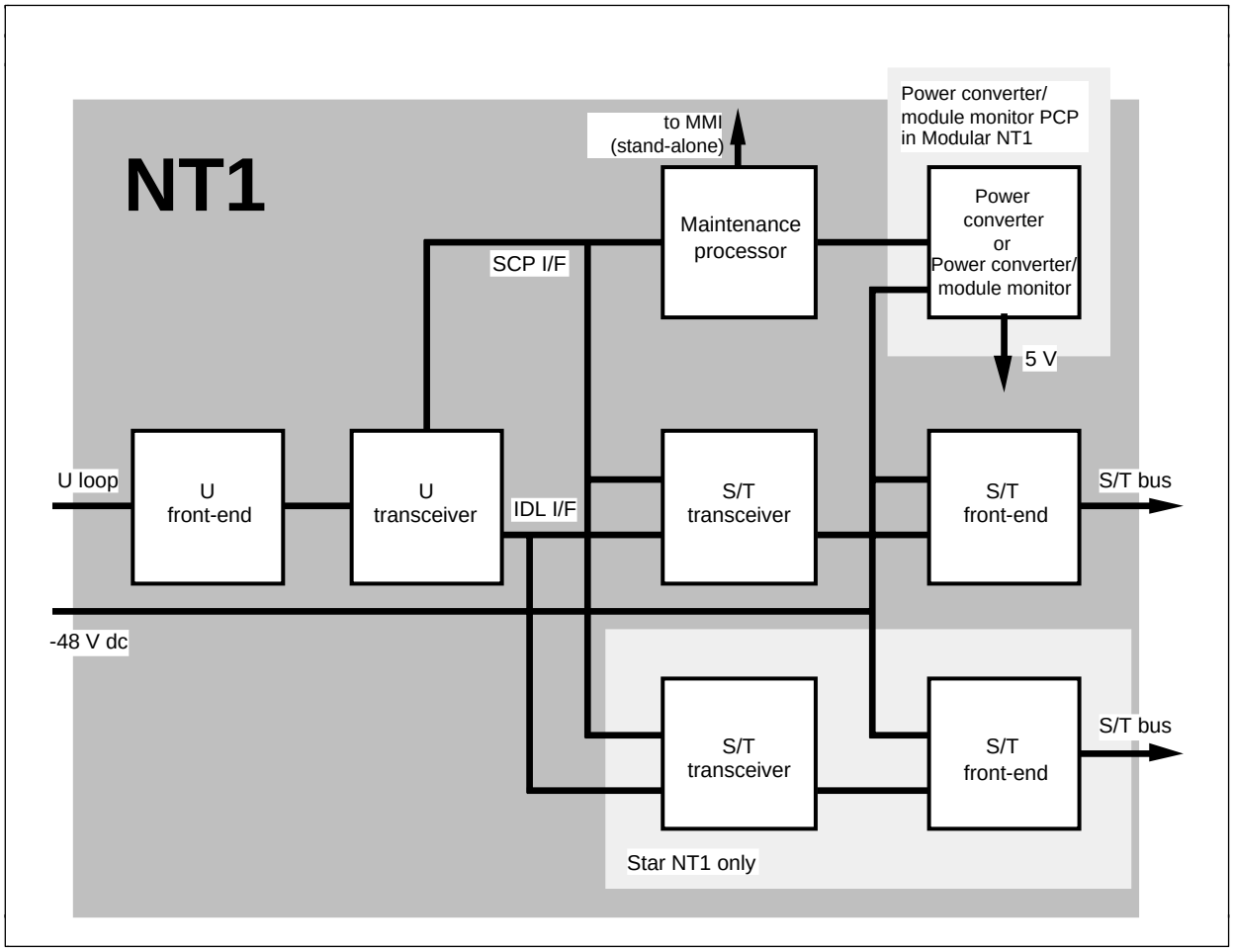
The U front-end block interfaces the NT1 to the subscriber loop, providing all of the required metallic front-end functions, and the two- to four-wire conversion for coupling to the U transceiver. The block performs the following major functions:

- U loop interfacing
- U loop protection
- dc termination
- remote maintenance signal detection.

U loop interfacing

The subscriber loop interface terminates the transmission line, and performs two- to four-wire conversion between the 2-wire U loop and the U interface transceiver. A hybrid transformer provides circuit isolation, and the interface is non-sensitive to the polarity of the U loop connection.

