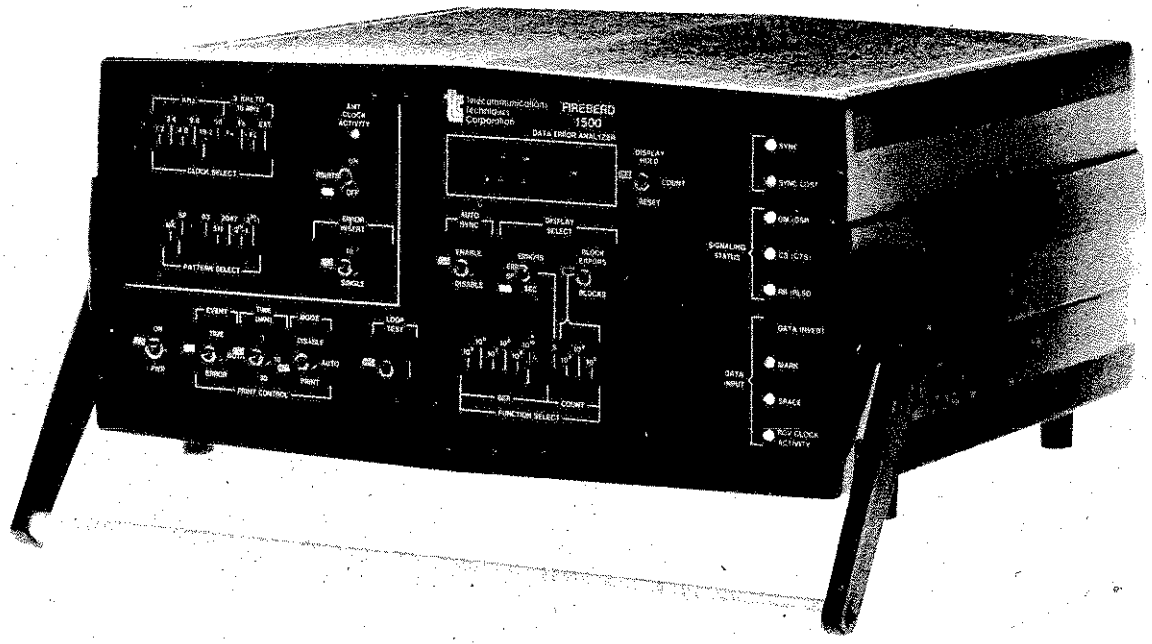
FIREBERD 1500

DATA ERROR ANALYZER

OPERATING MANUAL



Telecommunications Techniques Corporation T.M. A DYNATECH CO.

EXPECT EXCELLENCE

TABLE OF CONTENTS

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TABLE OF CONTENTS (Cont'd)

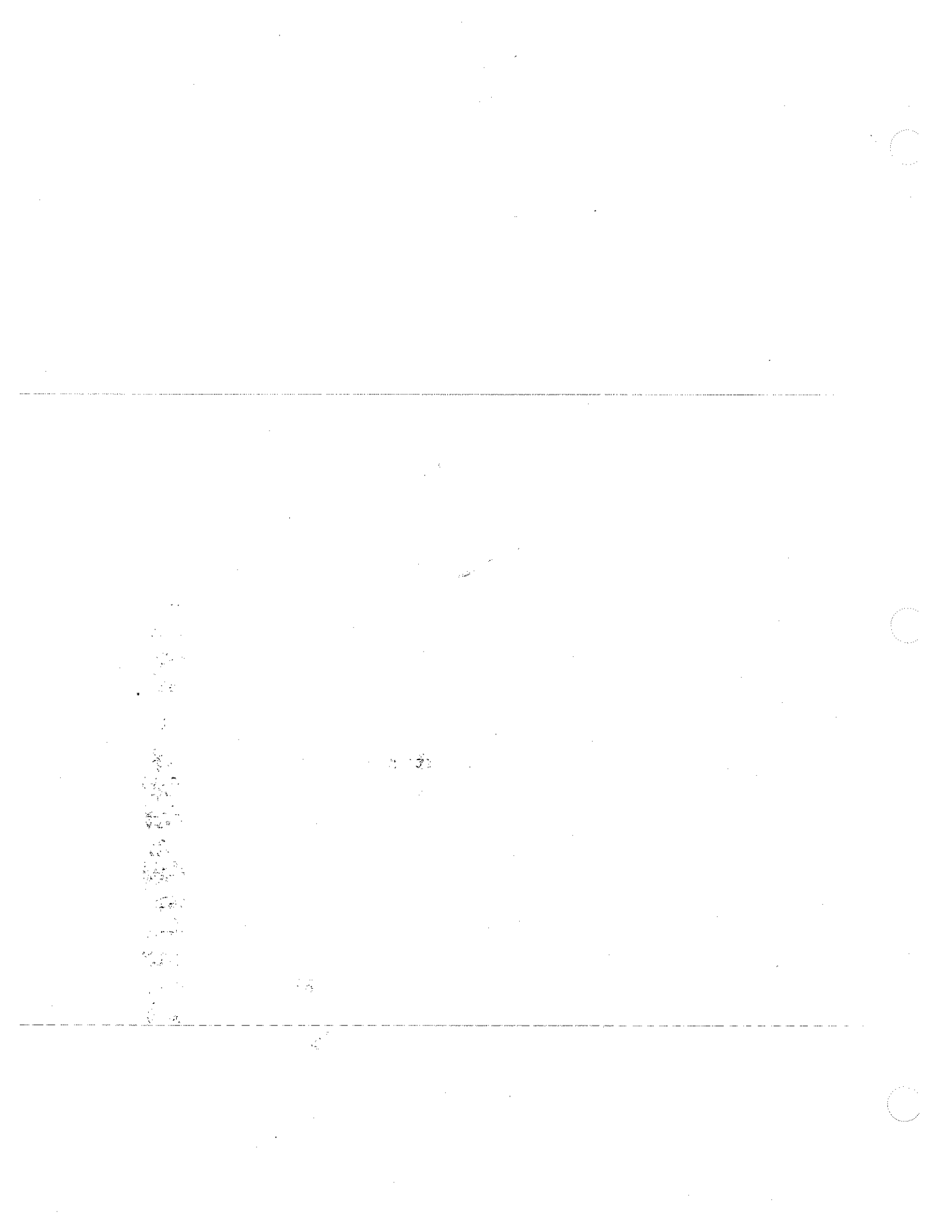

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

LIST OF ILLUSTRATIONS

LIST OF TABLES

The following sections have been intentionally omitted:

6.5 WECO 303 INTERFACE ADAPTOR MODULE
6.6 DS1 INTERFACE ADAPTOR MODULE
6.7 LAB INTERFACE ADAPTOR MODULE

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

This Operating Manual contains information required to install and operate the FIREBERD 1500 Data Error Analyzer. This section contains general information relating to the FIREBERD 1500. This information includes instrument identification, specifications, instrument description, options, accessories and initial inspection procedure. Other sections contain information on front and rear panel controls, indicators and connectors, operation, printer interfaces, data interface modules, options, accessories, and service.

1.2 INSTRUMENT IDENTIFICATION

An identification sticker is attached to the rear panel of each instrument. The serial number on this plate should be quoted in any correspondence with TTC. This manual is applicable to all instruments with serial number 005 and up.

1.3 SPECIFICATIONS

- Test Patterns: Pseudorandom sequences of length 63, 511, 2047, 2^{15}-1, and 2^{20}-1. Constant mark, constant space and alternating mark-space
- Bit Rate: 300 Hz to 10 MHz
- Internal Standard Clock Frequencies: 1.2, 2.4, 4.8, 9.6, 19.2, and 56 kHz
- Internal Optional Clock Frequencies (up to 3): 300 Hz to 10 MHz
- Internal Clock Accuracy (std. or opt. clocks): 50 PPM accuracy 0 to 50°C (optional: 1 ppm accuracy at 25°C and 5 ppm stability from 0 to 40°C)
- Block Length: 10^3, 10^4, or 10^5 bits
- BER Test Length: 10^5, 10^6, 10^7, 10^8, 10^9 or 10^{10} bits

- BER Range: 1 to 10^{-10} errors/bit
- Error Insertion: Single error or constant 10^{-3} error rate
- LED Indicators: Sync, Sync Lost, Receive Data Invert, Receive Clock Activity, Transmit Clock Activity, Receive Data Mark, Receive Data Space, DSR (DM), CTS (CS), RLSD (RR)
- Input/Output Signals via Interface Modules: TX Clock Out, TX Clock In, TX Data, RCV Data, RCV Clock, DSR (DM), CTS (CS), RLSD (RR), RTS (RS), DTR (TR)
- Signals at Rear Test Points (TTL Levels): TX Sync, RCV Sync, RCV Data, RCV Clock, RCV Data Error
- Interfaces: RS-232, V.35, MIL-188C, RS-449 (RS-423 or RS-422), DS1, WECO 303, Lab
- Size: 6" x 12" x 12"
- Weight (approx.): 9 lbs.
- Power: Switch selectable 100/120/220/240 VAC. $\pm$ 10% 50/60 Hz
- Environmental: 0 to 50°C operating range

1.4 DESCRIPTION

The FIREBERD 1500 is designed to aid in troubleshooting and evaluating digital communication systems. It generates a variety of test patterns which are transmitted through the system. The receiver counts discrepancies between what is received and what was transmitted. The FIREBERD 1500 has an independent transmitter and receiver which can be used to either provide loop-around or end-to-end testing capability.

The FIREBERD 1500 measures bit error rate, bit errors, block errors, error seconds and total seconds of test at any data rate between 300 bps and 10 Mbps. Additional measurement features include automatic polarity detection, automatic synchronization and the ability to count through error bursts. These capabilities will be described later in more detail.

All data and clock signals interface with the FIREBERD 1500 via rugged plug-in modules which insert through the rear panel. Each module meets a different standard interface specification and includes the standard connector.

Full self-test capability is provided. This feature allows the entire FIREBERD 1500 and the interface module in use to be tested without any additional test equipment.

The FIREBERD 1500 provides an RS-232 printer interface and printer controls as standard equipment. An IEEE 488 printer interface is also available. This interface can be used to output directly to a 488-compatible printer. Alternatively, this interface allows the FIREBERD 1500 to act as an "addressable talker" in a 488 bus configuration.

A six digit display and a variety of front panel indicators provide measurement results and the status of the system under test. Rear panel test points allow data from the system under test to be further analyzed with an oscilloscope.

1.5 OPTIONS

The following options extend the usefulness of the 1500.

Option No.	Description
001	RS-232C Data Interface Module
002	V.35 Data Interface Module
003	MIL-188C Data Interface Module
004	WECO 303 Data Interface Module & Cable
005	RS-449 (422/423) Data Interface Module
006	DS1 Data Interface Module
007	Lab Data Interface Module
008	Thermal Printer with Serial RS-232 Interface (with cable)
009	IEEE 488 Interface (Addressable Talker Only)
010	Rack Mount Assembly - FIREBERD & Printer
011	Thermal Printer Paper (12 rolls)
012	High Stability (1 PPM) Internal Clock
013A	One Additional Internal Clock Rate* - 50 PPM
013B	One Additional Internal Clock Rate* - 1 PPM
014A	Two Additional Internal Clock Rates* - 50 PPM
014B	Two Additional Internal Clock Rates* - 1 PPM
015A	Three Additional Internal Clock Rates* - 50 PPM
015B	Three Additional Internal Clock Rates* - 1 PPM
016	Carrying Case - (holds FIREBERD, Printer, cables and spare interface modules)

* Customer Specified Frequencies

1.6 ACCESSORIES SUPPLIED

The following accessories are supplied with each FIREBERD 1500:

Power cord
Operating Manual

1.7 ACCESSORIES AVAILABLE

The following accessories are available:

RS-232 Interface Cable, 6 ft. long with a male connector at each end.

V.35 Interface Cable, 6 ft. long with a male connector on each end.

RS-449 Interface Cable, 6 ft. long with a male connector on each end.

1.8 INITIAL INSPECTION

Inspect the shipping container for damage. If the shipping container or shipping material is damaged it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section 4.6. If the contents are incomplete, if there is mechanical damage or defect, or if the FIREBERD 1500 does not pass the performance tests, notify TTC. If the shipping container is damaged, notify the carrier as well as TTC. Keep the shipping materials for the carrier's inspection.

SECTION 2
PREPARATION FOR USE

2.1 INTRODUCTION

This section provides operating warnings and power requirements.

2.2 WARNINGS

The following precautions must be observed before and during all phases of operation of the instrument. Failure to comply with these precautions or specific warnings elsewhere in the manual may cause physical harm to the operator or to the instrument. TTC assumes no liability for the customer's failure to comply with these requirements .

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

USE PROPER LINE VOLTAGE SETTING AND FUSE SIZE

Before connecting the AC power cord, verify that the line voltage selector card is positioned for the correct operating voltage. Never operate the instrument with the incorrect fuse size. See Section 2.3 for detailed information on setting the line voltage selection card and proper fuse size.

KEEP AWAY FROM LIVE CIRCUITS

Do not remove instrument covers or insert fingers or other objects through rear panel holes while power is applied to the instrument.

DO NOT SERVICE THE INSTRUMENT

Component replacement and internal adjustments must be made only by qualified maintenance personnel authorized by TTC.

TURN OFF POWER BEFORE INSERTING OR REMOVING INTERFACE MODULES

DO NOT OPERATE IN AN AMBIENT TEMPERATURE ABOVE 50° C

2.3 POWER REQUIREMENTS

The instrument requires a power source of 100, 120, 220 or 240 volts AC $\pm$ 10%, single phase, 48 to 66 Hz that can deliver 60 volt-amperes (maximum).

The instrument is normally shipped from the factory set to operate from a 120 volt power source. To operate the instrument from a different source voltage, proceed as follows:

a. Remove the input power cord.
b. Slide the plastic door to the left.
c. Remove the fuse.
d. Pull the voltage select card straight out.
e. Change the orientation of the voltage select card and reinsert so the appropriate operating voltage is visible on the card after it has been installed.
f. Install the appropriate size fuse (See Table 2-1).
g. Slide the plastic door to the right and reinsert power cord.

TABLE 2-1

FUSE SIZE

Operating Voltage	Fuse Size	Fuse Type
100	½ amp 250V	3AG
120	½ amp 250V	3AG
220	¼ amp 250V	3AG
240	¼ amp 250V	3AG

SECTION 3
INSTRUMENT DESCRIPTION

3.1 INTRODUCTION

This section provides a detailed description of each control, indicator, connector and test point on the FIREBERD 1500. This is followed by a functional description for each of the major elements which make up the instrument.

3.2 CONTROLS, INDICATORS, CONNECTORS and TEST POINTS

Figures 3-1 and 3-2 are photographs of the 1500 front and rear panels, respectively. The numbers on these figures correspond to the numbered descriptions which follow.

3.2.1 Selector Switches

1. PATTERN SELECT

Selects the transmitter and receiver test patterns from: constant mark, constant space, alternating mark-space (1:1), or one of the five pseudorandom patterns (63, 511, 2047, 2^{15}-1, i.e. 32767, or 2^{20}-1, i.e. 1048 575).

2. CLOCK SELECT

Selects the transmit clock from: one of the six standard internal frequencies (1.2, 2.4, 4.8, 9.6, 19.2, or 56 kHz), one of the optional user selected internal frequencies (F_A, F_B, or F_C), or the external input on the plug-in interface module.

3. ERROR INSERT: SINGLE/NONE/10^{-3}

One error is inserted in the transmit data pattern each time this switch is depressed. In the center position, (NONE) no errors are inserted. In the top position, (10^{-3}) a continuous error rate of one error per 1000 bits is inserted into the transmit data stream.

4. RTS: ON/OFF

Controls the state of the Request to Send signalling lead output on the V.35/306, RS-232, RS-449 or WECO 303 Interface Modules. Not applicable when a DS1, Lab or MIL-188 Interface Module is used.

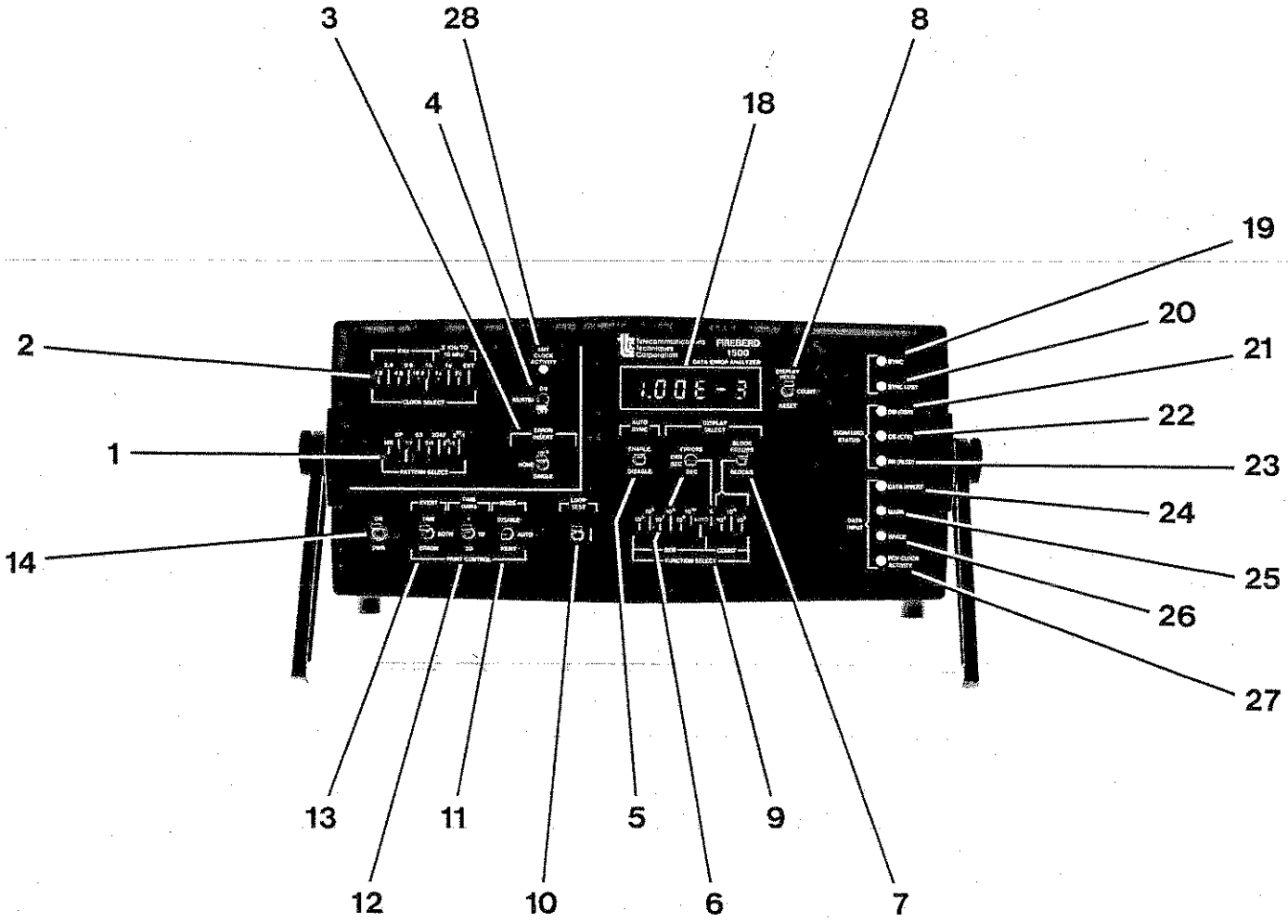

Figure 3-1

FIREBERD 1500 FRONT PANEL

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DWG 40214

5. AUTO SYNC: ENABLE/DISABLE

When the automatic synchronization circuitry is enabled the FIREBERD 1500 receiver automatically locks onto the receive data. In this mode, the receiver will automatically resynchronize and restart the test when synchronization is lost or momentarily interrupted. In the DISABLE position, the receiver is inhibited from resynchronizing when the error rate exceeds 10^{-1}. This allows the unit to perform measurements on channels with high error rates which would normally cause the unit to resynchronize and restart the test. The ENABLE position should be used unless error bursts or error rates greater than 10^{-1} are expected. Section 4.5.5 provides additional information on the synchronization circuitry.

6. DISPLAY SELECT: ERRORS/ERR SEC/SEC

Selects the result to be displayed in Single Error Count mode.

7. DISPLAY SELECT: BLOCK ERRORS/BLOCKS

Selects the result to be displayed in Block Error Count mode.

8. DISPLAY HOLD/COUNT/RESET

Depressing this switch into the RESET position resets the entire instrument and restarts the test when the switch is released. The COUNT position is the normal operating position for the test set. In this position, measurements are performed and the display is updated as new results are available. The DISPLAY HOLD position freezes the result currently being displayed and any other results for the particular operating mode. Measurements continue but new results will not be displayed until the switch is returned to the COUNT position. In the DISPLAY HOLD position, the DISPLAY SELECT switches may be used to view any of the results for the selected operating mode.

9. FUNCTION SELECT

Selects the operating mode of the Error Analyzer. The seven left-most switch positions are variations of the BER mode. The position with an S label is the Single Error Count mode, and the three right-most positions are variations of the Block Error Count mode.

The number over each of the left-most 6 positions indicates the number of bits used to compute the BER. For example, in the 10^7 position, errors are accumulated over a period of 10^7 bits and then the number of errors is divided by 10^7 to get the BER.

In the AUTO BER position, errors are counted over a 10^5 bit interval. After 10^5 bits the BER will be displayed and the test restarted, provided that more than 80 errors have occurred. If less than 80 errors have been counted the test will continue until 10^6 bits have been received at which time the BER will be displayed, provided that more than 80 errors have been counted. If less than 80 errors are present, the measurement will continue until 10^7 bits have been received. In this manner, the test will continue until a result with at least 80 errors is available.

In any of the BER mode switch positions, only one result is available (BER) and both DISPLAY SELECT switches are inactive.

In the Single Error Count (S) position, errors, errored seconds and total seconds of the test are continuously accumulated. The ERROR/ERR SEC/SEC Display Select switch determines which result is displayed.

In the Block Error Count mode (3 right-most switch positions) blocks and block errors are continuously accumulated. The number above each switch position (10^3, 10^4, or 10^5) represents the block length in bits. The BLOCK ERROR/BLOCKS Display Select switch position determines which result is displayed.

10. LOOP TEST

When the LOOP TEST switch is depressed, a relay on the interface module loops the transmit clock and data outputs back to the receive clock and data inputs. At the same time, the relay also isolates the interface connector so that the interface cable need not be removed.

11. MODE: DISABLE/AUTO/PRINT

The DISABLE position inhibits data output from either the RS-232 or IEEE 488 printer interfaces.

In the AUTO position, data will be provided to the printer 1) upon the occurrence of a loss of receiver synchronization in any operating mode 2) at the end of the measurement cycle in BER mode, 3) according to the settings of the EVENT and TIME switches in Single Error Count or Block Error Count mode.

When the MODE switch is depressed into the PRINT position, an immediate printout of all present results occurs.

12. TIME: 1/10/30

Selects the time in minutes between print-outs when the PRINT EVENT switch is in the TIME or BOTH positions. Not applicable for BER mode (see switch number 11).

13. EVENT: TIME/BOTH/ERROR

The TIME position causes printouts at time intervals selected by the TIME 1/10/30 switch. The ERROR position causes a printout on the occurrence of an error. The BOTH position causes printouts both on the selected time intervals and the occurrence of errors. Not applicable for BER mode (see switch number 11).

14. PWR: ON

Applies power to, or removes power from the entire instrument.

15. IEEE 488 Bus Switches

This Switch is included only when the IEEE 488 bus (option 009) is supplied. The right-most switch selects between ADDRESSABLE and TALKER ONLY mode. TALKER ONLY mode is used when the FIREBERD 1500 is connected directly to a printer such as the HP5150A operating in the LISTEN ONLY mode. ADDRESSABLE mode is used when the FIREBERD 1500 is connected on a bus with a 488 Controller on line. The left-most 5 switches are used to set the FIREBERD 1500s address when operating in ADDRESSABLE mode.

