INSTRUCTIONS

For

MODEL 2349

DLTM4
DATA LINK TEST MODULE

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TABLE OF CONTENTS

210 South 3rd Street, North Wales, PA 19454
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TABLE OF FIGURES

TABLE OF TABLES

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APOGEE LABS

MODEL 2349

DLTM4
DATA LINK TEST MODULE

1. FEATURES

- **Independent Transmit & Receive Functions**
- **Bit Rate from 100 bps to 50 Mbps**
  - **Adjustable in 1 bps steps**
- **Internal Synthesizer or External Clock**
  - **20 ppm Accuracy and Stability**
- **Input/Output Bit Code Selection:**
  - **NRZ-L/M/S; BiP-L/M/S;**
  - **RNRZ-L; DM-M/S**
- **Link Delay Measurement**
  - **Round Trip or simplex**
- **Simulates Doppler Shift**
- **User Configurable Measurements**

2. PURPOSE OF MODULE

The Model 2349 DLTM4 provides the capabilities needed to perform bit-error-rate performance testing of data links and associated hardware, such as PCM bit synchronizers and frame synchronizers. Data bit rates from 100 bps to 50 Mbps are supported. Measurement capabilities include: Bit Error related tests, bit slip tests, and measurement of round trip data link delay.

Basic input and output interfaces included on the module may be supplemented by the addition of I/O interface modules at the system level.

3. FUNCTIONAL DESCRIPTION

The transmitter and receiver contain independent circuits to generate test data and to receive and detect errors using either pseudo-random number (PRN) data sequences or time division multiplexed (TDM) programmed data values (PCM data). No operator intervention is required to initiate the data synchronization process, regardless of link delays. Data code conversion is included for all IRIG-106 codes. Figure 1 is a functional block diagram of the DLTM4 module.

The PRN Receiver automatically synchronizes a local data generator to the received PRN data sequence. The error free locally generated data stream is compared bit-by-bit to the input data to detect and identify errors.

When using the PCM mode of operation, the format instructions entered into the transmit (TX) memory are copied into the receive (RX) memory. The PCM Receiver monitors the received data stream, locates the frame sync pattern and synchronizes a local data generator to the delayed PCM data being received. Bit by bit comparisons are made between the received data and the local data generator to detect and identify received errors.

The module occupies three slots in an AL4300-LCD or AL6300-LCD chassis.

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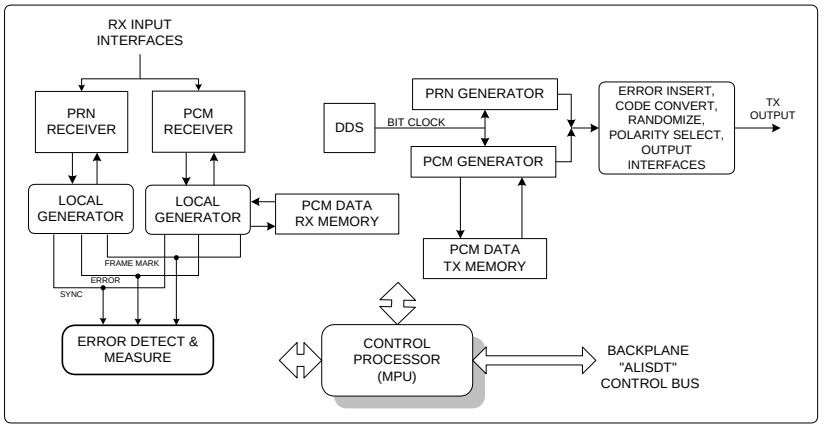

Figure 1: Model 2349 DLTM4 Block Diagram

4. SPECIFICATION

TEST MODES

Accumulate (manual reset and re-start)
Time-Based Interval (1 second to 500 hours)
Bit-Based Intervals (10 to 10^{12} bits)

MEASUREMENTS

Received Bit Rate
Bit Count
Receiver Re-Syncs (slips)
Bit Error Count
Ones in Error
Bit Error Rate
Bit Slip Probability
Symmetry
Frames in Error
Seconds in Test
Seconds in Error
Link Round-Trip Link Delay
One-Way Link Delay

ENVIRONMENT

Operating temperature: 0° to +50° C
Relative Humidity: 0 to 95%, non-condensing
Requires 3 card slots

TX / RX COMMON FEATURES

Bit Codes

NRZ-L/M/S, BIP-L/M/S, DM-M/S, RNRZ-L

PRN Patterns: Forward and Reverse

2^7-1, 2^9-1, 2^{11}-1, 2^{15}-1, 2^{20}-1, 2^{23}-1, 2^{31}-1

TDM Format

4-32 bit Frame Synchronization
Up to 4096 words/frame
8, 16, 32 bits per word
General and Unique Data

TRANSMITTER

Bit Rate

100 bps to 50 Mbps
User selectable Doppler shift rates

Error Injection

One Error per Command
Constant Rate 10^{-2} to 10^{-6} error rates
Uniform or random distribution

Blanking

10 to 4096 bits every 64 to 1024 bits
Free running or Synchronized to frames

Force output to all zeros

Force 1 TX bit slip

RECEIVER

Auto Synchronization

PRN or TDM

Signal Polarity Selection

Clock and/or Data Normal or Inverted

INTERFACES

TTL - 50/75 ohm, BNC Connector
RS422 - 120 ohm
BiPolar Output - 100 bps to 35M bps (2V p-p)

POWER CONSUMPTION

4.8 Watts

5. INSTALLATION

5.1 GENERAL

The DLTM4 module is the test data generator / receiver and measurement device used in the AL6300-LCD Data Link Test Set. It also may be used in the AL4300-LCD series equipment in combination with Apogee Labs data multiplexing / demultiplexing devices. The module is self-contained: transmitter, receiver, and measurement functions are combined with a microprocessor that supports front panel and remote control operations. Signal input and output connections are provided on the circuit board I/O panel. The module does not connect to the data paths on the chassis backplane. Only DC power is drawn and front panel communication occurs with the chassis. When used in the AL6300-LCD chassis, front panel LCD status indicators are connected to the module. These indicators are user-configurable to illuminate for conditions that benefit the user. All operating firmware is contained on the module. Therefore, installation of a DLTM4 in the field is accomplished simply by plugging it into an Apogee Labs LCD chassis.

5.2 MODULE PLACEMENT CONSIDERATIONS

The DLTM4 plug-in module requires three card slots and can be placed in any slot of an AL6300-LCD chassis .When placing the DLTM4 in an AL4300-LCD chassis, it also may be placed anywhere within the chassis. When placing the DLTM4 in a chassis that also contains multiplexing equipment, in the interest of operational efficiency, it is best to place this module in the card slot at the far right side of the multiplexing cards facing the rear of the chassis.

Module position has an effect on front panel and remote control operations. When the PAGE/NEXT/PREV keys are depressed, the next or previous card slot is activated for front panel operations. Remote control of a module is governed by the slot in which the module resides. The Slot number of each installed module is determined by the slot number along the top that is white.

5.2.1 SYNC STATUS INDICATION (AL6300-LCD CHASSIS SYNC DISPLAY)

Located on the top of the front panel LCD display of an AL6300-LCD or AL4300-LCD chassis are a row of status indicators. These indicators are user configurable and can be set to turn green or red depending on what the user set as fault conditions. Any status field can be monitored and a condition can be set to change the status indicator from one color to another.

5.3 CONNECTION & PHYSICAL CONFIGURATION

The DLTM4 module outputs and inputs serial test data with an associated coherent clock. The signaling to this module may be either TTL or RS-422. The TTL serial input connectors are BNC type with shield connected to chassis and digital ground. RS-422 signals are to be found on the Triaxial connectors.

An external, user supplied, TTL level bit-clock may be used in place of the internally generated clock. This is called system timing (ST). This signal is applied to a BNC connector. It is recommended that good quality coaxial cables be used for all signal connections. Figure 2 illustrates the connector panel and side view of the module. Table 1 provides the termination configuration for the DLTM4. Table 2 provides definitions for each connector and an associated reference line drawing of the I/O panel detailing the location and designation of the connectors.

