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MODEL RDU-1510
REMOTE DISPLAY UNIT

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1 INTRODUCTION

1.1 OVERVIEW

The RDU-1500 Remote Display Unit is a single rack unit device which displays textual information as directed by an external device through an RS-422/RS-232 port. The display area is 0.7" high and can show information with red, green, and amber LED's.

The RDU-1500 is a series of products, some with a different display widths. The unit's display area can be partitioned into one, two, or three sections, where each operates as if it were a separate remote display unit. Sections of a partitioned display unit need not be the same width.

Display information and control commands are fed to the remote display unit through its RS-422/RS-232 serial port. Using the remote display unit's external control protocol, an external device can control many remote display units individually, simultaneously, or in groups. The external device can be a personal computer, terminal, routing switcher system, machine control system, or any other device equipped with an RS-232 or RS-422 serial communication port. In this document, the external device is referred to as the "host system".

An external tally input feature is provided for use as an "on-air" indicator or for any other convenient purpose. There are two external tally inputs. The remote display unit can be programmed to change the message displayed, change the display color, change the flash rate, blank the display, or control a set of timers and counters as directed by external tally inputs. For example, a display can be programmed so that it becomes red upon tally activation.

The remote display unit is also equipped with diagnostic and test functions to confirm proper operation of internal components and the display's LED modules.

The remote display unit contains non-volatile memory where various operating parameters are permanently stored. A multi-level menu system can be used to examine and modify all of the unit's operating parameters. Alternately, the same parameters can be modified by host system commands.

1.2 DISPLAY IDENTIFICATION

During normal operation, the remote display unit must receive instructions from the host system in order to display any information beyond a diagnostic or set-up nature. The host system's instructions can be directed to a specific display unit or a specific section of a partitioned unit. An identification number is assigned to each display section using host commands or the menu system. See *DISPLAY IDENTIFICATION NUMBERS* in section 2.5 for more information.

2 INSTALLATION

This section is intended to assist in the installation of the Model RDU-1500 Remote Display Unit. It is recommended that all personnel involved in this process become familiar with the information contained herein prior to attempting to install the unit.

2.1 MOUNTING

There is a series of remote display unit models which differ in their display capacity and mounting requirements. Some units are intended to be mounted in a standard 19-inch equipment rack. In other units the front cover must be removed to gain access to the mounting hardware.

Adequate clearance should be provided at the top of the display area for ventilation. The unit should not be located over equipment which generates an excessive amount of heat. It should also be noted that bright or direct light on the front of the unit may make the displays difficult to read.

2.2 HOST SYSTEM CONNECTION

The host system connects to the remote display unit using either of the RJ11 type connectors labelled CONTROL on the rear of the unit. This is an RS-422/RS-232 serial communication port through which the host system provides all the necessary display information and control commands. Alternately, a terminal can be connected to this port to access the remote display unit's built-in menu system.

Both connectors have the same pinout, providing a loop-through feature. This method of inter-connection eliminates the need for a single multi-point cable which must be customized to the system's specific layout. Instead, separate cables can be used to connect remote display units together making unit re-location easier.

The connector's pinout is shown below. Pin 1 is at the bottom of the connector.

Pin	*Function*
1	no connection
2	ground
3	RS-422 non-inverted data or grounded for RS-232
4	RS-422 inverted data or RS-232 data
5	no connection
6	no connection

The host system can be connected to either the RS-422 data pins or the RS-232 data pin. When using RS-232, pin 3 must be connected to ground.

The remote display unit does not transmit data to this serial port connector.

The number of remote display units which can be connected to the host system is limited by the drive capabilities of the host system's serial port. Typically, up to 32 remote display units can be accommodated. If more than 32 units are to be connected to the same host system, some external drive-amplifying device may be required.

The serial port accepts standard asynchronous data communication. The data rate is factory-set to 9600 bits per second. If desired, use the menu system to change the data rate.

2.3 EXTERNAL TALLY INPUT CONNECTION

The terminal block labelled TALLY 1 and 2 on the rear of the unit is provided for connection of external tally input signals.

The external tally input signals operate at TTL levels. The consequence of signal level changes is dependent on display control commands supplied by the host system.

2.4 DISPLAY SECTIONS

The number and arrangement of display sections must be programmed for each unit. There can be one, two, or three sections, each with different positions and widths. Some parts of the display area can be designated as unused. These areas remain blank.

Display section arrangement must be customized to suit a unit's particular application. If the unit is to identify signals on a bank of three video monitors mounted above it, for example, then three evenly spaced sections would be appropriate.

See *MENU OPERATION* in section 3.6 for more information on arranging display sections.

One display section occupying the entire display area is assigned at the factory.

2.5 DISPLAY IDENTIFICATION NUMBERS

Identification numbers must be set for each section of a remote display unit. Any number from 0 to 255 is permitted, although the host system ultimately decides which display units and sections it uses. If the host system does not send display information for a specific display number, the displays which are assigned that number remain blank. If more than one display is assigned the same identification number, display information associated with the identification number appears on all displays which are assigned that number.

See *MENU OPERATION* in section 3.6 for more information on setting identification numbers.

In addition, a remote display unit can be assigned a name of up to 16 characters. The display unit's name is assigned by editing the contents of message number ten. As with the identification numbers, the name can also be used to distinguish displays from one another. Either method, or a combination of both, can be used.

It is the responsibility of the host system to choose the method of remote display unit identification.

The factory-assigned name of each unit is it's serial number and all sections have the identification number 0.

2.6 INITIAL MESSAGES

Using previously stored messages, a remote display unit can be pre-programmed to show any of these messages immediately after it is powered-on. This permits stand-alone operation where each display unit section shows a custom message even without connection to the host system. Up to ten messages can be stored in non-volatile memory.

See *MENU OPERATION* in section 3.6 for more information on editing messages and programming initial conditions.

2.7 POWER

Power for the remote display unit is supplied through a wall-mount power pack. Plug the power pack into any available AC power source and connect it's sub-miniature jack into the power connector at the rear of the remote display unit.

The power rating as printed on the power pack should be checked to ensure that it conforms to the available power.

3 OPERATION

3.1 POWER UP DIAGNOSTICS

Diagnostic tests are performed immediately after the remote display unit is powered up or immediately after its microprocessor is reset. A ROM verification test, ROM version report, and identification number reports are performed. The ROM is a memory device containing all the instructions for the display's central processing unit (CPU).

In the event that the ROM verification test fails the message ROM FAIL - *nn*, where *nn* is a hexadecimal number, appears briefly instead of the ROM version.

A successful ROM test is confirmed by messages showing the manufacturer and model name of the product including firmware version numbers.

Next, the identification number of each display unit section appears in order of display sections from left to right (sections 1, 2, and 3). A unit programmed to operate as one section shows only one identification number.

After the identification number reports, the remote display unit blanks it's displays and prepares to accept commands from the host system in it's normal operating mode. If pre-programmed to do so, the unit may display some previously defined messages.

3.2 CONTINUOUS MONITORING

An independent watchdog circuit is always standing by to reset the unit's microprocessor within a ½ second if the microprocessor ceases to provide a continuous "alive" signal.

3.3 OPERATING MODES

The remote display unit is not equipped with any front panel operator-controllable features. During normal operation, it must receive instructions from the host system in order to display any information or perform diagnostic or set-up functions.

The remote display unit's serial port operates in two distinct modes. The normal operating mode is the most common. In this mode, the remote display unit's external control protocol is accepted providing access to nearly all functions through a host system.

The second operating mode consists of a multi-level system of menus that can be navigated using a simple terminal. The menus allow an operator to set-up and program a remote display unit for stand-alone use or for further use with the host system.

A special command, accepted during the normal operating mode, activates the menu system. Once activated, a completely different set of characters selects all menus and functions. The menu system is intended to be used by an operator who is able to see the remote display unit while sending menu control characters to the unit. None of the external control protocol commands are accepted by the remote display unit during menu system operation. The operator must terminate the menu mode before the host system can resume sending commands under the normal operating mode.

3.4 HOST-INITIATED DISPLAY TEST

At any time during normal operation, the host system can request that the remote display unit perform a display test in which all red or green dots are activated, continuously alternating. This test continues until terminated by another command from the host system. After the display test the display's previous contents are restored.

Additional dot column and row-specific display tests are available through the menu system.

3.5 NORMAL OPERATION

3.5.1 Host System

During normal display operation, the host system sends commands and data to the unit to control its displays. The host system consists of a computer or terminal equipped with a serial communication port using the RS-422 or RS-232 interface standard and communications software to access the port. Although the host system may be just a terminal, a computer host system is more flexible. The RS-422 standard allows many remote display units to be connected to the same host system. Operating the displays using a terminal is only feasible where changing display information is infrequent. Operating remote display units through a computer allows custom programs to provide an unlimited number of display applications.

3.5.2 Sections

A remote display unit can be partitioned to provide up to three independent sections. Although this does not provide any additional display surface, it does allow one unit to behave as one, two, or three separate units from the perspective of the host system. This can simplify host system design. It relieves the host from providing special information for multiple sections of a single display unit. The host simply provides information as if all display sections were single display units.

3.5.3 Lines

Each display section consists of three storage areas called lines, numbered from one to three. At any given moment, the text appearing on the display comes from one of these lines. Displays which are not programmed to use the flashing feature can use any single line.

Display information given to the unit is always directed to the "selected" lines only. Any one, two, or all three lines can be selected prior to submitting text for those lines. To instruct the unit to display lines one after another the flash period of each line to be displayed should be set to a non-zero value. There are commands to set the flash period for currently selected lines.