16. AUDIO INDICATOR

Sets the internal Audio Indicator to high volume, off, or low volume. The Audio Indicator produces a tone burst on the occurrence of a sync loss. In BER mode, it also produces a tone burst at the end of each measurement cycle. In Single Error Count or Block Error Count mode it produces a tone burst on the occurrence of each error.

17. VOLTAGE SELECT 100/120/220/240

Used to select AC operating voltage. Selector card may be removed by: removing power cord, sliding plastic door to the left, removing fuse and finally removing selector card. Once removed the card may be flipped over and reinserted to select a different operating voltage range. The operating voltage selected is visible through the plastic door once the card is installed.

3.2.2 Indicators

18. SIX DIGIT DISPLAY

Displays test results.

19. SYNC

Indicates that the receiver is synchronized to incoming data. Must be illuminated for test to proceed.

20. SYNC LOST

In AUTO SYNC ENABLE mode this indicator will be illumiated if synchronization has been lost and reacquired since the beginning of the test. In AUTO SYNC DISABLE mode this indicator will flash if the error rate has exceeded 10^{-1} over any 1000 bit interval since the test initialization.

21. DM (DSR)

Illuminates when the Data Set Ready Signalling lead is in the ON condition for the RS-232, WECO 303 or V.35/306 Interface or when the Data Mode signalling lead is in the ON condition for the RS-449 Interface. Not applicable for the DS1, Lab or MIL-188 Interface.

22. CS (CTS)

Illuminates when the Clear to Send Signalling lead is in the ON condition for the RS-232, WECO 303, RS-449 or V.35/306 Interface. Not applicable for DS1, Lab or MIL-188 Interfaces.

23. RR (RLSD)

Illuminates when the Receive Line Signal Detector is in the ON state for the RS-232 or V.35/306 Interfaces or when the Receiver Ready lead is ON for the RS-449 Interface or when the AGC lead is ON for WECO 303 Interface.

24. DATA INVERT

Indicates the incoming received data is inverted with respect to the transmitted data.

25. MARK

Indicates that marks or binary ones are present in the receive data.

26. SPACE

Indicates that spaces or binary zeros are present in the receive data.

27. RECEIVE CLOCK ACTIVITY

Indicates that a receive clock is present at the receiver input.

28. TRANSMIT CLOCK ACTIVITY

Indicates that a clock is present at the pattern generator input.

3.2.3 Connectors

29. IEEE-488 INTERFACE CONNECTOR

Provided when the IEEE-488 Interface (option 009) is supplied.

30. RS-232 PRINTER CONNECTOR

Used to interface with RS-232 printer.

31. AC INPUT

Power input from AC line.

3.2.4 Test Points

32. RECEIVE SYNC

Receive pattern sync output provides one pulse for each repetition of the received pseudorandom pattern.

33. ERROR

Provides one pulse for each error detected in the receive data.

34. RECEIVE CLOCK

Section 6 provides information on the phase relationships that should exist between the receive clock and receive data for normal operation.

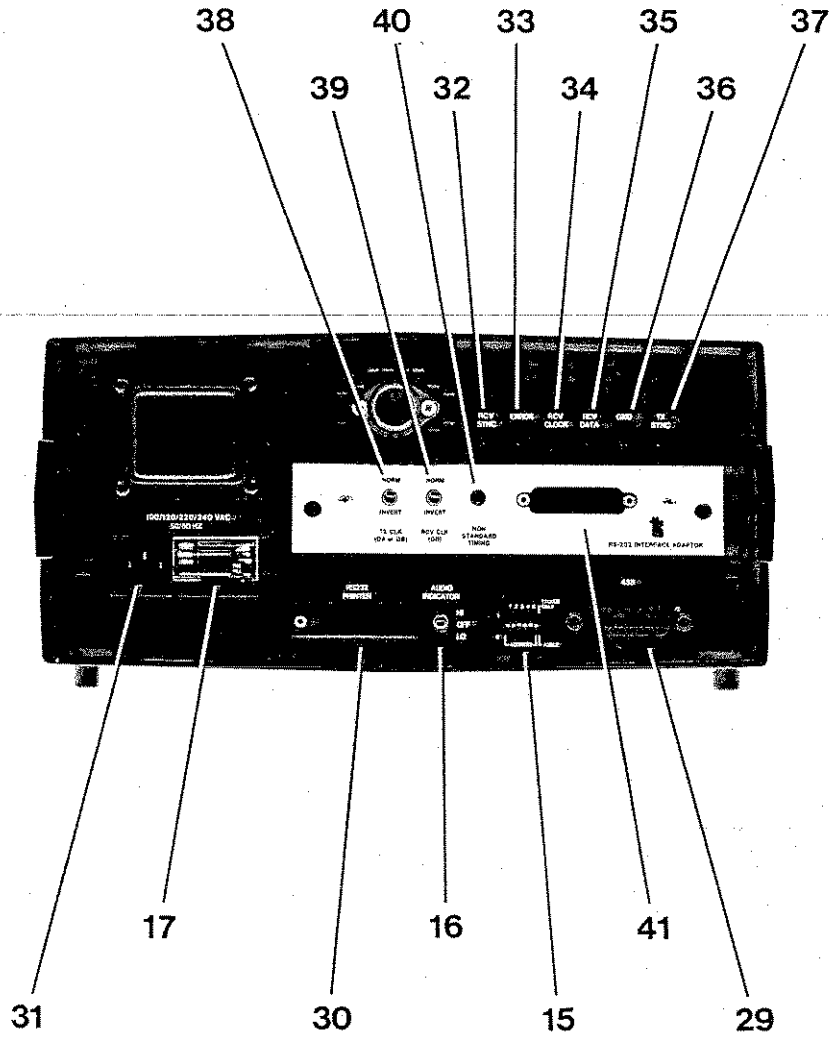


Figure 3-2

FIREBERD 1500 REAR PANEL

35. RECEIVE DATA

36. GROUND

37. TRANSMIT SYNC

Transmit pattern sync output provides one pulse for every repetition of the selected pseudorandom pattern.

3.2.5 Interface Module Components (RS-232 Interface shown)

38. TRANSMIT CLOCK: NORM/INVERT

The NORMAL position provides for the data/clock phase relationships specified by the interface specification. The INVERT position provides the opposite data clock phasing.

39. RECEIVE CLOCK: NORM/INVERT

Same as TRANSMIT CLOCK switch except for the receive clock.

40. NON-STANDARD TIMING

Illuminates when either the TRANSMIT CLOCK OR RECEIVE CLOCK switch is placed in the INVERT position.

41. RS-232 DATA INTERFACE CONNECTOR

3.3 FUNCTIONAL DESCRIPTION

3.3.1 General

The FIREBERD 1500 can be functionally divided into six sections: Transmitter, Interface Module, Receiver, Processor, Printer Interfaces and Power Supply. Figure 3-3 is a block diagram for the FIREBERD 1500. Refer to this diagram for the following description.

The Transmitter generates the test pattern to be used for the error analysis measurements. The transmit side of the Interface Module provides a signal conversion from the TTL characteristics provided by the Transmitter to the characteristics appropriate for the interface standard in use. The output of the Interface Module drives the system under test. The test pattern passes through the system under test and is received by another FIREBERD 1500 or is looped back to the same FIREBERD which originated it. In either case, the receive portion of the Interface Module converts the received pattern into a TTL signal and passes it to the Receiver.

The Receiver synchronizes a pattern generator identical to the one in the transmitter with the incoming data stream. The output of this pattern generator is compared with the incoming data. An error pulse is then generated for each discrepancy between transmitted and received data streams. Several counters in the Receiver accumulate error counts and bit counts.

The Processor periodically adds the data from the receiver subsystem counters to its internal software accumulators and then resets the hardware counters. The Processor also computes and accumulates the measurement results and provides them to the Display and Printer Interfaces at appropriate times.

The RS-232 Printer Interface provides an output compatible with an RS-232 printer such as TTC's PR1500 alphanumeric thermal printer. The IEEE-488 Printer Interface provides an output compatible with the IEEE-488 Standard Digital Interface for Programmable Instrumentation (1978).

The Power Supply provides DC power to all circuitry within the 1500.

3.3.2 Transmitter

The transmitter generates the digital test pattern using a 20 stage shift register with adjustable feedback taps to an exclusive-OR gate feeding the shift register input. The configuration of this shift register

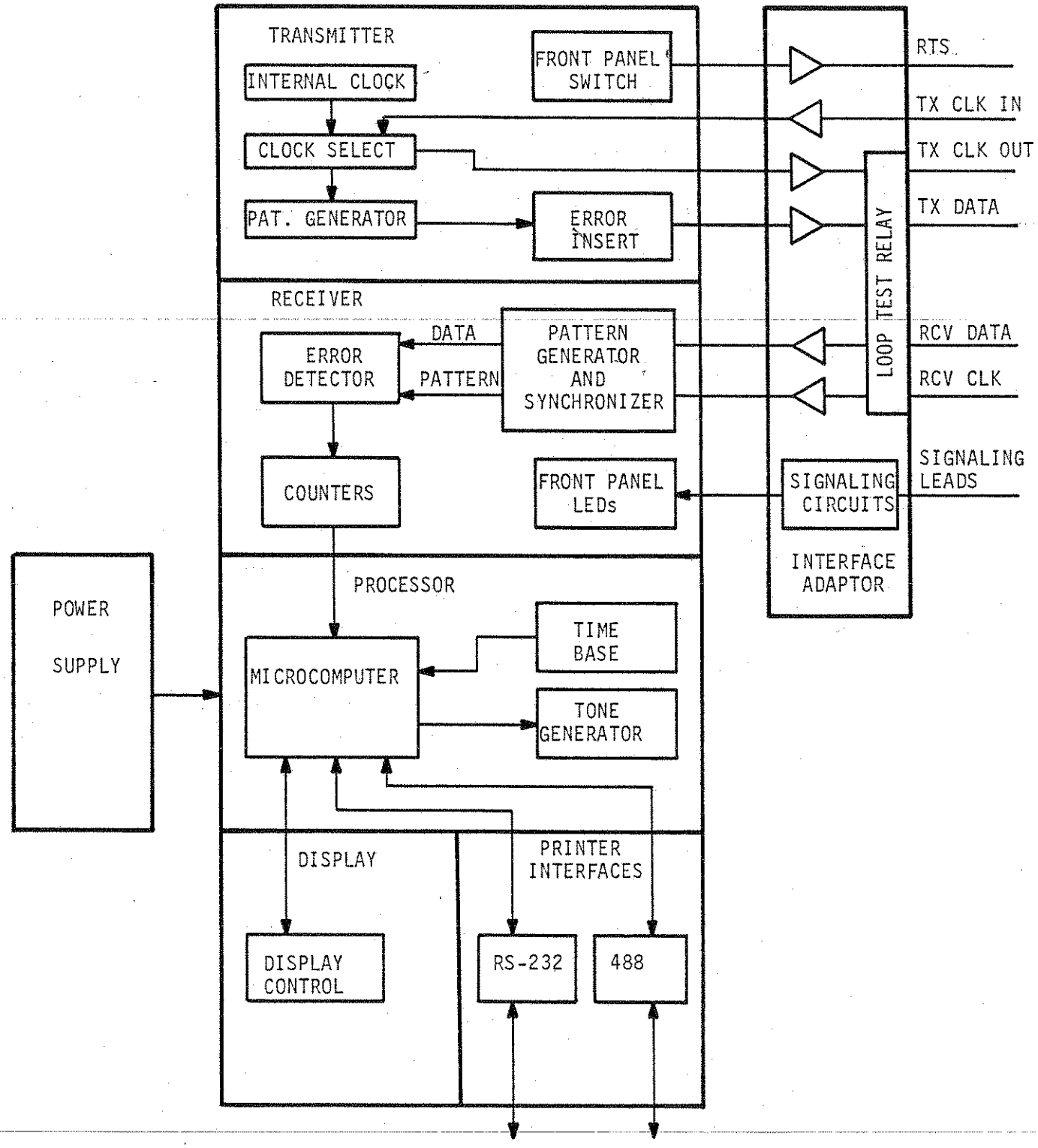


FIGURE 3-3
FIREBERD 1500 BLOCK DIAGRAM

is set by a front panel switch to provide 63, 511, 2047, 2^{15-1} or 2^{20-1} pseudorandom patterns. Alternatively, a mark, space, or alternating mark-space (1:1) pattern may be selected.

The clock used to generate the test pattern may be selected from one of the standard internal rates, one of the three optional user specified internal frequencies, or supplied externally via the interface module.

Each time the ERROR INSERT switch is depressed to the SINGLE position, one bit in the transmitted data stream is inverted. When the switch is placed in the 10^{-3} position, one bit in every thousand bits is inverted.

A transmit pattern sync output on the rear panel provides one pulse for every repetition of the selected pseudorandom pattern. This output may be used to synchronize an oscilloscope to the pseudorandom pattern while tracing the test pattern through a system or looking for the presence of errors.

The transmit data and clock are passed from the pattern generator to the interface module which provides the electrical characteristics appropriate to drive the system under test.

3.3.3 Interface Module

The Interface Module shown in Figure 3-3 is a synchronous type. It provides a transmit clock output along with the transmit data and requires a receive clock which is synchronous with the receive data. Self-clocking interfaces such as the DS1 Interface Module are available. These interfaces recover receive timing from the receive data and do not output a transmit clock. This section describes only a synchronous DTE Interface Module which allows the FIREBERD 1500 to act as Data Terminal Equipment (DTE) when testing Data Communications Equipment (DCE). Specific information on each Interface Module available is provided in Section 6.

The transmit section of the Interface Module contains a line receiver which receives an external clock (if one is in use) and provides it to the Transmitter's clock select circuitry. It also provides line drivers for the transmit clock and data signals. Most Interface Modules provide a driver for the RTS (Request to Send) signalling line. This driver is controlled by the RTS switch on the FIREBERD 1500 front panel.

The receive section of the Interface Module provides line receivers for the receive clock and data signals. Most modules provide line receivers for

the CTS (Clear to Send), DSR (Data Set Ready) and RLSD (Receive Line Signal Detect) signalling leads. The state of each of these signalling leads is displayed on the FIREBERD 1500 front panel.

Most Interface Modules provide NORM/INVERT switches for both the transmit and receive clocks. When the transmit clock NORM/INVERT switch is in the NORM position, the phasing between the transmit clock and data is specified by the applicable interface specification. The receive clock NORM/INVERT switch works in the same manner for the phasing between the receive clock and data. On interfaces where NORM/INVERT switches are provided, a red LED illuminates to warn the operator of non-standard timing when either of the switches is taken out of the NORM position.

On all Interface Modules except the Lab Interface, a relay is provided for loop testing. When the LOOP TEST switch on the FIREBERD 1500 front panel is depressed, the relay on the interface board loops the transmit clock and data outputs back to the receive clock and data inputs. The relay also disconnects these same lines from the interface connector so that the interface cable does not need to be disconnected for the test. This loop test feature allows the operator to insert errors with the ERROR INSERT switch and verify proper operation of both the FIREBERD 1500 and the Interface Module. On the Lab Interface, a data selector is provided between the line driver inputs and the receiver outputs. This allows loop testing to be performed but does not test the line drivers and line receivers. The drivers and receivers may be tested by looping the transmit data and clock signals to the receive data and clock signals externally to the Interface Module.

3.3.4 Receiver

The Interface Module provides receive data and clock signals at TTL levels to drive the receiver. The receiver contains a pattern generator identical to the one in the transmitter. On test initialization, the pattern generator in the receiver is automatically synchronized to the incoming data. Once synchronization has occurred, the error detector compares the incoming data with the internally generated pattern and counts discrepancies as errors. If the incoming data is inverted, the unit will automatically correct the inversion and illuminate a front panel indicator. This allows the measurement to be performed and warns the operator of the data inversion in the

system under test.

If a loss of synchronization is detected between the incoming data and pattern generator after synchronization has been obtained, the unit will automatically resynchronize the receive pattern generator, turn on the SYNC LOST LED and restart the measurement. The SYNC LED will always be illuminated when the 1500 has obtained synchronization. It must be illuminated for the test to proceed.

A group of counters in the Receiver accumulate error count and bit count or block error count and block count. The results in these counters are periodically added into software accumulators. After the addition the hardware counters are reset. This prevents any counter from ever overflowing, even in the presence of a 100% error rate.

3.3.5 Processor

The Processor periodically scans the front panel controls to determine the results to be displayed, the operating mode, etc. It accumulates data from the Receiver, performs computations and formats the results for output to the display and printer interfaces.

An internal tone generator, driven by the processor, produces a tone burst on the occurrence of a loss of receiver synchronization. In BER mode, it also produces a tone burst at the end of each measurment cycle. In Single Error Count or Block Error Count mode it produces a tone burst on the occurrence of each error.

3.3.6 Printer Interfaces

An RS-232 printer interface and controls are provided as standard equipment. An IEEE-488 printer interface is available as an option.

A three-position PRINT MODE switch may be used to disable the printer entirely, cause the latest results to be printed out, or to provide automatic printouts on the occurrence of selected events. In the AUTO position of the PRINT MODE switch, printouts will occur at the end of each measurement cycle in BER mode or according to the PRINT EVENT switch in Single Error Count or Block Error Count mode. The PRINT EVENT switch may be set to cause the printer to print:

1) on the occurrence of an error
2) periodically at selected time intervals
3) both on the occurrence of an error and periodically

The time interval between prints may be set to 1, 10, or 30 minutes with the PRINT TIME switch. In any operating mode, the printer will print "SYNC LOSS" on the occurrence of a loss of synchronization in the receiver provided that the PRINT MODE switch is not in the DISABLE position.

A 25 pin "D" connector is provided for the RS-232 printer interface. A 24 pin microribbon connector is provided for the IEEE-488 interface. Section 5 provides detailed information on the electrical characteristics of both types of printer interfaces.

3.3.7 Power Supply

The power supply provides well regulated DC voltages to all circuitry within the FIREBERD 1500. The instrument case incorporates an internal metalized coating and line filter to minimize EMI/RFI susceptibility. Detailed AC power requirements and instructions for changing the operating voltage range are provided in Section 2.3.

SECTION 4
OPERATION

4.1 INTRODUCTION

This section provides operating procedures, followed by descriptions of measurement capability, measurement configurations, and operating considerations. Finally, a detailed self-test procedure is provided in Section 4.6.

4.2 OPERATING PROCEDURE

The following step by step sequence may be followed to perform error analysis measurements with the FIREBERD 1500. It is intended to act as a guide and is not the only operating sequence. A brief self check is included in the test.

1) Select a measurement configuration. If local modem testing or full duplex loop-around testing is to be performed, only one FIREBERD 1500 will be required. If half duplex end-to-end or full duplex end-to-end testing is desired, two FIREBERD 1500's will be required. In this case, the procedure should be followed for the FIREBERD 1500 at each end of the link. Section 4.4 provides more details on measurement configurations.

2) Set the FIREBERD 1500 for the appropriate line voltage. See Section 2.3 for details.

3) Select the appropriate Interface Module for the system to be tested. Insert the module in the FIREBERD 1500 with the power off.

4) Set the CLOCK SELECT switch to the appropriate position. Choose the EXT position if the clock is to be supplied externally through the interface; otherwise, select one of the internally generated frequencies.

5) If they exist for the Interface in use, set the CLOCK INVERT switches to the NORM position. Set any other Interface switches to their appropriate positions. See Section 6 for more details on individual Interface Modules.

6) Select one of the pseudorandom patterns. For full or half duplex end-to-end testing, both FIREBERD 1500s must have their PATTERN SELECT switches in the same position. Section 4.5.4 provides more detailed information on pattern selection.

7) Place the FUNCTION SELECT switch in the "S" position.

8) Connect the system to be tested to the Interface Connector.

9) Set other switches as follows:

AUTO SYNC - ENABLE
DISPLAY HOLD/COUNT/RESET - COUNT
ERROR INSERT - OFF
RTS - ON
PRINT MODE - DISABLE
POWER - ON
DISPLAY SELECT - ERRORS

10) Hold down the LOOP TEST switch. The XMT CLOCK ACTIVITY, RCV CLOCK ACTIVITY, MARK and SPACE LEDs should all illuminate.

11) With LOOP TEST held down, momentarily depress the DISPLAY HOLD/COUNT/RESET switch in to the RESET position (reset the instrument). About one second after the switch has been released the SYNC LED should illuminate and the display should indicate zero errors. Insert single errors with the ERROR INSERT switch and verify that they are counted. Once successful operation has been achieved in loopback, you are ready to operate through the system under test.

12) Release the LOOP TEST switch and reset the instrument. After one second the SYNC LED should illuminate to indicate that data is getting through the system. For local modem or full duplex loop around testing, errors inserted with the ERROR INSERT switch should be counted by the unit which originated them. For half or full duplex end-to-end testing, errors inserted at one location should be counted at the other location. A 10^{-3} error rate may be inserted through the system under test to verify the data path, provided that the system error rate is significantly less than 10^{-3}.

13) Now that the units are operating through the system the FUNCTION SELECT switch may be switched to any position desired for the actual measurements. Be sure to set the ERROR INSERT switch to NONE before starting the actual measurements. If a printer is in use, set the printer controls appropriately and verify proper operation of the printer by depressing the PRINT MODE switch into the PRINT position.

14) Reset the FIREBERD 1500 to start the test. Once the test is started, only the DISPLAY SELECT, PRINT CONTROL, AUDIO INDICATOR, and DISPLAY HOLD switches should be moved.

4.3 MEASUREMENT CAPABILITY

Each of the three measurement modes, BER, Single Error Count and Block Error Count, provide different sets of measurement results.

BER mode provides bit error rate data which is the number of bits received in error divided by the total number of bits received. The number of bits used to make the measurement may be sent to a fixed number equal to 10^5, 10^6, 10^7, 10^8, 10^9 or 10^{10}. Alternatively, AUTO mode may be used. In AUTO mode, the BER is measured over the smallest number of bits in the set 10^5, 10^6, 10^7, 10^8, 10^9 or 10^{10} which produces at least 80 errors (and is thus a statistically valid result).

In Single Error Count mode, single errors, error seconds and seconds of test are continuously accumulated. An error-second is counted each time the second counter is incremented if one or more errors have occurred since the last time the second counter was incremented.

In Block Error Count mode, blocks and block errors are continuously accumulated. The block length may be set to 10^3, 10^4 or 10^5 bits. One count is added to the block error result each time a block of bits has been received which contains one or more errors.

4.4 MEASUREMENT CONFIGURATIONS

Figure 4-1 shows four possible measurement configurations for system testing with the FIREBERD 1500.

Figure 4-1a shows local modem testing. One FIREBERD 1500 test set is used to test a modem which has its transmit output looped back to its receive input.

