TM2500/TM2700
OEM MICROTERMINALS

Manual

855M384   Revision E
May 10, 2006
Warranty and Repair Policy Statement

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Seller's warranty as herein set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of, Seller's rendering of technical advice, facilities or service in connection with Buyer's order of the goods furnished hereunder. Products returned for warranty service, but which are found to be fully functional and in conformance with specifications may be subject to a nominal service charge and return freight charges. Periodic re-calibration of products, if required, is the responsibility of Buyer and is not provided under this Warranty.

Static Sensitivity

Seller ships all static-susceptible products in anti-static packages. Seller's Warranty as herein set forth shall not cover warranty repair or replacement for products damaged by static due to Buyer's failure to use proper protective procedures when handling, storing, or installing products.

Obtaining Service. Should your TM2500/TM2700 require service, please call a Customer Service Representative at 1-800-685-9911 (for international 520-573-0887) and request a Return Material Authorization (RMA) prior to returning a unit for repair. Please reference the RMA number in shipping documents, and include a detailed description of the problem with the unit.

TM2500/TM2700
Manual Revision History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>980713</td>
<td>Corrected typographical errors.</td>
</tr>
<tr>
<td>D</td>
<td>990701</td>
<td>Revised the date and version number on the cover page, for item Key Click on page 3-5 removed (default) from the OFF setting and added the word (default) to the ON setting. Under the default settings list on page 3-6: changed setting KC from 0 OFF (no key click) to 1 ON (key click enabled).</td>
</tr>
<tr>
<td>E</td>
<td>060510</td>
<td>Remove BB logo</td>
</tr>
</tbody>
</table>
Chapter 1  ABOUT THE TM2500/TM2700

Chapter 2  INSTALLATION

2.1 Unpacking

2.2 Power and Interface Connections

2.3 RS-232-C Interconnections

2.4 Power-Up Self Test

2.5 Self Test Results

Chapter 3  MANUAL SETUP MODE

3.1 Placing Terminal in SETUP Mode

3.2 Key Operation During SETUP

3.3 SETUP Category Description

3.4 Default Settings

Chapter 4  CHARACTER MODE OPERATION

4.1 Summary

4.2 Data Buffers

4.3 Handshake Operation

Chapter 5  BLOCK MODE OPERATION

5.1 Summary

5.2 Block Mode Input

5.3 Block Mode Output

5.4 Multidrop (polled) Operation

5.5 Multidrop Input

5.6 Multidrop Output

5.7 RS-422 Connections

5.8 Handshake Operation
This document has been prepared as a guide and reference for using the TM2500 and TM2700 Microterminals. To assure a successful installation, please read Chapter 2 thoroughly before beginning to install your terminal. In this manual, microterminal and terminal are interchangeable.

The following conventions are used in this manual for the representation of command formats, comments, and examples:

ASCII control characters are represented by placing the character mnemonic in angle brackets. For example, the Line Feed character is represented as <LF>. For example, Line Feed character is represented as <LF>. In sending data to the terminal, the actual ASCII character value of 00001010 (binary) would be sent, not <LF>.

The character codes for ASCII characters are given as decimal numbers, often enclosed in parentheses following the mnemonic, as in <LF> (010).

If you encounter problems or questions while installing or operating these terminals, application assistance is available by calling 1-800-685-9911 (for international service call 520-573-0887). Should your terminal require service, please call a Customer Service Representative at the same number(s) above and request a Return Material Authorization (RMA) prior to returning a unit for repair. Please reference the RMA number in shipping documents, and include a detailed description of the problem with the unit.

Intelligent Instrumentation Incorporated
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The TM2500 and TM2700 are compact, rugged, industrial data entry and display terminals. They are intended for use as operator panels and as service/setup panels in microprocessor based equipment. The only difference between the two units is that the TM2500 has an RS-232-C communications interface, while the TM2700 has an RS-422 communications interface.

These units offer a large, 16-character liquid crystal display. The viewing angle may be operator adjusted electronically. The sealed keyboard consists of 24 keys, including a numeric keypad and six back-lit function keys. These units include an audible tone generator which may be used to provide a key "click," and may be controlled by the host.

The TM2500/TM2700 offers two operating modes: character mode and block mode. In character mode, characters are transmitted as a key is depressed. In block mode, output messages are transmitted as a whole when the Enter key is pressed. Multidrop operation, in which a number of terminals are connected to the same RS-422 communications line, is possible with the TM2700 in block mode. Each terminal has a unique address for multidrop operation. Operating parameters, which can be selected, are viewing angle, mode, turnaround delay, baud rate, data format, handshaking, local echo, terminators, key click, key repeat, and cursor type. These selections are made during SETUP through the keyboard. Most can be controlled by downline host commands as well.
2.1 Unpacking

These terminals are shipped complete in one package. Inspect all received parts for damage and report problems to the carrier. Do not attempt to use a terminal with a damaged case or display.

As with all electronic equipment, it is important to avoid electrostatic discharge to electronic components and connectors. It is good practice to touch a grounded metal surface before making connections to these terminals.

Each terminal is shipped with these items:

1. Power connector kit described below.
2. Gasket to seal terminal when mounting from rear of a panel.
3. Gasket to seal terminal when mounting on front of a panel.
4. Installation guideline card.

2.2 Power and Interface Connections

There are two connectors on the back of the TM2500/TM2700 case. The diagram below shows use of these connectors.

Figure 2-1: Connectors
These units use a nine pin host communications connector and a two pin power connector. They require a DC power supply of +5Vdc or +7.5Vdc to +10Vdc. Host communications and power may be wired through the nine pin communications connector. Alternatively, power may be connected through the two pin power connector if desired. The maximum power supply current required is 350mA for the TM2700 and 250mA for the TM2500. The power supply current required is less if the beeper or LED backlighting for function keys is not used (see Chapter 9 for details).

The host communications connector in the terminal is a DE-9S connector. The mating connector is a DE-9P which is not supplied with the terminal. The power connector on the terminal uses a Molex 5219 series connector. The power mating connector is supplied with the terminal. (The power mating connector consists of a Molex 19-09-1029 housing with two Molex 02-09-1119 terminals. The terminals may be hand inserted or inserted with a Molex 11-01-0084 tool.)