3.5.4 Current Character Position

For each line of each display section the current character position is maintained. The current character position specifies the location in which the next display character is placed. The position is advanced as each character is provided.

3.5.5 Attributes

Attributes can be placed among normal (displayable) characters to alter their appearance or position. There are commands to set the color, font, and justification, of any subsequently received characters. Attributes remain in effect until changed by another attribute command, or until other displays or lines are selected. Default attributes are in effect where none are provided by explicit commands.

3.5.6 Downloadable Characters

Up to 31 special characters can be "created" by the host system and downloaded into the remote display unit. The host can then place these characters anywhere in a display.

Downloadable characters are specified by complete dot maps and can therefore be any arrangement of dots, providing a custom character or graphic symbol.

The dot maps for all downloadable characters combined is limited to a maximum number of columns. Each character, however, can use the entire dot map (if only one special character is required). This allows characters to be created which are much wider than any of those in the remote display unit’s resident character sets.

3.5.7 Programmable Timers/Counters

Each remote display unit has four programmable 8-digit variables which provide timer or counter functions. All or part of any variable can appear anywhere in a display section. The four variables are common to all display sections of one remote display unit. The host system can program each variable’s current value and mode of operation.

When programmed as a timer, the variable is automatically changed once per frame without any further host system involvement. The number of frames that equal one second is also programmable. This allows the variable to operate as a time of day clock, elapsed time clock, or count down clock. As the variable changes, the display also changes. Display of frames (or any other digits) is optional.

When programmed as a counter, the variable is changed as directed by the remote display unit’s external tally inputs. This allows the variable to operate as an external event counter. External tally inputs can be programmed to advance, reset, or hold the counter. The counter control signals can be provided by another device, or controlled directly by the host system.

A variable counter can be programmed to count up or down. It can also be programmed to stop when the terminal count is reached. An 8-digit variable counter is actually a 6-digit counter with a 2-digit prescaler set to divide incoming counts by 100. The prescaler can be set to any value from 1 to 100, allowing multiples of events other than 100 to be counted by a 6-digit counter.

External tally inputs can be programmed to reset or hold timers as well as counters. In addition, the external tally input's active level or edge is programmable for each variable.

Any of a variable's digits (including frames) can appear anywhere in a display section. The digits need not be adjacent on the display and can appear in more than one place on the same display.

Other characters can be placed among variable digits, such as colon separators for a clock display. Automatic blanking of leading zeros is also programmable. For a time of day clock, a 12-hour format and AM/PM indicator can be selected.

3.6 MENU OPERATION

Due to the limited viewing space, the menu system is not available on remote display units with small display areas. In this case, essential functions, such as display identification number assignment, must be accomplished through the host system. Consult host system documentation for more information.

One remote display units with adequate viewing space, the menu system operates as described in this section.

3.6.1 Host System

Depending on the host system, an operator may be able to use the menu system from within the host system. If this is not possible, the remote display unit must be disconnected from the host system then re-connected to a simple terminal or personal computer equipped with a serial communication program.

The remote display unit does send any feedback through the it's serial port during the menu operating mode. All feedback appears in the unit's display area.

The terminal, computer, or host system operates the menu system with single character commands such as escape (decimal 27), carriage return (decimal 13), period, plus, minus (dash), digits, etc.

3.6.2 Activating the Menu System

To activate the menu system, the operator must select the desired remote display unit, then send the menu activation command.

Example

```
%0D%2X
```

Activate the menu system in display unit 0.

If only one remote display unit is connected to the operator's terminal the display identification number can be omitted (`%D%2X`). Where many units are connected, the particular display unit of interest must be isolated from the others to avoid activating the menu system in the other units. To activate the menu system in a specific unit, use the character sequence shown in the example, replacing the zero character with the desired identification number.

Upon reception of the X character, the menu system is activated, the main menu appears and the remote display unit operates as described in the remainder of this section.

3.6.3 Navigating the Menus

Each menu consists of an amber menu name at the left side of the display area followed by two or more numbered green menu items. Selecting an item may access another menu or perform some other function.

The operator can navigate through the menu system in two ways; selecting a menu item using the decimal digit characters 1 through 9 to the left of the desired item, or, moving the flashing cursor right or left to the desired menu item using the plus or minus characters, respectively, then selecting the cursored item with carriage return. The period character moves the flashing cursor to the first item in a menu. The menu item cursor flashes over the menu item number to the left of an item.

In some menus, all items may not fit in the display area. In this case, a red pointer appears to the right of the last visible item, indicating that some higher-numbered items are not visible. To make these items visible, the operator can move the flashing cursor to the right using the plus character. The digit characters can select menu items regardless of their visibility.

To return to the previous menu, use the escape character. This terminates menu operation if the main menu is displayed.

3.6.4 Numeric Entry

Some menu options require entry of numeric information (usually to set some operating parameter). The operator can specify a numeric parameter in two ways; using the decimal digits characters 0 through 9 to enter the value directly, or, using the plus or minus characters to increment or decrement the current value until the desired value is reached.

Regardless of the entry method, numeric parameter changes can be discarded using the escape character, or kept using the carriage return character.

3.6.5 Main Menu

The main menu is the first to appear when the menu system is activated. It is identified by MENU and shows three options; TEST, SETUP, and MESSAGE. The options select other menus related to diagnostic functions, set-up of operating parameters, and editing of stored messages, respectively.

Once all desired menu actions have been taken, send the escape character to terminate the menu operating mode and resume the normal operating mode.

3.6.6 Test Menu

The TEST menu offers four options related to performing tests on the remote display unit's hardware. Three options select another menu. Choose MEM to perform various memory device tests, PORT to test the serial port or external tally inputs, LED to test the dots on the display area, or WATCHDOG to test the external watchdog circuit.

Once all desired test functions are performed, send the escape character to return to the main menu.

3.6.7 Memory Menu

Access the MEM menu from the TEST menu. This menu has three options: ROM, RAM, and EE-NVM. Selecting an option performs a test on the corresponding memory device as described in the following paragraphs. After performing a test, send the escape character to return to the MEM menu. Any other character repeats the selected test. While a test is performed, the message PLEASE WAIT... is displayed.

ROM Test

The ROM test reports the result of summing all data in the unit's Read-Only-Memory. If the sum correctly matches the expected value (stored in the same ROM), a message identifying the remote display unit's model and firmware version is displayed. Otherwise, the message ROM FAIL - *nn*, where *nn* is the sum in hexadecimal, appears in red.

This test is also performed each time the remote display unit is powered on or reset.

RAM Test

Each location of the unit's Random-Access-Memory is written and read twice to confirm proper operation. The result of the RAM test is indicated by the green message RAM OK or the red message RAM FAIL appearing in the display area.

EE-NVM Test

The Electrically-Erasable-Read-Only-Memory is tested by non-destructively writing and verifying each location in the device twice. The result of the EE-NVM test is indicated by the green message EE-NVM OK or the red message EE-NVM FAIL appearing in the display area. The test takes several seconds as this type of memory device requires considerably more time to write than to read.

3.6.8 Port Menu

The PORT menu is accessed from the TEST menu. This menu has three options: SERIAL, TALLY, and SPEED. These items start a serial port test, an external tally port test, and set the serial port baud rate, respectively.

Serial Port Test

The serial port test can be of some use in diagnosing serial port problems. Of course, the test can't be started unless the serial port is functioning to some degree.

During the serial port test, each character received by the remote display unit is displayed immediately. The display is cleared each time it becomes full. Only the escape character terminates the serial port test.

Tally Test

The tally test verifies proper operation of the external tally inputs. During the test, the low of high level of external tally input one is indicated to the right of TALLY1 and that of the other input is indicated to the right of TALLY2. A low level applied to an external tally input is indicated by ON, while a high level is indicated by OFF. The display changes dynamically as input levels are changed.

The escape character terminates the tally test.

Speed Selection

The remote display unit serial port baud rate is programmable. Selecting the SPEED option from the PORT menu displays the currently programmed baud rate and a menu of the available baud rates.

The available baud rates are 38.4K, 19.2K, 9600, 4800, 2400, 1200, 600, and 30 bits per second. Select any of these rates by choosing the corresponding menu item. Once selected, the menu name shows the new rate. The baud rate currently in use does not change immediately, however. The new rate is only put into effect when the menu operating mode is terminated.

Changing the serial port baud rate is not permanent until all operating parameters are stored in non-volatile memory. See *Save Menu* in section 3.6.19 for more information.

3.6.9 LED Menu

The LED menu is accessed from the TEST menu. This menu offers seven options to conduct tests on all remote display unit LED's. Selecting any option activates the display test immediately. If desired, use the period, plus, or minus characters to re-display the LED menu. All menu options are still selectable even though the display test is in progress and the menu is not visible.

The LED's can be tested by horizontal row, vertical column, or all dots at once. The first three menu options, ALL, ROW, and COL, determine which type of test is performed. If one of these options is not selected, all dots are tested. During a row or column test, each row or column of dots in the display area is activated in sequence from top to bottom or left to right.

The next set of three menu options, RED, GRN, AMB, select only red, green, or amber colored dots to be used during the test. Initially, every other test uses red or green dots. If a color selection is made, the most recently selected two colors are used; one for every other complete test sequence. To use the same color continuously, select the desired color twice consecutively.

The last menu option is SPEED. This option changes the speed at which the test sequence advances. Each time the option is selected, the speed changes to one of 5, 2, 1, 0.5, 0.2, 0.1, or 0.05 seconds, or paused.

The escape character terminates the LED test and returns to the TEST menu.

3.6.10 Watchdog Test

The watchdog test verifies proper operation of the remote display unit's external watchdog circuit. The operator can also enable or disable the watchdog circuit before the test.