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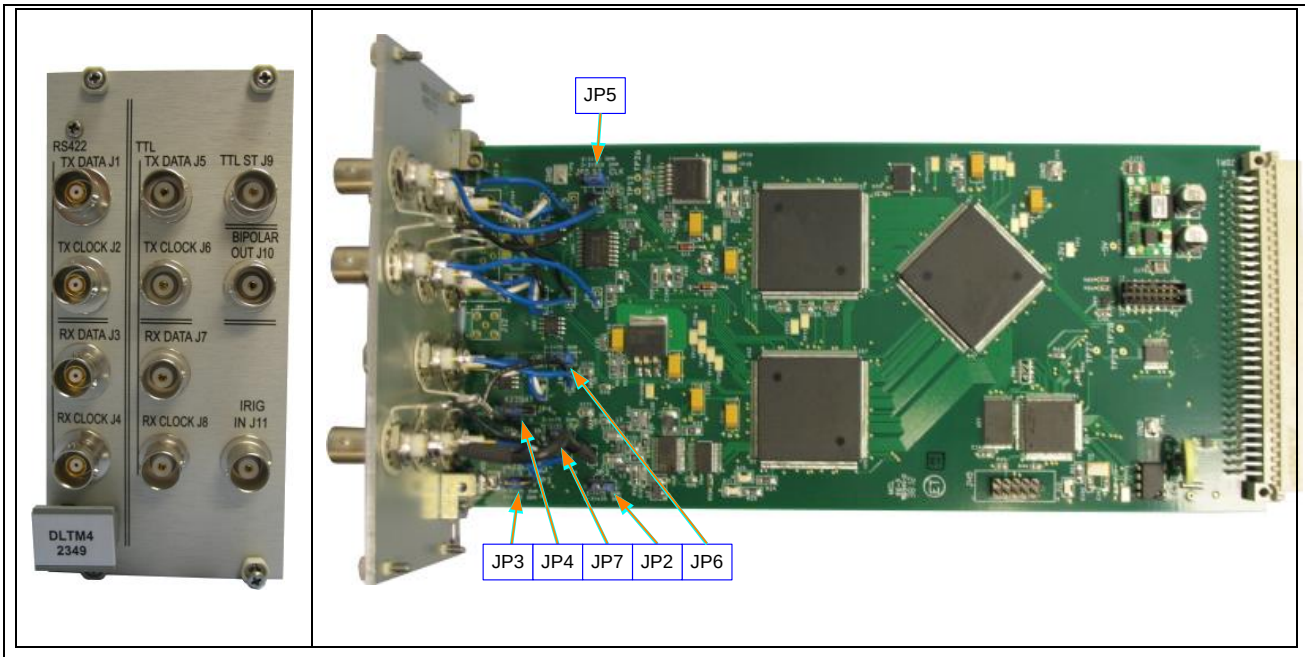


Figure 2: Model 2349 Connection Panel and Side Views

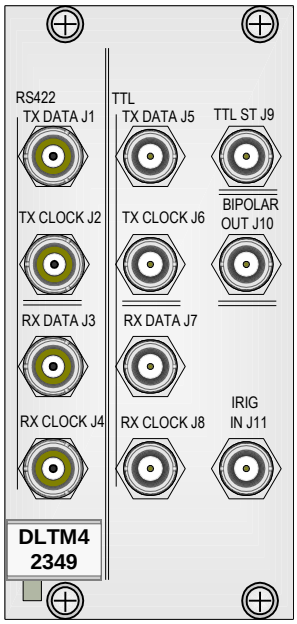
The BNC input connections are terminated on the module. Jumpers are installed or removed to select the desired value of shunt resistance. Table 1 defines the resulting shunt resistance for given jumper configurations. Figure 2 indicates the location of each jumper.

Table 1: Jumper Configuration

Signal		Jumper	Shunt Resistance		
Name	Connector		Jumper 2-3	OPEN	Jumper 1-2
SYSTEM TIME (ST)	J9	JP5	50Ω	10KΩ	75Ω*
TTL RX DATA	J7	JP6	50Ω	10KΩ	75Ω*
TTL RX CLOCK	J8	JP7	50Ω	10KΩ	75Ω*
RS422 RX DATA	J3	JP4	75Ω	Invalid	110Ω*
RS422 RX CLOCK	J4	JP3	75Ω	Invalid	110Ω*
IRIG	J11	JP2	600Ω*	600Ω	75Ω

*Default configuration.

Table 2: I/O Connector Definitions



Reference	Signal Name	Standard	Direction*
J1	TX DATA	RS-422	OUT
J2	TX CLOCK	RS-422	OUT
J3	RX DATA	RS-422	IN
J4	RX CLOCK	RS-422	IN
J5	TX DATA	TTL	OUT
J6	TX CLOCK	TTL	OUT
J7	RX DATA	TTL	IN
J8	RX CLOCK	TTL	IN
J9	System Time (ST)	TTL	IN
J10	BiP DATA	BIPOLAR	OUT
J11	TIME	IRIG-B	IN

*Direction is in reference to the DLTM4 (OUT means out of DLTM4).

The Input and Output circuits for each of the interfaces are shown in the following figures. Both interfaces, TTL (Figure 3 and Figure 5) and RS-422 (Figure 4 and Figure 6) present inputs and outputs for data and clock. Both data and clock are supported by the typical circuit presented. The BiPolar circuit (Figure 7) is an output and does not have a corresponding input circuit. The System Time (ST) input is supported by a typical TTL input circuit.

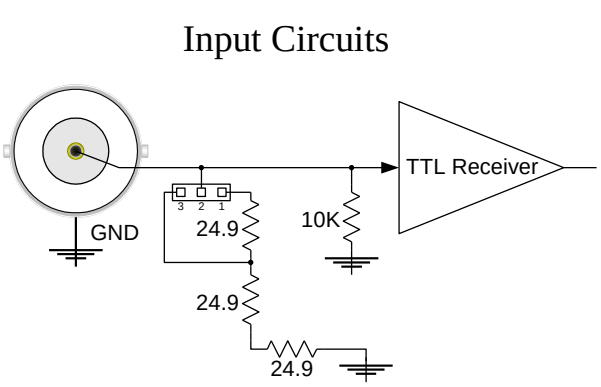


Figure 3: TTL Data, Clock and System Time (ST) Input

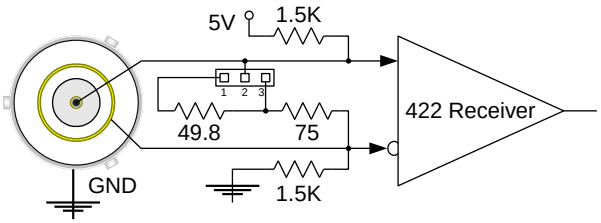


Figure 4: RS-422 Data and Clock Input

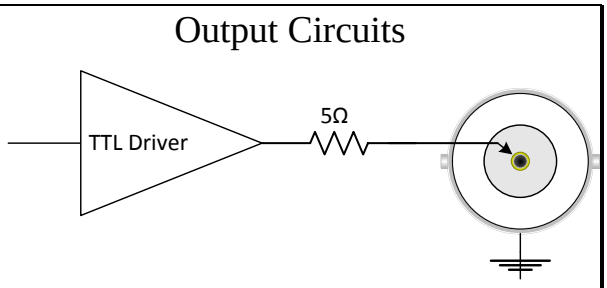


Figure 5: TTL Data and Clock Output

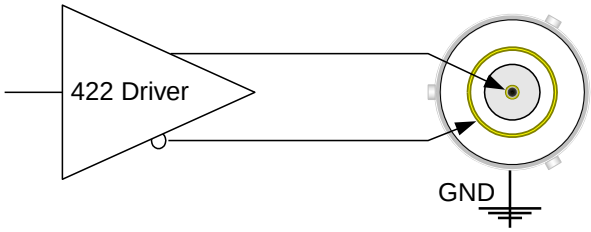


Figure 6: RS-422 Data and Clock Output

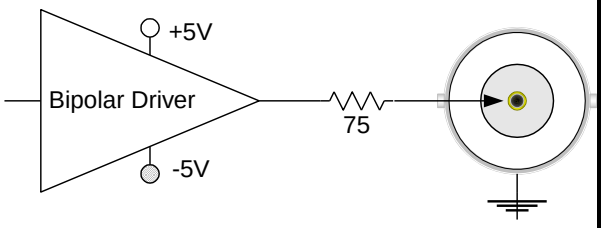


Figure 7: Bipolar Output

5.4 OPERATION

The DLTM4 may be controlled and monitored from the front panel of the chassis in which it is installed or by means of the remote control features provided by that chassis. More detailed information explaining the use of the front panel controls that are used to access and program the menus depicted in the following paragraphs is to be found in the AL6300-LCD or AL4300-LCD Instruction Manual. A brief explanation is presented here.

To change from one module to another module within the AL6301 chassis, press the NEXT or PREV buttons on the top right of the display. This will display the next or previous module in the chassis based on slot location. The current slot location can be determined by which slot number above the indicator lights is shaded white. Note that the DLTM4 module occupies 3 slots, but its front panel location is the lowest slot the module occupies. Below the status indicator will be the module's name, software version and page title.

The DLTM4 has multiple screens for configurations and status. The screens can be navigated between by pressing the function (F*n*) buttons on the right of the display or touching the field on the display.

To change a value of a parameter associated with a given field, use either the directional arrows to move to the field desired or you can use the touch-screen and touch the field wanted to be edited. To modify the field use the INC/DEC buttons to change text values. Use the numeric keypad to edit numeric values. After setting the value, press the enter button.

5.4.1 MEASUREMENTS MENU

The initial screen that the DLTM4 comes to is the Measurements Menu. The Measurements menu is depicted in Figure 8.