Figure 3-1
NT1 functional block diagram



U loop protection

The U front-end block provides U loop protection for outside plant wiring caused by any of the following faults:

- 60 Hz power line cross
- cross with other services (e.g., POTS)
- lightning strikes.

DC termination

The dc termination circuitry provides a sink for the sealing current generated by the U line card. The termination circuit is a normally-open device, which is closed by the application of voltage across Tip and Ring. It is held closed while current is flowing, and opened by the cessation of the loop current flow. The circuitry provides:

- dc termination for up to 20 mA current (maximum sealing current level)
- termination for metallic loop testing
- dc signature (high and low impedances).

Remote maintenance signal detection

The U interface includes a signalling detector to support remote network loop maintenance by supporting:

- NT1-generated 2B1Q test signal
- quiet interval
- return to normal operation.

U transceiver

The U transceiver block performs 2B1Q transceiver functions, providing a master inter-digital link (IDL) interface for the 2B+D user data transfer to the S/T transceiver, and a serial control port (SCP) interface to the maintenance processor for maintenance and control functions.

The block performs the following major functions:

- data transmission
- timing and synchronization
- frame and superframe structuring
- activation and deactivation
- maintenance functions and SCP interfacing
- IDL interfacing to the S/T transceiver.

Data transmission

The U transceiver block, which is a single Motorola U-chip, provides full-duplex 144 k/bs user data transmission over the 4-wire connection to the U front-end block, performing 2B1Q line encoding and decoding of the data. The block also performs cancellation of local echo, and adaptive equalization for U loop characteristics such as cable lengths, cable gauges, and bridged taps.

The block provides scrambling/descrambling functions for both directions of data transmission over the U loop:

- all data in the 2B+D and M channels is scrambled
- different scrambler polynomials are used for either direction of transmission
- framing bits and tones used during the start-up procedures are not scrambled.

The NT1 ensures data transparency of 2B+D user data, providing unrestricted data transmission in both directions for normal operation. When full operational status is not achieved (activation is not completed), or when non-transparent loop-backs are invoked, the NT1 data is non-transparent, and the U transceiver inserts idle (all ones) data into the user channels.

Timing and synchronization

NT1 timing is synchronized and slaved to the network, the clock being recovered from the received data (160 kb/s). The IDL interface to the S/T transceiver is then synchronized to the recovered network clock. In the absence of a network signal, the NT1 timing is free-running.

Frame and superframe structuring

The U-chip performs frame structure alignment for the proper identification of the B1, B2, D, and M channels. The frames consist of 120 quaternary symbols (240 bits) with a nominal frame time of 1.5 ms, and are identified by leading sync words or inverted sync words. For both directions of transmission, the bits in each frame are allocated as follows:

Channel	Number of bits	Function
Frame	18	sync word or inverted sync word
2B+D	216	user data: 12 x (2B+D)
M	6	maintenance data

The received and transmitted frames are offset by one-half of a frame (0.75 ms).

Frames are aligned into superframes for the identification of maintenance information in the M channel. Superframes consist of 8 basic frames (12 ms), and are identified with an inverted sync word. Each superframe contains 48 maintenance bits.

Activation and deactivation

The NT1 has the ability to operate in a low power mode in response to a deactivation condition initiated by the network. Activation procedures can be initiated either by the network or by the NT1 (following customer initiation from the TE). The NT1 may also be activated over the U or S/T interface for maintenance purposes only.

Maintenance functions and SCP interfacing

The U transceiver performs maintenance functions under control of the maintenance processor:

- cyclic redundancy check (CRC) code generation and checking for transmitted and received data
- CRC code performance testing through the generation of intentionally corrupted CRC codes
- data loopback functions
- high frequency test signal generation for U loop loss test
- embedded operations channel protocol implementation
- insertion and monitoring of M channel indicator bits.

The SCP interface is used to provide the communication link between the maintenance processor and the U transceiver. The interface generates interrupt requests to alert the processor of operational or maintenance activities.

IDL interfacing

The IDL interface re-formats the data to meet the IDL bit-ordering format, adapting the rate between the continuous 144 kb/s on the U loop and the burst 2.56 mb/s on the IDL interface. The interface also provides the master clocking and framing (synchronized to the U transceiver) for the S/T transceiver.

S/T transceiver

The S/T transceiver block performs the S/T transceiver functions, providing a slave IDL interface for the user data transfer to the U transceiver, and an SCP interface to the maintenance processor for maintenance and control functions.