The watchdog circuit test is performed immediately upon selection of the WATCHDOG menu item from the TEST menu. If the circuit is enabled and working properly, the remote display unit is reset after less than one second, and the message WATCHDOG OK appears in green. If the circuit is disabled or not working properly, the message WATCHDOG FAIL appears in red after one second.

The escape character returns to the TEST menu. Any other character repeats the watchdog circuit test.

To enable the watchdog circuit, send the control-Y character (decimal 25). A watchdog circuit test is conducted immediately to verify that the watchdog circuit is enabled. To disable the watchdog circuit, send the control-X character (decimal 24). Again, a watchdog circuit test is conducted immediately but this time the test should fail.

Note

The watchdog circuit should only be disabled while the remote display unit is serviced. Even while servicing, it is unlikely that disabling the watchdog circuit becomes necessary. Do not disable the watchdog circuit in remote display units which are connected to a system or used in stand-alone operation.

3.6.11 Set-up Menu

The SETUP menu offers nine options to examine, modify, store, or, recall the remote display unit's operating parameters. Each option selects another menu as described in the next few sub-sections. A brief description of each option is provided here.

The ID option allows the operator to view or change display section identification numbers.

The WIDTH option adjusts the number, position, and width of display sections.

The TALLY option determines the way the external tally inputs affect each display section.

The START option assigns the stored message numbers which are to be automatically copied into display sections when the remote display unit is powered on.

The FONT and COLOR options set the default character set and color code, respectively, to be assumed by the unit where no attribute commands have specified otherwise.

The INTENSITY option sets the level of LED display intensity.

The SAVE option permanently stores all operating parameters previously set by other options in this menu. The parameters are stored in non-volatile memory after operator confirmation.

The RECALL option restores all operating parameters to their most recently stored settings, overriding any parameters that were previously set by other options in this menu. The parameters are recalled from non-volatile memory after operator confirmation.

If no other SETUP menu options are required, send the escape character to return to the main menu.

3.6.12 ID Menu

Each display section should be identified by a unique number so that the host system can direct commands and text to individual display areas. The ID menu allows the operator to set these identification numbers. The numbers to be set usually depend on the how the host system uses the remote display unit.

From the ID menu, choose the desired display section by selecting option D1, D2, or D3, respectively. The currently programmed identification number for the chosen section appears.

If desired, specify a different value from 0 to 255 as described in section 3.6.4. Otherwise, send the escape character to avoid any changes.

Another display section can be selected if further changes are desired. Otherwise, send the escape character to return to the SETUP menu.

3.6.13 Width Menu

The remote display unit's display area can be partitioned into one, two, or three sections. Each section then appears to the host system as an independent unit. The WIDTH menu allows the operator to arrange display sections as dictated by the remote display unit's location. If the unit is located below a bank of three unequally-sized video monitors, for example, the operator may position each display section to match the width and position of each monitor.

The WIDTH menu contains seven options. Selecting any option except DONE causes the display to show the current section arrangement for a few seconds. Each section is indicated by a repeated sequence of its section number: 1, 2, or 3. At any given moment, one of the three sections is selected for positioning and sizing. The selected section is indicated in red while the other sections appear green. Use the SELECT option to make each display section the selected section in turn.

The LEFT and RIGHT options move the selected section left and right. The EXPAND and CONTRACT options change the width of the selected section. Note that display sections cannot overlap, therefore changing the position and width of a section may have an effect on adjacent sections. Also note that a section can have no width and is therefore not visible in the display area. Regardless of its visibility, any of the three sections can always be selected at any time for positioning and sizing. When restoring a zero-width section, select the section then expand and move it until it becomes visible.

As a section is positioned and sized, empty space areas may appear. These areas can be kept to provide spacing between sections, or re-claimed by adjusting other sections. During normal remote display unit operation, spacing areas always remain blank.

Select the DEFAULT option to discard the current section arrangement in favour of the three most commonly used layouts. Each time the DEFAULT option is selected, one of the following common layouts is chosen; single full-width section, two half-width sections, or three third-width sections. The common layouts do not include any spacing areas between sections. After selecting a common layout, it can be adjusted as previously described.

The WIDTH menu returns to the display if no adjustments or selections are made for a few seconds. Send a menu cursor movement character such as plus or minus to re-display the menu immediately. Use the SELECT option to return the current section arrangement to the display.

Once the desired section arrangement is found, select the DONE option to keep the new section layout and return to the SETUP menu. Otherwise, send the escape character to restore the original section layout and return to the SETUP menu.

The remote display unit is factory-set to operate as one full-width section.

3.6.14 Tally Menu

Each display section is associated with a "tally state". The tally state affects color selection and line durations within a display section. The TALLY menu allows the operator to set the tally mode which determines how the external tally inputs affect the tally state of a display section. The tally modes to be set usually depend on how the host system uses the remote display unit.

From the TALLY menu, choose the desired display section by selecting option D1, D2, or D3, respectively. Another menu appears. The menu's name contains the chosen section number and the currently programmed tally mode for that section. The menu's items list of all the possible tally modes. The external tally input levels required for each tally state are described in the following table.

Menu Item	*External Tally Input Level*							
	State 0		*State 1*		*State 2*		*State 3*	
	Tally 1	*Tally 2*	*Tally 1*	*Tally 2*	*Tally 1*	*Tally 2*	*Tally 1*	*Tally 2*
T1	high	none	low	none	none	none	none	none
T2	none	high	none	low	none	none	none	none
T1T2	high	high	low	high	high	low	low	low
T2T1	high	high	high	low	low	high	low	low
T1-	low	none	high	none	none	none	none	none
T2-	none	low	none	high	none	none	none	none
T1T2-	low	low	high	low	low	high	high	high
T2T1-	low	low	low	high	high	low	high	high

If desired, select a different tally mode. The menu name changes to reflect the new selection. Send the escape character return to the TALLY menu.

Another display section can be selected if further changes are desired. Otherwise, send the escape character to return to the SETUP menu.

At the factory, the display sections 1, 2, and 3, are programmed for tally modes T1, T2, and T1T2, respectively.

3.6.15 Start Menu

Each line of each display section can be programmed to begin operating with any one of the remote display unit's stored messages in its display area. The START menu lets the operator select these messages (or no message). Of course, if a host system is connected it can change the contents of the display section's lines at a later time. The starting message feature is most commonly used in remote display units designated for stand-alone operation (without a host system connection).

From the START menu, choose the desired display section by selecting option D1, D2, or D3, respectively. Another menu appears. Choose the desired line number by selecting option LINE1, LINE2, or LINE3. The currently programmed message number from 1 to 10 for the chosen section and line appears. If no message is programmed, the message number is zero.

If desired, specify a different value from 0 to 10 as described in section 3.6.4. Otherwise, send the escape character to avoid any changes.

Another line can be selected if further changes to the chosen display section are desired. Otherwise, send the escape character to return to the START menu.

Another display section can be selected if further changes are desired. Otherwise, send the escape character to return to the SETUP menu.

All display section lines are programmed for no message at the factory, causing each section to be blank after the unit is powered on.

3.6.16 Font Menu

The remote display unit has a default character set selector. The selector determines which of four resident character sets are to be used if the host system does not choose a character set directly. The FONT menu provides the means to set the default character set selector.

From the FONT menu, choose the desired character set or select the SHOW option to briefly display a description of the currently selected character set. The FIXED option selects the 7-dot high, 5-dot wide, fixed spacing character set. The PROP1 option selects the 7-dot high, mostly 5-dot wide proportionally spaced character set. The PROP2 option selects the 7-dot high, mostly 4-dot wide proportionally spaced character set. The SMALL option selects the 5-dot high, mostly 3-dot wide proportionally spaced character set. Selecting any character set causes a description to appear briefly.

Only the last character set selection remains in effect. Send the escape character to return to the SETUP menu.

The fixed spacing character set is the factory-set default.

3.6.17 Color Menu

The remote display unit has a default color code. The color code is made up of four color selectors which correspond to the four tally states. This can be used to change the color of displayed information because external tally inputs control the tally state. The default color code determines the color code to be used if the host system does not choose a color code directly. The COLOR menu allows the operator to set the four colors in the default color code.

From the COLOR menu, choose the desired four colors or select the SHOW option to briefly display the four colors of the current default color code. The colors are shown from left to right in ascending order of tally state. The RED, GREEN, AMBER, and BLANK options select the color for tally state 0 while the other colors move to the next tally state. Selecting any color causes a last four selections to appear briefly. The blank color can be used to blank text from the display as directed by the tally state.

Only the last four selections remain in effect. Select the same color four times consecutively to make the default color code immune to tally state changes. Once the desired color code is selected, send the escape character to return to the SETUP menu.

The GREEN/RED/GREEN/RED color code is the factory-set default.

3.6.18 Intensity Menu

The INTENSITY menu allows the operator to adjust the intensity level of the remote display unit's LED displays. The host system can also set display intensity. There are 37 levels of intensity.

The INTENSITY menu offers six options. Select the INCREASE or DECREASE option to adjust the intensity level by one step. Select the MAXIMUM or MINIMUM option to immediately jump to an intensity level limit. As adjustments are made, the display is filled with a test message to help in choosing the desired level. Select the COLOR option to change the color of the test message from red to green to amber. Send a menu cursor movement character such as plus or minus to re-display the menu.

Once the desired intensity level is reached, select the DONE option to keep the new level and return to the SETUP menu. Otherwise, send the escape character to restore the original intensity level and return to the SETUP menu.

The remote display unit is set to maximum intensity at the factory.

3.6.19 Save Menu

All of the other previously described options in the SETUP menu affect the remote display unit's operating parameters. Unless saved, changes to operating parameters are lost if the remote display unit is powered off. The SAVE menu allows the operator to permanently save all operating parameters at once.