**Figure 2-2: Connector pinouts**

<table>
<thead>
<tr>
<th>COMMUNICATIONS CONNECTOR</th>
<th>DE-9S ON-BOARD CONNECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN FUNCTION</td>
<td>PIN FUNCTION</td>
</tr>
<tr>
<td>1 Power Ground -</td>
<td>1 Power Ground -</td>
</tr>
<tr>
<td>2 B</td>
<td>2 Transmit</td>
</tr>
<tr>
<td>3 A</td>
<td>3 Receive</td>
</tr>
<tr>
<td>4 B'</td>
<td>4 N/C</td>
</tr>
<tr>
<td>5 A'</td>
<td>5 Clear to Send (CTS)</td>
</tr>
<tr>
<td>6 N/C</td>
<td>6 Data Terminal Ready (DTR)</td>
</tr>
<tr>
<td>7 Signal Ground</td>
<td>7 Signal Ground</td>
</tr>
<tr>
<td>8 Tie to Pin 9 for +5Vdc Power</td>
<td>8 Tie to Pin for +5Vdc Power</td>
</tr>
<tr>
<td>9 Power Input +</td>
<td>9 Power Input +</td>
</tr>
</tbody>
</table>

Full specifications for all signals are given in Chapter 9.
NOTE: For +7.5Vdc to +10Vdc power input on either connector leave pin 8 open; for +5Vdc power input on either connector tie pin 8 to pin 9 on communications connector. For either voltage, connect power between pin 9 and pin 1 of the communications connector or pin 1 and pin 2 of the power connector.

2.3 RS-232-C Interconnections

The following interconnections may be made between a TM2500 and a host with a typical DB-25 RS-232-C connector configured as DTE.

**Figure 2-3: RS-232 Connections**

```
<table>
<thead>
<tr>
<th>Host</th>
<th>TM2500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive</td>
<td>3 → 3 Receive</td>
</tr>
<tr>
<td>Transmit</td>
<td>2 → 2 Transmit</td>
</tr>
<tr>
<td>Ground</td>
<td>7 → 7 Ground</td>
</tr>
<tr>
<td>CTS</td>
<td>5 → 6 DTR</td>
</tr>
<tr>
<td>DTR</td>
<td>20 → 5 CTS</td>
</tr>
</tbody>
</table>
```

2.4 Power-Up Self Test

These terminals provide a built-in self-test, activated when power is applied. The CPU, LED's, Display, Beeper, RAM, ROM, and nonvolatile storage (EEPROM) are tested. The test sequence is:

1. CPU test
2. ROM test
3. RAM test
4. Internal I/O test
5. Beep
6. Turn all display dots on; then off
7. Turn all function key LEDs on; then sequentially turn them off
8. Display start-up message
9. Load operating parameters from EEPROM and test
10. If "." (period) key is depressed anytime during self-test, Enter SETUP.

**NOTE:** SETUP is described in Chapter 3; SETUP may be bypassed by host command. (Chapter 6)
2.5 Self-Test Results

After self-test, this message appears for a few seconds indicating a successful self-test: "Vxx.yy Test OK". xx are two ASCII digits indicating the firmware version, and yy are two ASCII digits indicating the revision level of the firmware in the terminal. A cursor then appears in the left hand side of the display to indicate that the terminal is ready for operation. If an error condition is detected during self-test, the cursor will not appear and the display will be black. If an EEPROM error is detected at any time, the words "EEPROM ERROR" will appear in the display. If any error is detected, the terminal will not function or respond to inputs.
Communications and operating parameters of the TM2500/TM2700 may be selected interactively through the keyboard. Operating parameters may also be selected through commands from the host. Selections are stored in the unit's nonvolatile EEPROM, and they are recalled automatically the next time the terminal powers up.

Setup selections are made in a special SETUP mode which prompts the operator through various categories and choices. After the initial setting of parameters, SETUP need only be entered when an option is to be changed. In order to guard against accidental changes by untrained operators, the operator SETUP mode can be bypassed via host command (see k command in Chapter 6).

3.1 Placing Terminal in SETUP Mode

1. Apply power
2. Depress "." (decimal point) key until self-test is complete. Note: If "." key is not depressed, terminal goes to ready condition.

In the SETUP mode, the operator is prompted for the current category to be selected with a two character abbreviation followed by the current option. The option is one or two digits. To change the option, the operator enters one or two digits as required by the category. The upper left function key (function key 01) is used to save changes in nonvolatile EEPROM at the end of SETUP.
3.2 Key Operation During Set-up

<table>
<thead>
<tr>
<th>Key</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function Key 01</td>
<td>Save changes in nonvolatile EEPROM</td>
</tr>
<tr>
<td>&lt;</td>
<td>Move to previous category</td>
</tr>
<tr>
<td>&gt;</td>
<td>Move to next category</td>
</tr>
<tr>
<td>0-9</td>
<td>Select option</td>
</tr>
<tr>
<td>Enter</td>
<td>Exit SETUP</td>
</tr>
</tbody>
</table>

If an invalid key is pressed, the terminal signals with an audible tone.

Figure 3-1: Keys used during SETUP

Following is a listing of the SETUP categories and the available options. Note that some selections are not required for certain terminal modes.
### 3.3 SETUP Category Description

The available categories for manual SETUP are described below: category is shown first, followed by the two letter prompt for that category, which appears on the terminal display, and the available options for that category:

<table>
<thead>
<tr>
<th>Category</th>
<th>Display Prompt</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewing Angle</td>
<td>VW</td>
<td>0</td>
</tr>
<tr>
<td>TM</td>
<td>0</td>
<td>Character mode</td>
</tr>
<tr>
<td>MA</td>
<td>00</td>
<td>through 32</td>
</tr>
<tr>
<td>TD</td>
<td>0</td>
<td>0ms (default)</td>
</tr>
</tbody>
</table>

VW is used to adjust LCD viewing angle

In character mode, data is transmitted as keys are pressed. In block mode, data is buffered and then transmitted when the Enter key is pressed.

MA selects the terminal's optional address. This is only available in block mode operation. If any address other than 00 is selected, the terminal operates in polled mode, transmitting data only when requested by host computer.

TD is used to select turnaround delay between the host computer's transmit command and the reply.
### Baud Rate (BR)

<table>
<thead>
<tr>
<th>BR</th>
<th>Baud Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>300 baud</td>
</tr>
<tr>
<td>1</td>
<td>1200 baud</td>
</tr>
<tr>
<td>2</td>
<td>9600 baud (default)</td>
</tr>
</tbody>
</table>

BR selects the communications speed for transmitting to and receiving from host computer.