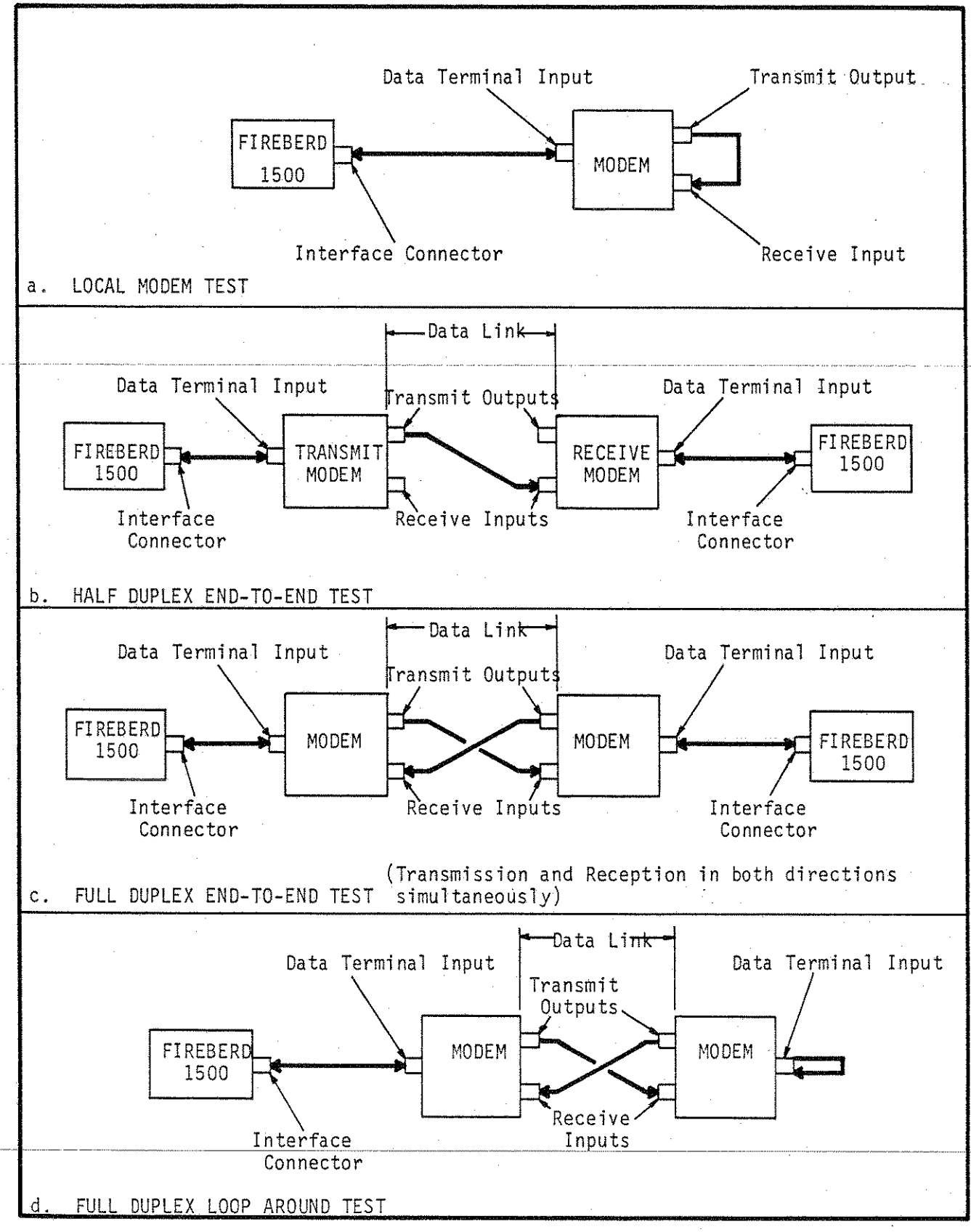
Figure 4-1b shows a half duplex end-to-end test. This configuration requires two FIREBERD 1500 test sets located at opposite ends of the link.

Figure 4-1c shows a full duplex end-to-end test. This test is similar to the half duplex test except that testing is simultaneously performed in both directions. Whenever two test sets are used for measurements, each test set displays the results measured by its receiver.

Figure 4-1d shows a full duplex loop around test. The data is looped around at the digital side of the modem at the remote end of the link.[1]

1. The total errors counted will be equal to the sum of the errors caused by each pass through the link unless the error rate is extremely high. If the error rate is very high, the measured error rate will be slightly less than the sum of the error rates in the two directions. This is because errors in one direction will occasionally cancel errors in the other direction.

FIGURE 4-1
MEASUREMENT CONFIGURATIONS



4.5 OPERATING CONSIDERATIONS

4.5.1 Synchronous Timing Modes

The FIREBERD 1500 is designed to act as Data Terminal Equipment (DTE) in testing Data Communications Equipment (DCE). Figure 4-2 shows various timing modes for synchronous operation.

Figure 4-2a shows the FIREBERD 1500 providing transmit timing and data at one of the standard internal rates or with an optional frequency provided by F_A, F_B, or F_C. Receive timing and data are provided by the DCE.

Figure 4-2b shows the FIREBERD 1500 receiving external transmit timing from the DCE. The external timing is used to generate transmit timing and data which is sent back to the DCE. The DCE provides receive data and timing.

Figure 4-2c shows the FIREBERD 1500 receiving external timing from the DCE and generating transmit data with this timing. This mode of operation is similar to the mode shown in 4-2b except the DCE does not accept the transmit timing which accompanies the transmit data. Care must be used with this timing mode. The delay caused by the cable along with the delay in generating transmit data from the external transmit clock causes a phase shift between the transmit data received at the DCE and the transmit timing sent out by the DCE. At high speeds, this delay may become a significant fraction of a data period and cause invalid clock-data phasing at the DCE. The individual interface specifications in Section 6 provide actual values for the delay between the received external clock and transmitted data. This information along with cable length may be used to compute the maximum operating frequency for this timing mode.

Any of the timing configurations shown in Figure 4-2 may be used for half-duplex as well as full-duplex or loop-around testing. In half-duplex operation, either the transmit or the receive clock and data will not be used.

When the LOOP TEST switch is depressed, the outgoing transmit clock and data outputs get connected to the receiver clock and data inputs as shown in Figure 4-2d and e. This allows the loop test to be performed with one of the internal standard frequencies (Fig. 4-2d) or an external transmit clock (Fig. 4-2e). If a loop test is performed with CLOCK SELECT switch in the EXT position and no external clock is provided, no data will be generated

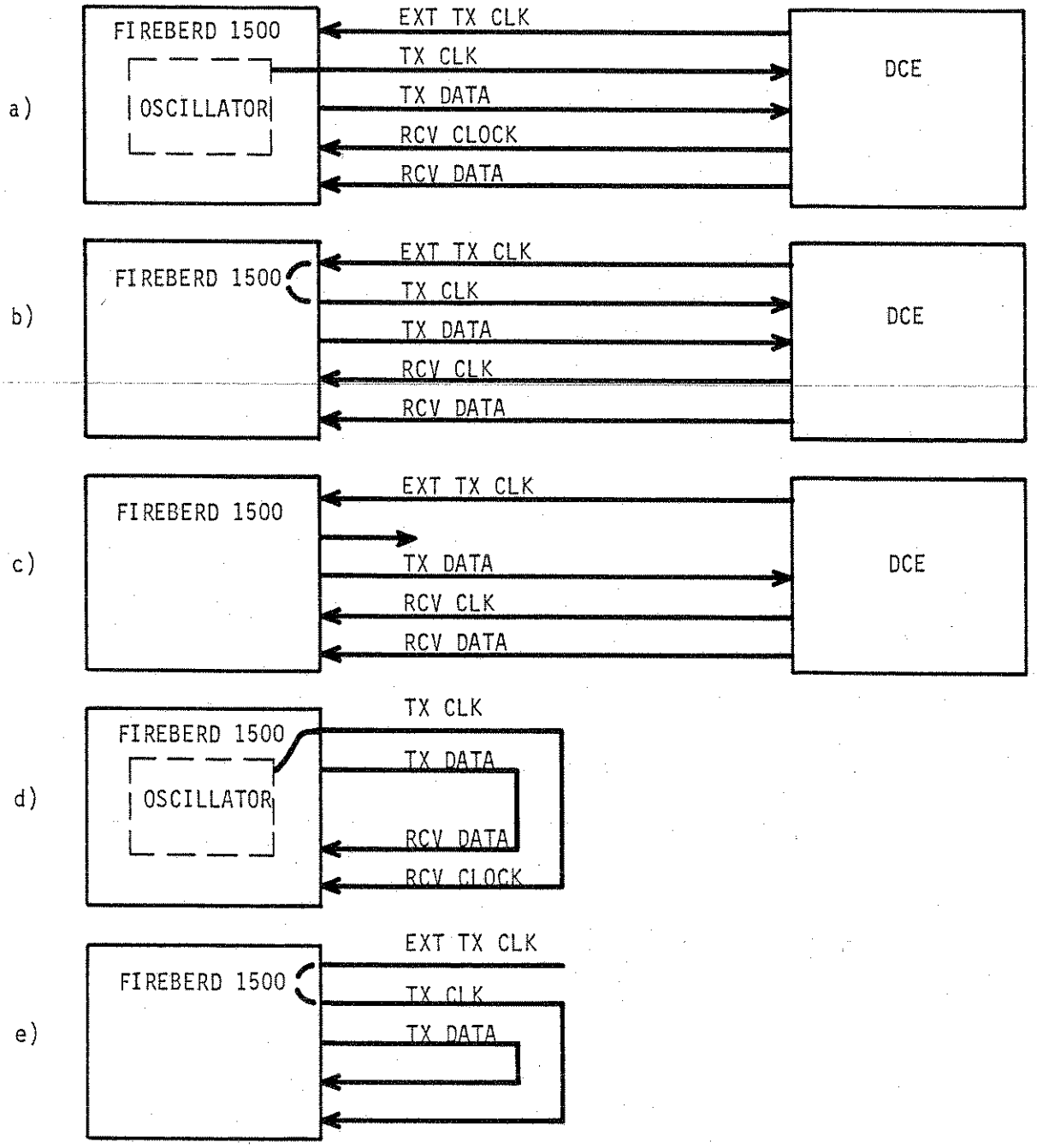


FIGURE 4-2

SYNCHRONOUS TIMING MODES

and the test will be unsuccessful. In this case, the TRANSMIT CLOCK ACTIVITY LED will be off, indicating the lack of a transmit clock.

When the TRANSMIT CLOCK INVERT switch (on the Interface Module) is in the NORM position, the phasing between the external transmit clock and transmit data, and the phasing between the outgoing transmit clock and data is specified by the interface specification in use.[1] When the switch is in the INVERT position, both of these clock-data phase relationships are reversed.

When the RECEIVE CLOCK INVERT switch is in the NORM position, the FIREBERD 1500 expects to see receive clock-data phasing consistent with the interface specification in use.[2] In the INVERT position the FIREBERD 1500 expects to see opposite phasing.

In loop test, both the TX and RCV CLOCK INVERT switches should be in the same position (either NORM or INVERT) to assure valid results.

4.5.2 Self-Clocked Timing Modes

The FIREBERD 1500 is capable of performing measurements on certain types of systems where timing information is not transmitted separately from the data. The DS1 Interface is capable of recovering receive timing from the incoming receive data stream at 1.544 Mbps. This interface does not provide a transmit clock output or a receive clock input.

The FIREBERD 1500 is not capable of performing measurements on asynchronous data streams employing start and stop bits and non-continuous data streams .

4.5.3 Measurement Modes

4.5.3.1 BER Mode

When operating in BER mode, the test length should be chosen such that enough errors are accumulated during the measurement interval to produce a statistically reliable result. If the errors in the received data are statistically independent, a test length which collects more than 80 errors will provide a result withing ± 20% of the true error rate with approximately a 90% confi-

1. Most interface specifications require transmit data to be valid on the falling edge of the transmit clocks.
2. Most interface specifications require receive data to be valid on the falling edge of the receive clock.

dence level. In some systems, errors may not be statistically independent. Differential encoders, self-sychronizing scramblers or other devices in the communications system or channel characteristics may cause errors to occur in groups. If this is the case, the test length should be chosen to accumulate a larger number of errors to insure reliable results. Generally if AUTO mode is used or if the test length is set to be two orders of magnitude above the reciprocal of the anticipated BER, reliable results will be produced.

4.5.3.2 Block Error Count Mode

Block error measurements are useful in determining information about the statistics or distribution of errors. If BER measurements are performed on the channel and block and block error measurements are also performed, information on the error distribution may be deduced. For example, if the BER is 10^{-5}, and 100 10^{5}-bit blocks are received with only two block errors, it can be inferred that the errors are occurring in bursts. If the test were repeated with 10,000 10^{3}-bit blocks and only several block errors were counted, it can further be inferred that the errors are occurring in relatively short bursts (< 1000 bits).

The errored-seconds measurement may be used to obtain a block length equal to the number of bits per second received. For example, at 56,000 bps, each second counted corresponds to a block of 56,000 bits and each error-second is a block error for the 56,000 bit block length.

4.5.4 Pattern Selections

The FIREBERD 1500 provides three patterns which are not pseudorandom in nature: Mark, space and 1:1 (alternating mark-space). These patterns may be used for signal tracing or error analysis. It should be noted that some communication systems may not function normally with some of these non-random patterns.

Due to the nature of the 1:1 pattern, the receiver may light the DATA INVERT LED when receiving a 1:1 pattern even though no inversion exists in the system under test. Ignore the DATA INVERT LED when using the 1:1 pattern.

Five different pseudorandom patterns with the following lengths (in bits) are provided: 2^{6}-1=63, 2^{9}-1-511, 2^{11}-1=2047, 2^{15}-1=32767, 2^{20}-1= 1048575. Each of these patterns repeats with a time period equal to the

pattern length (in bits) times the bit period (in sec/bit). Each 2^N-1 length pattern also has the property that no more than N sequential ones or N-1 sequential zeros will ever occur. Thus the longer pattern lengths will occasionally produce longer sequences of identical bits and thus longer sequences of data with no transitions. This is important for testing certain systems with clock recovery since long sequences of data with no transitions will stress clock recovery loops and may cause clock recovery problems.

4.5.5 Synchronization Modes

The FIREBERD 1500 should normally be operated in AUTO SYNC ENABLE mode. This allows the unit to synchronize to the incoming data and measure error rates up to 10^{-1}. In this mode, the unit will resynchronize and restart the test when the receiver detects more than 100 errors in any group of 1000 bits. Any true loss of synchronization will cause a 50% error rate to be detected by the receiver and will thus cause a resynchronization.

AUTO SYNC DISABLE mode is used when bursts of errors may produce error rates higher than 10^{-1} over 1000 bit intervals. In this mode, resynchronization is inhibited once synchronization has initially been obtained. Internal counters will not overflow even at 100% error rates until the result becomes larger than 6 digits (display size) for Single Error Count or Block Error Count mode. The internal counters will not overflow under any circumstances in BER mode. The disadvantage of using AUTO SYNC DISABLE mode is that if a true loss of synchronization occurs[1] it will not cause a resynchronization. In this event, the measured BER will be .5. As a warning of possible loss of synchronization, the SYNC LOSS light will start flashing if the error rate exceeds 10^{-1} in AUTO SYNC DISABLE mode. Once this indicator starts flashing, it will not stop until the RESET switch is depressed.

4.5.6 Display

Errors, error-seconds, seconds, blocks and block errors are all displayed in six digit format with no decimal point or exponent. If the internal counter for any of these parameters overflows the leftmost digit will become a backwards "E" to indicate the overflow.

1. Such as would happen if a clock slip occurred.

BER is displayed in the format X.XXE-X. For measurement results with more than 99 errors the display format will be scientific notation; for example, 1.03E-6. If the result has more than nine but less than 100 errors, the result will only be displayed with a two digit mantissa; for example, .99E-6. If the result has less than ten errors, a one digit mantissa is provided; for example, .09E-6. The intent of this method of display format is to warn the operator that the result may not contain enough errors to be statistically reliable.

4.5.7 Interfaces

The FIREBERD 1500 is intended to act as DTE (Data Terminal Equipment) when testing DCE (Data Communications Equipment). To use the FIREBERD 1500 to test DTE, an adaptor cable will be required in order to provide the clock and data signals on the appropriate interface pin numbers. Section 6 provides interface pinouts for each type of interface.

4.5.8 Operation Above 10 MHz

Although the unit is only guaranteed to run to 10 MHz, it will typically run to about 15 MHz. To operate above 10 MHz, the interface must be a high speed type (V.35, RS-449 or Lab). The cables used for high speed operation should be as short as possible and twisted pair or coaxial cable should be used. The 10^3 bit block length should not be used above 10 MHz since it may yield invalid results.

4.6 SELF TEST

4.6.1 Introduction

This procedure is designed to offer a quick method of determining the operating status of the FIREBERD 1500. Each section will ask the operator to perform a specific action (A) on the FIREBERD 1500. Each action is followed by an observation (O). If the designated observation is not made, an operator serviceable diagnostic (D) is available. To increase the thoroughness of this procedure each section may be tested in every possible combination of CLOCK, PATTERN, and FUNCTION SELECT positions.

Each test section is directly related to the interface module. If a failure occurs insert another interface and repeat entire test.

If the interface module has clock invert switches they must be placed in the NORMAL position. Other interface module switches should be set appropriately. Refer to Section 6 if necessary. If servicing is required, it is helpful to note the section of the self test procedure where your FIREBERD failed.

4.6.2 Preparation

1) Any of the FIREBERD 1500 Data Interface Modules may be used for this self test procedure. Be sure to install the interface module with the AC power off.

2) Verify that the AC line voltage card is set appropriately for the existing line voltage (see Section 2.3). Then, turn the power (PWR) ON.

3) The LOOP TEST switch must be depressed throughout entire test unless otherwise specified.

4.6.3 Procedure

1) CLOCK

A (Action): Set the CLOCK SELECT switch to the desired frequency.

O (Observation): The XMT and RCV CLOCK ACTIVITY detectors are now on.

D (Diagnostic): The CLOCK SELECT must be set at an available clock frequency. If the CLOCK SELECT switch is set in the EXT position, the clock signal used for the test must be input through the interface module.

2) DATA

A: Set the CLOCK SELECT switch to 56 kHz and the PATTERN SELECT to MK.

O: The MARK LED is now on. Both the DATA INVERT and the SPACE LEDs are off.

A: Set the PATTERN SELECT switch to SP.

O: Verify the SPACE LED is on and both the MARK and DATA INVERT LEDs are off.

A: Set the PATTERN SELECT switch to 63.

O: Both the MARK and SPACE LEDs are on and the DATA INVERT is off.

D: The RCV CLK ACTIVITY LED must be on for proper Mark and Space combinations. If the DATA INVERT LED is flashing, synchronization has not occurred. Be sure you are in LOOP TEST and check the interface module.

3) SINGLE ERROR COUNT MODE

A: Initial conditions. Set:

1. PATTERN SELECT to $2^{20}-1$
2. CLOCK SELECT to 56 kHz
3. ERROR INSERT to NONE
4. DISPLAY to COUNT
5. AUTO SYNC to ENABLE
6. DISPLAY SELECT to ERRORS and BLOCK ERRORS
7. RESET

O: The display now reads zero (0) the SYNC LED is on and the SYNC LOST and DATA INVERT LEDs are off.

A: Depress ERROR INSERT (SINGLE) 10 times.

O: Verify the display has counted at least one err sec, 10 errors and is counting seconds via the DISPLAY SELECT switch.

D: The display cannot function without the RCV CLK ACTIVITY and SYNC LED on.

4) BLOCK ERROR COUNT MODE (10^3, 10^4, 10^5)

A: Set the FUNCTION SELECT switch to the 10^3 COUNT mode position. Set the CLOCK SELECT to 56 kHz and depress ERROR INSERT (SINGLE) 10 times.

O: Verify the display has counted 10 block errors and is continuously counting blocks via the DISPLAY SELECT switch.

D: Note: At lower clock rates or longer block lengths you may insert several errors into one block. These errors will be counted as one block error.

5) BER mode (10^5-10^{10}, Auto)

A: Set the FUNCTION SELECT switch to 10^5 BER and the ERROR INSERT to NONE. Set CLOCK SELECT to 56 kHz. Depress and release RESET switch.

O: Within 2 seconds of the Reset the display will read 0.00E-3.

A: Set the ERROR INSERT switch to 10^{-3}. Depress and release RESET.

O: Within 2 seconds of the reset the display will read 1.00E-3.

D: At other operating frequencies or test lengths the results may take longer to appear. In BER mode the display update rate is dependent on the clock rate and the BER test length.

$$\text{BER update time in seconds} = \frac{\text{test length (bits)}}{\text{clock frequency (bits/sec)}}$$

If the result doesn't appear at the appropriate time, make sure that the SYNC indicator is ON. Results will not be displayed if synchronization has not occurred.

6) AUTO SYNC

A: Initial conditions: Set:

1. FUNCTION SELECT to S
2. AUTO SYNC to DISABLE
3. ERROR INSERT to NONE
4. PATTERN SELECT to 2^{20}-1
5. RESET

O: The SYNC LED is now on and both the SYNC LOST and DATA INVERT LEDs are off.

A: Release the LOOP TEST switch, the depress and hold down again.

O: 1. The SYNC LED went off, then on again.
2. The SYNC LOST LED is now on and flashing.
3. Errors are counting at a high rate.

A: Set the AUTO SYNC switch to ENABLE.

O:

1. The SYNC LOST LED is still flashing.
2. The SYNC LED turns off and back on again within one second, and the display reads (0) errors.

D:

1. Be sure not to exceed the maximum data rates inherent to your particular interface module:

V.35 - 10 MHz	TTL - 10 MHz
RS-232 - 100 kHz	303 - 500 kHz
449-423 - 1 MHz	DS1 - 1.544 MHz $\pm$ 100 Hz
449-422 - 10 MHz	

2. Synchronization may not be lost in the MARK or SPACE patterns by toggling LOOP TEST.
3. Data may be inverted 50% of the time in the 1:1 pattern.

7) Printer

A: Connect the cable provided between the PR1500 printer and the RS-232 PRINTER connector on the rear panel of the FIREBERD 1500.

A: Initial conditions. Set:

1. CLOCK SELECT to 56 kHz.
2. FUNCTION SELECT to 10^5.
3. ERROR INSERT to 10^{-3}.
4. PRINT CONTROL (EVENT) to TIME.
5. PRINT CONTROL (TIME) to 1.
6. PRINT CONTROL (MODE) to AUTO.
7. RESET.

O: Within two seconds after the reset the printer will output 1.00E-3.

A: Set the FUNCTION SELECT switch to S and depress the MODE switch to PRINT once.

O: The printer will output the following format immediately:

ERR SEC X
SEC Y
ERR Z

A: Set the FUNCTION SELECT switch to COUNT/10^3 mode and the PRINT CONTROL (EVENT) switch to ERROR.

O: The printer will output the following format continually:

```
BLK ERR     X
BLK         Y
```

A: PRINT CONTROL (MODE) switch to DISABLE.

O: The printer will stop printing after the last format is printed.

D:

1. Be sure the PRINT CONTROL (MODE) switch is not in the DISABLE position.
2. The printer must be plugged into an AC power outlet.
3. Verify the printer has paper and that the cable is secure.

SECTION 5
PRINTER INTERFACES

5.1 INTRODUCTION

This section describes the data output format and interface electrical characteristics of the RS-232 and IEEE-488 Interfaces. The interfaces are not intended to be operated simultaneously. If a device connected to the RS-232 connector holds the Data Terminal Ready line ON, this device will get data and the IEEE-488 Interface will be ignored by the instrument. Thus, devices connected to the RS-232 Printer Interface should be turned off or disconnected if operation of the IEEE-488 Interface is desired. Since the RS-232 Interface is given priority, instrumentation does not need to be disconnected from the IEEE-488 Interface for operation of the RS-232 Printer Interface. See Section 7.2 for information on specifications, use and installation of the PR1500 thermal printer.

5.2 EVENTS INITIATING DATA OUTPUT

Data output and events initiating data output are the same for either the RS-232 or IEEE-488 Interfaces. The events which trigger a data output are dependent on both the Printer Controls and the operating mode of the intrument as determined by the FUNCTION SELECT switch.

For any operating mode, data will not be sent to either printer interface if the PRINT MODE switch is in the DISABLE position. In any mode, data will immediately be output to the printer interface if the PRINT MODE switch is depressed into the PRINT position or if a loss of receiver synchronization occurs.

In BER mode, data will be provided to the printer interfaces at the completion of each measurement cycle (as determined by the FUNCTION SELECT switch) if the PRINT MODE switch is in the AUTO position.

In Single Error Count or Block Error Count mode, data will be provided to the printer interfaces according to the PRINT EVENT and PRINT TIME controls (see Section 3.2.1 for details) and on the occurrence of an overflow of any result accumulator.