The SAVE menu has only two options. Select the YES option to save operating parameters. The message SAVE DONE appears for a few seconds, then the SETUP menu re-appears.

To avoid the save operation at this time, select the NO option or send the escape character. The SETUP menu returns. Avoiding the save operation does not discard any previous changes to operating parameters. These remain in effect until the unit is powered off. If desired, the operator can select the SAVE menu again at a later time.

Note

The serial port baud rate, although not programmable through the SETUP menu, is considered an operating parameter and is therefore permanently stored by a save operation.

3.6.20 Recall Menu

The operator may wish to make temporary changes to some of the remote display unit's operating parameters. Once the temporary changes are no longer required, the most-recently saved operating parameters can be restored. The RECALL menu allows the operator to retrieve all operating parameters at once.

The RECALL menu has only two options. Select the YES option to recall operating parameters. The message RECALL DONE appears for a few seconds, then the SETUP menu re-appears.

To avoid the recall operation at this time and continue to use the temporary changes, select the NO option or send the escape character. The SETUP menu returns.

Note

The serial port baud rate, although not programmable through the SETUP menu, is considered an operating parameter and is therefore affected by a recall operation.

3.6.21 Message Menu

The MESSAGE menu has six options to select, edit, and load the remote display unit's ten stored messages. At any time, one of these messages is the currently selected message. The currently selected message appears in the menu's name. Initially, message number one is selected.

The NEXT option selects the next higher-numbered message, or message one if message ten is currently selected.

The PREVIOUS option selects the next lower-numbered message, or message ten if message one is currently selected.

The EDIT option activates the message editor to view or modify the currently selected message. See the next section for information on using the message editor.

The D1, D2, and D3 options allow the operator to immediately load the currently selected message into any line of any display section. To load a message into a display section, use the following procedure:

- choose the message to be loaded using the NEXT and PREVIOUS options until the desired message number appears in the menu name;

- if desired, optionally view the message contents by selecting the EDIT option, then sending the escape character;

- choose the desired display section by selecting option D1, D2, or D3, respectively, making another menu appear;

. choose the desired line number by selecting option LINE1, LINE2, or LINE3, loading the message into the selected line;

- send the escape character twice to return to the MESSAGE menu.

If no other MESSAGE menu options are required, send the escape character to return to the main menu.

3.6.22 Editing a Message

Although the host system is capable of creating and storing the ten remote display unit messages, an editor is also available so that an operator can perform the same task.

The message editor is invoked by selecting the message to be viewed or edited, then selecting the EDIT option from the MESSAGE menu. Once started, the original message (if any) is displayed using the full display area, and a special set of single character commands is available.

Text Cursor

Editing is directed by the position of a flashing cursor which appears as a block over the cursored character. Most commands either move the cursor's position or affect the text or attribute at the cursor's position.

Commands

The command characters involved in message editing are described in the following table. Decimal character values are indicated in parenthesis.

Character	*Function*
control-A (1)	insert amber color attribute
control-D (4)	decrease message duration by 0.05 seconds
control-F (6)	insert fixed spacing character set attribute
control-G (7)	insert green color attribute
control-H (8)	move cursor left one position
control-I (9)	increase message duration by 0.05 seconds

Character	*Function*
control-J (10)	insert text justification attribute as determined by next entry
control-L (12)	move cursor right one position
control-P (16)	insert large proportionally spaced character set attribute
control-Q (17)	insert medium proportionally spaced character set attribute
control-R (18)	insert red color attribute
control-S (19)	insert small proportionally spaced character set attribute
control-T (20)	insert green/red/green/red color attribute
control-V (22)	insert special variable or downloadable character determined by next entry
control-X (24)	delete character or attribute at cursor and move all beyond cursor left one position
control-Y (25)	move cursor to left-most position
control-[(escape, 27)	terminate message editing

All other characters are assumed to be text. Both text characters and attributes are inserted at the cursor's position and all characters and commands at and beyond this position are moved right by one position.

Attributes

Attributes affect subsequent text in a message until overridden by another attribute of the same type. Attributes occupy message space but not display space. Consequently, the cursor is not visible when positioned at an attribute (it has no width). Move the cursor to a nearby text character to ascertain the location of various attributes. Usually, the effect of the attribute, such as a color change, indicates its position.

Variable or Downloadable Characters

To insert a special variable or downloadable character, the control-V command must be followed by the actual character. This is necessary to avoid the special character from being interpreted as a control command from the table. For example, to insert the first of seven downloadable characters (decimal 25), send control-V then control-Y.

If the desired special character cannot be entered due to some host system limitation (using a simple terminal, for example), the same special character can also be specified by any other character having a value of 32, 64, or 96 more than the special character's decimal value. For example, a character with the decimal value 3 can be inserted into a message by sending control-V followed by any one of control-C, "#", "C", or "c".

Text Justification

To insert a text justification attribute, the control-J command must be followed by one of the letters, L, C, R, or F, corresponding to left, centre, right, and full justification modes. Any other character abandons the entry and control-J must be sent again. For example, to insert the centre justification attribute, send control-J then the letter C.

The full justification mode causes text to occupy the maximum area available by spacing the text evenly, eliminating the need to position text by inserting space characters (decimal 32). The advantage of using

any of the justification modes is that messages automatically adapt to the width of the display section in which they appear. This may be different than the width of other sections or the width of the message editor.

Note

It is possible to provide conflicting justification attributes. Generally, a message can contain one left, one right, and either one centre or one full justification attribute. Also, a left justification attribute must precede a centre or full justification attribute, which in turn must also precede a right justification attribute. Any other combination of justification attributes may yield unpredictable results.

Message Duration

Messages can be loaded into any of the three lines of a display section. If multiple lines are to be used, the message should be programmed to appear for a specific duration. Use the control-I and control-D commands while editing a message to increment or decrement the duration of a message. The duration can be set from 0 to 12.75 seconds in 0.05 second steps. Zero sets the duration as infinite. The first time control-I or control-D is sent, the message disappears and the current duration appears for a few seconds. This first command does not change the message duration. To actually change the duration send another command within a few seconds, before the message is restored to the display.

If only a single line of a display section is to be used, the message duration is not significant.

Portability Considerations

In general, while editing a message the message appears as it would if loaded into a display section. It is possible for the message to appear differently when placed in a section of less width (especially if text justification is used) or under various tally state conditions. A message can also appear different later on if the default color or character sets are changed after editing, and the message contains no attributes to override the default settings. To ensure message portability, the message should begin with attributes which override default settings and text justification should be exploited to prevent messages that are sensitive to width.

3.6.23 Saving a Message

Once message editing is complete, send the escape character from within the message editor. If no changes were made, the MESSAGE menu is re-displayed.

If changes were made, the SAVE menu appears offering three options; YES, NO, and RE-EDIT.

Select the YES option to permanently store the message contents. The message SAVE DONE appears for a few seconds, then the MESSAGE menu re-appears.

Select the NO option or send the escape character to abandon the changes and return to the MESSAGE menu. The original message is not affected. Note that unlike the operating parameter save function, there is no further opportunity to save an edited message; it must be saved now or the changes are discarded.

Finally, if further editing is desired, or the escape character was sent by mistake, select the RE-EDIT option to resume editing the same message. This includes any changes that have taken place since the EDIT option was selected from the MESSAGE menu. To re-edit the original message, or edit another message, abandon the changes by selecting the NO option, choose another message if desired, then select the EDIT option again.

4 EXTERNAL CONTROL PROTOCOL

External control of the remote display unit is governed by the remote display unit protocol. Using the protocol, the remote display unit can be operated according to the user's requirements. This is accomplished by sending a series of commands and data from a host system to the remote display unit's control port. The commands and data must conform to the protocol as described in this section.

It should be noted that the use of the remote display unit protocol assumes a thorough knowledge of the capabilities of the remote display unit as described elsewhere in this document.

4.1 ELECTRICAL CHARACTERISTICS

The port uses the RS-422 or RS-232 standard for received data. The remote display unit does not transmit to the port.

4.2 SERIAL FORMAT

Each character transmitted to the port must use standard asynchronous data communication in the following format:

Start bits	1
Data bits	7
Parity	even
Stop bits	1
Baud rate	programmable to 300, 600, 1200, 2400, 4800, 9600, 19200, or 38400 baud

All characters use ASCII encoding.

4.3 RESPONSES

There are no responses. The remote display unit cannot send data to its serial port.

4.4 COMMANDS

4.4.1 Command Format

Commands are received by the remote display unit. Commands direct the operation of the remote display unit and the interpretation of all subsequently received characters. All commands have the format shown below.

% decimal integer command descriptor

Commands are introduced by the percent character % (decimal 37). The percent character is followed by an optional dash or plus character and any number of ASCII decimal digits representing one decimal integer. The dash character denotes a negative decimal integer. The plus character, or omission of the dash character, denotes a positive decimal integer. The last character of the command is the descriptor which identifies a specific command. If the decimal integer is omitted, a command-dependent default is used.

Some commands must be immediately followed by other characters that further specify the intent of the command. All other characters received outside the scope of a command are assumed to be ASCII display information. The destination of this information depends on previously received commands or default conditions. The ASCII characters decimal 1 through 127 are accepted.

The special characters decimal 1 through 31 access variable information such as a time of day clock or host-downloadable characters. For maximum flexibility, the 31 special characters are actually split between access to variable digits and host-downloadable characters. The number of characters downloaded by the host system determines the split threshold. Special characters below the threshold access variable digits while the remaining characters (if any) access host-downloadable characters. If no characters are downloaded, all special characters access variable digits. If 31 characters are downloaded, there is no access to variable digits. Thus, the host system can split special character access as desired.