The transceiver performs the following major functions:

- data transmission
- timing and synchronization
- D channel access
- activation and deactivation
- frame structuring
- maintenance signaling
- IDL interfacing to the U transceiver
- SCP interfacing.

Data transmission

The S/T transceiver provides full-duplex data transmission at a rate of 192 k/bs over the 4-wire interface, the line coding using alternate space inversion (ASI) with a 100% pulse width. Both point-to-point and point-to-multipoint configurations are supported, and the star NT1 provides two separate S/T transmission interfaces.

The transceiver, which is a single Motorola S/T-chip, provides clear data transmission for B1, B2, and D channel data in both directions between the TEs and the NT1, as long as the S/T bus is activated and there are no loopbacks operated. (When clear transmission is not provided, idle (all ones) data is inserted into the channels.)

Timing and synchronization

S/T interface transmission from the NT1 is slaved to the recovered network clock delivered over the IDL from the U transceiver. Data recovery using either fixed or adaptive methods is provided, depending on the configuration of the S/T bus. The type of timing is selected on the NT1 using a configuration option jumper.

D channel access

The S/T transceiver provides D channel access procedures for multiple TEs connected to the S/T bus, reflecting the D channel bit received from the TEs in the next available D-echo bit position transmitted toward the TEs.

Activation and deactivation

The NT1 has the ability to operate in a low power mode in response to a deactivation condition initiated by the network. Activation procedures can be initiated either by the NT1 (under network control) or by the TE. The TE also has the ability to activate the S/T bus for maintenance purposes in the absence of a U loop.

Frame structuring

The S/T-chip performs frame structure alignment for the proper identification of the B1, B2, D, M, and overhead channels. The frames consist of 48 bits in each direction of transmission, with a frame duration of 250 µ s, and an offset of 2 bits from the transmitted frame to the received frame.

Maintenance signaling

In a multiframe structure of 20 frames (5 ms), the S/T transceiver controls the maintenance signaling channel to the TEs. It multiplexes signals onto the S channel toward the TEs, demultiplexes signals received from the TEs on the Q channel, and provides the coding for the Q/S channel messages.

IDL interfacing

The IDL interface re-formats 2B+D data to meet the IDL bit-ordering format for the U transceiver, and provides rate adaptation to handle the different data burst rates. The interface receives master clocking and framing from the U transceiver.

SCP interfacing

The SCP interface provides data transfer on the SCP slaved to the clock and selection control from the maintenance processor. When it receives maintenance messages from the TEs, or notes a change in S/T transmission states, the SCP interface generates an interrupt.

S/T front-end

The S/T front-end block interfaces the NT1 to the S/T bus, providing all of the required front-end functions, and couples to the S/T transceiver using two transmit and receive pairs. The block performs the following major functions:

- front-end protection
- receive filtering
- termination resistance
- terminal power sourcing.

Front-end protection

The NT1 provides protection of the S/T bus interface for inside plant wiring from crosses to other services and inside building voltage transients.

Receive filtering

The NT1 provides a low-pass filter which is used to filter out high frequency noise without affecting the receive signal.

Termination resistance

The S/T front-end block includes two pairs of 100 ohm terminating resistors which are used to provide one or two pairs of terminations for the S/T bus, depending on the bus configuration. In the stand-alone version of the NT1 unit, each pair of resistors can be individually switched in or out using one of two configuration option jumpers. In the module version, one pair of resistors is always switched in, and the other can be switched in or out with a jumper.

Terminal power sourcing

The NT1 is capable of providing TE powering using two methods. Phantom powering can be provided over the transmit and receive transmission signals coupled through the transformer central taps. Also, extra-pair powering can be transmitted over a separate pair of S/T bus wires.

Star S/T

The star version of the modular NT1 card provides two S/T interfaces to enable the connection of a second S/T bus to the network. The star S/T block is a duplicate of the S/T circuitry in the basic version, so that the star NT1 contains a second S/T transceiver block and a second S/T front end block. For the purposes of maintenance and control, the maintenance processor treats the two S/T interfaces as a single interface.

The timing (fixed or adaptive) and terminating resistor options are selected independently for each S/T interface to allow complete flexibility of bus configurations.

To enable the NT1 to run in star mode, logical ANDing is performed on the D channel data received on each S/T bus. The Q/S channel is handled by transmitting identical S channel messages on both S/T busses, and by prioritizing the Q channel messages from the two S/T busses in the maintenance processor.

