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**RS-449 DTE/DCE
DATA INTERFACE
OPERATING MANUAL
(MODEL 40200)**

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GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains descriptions, set-up and operating instructions, specifications, maintenance, and service information for the Telecommunications Techniques Corporation (TTC) Model 40200 RS-449 DTE/DCE Data Interface. The RS-449 DTE/DCE Data Interface allows all FIREBERD mainframes to be connected to RS-449-type compatible circuits and act as the data terminal equipment (DTE) or data communications equipment (DCE).

1.2 INTERFACE FEATURES

The Model 40200 RS-449 DTE/DCE Data Interface has the following features.

- Enables a FIREBERD mainframe to act as the DTE or DCE with an appropriate adaptor cable.
- Front panel switches allow control over connector termination, clock polarity, and timing mode.
- Allows testing of RS-449-type circuits using serial binary formatted data up to 15 MHz.

1.3 INTERFACE COMPATIBILITY

The Model 40200 RS-449 DTE/DCE Data Interface is designed in accordance with the following specifications.

- EIA Standard RS-449, General Purpose 37-position and 9-position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange, November 1977.
- EIA Standard RS-422-A, Electrical Characteristics of Balanced Voltage Digital Interface Circuits, December 1978.

- EIA Standard RS-423-A, Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits, December 1978.
- CCITT Recommendation V.10 (or X.26), Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications.
- CCITT Recommendation V.11 (or X.27), Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications.
- ISO 4902-1980 (E), Data communication - 37-pin and 9-pin DTE/DCE interface connectors and pin assignments.

1.4 OPTIONS AND ACCESSORIES

The following cables are available from TTC for the RS-449 DTE/DCE Data Interface. Cable diagrams are provided in Appendix A.

- Model 10215, 6' cable with 37-position male D connectors.
- Model 10417, 10' cable with 37-position male D connectors.
- Model 10210, 9" DCE-to-DTE crossover cable with 37-position male and female connectors (supplied with interface).

INTERFACE DESCRIPTION

2.1 INTRODUCTION

This section describes the RS-449 DTE/DCE Data Interface front panel connector and functional description of each of the interface's capabilities and features.

2.2 PHYSICAL DESCRIPTION

The Model 40200 RS-449 DTE/DCE Data Interface has three 3-position toggle switches, one 3-position rotary switch, and one EIA RS-449 compatible D-type connector on its front panel as shown in Figure 2-1. The switches control clock polarities, timing, and connector termination. The wording in parentheses on the front panel refers to FIREBERD DCE operation.

2.2.1 Interface Switches

422 TERM/422 UNTERM/423 Switch - This switch controls the electrical characteristics of the interface connector when testing balanced (terminated and unterminated) and unbalanced circuits.

The **422 TERM** position configures the interface connector for terminated balanced operation by terminating the Send Timing (ST), Receive Timing (RT), and Received Data (RD) leads with a low input impedance (100 ohms). This position meets the EIA RS-422-A requirements for balanced terminated circuit operation.

The **422 UNTERM** position configures the connector for unterminated balanced operation. Only the ST, RT, and RD leads are affected. This position meets the EIA RS-422-A requirements for balanced unterminated circuit operation.

The **423** position configures the interface connector for testing unbalanced circuit operation. The Terminal Timing (TT), Send Data (SD), ST (DCE only), Terminal Ready (TR), and Request to Send (RS) leads are configured for unbalanced operation in this position. This position meets the EIA RS-423-A requirements for unbalanced circuit operation.

(TX) RCV INV (TM) RL OFF/(TX) RCV NORM (TM) RL OFF/(TX) RCV NORM (TM) RL ON Switch - The receive (transmit, DCE mode) clock polarity switch controls which clock pulse edge the mainframe is expecting to find valid data on. The

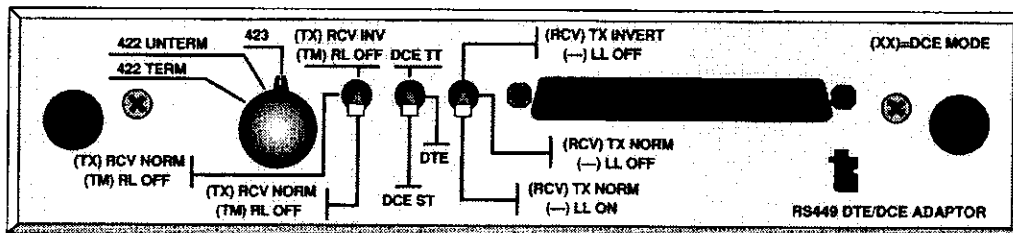


Figure 2-1
The RS-449 DTE/DCE Data Interface

switch also controls the Remote Loopback (RL) (TM, DCE mode) lead.