The null character (decimal 0) is ignored by the remote display unit.

4.4.2 Storage Capacity

The remote display unit has 255 locations in which to hold characters and attributes. Each character requires one location. Attributes such as those produced by color, character set, and justification commands, each require two locations. To make the most efficient use of this space, it is shared among all display sections and lines.

Important

Although a remote display unit can be programmed to operate with only one or two display sections, the unused display sections can still accept characters and commands. Space is allocated for this information as usual, reducing the space available for visible display section information. It is therefore recommended that unused display sections be programmed with a specially-designated identification number such as zero so that they are not inadvertently selected. The designated identification number should not be assigned

to visible display sections. In this way, characters and commands are only accepted by visible display sections and storage capacity is maximized.

Overflow

In the event that characters and commands are supplied to the remote display unit which exceed the 255 location limit, the excess data is ignored. This is likely to produce undesirable display contents and should be avoided.

4.4.3 Command Descriptors

Each descriptor character identifies a specific command. The following table shows each command with its descriptor, the meaning and valid range of the numeric parameter (if any), and the command's default.

Descriptor	*Command*	*Parameter*	*Range*	*Default*
D	select display	display number	0 to 255	all
S	select lines	line number bit-map	0 to 7	1
F	set normal flash period	period, 50 mS units	0 to 255	0
T	set tally flash period	period, 50 mS units	0 to 255	0
C	set color	color code	0 to 255	user-programmable
A	alternate character set	font number	0 to 3	user-programmable
J	text justification	justify mode	0 to 3	0
Z	end of display info	none		
Y	synchronize flashing	none		
I	set display intensity	intensity level	0 to 36	0
L	downloadable character data	data length	0 to 202	none
V	set variable	variable number	1 to 4	1
Q	set character mapping	data length	0 to 62	none
O	control external tally	command number	1 to 10	none
U	select unique display	name length	1 to 20	none
N	set data for function	function data	0 to 255	none
W	execute function	function number	0 to 255	none
X	auxiliary function	function number	0 to 4	0
%	percent character	none		

Alphabetic descriptor characters are not case sensitive. Using upper case or lower case has the same effect. If an invalid command descriptor is received, the command is ignored. The following sub-sections provide more detailed information on each command. In the command formats, a single decimal integer is represented by *n* and variable characters are represented by lower case letters in italics.

4.4.4 Display Select Command

Format

`%nD`

This command selects the displays sections having the identification number *n*. If *n* is positive, all subsequent commands and display characters are directed to the selected display sections until another display select command is received. If *n* is negative, any previously selected display sections remain selected and the selection is "extended" to include display sections which have an identification number matching the absolute value of the parameter *n*. This allows subsequent commands to apply to a group of displays.

If the parameter *n* is omitted, all sections of all display units are selected.

This command can be used in place of, or in addition to, the unique display select command.

Example 1

```
%12D%1SINFO%Z
```

All displays with identification number 12 display "INFO".

Example 2

```
%12D%-100D%-107D%1SINFO%Z
```

All displays with identification numbers 12, 100, and 107 display "INFO".

4.4.5 Line Select Command

Format

`%nS`

This command selects the lines specified by the command's parameter. All subsequent text and line-sensitive commands affect each selected line until another line select command is received. The meaning and allowed values for this command's parameter are shown in the following table.

Parameter	*Lines Selected*
0	none
1	1
2	2
3	1 and 2
4	3
5	1 and 3
6	2 and 3

Parameter	*Lines Selected*
7	1, 2, and 3 (all)

The line select command parameter is actually a bit-map, one bit for each line. A line is selected when its corresponding bit in the bit-map is set to one.

If the parameter is omitted, only line number 1 is selected. If the parameter is not allowed, all lines are deselected.

This command affects selected display sections only.

Example

```
%8D%S%10FINFO ONE%2S%10FINFO TWO%Z
```

Display 8 shows "INFO ONE" and "INFO TWO" continuously flashing for a ½ second each.

4.4.6 Color Command

Format

`%nC`

This command sets the current color attribute for subsequently received text characters. The command's parameter is a color code representing four display colors using an eight-bit value (0 to 255). One of the four colors is displayed when the external tally input, or inputs, are activated in up to four combinations, or tally states. The combinations depend on the tally mode programmed for the display section. A display section programmed to use only one external tally input can access tally states 0 and 1. Programming a display section to use two external tally inputs provides access to tally states 0, 1, 2, and 3.

The color code is actually a bit-map. The current tally state for a display section determines the portion of the color code selected for characters in its display. The tally state selects a pair of color code bits. The meaning of each bit in the color code is described in the following table.

Color Code Bit	*Description*
0	red while tally state is 0
1	green while tally state is 0
2	red while tally state is 1
3	green while tally state is 1
4	red while tally state is 2
5	green while tally state is 2
6	red while tally state is 3
7	green while tally state is 3

Set both red and green bits of a pair to one to produce the color amber. Set both bits of a pair to zero to produce a "blank" color. Characters with a blank color attribute do not appear on the display.

To display characters in a color which is not affected by the external tally inputs, use a color code which specifies the same color for all external tally input conditions. For red, green, and amber, the color codes which are not affected by external tally inputs are decimal 85, 170, and 255, respectively.

If the color command parameter is invalid or omitted, a pre-programmed default color code is used. The default color code could be different in each remote display unit.

This command affects selected display sections only.

Example

```
%22D%1S%246CGREEN/RED/AMBER%Z
```

Display 22 shows "GREEN/RED/AMBER" in red when the tally state is 0, green when the tally state is 1, and amber otherwise.

4.4.7 Alternate Character Set Command

Format

%*n*A

This command sets the current character set (font) attribute for subsequently received text characters. The command's parameter is a font number selecting one of four resident character sets numbered 0 to 3 as shown in the following table.

Font Number	*Description*
0	characters are fixed spaced, 5 dots wide and 7 dots high
1	characters are proportionally spaced, mostly 5 dots wide and 7 dots high
2	characters are proportionally spaced, mostly 4 dots wide and 7 dots high
3	characters are proportionally spaced, mostly 3 dots wide and 5 dots high

If the command parameter is invalid or omitted, a pre-programmed default character set is used. The default character set could be different in each remote display unit.

This command affects selected display sections only. Display of downloadable characters is not affected by alternate character set selection.

This command affects selected display sections only.

Example

```
%8D%1S%2ATHIN%0A FIXED%Z
```

Display 8 shows "THIN" in the mostly 4 dot font and "FIXED" in the 5 dot font.

4.4.8 Text Justification Command

Format

```
%nJ
```

This command sets the current justification mode attribute for subsequently received text characters. The command's parameter is the justification mode. Justification modes are numbered 0 to 3 as shown in the following table.

Justification Mode	*Description*
0	left, characters are positioned from the left
1	centre, characters are centred
2	right, characters are positioned from the right
3	full, characters are evenly spaced to fill the display area

If the command parameter is invalid or omitted, left justification is assumed.

This command affects selected display sections only.

Note

It is possible to provide conflicting justification commands. Generally, a single line can contain one left, one right, and either one centre or one full justification command. Also, a left justification command must precede a centre or full justification command, which in turn must also precede a right justification command. Any other combination of justification commands may yield unpredictable results.

Example

```
%8D%1SLEFT%1JCENTRE%2JRIGHT%Z
```

Display 8 shows "LEFT", "CENTRE", and "RIGHT" with equal space between text areas. Note that "CENTRE" is not centred in the full display area. It is centred in the display area remaining between "LEFT" and "RIGHT".

4.4.9 Normal Flash Period Command

Format

`%nF`

This command sets the amount of time that the selected lines are displayed regardless of external tally input activity. The command's parameter is specified in units of twentieths of a second (50 milliseconds). If the parameter is omitted, zero is assumed. If the parameter is larger than 255, 255 is assumed. The maximum flash period for each line is 12.75 seconds.

This command affects selected display sections only.

Example

```
%0D%1S%20FMAIN%2S%4FAUX 1%4S%8FAUX 2%Z
```

Display 0 flashes "MAIN" for 1 second, "AUX 1" for 1/5 of a second, and "AUX 2" for 2/5 of a second, then repeats.

4.4.10 Tally Flash Period Command

Format

`%nT`

This command is similar to the normal flash period command except that it only affects the amount of time that the selected lines are displayed when a display section's tally state is not zero. As with the normal flash period command, the tally flash period command's parameter is specified in units of twentieths of a second (50 milliseconds). If the parameter is omitted, zero is assumed. If the parameter is larger than 255, 255 is assumed. The maximum flash period for each line is 12.75 seconds.

This command shares control of the "tally state not zero" flash period with the normal flash period command. The normal flash period command sets the flash period which is used regardless of tally activity. The tally flash period command sets the flash period which is used only when the tally state is not zero. The most recently received of these commands determines the actual flash period.

This command affects selected display sections only.

Example

```
%12D%1S%20FACTIVE%2S%0F%10T %Z
```

Display 12 shows "ACTIVE" when the tally state is zero and flashes "ACTIVE" (1 second on, ½ of a second off) when the tally state is not zero.

4.4.11 End of Display Information Command

Format

```
%Z
```

This command submits the previously received characters to the selected display sections and lines, and blanks any remaining portion of the display section. No command parameter is required. If a command parameter is supplied, the parameter is discarded and the command is performed.

This command is also implied by any display and line select commands. Selecting any display or line is identical to first sending this command followed by a display or line select command. In fact, the end of display information command need only be sent after the host has completed all messages to all the remote display units which are connected together.