Maintenance processor

To support the maintenance and testing requirements of the network, the subscriber loop, and the customer, the NT1 must provide the following features:

- cyclic redundancy check (CRC) handling, which supports transmission performance monitoring by the network
- metallic testing, sealing current, and test signal handling, which support U loop maintenance by the network
- continuous status monitoring and messaging over the embedded operations channel (EOC), which support network maintenance functions over the M channel
- a 2B+D loopback, loopbacks of individual B channels (B1 or B2), and testing and status indicators, which support testing by the network
- B channel loopbacks, messaging over the Q/S maintenance channel, and self-test features, which support testing by the customer.

To implement these features, the maintenance processor, whose heart is a single-chip microcomputer, provides the following functions:

- SCP interfacing
- EOC message and M channel handling

- S and Q channel message processing
- MMI interfacing
- self-testing.

SCP interfacing

The SCP interface is provided to communicate with the control registers in the U transceiver and the S/T transceiver blocks. The interface is the master for SCP interface timing and for device selection, resolving interrupts from the three possible sources.

EOC message and M channel handling

The EOC supports the messaging of network commands to the NT1, and the NT1 responses to the network. (Messages always originate at the network, rather than at the NT1.) For an inherent check on the performance of this maintenance channel, a time-out period is provided for the receipt of the NT1 response to an EOC message.

Dedicated bits in the M channel carry indicators, which support continuous status monitoring and mode indications between the network and the NT1.

As well as providing 2B+D loopbacks toward the network, the NT1 provides the following maintenance and testing features:

- a far end block error (FEBE) indicator bit signals the network that a CRC violation has been detected on the last received superframe
- a performance monitoring check using intentionally corrupted CRCs is used to check the CRC-based transmission monitoring system
- to permit simultaneous operation of multiple maintenance actions, the NT1 responds to 'return to normal' and 'hold state' messages from the network, and is able to send an 'unable to comply' message to the network on receipt of a message that is not in the NT1 menu
- test mode, activation, and cold start only indicators on the M channel are used to signal test and activation status to the network.

S and Q channel message processing

The maintenance processor controls message processing and encoding for maintenance messages from the NT1 to the TEs on the S channel, and for messages from the TEs to the NT1 on the Q channel. As well as individual B channel loopbacks towards the TEs, the following features are provided:

- a 'loss of power' message indicates the imminent loss of total power by either the NT1 or the TE
- on receipt of the 'self test' message from the TEs, the NT1 performs a self-test
- the 'disruptive operation indication' message is issued to the TEs whenever the NT1 is operating under a condition that may disrupt the normal flow of D channel messages

- the 'loss of received signal' message indicates to the TEs that the NT1 can't identify the received signal at the U interface; this message is sent continuously until the correct U interface signal is received.

MMI interfacing

The MMI interface provides the communications between the maintenance processor and either the status LED indicators on the stand-alone version of the NT1, or the module monitor in the modular version. The interface defines the type of NT1 circuit pack (stand-alone, basic NT1 unit, or star NT1 unit), and specifies the configuration jumper selections, power status, U and S/T sync status, and self-test and laboratory test status of the NT1.

Self-testing

The maintenance processor provides three levels of self-testing:

1. The customer self-test is initiated by the TEs over the S/T interface, using Q/S channel messaging. Since the test can't disrupt operation or service, it checks only the processor RAM and ROM and the SCP communications to the U and S/T chips.
2. The power-up self-test is performed immediately after power-up, and also in response to the maintenance panel self-test selection on the modular version of the NT1. The test is service-affecting, and checks the processor RAM and ROM, SCP communications, the processor timers, U chip loopback (digital), and TE powering.
3. The factory self-test is provided to allow the maximum level of self-testing during manufacturing. As well as the functions tested under the power-up self-test, the factory self-test includes checking the activation/deactivation procedures (U and S/T), and a U interface analog loopback.

Power converter

This block converts the -48 V dc input power to the 5 V dc needed by the NT1. In the stand-alone version of the NT1, the power converter is part of the NT1 unit card. In the modular version, the power converter is a separate circuit pack, which also contains the module monitor. In the modular version, the 5 V power is distributed to the NT1 cards via the module backplane.