5.3 DATA BUFFERING

Once the FIREBERD 1500 has decided to initiate a data output, and has determined that a device is connected to the printer interface and ready to accept data, all data to be output is transferred from the internal result

accumulators to a print buffer. The data in the buffer will not change until all of the data in the buffer has been output. If, during the time it takes to completely output the data in the buffer to the printer, multiple new results have been accumulated and are ready to output, the most current result will be loaded into the print buffer and output.

If a loss of synchronization occurs, the words "SYNC LOSS" will be output immediately if a print operation is not in progress, or will be output at the completion of an on-going print-out, independent of the presence of any other data to be printed.

5.4 DATA FORMAT

The seven-bit American Standard Code for Information Interchange (ASCII) is used to code each character. Each data output consists of a number of lines between one and three. Each line is less than 20 characters long and ends with a carriage return (ASCII character CR). A Linefeed (ASCII LF) is sent after each complete data output to cause a blank line to be printed for RS-232 operation. Table 5-1 shows exactly which characters are output for various operating conditions and how these would be printed by a typical printer such as TTC's PR1500 alphanumeric thermal printer.

5.5 RS-232 PRINTER INTERFACE

5.5.1 General Description

This interface provides serial asynchronous data with levels, connector, and pin-outs as specified by EIA standard RS-232C. The interface is set up such that the FIREBERD 1500 acts as Data Communications Equipment sending data to Data Terminal Equipment (the printer). Four signal lines are supported: signal ground, protective ground, Receive Data and Data Terminal Ready (DTR).

When the FIREBERD 1500 is ready to output data, it looks at the DTR line for an ON condition. If DTR is not ON, the printer is not connected or turned on and the output is aborted. If DTR is ON, one data byte is output on the receive data line. If the DTR line stays in the ON condition after this byte has been fully output, another byte will be output. In this manner, the FIREBERD 1500 will continuously output data bytes to the receive data line, inserting pauses whenever the DTR line goes to the OFF state.

CHARACTERS OUTPUT (HEX)	PRINTED DATA
20,45,52,52,20,53,45,43,20,20,20,20,20,20,20,33,0D	ERR SEC 3
20,53,45,53,20,20,20,20,20,20,20,20,20,20,20,33,0D	SEC 3
20,45,52,52,20,20,20,20,20,20,20,20,20,31,33,31,0D,0A	ERR 131
20,42,4C,4B,20,45,52,52,20,20,20,20,20,31,38,37,0D	BLK ERR 187
20,42,4C,4B,20,20,20,20,20,20,20,20,20,33,38,33,0D,0A	BLK 383
20,42,45,52,20,30,2E,30,30,45,2D,33,0D,0A	BER 0.00E-3
20,53,59,4E,43,20,4C,4F,53,53,0D, 0A	SYNC LOSS

TABLE 5-1
DATA FORMAT

This allows the printer or DTE to stop the data flow while it takes time to print a line or store the data. Once the last byte has been output and DTR goes to the ON condition, the data output is complete.

5.5.2 Signal Format

Each FIREBERD 1500 is shipped with the RS-232 printer interface configured to run at 2400 baud. Each data byte consists of one start bit, followed by 7 data bits, one even parity bit and 2 stop bits.

The FIREBERD 1500 may be modified to run at 300, 600, 1200 baud, to provide only only stop bit or to provide odd parity. Consult TTC if it is necessary to change the signal format.

5.5.3 RS-232 Connector Pin Assignments

The 25 pin "D" type connector has the following pin assignments.

Pin	Signal Name	Comments
1	Protective Ground	
3	Receive Data	Output
5	Clear to Send	Output - Not used for normal operation
6	Data Set Ready	Output - Not used for normal operation
7	Signal Ground	Pins 1 and 7 are internally connected
20	Data Terminal Ready	Input

All other pins are not used for normal operation.

5.6 IEEE-488 INTERFACE

5.6.1 General Description

The IEEE-488 Interface (Opt. 009) has two basic modes of operation: Talk Only and Addressable Talk Only.

In the Talk Only mode, the FIREBERD 1500 is designed to directly drive a Listen Only device such as an HP5150A Printer. In this mode, the FIREBERD 1500 should be directly connected to the printer with no other device acting as a Controller or Talker connected to the bus.

In the Addressable Talker Only mode, the FIREBERD 1500 should be connected to the 488 bus along with a Controller. When the FIREBERD 1500 has data to output, it will request service from the Controller which may elect to have it output the data. In this mode, multiple devices may be connected to the bus. The Controller is responsible for preventing any two devices from ever simultaneously ouputting to the bus.

For either operating mode, the actual data output is the same. The data output is as shown in Table 5-1 except the Linefeed (Hex 0A) is not output at the end of each data output*.

5.6.2 Talk Only Mode

The Talker Only mode is selected by placing the right-most switch on the rear panel DIP switch in the TALKER ONLY position (UP). In this position, the five address switches on the DIP switch are not applicable. The printer or other device to be connected to the FIREBERD 1500's 488 connector should be set for continuous listening. The FIREBERD 1500 acting as a talker may then be connected to the listener with a standard IEEE-488 type cable. The interface should be ready to operate provided that no device is holding the DTR line on the RS-232 printer interface in the ON condition.

Once the FIREBERD 1500 has decided to initiate a data ouput, the data will be transferred from the FIREBERD 1500 to the listening deivce. A standard 488 three-wire handshake between the FIREBERD 1500 and listener will assure valid data transfer and determine the transfer rate. Once a data transfer has been initiated, the data in the print buffers will not change until the complete set of data has been output.

*Note that the printer or listener should perform a carriage return and linefeed when it receives the CR. Thus a printer such as the HP5150A should have its CR/LF switch in the CR position.

5.6.3 Addressable Talk Only Mode

5.6.3.1 Preparation For Use

To select the Addressable Talk Only mode, place the right-most switch on the rear panel DIP switch in the "ADBLE" (ADDRESSABLE) position. Set the other switches on the DIP switch for an appropriate address. Table 5-2 shows allowable Talk and Listen addresses. Although the addresses consists of seven bits, only the lower five bits are switch selectable since bits 6 and 7 are always 01 or 10 for a talker or listener respectively. The switch positions labeled 1...5 correspond to bits 1...5 of the address. Once each of the other units on the bus has had its address selected and has been prepared for operation, the units may be interconnected and turned on.

The FIREBERD 1500 only inputs the ADDRESS and TALK ONLY/ADBLE switch settings during power up or when the RESET switch is depressed. Thus always depress RESET if these switches are changed on a unit with the power applied.

5.6.3.2 Operating Sequence

The FIREBERD 1500 uses the Service Request and Serial Poll feature of the 488 bus to allow it to alert the controller that it has data to output. The sequence of events is as follows:

a) The FIREBERD 1500 decides to initiate a data output and determines that no device is connected to the RS-232 Printer Interface. Since the FIREBERD is operating in the Addressable mode it initiates a 488 Service Request by setting the 488 bus SRQ line low.

b) The Controller periodically checks the state of the SRQ and determines when a Service Request has been initiated.

c) If a Service Request is present, the controller sets the Serial Poll mode. The Serial Poll mode is initiated by the controller transmitting the Universal Command "Serial Poll Enable" (ASCII character "CAN") in the "Command Mode".

d) The Controller sequentially polls each of the devices that may have requested service. Once the Serial Poll mode has been enabled, each of the devices on the bus in prepared to accept a Serial Poll. The Serial Poll is performed by setting the 488 ATN line, addressing the device as a talker,

TABLE 5-2

488 TALK AND LISTEN ADDRESSES

Listen Addresses									Talk Addresses								
Bits								ASCII Character	Bits								ASCII Character
b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1		b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1	
X	0	1	0	0	0	0	0	SP	X	1	0	0	0	0	0	0	@
X	0	1	0	0	0	0	1	!	X	1	0	0	0	0	0	1	A
X	0	1	0	0	0	1	0	"	X	1	0	0	0	0	1	0	B
X	0	1	0	0	0	1	1	#	X	1	0	0	0	0	1	1	C
X	0	1	0	0	1	0	0	$	X	1	0	0	0	1	0	0	D
X	0	1	0	0	1	0	1	%	X	1	0	0	0	1	0	1	E
X	0	1	0	0	1	1	0	&	X	1	0	0	0	1	1	0	F
X	0	1	0	0	1	1	1	'	X	1	0	0	0	1	1	1	G
X	0	1	0	1	0	0	0	(	X	1	0	0	1	0	0	0	H
X	0	1	0	1	0	0	1	)	X	1	0	0	1	0	0	1	I
X	0	1	0	1	0	1	0	*	X	1	0	0	1	0	1	0	J
X	0	1	0	1	0	1	1	+	X	1	0	0	1	0	1	1	K
X	0	1	0	1	1	0	0	,	X	1	0	0	1	1	0	0	L
X	0	1	0	1	1	0	1	-	X	1	0	0	1	1	0	1	M
X	0	1	0	1	1	1	0	.	X	1	0	0	1	1	1	0	N
X	0	1	0	1	1	1	1	/	X	1	0	0	1	1	1	1	O
X	0	1	1	0	0	0	0	0	X	1	0	1	0	0	0	0	P
X	0	1	1	0	0	0	1	1	X	1	0	1	0	0	0	1	Q
X	0	1	1	0	0	1	0	2	X	1	0	1	0	0	1	0	R
X	0	1	1	0	0	1	1	3	X	1	0	1	0	0	1	1	S
X	0	1	1	0	1	0	0	4	X	1	0	1	0	1	0	0	T
X	0	1	1	0	1	0	1	5	X	1	0	1	0	1	0	1	U
X	0	1	1	0	1	1	0	6	X	1	0	1	0	1	1	0	V
X	0	1	1	0	1	1	1	7	X	1	0	1	0	1	1	1	W
X	0	1	1	1	0	0	0	8	X	1	0	1	1	0	0	0	X
X	0	1	1	1	0	0	1	9	X	1	0	1	1	0	0	1	Y
X	0	1	1	1	0	1	0	:	X	1	0	1	1	0	1	0	Z
X	0	1	1	1	0	1	1	;	X	1	0	1	1	0	1	1	[
X	0	1	1	1	1	0	0	<	X	1	0	1	1	1	0	0	\
X	0	1	1	1	1	0	1	=	X	1	0	1	1	1	0	1	]
X	0	1	1	1	1	1	0	>	X	1	0	1	1	1	1	0	^

X = don't care

and then removing ATN. If the device being polled was the device that requested service, it will respond by setting DIO line 7 low.

e) Now that the Controller has determined which device requested service the Controller terminates the Serial Poll mode by issuing the Universal Command "Serial Poll Disable" (ASCII character "EM").

f) The Controller should now address the appropriate devices to listen (possibly itself) and then address the FIREBERD 1500 to talk. The FIREBERD 1500 will then perform its data output with the standard three-wire handshake with each byte. On the last byte output the FIREBERD 1500 will set the EOI line to indicate the end of the data transfer.

g) The data ouput is now complete, and the Controller may address another device to talk or send an unaddress command.

If a FIREBERD 1500 initiates a Service Request and does not receive a Serial Poll within about 3 seconds of initiating the request, it will clear the Service Request. It will then update the data in its Print Buffer and initiate a new Service Request.

The full sequence of polling is not necessary in all cases. For example, a system may have only one device that requests service. When the Controller detects a Service Request, the source of the request and the appropriate action are known immediately.

5.6.3.3 Device Clear

When the FIREBERD 1500 is in the Addressable mode it is capable of responding to the DCL (Device Clear) or SDC (Selective Device Clear). When it receives either of these commands it performs a total reset of all counters and reinitializes itself in the same manner as it does when the front panel RESET switch is depressed.

SECTION 6

INTERFACE ADAPTOR MODULES

6.1 INTRODUCTION

Section 6 describes each of the interface adaptor modules available with the FIREBERD 1500. All signals (data, clock, signalling) sent to and from the FIREBERD 1500 will pass through the Interface Adaptor Module. An Interface Adaptor is required for all operating modes of the FIREBERD 1500. The following Interface Adaptors are included:

RS-232C
V.35/306
RS-449 (422/423)
DS1
WECO 303
Lab

6.2 RS-232 INTERFACE ADAPTOR OPTION 001

6.2.1 Introduction

The FIREBERD 1500 RS-232 Interface Adaptor meets the specifications of the Electronic Industries Associations RS-232C Standard dated August 1969. This interface adaptor, incorporated with the FIREBERD 1500, is designed to act as Data Terminal Equipment for use in the testing of Data Communications Equipment. The data is exchanged in a serial binary format with a synchronous clock. The Interface Adaptor is contained as a single unit.

A female RS-232 type-D connector is provided with the interface adaptor. An interconnecting male-to-male cable may be purchased separately. The following sections will provide a functional, switch, and specification description of the RS-232 Interface Adaptor.

6.2.2 Functional Description

The RS-232 Interface Adaptor is designed to convert between the serial binary signals specified by the EIA RS-232C standard and the TTL signals used in the FIREBERD 1500.

Drivers are provided for the Transmit Clock, Transmit Data, Request to Send (RTS), and Data Terminal Ready (DTR). The DTR output is tied ON and

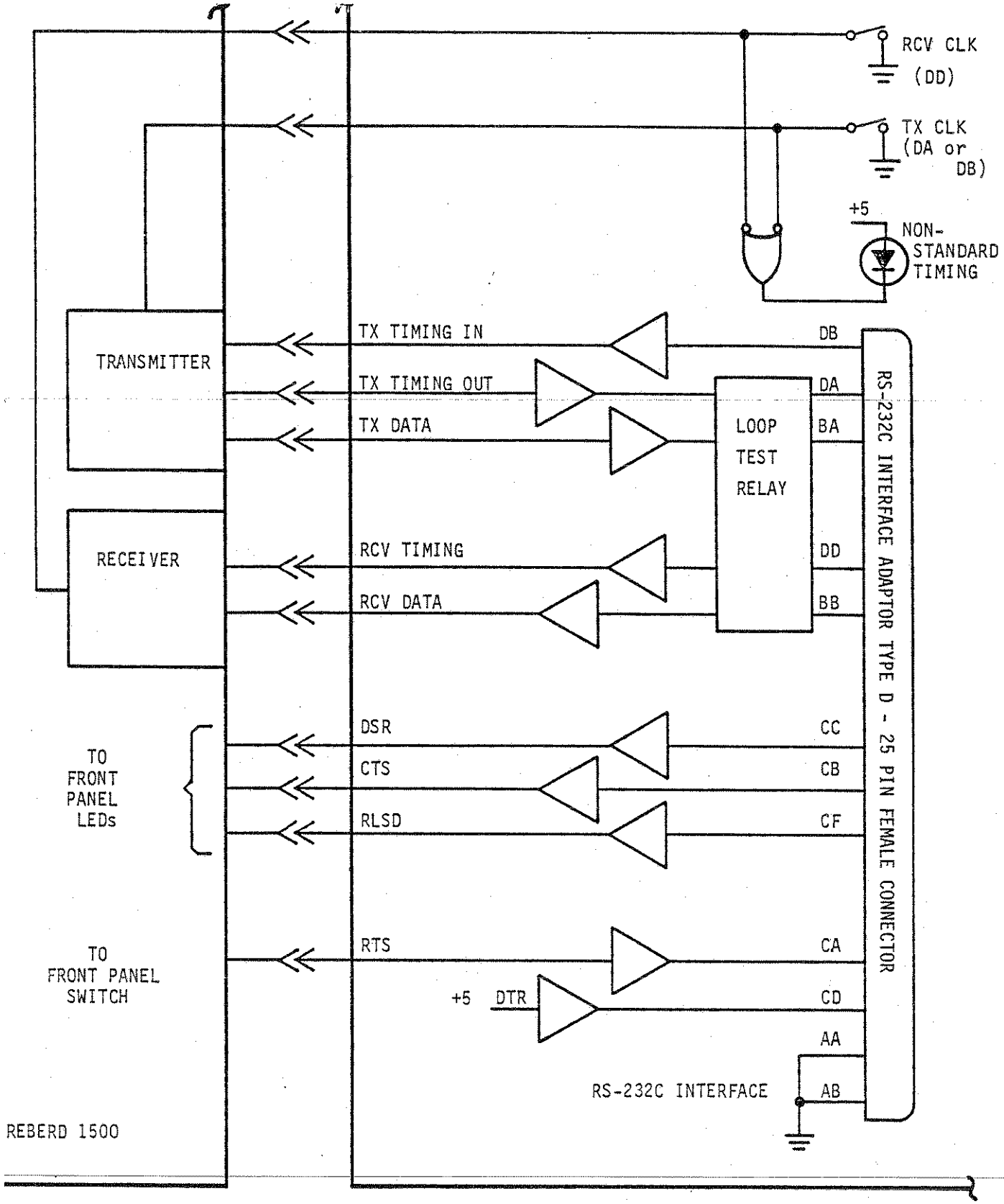


FIGURE 6-1
RS-232C INTERFACE ADAPTOR BLOCK DIAGRAM

the RTS output is controlled by a FIREBERD 1500 front panel switch.

There are six receivers, three of which directly drive the FIREBERD 1500 front panel DSR, CTS and RLSD LEDs. The Transmission Signal Element Timing (DCE Source) is sent to the transmit section of the FIREBERD 1500 where it may be selected for use by the CLOCK SELECT switch. The other two receiver output signals, Rcv Timing and Rcv Data are sent to the receive section for error analysis.

The interface adaptor also includes a loop test relay. When the LOOP TEST switch is depressed on the FIREBERD 1500 front panel, this relay will connect the Tx Data and Clock driver outputs to the Rcv Data and Clock receiver inputs. It will also disconnect the driver and receiver signals from the interface connector.

6.2.3 Receive Test Points

This section describes the phase relationship between the RS-232C Interface Adaptor data and clock input signals and the FIREBERD 1500 Rear Panel Test Points.

The signal level at the RCV DATA test point is ≥ 3 volts when the RCV data at the Interface Adaptor is a Mark (<-3V). The RCV Data test point is <.4V when incoming data is a Space (>+3V).

The signal at the RCV CLOCK test point is opposite in polarity to the clock received at the interface. When a signal less than minus 3 volts is input through the Receive Timing lead of the interface adaptor a signal greater than 3 volts will be on the RCV CLOCK test point. Therefore, data received falling edge valid with respect to the Interface Adaptor will appear rising edge valid at the RCV CLOCK and RCV DATA test points. The action of the clock invert switch occurs after the RCV CLOCK and DATA test points, thus no inversion of the Rcv Clock will be noticed at the RCV CLOCK test point.

6.2.4 Switch and Indicator Description

RCV CLK (DD)

The RCV CLK (DD) switch controls the polarity of the received clock inside the FIREBERD 1500. In the normal (NORM) position, FIREBERD 1500 is prepared to accept data which is falling edge (ON-OFF) valid as specified in the EIA RS-232C Standard (Figure 6-2a). In the INVERT position the

FIREBERD is prepared to receive data that is rising edge (OFF-ON) valid due to the inverted received clock (Figure 6-2b).

TX CLK (DA or DB)

The TX CLK switch controls the polarity of the clock used to develop the transmit clock and data functions inside the FIREBERD 1500. The NORM position transmits data-clock phasing as stated in the RS-232C Specification. In the INVERT postion, the transmit data and clock phasing will be inverted with respect to the RS-232C Specification (Figure 6-3).

NON-STANDARD TIMING

This indicator will illuminate when either or both clock invert switches are in the INVERT position.

6.2.5 Specifications

General: Maximum Speed -20 Kbits/sec (per RS-232C); normally functions to 100 kHz.

Data polarity - Data Mark/binary "1"; control lead OFF: $\leq$ -3 volts. Data Space/binary "0"; control lead ON: $\geq$ +3 volts.

Output rise time: $\geq$20 µs

Generator impedence: < 100 Ω

Drivers: Signal swing: 10V $\pm$ 2V into 7KΩ
Short circuit current: $\leq$ 100 mA

Receivers: Load impedence: 3 -7KΩ
Maximum input voltage: 25V

TABLE 6-1
RS-232C CONNECTOR PIN ASSIGNMENTS

Pin	Circuit	RS-232C Description	Lead status on FIREBERD 1500 Interface Adaptor
1	AA	Protective Ground	internally connected to Pin 7
2	BA	Transmitted Data	output
3	BB	Received Data	input
4	CA	Request to Send	output
5	CB	Clear to Send	input
6	CC	Data Set Ready	input
7	AB	Signal Ground (Common Return)	internally connected to Pin 1
8	CF	Received Line Signal Detector	input
9	--	(Reserved for Data Set Testing)	open
10	--	(Reserved for Data Set Testing	open
11		Unassigned (see Section 2.3)	open
12	SCF	Sec. Rec'd. Line Signal Detector	open
13	SCB	Sec. Clear to Send	open
14	SBA	Secondary Transmitted Data	open
15	DB	Transmit Signal Element Timing (DCE Source)	input
16	SBB	Secondary Re'cd. Data	open
17	DD	Recv'r. Sig. El. Timing (DCE Source)	input
18		Unassigned	open
19	SCA	Sec. Request to Send	open
20	CD	Data Terminal Ready	output (tied ON)
21	CG	Sig. Quality Detector	open
22	CE	Ring Indicator	open
23	CH/CI	Data Sig. Rate Selector (DCE/DTE Source)	open
24	DA	Txmt. Sig. El. Timing (DTE Source)	output
25		Unassigned	open

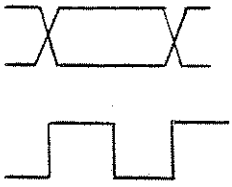
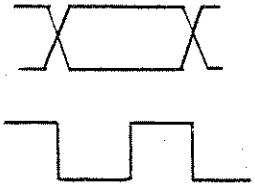
Signal	Clock-Data Phase Relationship
Received Data (BB) RCV Clock (DCE Source) (DD)	Normal  (a) Invert  (b)

FIGURE 6-2
RS-232C RCV CLOCK-DATA PHASE RELATIONSHIP

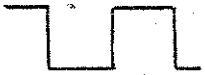
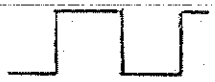
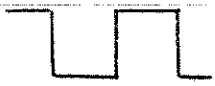
Signal	TX Clock Switch Position	
	Normal	Invert
Transmitted Data (BA)		
TX Clock (DCE Source) (DB)		
TX Clock (DTE Source) (DA)		

FIGURE 6-3

RS-232C TX CLOCK-DATA PHASE RELATIONSHIP

6.3 V.35/306 INTERFACE ADAPTOR MODULE OPTION NUMBER 002

6.3.1 Introduction

The V.35/306 INTERFACE ADAPTOR MODULE is designed to meet the following interface specifications:

1) CCITT Recommendation V.35
2) 306 Type Wideband Data Set. Bell System Technical Reference Publication 41304
3) Digital Data System Data Service Unit. Bell System Technical Reference Publication 41450

This interface enables a FIREBERD 1500 to act as Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE). The data is exchanged in serial binary format with a synchronous clock. The following sections provide functional, switch and specification descriptions.

