Model 2044 / 2045

DS1LNK1 / DS1CX1

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MODEL 2044/45

DS1LNK1 / DS1CX1

1. INTRODUCTION

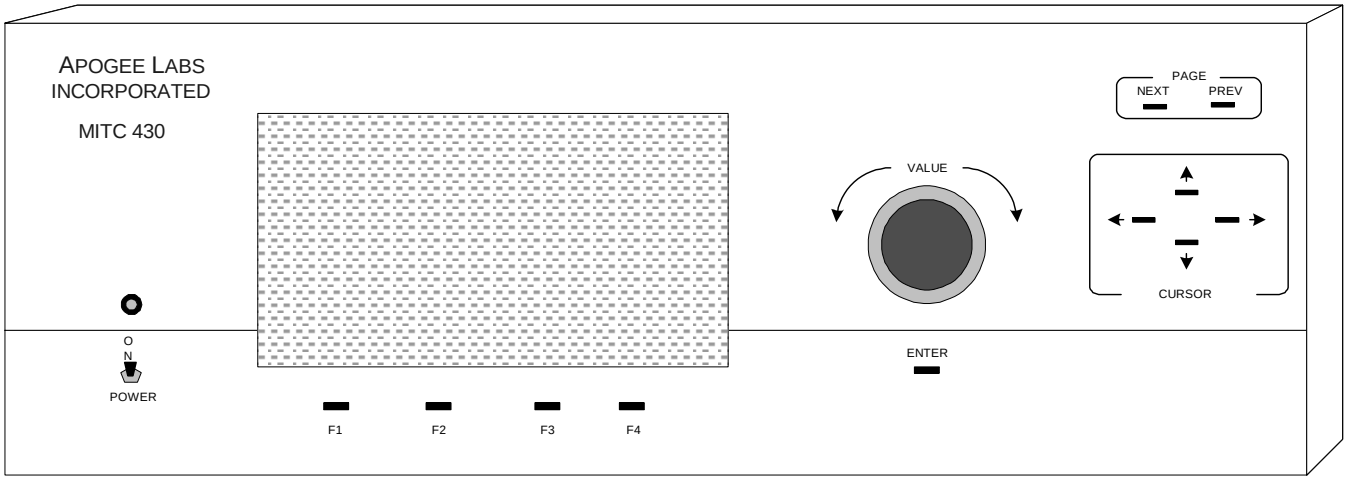


Figure 1-1 - MITC-*FALCON*, Inverse T1 MUX/DEMUX Unit

1.1 PURPOSE OF MODULES

The Inverse T1 Multiplexer, as part of the MITC Falcon Product Family, accepts data from the entire Falcon Series of application data modules (video, time, PCM, etc.) and transmits this data, in parallel, over multiple T1 communications links. The system is useful in environments where the combined data load varies between communication sessions requiring a varying number of T1 links. The system is also useful in locations where there is more data than a single T1 link but a higher bandwidth link (T3, for example) is not available or otherwise not feasible.

The system is capable of automatically prioritizing links, based on link quality. The user can prioritize the application data modules to place the most important data on the highest priority and most robust links. Bi-directional links utilize full-loop quality feedback, where received data quality is passed back to the sending module, allowing the sending system to adjust the communications configuration based on the quality of transmitted data.

The system allows from one (1) to a maximum of fourteen (14) individual bi-directional T1 links for a maximum composite data transmission greater than 20 Mbits/sec (Total Transfer Bandwidth 40 Mbits/sec bi-directional on full-duplex channels).

1.2 MODULE OVERVIEW(S)

DS1CX1 Channel Controller (Model 2045) module initializes and controls the DS1LNK1 Link Modules (Model 2044). Each DS1LNK1 module contains two channels. Up to seven (7) DS1LNK1 modules can be installed into a Falcon Series chassis for a maximum of fourteen (14) channels.