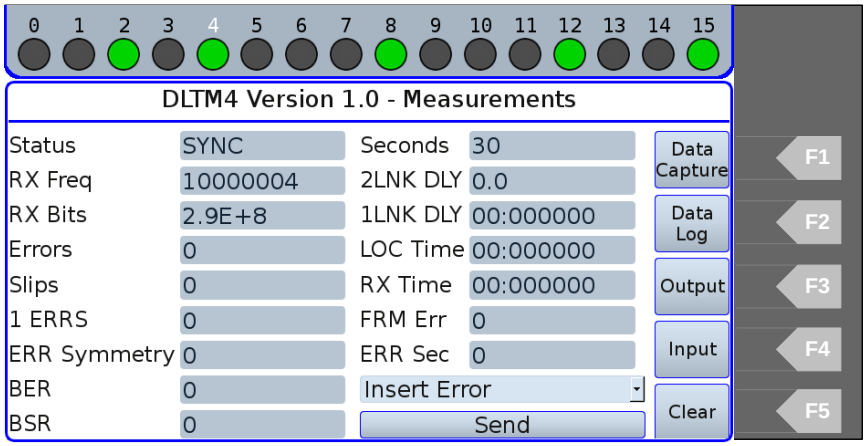


Figure 8: Measurements Menu

The Measurements Display provides status of the currently running test. The Clear (F5) button clears out any current measurements and allows the test to continue running. The action field is associated with the send button. The action field allows the user to select between different actions to perform during a test. The table bellows describes the actions.

Table 3: Selectable Definitions of the actions field on the Status Screen

Selectable Function	Definition
Insert Error	Invert a single bit in the output bit stream
Insert Slip	Cause a bit slip resulting in loss of receiver lock
Start Zero	Force the output stream to all Zeros
Stop Zero	Restore normal output data stream
Force Resync	Force the receiver correlator to resynchronize
Freeze Display	Freezes the current values on the display
Update Display	Restores the measurement process
Test link delay	Initiates the data link delay process – Only valid for PRN on a “Clean Link.”

Pressing the send button on the touch-screen performs the actions in the action field.

The other fields on the right (F1-F4) bring up the screen for different menus. See the following sections for descriptions of these screens.

5.4.2 OUTPUT SETTINGS

Selecting the Output Settings screen brings the display shown in Figure 9.

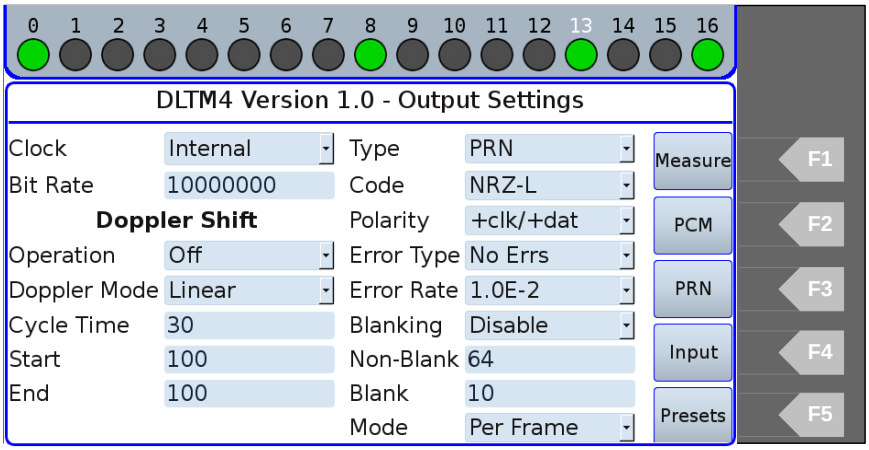


Figure 9: TX SETUP SCREEN

Using this menu, configure the primary functions of the Transmit (output) interface. Each of the fields contained on the display are explained below. The Output settings control the data and clock characteristics, including data content, Doppler shifting, error insertion and blanking.

Table 4: Selectable Definitions of the actions field on the Status Screen

Field	Definition
Clock	Select Internal or External clock. This field is automatically modified to show DOPPLER if the DOPPLER function is selected and enabled.
Bit Rate	Data rate of internal clock from 100 bps to 75,000,000 bps The maximum rate of 75Mbps is valid, but the module is only specified to operate up to 50Mbps. At higher rates, careful attention must be payed to cabling and termination.
Type	Selects the output data source as PRN or PCM data
Code	NRZ-L, NRZ-M, NRZ-S, BiP-L, BiP-M, BiP-S, RNRZ-15, DM-M, DM-S
Polarity	+clk/+dat, -clk/+dat, +clk/-dat, -clk/-dat (Refer to Figure 10: CLOCK POLARITY SETTINGS and Figure 11: DATA POLARITY SETTINGS)
Doppler Shift	
Operation	The Doppler function is enabled (On) by selecting Single sweep, Cycle sweep or Sawtooth sweep. The Doppler function is disabled by selecting Off.
Doppler Mode	Determines the bit rate change curve. Selecting Curve causes the output bit rate to follow a frequency change curve that emulates the data rate changes received from an orbiting satellite. Selecting Linear results in a bit rate change profile that is a linear ramp function.
Cycle Time	Sets the time to cycle from the START bit rate to the END bit rate; programmable from 1 to 600 seconds.
Start	Starting frequency from 100 bps to 50,000,000 bps
End	Ending frequency from 100 bps to 50,000,000 bps
Error Insertion	
Error Type	No Errs, Periodic, Random
Error Rate	1.0E-2, 1.0E-3, 1.0E-4, 1.0E-5, 1.0E-6

Blanking	
Blanking	Enable or Disable
Non-Blank	Define the number of bits transmitted that remain as intended by the generator before permitting the blanking function to force bits to zero. This value is programmable from 64 to 1024.
Blank	Defines the number of bits after NON-BLANK that are to be forced to zero. This value is programmable from 10 to 4096.
Mode	Free Running or Per Frame as referenced to the start of each frame or PRN sequence.
Function Keys	
F1	Go directly to Measurements display
F2	Go directly to PCM display
F3	Go directly to PRN display
F4	Go directly to Input Settings display
F5	Go directly to Presets display

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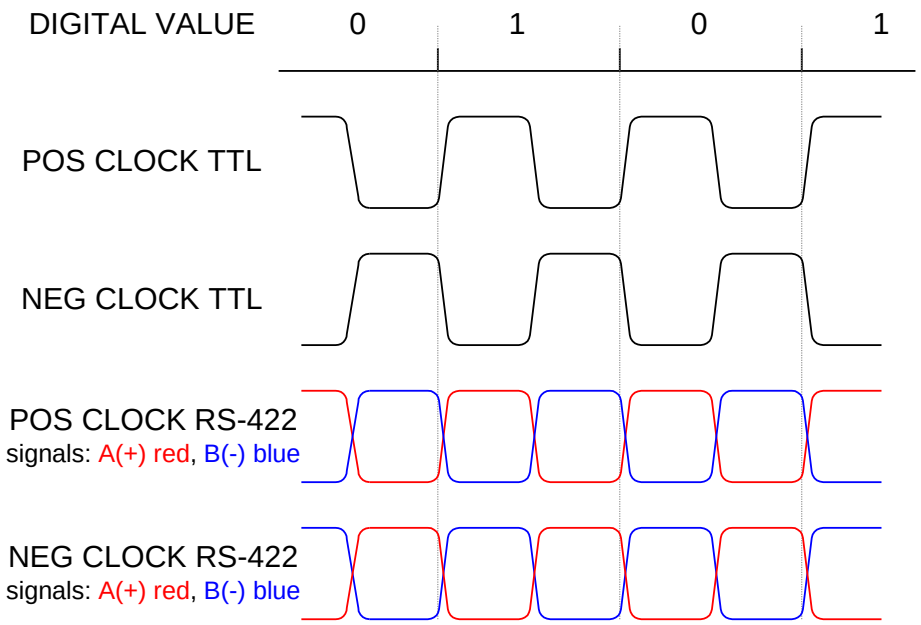

Figure 10: CLOCK POLARITY SETTINGS

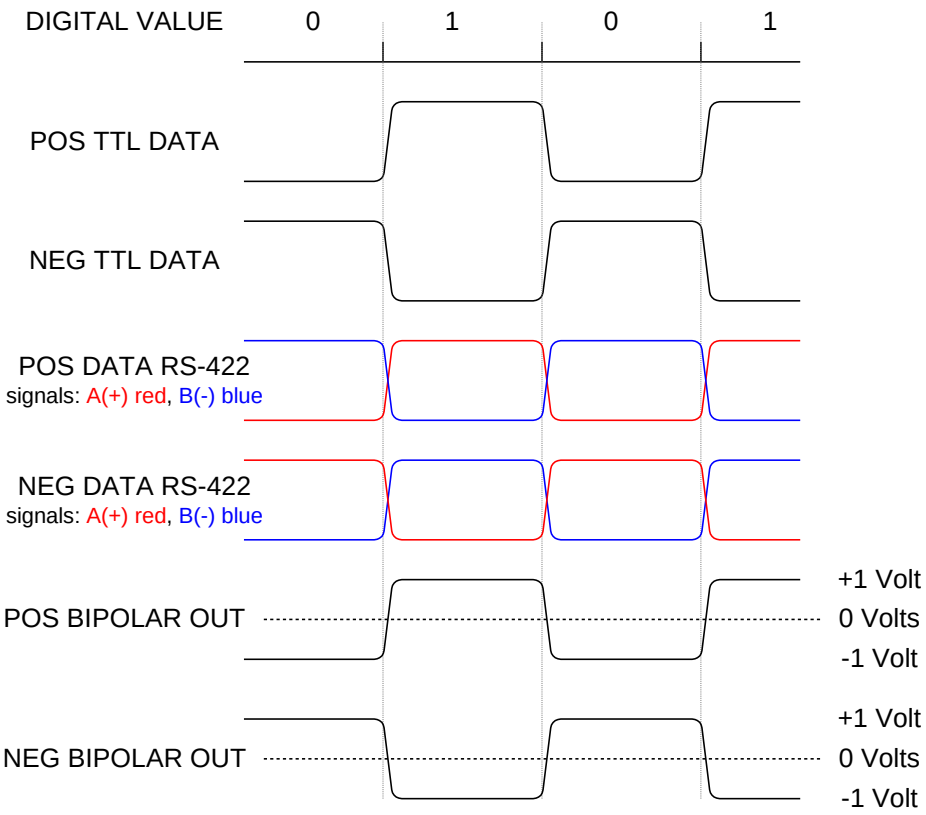

Figure 11: DATA POLARITY SETTINGS

5.4.3 INPUT SETTINGS

The Input Settings display provides the ability to control the parameters associated with the data and clock being received by the DLTM4. This screen is shown in Figure 12.