Example

```
%11D%1SBEGIN%12D%1SEND%Z
```

Show "BEGIN" in line 1 of display 11 and "END" in line 1 of display 12.

4.4.12 Synchronize Flashing Command

Format

```
%Y
```

This command synchronizes the flashing of the selected displays so that different displays appear to flash together. When this command is received, the remote display unit immediately displays the first active line (usually line number 1) of the selected displays.

In order for different displays to flash synchronously, each display must be programmed to flash using the same number of lines and the same flash periods for each line. Otherwise, the display flashing becomes unsynchronized once the next line is displayed. This command should be issued periodically to prevent noticeable accumulation of minor timing differences which may exist between remote display units. If flashing displays are not required, this command is not significant.

No command parameter is required for the synchronize flashing command. If a command parameter is supplied, the parameter is discarded and the command is performed.

Although this command affects selected display sections only, it is normally broadcast to all display units by first sending a non-specific display select command.

Example

```
%D%Y
```

Synchronize flashing in all displays.

4.4.13 Set Display Intensity Command

Format

%*n*I

This command sets the intensity of a remote display unit's LED displays. The command parameter is the intensity level from 0 to 36. The command parameter can also be 255 to increase the intensity level, or -255 to decrease the intensity level. Set the intensity level to 0 for maximum intensity. Set the level to 36 for minimum intensity. The increase or decrease commands have no effect when the intensity level reaches the maximum or minimum, respectively. If the command parameter is omitted, maximum intensity is assumed.

This command is not specific to selected display sections but at least one display section must be selected before the command is accepted. All display sections always have the same intensity level regardless of which display section accepted the command.

4.4.14 Set Downloadable Characters Command

Format

%*n*L$x_1x_2...x_n$

This command initiates a data transfer that defines the contents of up to 31 special "downloadable" characters. Downloadable characters allow the host to show customized text or graphic symbols on the remote display unit.

The data to be transferred must follow the command descriptor. The number of data characters must match the command's parameter *n*, the data length. Each pair of data characters represents one 8-bit value using hexadecimal notation (most significant digit first, not case-sensitive). This means that the data length must be an even number. When decoded by the remote display unit, the sequence of 8-bit values (bytes) is translated into *m* downloadable characters dot maps according to the following list:

width of first character, n_1
n_1 bytes of column dot maps defining first character
width of second character, n_2
n_2 bytes of column dot maps defining second character
width of third character, n_3
n_3 bytes of column dot maps defining third character
width of fourth character, n_4
n_4 bytes of column dot maps defining fourth character
.
.
width of last character, n_m
n_m bytes of column dot maps defining last character
check value

Each group of column dot maps describes the pattern of dots for one downloadable character from left to right, with the least significant bit (bit 0) of each column dot byte corresponding to the top dot in a column and bit 6 corresponding to the bottom dot in a column. A bit's value is set to one to turn on a dot and set to zero to turn off a dot. The most significant bit (bit 7) must be zero.

The check value provides a measure of data integrity. The check value is the two's complement of the 8-bit sum of the *m* width bytes and all dot map bytes. Using a two's complement means that the 8-bit sum of all bytes transferred, including the check value, is zero.

When it is not convenient to calculate the correct check value, a special check value of hexadecimal "FF" can be used. This value effectively bypasses the data integrity check. Use the check value "FF" during system development only, where a data transfer is verified visually. Normally, the correct check value should be provided.

All of the downloadable characters can be different widths (including zero) as long as the total width of all characters combined does not exceed the maximum decoded data length of 81, including the width bytes and check value, Thus, the maximum number of hexadecimal characters is 162 (even numbers only).

If the host system downloads dot maps which contain more than 31 characters, or the received check value does not match the calculated value, the data is considered invalid and the remote display unit prevents access to downloadable characters (special characters access variable digit access only).

Note

Each of the characters from the remote display unit's resident character sets contain a blank single column at the right side of the character for spacing purposes. If the host intends to place downloadable characters to the left of any non-downloadable characters, it is suggested that a blank column on the character's right side should be included in the column dot maps of affected downloadable characters. This avoids the display of characters which appear to "touch". Of course, the blank column is optional. In some cases it may be the host system's intention that some characters be placed immediately next to others.

To prevent use of downloadable characters in the displays, the host should remove all downloadable characters. To do this, the decoded list consists of the check value (which should be zero) only.

This command is not specific to selected display sections but at least one display section must be selected before the command is accepted. Any display sections containing downloadable characters are updated once this command and subsequent data transfer is completed.

Downloadable character dot maps are <u>not</u> stored in non-volatile memory. All downloadable characters are not accessible when the remote display unit in powered on. It is suggested that the host periodically re-send downloadable character dot maps to ensure that all remote display units hold the correct information. If identical information is re-sent, there is no effect on the display area.

Example 1

```
%2L00
```

Specifies that there are no downloadable characters, preventing their use.

Example 2

```
%72L08081C3E1C08080808000808080808083E1C08000604067F0604000610307F30100032
```

Specifies four downloadable characters; left arrow, right arrow, up arrow, and down arrow. Use ASCII values 28, 29, 30, and 31 to put these characters in displays.

WARNING

DO NOT USE THE *SET DOWNLOADABLE CHARACTERS* COMMAND TO CREATE CHARACTERS WHICH CONSIST OF MANY DOTS THEN REPEATEDLY PLACE THESE CHARACTERS ON THE DISPLAY. FAILURE TO AVOID THIS SITUATION MAY OVERLOAD OR DESTROY THE REMOTE DISPLAY UNIT POWER SUPPLY. For continuous operation, the remote display unit should have no more than about half of it's LED dots simultaneously activated.

4.4.15 Set Variable Command

Format

```
%nVd8d7d6d5d4d3d2d1f2f1mt1t2
```

This command sets the value and operating mode of one of four programmable variables. A variable can be programmed to operate as a timer or counter. The command parameter *n* selects one of the variables, numbered from 1 to 4.

Exactly 13 characters must be supplied after the command descriptor. The parameters d_8 through d_1 become the variable's new 8-digit value. The parameters f_2 and f_1 set the prescaler value for a counter or the number of frames less one equalling one second for a timer. The parameter *m* sets the variable's operating mode according to the following table.

Parameter	*Description*
0	disabled (static variable)
1	8-digit incrementing
2	8-digit decrementing
3	100-hour incrementing
4	100-hour decrementing
5	8-digit incrementing with stop at 99999999
6	8-digit decrementing with stop at 00000000
7	100-hour incrementing with stop at 99:59:59 + frames per second - 1
8	100-hour decrementing with stop at 00:00:00.00
9	24-hour incrementing

The parameters t_1 and t_2 each set the operating mode for external tally input number 1 and 2, respectively, according to the following table. Lower case letters cannot be used for this parameter.

Parameter	*Description*

0	external tally input not used with this variable
1	clocking function, count up or down on change from high to low
2	clocking function, count up or down on change from low to high
3	gate function, external tally input must be low to enable counting
4	gate function, external tally input must be high to enable counting
5	reset function, set variable to minimum or maximum on change from high to low
6	reset function, set variable to minimum or maximum on change from low to high
7	hold function, keep variable at minimum or maximum while low
8	hold function, keep variable at minimum or maximum while high
9	output function, hold external tally low while variable is at terminal count
A	output function, hold external tally high while variable is at terminal count
B	output function, pulse external tally low for ¼ second when variable reaches terminal count
C	output function, pulse external tally high for ¼ second when variable reaches terminal count

A variable is programmed as an event counter by selecting either external tally input for the clocking function. Otherwise, the variable becomes a timer and changes occur at the programmed frame rate. The variable mode determines the counting direction and the intermediate counting limits between pairs of variable digits. A 100-hour incrementing variable changes from 355959 to 360000 regardless of whether it is clocked by an external tally input or once each second, while an 8-digit incrementing variable changes from 355959 to 355960.

The prescaler determines the number of counts in digits 1 and 2 required to advance digit 3. Therefore, to program a variable as an 8-digit counter, the prescaler value should be 100, which is selected by the prescaler digits f_2 and f_1 set to 99. Setting the prescaler digits to 00 (prescaler value of 1) results in a 6-digit counter (digits 8 through 3) because variable digit 3 would change on each count. Setting the prescaler digits to 02 (prescaler value of 3) makes a 6-digit counter which advances once for every three counts.

When used as a timer, the prescaler is the number of frames less one which are to equal one second. Thus variable digit 3 advances once each second while variable digits 2 and 1 count in frames. Setting the prescaler digits of a variable timer to 29 provides 30 frames per second operation.

Note

A variable programmed as a timer always counts internally at 20 frames per second regardless of the programmed frame rate. The digits which can appear in the display are normalized according to the programmed frame rate before being displayed. During normal continuous timing, the frame digits change too rapidly to notice the 20-frame normalization. If an external tally is used to hold a timer, however, counting stops and the frame digits may not be completely accurate. For example, with a variable programmed for 30 frames per second, the internal frame counter advances from 0 through 19. Normalizing 19 of 20 frames into 30 frames yields the integer 28. Consequently, the display will never read 29 frames. Programming a multiple or even divisor of 20 (such as 1, 2, 4, 5, 10, 20, 40, 60, 80, or 100) as the frame rate eliminates this inaccuracy. Display of frame digits is optional.

The same external tally input can be programmed for use with more than one variable. In addition, one variable can be programmed to use both external tally inputs. It is possible to program different variables

to make conflicting demands on an external tally input. This should be avoided as the results may not be predictable. When external tally inputs are programmed for output functions they must not be connected to a device which holds the signal low.

The set variable command is not specific to a display section. A remote display unit has only three variables which must be shared by each display section. At least one of the three display sections must be selected before the set variable command is accepted. Any display sections containing variable characters are updated once this command and subsequent parameters are received.