### Data Format (DF)

<table>
<thead>
<tr>
<th>DF</th>
<th>Data Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7-bits/odd parity</td>
</tr>
<tr>
<td>1</td>
<td>7-bits/even parity</td>
</tr>
<tr>
<td>2</td>
<td>7-bits/mark parity</td>
</tr>
<tr>
<td>3</td>
<td>7-bits/space parity (default)</td>
</tr>
<tr>
<td>4</td>
<td>8-bits/no parity</td>
</tr>
</tbody>
</table>

DF selects the communications word length and parity. The parity bit is ignored on received data if mark or space parity is selected. All formats generate one stop bit.

### Handshake (HS)

<table>
<thead>
<tr>
<th>HS</th>
<th>Handshake</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>DTR-Asserted (default)</td>
</tr>
<tr>
<td>1</td>
<td>DTR-Asserted/CTS control</td>
</tr>
<tr>
<td>2</td>
<td>Xon/Xoff Control</td>
</tr>
</tbody>
</table>

HS selects the flow control handshaking used by the terminal in the host interface. DTR (data terminal ready) and CTS (clear-to-send) are only used with the TM2500 (RS-232-C). The 0 option must be selected with the TM2700. When Xon/Xoff is selected, the ASCII (DC1) and (DC3) control characters are used to control transmission in both directions. Xon/Xoff can only be selected if character mode has been selected.

### Character Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>Character Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DTR-Asserted/CTS control</td>
</tr>
<tr>
<td>2</td>
<td>Xon/Xoff Control</td>
</tr>
</tbody>
</table>

### Block Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>Block Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DTR-Asserted/CTS control</td>
</tr>
</tbody>
</table>

Block Mode is not specified in the document.
Local Echo  LE  0  OFF (default)  
1  ON
LE selects whether characters entered from the keyboard are written to the display before being transmitted. (Only available in character mode.) OFF means the characters are NOT written to the display before transmission.

Enter/LINE  EN  0  ETX
Terminator  
1  CR (default)  
2  LF  
3  CRLF
In character mode, EN selects the character(s) transmitted when the Enter key is pressed. In block mode, EN selects the character(s) appended to any message transmitted from the terminal and the character(s) which define the end of a received message.

Key Click  KC  0  OFF 
1  ON (default)  
KC selects if the internal beeper is used to provide audible feedback for each key depression.

Key Repeat  KR  0  OFF 
1  ON (default)  
KR selects whether the data entry keys will repeat if held down for approximately one second.

Cursor  CU  0  None 
1  Underscore  
2  Flashing Block (default)  
CU selects the type of cursor used in the display.
### 3.4 Default Settings

<table>
<thead>
<tr>
<th>Option</th>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VW</td>
<td>= 4</td>
<td></td>
</tr>
<tr>
<td>TM</td>
<td>= 1</td>
<td>Block Mode</td>
</tr>
<tr>
<td>MA</td>
<td>= 01</td>
<td></td>
</tr>
<tr>
<td>TD</td>
<td>= 0</td>
<td>(0ms turnaround delay)</td>
</tr>
<tr>
<td>BR</td>
<td>= 2</td>
<td>9600 baud</td>
</tr>
<tr>
<td>DF</td>
<td>= 3</td>
<td>7 bits/space parity</td>
</tr>
<tr>
<td>HS</td>
<td>= 0</td>
<td>DTR asserted</td>
</tr>
<tr>
<td>LE</td>
<td>= 0</td>
<td>OFF (no local echo)</td>
</tr>
<tr>
<td>EN</td>
<td>= 1</td>
<td>CR (Enter key transmits CR)</td>
</tr>
<tr>
<td>KC</td>
<td>= 1</td>
<td>ON (key click enabled)</td>
</tr>
<tr>
<td>KR</td>
<td>= 1</td>
<td>ON (key repeat)</td>
</tr>
<tr>
<td>CU</td>
<td>= 2</td>
<td>Flashing block (cursor)</td>
</tr>
</tbody>
</table>

All options selected are stored in nonvolatile EEPROM. This means the selections are permanently saved with or without power.
### 4.1 Summary

In character mode these terminals operate much like a simple, conversational mode CRT terminal with a one-line, 80-character display. All input and output is character oriented. Characters from the host are displayed upon receipt. Characters entered from the keyboard are transmitted when the key is pressed.

When the **Enter** key is pressed, the selected line terminator is transmitted. When an ASCII <RS>(030) character is defined as the last character of a function key message, the selected line terminator is transmitted as the last character(s) of the function message.

Local echo is used in half-duplex environments to display each output character as it is being transmitted to the host. When local echo is OFF, only characters received from the host are displayed. In character mode, the Delete key transmits the ASCII <DEL> (127) character; the Clear key transmits the ASCII <FF>(012) character.

### 4.2 Data Buffers

The host can transmit up to 80 characters to the terminals' display buffer. Host commands may also be transmitted to the terminal (see Chapter 6). These terminals also feature a 17-character receive buffer. The receive buffer is totally transparent except for two commands which require extra processing time: 1) Define Function Keys (<ESC>m), and

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**Figure 4-1: Character Mode Buffers Diagram**

![Character mode data buffers diagram](image-url)
2) Backup parameters (<ESC>b). These two commands write to the terminal's EEPROM and require 75 milliseconds delay for completion. During the required 75 millisecond delay, data received up to the total 17 characters of the receive buffer will be stored. *Characters in excess of 17 will be ignored.* Commands are transferred to the 16-character command buffer upon receipt. The <ESC> character is not stored. The command is stored. Thus, if the Backup Parameters command is transmitted, it will use two characters (b<terminator>) of the 16-character command buffer. The two EEPROM storage commands should be used at the end of transmission to the terminal to minimize delays.

When the 80-character display buffer is full, new characters received will write over the last character of the buffer. The line feed <LF>(010) character clears the display; therefore, the first character of each transmission should be the line feed.

### 4.3 Handshake Operation

In character mode, three different handshake configurations are possible.

**DTR Asserted**

(TM2500 only) In this mode the DTR line will be de-asserted when the receive buffer is eight characters short of being full and will be re-asserted when the buffer is empty. Normally, the only time the receive buffer may fill is during EEPROM storage command processing or during host CTS de-assertion while the operator is entering data.