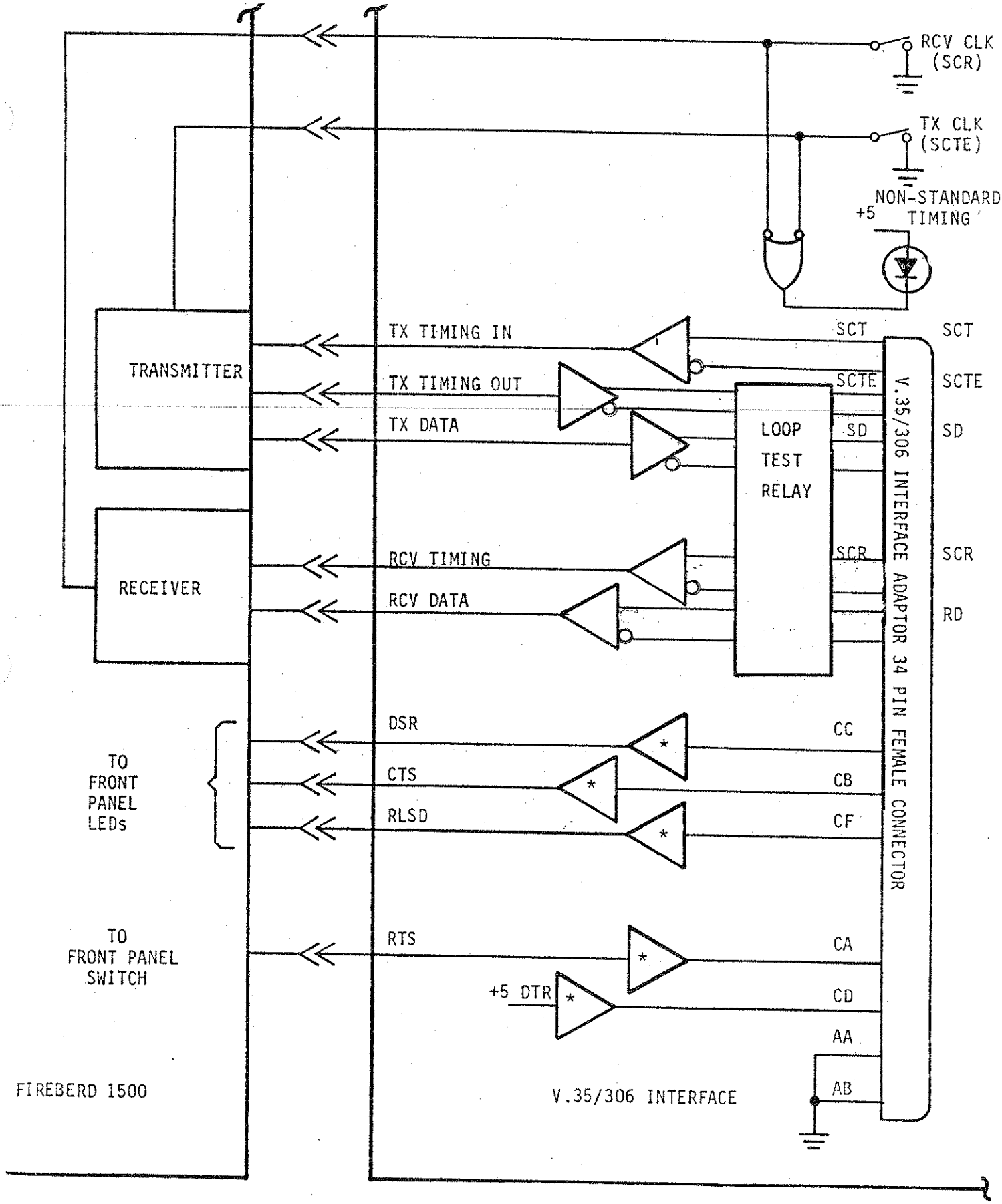
6.3.2 Functional Description

The V.35/306 Interface Adaptor converts between the signal characteristics specified by the appropriate interface specifications and the TTL signals used by FIREBERD.

When the unit is used in a 306 type system, the DCE supplies timing to the FIREBERD 1500 on the SCT lead. This signal is selected by the TRANSMIT CLOCK SELECT switch on the FIREBERD 1500 front panel. The selected clock is used to generate Send Data (SD) and Serial Clock Transmit External (SCTE), which are sent back to the DCE.

When the unit is used in a V.35 or Data Service Unit (DSU) System, timing is supplied to the FIREBERD 1500 in the same manner as 306 type systems. However, V.35 and DSU systems do not accept the SCTE signal from the FIREBERD 1500. The maximum operating speed is limited in this operating mode due to the cable delay and the 60 ns delay between the incoming SCT signal and the out-going SD signal.

Two high speed balanced V.35 type drivers are provided for the Send Data and SCTE differential outputs. Two other drivers, Request to Send (RTS) and Data Terminal Ready (DTR) are designed according to RS-232C and CCITT V.28 specifications. The DTR ouput is tied ON and the RTS ouput is controlled by a FIREBERD 1500 front panel switch. There are three high speed balanced V.35 type



* RS-232C Type drivers and receivers

FIGURE 6-4

V.35/306 INTERFACE ADAPTOR MODULE BLOCK DIAGRAM

receivers provided for the Serial Clock Transmit (SCT), Rcv Data (RD) and the Serial Clock Receive (SCR). The SCT signal is sent to the transmit section of FIREBERD 1500 where it may be selected for use by the CLOCK SELECT switch. Receive Data (RD) and the Serial Clock Receive (SCR) signals are sent to the receiver section of FIREBERD 1500 for error analysis. Three other receivers, Data Set Ready (DSR), Clear to Send (CTS) and Receive Line Signal Detector (RLSD) directly drive the FIREBERD 1500 front panel LEDs. These receivers are designed according to the RS-232C and CCITT V.28 specifications.

Also included in the interface adaptor is a loop test relay designed to connect the transmit clock and data outputs to the receive clock and data inputs when the FIREBERD 1500 LOOP TEST switch is depressed. This relay will also disconnect the drivers and receivers from the interface connector. LOOP TEST does not affect the TX TIMING IN (SCT) signal (see Figure 6-4).

6.3.3 Receive Test Points

This section describes the relationship between the data at the interface connector and the FIREBERD 1500 test points when the V.35/306 Interface Adaptor is in use.

The RCV DATA test point is <.4 volts when the received data at the interface adaptor is a differential voltage such that the A input is more positive than the B input (Space). The RCV DATA test point is >3 volts when a differential voltage at the interface consists of input B being more positive than input A (Mark).

The signal at the RCV CLOCK test point is opposite in polarity to the clock received at the V.35/306 Interface Adaptor. Therefore, data received falling edge valid with respect to the Interface Adaptor will appear rising edge valid at the RCV CLOCK and RCV DATA test points. The action of the RCV clock invert switch occurs after the RCV CLOCK and DATA test points, thus no inversion of the Rcv Clock will be noticed at the RCV CLOCK test point when the RCV CLOCK INVERT switch is changed.

6.3.4 Switch and Indicator Description

RCV CLK (SCR)

The RCV CLK (SCR) switch controls the polarity of the received clock signal (SCR) as it enters the FIREBERD 1500 from the V.35/306 Interface

Adaptor. In the NORM position, the data (RD) - clock (SCR) phasing is accepted according to the interface specifications (Figure 6-5a). The INVERT position allows FIREBERD to accept data and clock phasing inverted with respect to the interface specifications (Figure 6-5b).

TX CLK (SCTE)

The TX CLK (SCTE) switch controls the polarity of the clock used to develop the transmit clock and data functions inside the FIREBERD 1500. The NORM position transmits the data-clock phasing at the interface as stated in the interface specifications. In the INVERT position the transmit data and clock are phased inverted with respect to the specifications (Figure 6-6).

NON-STANDARD TIMING

This indicator will illuminate when either or both clock invert switches are in the INVERT position.

6.3.5 Specifications

General:	Maximum speed: (Normally functions to 10 MHz)
	Delay SCT to SD: ≈ 60 ns
	Skew SCTE to SD: 15 ns
Balanced drivers:	Signal swing (Bipolar): .55V ± .1 into 100 Ω
	Short circuit current: < 100 mA
	Rise time: < 20 ns
	Generator impendence: 100 Ω
Balanced Receivers:	Load resistance: 100 Ω
Unbalanced Drivers (RS-232):	Rise time: > 20 µs
	Generator impendence: < 100 Ω
	Output level with 7K load: ± 10V ± 2V
	Short circuit current: ≤ 100 mA
Unbalanced Receivers (RS-232):	Load impedence: 3 to 7K Ω
	Maximum input voltage: ± 25V

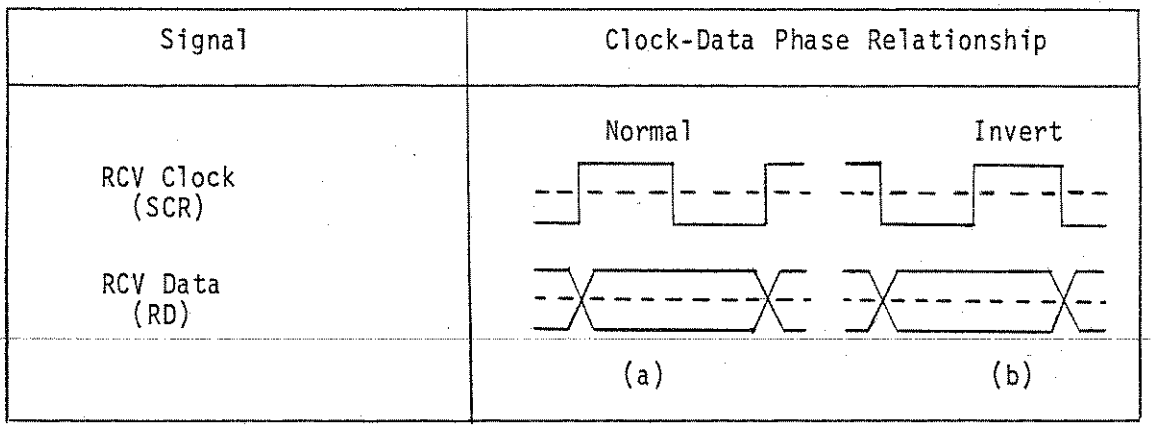


FIGURE 6-5

V.35/306 RCV CLOCK-DATA PHASE RELATIONSHIP

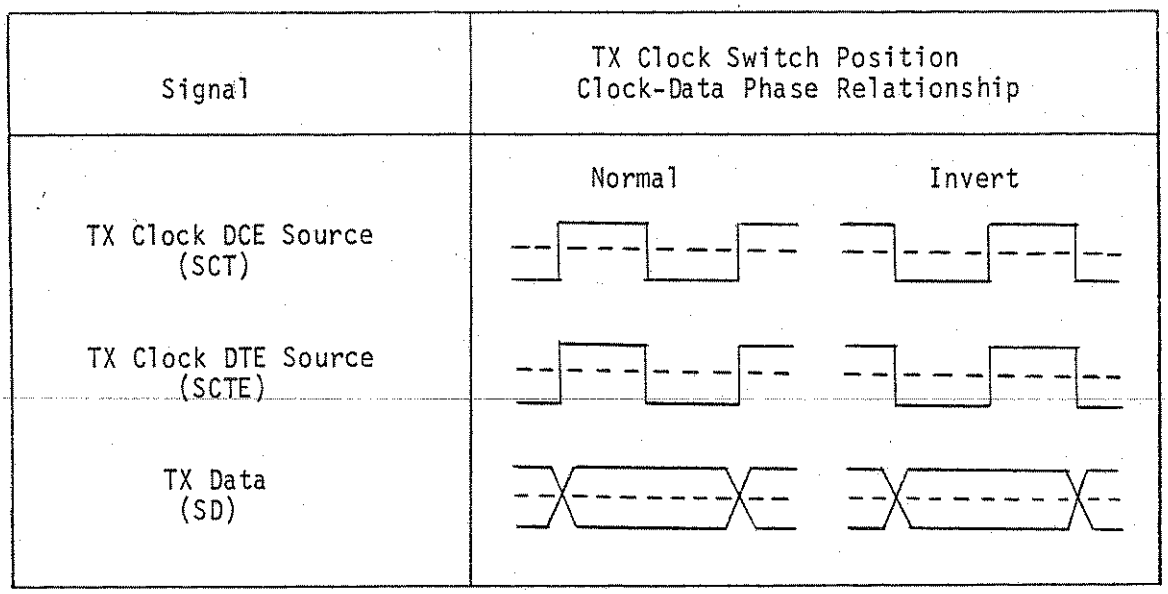


FIGURE 6-6

V.35/306 TX CLOCK-DATA PHASE RELATIONSHIPS

PIN	CIRCUIT	V.36/306 DESCRIPTION	COMMENT
A	AA	Protective Ground	internally connected to B
B	AB	Signal Ground	internally connected to A
C	CA	Request to Send	output
D	CB	Clear to Send	input
E	CC	Data Set Ready	input
F	CF	Received Line Signal Detector	input
H	CD	Data Terminal Ready	output
J	CE	Ring Indicator	open
K	--	Local Test	open
R	RD (A)	Received Data	input
T	RD (B)	Received Data	input
V	SCR (A)	Serial Clock Receive	input
X	SCR (B)	Serial Clock Receive	input
P	SD (A)	Send Data	output
S	SD (B)	Send Data	output
U	SCTE (A)	Serial Clock Transmit External	output
W	SCTE (B)	Serial Clock Transmit External	output
Y	SCT (A)	Serial Clock Transmit	input
AA or a	SCT (B)	Serial Clock Transmit	input

TABLE 6-2
V.35/306 CONNECTOR PIN ASSIGNMENTS

V.35/306 INTERFACE ADAPTOR MODULE ERRATA

A few of the V.35 Interface Modules produced have opposite phasing between Send Data (SD) and Serial Clock Transmit (SCT) to that shown in Figure 6-6. The phasing between SD and SCTE is as shown in the figure. These Interface Modules meet the requirements of the CCITT V.35 and Bell 306-type data sets. They do not meet the Bell DSU requirements. The TX Clock switch may be used to invert the phase relationship or the units may be modified by TTC to correct the inversion. Consult TTC if you have units that require modification. V.35 Interface Modules with the following serial numbers have inverted phasing: 001, 003, 005, 008, 009 - 012, 014, 017, 019, 020, 021, 023 - 027, 031, 033, 035, 039, 040, 042 - 044, 049 and 054.

6.4 RS-449 (422-423) INTERFACE ADAPTOR MODULE OPTION 005

6.4.1 Introduction

The RS-449 INTERFACE ADAPTOR has been designed according to the Electronic Industries Association (EIA) Standard RS-449 dated November 1977. This interface, incorporated with the FIREBERD 1500 will act as Data Terminal Equipment to test Data Communications Equipment employing serial data with a synchronous clock. The interface incorporates a standard 37 pin D-type connector on its front panel. An optional 37 conductor cable with a male connector at each end is available at additional cost.

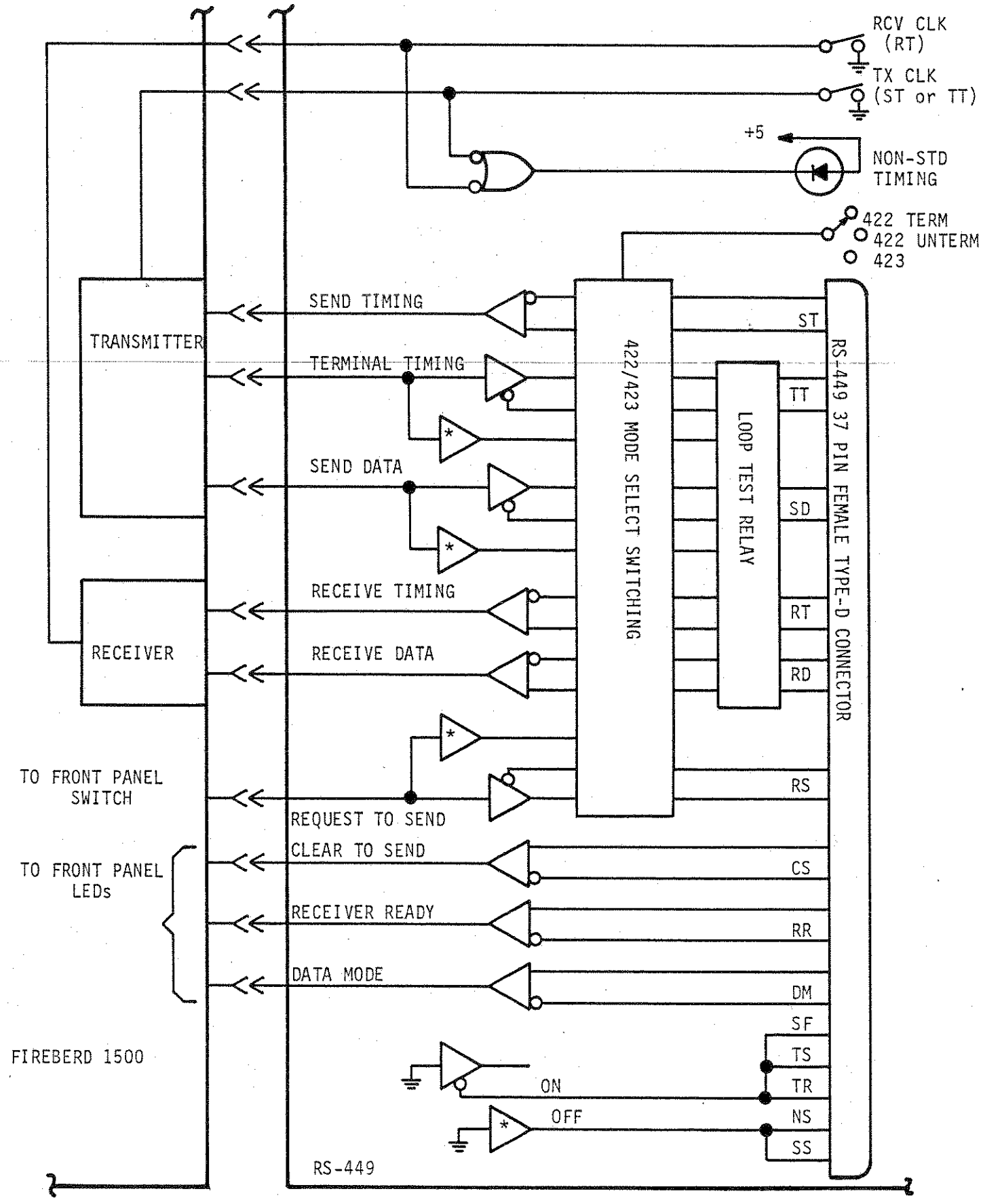
The RS-449 specification describes two categories of signals; category one and category two. The specification allows category one to be implemented with 422 or 423 drivers and receivers. The 449 MODE switch on this Interface Module allows category one circuits to be switched between RS-422 TERM, RS-422 UNTERM and RS-423. Category two circuits are always 423 type.

The following sections will provide a complete functional, and specification description of the RS-449 INTERFACE ADAPTOR.

6.4.2 Functional Description

The RS-449 INTERFACE ADAPTOR will convert between the 422 or 423 signals as specified, and the TTL signals used by the FIREBERD 1500. This unit has three basic modes of operation 422 TERM, 422 UNTERM and 423. The 423 mode drivers and receivers are designed for bipolar unbalanced signals to operate at a maximum speed of 2 MHz. These drivers and receivers are designed according to the RS-423A EIA specification (1978). The 422 Terminated (TERM) and 422 Unterminated (UNTERM) operating modes provide drivers and receivers that operate with high speed bipolar balanced signals. They will operate to 10 MHz in either mode.

The 422 TERM and 422 UNTERM modes differ in that the terminate 422 mode will place 100 ohm resistors across the Receive Data (RD), Receive Timing (RT) and Send Timing (ST) inputs. In the 422 unterminate mode the data and clock receivers have a load impedence of >4K ohms. The 422 mode offers high speed bipolar line drivers for the Send Data (SD), Terminal Timing (TT), and Request to Send (RS). The Send Data (SD) driver will transmit the serial data generated inside of FIREBERD to SD outputs of RS-449 interface connector. The Terminal Timing (TT) driver transmits the synchronous clock



* 423 Type driver

FIGURE 6-7
RS-449 INTERFACE
MODULE

selected by the CLOCK SELECT switch on the front panel of the FIREBERD 1500. The RS driver will be ON or OFF at the connector dependent on the RTS switch on the front panel of the FIREBERD 1500. The output Terminal Ready (TR) is tied ON by a 422 type driver. This will appear as an ON whether a 422 or 423 receiver is connected to this driver.

There are six high speed balanced line receivers, Send Timing (ST), Receive Timing (RT), Receive Data (RD) and the three signalling inputs, Clear to Send (CS), Receiver Ready (RR) and Data Mode (DM). The three receivers connected to the signalling inputs directly drive the front panel signalling LEDs on the FIREBERD 1500. The labels in parenthesis on the front panel of FIREBERD 1500 are the 449 nomenclature. The Send Timing receiver is sent to the transmit section of FIREBERD 1500 where it may be selected for use by the CLOCK SELECT switch as an internal clock. The synchronous Receive Data and Receive Timing inputs are sent to the receive section of FIREBERD 1500 for error analysis.

The 423 mode drivers provide bipolar transmit Data, Clock and RS signals. This mode outputs a serial unbalanced data signal to the SD (A) output, a serial unbalanced clock signal to TT (A) output and a RS bipolar signal to the RS (A) output of the 37 pin connector. The (B) leads of each of these drivers will be grounded internally by the 423 mode switch. The receivers in 423 mode are the same receivers used in 422 mode except they are now used to input bipolar unbalanced signals. The Receive Timing (RT) will input serial clock signals at the RT input to the RS-449 connector. The Receive Data (RD) will input serial data signals to the RD (A) input and Send Timing (ST) through the ST (A) input of the connector. The (B) inputs to each of these receivers will be floating and should be grounded at the drivers in 423 mode. The three signalling receivers Clear to Send (CS), Receiver Ready (RR) and Data Mode (DM) receive signals through their respective (A) inputs CS, RR, and DM at the interface connector. The (B) inputs will be floating and should be grounded externally.

Also included in the RS-449 Interface Adaptor is a loop test relay designed to connect the Transmit Timing and Send Data outputs to the Receive Timing and Receive Data inputs when the FIREBERD 1500 LOOP TEST switch is depressed. This relay will also disconnect the drivers and receivers from the interface connector. LOOP TEST does not affect the Send Timing (ST) input signal (Figure 6-7).

6.4.3 Receive Test Points

This section describes the relationship between the data at the interface connector and the FIREBERD 1500 rear panel test points in either the 422 or 423 modes. The RCV DATA test point is < .4 volts when the Received Data signal at the input to the interface is a Space and > 3V when a Mark is received by the interface adaptor. The RCV CLOCK test point is > 3 volts when the Received Timing signal at the input to the interface is ON and <.4 volts when the Receive Timing input at the interface adaptor is OFF. Therefore, the data-clock phase relationship appearing at the RCV CLOCK and DATA test points of the FIREBERD 1500 will be equivalent to that detected at the input to the RS-449 Interface Adaptor. The action of the Receive Clock invert switch occurs after the RCV CLOCK test point, thus no inversion of the Receive Timing will be noticed at the RCV CLOCK test point.

6.4.4 Switch and Indicator Description

RCV CLK (RT)

The RCV CLK invert switch controls the polarity of the received clock signal (RT) as it enters the FIREBERD 1500 from the 449 Interface Adaptor. In the NORMAL position, the data-clock phasing is accepted according to the interface specifications (Figure 6-8a). The INVERT position allows FIREBERD to accept data-clock phasing inverted with respect to the interface specifications (Figure 6-8b).

TX CLK (ST or TT)

The TX CLK switch controls the polarity of the clock used to develop the transmit clock and data functions inside the FIREBERD 1500 for either the 422 or 423 modes of operation. The NORMAL position transmits the data-clock phasing at the 449 interface adaptor outputs as stated in the interface specifications. In the INVERT position the transmit data (SD) and clock (TT) are phased inverted with respect to the specifications (Figure 6-9).

NON-STD TIMING

This indicator will illuminate when either or both Clock Invert switches are in the INVERT position.

6.3.5 Specifications

General:

Data Polarity:

423 - Data Mark/binary "1"; control lead OFF; negative. Data Space/binary "0"; control lead ON; positive.