Stand-alone NT1 version

The 1.2 W dc-to-dc power converter on the stand-alone version of the NT1 performs the following functions:

- regulated -48 V dc to 5 V dc conversion at 1.2 W maximum power output
- input over-voltage and surge protection
- output voltage hold-up time

- inrush current limiting
- short circuit protection on the output
- generation of a power-up reset pulse
- normal or restricted powering and dying gasp indication to the maintenance processor.

Modular NT1 version

As shown in Figure 3-2, the power converter / module monitor is formed of four functional blocks:

1. Monitor processor.
2. Maintenance panel interface.
3. NT1 interface.
4. DC converter.

Monitor processor

The monitor processor block provides the following processing functions:

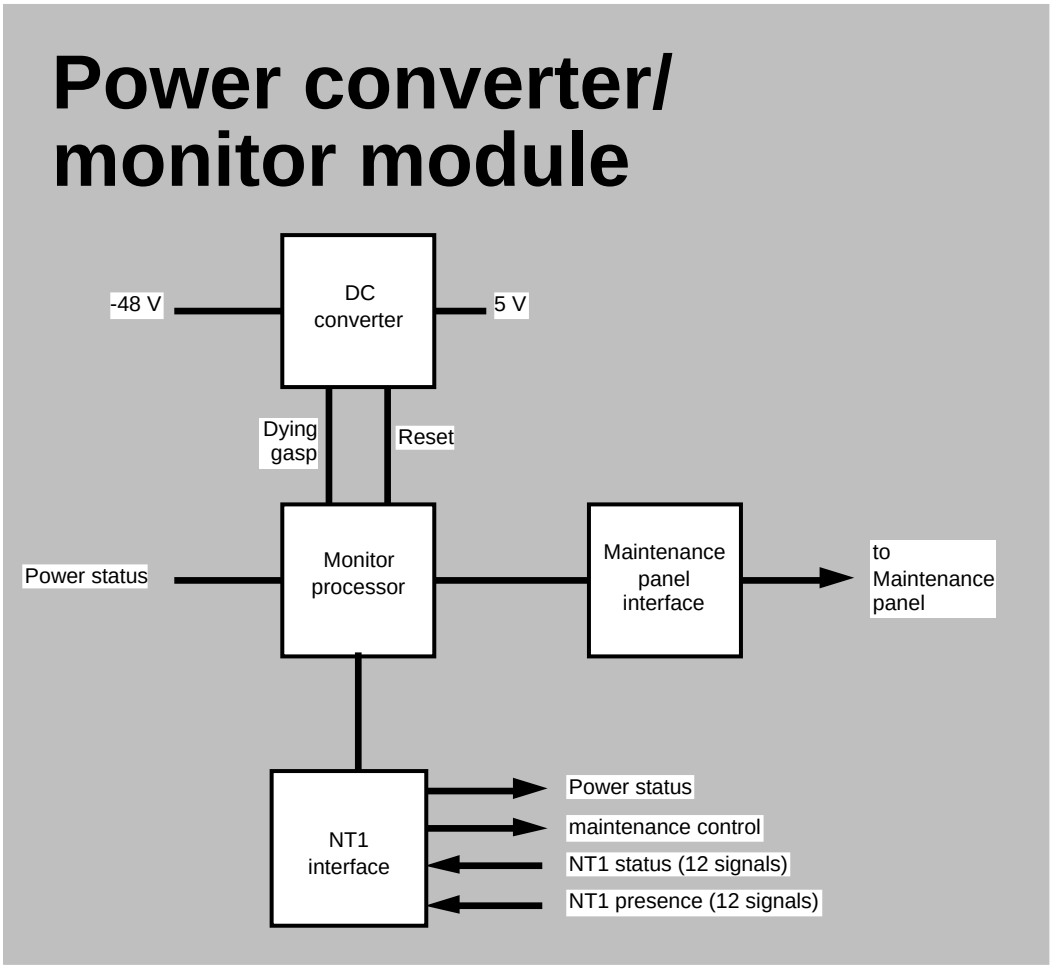
- monitoring power status (both ac and battery) from the power supply module
- monitoring dying gasp status from the dc converter
- controlling the conditions of the visual indicators on the maintenance panel (on, off, or flash)
- monitoring the operation of the NT1 selection and self-test switches on the maintenance panel
- providing power status indication to the NT1s.

Maintenance panel interface

This block provides the interfacing functions between the monitor processor and the maintenance panel. It contains 16 LED visual indicators, and addressable latches for selecting and storing indicator states.