**DTR Asserted/CTS Control**

(TM2500 only) In this mode, the DTR line operates as described above. In addition, the CTS line from the host controls the terminal's transmission. That is, the terminal will not transmit unless CTS is asserted. If CTS is not asserted, one character entry from the keyboard will be buffered. Additional key depressions will be ignored while CTS is de-asserted.
XON/XOFF

(TM2500 and TM2700) In this mode, the terminal will transmit an XOFF character <DC3>(019) when its buffer is within eight characters of full to cause the host to stop transmitting. The host must stop transmitting within eight characters to avoid overrunning the terminal's buffer and losing data. As soon as the characters in the buffer are processed and the buffer is Clear, the terminal will transmit an XON character <DC1>(017) to allow the host to resume transmitting. In a similar way, upon receipt of an XOFF character from the host, the terminal will stop transmitting within three characters. Transmission will be re-enabled upon receipt of an XON character. When an XOFF inhibits transmission, one character entered from the keyboard will be stored; additional key depressions which occur before an XON is received will be ignored. Normally, the only time the terminal's receive buffer may fill is during EEPROM storage command processing or during host CTS de-assertion while the operator is entering data.
This page intentionally left blank
5.1 Summary

In block mode, the terminal buffers output messages so that whole messages (up to 16 characters) are transmitted together. This mode of operation is well suited to prompt/response transaction systems and, most important, with the TM2700 this mode allows for multidrop operation in which several terminals are connected to the same RS-422 line.

5.2 Block Mode Input

Characters from the host are displayed as they are received. A line terminator ends the data received. A subsequent transmission clears the display and writes to a new display.

A 17-character input receive buffer is totally transparent except for two commands which require extra processing time: 1) Define Function Keys (<ESC>m) and 2) Backup Parameters (<ESC>b). These two commands write to the terminal's EEPROM and require 75 milliseconds delay for completion. During the required 75 millisecond delay, received data is stored up to the 17 character total of the receive buffer. Characters in excess of 17 will be ignored. Commands are transferred to the 16-character command buffer upon receipt. The <ESC> character is not stored in the command buffer; only the command itself is stored. The two EEPROM storage commands should be used at the end of transmissions to the terminal to minimize delays.

Figure 5-1: Block Mode Buffers Diagram
5.3 Block Mode Output

Keyboard entries in block mode are accumulated in a 16 character output buffer. When the Enter key is pressed, the entire accumulated message plus the line terminator is transmitted to the host. If the keyboard input exceeds 16 characters, the terminal will ignore the entry and sound an error beep. The line terminator is not included in the 16 character limitation. If the total characters of a function key will exceed the 16 character limit, the function key will be ignored and an error beep sounds. After the Enter key has been pressed, the next key pressed will appear in the display after clearing the previous message from the output buffer and display.

The Delete and Clear keys operate only during composition of a message in block mode. The Delete key will clear the immediately preceding character from the display and output buffer. The Clear key will clear the entire output buffer and the corresponding characters from the display. These keys affect only the message being composed. Control characters entered by the operator are displayed as an inverse video "C," but the actual control character is placed in the output buffer.

Input messages are discarded while the operator is entering data. That is, after any data key has been depressed, but before the Enter key is depressed, host text messages are ignored. Commands are processed during operator input. Therefore, the host can easily take control of the terminal for a priority message with the clear output buffer command.

There are two special host commands not used during normal operation which take control of the output buffer and clear it. These two are echo (<ESC>e) and Request Configuration (<ESC>c). Chapter 6 describes host commands.

5.4 Multidrop (polled) Operation

In multidrop operation, each TM2700 terminal on the same RS-422 communications line is given a unique address. The address is selected in the SETUP mode. Selecting any address other than 00 places the terminal in Multidrop Operation. All messages sent to the terminal must be prefixed with the terminal's two character address. Any transmission from the terminal is prefixed with the two character address. The TM2500 terminal with RS-232-C communications interface can be given a unique address as well, but RS-232-C is not suited for multidrop operation without the use of modems.
5.5 Multidrop Input

After a valid terminal address is received, characters appear on the display as they are received until a line terminator is received. The receipt of a line terminator alerts all terminals that the next character received will be a terminal address. Receipt of the line terminator thus serves to resynchronize communications. In a continuous stream of data, the multidrop address characters must immediately follow the previous line terminator. Any intervening characters will cause the terminals in the line to not recognize their address characters. For example, if the selected line terminator is a <CR> and <CR><LF> is actually transmitted at the end of the message, each terminal would attempt to interpret the <LF> as the first character of its multidrop address. Since <LF> would not be the first character of any address, the message following would be ignored.

AS AN EXAMPLE: 03ENTER FREQUENCY<CR> would be received by a terminal with an address of 03. ENTER FREQUENCY would be displayed. All other terminals would ignore the transmission. All host commands must also be prefixed with a valid terminal address. A message from the host with an address of 00 will be received by all terminals.

5.6 Multidrop Output

In multidrop operation, messages are entered as in block mode. However, the message is not transmitted until the host requests the data with an <ESC>p "Poll" command. When the Enter key is pressed, the terminal goes into the output pending state until a "poll" command is received. The display flashes while the terminal is in the output pending state. The operator cannot enter another message while the terminal is in the output pending state. The Clear key will not clear the output buffer while the terminal is in the output pending state.

Function keys can be terminated by an ASCII<RS>(030) to cause an automatic Enter when the function key is pressed.

All messages transmitted by the terminal are prefixed by its two character address.
5.7 RS-422 Connections

When using the TM2700 which features a RS-422 interface, up to 32 terminals may be connected to a single communications line as shown below.

It is important that the length of the main cable be less than 4000 feet (1200 meters) for reliable communications. Short stub lines to each terminal should be less than 50 feet (15 meters).

RS-422 is a balanced line interface and requires the main line to be terminated at the furthest point from the host system. The recommended value for most installations is 240Ω. In addition, the signal ground should be connected to the common of the host interface to obtain a reliable reference.

Figure 5-2: RS-422 Connection Diagram

5.8 Handshake Operation

In block mode, only the TM2500, which features an RS-232-C interface, provides handshake capabilities. Two handshake configurations are possible.
**DTR Asserted**

In this mode the DTR line will be de-asserted when the receive buffer is eight characters short of being full and will be released when the buffer is empty.