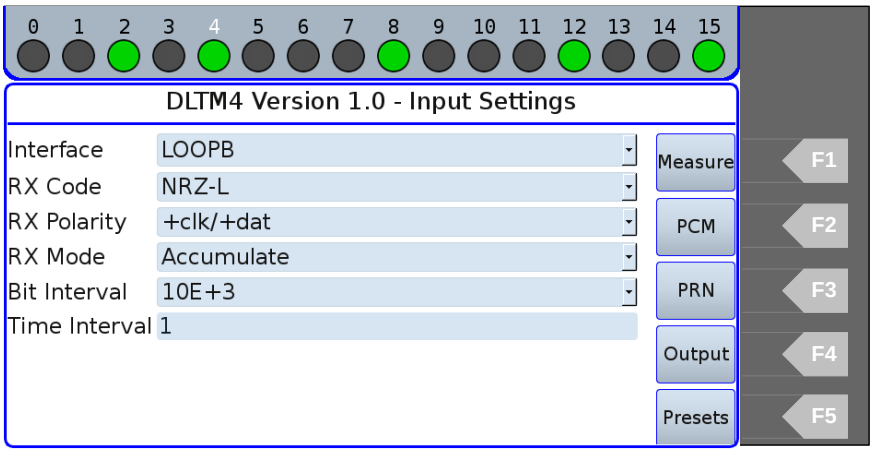

Figure 12: Input Settings Display

This allows the configurations of the ability to control which interface to test and how the data is being received. The descriptions of the options are listed below:

Table 5: Selectable Definitions of the actions field on the RX Settings display

Field	Definition
Interface	TTL, RS422, LOOPB
RX Code	This field is used to select the bit code that is applied to the receiver. The selectable codes are: NRZ-L, NRZ-M, NRZ-S, BiP-L, BiP-M, BiP-S, DM-M, DM-S
RX Polarity	+clk/+dat, -clk/+dat, +clk/-dat, -clk/-dat (Refer to Figure 10 and Figure 11)
RX Mode	Accumulate: collect data continuously. Timed: collect data per time period. Bit Period: collect data per defined number of bit periods
Bit Interval	This field defines the test period in bits if the RX MODE is set to Accumulate. The number of bits is selectable to be: 10E+1 through 10E+12 If the RX MODE is set to Timed, the test is based on elapsed time and is programmable from 1 to 1,800,000 seconds.
Function Keys	
F1	Go directly to Measurements display
F2	Go directly to PCM display
F3	Go directly to PRN display
F4	Go directly to Output Settings display
F5	Go directly to Presets display

5.4.5 PRN SETTINGS

The PRN SETUP screen is used to define the pseudo random number sequence and its generator direction. The information on this screen is only pertinent if, on the Output SETUP screen in Figure 9, the TYPE is set to PRN.

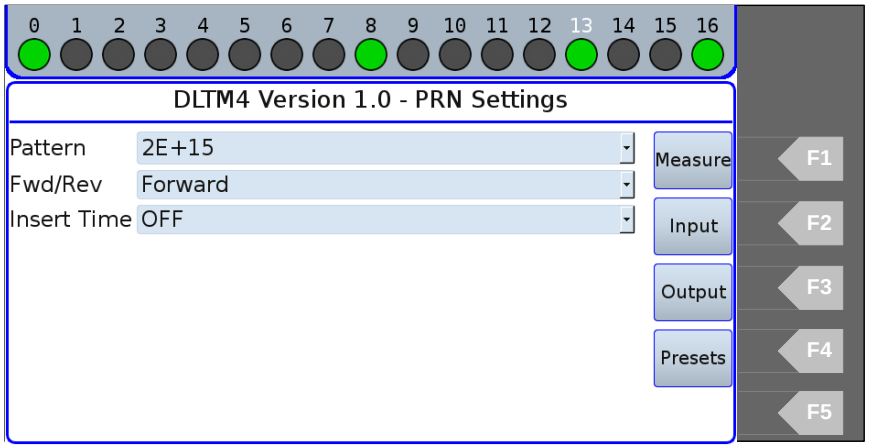

Figure 13: PRN Generator Setup Screen

The following table describes the fields from the PRN Setting display.

Table 6: Selectable Definitions of the actions field on the PRN Settings display

Field	Definition
Pattern	Select the pseudo random data sequence (PRN) length from: 2E+7, 2E+9, 2E+11, 2E+15, 2E+20, 2E+23, 2E+31
Fwd/Rev	Defines the direction of the PRN pattern generation as Forward or Reverse
Insert Time	ON/OFF. This tells the DLTM4 to insert the IRIG time into the PRN stream for link delay testing
Function Keys	
F1	Go directly to Status screen
F2	Go directly to Input Settings display
F3	Go directly to Output Settings display
F4	Go directly to Presets display

5.4.6 PCM SETTINGS

The DLTM4 is programmable to output either a PRN data sequence or a simulated time-division-multiplexed (TDM) PCM data stream. The PCM Settings display is used to configure the fixed parameters of the TDM stream. Dynamic data associated with the stream are configured in this menu and in the EDIT PCM menu (Figure 15).

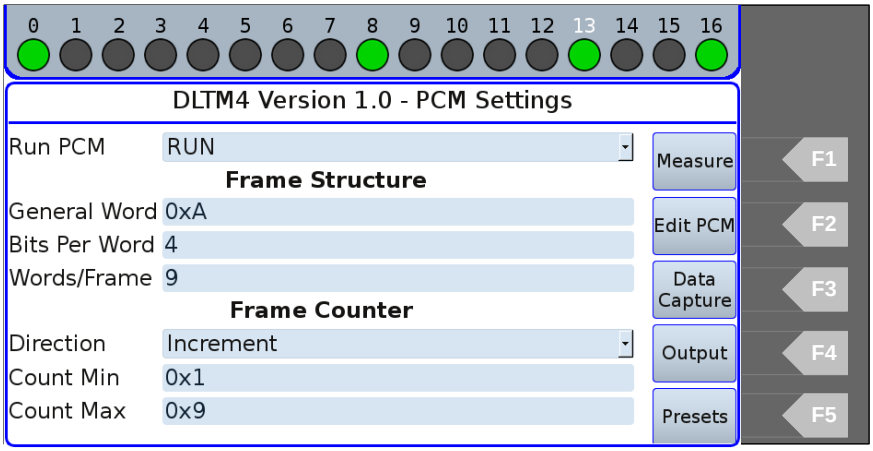

Figure 14: PCM SETUP SCREEN

The PCM Settings display provides for turn the PCM output on or off. It also allows from the general frame size and The Frame Counter changes once per frame and is configured to operate according to the user's settings.

Table 7: Selectable Definitions of the actions field on the PCM Settings display

Field	Definition
Run PCM	RUN/HALT This field tells the DLTM4 whether to output the PCM data or not, this must be set to RUN for the PCM to be output.
Frame Structure	
General Word	This defines the "General Word", which is a word that can be defined for inclusion in the PCM frame in the EDIT PCM display.
Bits per Word	This defines the number of bits per word in the PCM frame. This can be set from 4 to 16 bits.
Words/Frame	This defines the number of words in the PCM frame. This can be set from 8 to 4096 words.
Frame Counter	
Direction	Increment/Decrement – This tells the frame counter if it counts up or down.
Count Min	Set to 0x0 or 0x1. This defines the lowest value for the Frame Counter.
Count Max	From 0x1 to 0xFFFF. This defines the highest value for the Frame Counter.
Function Keys	
F1	Go directly to Status screen
F2	Go directly to the Edit PCM display
F3	Go directly to the Data Capture display
F4	Go directly to Output Settings display
F5	Go directly to Presets display

NOTE:

1. **Programming changes cannot be made to any PCM related function while the program is running.**
2. **Type must be set to PCM in Output SETUP menu for a PCM program to run.**

5.4.7 EDIT PCM

The EDIT PCM menu permits the definition of the TDM output data stream. Up to 4096 data words per frame may be generated using a combination of instructions defined in Table 8.