The maintenance panel is a touch-sensitive membrane panel located at the front of the NT1 module. It is connected to the power converter / module monitor card with a ribbon cable. The panel provides the NT1 selection and self-test switches, windows for the LED indicators, the NT1 module graphics and label information.

Figure 3-2
Power converter/module monitor functional block diagram



NT1 interface

This block interfaces the monitor processor to the 12 NT1s in the NT1 module by providing the following functions:

- buffering power status and serial communication transmit signals
- multiplexing status information from the 12 NT1s (serial communication receive signals)
- multiplexing presence signals from the 12 NT1s, which identify the NT1s installed in the NT1 module.

DC converter

This block provides regulated conversion of the -48 V dc input power to the 5 V dc used by the NT1 cards at 18 W maximum power output. The converter also provides:

- dying gasp indication to the monitor processor
- output voltage hold-up time
- power reset for the card.

Specifications

The NT1's U and S/T interfaces meet the requirements defined in the ANSI standards. Table 4-1 lists the specifications for the U interface, and Table 4-2 lists those for the S/T interface.

Table 4-1
NT1 U interface specifications

Parameter	Requirement
Line code	A 4-level pulse amplitude modulation (PAM) 2B1Q (2 binary, 1 quaternary) code without redundancy, in which pairs of transmitted bits are converted into quaternary symbols.
Baud rate	A received baud rate of 80 kbaud ± 5 ppm, corresponding to a nominal symbol width of 12.5 µs.
Pulse height	A nominal pulse height, within a tolerance of ± 5%, as follows: Quaternary symbol — Pulse height (V) +3 — +2.500 +1 — +0.833 -1 — -0.833 -3 — -2.500
Average signal power	13.5 dBm over the frequency band from 0 Hz to 80 kHz, into a 135 Ohm load
Loop range	over cables exhibiting a loop attenuation of 0 dB to 46 dB, measured at a frequency of 40 kHz
Impedance	135 Ohms

Table 4-2
NT1 S/T interface specifications

Parameter	Requirement
Line code	Bipolar alternate space inversion (ASI), in which binary zeros are represented by positive or negative pulses while binary ones are represented by no signal, with pulse width of 100%, return to zero.
Bit rate	Nominal bit rate of 192 k/bs, corresponding to a pulse width of 5.21 µs, normally synchronized to the network clock. In free-running mode (no U loop), the bit rate tolerance is ± 100 ppm.
Line termination	Receive and transmit line terminations of 100 Ohms, ± 5%.
Pulse height	Nominal pulse height of 750 mV, zero to peak, with a tolerance of ± 10% and an imbalance between positive and negative pulses less than 5%.
Short passive bus with fixed timing	• input signal amplitude within the range of 1.5 dB to -3.5 dB relative to the nominal transmitted signal • maximum cable signal loss 2 dB • total round trip delay in the range of 10 µs to 13.9 µs (3.9 µs differential) • maximum round trip cable delay of 2 µs
Short passive bus with adaptive timing	• total round trip delay in the range of 10 µs to 13 µs (3 µs differential) • maximum round trip cable delay of 1 µs
Point-to-point	• input signal amplitude within the range of 1.5 dB to -7.5 dB relative to the nominal transmitted signal • maximum cable signal loss 6 dB • total round trip delay in the range of 10 µs to 42 µs

(...continued)

Table 4-2
NT1 S/T interface specifications (continued)

Parameter	Requirement
Extended passive bus	• input signal amplitude within the range of 1.5 dB to -5.5 dB relative to the nominal transmitted signal • maximum cable signal loss 3.8 dB • total round trip delay in the range of 10 µs to 42 µ s • maximum differential delay of signal from different TEs in the range of 0 to 2.75 µ s

List of terms

2B1Q
four-level PAM code with 2 binary to 1 quaternary symbol coding

ANSI
American National Standards Institute

ASI
alternate space inversion

BRA
basic rate access

CCITT
International Telegraph and Telephone Consultative Committee

CO
central office

CRC
cyclic redundancy check

DMS
Digital Multiplex System

EOC
embedded operations channel

FEBE
far end block error

IDL
inter-digital link

ISDN
integrated service digital network

ISLC
ISDN line card

OSI
Open Systems Interconnection

NT1
Network Termination 1

PAM

pulse amplitude modulation

POTS

plain ordinary telephone service

SCP

serial control port

S/T

CCITT S and T reference points

TE

terminal equipment

U

CCITT U reference point

U-ISLC

U ISDN line card