**DTR Asserted/CTS Control**

In this mode DTR operates as described above. In addition, the CTS line from the host controls the terminal's transmission. That is, the terminal will not transmit unless CTS is asserted. If CTS is not asserted, one message (signified by depression of Enter key) will be buffered. Additional key depressions will be ignored while CTS is de-asserted.
6.1 Summary

In addition to sending text messages to the terminal, the host computer may use a set of command or Escape sequences to control the operation of the terminal. A command sequence consists of the ASCII control character <ESC>(027), followed by a command letter, parameters and a command terminator. These command sequences are compatible with Intelligent Instrumentation’s TM8400 communication protocol. Some command sequences require dummy parameters indicated by <dummy>. The number 0 (zero) should be used for the dummy parameters. Command sequence format:

<ESC><command letter>[<parameters>]<terminator>

<table>
<thead>
<tr>
<th>Command Letter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMUNICATION</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Poll terminal for output</td>
</tr>
<tr>
<td>r</td>
<td>Retransmit last data</td>
</tr>
<tr>
<td>e</td>
<td>Echo message from host</td>
</tr>
<tr>
<td>o</td>
<td>Clear output buffer</td>
</tr>
<tr>
<td>t</td>
<td>Set turnaround delay</td>
</tr>
<tr>
<td>KEYBOARD</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>Set keyboard parameters</td>
</tr>
<tr>
<td>m</td>
<td>Define function message*</td>
</tr>
<tr>
<td>h</td>
<td>Control function key backlights</td>
</tr>
<tr>
<td>DISPLAY</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Set display characteristics</td>
</tr>
<tr>
<td>f</td>
<td>Set display format</td>
</tr>
<tr>
<td>i</td>
<td>Insert function message in output stream</td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Backup parameters in nonvolatile EEPROM*</td>
</tr>
<tr>
<td>c</td>
<td>Configuration request</td>
</tr>
</tbody>
</table>

All command sequences must be properly terminated to be executed by the terminal. The ASCII control character <STX>(002) can be used to terminate commands in both block and character modes. In block mode, the selected line terminator (<ETX>, <CR>, <LF> or <CRLF>) may also be used provided the command is at the end of a transmitted line. Using the <STX> terminator allows multiple commands to be imbedded, along with text, in a line sent to the terminal.
When the terminal receives commands containing errors or invalid parameters, valid command characters at the beginning of the command are processed; remaining characters from the first invalid character to the terminator are ignored. Commands which allow several parameters may be terminated prematurely without affecting the unspecified parameters.

### 6.2 Communications Commands

**p**
The `poll` command causes the contents of the transmit buffer to be transmitted to the host. If transmit buffer is empty, the line terminator alone is sent.

**Modes:** Block only.

\[<\text{ESC}>p<\text{terminator}>\]

**r**
The `retransmit` command causes retransmission of the last data sent by the terminal. If the output buffer has been overwritten, the line terminator alone is transmitted by the terminal.

**Modes:** Block, Character

\[<\text{ESC}>r<\text{terminator}>\]

**e**
The `echo` command allows the host computer to verify communications to and from the terminal. The host transmits a text string, embedded in the command, to the terminal, and the terminal sends back the string.

**Modes:** Block, Character

\[<\text{ESC}>e<\text{text}><\text{terminator}>\]
The text string may be from 0 to 15 characters in length. The terminal will respond to this command with:
<text><line terminator>

0
The Clear output command allows the host computer to clear the output buffer. Any partial (unterminated) output message in the display is also erased. If the output buffer is pending transmission, this condition is also cleared. **Any data in the output buffer will be lost.**

In block operation, normal text messages from the host are discarded while the operator is entering an output message into the terminal. The Clear output command gives the host the capability to clear this condition and **break through.**

**Modes:** Block only

<ESC>o<terminator>

1
The set turnaround delay command allows the host computer to specify the minimum time which must elapse between a command which causes the terminal to transmit data immediately and the actual transmission of that data. This is necessary only for host systems which require time to prepare to read input after sending output to the terminal.

**Modes:** Block, Character

<ESC>t<delay><terminator>

The delay should be specified as a single ASCII digit 0-3. Values are:

<table>
<thead>
<tr>
<th>Value</th>
<th>Delay in mS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>250</td>
</tr>
</tbody>
</table>

**Example:**
Set turnaround delay to 100 mS:
<ESC>t2<STX>
6.3 Keyboard Commands

The keyboard includes six programmable function keys. The corresponding function messages are numbered 01 through 06. It is possible to selectively enable and disable the keyboard, key repeat, audible key click, and the manual SETUP mode.

**k**

The **keyboard** command allows the keyboard operating characteristics to be specified. Any of the parameters may be modified without altering the settings of the others. <dummy>=0.

**Modes:** Block, Character

<ESC>k<keyboard><dummy><key repeat><keyclick><SETUP><terminator>

Values for keyboard are:

0 no change  
1 OFF  
2 ON  

This parameter selects whether the keyboard is disabled (OFF) or enabled (ON). When OFF, all key depressions are ignored.

Values for key repeat are:

0 no change  
1 OFF  
2 ON  

When ON, data keys repeat at five times per second when held down for one second.

Values for keyclick are:

0 no change  
1 OFF  
2 ON  

When ON, an audible "keyclick" sounds on each key depression.

Values for SETUP are:

0 no change  
1 OFF  
2 ON
When ON, depression of "." (period) key on power up puts terminal into manual SETUP mode.
When OFF, terminal cannot be placed in manual SETUP mode.

Example:
Disable keyboard leaving all other parameters unchanged.
<ESC>k10000<STX> or simply <ESC>k1<STX>

The **define function message** command allows the host computer to redefine function messages.
Text stored as a function message will be entered into the terminal when the corresponding key is
pressed, as if the operator had typed the individual characters. This command stores directly to
nonvolatile EEPROM and requires 75 milliseconds processing time in the terminal after reception.

A function message which ends with the ASCII control character <RS>(030) is equivalent to a
message typed on the keyboard followed by depression of the **Enter** key.

The default values for the six function messages are the six letters A through F.