Each DS1LNK1 module perform all operations relating to the two installed channels on the module: Configuration and establishment of a link, transmitting and receiving data, link and data quality detection and reporting.

The DS1CX1 controller module monitors and controls all DS1LNK1 modules, enabling the multiple links to operate as a single high-speed composite data transmission system. The controller identifies and corrects for the communications latencies between the links. Faulty links are removed or moved to positions that handle lower priority data. All settings for both the DS1CX1 and all DS1LNK1 are combined onto the DS1CX1. The DS1CX1 collects and reports all system information to the user.

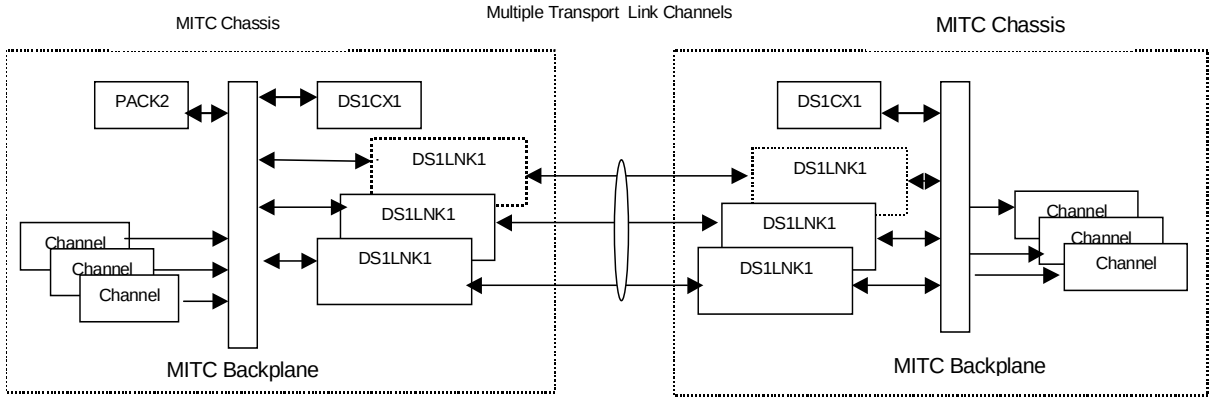


Figure 1-2 - Block Diagram

1.3 FEATURES

The Inverse T1 System Modules provide the following features:

- Up-to fourteen (14) T1 links can be combined to get 20Mbps composite data bandwidths
- Simplex and duplex configurations supported.
- Auto re-sequencing of T1 connections based on link quality. (Duplex links required)
- Automatic load shedding of lower priority data on loss of links.
- Full-loop quality feedback - Transmitting channel is informed of quality of transmission.
- Differences of T1 Link Delay relative from 0 to 600 ms supported.

1.4 SPECIFICATIONS

Physical

DS1CX1, Controller Card:

1 Controller required, any configuration, must be installed in slot 0
1 Slot wide module, no external connections

DS1LNK1, Link Card(s):

1 Slot wide module, placed in consecutive adjacent slots starting with slot 1

RJ-45 connectors (2) on rear panel for T1 links

2 Full duplex capable link channels per module

Electrical

DS1CX1, Control Card:

No external connections on the DS1CX

DS1LNK1, Link Card(s):

AMI, B8ZS Bipolar signal type, isolated transformer coupled

D4/ESF Selectable frame format

Auto select, long & short haul

0 dB to –36 dB Rx sensitivity (supports up to 6000 feet)

Selectable Tx output: CSU 0 to –22.5 dB, DSX1 0 to 655 feet

Each link channel supports Simplex or Duplex operations

Transmit using Receiver Timing Loop Back or local oscillator (25 ppm)

Up-to 600 ms T1 Link data buffering (user selectable limit)

All Channels on T1 are utilized (1.536 Mbps Transfer Bandwidth used).