When the FIREBERD is configured as the DTE (interface emulation control switch set to DTE), setting the receive clock polarity (RECEIVE CLOCK INVERT) switch to the **RCV INVERT RL OFF** (up) position causes the FIREBERD to expect valid receive data on the rising edge of the receive timing clock source. Setting the switch to the **RCV NORM RL OFF** (middle) position causes the FIREBERD to expect valid receive data on the falling edge of the receive timing clock source. The middle switch position provides the normal clock/data timing relationship required by the EIA RS-449 standard. The RL lead is OFF in both positions. Setting the switch to the **RCV NORM RL ON** (bottom) position maintains the normal clock/data timing relationship as does the middle switch position, but the RL lead is turned ON.

When the FIREBERD is configured as the DCE (interface emulation control switch set to DCE TT or DCE ST and adaptor cable attached), setting the transmit clock polarity (TRANSMIT CLOCK INVERT) switch to the **(TX) INVERT (TM) OFF** (up) position causes the FIREBERD to expect valid send data on the rising edge of the selected clock source (TT or ST). Setting the switch to the **(TX) NORM (TM) OFF** (middle) position causes the FIREBERD to expect valid send data on the falling edge of the selected clock source. The middle switch position provides the normal clock/data timing relationship required by the EIA RS-449 standard. The Test Mode (TM) lead is OFF in both switch positions. Setting the switch to the **(TX) NORM (TM) ON** (bottom) position maintains the normal clock/data timing relationship as does the middle switch position, but the TM lead is turned ON.

DCE TT/DTE/DCE ST Switch - The emulation switch controls the mainframe emulation operation, i.e., DTE or DCE with TT or ST.

The **DCE TT** position configures the mainframe for DCE operation and sends SD and Terminal Timing (TT) to the FIREBERD receive section for analysis.

The **DTE** position configures the mainframe for DTE operation. TT is generated by the mainframe depending on the generator clock setting (GEN CLK switch on FIREBERD 6000 and SETUP GENERATOR CLOCK menu on FIREBERD 4000).

The **DCE ST** position configures the mainframe for DCE operation and sends SD and the internally gener-

ated ST clock (ST, DCE only leads) to the FIREBERD receive section for analysis.

(RCV) TX INVERT (—) LL OFF / (RCV) TX NORM (—) LL OFF / (RCV) TX NORM (—) LL ON Switch - The transmit (receive, DCE mode) clock polarity switch controls which clock pulse edge the mainframe is expecting to find valid data on. The switch also controls the DTE Local Loopback (LL) lead.

When the FIREBERD is configured as the DTE (emulation switch set to DTE), setting the transmit clock polarity (TRANSMIT CLOCK INVERT) switch to the **TX INVERT LL OFF** (up) position causes send data to be valid on the rising edge of the selected clock source. Setting the switch to the **TX NORM LL OFF** (middle) position causes send data to be valid on the falling edge of the selected clock source. The middle switch position provides the normal clock/data timing relationship required by the EIA RS-449 standard. The LL lead is OFF in both positions. Setting the switch to the **TX NORM LL ON** (bottom) position maintains the normal clock/data timing relationship as does the middle switch position, but LL is turned ON.

When the FIREBERD is configured as the DCE (emulation switch set to DCE TT or DCE ST and adaptor cable attached), setting the receive clock polarity (RECEIVE CLOCK INVERT) switch to the **(RCV) INVERT (—) OFF** (up) position causes the FIREBERD to generate valid receive data on the rising edge of the receive timing clock source. Setting the switch to the **(RCV) NORM (—) OFF** (middle) position causes the FIREBERD to generate valid receive data on the falling edge of the receive timing clock source. The middle switch position provides the normal clock/data timing relationship required by the EIA RS-449 standard. Setting the switch to the **(RCV) NORM (—) ON** (bottom) position maintains the normal clock/data timing relationship as does the middle position, however, it does not have a secondary function.