422 - Data Mark/binary "1"; control lead OFF; lead A more negative than B Data Space/binary "0"; control lead ON; lead A more positive than B

423 Drivers:

Generator impedance: < 50 ohms
Short circuit current: < 150 mA
Output rise time: > 20 µs
Signal swing: ± 5V ± 1 into 450 ohms

422 Drivers:

Generator impedance: < 100 ohms
Short circuit current: < 150 mA
Output rise time: > 20 µs
Signal swing (either output): > 2.5V into 100 Ω
> 4.0V unterminated

423/422 UNTERM Receivers:

Load impedance: ≥ 4K ohms
Input threshold: ± .2 volts

422 TERM Receivers:

Load impedance: ≈ 100 ohms
Input threshold: ± .2 volts

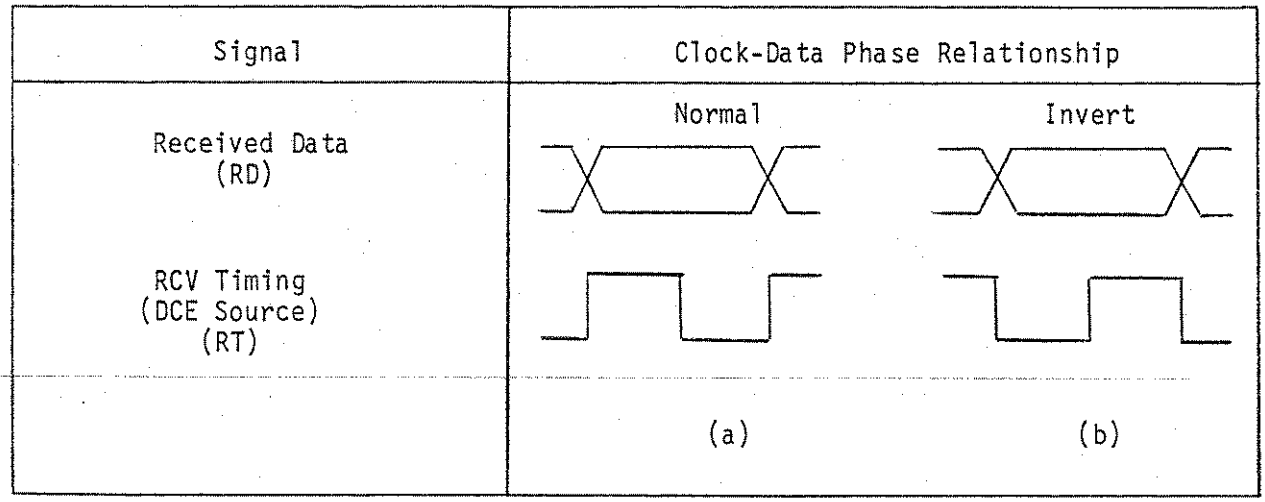


FIGURE 6-8

RS-449 RCV CLOCK-DATA PHASE RELATIONSHIP

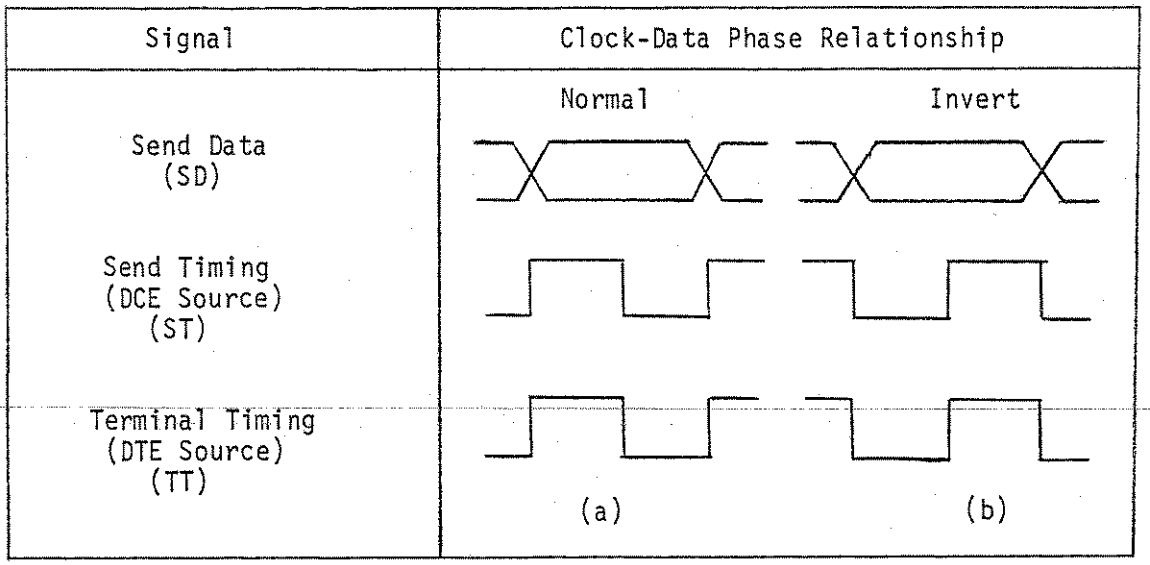


FIGURE 6-9

RS-449 TRANSMIT CLOCK-DATA PHASE RELATIONSHIP

TABLE 6-3

RS-449 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
1	SHIELD	Ground	internally connected to 20, 37, 19, 30
2	SI	Signalling rate indicator	open
3	SPARE	Spare	open
4	SD (A)	Send Data	output
5	ST (A)	Send Timing	input
6	RD (A)	Receive ~~Timing~~ DATA	input
7	RS (A)	Request to Send	output
8	RT (A)	Receive Timing	input
9	CS (A)	Clear to Send	input
10	LL	Local Loopback	423 output tied OFF
11	DM (A)	Data Mode	input
12	TR (A)	Terminal Ready	422/423 output tied ON
13	RR (A)	Receiver Ready	input
14	RL	Remote Loopback	423 output tied OFF
15	IC	Incoming Call	open
16	SF/SR+	Select Frequency/ Signalling Rate Selector	423 output tied ON
17	TT (A)	Terminal Timing	output
18	TM	Test Mode	input
19	SG	Signal Ground	
20	RC	Receive Common	
21	SPARE	Spare	open
22	SD (B)	Send Data	output
23	ST (B)	Send Timing	input
24	RD (B)	Receive ~~Timing~~ DATA	input
25	RS (B)	Request to Send	output
26	RT (B)	Receive Timing	input
27	CS (B)	Clear to Send	input
28	IS	Terminal in Service	423 output tied ON
29	SM (B)	Data Mode	input

TABLE 6-3 (Cont'd)

RS-449 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
30/12	TR (B)	Terminal Ready	grounded
31/13	RR (B)	Receiver Ready	input
32/14	SS	Select Standby	423 output tied OFF
33/5	SQ	Signal Quality	open
34/6	NS	New Signal	423 output tied OFF
35/17	TT (B)	Terminal Timing	output
36/8	SB	Standby Indicator	open
37/9	SC	Send Common	

6.5 WECO 303 INTERFACE ADAPTOR MODULE (OPTION 004)

6.5.1 Introduction

The 303 Interface Adaptor Module meets the interface specifications of the 303 type Wideband Data Stations, Bell System Technical Reference Publication 41302 (1974). This interface adaptor, incorporated with a FIREBERD 1500 is designed to act as Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE). The data is exchanged in a serial binary format with a synchronous clock.

A cable is provided with each 303 Interface Module. This cable provides the connection between the 25 pin type-D connector on the interface module (Figure 6-10) and the 303 Data Station.

The following sections provide a functional, switch and specification description for the module.

6.5.2 Functional Description

The 303 Interface Adaptor module converts between the signal levels specified in the 303 Interface specification and the TTL signal levels used in the FIREBERD 1500.

This interface provides high-speed current-mode drivers for the Send Data (SD), Serial Clock Transmit External (SCTE) and the Request to Send (RS) outputs. The SD and SCTE signals are transmitted according to the 303 specification. The RS output is controlled by a FIREBERD 1500 front panel switch.

There are six high speed current mode receivers, three of which directly drive the FIREBERD 1500 front panel DSR, CTS and RLSD LEDs. The other receivers consist of the Serial Clock Transmit (SCT), Receive Data (RD), and the Serial Clock Receive (SCR). The SCT signal is sent to the transmit section of FIREBERD where it may be selected for use by the CLOCK SELECT switch. The SCR and RD signals are sent to the receive section for error analysis. An EIA RS-232 type driver is provided to hold the DTR line in the ON condition.

The interface adaptor also includes a loop test relay. When the LOOP TEST switch is depressed on the FIREBERD 1500 front panel, this relay will connect the SD and SCTE driver outputs to the RD and SCR receiver inputs. It will also disconnect the driver and receiver signals from the interface connector.

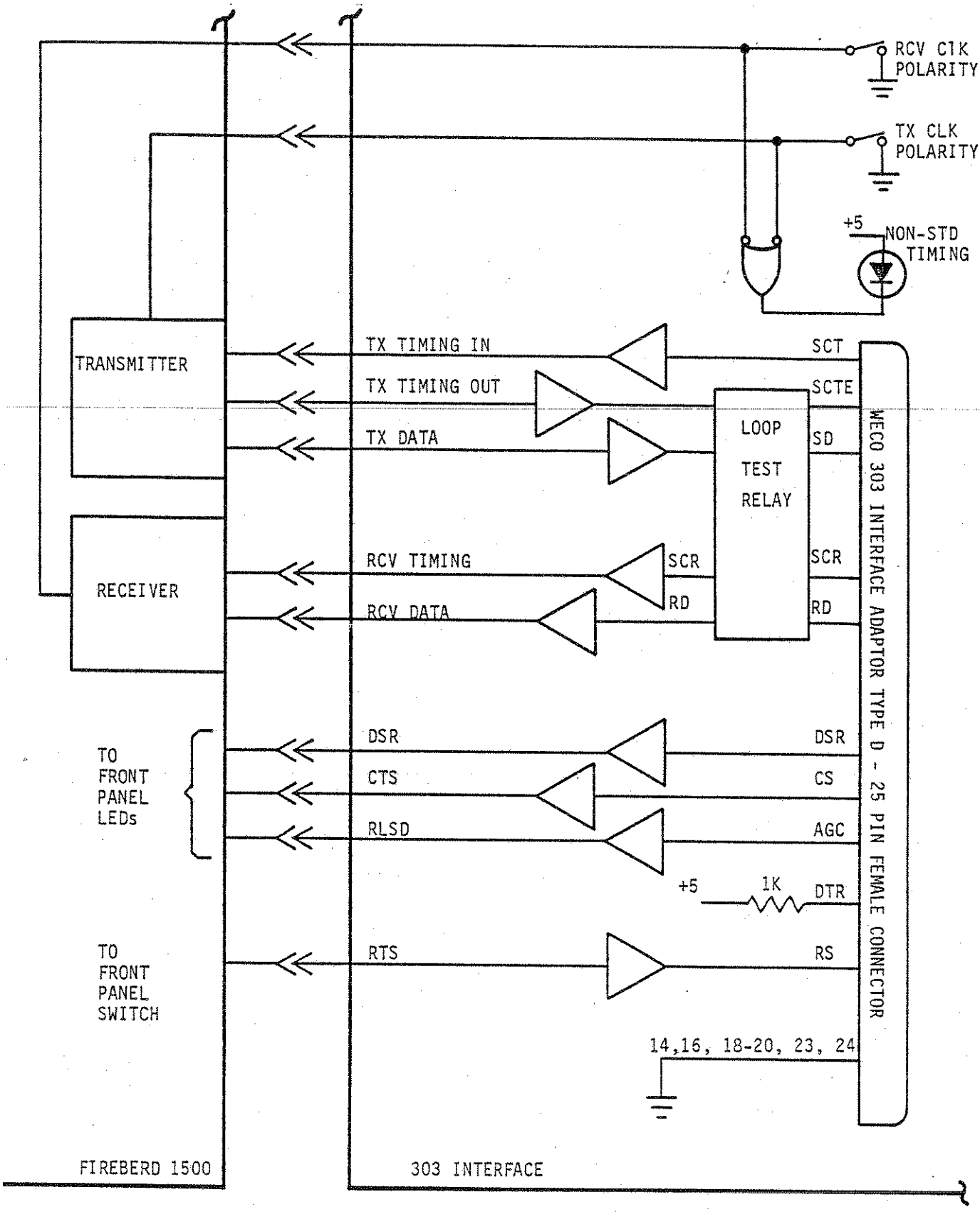


FIGURE 6-10
WECO 303 INTERFACE ADAPTOR
BLOCK DIAGRAM

6.5.3 Receive Test Points

This section describes the relationship between the 303 Interface Adaptor data and clock input signals and the FIREBERD 1500 Rear Panel Test Points.

The signal level at the RCV DATA test point is > 3 volts when the rcv data at the Interface Adaptor is a Mark. The RCV DATA test point is < .4V when incoming data is a Space.

The signal at the RCV CLOCK test point is not in polarity with the clock received at the interface. When an OFF state is input through the Receive Timing lead of the interface adaptor, a signal greater than 3 volts will be on the RCV CLOCK test point. Therefore, data received falling edge valid at the interface connector will be rising edge valid at the RCV CLOCK and RCV DATA test points. The action of the Clock Invert switch occurs after the RCV CLOCK and DATA test points, thus no inversion of the rcv clock will be noticed at the RCV CLOCK test point.

6.5.4 Switch and Indicator Description

RCV CLK POLARITY

The RCV CLK POLARITY switch controls the polarity of the received clock (SCR) inside the FIREBERD 1500. In the NORMAL position, FIREBERD 1500 is prepared to accept data which is falling edge (ON-OFF) valid as specified in the Bell 303 Standard (Figure 6-11a). In the INVERT position the FIREBERD 1500 is prepared to receive data rising edge (OFF-ON) valid due to the inverted received clock (Figure 6-11b).

TX CLK POLARITY

The TX CLK POLARITY switch controls the polarity of the clock used to develop the transmit clock (SCTE) and data functions inside the FIREBERD 1500. The NORMAL position transmits data-clock phasing as stated in the Bell 303 specification. The INVERT position transmits the data-clock phasing inverted to that in the 303 specification (Figure 6-12).

NON STD TIMING

This indicator will illuminate when either or both Clock Invert switches are in the INVERT position.

6.5.5 Specifications

General:	Data polarity: Data Mark/binary 1; control lead OFF < 5 mA Data Space/binary 0; control lead ON > 23 mA
Drivers:	Mark/OFF < 4 mA Space/ON ≃ 35 ma
Receivers:	Input impedence: 100 ohms Open circuit voltage: ≃ -1 volt Maximum input voltage: 25 volts Thresholds: OFF or Mark < 10 ma ON or Space ≥ 10 ma

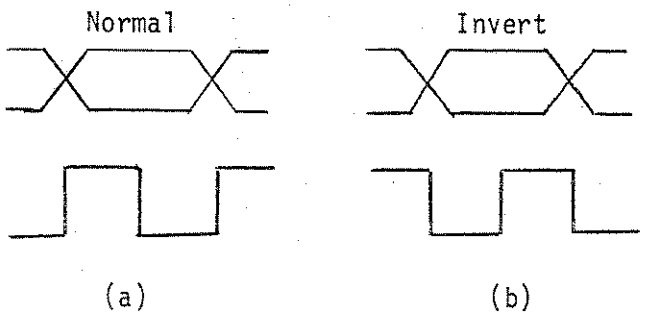
Signal	Clock-Data Phase Relationship
Received Data (RD) RCV Clock (SCR)	

FIGURE 6-11
WECO 303 RCV CLOCK-DATA PHASE RELATIONSHIP

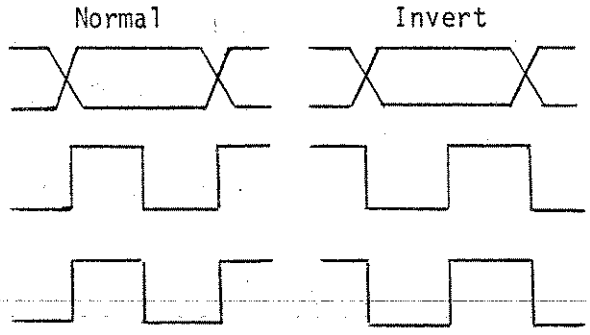
Signal	TX Clock Switch Description
Transmitted Data (SD) TX Clock (DCE Source) (SCT) TX Clock (DTE Source) (SCTE)	

FIGURE 6-12

WECO 303 TX CLOCK-DATA PHASE RELATIONSHIP

TABLE 6-4

CONNECTOR PIN-OUT DESCRIPTION

D-Type Pinouts	Burndy Cable Pinouts	Circuit	Description	Comment
1	E	SD	Send Data	output
2	H	SCTE	Serial Clock Transmit External	output
3	D	RS	Request to Send	output
4				open
5	M	AGC	AGC Center Conductor	input (RLSD LED)
6	J	SCT	Serial Clock Transmit	input
7	C	CS	Clear to Send	input
8				open
9	F	DSR	Data Set Ready	input
10	K	RD	Receive Data	input
11	L	SCR	Serial Clock Receive	input
12				open
13				open
14	ES	(SD)	ground	
15	HS	(SCTE)	ground	
16	DS	(RS)	ground	
17				open
18	MS	DTR	Data Terminal Ready (outer conductor)	tied ON
19	JS	(SCT)	ground	
20	CS	(CS)	ground	
21				open
22				open
23	KS	(RD)	ground	
24	LS	(SCR)	ground	
25				open

6.6 DS1 INTERFACE ADAPTOR MODULE

6.6.1 Introduction

The DS1 Interface Adaptor module meets the interface requirements of the Bell System 1.544 Mbps Channel Service unit specification (Pub. 41451) and other systems with DS1 type signals. The DS1 interface incorporated with the FIREBERD 1500 will act as Data Terminal Equipment (DTE) and exchange a serial data signal used in the testing of Data Communication Equipment (DCE). The data signal is transmitted and received through the female plugs (TX OUTPUT, RCV INPUT) or the 15 pin D-type connector on the DS1 Interface Adaptor.

The following sections will give a functional, switch and specification description of the DS1 Interface Adaptor.

6.6.2 Functional

The DS1 Interface Adaptor is designed to convert between the DS1 signals according to the Bell System Specification and the TTL signals required by the FIREBERD 1500. The DS1 signals are serial, differential return to zero (RZ) with alternate mark inversion (AMI) coding. The transmit data is sent to the TX OUTPUT plug, and the TX OUTPUT of the D-type connector on the DS1 front panel. Only one of these outputs should be used at any one time.

Timing for the transmit data signal may be developed by selecting either the recovered receive clock signal or the external clock signal input through the BNC connector on the DS1 front panel. The external (EXT) or recovered (RECOV CLK) clock signal may be selected by the TX TIMING switch on the DS1 front panel. The TX TIMING is then input into FIREBERD 1500 with the CLOCK SELECT switch in the EXT position. Timing for the transmit data may also be selected from the F_A, F_B, or F_C optional oscillators provided that the selected oscillator is 1.544 MHz.

There are two types of receivers on the DS1 interface. One receiver accepts the external clock input. This receiver incorporates capactive coupling and an internal schmitt trigger. The other receiver will accept a RZ coded, differential, AMI data signal at 1.544 MHz ($\pm$ 100 Hz).

This data will be input through the RCV INPUT plug or the RCV INPUT of the D-type connector. The two receive data inputs are tied together internally, therefore, only one should be used at a time. This data signal is then used to develop a recovered clock signal through the use of a phase lock loop (PLL) circuit. The PLL is designed to lock up to a 1.544 MHz ($\pm$ 100 Hz) data signal with less than 19 sequential zeros (spaces). The DS1 Interface Adaptor will accurately recover a clock signal from all the patterns available on the 1500 except the Space (SP) pattern.

Due to the RZ coding signal of the DS1 interface and the NRZ (non return to zero) signal of the 1500 a solid Mark received by the DS1 will cause the MARK and SPACE LEDs to light alternately. This only affects the MARK and SPACE LEDs.

The clock recovery circuit always provides a receive clock independent of the Rcv data. Therefore, with the DS1 interface installed, the RCV CLK ACTIVITY LED will detect a received clock signal. The RCV CLK ACTIVITY detector does not indicate that the recovered clock is phase locked to the incoming data.

Receive Test Points

This section describes the signals appearing at the RCV CLOCK and RCV DATA test points on the rear panel of the FIREBERD 1500.

The data signal received by the DS1 Interface Adaptor does not require a synchronous clock. Therefore, the clock-data phase relationship at the RCV CLOCK and DATA test points will always be rising edge valid when the PLL is locked onto the received data.

6.6.3 Switch and Connector Description

TX TIMING

The clock signal selected by the TX TIMING switch on the DS1 Interface Adaptor is selected for use by FIREBERD through the EXT position of the CLOCK SELECT switch. (Other 1.544 Mbps timing signals may be selected by F_A, F_B, and F_C if available.)

In the TX TIMING RECOV position, the clock signal used by FIREBERD to generate the transmit data (SD) is the clock recovered from the received data signal (RD). In the TX TIMING EXT position the clock signal used by FIREBERD 1500 is the external clock signal input through the BNC connector on the DS1 interface front panel.

RCV IMPED

The RCV IMPED switch selects either a 1000 ohm receiver load impedence ((BRDG) 1000) or 100 ohm receiver load impedence (110 ohm).

6.6.4 Specifications

General: Operating frequency: 1.544 MHz (± 100 Hz)

Driver: Signal swing: ± 3 volts

Data Receivers: Load resistance: 1000/110 ohms

EXT Clock Receiver: Wave type: sine or square; unipolar or bipolar
voltage: .5 to 10 vpp

PLL: Center frequency: 1.544 MHz
Minimum pullin range: ± 100 Hz

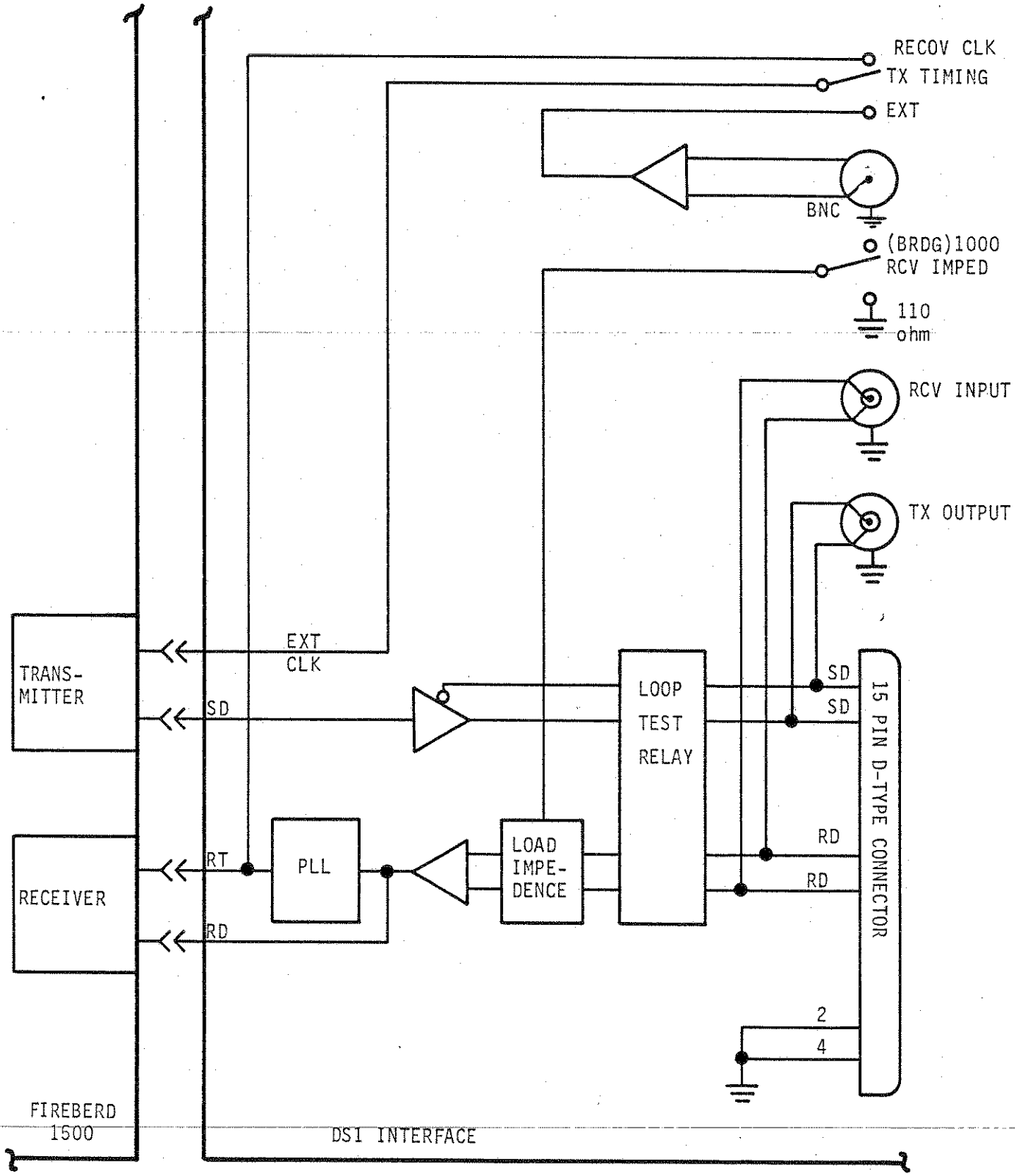


FIGURE 6-13

DS1 INTERFACE ADAPTOR

TABLE 6-5

D-TYPE CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	DESCRIPTION	COMMENT
1	A	Transmit data (SD)	output - internally connected to ring of TX OUTPUT.
2		ground	internally connected to pin 4.
3	A	Receive data (RD)	input - internally connected to ring of RCV INPUT.
4			open
5			open
6			open
7			open
8			open
9	B	Transmit data (SD)	output - internally connected to tip of TX OUTPUT.
10			open
11	B	Receive data (RD)	input - internally connected to tip of RCV INPUT.
12			open
13			open
14			open
15			open

6.7 LAB INTERFACE ADAPTOR MODULE (MODEL 40227)

6.7.1 Introduction

The Lab Interface Adaptor Module is a versatile interface unit which allows the FIREBERD 1500 to test a wide variety of data handling devices. Capable of driving any load from 50 ohms to high impedances, with user-selectable receiving impedances, the Lab Interface allows the user to select bipolar or unipolar, balanced or unbalanced operating modes.