2. INSTALLATION

2.1 MODULE PLACEMENT CONSIDERATIONS

The controller module must be placed in the first slot (SLOT 0) on the left when looking at the rear of the MITC. The link module(s) must be installed beginning immediately next to the controller module (beginning in SLOT 1) and occupy consecutive locations in the chassis backplane.

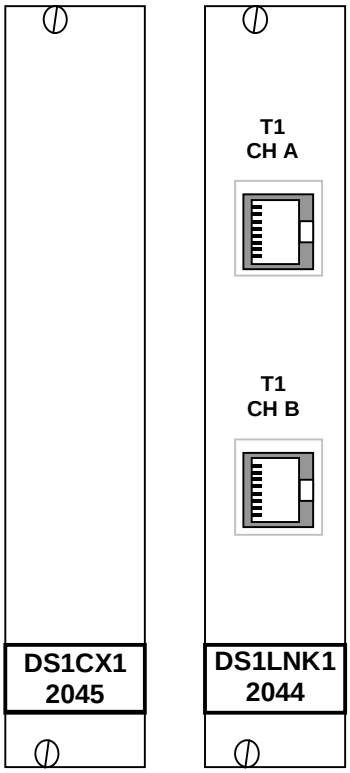
2.1.1 DATA PRIORITY

Each data module (Clock/Audio, Video, PCM) is prioritized by installed slot location. Should load shedding be required, the application modules stored in the lower slot numbers have transmission priority over modules installed in higher module numbered slots. When T1 channels are disabled, the data from the modules in the higher numbered slots will be discarded first.

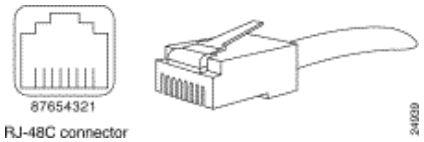
CAUTION

The DS1CX1 (Model 2045) Module must not be installed in a chassis with a DEPACK2 (Model 2025) module. The DEPACK2 provides similar functions as the DS1CX1 Module and will cause back-plane bus contention.

2.2 INTERFACES AND CABLING



T1 Connector: (RJ48-C)



Pin 1: Rx ring	Pin 5: Tx tip
Pin 2: Rx tip	Pin 6: NC
Pin 3: NC	Pin 7: NC
Pin 4: Tx ring	Pin 8: NC

A PACK2 (Module 2024) is required for operation. On the PACK2, the user can define the SI (sample interval) of either 1 (one) or 10 (ten) milliseconds. Also on the PACK2, a valid clock source must be defined (PDI Synth, for example) as well as a clock rate that exceeds the user data requirements. A clock rate of 5M Bytes/Sec, for example, is greater than required by a maximum Inverse T1 configuration of 14 channels. No additional overhead is inserted for rates higher than the minimum requirement (5M Bytes/Sec is about twice the maximum rate of a maximum Inverse T1 configuration but does not insert additional overhead),

2.3 CONFIGURATION

There are no physical configuration settings or jumpers on either the DS1CX1 or DS1LNK1 modules.

Physical Link configuration settings are performed via software controls on the front panel (Line Build out, T1 Format).