2.2.2 Interface Connector

The interface connector is a female 37-position D-type connector which allows connections to EIA RS-449 compatible DTE and DCE devices. The connector pin assignments are listed in Table 2-1 and defined by the EIA RS-449, RS-422-A (CCITT V.11), and RS-423-A (CCITT V.10) interface standards. Only those pin assignments listed in Table 2-1 are provided by the interface connector.

Table 2-1
RS-449 Interface Connector Pin Assignments

Pin	Circuit Designation		Category	Signal Direction	Description
	RS-449	CCITT			
1	—	—	-	—	Shield ¹
3	ST (A)	—	I	output	DCE Send Timing (DCE mode only) ²
4	SD (A)	103	I	output	Send Data (TD)
5	ST (A)	114	I	input	Send Timing (SCT)
6	RD (A)	104	I	input	Received Data (RD)
7	RS (A)	105	I	output	Request To Send (RTS)
8	RT (A)	115	I	input	Receive Timing (SCR)
9	CS (A)	106	I	input	Clear To Send (CTS)
10	LL	141	II	output	Local Loopback (LL)
11	DM (A)	107	I	input	Data Mode (DSR)
12	TR (A)	108/2	I	output	Terminal Ready (DTR)
13	RR (A)	109	I	input	Receiver Ready (RLSD)
14	RL	140	II	output	Remote Loopback (RL)
17	TT (A)	113	I	output	Terminal Timing (SCTE)
18	TM	142	II	input	Test Mode (TM)
19	SG	102	-	—	Signal Ground ¹
20	RC	102b	II	—	Receive Common ¹
21	ST (B)	—	I	output	DCE Send Timing (DCE mode only) ²
22	SD (B)	103	I	output	Send Data (TD)
23	ST (B)	114	I	input	Send Timing (SCT)
24	RD (B)	104	I	input	Receive Data (RD)
25	RS (B)	105	I	output	Request To Send (RTS)
26	RT (B)	115	I	input	Receive Timing (SCR)
27	CS (B)	106	I	input	Clear To Send (CTS)
29	DM (B)	107	I	input	Data Mode (DSR)
30	TR (B)	108/2	I	output	Terminal Ready (DTR)
31	RR (B)	109	I	input	Receiver Ready (RLSD)
35	TT (B)	113	I	output	Terminal Timing (SCTE)
37	SC	102a	II	—	Send Common ¹

¹ Pins 1, 19, 20, & 37 are connected to signal ground.

² Only used in DCE mode. Requires adaptor cable, Model 10210.

2.3 FUNCTIONAL DESCRIPTION

The RS-449 DTE/DCE Data Interface converts the signal characteristics specified by the EIA RS-449 standard to the TTL signal levels used by the FIREBERD to analyze and test circuit operation (see Figure 2-2). This interface enables the FIREBERD to operate as the DTE when testing DCEs. The interface can also operate as the DCE when the DTE/DCE adaptor cable is attached (cable supplied with interface) to test the DTE.

The interface driver and receiver circuits are designed to accommodate two circuit categories described in the EIA RS-

449 standard. Category 1 circuits are implemented with either RS-422-A/V.11 (balanced) or RS-423-A/V.10 (unbalanced) designed drivers and receivers. Category 2 circuits are implemented with RS-423-A/V.10 designed drivers and receivers. Both types of circuits are available through the interface. The categories and applicable circuits are indicated in Table 2-1.

Synchronous, asynchronous (not in the 4000), or recovered timing (requires option 6004) can be used with this interface. With asynchronous timing, data analysis can be performed at speeds up to 20 kb/s. With synchronous and recovered timing, operating with RS-423/V.10 (unbalanced)