Data is exchanged in a serial binary format with a synchronous clock signal. All connections with the Lab Interface are made through BNC connectors.

The following sections will provide functional and operational descriptions and the specifications for the Lab Interface Adaptor.

6.7.2 Functional Description

The Lab Interface Adaptor Module is designed to convert between the TTL signals used within the FIREBERD 1500 and the user-selected signal type.

Data generated in the FIREBERD are transmitted through the TX DATA jack. The synchronous transmitted clock signal is sent through the TX CLK OUT jack. Data is returned to the FIREBERD for error analysis through the RCV DATA jack. The synchronous returned clock is sent through the RCV CLK jack.

Timing for the transmitted data signal may be developed either by selecting one of the FIREBERD's internal clock signals or by providing a clock signal via the EXT TX CLK IN jack, and selecting the "EXT" setting of the CLOCK SELECT switch.

The Lab Interface Adaptor also includes a Loop test multiplexer designed to connect the TTL-Level transmit data and clock signals directly to the FIREBERD TTL-Level receive data and clock inputs when the LOOP TEST switch is depressed. When in the loop test mode, the Lab Interface transmit data and clock signals are unaffected. The receive data and clock signals' terminations are not affected by the Loop test mode, although these signals do not reach the FIREBERD itself.

6.7.3 Switch Operation and Control

The Lab Interface Adaptor has three switches each with four positions affecting the operation of the unit. By properly selecting the switch positions, any of up to 64 operating modes may be accommodated.

INPUT IMPEDANCE SWITCH

The INPUT IMPEDANCE switch affects the three inputs: RCV DATA, RCV CLK, and EXT TX CLK IN. When in the "50 OHMS" position, the switch places a 50 ohm terminating resistor across each of the three inputs. When placed in the "75 OHMS" position, a 75 ohm resistor terminates each of the three inputs. The "100 OHM" position provides a 100 ohm terminating resistor, and the "8K OHMS" position allows the input signals to go directly to the line receiver integrated circuits with no other resistive termination.

MODE SWITCH

The MODE switch controls the mode of operation of all five data and clock jacks. Two major modes of operation are available: the Bipolar configuration (both positive and negative with respect to ground) and the Unipolar configuration (positive only with respect to ground). For each of these two modes, an Unbalanced arrangement (the outer conductor tied directly to ground) or a Balanced arrangement (the outer conductor used as a complementing driver) are selectable.

Figure 6-14 shows the output voltage levels and the signal arrangements for each of the four selectable modes. Figure 6-15 shows the voltage levels required by the RCV DATA, RCV CLK, and EXT TX CLK IN signal jacks for proper operation. Note that the voltage levels required are independent of the terminating impedances.

CLOCK PHASING SWITCH

The CLOCK PHASING switch controls the data and clock phase relationships for both the transmit and receive ports. For both the transmit and receive sides, either falling-edge valid or rising-edge valid can be selected. Figure 6-16 shows the four available switch positions and the resultant data/clock relationships.

6.7.4 Receive Test Points

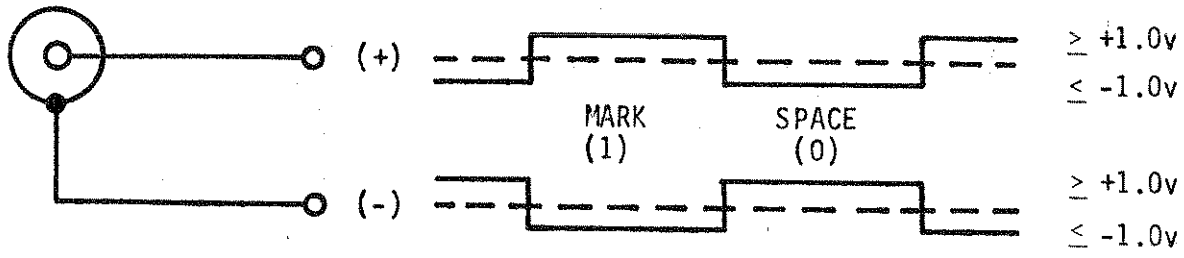
This section describes the relationship between the Lab Interface Adaptor data and clock input signals and the FIREBERD 1500 rear panel test points.

The signal level at the RCV DATA test point is >3 volts when the receive data at the Interface Adaptor is a mark (logic 1). The RCV DATA test point is <0.4 volts when the receive data is a space (logic 0).

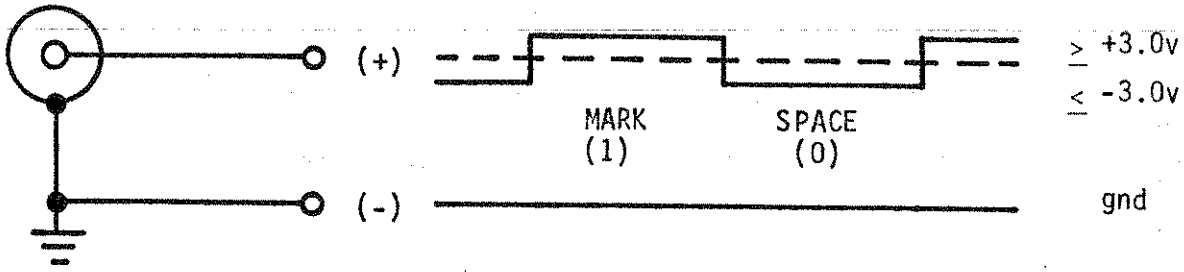
The signal at the RCV CLK test point will bear the same phase relationship to the RCV DATA test point as the clock and data entering the Interface Adaptor. E.G., if the data is rising-edge valid at the Interface Adaptor, the data will be rising-edge valid at the rear panel test points.

6.7.5. Applications Information

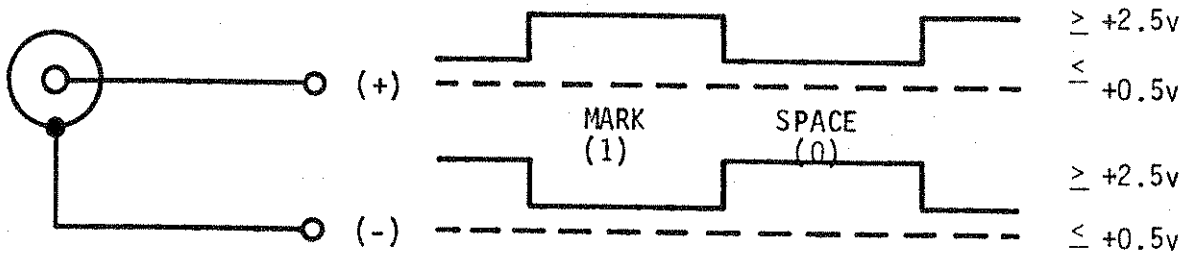
The following information is provided to aid in using the Lab Interface Adaptor to best advantage.



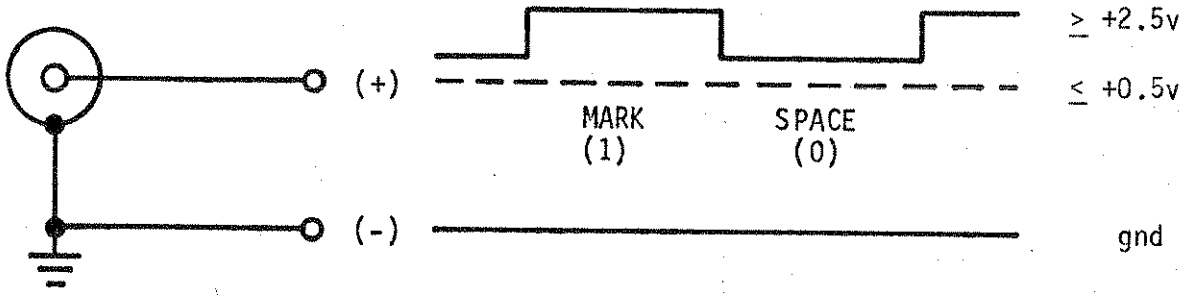
A. Bipolar Balanced



B. Bipolar Unbalanced

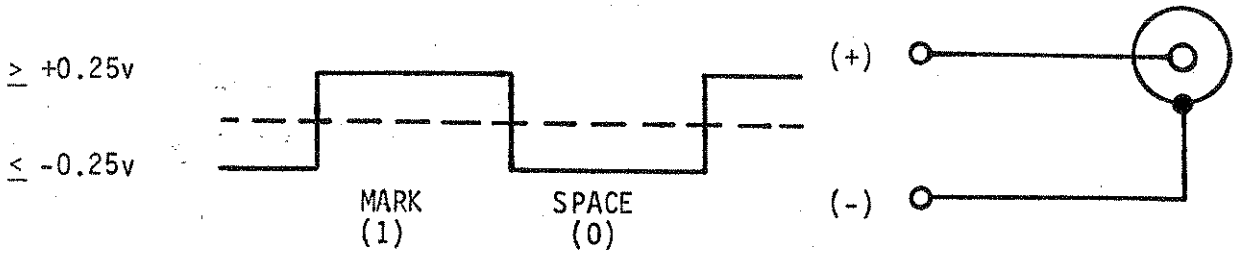


C. Unipolar Balanced

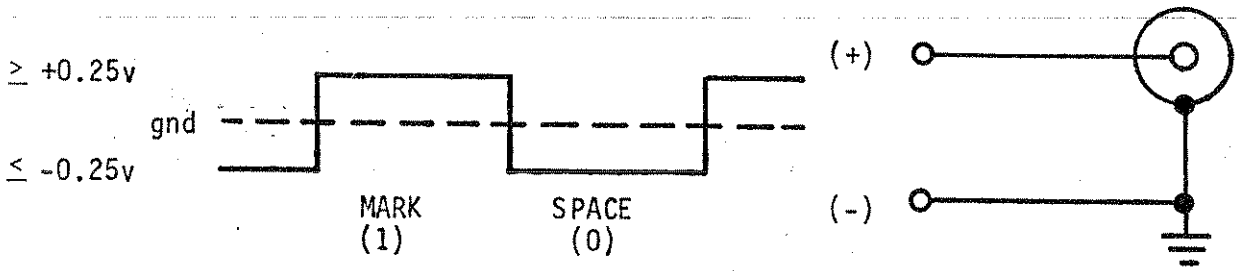


D. Unipolar Unbalanced

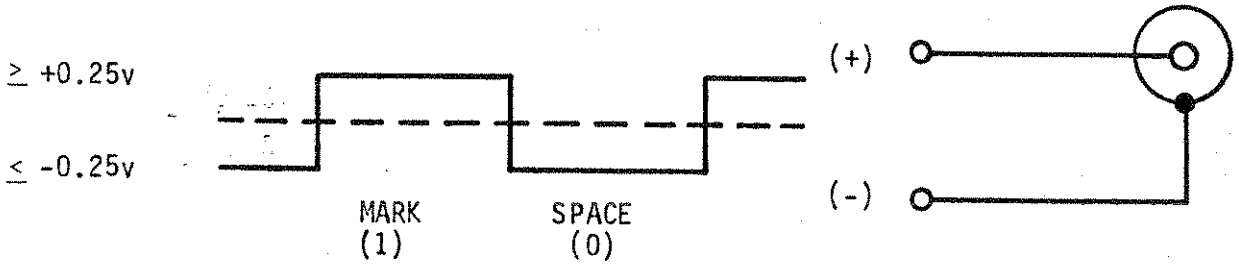
Figure 6-14
Selectable Operating Modes
Transmit Data and Clock Outputs



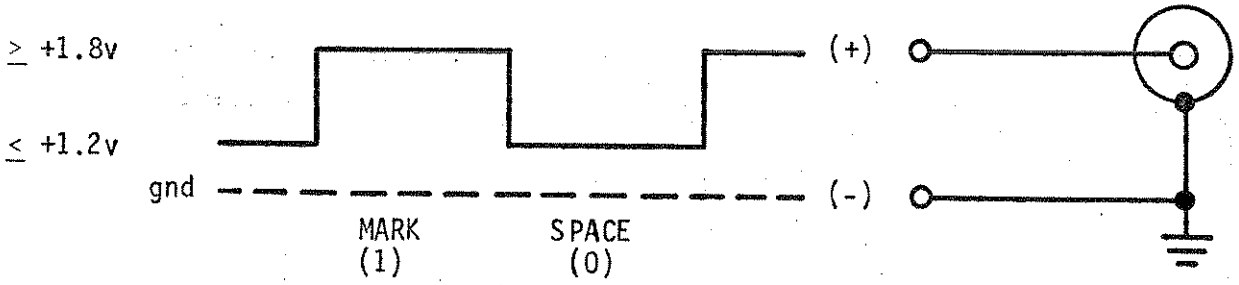
A. Bipolar Balanced (Differential voltage)



B. Bipolar Unbalanced



C. Unipolar Balanced (differential voltage)



D. Unipolar Unbalanced

Figure 6-15
Selectable Operating Modes
Minimum Required Input Levels

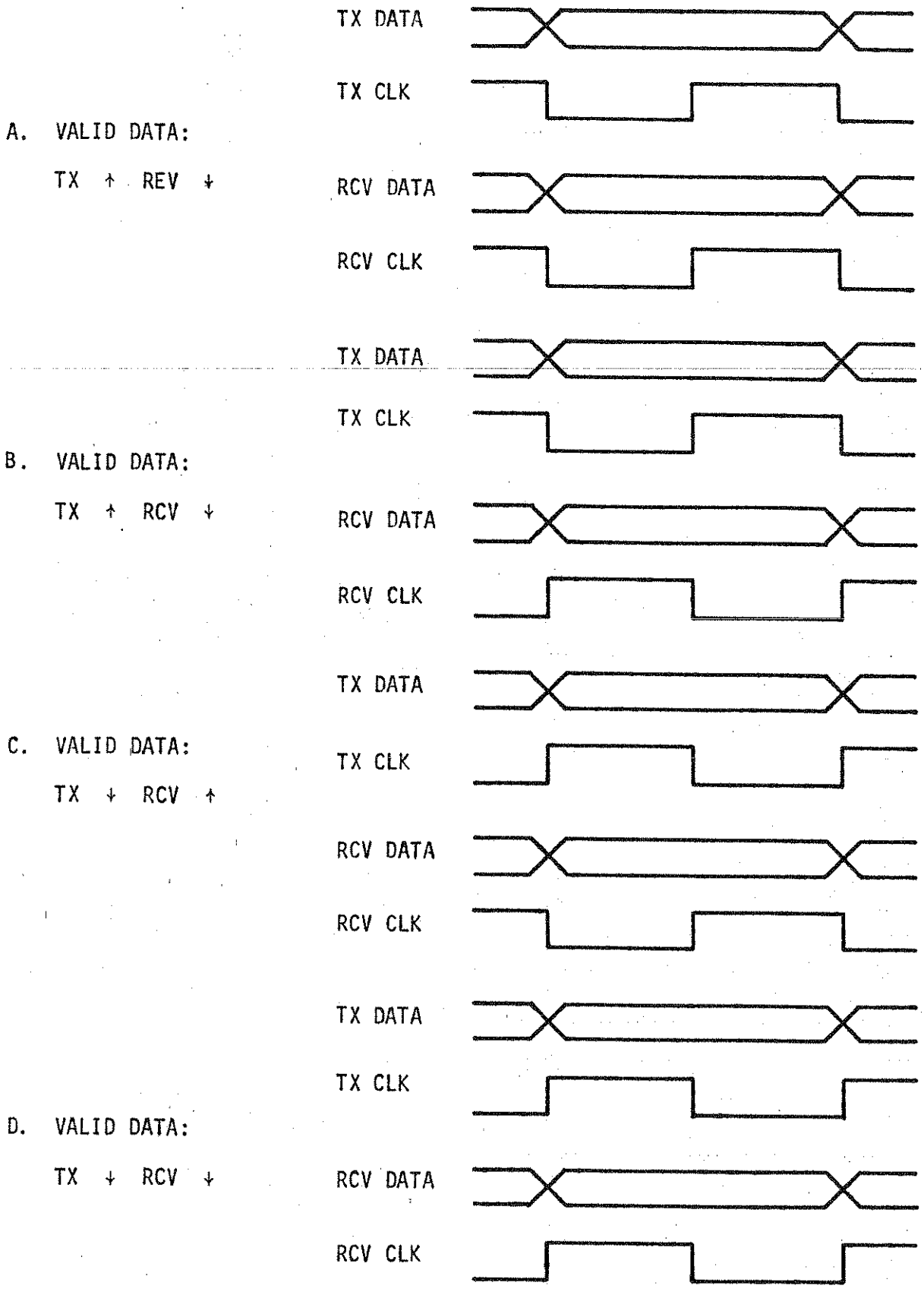


Figure 6-16
Clock Phasing Selections

When operating at a high bit rate or when driving long cables, it is recommended that a terminating impedance be placed at the receiving end. The Lab Interface line drivers are low impedance drivers and can operate into any load down to 50 ohms. The terminating impedance will serve to reduce ringing and cable crosstalk.

When supplying the Lab Interface with an external clock input, note that the external clock signal must be in the same mode (e.g. Unipolar Unbalanced) as the transmit and receive data and clock signals.

The transmit data and clock outputs are high level (>19 dBm into 50 ohms) and caution should be used when connecting to sensitive equipment.

When operating in the UNIPOLAR UNBALANCED mode with the INPUT IMPEDANCE switch set to "8K OHMS", the transmit and receive data and clock signals can be directly connected to any TTL family circuits. The Lab Interface inputs and outputs are compatible with all TTL families (e.g. Schottky TTL, LS TTL).

When operating in the UNIPOLAR BALANCED mode with the INPUT IMPEDANCE switch set to either "8K OHMS" or "100 OHMS" and with the CLOCK PHASING switch set to " ↓↓", the Lab Interface should be functionally compatible with RS-422A systems.*

When operating in the BIPOLAR UNBALANCED mode with the INPUT IMPEDANCE switch set to either "8K OHMS" or "100 OHMS" and with the CLOCK PHASING switch set to " ↓↓ ", the Lab Interface should be functionally compatible with RS-232C, RS-423A or Military Standard 188-114 bipolar unbalanced systems.*

When operating in the BIPOLAR BALANCED mode with the INPUT IMPEDANCE switch set to "100 OHMS" and the CLOCK PHASING switch set to " ↓↓", the Lab

---

*Note: Full compliance with the mentioned system parameters is not guaranteed.

Interface should be functionally compatible with Military Standard 188-114 bipolar balanced and, with a pad on the outputs, V.35 systems.*

6.7.6 Specifications

OUTPUT LEVELS:

Bipolar Balanced: ± 2.0 volts minimum differential voltage
(+19.0 dBm minimum into 50 ohms)
(+17.3 dBm minimum into 75 ohms)

Bipolar Unbalanced: ± 3.0 volts d.c. minimum
(+22.6 dBm minimum into 50 ohms)
(+20.8 dBm minimum into 75 ohms)

Unipolar Balanced: ± 2.0 volts minimum differential voltage
(+19.0 dBm minimum into 50 ohms)
(+17.3 dBm minimum into 75 ohms)

Unipolar Unbalanced: +2.5 volts d.c. minimum Mark (logic 1)
+0.5 volts d.c. maximum Space (logic 0)

INPUT LEVELS:

Bipolar Balanced: ±0.25 volts minimum differential voltage
(+1.0 dBm @50 ohms; -0.5 dBm @75 ohms)
± 12.0 volts dc maximum with respect to FIREBERD ground.

*Note: Full compliance with the mentioned system parameters is not guaranteed.

Bipolar Unbalanced: +0.25 volts d.c. minimum Mark (logic 1)
-0.25 volts d.c. minimum Space (logic 0)
(+1.0 dBm @ 50 ohms; -0.5 dBm @ 75 ohms)

Unipolar Balanced: ±0.25 volts minimum differential voltage
(+1.0 dBm @ 50 ohms; -0.5 dBm @ 75 ohms)
±12.0 volts d.c. maximum with respect to
FIREBERD ground

Unipolar Unbalanced: +1.8 volts d.c. minimum Mark (logic 1)
+1.2 volts d.c. maximum Space (logic 0)

MAXIMUM INPUT LEVELS:

The following voltage levels are not to be exceeded at any time (differential voltage for Balanced operation, volts d.c. for Unbalanced operation):

50 ohms	±3.3 volts	(23.4 dBm)
75 ohms	±4.0 volts	(23.3 dBm)
100 ohms	±4.7 volts	(23.4 dBm)
8K ohms	±15.0 volts	

SECTION 7
OPTIONS AND ACCESSORIES

7.1 INTRODUCTION

This section contains information on some of the options and accessories which may be used with the FIREBERD 1500. It contains information on the PR-1500 Thermal Printer, RM-1500 Rack Mount, high stability option for the standard clock, optional clock frequencies and the shipping case. Information on data interface modules and the IEEE-488 Interface are contained in other sections of the manual.

7.2 PR-1500 THERMAL PRINTER (Option 008)

7.2.1 Introduction

The PR-1500 is a quiet, non-impact, alphanumeric thermal printer. It is capable of printing the full ASCII character set with up to 20 characters per line. This small portable unit may be operated on a bench top or rack mounted along with the FIREBERD 1500 in the optional RM-1500 Rack Mount. A cable is included with each printer which allows it to interface directly with the FIREBERD 1500 RS-232 Printer Interface at 2400 baud.

7.2.2 Front Panel Components

POWER ON

Red light-emitting diode illuminates when power is applied.

FEED

2-position momentary toggle switch. Actuating either up or down advances paper continuously at 2.9 lines/second.

PAPER SUPPLY INDICATOR

Mechanical pointer which rides on paper roll showing relative amount of paper remaining. "F" indicates full roll, "E" indicates empty.