2.4 T1 LINK BANDWIDTH GUIDELINES

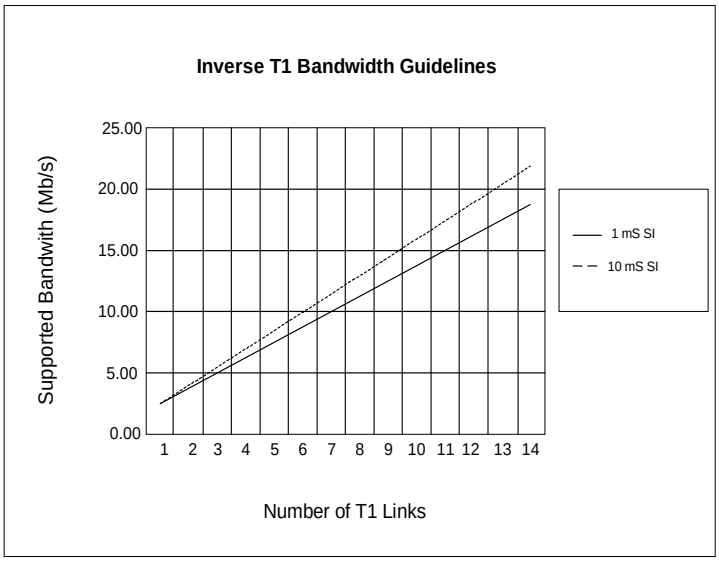
The Inverse T1 system provides efficient transfer of composite data via the T1 links with a small amount of bandwidth used on the T1 Link for packetization overhead. The Multiplexing Packetizer (i.e. PACK2, module 2024) can be configured for 1 ms SI or 10 ms SI (sample interval). The 1 ms SI setting provides the lowest system latency where the 10 ms SI provides the highest transport efficiency (98%). See Table 2-1, T1 Link Bandwidth Estimates for a comparison of transport efficiency between the two Sample Intervals. A system latency on a 10 ms SI is 30 ms plus the longest latency of the T1 lines. For 1 ms system, the latency is 3 ms plus the T1 latency.

Table 3-1 T1 Link Bandwidth Estimates

10 ms SI		1 ms SI	
Number of T1 Channels	**Available Bandwidth for Multiplexing Applications**	**Number of T1 Channels**	**Available Bandwidth for Multiplexing Applications**
1	1.51 Mbps	1	1.35 Mbps
2	3.02 Mbps	2	2.70 Mbps
3	4.53 Mbps	3	4.06 Mbps
4	6.04 Mbps	4	5.41 Mbps
5	7.55 Mbps	5	6.76 Mbps
6	9.06 Mbps	6	8.11 Mbps
7	10.57 Mbps	7	9.46 Mbps
8	12.08 Mbps	8	10.82 Mbps
9	13.59 Mbps	9	12.17 Mbps
10	15.1 Mbps	10	13.52 Mbps
11	16.61 Mbps	11	14.87 Mbps
12	18.12 Mbps	12	16.22 Mbps
13	19.63 Mbps	13	17.58 Mbps
14	21.14 Mbps	14	18.93 Mbps

Each data channel packetizes data into source packets. For example, the Mux9 has two channels. Thus at 1 ms SI the Mux9 generates 2 x 96 kb/s (or 192 kb/s) of overhead. The Mux9, with two channels active, at 10m SI has only 19.2 kb/s of overhead.

Each source packet contains 96 bits of overhead. Thus 96 kb/s is generated per data channel with the 1 ms SI setting, or only 9.6 kb/s with 10m SI. For example, 5 active data channels can save 432,000 b/s of bandwidth using the 10m SI.



3. OPERATION

3.1 GENERAL

The inverse T1 system modules perform the following on power up.

1. Power up
2. The DS1CX1 (Controller Module) will start up and discover all the T1 link cards installed in the system. Link Cards are Disabled during power up.
3. The DS1CX1 module then assigns link priority to all the T1 Links that are determined to be active.
4. On the receive side, Link buffering is adjusted, using Link Delay and then the channel is enabled to receive data.
5. After links are established, in "Automatic Mode", they are continuously monitored for link and data integrity on the transmitting and receiving side. Should excessive errors be detected on the transmit side; the channel is removed from the configuration. When the channel is then clear of errors, it is added to the lowest priority position.
6. In Automatic Mode, if major link failures or data errors are detected then the Link Priority for that channel is adjusted to a lower priority.

3.2 FRONT PANEL CONTROLS AND STATUS

The main screen displays the general status of the system. It displays the status of each of the possible links available, installed, enabled, disabled, and if it has errors. The global status and settings are the link delay (LnkDl), mode (Mode), T1 frame format (T1Fmt), and bandwidth (BdWth).