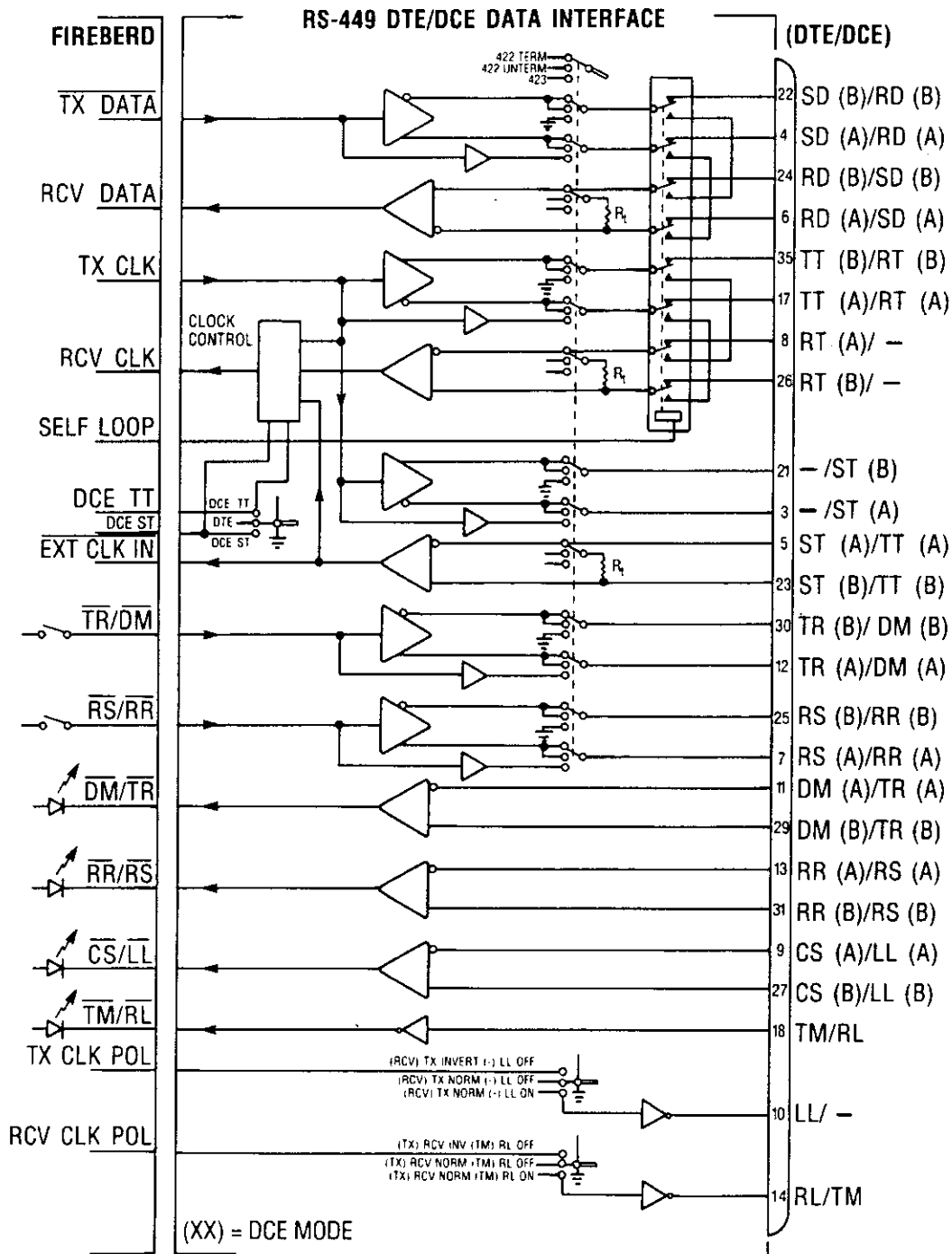


Figure 2-2
RS-449 DTE/DCE Data Interface Block Diagram

circuits, data analysis is possible at speeds up to 130 kb/s. With RS-422/V.11 (balanced) circuits, operation at speeds up to 520 kb/s is possible with recovered timing and 15 Mb/s with synchronous timing.

2.3.1 Operating as the DTE

The RS-449 DTE/DCE interface is configured to perform like the DTE by attaching the standard DTE-to-DCE cable (see Appendix A) to the interface connector and selecting the DTE timing mode from the interface panel. When testing RS-449 DCE circuits, the DCE normally supplies ST and RT to the FIREBERD through the ST and RT leads. Depending on the mainframe generator clock setting, the FIREBERD generates SD and TT coincident with the ST clock or ignores the ST leads and generates SD and TT coincident with the mainframe GEN CLK IN input (BNC connector on rear panel) or internal timing source. RD and RT are received for analysis.