Although variable timers can operate without further host system intervention, variable modes and values are not stored in non-volatile memory. All variables are static and have a zero value when the remote display unit is powered on. It is suggested that the host periodically re-send timer variable commands, if possible, to ensure that all remote display units hold the correct information. This strategy also prevents noticeable accumulation of minor timing differences which may exist between remote display units.

Example 1

```
%1V2359450029900
```

Program variable 1 as a time of day clock with 30 frames per second, no external tally input controls, and set to 23:59:45.00.

Example 2

```
%3V0000000099114
```

Program variable 3 as an 8-digit event counter advanced by changes on external tally input 1, gated by external tally input 2, and set to 00000000.

4.4.16 Set Character Mapping Command

Format

$\%nQx_1x_2...x_n$

This command initiates a data transfer that defines the "mapping" of up to 31 variable digit characters. Variable digit characters access digits from the four variables to show timer and counter values on the remote display unit.

This command is necessary because the number of simultaneously accessible variable digit characters is limited to 31 while there are many more variable digits and their derivatives available for display.

The data to be transferred must follow the command descriptor. The number of data characters must match the command's parameter *n*, the data length. Each pair of data characters represents one 8-bit value using hexadecimal notation (most significant digit first, not case-sensitive). This means that the data length must be an even number. When decoded by the remote display unit, the sequence of 8-bit values (bytes) becomes a selector list to determine the actual variable digits which are accessed by each of the 31 special

characters. The following table lists all available variable digits and the selectors required to access the digit.

Character	*Default*	*Variable*	*Description*
1	1	1	digit 8 or tens of hours
2	2	1	digit 7 or units of hours
3	3	1	digit 6 or tens of minutes
4	4	1	digit 5 or units of minutes
5	5	1	digit 4 or tens of seconds
6	6	1	digit 3 or units of seconds
7	7	1	digit 2 or tens of frames
8	8	1	digit 1 or units of frames
9	9	1	zero-blanked tens of hours in 12-hour format
10	10	1	units of hours in 12-hour format
11	11	1	am/pm indicator, upper case A or P
12	12	1	am/pm indicator, lower case a or p
13	13	2	digit 8 or tens of hours
14	14	2	digit 7 or units of hours
15	15	2	digit 6 or tens of minutes
16	16	2	digit 5 or units of minutes
17	17	2	digit 4 or tens of seconds
18	18	2	digit 3 or units of seconds
19	19	2	digit 2 or tens of frames
20	20	2	digit 1 or units of frames
21		3	digit 8 or tens of hours
22		3	digit 7 or units of hours
23		3	digit 6 or tens of minutes
24		3	digit 5 or units of minutes
25	21	3	digit 4 or tens of seconds
26	22	3	digit 3 or units of seconds
27	23	3	digit 2 or tens of frames
28	24	3	digit 1 or units of frames
29		4	digit 8 or tens of hours
30		4	digit 7 or units of hours
31		4	digit 6 or tens of minutes
32		4	digit 5 or units of minutes
33	25	4	digit 4 or tens of seconds
34	26	4	digit 3 or units of seconds
35	27	4	digit 2 or tens of frames
36	28	4	digit 1 or units of frames
37		1	digit 8 or tens of hours, zero-blanked
38		1	digit 7 or units of hours, zero-blanked
39		1	digit 6 or tens of minutes, zero-blanked
40		1	digit 5 or units of minutes, zero-blanked
41		1	digit 4 or tens of seconds, zero-blanked
42		1	digit 3 or units of seconds, zero-blanked
43		1	digit 2 or tens of frames, zero-blanked

Character	*Default*	*Variable*	*Description*
44		2	digit 8 or tens of hours, zero-blanked
45		2	digit 7 or units of hours, zero-blanked
46		2	digit 6 or tens of minutes, zero-blanked
47		2	digit 5 or units of minutes, zero-blanked
48		2	digit 4 or tens of seconds, zero-blanked
49		2	digit 3 or units of seconds, zero-blanked
50		2	digit 2 or tens of frames, zero-blanked
51		3	digit 8 or tens of hours, zero-blanked
52		3	digit 7 or units of hours, zero-blanked
53		3	digit 6 or tens of minutes, zero-blanked
54		3	digit 5 or units of minutes, zero-blanked
55		3	digit 4 or tens of seconds, zero-blanked
56		3	digit 3 or units of seconds, zero-blanked
57		3	digit 2 or tens of frames, zero-blanked
58		4	digit 8 or tens of hours, zero-blanked
59		4	digit 7 or units of hours, zero-blanked
60		4	digit 6 or tens of minutes, zero-blanked
61		4	digit 5 or units of minutes, zero-blanked
62		4	digit 4 or tens of seconds, zero-blanked
63		4	digit 3 or units of seconds, zero-blanked
64		4	digit 2 or tens of frames, zero-blanked
65	29		hundreds digit of section identification number
66	30		tens digit of section identification number
67	31		units digit of section identification number
68			hundreds digit of section identification number, zero-blanked
69			tens digit of section identification number, zero-blanked

The maximum number of decoded bytes in the selector list is 31. Thus, the maximum number of hexadecimal characters transferred is 62 (even numbers only). If desired, fewer than 31 selector values can be transferred. In this case, the remaining selectors are unchanged. If the host system provides a selector value which does not appear in the table, the corresponding special character (if used in a display) appears as a blank.

The character selector map is not stored in non-volatile memory. The table indicates the default mapping in effect when the remote display unit in powered on. It is suggested that the host periodically re-send character mapping data to ensure that all remote display units hold the correct information. If identical information is re-sent, there is no effect on the display area.

The table also refers to section identification number digits. These digits represent the 3-digit identification number assigned to a section from 0 to 255. Unlike other variable digits, these digits can appear differently depending on the section in which they appear.

The set character mapping command is not specific to a display section. At least one of the three display sections must be selected before the command is accepted. Any display sections containing variable characters are updated once this command is received.

Example

```
%D%62Q0102030405060708090A0B0C0D0E0F1011121314191A1B1C21222324414243
```

Set all displays to use two 8-digit variables, two 4-digit variables, and the 3-digit section number, all with leading zeros. This is the default mapping.

4.4.17 Output Control Command

Format

```
%n0
```

This command allows the host system to set the level appearing on the remote display unit's external tally inputs. This effectively simulates input changes as if they were controlled by another external device or system. The remote display unit acts on input changes (if programmed to do so) regardless of the originating control device.

To permit external devices to control the inputs, the host system must set each input to a high level. This is only necessary if the host system had set an input level low in the past. At power on, the input levels are set high.

Valid command parameters and their functions are described in the following table. If the command parameter is omitted, the command is ignored.

Parameter	*Description*
1	set external tally input 1 low
2	set external tally input 1 high
3	pulse external tally input 1 low for ¼ second
4	pulse external tally input 1 high for ¼ second
5	toggle external tally input 1
6	set external tally input 2 low
7	set external tally input 2 high
8	pulse external tally input 2 low for ¼ second
9	pulse external tally input 2 high for ¼ second
10	toggle external tally input 2

Example

```
%7D%60%20
```

On display unit 7, set external tally input 2 to a low level and external tally input 1 to a high level.

4.4.18 Unique Display Select Command

Format

$\%n\mathrm{U}x_1x_2x_3\ldots x_n$

This command selects the remote display units and their sections that qualify according to a character string *x* supplied after the command descriptor. The length of this "qualification string" is given by the command's parameter *n*, which cannot have an absolute value exceeding 20.

The qualification string is structured to contain a display unit's name and section identification number. The string may contain the wild card characters "*" and "?". This allows a single command to select more than one remote display unit or section without selecting all units (group addressing).

Just like the regular display select command, once a group of display units or sections is selected, all subsequent commands and display characters are directed to those display sections. Another unique display select command or regular display select command must be received to select other remote display units or sections. Also like the regular display select command, the parameter *n* can be negative causing any previously selected display sections to remain selected while extending the selection to include display sections that qualify according to character string *x*.

If the qualification string is omitted (the command parameter *n* is zero), current display selections are not affected.

A remote display unit determines whether its own display sections are being selected (or de-selected) by comparing the command's qualification string against a synthesized string in the following format:

contents of message 10 . *section identification number*

The contents of message number 10 should hold the remote display unit's unique name. Of course, the host system can program any message into message number 10. To effectively use the unique display select command, however, each remote display unit in a system should be given a name of up to 16 characters that both uniquely identifies the unit and, if desired, permits easy addressing of display groups when wild card characters are used in the qualification string. The section identification numbers are the same numbers used by the regular display select command. In the synthesized string, however, the numbers are padded to three digits with the zero character.

The menu system can also be used to program message number 10. The message can contain color change or other attribute commands but these are skipped by the remote display unit when being compared to the qualification string.

A period character separates the unit name and section number. The unit name can contain period characters if desired. The last period in the string is taken to be the actual separator. Although not excluded, use of wild card characters in the unit name should be avoided.

The qualification string can contain the wild card characters "?" and "*". "?" matches any single character. "*" matches any string of characters and subsequent characters are ignored up to the period separator, if present. If "*" is used to match with all or part of the section number, the section number need not be three characters long.

Examples

Assume message 10 contains "ABC" and the display's three sections have identification numbers 10, 33, and 140.

```
%7UABC.010%1SSECTION 1%7UABC.033%1SSECTION 2%7UABC.140%1SSECTION 3%Z
```

Each section displays "SECTION 1", "SECTION 2", and "SECTION 3", respectively.

Here are some group addressing command examples.