The channel detail displays the settings and status of each link. It shows the physical location (ID) of each link, whether the link is enabled (Enbl), the link build setting (LnBld), whether or not there is a lock on the frames and on the data (active). The relative delay of the link is displayed (RelDly). The relative delay is the length of time, in milliseconds, that data arrives at the link compared to the link with the shortest latency. This can be used to set the link delay value for the system. If the relative delay is zero, the link has (or links have) the shortest latency. The received error seconds (RxErSec), transmitted error seconds (TxErSec), and operation seconds (OperSec) are also displayed on this screen.

3.2.1 SYSTEM STATUS

SYSTEM USER STATUS & CONTROL SCREEN

```
DS1CX  1.0                                    SLOT  00
Lnk#  0123456789ABCD  Lnk Dly: >400 Ms
Stat: ++xxx+++++++++  Mode:  Man
Enbl: MMMMMMMMMMDD    T1 Fmt: ESF L
                      BdWth: 100%
[CLRALL]                    [DETAIL]
```

Field	Description
Lnk#:	This is the number for the links; the links are numbered from 0 to 13 (with A – D to identify links 10 – 13). The physical location of the link can be found by looking at the channel detail for this link.
Stat:	Displays the status of the board, ‘ ’ indicates there is no channel installed, ‘+’ indicates an installed channel with no errors. A blinking ‘X’ indicates errors have occured on the channel. Select the 'DETAIL' for the channel for additional information on the errors.
Enbl:	The status will be one of the following, (M)anual, (A)uto or (D)isabled. If it is (M)anual, or (A)uto, the channel is enabled and operating per the selected mode (see Mode below). If it is (D)isabled, the channel hardware is turned off and will not transmit nor receive data. This value can be changed by rotating the Value knob when the cursor is below this field (followed by pressing the Enter key).
BdWth:	Displays the percentage of the total bandwidth used. This field exceeds 100% when there is more application data than can be transmitted over available links and load shedding is occurring
LnkDl:	This setting controls the channel-to-channel relative link delay (inter-channel latency) in milliseconds from 0 to 600. Some T1 links take longer to get from the source to the destination than others. This field defines the amount of time that the fastest link will buffer information to allow the slowest link to receive data. If one or more channels have a longer latency than this setting, the data on those channels will arrive too late and will be discarded.
Mode:	Mode can be set to Reset, Manual or Auto. In Auto Mode, the system monitors the status of the links and will temporarily disable channels that have errors. When these channels are then found to be clear, they will be inserted back into the data stream, but at the lowest priority. The most robust links will move to the highest priority positions. Manual Mode is provided to address Simplex operation. Line quality must be monitored by the user (it is not available from the link). Error prone links must be disabled manually. Selection of 'Reset' re-initializes the Inverse T1 system, similar to a power-up initialization. After reset, the system is returned to the previously selected mode (either Manual or Auto).
T1Fmt:	D4 or ESF T1 frame format combined with either local or network clock source. Confirm this setting with the network service supplier.

3.2.2 CHANNEL DETAIL

Channel Detail User Status & Control Screen

D	S	1	C	X		1	.	0		C	H	A	N	N	E	L		D	E	T	A	I	L		S	L	O	T		0	0
L	O	C	:		0	4	A		R	S	t	a	t	:	A	c	t	i	v		X	S	t	a	t	:	A	c	t	i	v
E	N	b	l	:		Y	E	S										R	x	E	r	S	e	c	:	0	0	0	0	0	0	0
L	N	B	l	d	:		1	3	3	F	T							T	x	E	r	S	e	c	:	0	0	0	0	0	0	0
R	e	l	D	l	y	:		0	2	0	m	s						O	p	e	r	S	e	c	:	0	0	0	0	0	0	0
[	N	X	T	C	H	N	]											[	C	L	E	A	R	]		[	T	O	P	]		