The two mainframe interface switches control the RS and TR leads in the DTE mode. The Clear to Send (CS), Receiver Ready (RR), Data Mode (DM), and Test Mode (TM) leads are monitored and their status is displayed on the FIREBERD front panel.

2.3.2 Operating as the DCE

The RS-449 DTE/DCE interface can be configured to emulate the DCE by attaching the DTE/DCE adaptor cable (included with interface and shown in Appendix A) to the interface connector and selecting one of two DCE timing modes. When testing RS-449 DTE circuits, the FIREBERD supplies send timing to the DTE through the ST (DCE only) leads (see Table 2-1). The DTE returns both SD and TT to the FIREBERD.

The two DCE timing modes are selectable from the interface panel: DCE TT and DCE ST. In the DCE TT mode, SD and TT are sent to the FIREBERD's receive section for analysis. In the DCE ST mode, SD and the internally generated ST (DCE only) are sent to the FIREBERD's receive section for analysis. Depending on the mainframe generator clock setting, RD and RT are generated coincident with TT from the DTE, or coincident with the mainframe GEN CLK IN input (BNC connector on rear panel) or internal timing source.

At the DTE end of the DTE/DCE adaptor cable, CS is directly tied to RS. The two mainframe interface switches control the RR and DM leads. The TR, RS, LL, and RL leads are monitored and their status is displayed on the FIREBERD front panel.

2.3.3 Self-Loop Testing

The interface can be tested using the mainframe self-loop test switch. When activated, the interface SD and TT outputs are looped back to the RD and RT inputs (see Figure 2-2). The loop test tests the drivers and receivers used during normal operation. User connections do not have to be removed during the loop test.

INSTALLING AND SETTING UP THE INTERFACE

3.1 INTRODUCTION

This section describes how to install and set up the RS-449 DTE/DCE Data Interface with each of the FIREBERD mainframes.

NOTE: Configure the FIREBERD and RS-449 interface before connecting it to the circuit being tested. This will avoid unnecessary troubleshooting and circuit downtime.

3.2 INSTALLING THE INTERFACE

CAUTION: Turn the AC power OFF to the FIREBERD mainframe before installing the interface module.

- (1) Turn the AC power off to the FIREBERD.
- (2) Facing the FIREBERD rear panel, insert the interface into the opening with its plastic cover facing down and PC (printed circuit) board facing up.
- (3) Press the module into the FIREBERD until the interface panel is flush with the rear panel.
- (4) Secure the interface with the fasteners on interface panel.
- (5) Turn the AC power on and perform self-loop test on the interface.

3.3 INTERFACE SETUP

- (1) Set the interface control switch to the appropriate position as indicated.
 - **422 TERM** - Recommended for testing balanced (RS-422/V.11) circuits operating up to 10 Mb/s.

- **422 UNTERM** - Recommended for testing balanced (RS-422/V.11) circuits operating up to 200 kb/s.
- **423** - Recommended for testing unbalanced (RS-423/V.10) circuits operating up to 20 kb/s.

- (2) Set the emulation control switch to the appropriate setting as indicated.

- **DCE TT** - Configures the mainframe for DCE operation with TT acting as the timing source. Requires DTE/DCE adaptor cable, Model 10210.
- **DTE** - Configures the mainframe for DTE operation. Set generator clock source as required.
- **DCE ST** - Configures the mainframe for DCE operation with ST acting as the timing source. Requires DTE/DCE adaptor cable, Model 10210.

- (3) Set the receive (transmit, DCE mode) clock polarity switch to the appropriate position as indicated.

- **(TX) RCV INV (TM) RL OFF** - The FIREBERD expects valid RD (SD) on the rising edge of RT (clock source). RL (TM) is OFF.
- **(TX) RCV NORM (TM) RL OFF** - The FIREBERD expects valid RD (SD) on the falling edge of RT (clock source). RL (TM) is OFF.
- **(TX) RCV INV (TM) RL ON** - The FIREBERD expects valid RD (SD) on the falling edge of RT (clock source). RL (TM) is ON.

- (4) Set the transmit (receive, DCE mode) clock polarity switch to the appropriate position as indicated.