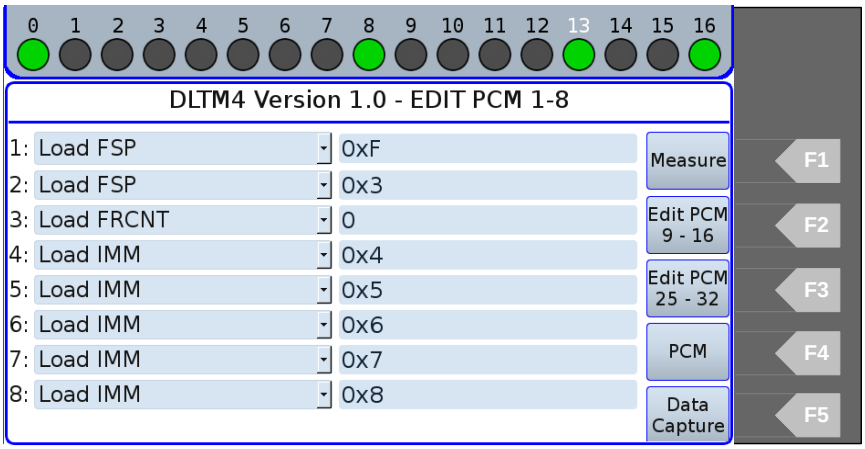

Figure 15: PCM DATA EDIT SCREEN

Up to 32 instructions are accepted for this process. The EDIT PCM display is divided into up to three sub-screens that are accessed by using the F2 and F3 function keys. The instruction numbers are displayed at the left of each sub-screen. On the left column the type up data must be selected. On the right column, the data is placed that corresponds to the instruction to the left of it. Any values placed that exceed the frame length ate ignored.

Table 8: Selectable Definitions of the actions field on the EDIT PCM display

Instruction	**Definition**
Load FSP	Transmit bits for the sync pattern. The FSP in location 1 is the first word and the FSP in location 2 is the second word.
Load IMM	Transmit a user programmable immediate hex value from command data field
Load FRCNT	Transmit a frame counter (setup in FRCNT)
Repeat	Repeat the preceding command N times where N is a decimal value programmed in command data field
Function Keys	
F1	Go directly to Measurements display
F2	Go directly to the instruction sub-screen listed
F3	Go directly to the instruction sub-screen listed
F4	Go directly to the PCM Settings display
F5	Go directly to the Data Capture display

Note: Programming PCM functions must be done in Halt Mode only.

5.4.8 DATA LOG SETUP

Automatic logging of test data results is supported by the DLTM4. The Data Log Setup display in Figure 16 permits the user to configure this automatic feature.

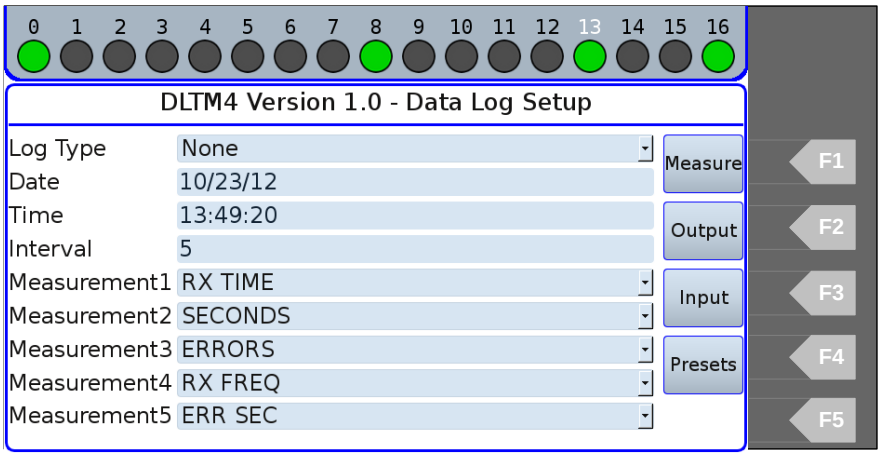

Figure 16: Data Log Setup Display

The current date and time can be entered by the user if needed. There are five measurements that are displayed on the Data Log Setup in the Measurement 1-5 fields are reported following the date and time. These fields can be any of the fields from the Status Display (in Table 3).

Data Log records are transmitted through the remote programming port

Table 9: Selectable Definitions of the actions field on the Data Log Setup Display

Field	**Definition**
Log Type	This field is set by the user to select the data logging mode. Three selections are offered: None, Interval and On Change. Selecting None disables the Data Log process. The Interval mode causes a report to be generated at the expiration of the number of seconds specified in the LOG TIME field. Selecting the On Change mode causes a report to be generated each time a measurement changes from its previous value. The On Change mode should not be used if measurements are expected to change at a rapid rate.
Date	Operator entry field for the current date in mm/dd/yy format
Time	Operator entry field for the current time in hh/mm/ss format
Interval	Interval in seconds between data log records if the DATA LOG field is set to Interval
Measurement*n*	This field allows selection of any measurement from the Status display for logging
Function Keys	
F1	Go directly to Measurements display
F2	Go directly to the Output Settings display
F3	Go directly to the Input Settings display
F4	Go directly to the Presets display

5.4.9 PRESETS

The Presets display allows the saving and recalling of configurations to and from memory. The display is shown below.

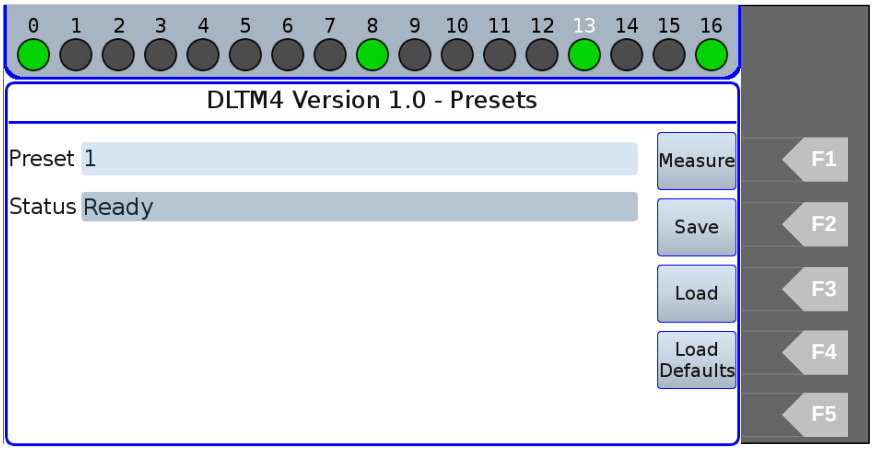

Figure 17: PRESET Control Screen

The PRESET menu is used to define a Preset file number *nn*, in the range from 1 to 30, to which the current module program is to be stored or from which the module is to be loaded. All setup registers and memory locations required to operate the program are stored or retrieved.

Table 10: Selectable Definitions of the actions field on the Presets display

Field	**Definition**
Preset	File Number of the current program to be Saved or the number assigned to a previously Saved program to be Loaded, 1 to 30
Status	Status indication for the saving or loading process. The message Ready indicates that the process is idle and awaiting an operator action. Saving indicates that the current program is being saved as a result of the operator pressing F1. After requesting the module to be loaded by depressing F2, the status indication Loading is displayed. If the requested Preset file number is invalid, the status No Preset is displayed.
Function Keys	
F1	Go directly to Measurements display
F2	Save the Current settings to the Preset file number specified
F3	Load the current settings to the Preset file number specified
F4	The Load defaults command does not clear out any of the Preset fields, but preps the unit to come up in a factory default configuration on the next power cycle. The presets will still be saved and will not be cleared out.

NOTE: When saving to a Preset, data saved from the Edit PCM menu only include the data words that are included within the active words (as defined by Words/Frame field). Refer to PCM Setup Figure 14 for information on configuring the frame size.

5.4.10 DATA CAPTURE

The Data Capture display provides the facility to capture and display up to four selected words that are being received from the incoming TDM PCM data stream. Figure 18 shows what this display looks like.

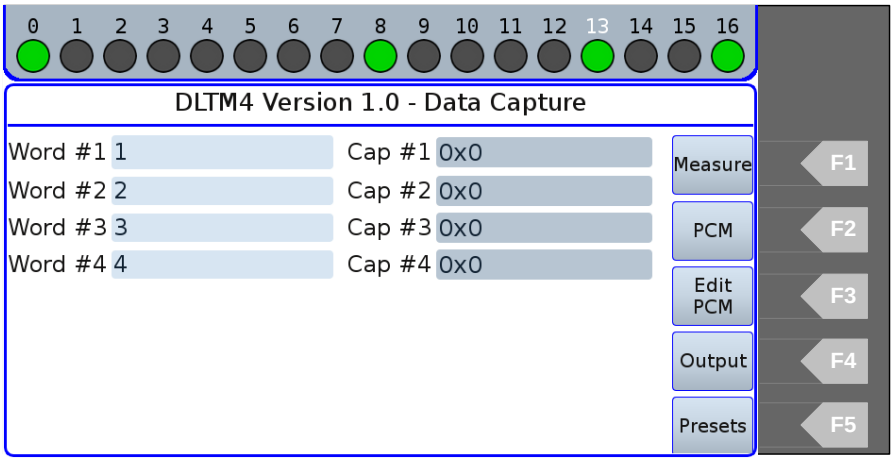

Figure 18: DATA CAPTURE Screen

The Word number (Word #*n*) is input on the display. The data capture field (Cap #*n*) displays what word is received in that word location (in hexadecimal format). The Word #*n* is entered in decimal format.