HOUSING LATCH

Rotating "UNLOCK" knob ¼ turn counter-clockwise frees mechanism from housing and electronics. Mechanism is pulled out to replace paper roll. This disconnects power to the mechanism and stops printing.

7.2.3 Power Supply

LINE CORD: 6 ft. 3-wire grounded plug.

FUSE: ½ Amp SLO-BLO for 115 volt operation.
¼ Amp SLO-BLO for 230 volt operation.
3AG Style

SUPPLY VOLTAGE: 105 to 130 VAC or 210 to 260 VAC. The voltage may be changed by withdrawing the front panel assembly as when the paper roll is changed and changing the 2 jumpers to the appropriately marked position.

FREQUENCY: 47 to 440 Hz.

POWER CONSUMPTION: 5 watts idling, 17 watts average during printing.

7.2.4 Paper Loading

HOW TO LOAD PAPER:

1. Shut off all power to the printer.

2. Slide out the printer mechanism by first turning the front panel thumbscrew counterclockwise until it stops. Pull the thumbscrew firmly straight out and the front panel/printer assembly will slide out all the way, separating the printer mechanism from the housing.

3. Raise the paper loading door by pulling forward until it stops. This automatically lifts the thermal printhead from the paper drive roller (see Figure 7-1). Remove any paper from a previous roll.

4. Pull the remaining paper backward out from under the printhead. Grasp both ends of the paper roll axle with fingertips and pull straight up out of the printer assembly. The axle will slide past the circular axle retaining spring as shown in Figure 7-1.

INSERTING NEW ROLL

5. Slide the paper roll axle out of the used paper roll and reinsert the axle in a new roll. Do not discard axle! The paper roll is supplied only in boxes of twelve rolls (order Option 011).

6. Slide the new roll and the axle past the retaining spring and insert the paper in the slot under the loading door and under the printhead until paper appears at front panel slot. Be sure the paper is threaded from the rear and passes over the roll. Paper should be cut straight across for easy insertion. Only the outside paper surface is treated for printing.

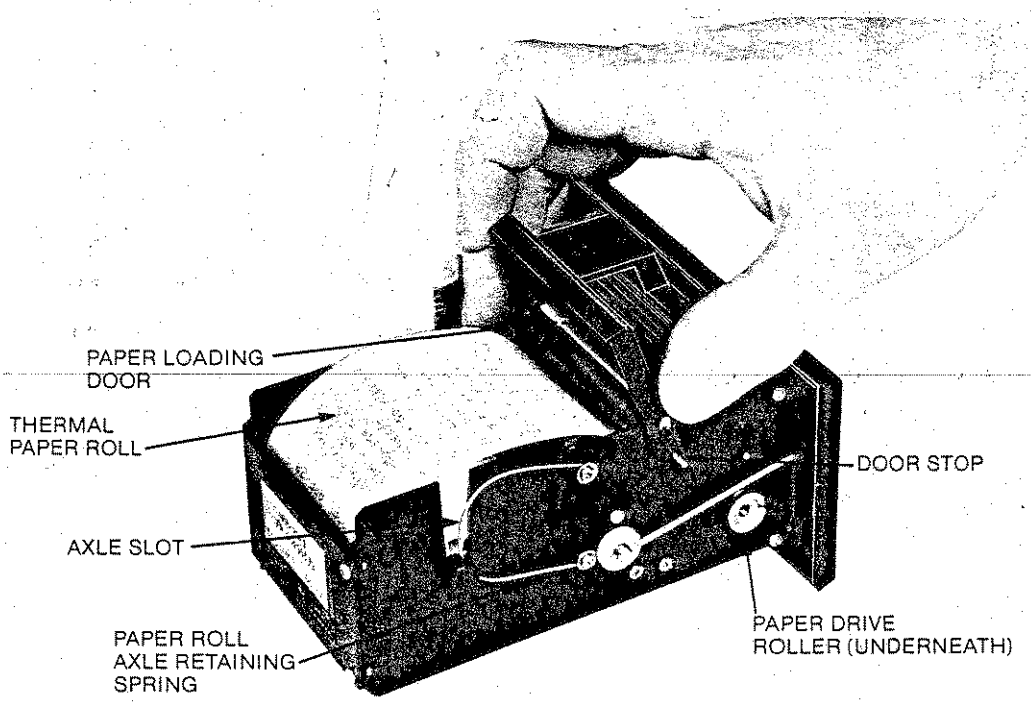
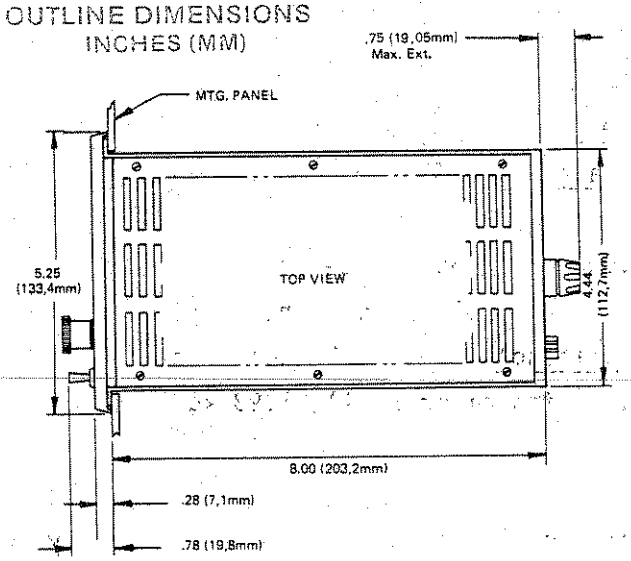


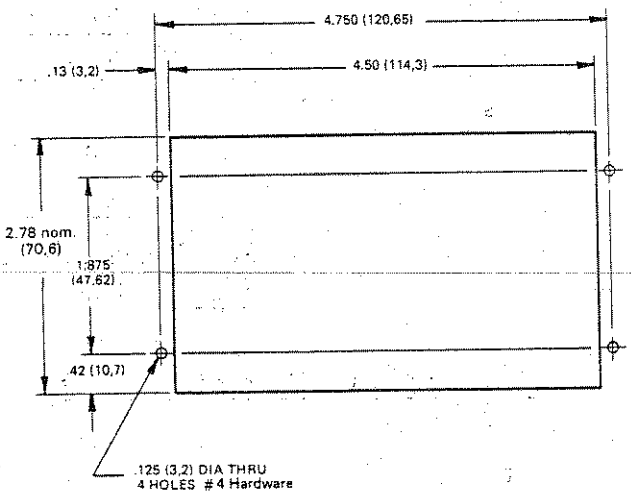
FIGURE 7-1
PAPER LOADING

FIGURE 7-2
PRINTER DIMENSIONS

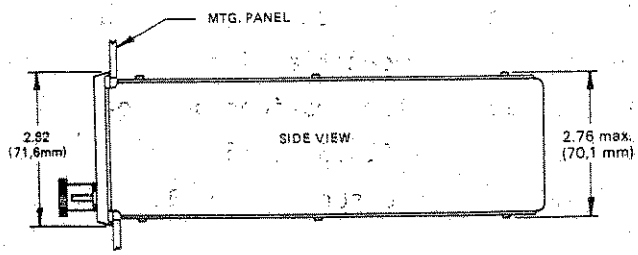
OUTLINE DIMENSIONS
INCHES (MM)



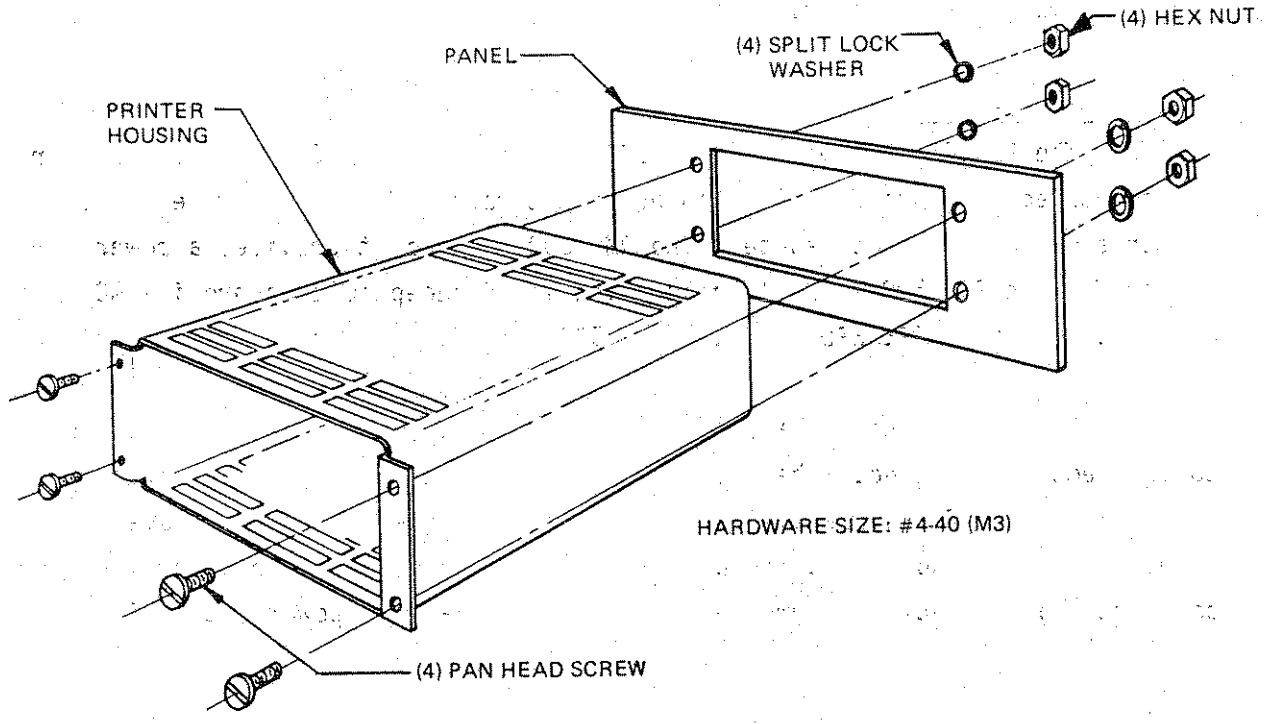
PANEL CUTOUT



NOTE:
TOLERANCE: .XX ± .01 (0,25)
.XXX ± .005 (0,10)



MOUNTING DETAILS



operating conditions. Printhead design is self-cleaning.

PHYSICAL-ENVIRONMENTAL-MECHANICAL:

Operating Temperature Range - 0° to +50°

Storage Temperature Range - -25°C to +85°C (Paper darkens above +60°C).

Altitude - 0 to 10,000 feet (3000 meters)

Relative Humidity - 20% to 90% (no condensation)

Acceleration (Non-operating) - ± 5G, 3 axes, 0 to 50 Hz

Weight - 4.25 pounds (with paper roll), 1,93 kg

7.2.8 Interface Connector and Cable

The cable supplied with each printer allows it to interface directly with the FIREBERD 1500 at 2400 baud. This cable provides strapping which forces the printer to operate in a manner which is compatible with the FIREBERD 1500. A standard RS-232 cable or a cable which provides one-to-one connections between the corresponding pins on the FIREBERD 1500 and printer will not function properly. Use only the cable supplied by TTC or one with a schematic as shown in Figure 7-3.

7.3 RM-1500 RACK MOUNT

7.3.1 General Information

The RM-1500 allows the FIREBERD 1500 and the PR-1500 Thermal Printer to be mounted in a standard 19 inch equipment rack. The assembly requires 7 inches of vertical rack space. The RM-1500 Rack Mount provides a power switch for the PR-1500 Thermal Printer and an AC receptacle to provide AC power to both the FIREBERD 1500 and PR-1500 Thermal Printer.

WARNING

To minimize shock hazard, the Rack Mount chassis must be connected to an electrical ground. The Rack Mount is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

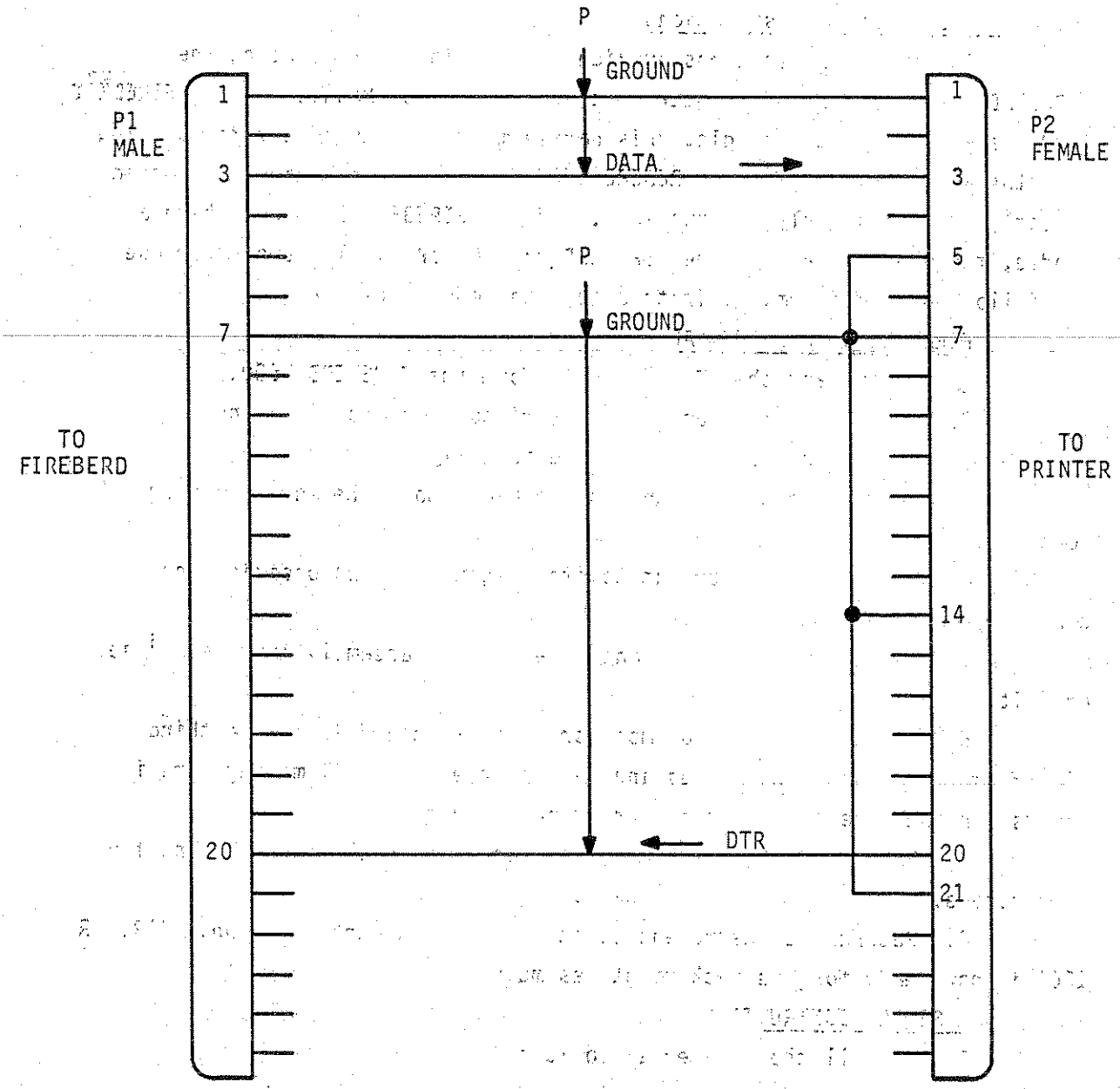


FIGURE 7-3
PRINTER CABLE SCHEMATIC

7.3.2 Installation Instructions

The following sections provide instructions for mounting the FIREBERD 1500 and PR-1500 Printer in the RM-1500 Rack Mount. If the FIREBERD 1500 has a swing-around handle, this handle must be removed before mounting into the Rack Mount. If the FIREBERD 1500 does not have a handle, proceed directly to the assembly instructions. If the FIREBERD 1500 does have a handle, the user may return the FIREBERD to TTC for handle removal or use the following handle removal instructions to remove the handle.

FIREBERD HANDLE REMOVAL

1. Disconnect the AC power cord form the FIREBERD 1500.
2. Remove the left and right knurl nuts on each side and spring the side arms enough to remove the handle assembly.
3. Lay the instrument on its top and remove the feet and four long screws.
4. Return the insturment to its "right side up" position and carefully remove the top shell.
5. Remove the hex screw and side ratchet assembly from each side of unit.
6. Make sure the error monitor (top) PC board is in the third slot from the top in side slides and remount the top shell making sure it "seats" in the side expanders and front and rear panels.
7. Lay the instrument on its top and reassemble the feet and four long screws. Do not overtighten the screws.
8. Return the instrument to its "right side up" position. FIREBERD 1500 is now ready for its rack mount assembly.

ASSEMBLY ISNTRUCTIONS

1. Install the printer as follows:[1]

   a) Remove printer panel and mechanism from the case.

   b) Insert the case through the rack mount panel from the front. Alternatively raise and lower front of printer as you insert into the opening as to clear the screw heads through the opening.

   c) Install printer bracket at rear of printer by removing the last two cover screws. Attach bracket with two #2 x 1/8 long screws and lock washers.

1. If a printer is not to be installed in the Rack Mount, a blank-off plate is available to cover the Printer Mounting hole.

d) Attach printer case to front panel with four #4 x 3/16 long pan head screws and secure foot of printer bracket to shelf with two #4 x 3/16 long pan head screws and two #4 lock washers.

2. Install FIREBERD 1500 as follows:

a) Make sure the FIREBERD 1500 does not have the handle or side handle ratchet installed. The sides of the FIREBERD must be free of handle components in order to fit into the rack adaptor.

b) Place the FIREBERD 1500 on the shelf, front panel facing front and carefully manipulate the front of the case through the opening. It should protrude through the front panel about ¼ inch.

c) Lift the rear of the FIREBERD 1500 and insert the two ¼ hex x 3/16 lg. standoffs in the rear feet and align with two holes in the shelf. Install two #6 x3/16 lg. screws and two lock washers through the bottom of the shelf into the standoffs.

d) Install the two "Z" hold-down brackets at the rear of the instrument using the #4 hardware provided with the rack adaptor.

e) Install printer head and lock in place.

f) Plug the FIREBERD 1500 and the printer into the 115 VAC receptacle. The printer should be plugged into the receptacle that is controlled by the front panel switch.

g) Fold and store excess FIREBERD 1500 and printer line cord under the printer. The bracket is designed for access.

3. Connect the cable supplied with the printer between the 25 pin "D" type connector on the rear of the printer to the RS-232 printer connector on the FIREBERD 1500.

4. The RM-1500 unit should now be ready for rack installation. The unit will mount in a rack by its front panel without further angle brackets or supports.

7.4 HIGH STABILITY STANDARD CLOCK OPTION

The high stability standard clock option (option 012) provides better frequency accuracy and stability for each of the standard internal frequencies: 1.2, 2.4, 4.8, 9.6, 19.2 and 56 kHz. When this option is provided, each of the standard internal rates will have the following characteristics:

accuracy at 25°C: ± 1 ppm
stability over 0 to 40°C: ± 5 ppm
typical aging per year: ± 5 ppm

These clocks may be periodically adjusted to within ± 1 ppm. This alignment should only be done by TTC-authorized personnel.

7.5 OPTIONAL CLOCKS

Up to three user specified frequencies may be provided in the unit. These clocks are selected by the F_A, F_B, and F_C positions of the CLOCK SELECT switch. All of the clocks supplied must have the same stability/accuracy specification.

The options are as follows:

Option Number	
013A	One Additional Internal Clock Rate
013B	One Additional Internal Clock Rate
014A	Two Additional Internal Clock Rates
014B	Two Additional Internal Clock Rates
015A	Three Additional Internal Clock Rates
015B	Three Additional Internal Clock Rates

Each option number ending in A provides frequencies which are accurate to within 50 PPM over the full 0 to 50°C operating temperature range. Each option number ending in B provides frequencies which are accurate to within ± 1 ppm at 25°C with ± 5 ppm stability from 0 to 40°C and 5 ppm typical aging per year. The frequency of any of the oscillators with a B in the option number may be periodically aligned to within ± 1 ppm by TTC-authorized personnel.

7.6 SHIPPING CASE

The option 016 shipping case holds a FIREBERD 1500, PR-1500 Thermal Printer, 5 Interface Modules, accessory cables and this manual. The rigid ABS molded case has a foam padded interior with cavities to hold the FIREBERD 1500 and its accessories. The case is rugged and water resistant, has stainless

steel draw latches and a molded handle. Case dimensions are 26½" x 19" x 11½".

7.7 SOFT CARRYING CASE

The FIREBERD 1500 soft side carrying case is constructed of canvas with dense foam inserts surrounding all sides, top and bottom. The dimensions are 19½" wide x 9½" deep x 16 1/8" high. The case is navy blue, has an I.D. pocket on the top cover. The top cover is hinged and secured with Velcro fasteners. The case is carried by a handle that supports across the bottom and up both sides.

The carrying case holds one FIREBERD 1500, one Printer, one manual and three interface adaptors in addition to the associated cables and line cords. Empty, the case weighs 6¼ lbs.

SECTION 8
MAINTENANCE AND SERVICE

8.1 IN CASE OF DIFFICULTY

If the unit fails to operate and no front or rear panel indicators illuminate, check the following:

AC power cord and AC supply

AC fuse size

If some indicators light but the unit fails to operate, verify that the Interface Adaptor Module in use is the correct type and properly inserted (turn off power before inserting or removing Interface). Check the interface cable and connections to the FIREBERD 1500. Try subsituting another Interface Module if one is available.

Follow the Self Test procedure in Section 4.6 as an aid to localizing the problem. If the unit cannot be made to operate properly, refer to the following sections for service information.

8.2 WARRANTY POLICY

All equipment manufactured by Telecommunications Techniques Corporation (TTC) is warranted against defects in material and workmanship. Defective equipment will be repaired or replaced (at our option) for a period of one year after receipt at no charge.

Liability under this warranty extends only to the replacement value of the equipment. This warranty is void:

1. If equipment has been altered or repaired without specific authorization by TTC.

2. If equipment is installed or operated other than in accordance with instructions containted in TTC literature and operating manuals.

After expiration of the warranty period, equipment must be returned prepaid to TTC for repair. Customer will be billed for parts cost plus the standard labor rates in effect at the time of repair.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

8.3 IN-WARRANTY SERVICE

Units in warranty should be returned to the factory with shipping prepaid. Equipment returned for in-warranty service should be packed and shipped in accordance with the instructions contained in Section 8.5 of this manual. Defective units will be repaired or replaced depending on severity of defect. The customer should provide a description of his complaint along with his name, address and telephone number and the serial number(s) of the equipment returned. Normal repair time is five working days.

Upon completing repairs, the unit will be tested to applicable specifications and burned-in for at least 24 hours. If the product functions properly following burn-in, it will be returned to the customer with shipping prepaid. A brief description of the work performed and the materials used will be provided on the "Equipment Repair Report".

8.4 OUT-OF-WARRANTY SERVICE

The procedure for repairing out-of-warranty equipment is the same as that used for units still in warranty. There is, however, a minimum charge of $75.00 applied to each request for out-of-warranty service. The $75.00 minimum charge guarantees the customer an estimate of the repair costs and is used as a credit against actual materials and labor costs should the equipment be repaired. The customer is required to furnish a purchase order prior to starting the repair work. A description of the labor and materials used is provided in the Equipment Repair Report.

8.5 REPACKAGING FOR SHIPMENT

If the instrument is to be shipped to TTC for repair, attach a tag showing owner, address and phone number, complete instrument serial number, and a description of the service requested. Use the original shipping container and material if possible. If the original container is not available, carefully pack the unit so it will not be damaged in transit. TTC is not responsible for units damaged during shipping.