`%7UABC.0??`	Select all sections of display unit with name "ABC" having section numbers less than 100.
`%7UAB*.001`	Select all display units having a name that begins with "AB" and having section number 1.
`%3UA?C`	Select all sections of display units with a three-character name that starts with "A" and ends with "C".
`%3UABC`	Select all sections of display units with the name "ABC".
`%5U*.12?`	Select all display unit sections having section numbers from 120 to 129. The unit's name is not significant.

`%1U.`
`%4U.???`
`%5U*.???`
`%3U*.*`
`%2U*.`
`%2U.*`
	All of these commands select all remote display units and sections.

The host system can use regular and unique display select commands interchangeably. It may also use just one command or the other. In general, if many display units are connected to one system, unit name selection may be preferable because section numbers are limited to the range 0 to 255. Use of unit names may also be preferred if group addressing by a single command is a system requirement. Otherwise, section numbers and the regular display select command should be used. In this case, message number 10 is free for general purpose use.

At the factory, a remote display unit's serial number is used as its unique name and stored in message number 10. The host system can use these names or some other naming convention.

4.4.19 Set Data Command and Execute Command

Format

%*n*N%-*n*N%*f*W%-*f*W

This sequence of commands allows the host system to perform a special function such as set a remote display unit operating parameter. The special function number *f* is executed using the data value *n*. Valid special function numbers and data values are listed in this section.

Access to most of these functions is duplicated by the remote display unit's menu system. Unlike an operator using the menu system, these commands do not require that the host system be aware of menus and related messages in the display area.

To provide a measure of data integrity, the host system must send four commands containing redundant information in a specific sequence before the remote display unit performs the requested function.

Each function requires one command data value parameter and one command function execute parameter. Each of these is repeated, once as a positive number and once as a negative number. The absolute value of each number pair must be equal, and the first of each pair must be the positive number.

No action is taken by the remote display unit until the fourth command is completely received. Any interruption by other commands or text, omission of a command parameter, or an incorrect sequence, causes the unit to discard the commands received to that point. The host system can send the first command at any time to restart the command sequence.

All of the valid special functions are listed below. Some commands change the contents of the remote display unit's non-volatile memory. Exercise caution when executing special functions as it is possible to permanently change remote display unit identification numbers and display section positions that could make the unit appear to operate improperly. Take special care when setting display section positions and widths. Each of these parameters must be changed in an order that does not cause sections to overlap. The proper order is usually different depending on whether a section is to increase or decrease its size or whether a section is to be re-positioned where another section currently resides.

Function	*Data*	*Default*	*Description*
111	0 to 255	0	set identification number of display section 1
112	0 to 255	0	set identification number of display section 2
113	0 to 255	0	set identification number of display section 3
121	0 to 180	0	set starting column position of display section 1
122	0 to 180	180	set starting column position of display section 2
123	0 to 180	180	set starting column position of display section 3
131	0 to 180	180	set width of display section 1 in dots
132	0 to 180	0	set width of display section 2 in dots
133	0 to 180	0	set width of display section 3 in dots

Function	*Data*	*Default*	*Description*
141	0 to 7	0	set external tally mode of display section 1
142	0 to 7	1	set external tally mode of display section 2
143	0 to 7	2	set external tally mode of display section 3
151	0 to 10	0	set start-up message number for display section 1, line 1
152	0 to 10	0	set start-up message number for display section 1, line 2
153	0 to 10	0	set start-up message number for display section 1, line 3
161	0 to 10	0	set start-up message number for display section 2, line 1
162	0 to 10	0	set start-up message number for display section 2, line 2
163	0 to 10	0	set start-up message number for display section 2, line 3
171	0 to 10	0	set start-up message number for display section 3, line 1
172	0 to 10	0	set start-up message number for display section 3, line 2
173	0 to 10	0	set start-up message number for display section 3, line 3
191	0 to 3	0	set default character set
192	0 to 255	102	set default color code
201	1 to 10		copy line 1 of first selected display section into message number (see note 1)
202	1 to 10		copy line 2 of first selected display section into message number (see note 1)
203	1 to 10		copy line 3 of first selected display section into message number (see note 1)
204	1 to 10		copy message number into line 1 of all selected display sections
205	1 to 10		copy message number into line 2 of all selected display sections
206	1 to 10		copy message number into line 3 of all selected display sections
211	1 to 10		copy display section 1, line 1, into message number (see note 1)
212	1 to 10		copy display section 1, line 2, into message number (see note 1)
213	1 to 10		copy display section 1, line 3, into message number (see note 1)
214	1 to 10		copy message number into display section 1, line 1
215	1 to 10		copy message number into display section 1, line 2
216	1 to 10		copy message number into display section 1, line 3
221	1 to 10		copy display section 2, line 1, into message number (see note 1)
222	1 to 10		copy display section 2, line 2, into message number (see note 1)
223	1 to 10		copy display section 2, line 3, into message number (see note 1)
224	1 to 10		copy message number into display section 2, line 1
225	1 to 10		copy message number into display section 2, line 2
226	1 to 10		copy message number into display section 2, line 3
231	1 to 10		copy display section 3, line 1, into message number (see note 1)
232	1 to 10		copy display section 3, line 2, into message number (see note 1)
233	1 to 10		copy display section 3, line 3, into message number (see note 1)

Function	*Data*	*Default*	*Description*
234	1 to 10		copy message number into display section 3, line 1
235	1 to 10		copy message number into display section 3, line 2
236	1 to 10		copy message number into display section 3, line 3
251	111		store operating parameters in non-volatile memory (see note 1)
251	112		recall operating parameters from non-volatile memory
251	113		replace operating parameters with default values listed in this table
255	1		restart remote display unit's CPU (soft reset)
255	2		restart remote display unit's CPU using external watchdog circuit (hard reset)
255	3		erase all the remote display unit's memory and restart it's CPU using external watchdog circuit (hard reset)
255	4		disable external watchdog circuit (see notes 1 and 2)
255	5		enable external watchdog circuit (see notes 1 and 2)

All function and data values not indicated in the table are reserved for future use. In subsequent versions of this product, new functions may be added that could produce undesirable effects if not used properly. For compatibility with future equipment, it is suggested that the host system send only those special function numbers and data values described in this section.

All special functions in the range 200 to 239 involve one of the remote display unit's stored messages. The data value supplied before the special function is the number of the message to be used.

All special functions in the range 100 to 199 temporarily set remote display unit operating parameters only. These parameters are not retained while the unit is powered off. To make permanent operating parameter changes special function 251 with data value 111 must be executed.

There are two other operating parameters that cannot be directly altered by a special function; display intensity level and serial port baud rate. These parameters are permanently stored with other operating parameters, however, and are therefore indirectly affected by special function 251 which can affect all operating parameter at once.

The display intensity level is set by another command. This command should be used to set the desired level before operating parameters are stored.

The serial port baud rate can only be changed from within the remote display unit's built-in menu system, followed by a termination of menu operation. The serial port baud rate should be set by system installation personnel only. Once the rate is changed, the equipment connected to the remote display unit (such as a terminal) must also change its rate for further use.

Note 1

The remote display unit is equipped with a non-volatile memory device which has a write cycle limit. Although the limit is very high, the host system should ensure that special functions which cause memory

device changes be performed infrequently and only when necessary. The special functions listed in the table referring to this note are the only functions that cause memory device changes.

Note 2

The remote display unit is equipped with an external watchdog circuit which resets the unit in the event of a malfunction. The circuit can be permanently enabled or disabled by special functions. The special function which disables the watchdog circuit is intended to be used only while the unit is tested or repaired. Do not disable the watchdog circuit in remote display units which are connected to a system or used in stand-alone operation.

Example

```
%1S%0FTHIS IS A MESSAGE%Z%8N%-8N%211W%-211W
```

Use line 1 to store "THIS IS A MESSAGE" in message number 8.

4.4.20 Auxiliary Command

Format

`%nX`

This command is used to start or terminate a test of the selected displays, control their visual selection mode, or to activate the multi-level menu system.

Display Test

If the command parameter is one, a display test begins. If the command parameter is zero, invalid, or omitted, a display test in progress is terminated and the previous display information is restored. During a display test, each selected display section alternates between all red and all green dots. Other commands and display characters are still accepted by the remote display unit, even while a display test is in progress. These commands have their normal effect but their effect is only seen once the display test is terminated.

Visual Selection Mode

If the auxiliary command parameter is four, the visual selection mode is activated. If the command parameter is three, the visual selection mode is de-activated. Activating the visual selection mode causes selected display sections to quickly alternate their normal contents with diagonal lines. It is intended that the host system use the visual selection mode to attract operator attention to one or more remote display units where there are a large number of units within the operator’s view.

The display section does not actually need to remain selected to sustain the visual selection mode. This allows the visual selection mode to be controlled in other units while a group of units continue to show a visual selection.

Menu System Activation

If the auxiliary command parameter is two, and the remote display unit is equipped with enough viewing space, the menu system is activated. Once activated, the menu system must be de-activated before any external control protocol commands can once again be accepted by the remote display unit. Refer to documentation describing remote display unit operations for information on the menu system. The menu system cannot be activated in remote display units that have too small a viewing area.

Example

```
%D%1X
```

Begin a display test on all display units.

4.4.21 Percent Character Command

Format

```
%%
```

The percent character (%) is specified as display information instead of introducing a command. No command parameter is required. If a command parameter is supplied, the parameter is discarded and a percent character is submitted.

Example

```
%3D%2S99%%
```

Display "99%" in line 2 of display 3.

5 JUMPERS

Jumper settings for the remote display unit's 12501 Processor Module are described in this section.

Jumper	*Description*
JP1	install this jumper to connect a 100 ohm termination resistor across the RS-422 signal inputs