**Modes:** Block, Character

\[ <ESC>m<number><text><terminator> \]

Values for function key number are:

<table>
<thead>
<tr>
<th>Number</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>A</td>
</tr>
<tr>
<td>02</td>
<td>B</td>
</tr>
<tr>
<td>03</td>
<td>C</td>
</tr>
<tr>
<td>04</td>
<td>D</td>
</tr>
<tr>
<td>05</td>
<td>E</td>
</tr>
<tr>
<td>06</td>
<td>F</td>
</tr>
</tbody>
</table>

Text is a string of 0 to 4 characters (including <RS> if used).

Example:
Define the word "End" on function key 01 which is transmitted immediately on depression of the key:
<ESC>m01End<RS><STX>
NOTE: The EEPROM is guaranteed for 10,000 programming cycles per location. Continual redefinition of function messages can wear out the EEPROM.

\textbf{h}

The \textit{control function backlight} command turns the function key backlights ON and OFF.

Modes: Block, Character

\textless\text{ESC}\textgreater\textbf{h}<\text{light}><\text{action}><\text{terminator}>

Values for \textit{light} are:

<table>
<thead>
<tr>
<th>Number</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Controls all backlights</td>
</tr>
<tr>
<td>1 through 6</td>
<td>Controls individual backlight</td>
</tr>
<tr>
<td>1-A</td>
<td></td>
</tr>
<tr>
<td>2-B</td>
<td></td>
</tr>
<tr>
<td>3-C</td>
<td></td>
</tr>
<tr>
<td>4-D</td>
<td></td>
</tr>
<tr>
<td>5-E</td>
<td></td>
</tr>
<tr>
<td>6-F</td>
<td></td>
</tr>
</tbody>
</table>

Values for \textit{action} are:

<table>
<thead>
<tr>
<th>Number</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Turn OFF</td>
</tr>
<tr>
<td>1</td>
<td>Turn ON</td>
</tr>
<tr>
<td>2</td>
<td>Toggle</td>
</tr>
</tbody>
</table>

Toggle changes the status of the light; that is, a light that is ON is turned OFF, while a light that is OFF, is turned ON.
6.4 Display Commands

d
The display characteristics command allows the host computer to flash the display and control the cursor. Display flashing may be enabled or disabled. The entire display flashes while flashing is enabled. \(<\text{dummy}>=0\).

Modes: Block, Character

\(<\text{ESC}>d<\text{flash}><\text{dummy}><\text{cursor}><\text{terminator}>\)

Values for flash are:
0 no change
1 OFF
2 ON

Values for cursor are:
0 no change
1 OFF (no cursor)
2 underscore
3 flashing block

Example:
Turn off the cursor;
\(<\text{ESC}>d001<\text{STX}>\)

f

The display format command allows the host computer to specify the format of the display. Output display may be used to disable the display for applications such as password security. This command is primarily useful in block mode. When disabled, only information received from the host computer will be displayed. Data entered from keyboard is not displayed. The local echo setting determines if keys are displayed before transmission in character mode. \(<\text{dummy}>=0\).

Modes: Block, Character

\(<\text{ESC}>f<\text{output display}><\text{dummy}><\text{local echo}><\text{terminator}>\)

Values for output display are:
0 no change
1 OFF
2 ON

When OFF, keyboard entered data will be blanked, only data from host computer is displayed.
Values for **local echo** are:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>no change</td>
</tr>
<tr>
<td>1</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>ON</td>
</tr>
</tbody>
</table>

Example:

Turn on local echo:

```
<ESC>f002<STX>
```

The host may specify a function message to be inserted in the output stream using the **insert message** command. In block mode, the message will be appended to the output buffer; in character mode, it will be transmitted.

**Modes:** Block, Character

```
<ESC>i<number><terminator>
```

Values for **number** are:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01-06</td>
<td></td>
</tr>
</tbody>
</table>

Example:

Insert function key 02.

```
<ESC>i02<STX>
```
6.5 Miscellaneous Commands

b
The **backup parameters** command causes the terminal's current operating parameters to be saved
in non-volatile EEPROM. These parameters are those selectable in the SETUP mode which may
have been modified by the host through the t, k, d, and f commands. This command requires 75
milliseconds processing time in terminal after receipt. The EEPROM is guaranteed for 10,000
programming cycles per location. Constant backup of parameters can wear out EEPROM.

Modes: Block, Character

```
<ESC>b<terminator>
```

c
The **request configuration** command causes the terminal to answer back with a message
identifying its characteristics.

Modes: Block, Character

```
<ESC>c<terminator>
```

The response to the c command contains the following information:

```
<class><version><revision><comm id><terminator>
```

- **class** is the terminal classification (1 for the TM2500 or TM2700)
- **version** is two ASCII digits for the firmware version
- **revision** is two ASCII digits for the revision level of the firmware
- **comm id** is one ASCII digit for the type of communications interface.

```
0 RS-232 - TM2500 only
1 RS-422 - TM2700 only
```

Example:
Configuration request is sent to a TM2500 with firmware version 01 revision 00.
```
<ESC>c<STX>
```
The response is
```
101000<CR>
```
6.6 Control Character Processing

The following table lists the response of the terminal to ASCII control characters with the exception that in block mode, the selected line terminator (<LF>, <CR>, <CRLF>, or <ETX>) is used to define the end of a message block from the host. In this case, the line terminator is stripped off by the terminal's receiver before the message is displayed.