- **(RCV) TX INVERT (—) LL OFF** - The FIREBERD causes SD (RD) to be valid on the rising edge of the selected clock source. LL is OFF.

4.3 MAINFRAME AUXILIARY FUNCTIONS

The FIREBERD can control the interface clock polarity switches through Auxiliary Functions 05, 01, and 02. When configured for DTE operation and the Auxiliary Function 05 (INTF CONTROL) is set to F-BERD (default), the interface clock polarities are controlled through Auxiliary Functions 01 (GEN CLK POL) and 02 (RCVR CLK POL). The interface clock switches only control the LL and RL leads. When configured for DCE operation, the interface clock switches only control the TM lead. When Auxiliary Function 05 is set to INTF, the interface clock switches are enabled.

4.4 MAINFRAME PRINTER OPERATION

Refer to the FIREBERD 6000 Operating Manual for printer set-up and operating instructions.

SETTING UP THE FIREBERD 4000

5.1 INTRODUCTION

This section describes how to set up the FIREBERD 4000 with the RS-449 DTE/DCE Data Interface. Refer to the FIREBERD 4000 Operating Manual for mainframe operating procedures.

NOTE: Configure the FIREBERD before connecting it to the circuit being tested avoiding unnecessary troubleshooting.

5.2 FIREBERD 4000 MAINFRAME SET-UP

- (1) Turn the AC power ON, if necessary.
- (2) Use the SETUP CATEGORY switch to select the **INTERFACE** set-up menu. Press the RS-449 soft key to select the RS-449 interface. The mainframe cannot control the interface switches.
- (3) Use the SETUP CATEGORY switch to select the **GENERATOR CLOCK** setup menu. Press the appropriate soft key to select the desired generator clock source:
 - **INTRNL** - Allows the selection of one of the fixed speeds from those displayed or if the synthesizer option is installed, manually enter the frequency from 50 b/s to 15 Mb/s.
 - **INTF** - Provides the generator clock through the interface received clock.
 - **BNC** - (GEN CLK IN connector on rear panel) Allows an input from an external clock source.
- (4) Use the SETUP CATEGORY switch to select the **PATTERN** set-up menu. Press the appropriate soft key to select the desired test pattern. Refer to the FIREBERD 4000 Operating Manual for valid test patterns.

- (5) Select the applicable categories and results displays from the **ANALYSIS RESULTS** panel. Refer to the FIREBERD 4000 Operating Manual for applicable results displays.
- (6) Connect the interface cable between the FIREBERD and circuit being tested.
 - Use the standard cable (Model 10215, 10417, or equivalent) to test the DCE.
 - Use the DCE/DTE adaptor cable (Model 10210 or equivalent) to test the DTE.
- (7) Perform circuit testing and analysis as required.

5.3 MAINFRAME PRINTER OPERATION

Refer to the FIREBERD 4000 Operating Manual for printer set-up and operating instructions.

INTERFACE SPECIFICATIONS

6.1 INTRODUCTION

Table 6-1 lists the specifications for the RS-449 DTE/DCE Data Interface.

**Table 6-1
RS-449 DTE/DCE Data Interface Specifications**

Item	Specification
<p>RS-449 Category 1 circuits (RS-423/RS422 TERM/UNTERM)</p>	<p>Send Data (SD) Received Data (RD) Terminal Timing (TT) Send Timing (ST) Receive Timing (RT) Request to Send (RS) Clear to Send (CS) Receiver Ready (RR) Terminal Ready (TR) Data Mode (DM)</p>
<p>RS-449 Category 2 circuits (RS-423/V.10 only)</p>	<p>Local Loopback (LL) Remote Loopback (RL) Test Mode (TM)</p>
<p>RS-423/V.10 operation Timing modes/speeds</p>	<p>Asynchronous: 20 kb/s Synchronous: 130 kb/s Recovered timing: 130 kb/s</p>
<p>Data/Control Mark (binary 1)/OFF Space (binary 0)/ON</p>	<p>Negative polarity Positive polarity</p>
<p>Line drivers Output voltage Short circuit current Output rise time</p>	<p>±3.5 V min. with 450-ohm load 150 mA max. Model 40200-01, 1 microsecond typical Model 40200-02, 4 microseconds typical</p>
<p>Receivers Load impedance Input threshold voltage</p>	<p>2000 ohms minimum ±0.25 V</p>