Table 11: Selectable Definitions of the actions field on the Presets display

Field	**Definition**
Word # 1 through 4	The operator enters the Word number to capture from the PCM data stream. This value is programmable from 1 to 4096 decimal.
Cap # 1 through 4	Displays the captured data value in hexadecimal format.
Function Keys	
F1	Go directly to Measurements display
F2	Go directly to the Edit PCM display
F3	Go directly to the Edit PCM display
F4	Go directly to Output Settings display
F5	Go directly to Presets display

5.5 REMOTE COMMANDS

5.5.1 SET

SET is used to assign values to program registers. The SET command has two fields separated by a comma: the register and the operand. The register is the desired programming field to be programmed. Refer to the DLTM programming pages for the allowable register names and values for each field.

Example:

SET CLOCK, EXTERNAL

5.5.2 READ

READ is used to interrogate values saved in program registers. The READ command has one field to designate the register. The register is the desired programming field to be interrogated. Refer to the DLTM4 programming menus for the register field names.

Examples:

READ CLOCK

READ PROG1 will return the PCM line 1

5.5.3 HELP

Issuing the HELP command to the DLTM4 after it is selected by using the SLOT command to select the module.

5.5.5 SAVE/LOAD

The SAVE command saves the current settings to the preset group number specified by the PRESET number. The LOAD command retrieves and replaces the current program with the settings from the preset group number specified by the PRESET number.

Example:

set preset=1

save

set preset=2

load

5.6 COMMAND DEFINITIONS

Table 12: Total Instruction Set

Field	Returned Value / Comments	Found in Sub-Menu
CLEAR	Clear received bit counter and accumulated error data.	Figure 8
FREEZE	Freeze received bit counter and error accumulation data. Consecutive Freeze commands update accumulated data values to the current values with no further accumulation.	Figure 8
UPDATE DISPLAY	Set received bit counter and error accumulation to continuous run mode.	Figure 8
ERROR	Insert a single error into the data stream	Figure 8
SLIP	Insert a single bit slip into the data stream	Figure 8
START ZERO	Start insertion of continuous zeros into the data stream.	Figure 8
STOP ZERO	Stop insertion of continuous zeros into the data stream.	Figure 8
STATUS	Returns SYNC status, SYNC, NO SYNC, NO DATA, NO CLOCK	

Table 12: Total Instruction Set

Field	Returned Value / Comments	Found in Sub-Menu
TEST LINK DELAY	Initiates the link delay test and places the result into the LINK DLY field for display. Requires far-end of data link to be looped-back.	Figure 8
CLOCK	Internal, External External requires input at the ST Clock connector.	Figure 9
BIT RATE	100 – 75000000 in bits per second The maximum rate of 75Mbps is valid, but the module is only specified to operate up to 50Mbps. At higher rates, careful attention must be payed to cabling and termination.	Figure 9
OUTPUT CODE	NRZ-L, NRZ-M, NRZ-S, BiP-L, BiP-M, BiP-S, RNRZ-15, DM-M, DM-S	Figure 9
TX POLARITY	+clk/+dat, -clk/+dat, +clk/-dat, -clk/-dat	Figure 9
TYPE	Select the data source to PCM or PRN	Figure 9
PATTERN	2E+7, 2E+9, 2E+11, 2E+15, 2E+20, 2E+23, 2E+31	Figure 13
FWD/REV	Set either the Forward or Reverse form of the selected PRN sequence	Figure 13
INSERT TIME	Turns on or off the insert time (IRIG) into the PRN stream. Set to either ON or OFF	Figure 13
FIRST TX	Set the first bit transmitted to MSB (left-most) or LSB (right-most)	Figure 14
BITS	4 – 16	Figure 14
WORDS/FRAME	8 – 4096	Figure 14
WORD #1	1- 4096 / Capture word 1 extraction location	Figure 18
WORD #2	1- 4096 / Capture word 2 extraction location	Figure 18
WORD #3	1- 4096 / Capture word 3 extraction location	Figure 18
WORD #4	1- 4096 / Capture word 4 extraction location	Figure 18
ERROR TYPE	No Errs, Periodic, Random	Figure 9
ERROR RATE	10E-2, 10E-3, 10E-4, 10E-5, 10E-6	Figure 9
BLANKING	Enable, Disable	Figure 9
NON-BLANK	64 – 1024 / bit periods	Figure 9
BLANK	10 – 4096 bit periods set to zero	Figure 9
MODE	Set Blanking mode to Free Run or Per Frame	Figure 9
INTERFACE	TTL, RS422, LOOPB	Figure 12
RX POLARITY	+clk/+dat, -clk/+dat, +clk/-dat, -clk/-dat	Figure 12
RX MODE	Accumulate, Timed, Bit Interval	Figure 12
BIT INTERVAL	10E+1, 10E+2, 10E+3, 10E+4, 10E+5, 10E+6, 10E+7, 10E+8, 10E+9, 10E+10, 10E+11, 10E+12	Figure 12
TIME INTERVAL	Test period in seconds for data to accumulate being begin cleared out. Values can be between 1 and 1,800,000 seconds.	Figure 12

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Table 12: Total Instruction Set

Field	Returned Value / Comments	Found in Sub-Menu
RX CODE	NRZ-L, NRZ-M, NRZ-S, BiP-L, BiP-M, BiP-S, RNRZ-15, DM-M, DM-S	Figure 12
START	100 to 50000000 / measured in bits per second	Figure 9
END	100 to 50000000 / measured in bits per second	Figure 9
CYCLE TIME	1 – 600 / measured in seconds	Figure 9
DATE	xx/xx/xx / The current date as mm/dd/tt	Figure 16
TIME	xx:xx:xx / The current time as hh:mm:ss	Figure 16
LOG TIME	1 to 9999 / The Logging interval indicated in seconds	Figure 16
DATALOG	None, Interval, On Change	Figure 16
RX BITS	Read Only / The number of received bits	Figure 8
ERRORS	Read Only / The number of detected errors	Figure 8
SLIPS	Read Only / The number of detected bit slips	Figure 8
1 ERRS	Read Only / The number of ones found to be in error	Figure 8
SYMETRY	Read Only / Reports the ratio of ones to zeros in %	Figure 8
BER	Read Only / Reports the bit-error-rate	Figure 8
BSP	Read Only / Reports the Bit Slip Probability	Figure 8
FRM ERR	Read Only / Reports the number of Frames containing errors	Figure 8
ERR SEC	Read Only / Reports the number of Seconds containing errors	Figure 8
RX FREQ	Read Only / Reports the measured Receive bit rate	Figure 8
CAP #1	Read Only – Data from Capture word 1	Figure 18
CAP #2	Read Only – Data from Capture word 2	Figure 18
CAP #3	Read Only – Data from Capture word 3	Figure 18
CAP #4	Read Only – Data from Capture word 4	Figure 18
PRESET	1 – 30 / Select a previously stored Preset format definition by its number	Figure 17
STATUS	Ready, Saving, Loading / Status of the Preset process	Figure 17
CNT MIN	0, 1 / The minimum value of the Frame Counter	Figure 14
CNT MAX	1-0Xffff / The maximum value of the Frame Counter	Figure 14
CNT INC/DEC	INCREMENT, DECREMENT / The count direction of the Frame Counter	Figure 14
1LNK DLY	READ ONLY / The measured Link Delay of IRIG based test in micro-seconds.	Figure 8
2LNK DLY	READ ONLY / The measured Link Delay of bidirectional based test in micro-seconds.	Figure 8
PC##	The PCM Command value sets the field that is to be set or read from the PV## field. This can be a value from 1 to 32 decimal.	Figure 15

Table 12: Total Instruction Set

Field	Returned Value / Comments	Found in Sub-Menu
PV##	The PCM Value field sets the value that is to be set or read into/from the value defined in the PC## field. Reading or editing a PCM field is a two-step process. First set the PC## to select which command to read/edit, then read/set the PV## to read/edit the value.	Figure 15