<table>
<thead>
<tr>
<th>Character</th>
<th>Value</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;NUL&gt;</td>
<td>000</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;SOH&gt;</td>
<td>001</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;STX&gt;</td>
<td>002</td>
<td>Command terminator</td>
</tr>
<tr>
<td>&lt;ETX&gt;</td>
<td>003</td>
<td>Ignored if not line terminator</td>
</tr>
<tr>
<td>&lt;EOT&gt;</td>
<td>004</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;ENQ&gt;</td>
<td>005</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;ACK&gt;</td>
<td>006</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;BEL&gt;</td>
<td>007</td>
<td>Sound beep tone</td>
</tr>
<tr>
<td>&lt;BS&gt;</td>
<td>008</td>
<td>Move cursor back one location</td>
</tr>
<tr>
<td>&lt;TAB&gt;</td>
<td>009</td>
<td>Move cursor forward one location</td>
</tr>
<tr>
<td>&lt;LF&gt;</td>
<td>010</td>
<td>Line feed - Clear display</td>
</tr>
<tr>
<td>&lt;VT&gt;</td>
<td>011</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;FF&gt;</td>
<td>012</td>
<td>Clear display</td>
</tr>
<tr>
<td>&lt;CR&gt;</td>
<td>013</td>
<td>Move cursor to beginning of line (carriage return)</td>
</tr>
<tr>
<td>&lt;SO&gt;</td>
<td>014</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;SI&gt;</td>
<td>015</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;DLE&gt;</td>
<td>016</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;DC1&gt;</td>
<td>017</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;DC2&gt;</td>
<td>018</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;DC3&gt;</td>
<td>019</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;DC4&gt;</td>
<td>020</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;NAK&gt;</td>
<td>021</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;SYN&gt;</td>
<td>022</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;ETB&gt;</td>
<td>023</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;CAN&gt;</td>
<td>024</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;EM&gt;</td>
<td>025</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;SUB&gt;</td>
<td>026</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;ESC&gt;</td>
<td>027</td>
<td>Command sequence introducer</td>
</tr>
<tr>
<td>&lt;FS&gt;</td>
<td>028</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;GS&gt;</td>
<td>029</td>
<td>Ignored</td>
</tr>
<tr>
<td>&lt;RS&gt;</td>
<td>030</td>
<td>Special function message terminator</td>
</tr>
<tr>
<td>&lt;US&gt;</td>
<td>031</td>
<td>Ignored</td>
</tr>
</tbody>
</table>
7.1 Summary

These terminals feature a 16-character liquid crystal (LC) display. The display can be moved with the left and right arrow keys through the 80-character display buffer. Characters enter the LC display from left to right across the screen. If more than 15 characters are transmitted to the display buffer, the LC display moves with the data showing the last 15 characters transmitted. The point at which characters are entered to the display is indicated by a cursor. The display can be made to flash under software control. The type of cursor used can be controlled by software.

The display of an output message entered from the keyboard can be disabled for security and password applications under software control. This is primarily useful in block mode. In character mode, local echo may be used to display characters entered to the terminal when they are transmitted to the host.

7.2 Cursor Control

Characters are always entered into the display at the current cursor position. If a character is present at this location, it will be replaced by the new character.

When the 80-character display buffer is full, the cursor will not move past the last character in the line. This means that extra characters will replace the last display character as they arrive.

Several ASCII control characters are provided to control the position of the display cursor:

- `<CR>` (013) move to the beginning of the line
- `<LF>` (010) Clear display buffer
- `<TAB>` (009) move forward one location in the line (nondestructive)
- `<BS>` (008) move back one location in the line (nondestructive)
- `<FF>` (012) Clear the display buffer and move the cursor and the window to the beginning of the line.
- `<DEL>` (127) Delete the character before the cursor
When any of the above characters would cause the cursor to move before the beginning of the line, it is ignored. When a new line of information is transmitted to the terminal, a prefix of <CR><LF> or <FF> will insure that the data is written at the start of the screen and display buffer.

The selection of the **Line Terminator** in block mode operation can affect whether or not <CR> and <LF> characters sent from the host computer will ever reach the display. If the terminator is set to <CR>, any <CR> received will be interpreted as an end of message and stripped off. Likewise, if set to <CRLF>, any <CRLF> sequence received will be stripped off before reaching the display; however, individual <CR>'s not followed by a <LF>, or <LF>'s not preceded by a <CR> will reach the display. Setting the line terminator to <ETX> is suggested if this is a problem.

### 7.3 Cursor Fonts

The cursor appears in one of three ways under software control:

1) no cursor  
2) underscore  
3) flashing block

### 7.4 Movement of Display Window

The **left arrow** and **right arrow** keys move the 16-character display window through the 80-character display buffer. An attempt by the operator to move the display window left or right beyond the display buffer will result in an error tone. Depression of any other key returns the window to the position it was at before it was moved.
Data may be entered to these terminals through the keyboard. There are 24 key locations. The keyboard features two-key rollover as well as optional auto-repeat and key-click sound. As keys are pressed, the characters appear in the display beginning in the leftmost position, with further characters appearing to the right.

8.1 Key Placement

There are three general classes of key functions used on the keyboard:

1) Terminal control keys
2) Numeric keys
3) Programmable function keys

Figure 8-1: Keyboard
8.2 Key Descriptions

Terminal Control Keys
- Left Arrow
- Right Arrow
- Delete
- Clear
- Enter

These five keys control the operation of the terminal. The left and right arrow keys move the display manually through the display buffer. In character mode the Delete key transmits a <DEL>(127) character to the host. In block mode the Delete key deletes the last character entered and the corresponding character in the output buffer only during message composition. In character mode the Clear key transmits a <FF>(012) character to the host. In block mode, the Clear key clears the output buffer and the corresponding characters from the display only during message composition. In character mode, the Enter key transmits the selected line terminator. In block mode, the Enter key causes the output buffer to be transmitted to the host as described in Chapter 5.

Numeric Keys

The numeric keypad arrangement is similar to that used on a telephone. The keys are used to enter 0 through 9 as well as ",", decimal point, and "." minus sign.

Programmable Function Keys

The six function keys are arranged on a block on the right half of the terminal. The keys themselves are unmarked so that the user can easily assign a function to them by placing a label in the adjacent label area. The label area to the right of each function key is depressed so that the label edges are protected and resistant to peeling.

Each function key is backlit by an LED. The backlighting is controlled by host command. The arrangement of the function keys with function numbers is shown below.
Each programmable function key may be programmed by the host to Enter a message up to four characters in length. Function messages are stored in nonvolatile EEPROM and retained when power is off. The default characters for each function key as shown below are the letters A through F, so that the keyboard may be used for hexadecimal input if desired.