Table 6-1
RS-449 DTE/DCE Data Interface Specifications
(continued)

Item	Specification
RS-422/V.11 operation	
Timing modes/speeds	Asynchronous: 20 kb/s Synchronous: 15 Mb/s Recovered timing: 520 kb/s
Data/Control	
Mark (binary 1)/OFF	Lead (A) more negative than lead (B)
Space (binary 0)/ON	Lead (A) more positive than lead (B)
Line drivers	
Output differential voltage	2.0 V minimum with 100-ohm load
Short circuit current	150 mA maximum
Output rise time	20 ns maximum
Terminated line receivers	
Load impedance	100 ohms \pm 10%
Differential input threshold voltage	\pm 0.25 V
Unterminated line receivers	
Load impedance	2000 ohms minimum
Differential input threshold voltage	\pm 0.25 V

MAINTENANCE AND SERVICE

7.1 INTRODUCTION

This section contains information on maintenance and service for the RS-449 DTE/DCE Data Interface. It also describes TTC's warranty policies and repair procedures.

7.2 MAINTENANCE

7.2.1 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 and fuse size

If some indicators illuminate but the unit fails to operate, verify that the interface 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. Try substituting another interface if one is available.

Follow the self-loop procedures in the FIREBERD Operating Manual as an aid in localizing the problem. If the unit continues to be inoperative, refer to the following sections for service information or call the TTC Customer Service Department for applications assistance.

7.3 SERVICE

7.3.1 Warranty Policy

All equipment manufactured by Telecommunications Techniques Corporation (TTC) is warranted against defects in material and workmanship. This warranty applies only to the original purchaser and is non-transferable unless express written authorization of the warranty transfer is granted by TTC.

Data interfaces, accessories, cables, breakout boxes, and all equipment other than FIREBERD mainframes will be repaired or replaced (at our option) at no charge for a period of one (1) year after shipment to the customer.

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

- (1) Equipment has been altered or repaired without specific authorization from TTC.
- (2) Equipment is installed or operated other than in accordance with instructions contained in TTC literature and operating manuals.

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

7.3.2 In-Warranty Service

Equipment in warranty must be returned to the factory with shipping prepaid. The equipment should be packed and shipped in accordance with the instructions in Section 7.3.4 of this manual. Before returning any equipment, the customer must obtain a Return Authorization (RA) number by contacting the TTC Repair Department. The RA number should then appear on all paperwork and be clearly marked on the outside of the shipping container.

After the equipment is repaired by TTC, it will be tested to applicable specifications, burned-in for at least 24 hours, retested, and 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 furnished with the returned equipment.

7.3.3 Out-of-Warranty Service

The procedure for repairing out-of-warranty equipment is the same as that used for equipment still in warranty. However, there is a minimum charge applied to each request for out-of-warranty service. The minimum charge guarantees the customer an estimate of the repair costs and is used as credit against actual materials and labor costs should the equipment be repaired. Contact the TTC Repair Department for specific information on the minimum out-of-warranty repair charge.

The customer will be billed for parts plus standard labor rates in effect at the time of repair. The customer will also be required to furnish a purchase order number before repair work can be started, and a hard copy of the purchase order must be received by TTC before the repaired equipment may be shipped to the customer. A description of the labor and materials used will be provided in the Equipment Repair Report.

Once an out-of-warranty repair is made, the repaired part or component is warranted for 90 days. This warranty applies only to the part or component that was repaired; other parts or components are not covered under the 90-day repair warranty.

7.3.4 Equipment Return Instructions

The customer should attach to all equipment returned for repair a tag that includes the following information:

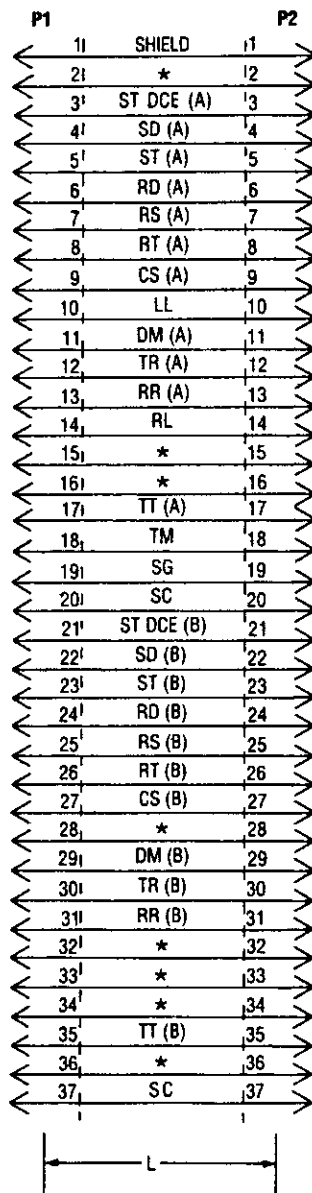
- (1) Owner name and address.
- (2) A list of equipment being returned and the applicable serial number(s).
- (3) A detailed description of the problem or service requested.
- (4) The name and telephone number of the person to contact regarding questions about the repair.
- (5) The Return Authorization (RA) number.

If possible, the customer should return the equipment using the original shipping container and material. If the original container is not available, the unit should be carefully packed so that it will not be damaged in transit. TTC is not liable for any damage that may occur during shipping. The customer should clearly mark the TTC-issued RA number on the outside of the package and ship it prepaid and insured to TTC.

CABLE DIAGRAMS

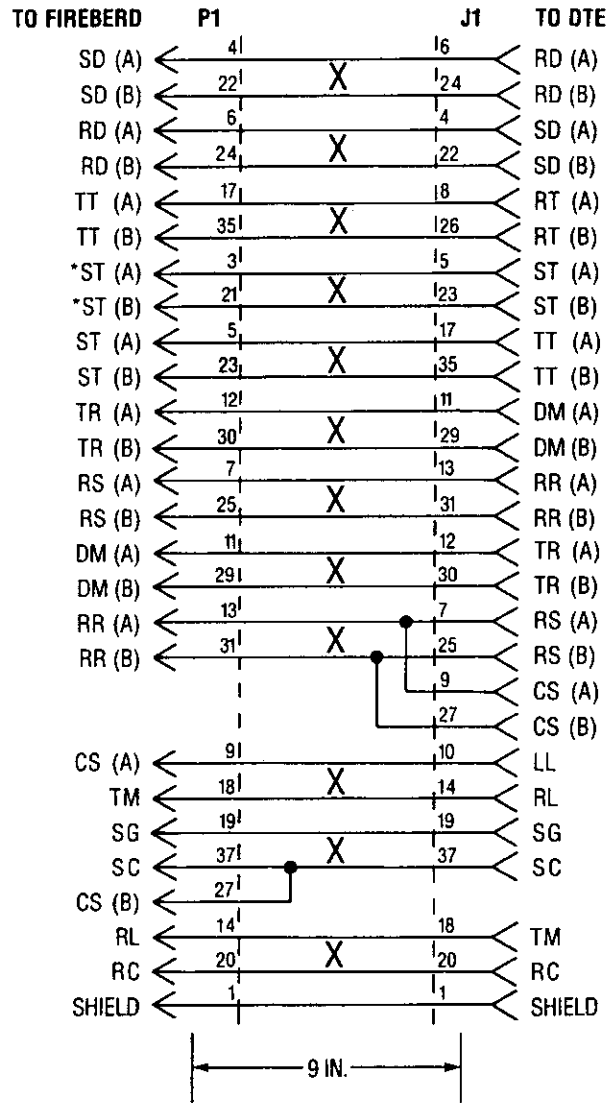
A.1 INTRODUCTION

This appendix provides cable diagrams for the TTC cables mentioned in this manual.



NOTES:
 P1/P2 - RS-449 37-POSITION MALE D CONNECTORS
 L - MODEL 10215, 6 FT.; MODEL 10417, 10 FT.

Figure A-1
FIREBERD-to-DCE Adaptor Cable, Model 10215/10417



- NOTES:**
P1 - RS-449 37-POSITION MALE D CONNECTOR
J1 - RS-449 37-POSITION FEMALE D CONNECTOR
* - ONLY FOR DCE OPERATION
X - TWISTED PAIR

Figure A-2
DTE/DCE Adaptor Cable, Model 10210