Field	Description
LOC:	Displays the physical slot location of the channel. There are a total of 32 different locations for up to 14 channels, slots 1 through 16, channels A or B. This field can be selected and used to display the details of other channels.
Enbl:	A user selected field, which can either be YES or NO. When disabled, the hardware for the channel is turned off and the channel can neither receive nor transmit data.
LnBld:	This field defines the electrical characteristics of the channel. Confirm this setting with the network service supplier. The possible settings are: 133ft, 266ft, 399ft, 533ft, 655ft, -7.5dB, -15db, -22.5dB.
XStat:	This status field displays the current transmit status of the link. Possible values are: See RStat.
RStat:	This status field displays the current receive status of the link. Possible values are: Active: This is displayed when the link is actively receiving or transmitting data and that data is passed on to the application data modules. DlyE: This status is displayed when the latency of this channel is longer than the user-provided maximum latency of the system on the Main display (LnkDl). Compare the displayed latency of this channel (the RelDly value to the LnkDl value). Increase the overall latency of the system to allow this channel to function correctly. LinkF: This message is displayed when the link hardware is not detected. Check cabling. DataF: This message is displayed when data is received but is not valid. Possible T1 Format mis-match. Possible data originated from a non-Apogee system. FarLk: This message is displayed when the local link is informed of a LinkF type error on the far end of the link. Possible far link receive data disconnected while transmiting data still good in duplex mode and auto. FarD: This message is displayed when the local link is informed of a DataF type error on the far end of the link. Far link received corrupted data in duplex mode and auto. Init: This message is displayed when the link is clear of errors and all that remains is the link to remain clear until it is re-enabled. Disbl: This message is displayed when the link has been disabled by the user.

RxErSec: This counter is incremented once per second if there are receive related errors detected during that second for that channel. Receive related errors are caused by data errors, link (physical) errors, or an excessive link delay error. This counter may be zeroed by pressing the CLEAR function key or, on the Main display by pressing the CLRALL function key.

TxErSec: This counter is incremented once per second when Transmit related errors are detected during that second for that channel. Quality information on transmitted data is returned by the remote end of the link, embedded within the received data packets (Duplex operation). If a receive data error renders this embedded information un-usable, the receive error will also be recorded as a transmit error. This counter may be zeroed by pressing the CLEAR function key or, on the Main display by pressing the CLRALL function key.

OperSec: This counter increments once per second when a channel is enabled by the user. This counter may be zeroed by pressing the CLEAR function key or, on the Main display by pressing the CLRALL function key.

3.3 DESCRIPTION OF OPERATION

The Inverse T1 System initializes each DS1LNK1 channel to collect data from application modules based on the interval defined by the PACK Module. Each module is configured to collect that portion of the data stream that corresponds to the priority sequence defined by the controller module. The highest priority module collects the first portion of data for transmission over the T1 link. The second collects the second portion, etc. As each link transmits the data, it includes, embedded with the data, the link order, or priority of the data so that the receiving end can re-construct the data stream in the same order.

On the receive side, the data is accepted by each link module and buffered as designated by the LnkDly operator setting. The LnkDly setting instructs the fastest links to add additional latency to received data so that the slower links can catch up. Once the delay period has expired, each link reconstructs the corresponding portion of the data stream. If the LnkDly is not long enough, the composite data stream would be incomplete with those sections from the slower links missing.

As the composite data is reconstructed, it is collected by the corresponding application data modules on the receive side.

If the links are Duplex, there is a corresponding Inverse T1 System that operates in the other direction. This second system is functionaly independent from the first with the exception of the shared T1 Channel hardware. In a Duplex system, the return link contains quality information on the data received by the first system. This information is used by the first system to set the priorities of the links based on the link quality. (The first system also returns quality information back to the second system for the same purpose.)

3.4 AUTOMATIC/MANUAL MODES OF OPERATION

In Auto mode, the link quality is monitored and the links are temporarily disabled for the duration of any faults. Once the link quality is good enough to resume transmission, the link is re-enabled, but at the lowest priority. The intent is to allow the most robust links to transmit the highest priority data.