6. APPLICATION NOTES

6.1 GENERALIZED DATA LINK TESTING

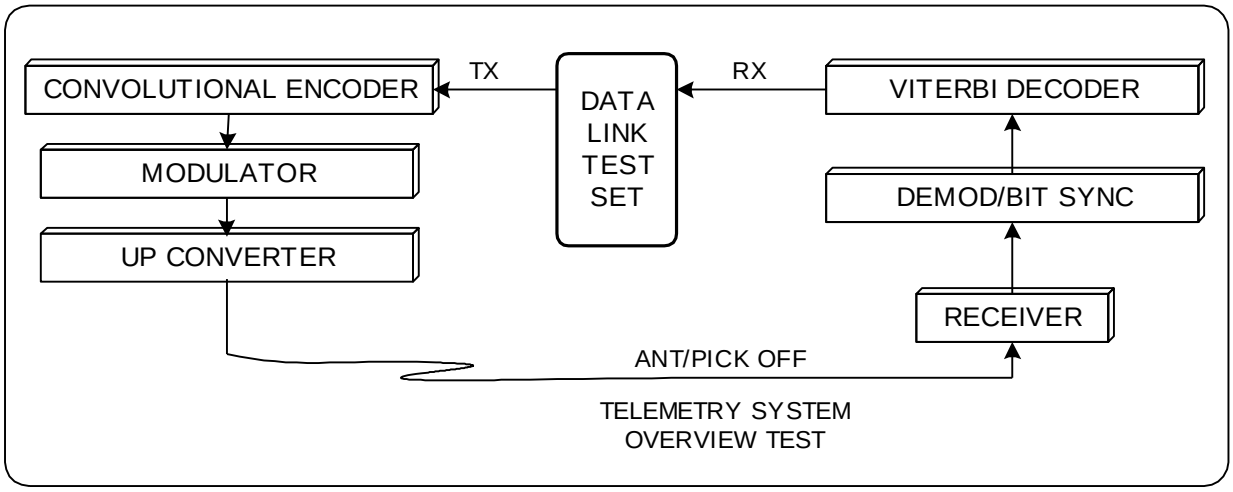

Figure 19: Typical Telemetry Data Link Block Diagram

The block diagram above illustrates a typical telemetry uplink and receive station loopback test configuration involving several types of equipment. Testing of these devices can benefit from using more than a simple bit error rate tester. This note identifies several unique requirements that the AL6300 Data Link Test Set addresses.

6.1.1 "I" & "Q" CHANNELS

Multiple DLTM4 modules may be housed in a single AL6300 DLTS chassis. Two channels are used to test independent "I" & "Q" channels in a QPSK data link. Operation at the same rate can be achieved by slaving one DLTM4 module transmitter to the other using the external clock input (ST). Therefore two independent data streams can be generated with a matched clock phase and frequency. The two channels can alternately be operated at different rates in an unbalanced QPSK data link.

6.1.2 ERROR SIMULATIONS

The DLTM4 Transmitter provides a number of useful error insertion tools. These errors are inserted after the PRN or PCM data is generated and before the IRIG bit-code converter.

6.1.2.1 Insert One Error

The first error type is the inversion of a single bit per command. This command provides a quick way to verify that the DLTM4 receiver, which is showing ZERO errors, is actually connected and properly functioning when it detects and displays the single error.

6.1.2.2 Insert Known Error Rate

This feature is useful when testing the DLTM4 receiver and display or for testing the error recovery

6.1.3 BLANKING

The Blanking feature forces a program-selectable number of data bits to the zero state after bit coding is applied. This simulates line dropouts and provides a measure of the ability of a bit synchronizer to achieve or maintain Lock during and after data periods without transitions. The DLTM4 allows the number of blanked bits to be set and it provides two operating modes. The first is a 'free-run' mode where the blanks are inserted after a programmable number of normal bits. For example, blank 100 bits then output normally for 900 bits. The second mode is 'frame synchronized' where the blanking begins a selectable number of bits after the start of the PCM (or PRN) frame and occurs only once per frame. This feature is handy when it is desired to erase a certain field in the PCM data stream.

6.1.4 SYMMETRY TESTS

Data symmetry is the ratio of data '1' bits to data '0' bits. PRN data begins with symmetry of 50%, an equal number of 1's and 0's in the long run. Thus if a link has a biasing problem, for example if the receiver discriminator is offset from the transmitted frequency, there may be a greater tendency to change 0's into 1's or vice versa. The DLTM4 detects and reports this bias.

The AL6300 DLTS provides a count of 1's in error and a symmetry calculation to support this kind of investigation. With random errors, the symmetry should show 50% with PRN data making the evaluation straightforward. While displaying the number of bit errors and 1's in error, FREEZE the AL6300 display updates and compare these numbers. Normally the 1's in error should be about half of the total bit errors. Any bias becomes apparent. An alternative method is to display the calculated SYMMETRY value, which is constantly updated by operating the AL63001 receiver in the periodic mode (vs. accumulate). The display is updated with the results of tests conducted every measurement period (10^6 bits, for example). This allows the operator to make adjustments in the link transmission and reception equipment while monitoring its effect on the symmetry.

Many times, a link may test good when using PRN data due to the large number of data transitions and the 50% data symmetry, only to have problems when PCM mission data begins to flow due to A.C. coupling. Pattern effects are detected by using the DLTM4 PCM data mode with a programmed frame format that resembles the data to be encountered. The unit allows data word values to be specified so that fewer transitions and data symmetry characteristics can be accurately modeled.

6.1.5 PULSE CODED MODULATION

Using PCM data allows more of the equipment in a link to be verified in addition to just the serial data link functions shown in Figure 19. Frame synchronizers, computer ingests and display systems, strip chart recorders, etc. can all be tested. The error insertion capability of the DLTM4 allows equipment performance to be evaluated under noisy path conditions. For example, a test might be conducted to determine how random errors in the data affect a strip chart display.

6.2 GENERATING PCM DATA STREAMS

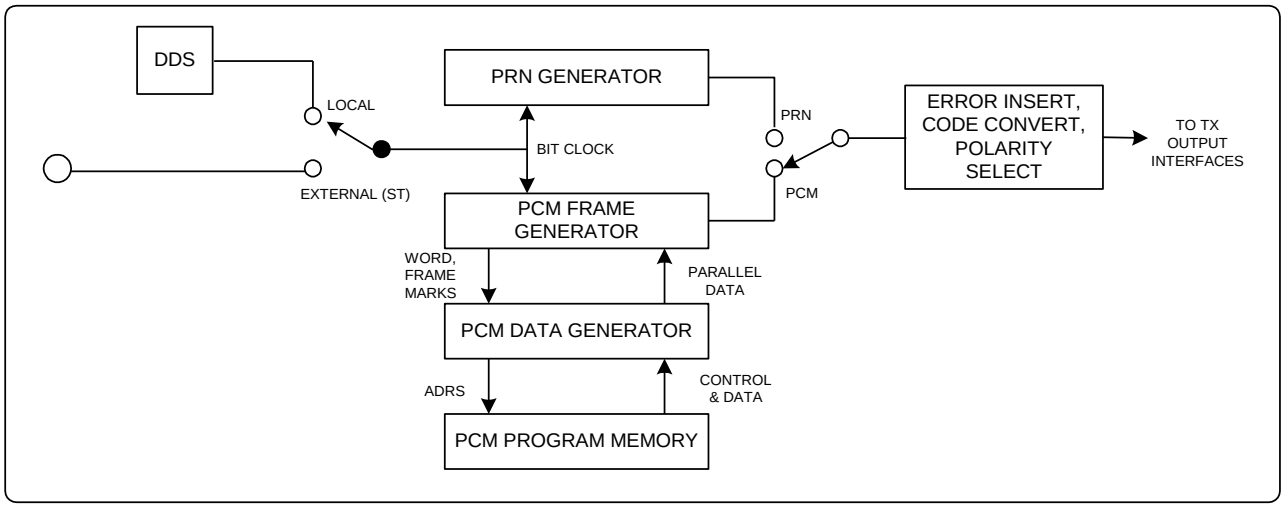

Figure 20: DLTM Transmitter Block Diagram

As detailed in Figure 20 above, the DLTM4 provides the ability to generate PCM data streams in addition to PRN data. This note provides a few examples of simple PCM streams used to test links and other equipment in the data link system.

5.4.10 BASICS

Two steps are required to define a TDM PCM data stream:

- describe the overall PCM frame format
- define the data values to be placed in it.

6.2.1.1 PCM SETUP

A separate menu is provided that allows the PCM frame to be defined:

- Sync Pattern
- Bits per Word (all words in the frame are the same length)
- Words per Frame
- MSB / LSB first (which direction the data is serialized)

6.2.1.2 EDIT PCM

This menu allows up to 32 instructions to be entered that control the content of the output TDM PCM frame. At the start of each TDM PCM frame, the first instruction in the list is executed, and then the second and so on until the last word of the frame (as defined by the Words per Frame setup) is output. Then the process repeats.

The instructions are simple:

LOAD FSP	Output the 1st and 2nd 16 bits (or fraction thereof if Bits per Word is < 16 bits) of the Sync Pattern
LOAD IMM	Output the data value immediately following this command
REPEAT	Repeat the previous LOAD instruction ‘n’ times
FR CNT	Outputs a count per frame (setup the Frame Counter)

The LOAD IMM instruction allows unique values to be placed anywhere in the frame. It can also be used with the REPEAT instruction to output a series of the same value (General / Background value).

6.2.1.3 SETUP THE FRAME COUNTER:

The Frame Count commands (Figure 14) are used to configure the Frame Counter and are part of the PCM SETUP menu (Figure 14). The Frame Counter is a binary counter that increments or decrements by one count in each frame.