<table>
<thead>
<tr>
<th>Key</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>A</td>
</tr>
<tr>
<td>02</td>
<td>B</td>
</tr>
<tr>
<td>03</td>
<td>C</td>
</tr>
<tr>
<td>04</td>
<td>D</td>
</tr>
<tr>
<td>05</td>
<td>E</td>
</tr>
<tr>
<td>06</td>
<td>F</td>
</tr>
</tbody>
</table>

### 8.3 User Labels

Each function key features a depressed label area to the right as described above. The function key label size is 26.1mm x 10.1mm, (1.030" x .400"). A label area for product name, logo, etc., has also been provided to the right of the Enter key. This label area is 62.6mm x 10.1mm, (2.400" x .400").
DISPLAY

<table>
<thead>
<tr>
<th>Type</th>
<th>Liquid Crystal Dot Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Characters</td>
<td>16</td>
</tr>
<tr>
<td>Matrix Size</td>
<td>5 x 7 with Cursor</td>
</tr>
<tr>
<td>Character Height</td>
<td>9.66mm (0.380&quot;)</td>
</tr>
<tr>
<td>Display Buffer</td>
<td>80 Characters</td>
</tr>
<tr>
<td>Attributes</td>
<td>Display flash</td>
</tr>
<tr>
<td></td>
<td>Display blank</td>
</tr>
<tr>
<td>Cursor Fonts</td>
<td>3 Cursor font options</td>
</tr>
</tbody>
</table>

KEYBOARD

<table>
<thead>
<tr>
<th>Type</th>
<th>Sealed Elastomeric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Keys</td>
<td>24</td>
</tr>
<tr>
<td>Actuation Force</td>
<td>135g</td>
</tr>
<tr>
<td>Travel</td>
<td>0.03&quot;</td>
</tr>
<tr>
<td>Service Life</td>
<td>1 million operations</td>
</tr>
</tbody>
</table>

PROGRAMMABLE FUNCTIONS

| Number of Function Keys | 6                          |
| Programmable memory    | 4 characters/key           |
INTERFACE

Electrical
- TM2500: RS-232-C
- TM2700: RS-422

Transmission: Serial Asynchronous

Code: ASCII

Baud Rate: 300, 1200 or 9600 user selectable

Protocol:
- Character mode (XON/XOFF)
- Block mode
- Multidrop block mode

Max Block Length:
- 80 characters (input)
- 16 characters (output)

Max Multidrop: 32 units/line

Connector Type:
- DE-9S (communications), DE-9P mating
- Molex 5219 series (power)

PROGRAMMING

Retention: EEPROM

PARAMETERS

Method: Interactive (keyboard)/host for all
- Host (comm line) if underlined

Options:
- Baud Rate
- Data Format
- Cursor
- Handshaking
- Turnaround Delay
- Key Repeat
- Display Format
- Local Echo
- Line Terminator
- Key Click
- Address
- Terminal Mode
- SETUP disable (comm line only)

FUNCTION KEYS

Method: Host (comm line)
POWER SUPPLY

Type             External
Voltage          +  5Vdc±5% or +7.5Vdc to +10Vdc
Current*         TM2500  250mA max
                  TM2700  350mA max
Connector        Molex 5219 Series
*includes Function LEDs @125mA, typical and audible alarm @ 20mA typical

PHYSICAL

Size             104.2mm x 180.4mm x 26.9mm (4.102” x 7.102” x 1.060”)
Weight           266g (10.5oz)
Case Material    ABS Plastic

ENVIRONMENTAL

Operating Temperature  0°C to +50°C
Storage Temperature    -20°C to +70°C
Relative Humidity      5% to 95% (non-condensing)

SEALING

Keyboard/Display    Resists dust, liquid
Case               Resists dust
Gaskets            Included with terminal

COMMUNICATIONS

On-board connector  DE-9S (TM2500 and TM2700)
TM2500             RS-232-C
Distance           50 ft.
Modem Control      CTS, DTR
Logic Levels:
Receive  Logic 1   -3V to -15V
          Logic 0   +3V to +15V
Transmit Logic 1   ≤ -6V with 3KΩ load
          Logic 0   ≥ +6V with 3KΩ load
Modem Control Handshaking with the RS-232 Interface

TRANSMIT
DATA

CTS

CTS TIMING

RECEIVE
DATA

DTR

DTR TIMING

* - 8 Character margin

TM2700
RS-422
Distance 4000 ft
Receiver:
Differential Input Voltage 0.2V<ΔV<6V
Input Impedance 12000 Ω min.
Logic Levels:
Logic 1 A' - low B' - high
Logic 0 A' - high B' - low
Transmitter:

**Differential Output Voltage**
- (open circuit) 5V max
- (full load, $R_L = 100\Omega$) 2V min

**Output Current**
- (active, $R_L = 100\Omega$) 20mA
- (inactive, power off) ±100µA

**Logic Levels:**
- Logic 1 A - low  B - high
- Logic 0 A - high  B - low

**Common Mode:**

- Input Voltage -0.75V to +7V
- Output Voltage -0.3V to +3.5V
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Appendices
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The following environmental qualification tests were performed on TM2500/TM2700:

<table>
<thead>
<tr>
<th>Test</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>Bench Drop Test Package Drop Test</td>
</tr>
<tr>
<td></td>
<td>50,000 feet (non-operational)</td>
</tr>
<tr>
<td></td>
<td>15,000 feet (operational)</td>
</tr>
<tr>
<td>Temperature Rating</td>
<td>-20°C to +70°C (storage)</td>
</tr>
<tr>
<td></td>
<td>0°C to +50°C (operational)</td>
</tr>
<tr>
<td>Keypad Service Life</td>
<td>One million operations</td>
</tr>
<tr>
<td>Vibration</td>
<td>Search-5-55 Hz in three planes</td>
</tr>
<tr>
<td></td>
<td>Cycling-55-500-55 Hz @ 3 G’s</td>
</tr>
<tr>
<td>Mechanical Shock</td>
<td>30 G’s with duration of 11 ms</td>
</tr>
<tr>
<td>Radio Interference</td>
<td>Meets FCC Class A compliance</td>
</tr>
<tr>
<td>Conducted Interference</td>
<td>Meets FCC Class A compliance</td>
</tr>
<tr>
<td>Radio Susceptability</td>
<td>2.0V per meter over 14 kHz-10 GHz</td>
</tr>
<tr>
<td></td>
<td>in vertical or horizontal sweep</td>
</tr>
<tr>
<td>Bench Drop Test</td>
<td>4” or 45° pivot drop to 1 5/8” thick bench top</td>
</tr>
<tr>
<td>Package Drop Test</td>
<td>Certified by the National Safe Transit Assoc.</td>
</tr>
</tbody>
</table>
TM2500/TM2700 mechanical dimensions (not drawn to scale)

TOLENCES: ± .05
These units can be recess mounted from the rear or surface mounted on the face of a panel using the drawings indicated on the preceding page.

Side View - Recess Mounting