In Manual mode, the system uses the line quality information to re-prioritize the links. If the T1 links are Simplex, this quality information may not be available for use. Manual mode requires the operator to disable links that are considered faulty. The remaining links are used for the transfer of data, with no error checking enabled.

4. REMOTE CONTROL

4.1 GENERAL

The user can access the unit via an RS-232 serial port. Commands can be sent with a simple serial port terminal and are not case-sensitive.

4.1.1 SET

SET is used to assign values to programmable fields. The SET command has two arguments for control card commands: the field and the operand(s), and three arguments for commands for each link: the field, the link number, and the operand(s). The following details the programming with the allowable field identifiers and values for each. Further information on each is given below these fields.

Example:

Control Card Commands

SET LNKDL=551<CR>

Note: The <CR> character has the ASCII DECIMAL 13 value (I.E. 0x0d).

Link Commands

SET ENBL=LN,YES<CR> (Where LN is the number of the Link)

4.1.2 READ

READ is used to confirm values of programmed fields. The READ command has one argument to designate the field for control card commands and two arguments for each link, the field and the link number.

Example:

Control Card Commands

READ BDWTH<CR>

Link Commands

READ ENBL=LN<CR> (Where LN is the number of the Link)

4.1.3 LOCK

The LOCK command locks the settings on the front panel so that the front panel cannot be changed until the UNLOCK command is sent. (Note a system power cycle will also "unlock" the front panel).

Example:

LOCK

4.1.4 UNLOCK

The UNLOCK commands unlock the settings on the front panel.

Example:

UNLOCK

4.2 SYSTEM COMMANDS

4.2.1 SET Commands

FIELD ID	OPERANDS / Comments
SET LNKDL=nnn<CR>	Sets the channel-to-channel link delay from 0 to 600 ms (milliseconds)
SET MODE=AUTO, MAN, RESET<CR>	Sets the MODE to Auto or Manual. Provides the capability of resetting the communications hardware.
SET T1FMT=ESFL, ESFN, D4L, D4N<CR>	Sets the framing mode to ESF or D4 for either local or network connections.

4.2.2 READ Commands

FIELD ID	OPERANDS / Comments
READ BDWTH<CR>	BDWTH=0-100(999 is returned if no link modules installed or enabled)<CR>
READ LNKDL<CR>	LNKDL=0-600 M<CR>
READ MODE<CR>	MODE=Auto/Manual<CR>
READ T1FMT<CR>	FRAME=ESFL, ESFN, D4L, D4N<CR>

4.3 CHANNEL COMMANDS

4.3.1 SET Commands

FIELD ID	OPERANDS / Comments
SET CLEAR=LN<CR>	Clears errors per channel(LN is the number of the channel)
SET ENBL=LN,[YES,NO]<CR>	Enables or Disables the link
SET LNBLD=LN,[133ft, 266ft, 399ft , 533ft, 655ft, -7.5dB, -15db, -22.5dB]<CR>	Select the Line Buildout to match the physical characteristics of the link. This setting should be determined based on T1 network service provider installation wiring etc.

4.4 READ Commands

FIELD ID	RETURNED STRING
READ LOC=LN<CR>	ID=NNL<CR>(NN = Slot number, L = channel A or B)
READ ENBL=LN<CR>	ENBL=LN,[YES,NO]<CR>
READ LNBLD=LN<CR>	LNBLD=LN,[133FT, 266FT, 399FT, 533FT, 655FT, -7.5dB, -15dB,-22.5dB]<CR>
READ RXERSEC=LN<CR>	RXERSEC=LN,[NNNNNNN]<CR>
READ TXERSEC=LN<CR>	TXERSEC=LN,[NNNNNNN]<CR>
READ OPERSEC=LN<CR>	OPERSEC=LN,[NNNNNNN]<CR>