5.4.10 EXAMPLES OF TDM PCM FORMATS

6.2.2.1 EXAMPLE #1

Output a simple pattern to evaluate a link with a 75% symmetry characteristic

(3 ones for each zero……111011101110…..).

PCM SETUP

Sync Pattern = 0xEEEE 0xEEEE; this is the data value (in HEX)

Bits per Word = 16

Words per Frame = 8

MSB / LSB first = MSB (If set to LSB the bit stream is reversed)

EDIT PCM

1 - LOAD IMM, EEEE; output the desired pattern:

set pc02=load imm

set pv02=0xEEEE

2 – REPEAT 7; fill out the PCM stream with all '1110' values

6.2.2.2 EXAMPLE #2

Output a simple frame of 16 words defined as follows:

PCM SETUP

Sync Pattern = FAF3 3400

Bits per Word = 16;

Words per Frame = 16; for 256 bits / frame

MSB / LSB first = MSB; desired direction

EDIT PCM

1 – PC01 = LOAD FSP; PV01 – 0xFAF3

2 – PC02 = LOAD FSP; PV02 – 0x3400

3 – LOAD IMM, 0000; General pattern will be all zeroes

4 – REPEAT 7; 8 total words of zero

5 – LOAD IMM, 1248; Unique value 1248 in word # 11

6 – LOAD IMM, 0000

7 – REPEAT 4; 5 words (12 through 16) containing 0000

6.2.2.3 EXAMPLE #3

Generate a PCM frame of 4096 words and include the Frame Counter.

PCM SETUP

Sync Pattern = FAF3 3400; using 32 bit Sync Pattern

Bits per Word = 16; use the largest number of hits per frame

Words per Frame = 4096; use the largest number of words per frame

MSB / LSB first = MSB;

FRCNT SETUP

CNT MIN = 0; Set the minimum value of the counter to 0

CNT MAX = FFFF; Have the maximum value of the counter be 0xFFFF

CNT INC/DEC = INC; Start with 0 and increment until 0xFFFF, then wrap around to 0

EDIT PCM

1 – PC01 = LOAD FSP; PV01 – 0xFAF3

2 – PC02 = LOAD FSP; PV02 – 0x3400

3 – LOAD FRNCT; load the frame counter into word 3

4 – LOAD IMM = 0001; load 0001 as the next word

5 – REPEAT = 4092; repeat 0001 for the rest of the word

6.3 MEASURING LINK DELAY ON A FULL DUPLEX LINK

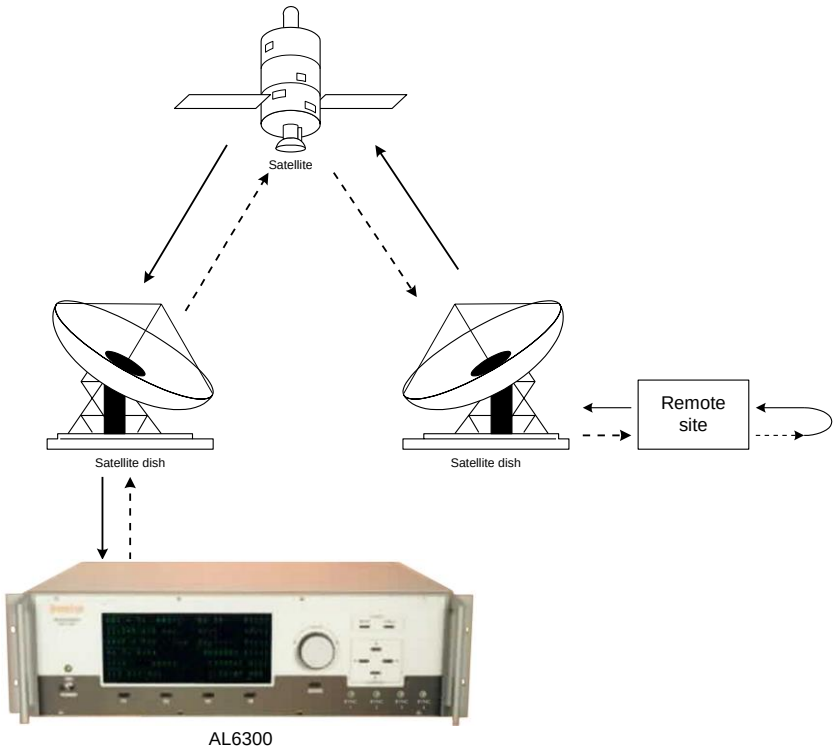

Figure 21: Basic Setup for Measuring Link Delay

The DLTM4 provides the facility for a user to measure the time delay introduced by a data path. This provides an easy solution for determining the path delay of a data communication system, such as through a satellite path.

Link delay is measured directly on the DLTM4 (Model 2349). The DLTM4 is configured to run PRN data through the system with the data being looped back to the DLTM4. To measure the link delay, an error is automatically inserted into the PRN pattern. The time it takes for that error to propagate through the link and back is measured; this value represents the full loop link delay. In the diagrammed example shown in Figure 21, the measured time represents the time to propagate twice the length of the link. The delay measurement is repeated to determine the average delay to account for any system variance in the data path. The DLTM takes into account internal delays caused by data rate and internal circuitry. Thus, the actual delay through the link is reported.

Because the delay is measured by inserting a known error into the data, link delay can only be measured in an error-free link. The value of the link delay is measured and displayed to an accuracy of one tenth of a microsecond.

5.4.10 SETUP & CONFIGURATION

The following steps describe the setup for the DLTM4 to configure it to measure the link delay on a full duplex system:

1. The system that is being tested is configured in full loop-back mode. Data from the DLTM4 passes through the system to be tested and is looped back at the remote end and returned back to the DLTM4.
2. The Transmit Side (Output Settings) is set up to run in PRN mode. The rest of the transmitter settings are configured to be compatible with the data being sent. Data and clock from either the TTL TX or RS422 TX are connected to the input of the link to be tested. On the Output Settings page, set the data rate.
3. The Receive Interface (RX Settings) is configured to be compatible with the data and interface electronics at the return link.
4. Observe the MEASURE screen and verify that the system is running and that it is passing error-free data through the system. If errors are present, check the ERRORS screen to verify that No Errors are programmed to be introduced into the transmit stream. If errors are still being received, verify that the interfaces are configured correctly. The Link delay cannot be accurately measured on a corrupted data link.

5.4.10 MEASURING THE LINK DELAY

After an error free link is established, the link delay can be measured by using the Status display.

1. In the right column, change the actions field to Test Link delay.
2. Verify that the data is running error free, press F5 (CLEAR) to clear the error counter. If data is running error free, press the Send button to initiate the measuring of the link delay.
3. The measured delay is displayed (in microseconds) in the 2LNK DLAY data field. Verify that no errors occurred in the ERRORS field. If an error occurs it may trigger the link delay measurement prematurely, which renders the measurement invalid.
4. Steps 3 and 4 are repeated to take subsequent measurements of the link delay.

6.4 DOPPLER SHIFT WITH THE DLTM4

The DLTM4 Data Link Test Module is programmable so as to simulate data rate changes due to Doppler Shift caused by the relative motion between the data source and the listening station. This is commonly seen when receiving a signal from a spacecraft. The DLTM4 mimics Doppler Shift by increasing and decreasing the output bit rate according to a programmed model. The shift in output bit rate is user set to follow one of three patterns: SINGLE, SAWTOOTH, or CYCLE output. Refer to section 5.4.14 for complete definitions of these modes. The bit rate change curve that is followed is determined by the setting of the setting of the DOP MODE field. Setting this field to Linear produces a linear change in output bit rate that follows the setting of the cycle time value in bits per second per second. Setting the DOP MODE to CURVE causes the rate of change of the output bit rate to follow a curve that emulates that which is caused by the motion of a satellite. The example setup below causes the output bit rate to follow the satellite curve.

- Program the DLTM4 to generate a PRN data pattern of whatever length that is appropriate for the system under test.

- Setup the transmit and receive interfaces and data coding to be compatible with the data link connections. Turn-off Blanking and Error generation.
- Configure the Doppler menu (Figure 9) as follows:
  - Set the START and END frequencies. These may be set up in either ascending or descending order.
  - Set the DOP MODE to Curve to emulate the motion effect of a satellite or set this field to Linear, which causes the output bit rate to change on a straight line function.
  - Program the CYCLE TIME to the period, in seconds, that it is desired for the output bit rate to change from START to END values.
  - Set the OPERATION to SINGLE, to generate single frequency sweep from START to END then stop; SAWTOOTH, create back to back cycles from START to END; or select CYCLE, which generates back to back cycles from START to END and END to START.

To demonstrate the effect of the Doppler setup without connecting to a data link, connect a BNC cable from the TTL DATA TX to the TTL DATA RX and a second BNC cable from the TTL CLK TX to the TTL CLK RX, on the DLTM4 I/O panel.

Select the Status Display (Figure 8) and set one of the fields to display the RX FREQ. The displayed bit rate will cycle from the Start to the End value at the rate set in the CYCLE TIME field.

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