

MTL647

IS Field Mounting Serial Text Display



Powering Business Worldwide

DECLARATION OF CONFORMITY

A printed version of the Declaration of Conformity has been provided separately within the original shipment of goods. However, you can find a copy of the latest version at <http://www.mtl-inst.com/certificates>

Contents

ii Declaration of conformity

1. Description

2. Operation

- 2.1 MTL646/7 protocol
- 2.2 MTL643/4 protocol

3. Intrinsic Safety Certification

- 3.1 Apparatus certificate (ATEX)
- 3.2 System certificates
- 3.3 Zones, groups and T rating
- 3.4 Power supply
- 3.5 External switches
- 3.6 Switch outputs
- 3.7 Certification label information

4. System Design for Hazardous Area

- 4.1 Cable length
- 4.2 Two wire system
- 4.3 Three wire system
- 4.4 Four wire system
- 4.5 Switch outputs

5. Installation

- 5.1 Location
- 5.2 Installation procedure
- 5.3 EMC

6. Configuration

- 6.1 Default configuration
- 6.2 Accessing the configuration menus
- 6.3 Summary of configurable functions
- 6.4 Quick access menu

7. Programming

- 7.1 Summary of MTL protocol
- 7.2 Command format
- 7.3 Response format
- 7.4 Operational modes
- 7.5 Multidrop operation
- 7.6 Summary of commands
 - 7.6.1 Screen handling & text
 - 7.6.2 Attributes
 - 7.6.3 System commands
 - 7.6.4 Line graphics
 - 7.6.5 Pixel graphics
- 7.7 Graphics download
 - 7.7.1 <DL> command
 - 7.7.2 <DG> command
- 7.8 Cyclic Redundancy Check
 - 7.8.1 Procedure for generating CRC.

8. Maintenance

- 8.1 Fault finding during commissioning
- 8.2 Fault finding after commissioning
- 8.3 Servicing
- 8.4 Routine maintenance
- 8.5 Guarantee
- 8.6 Customer comments

9. Accessories

- 9.1 Tag number
- 9.2 Pipe mounting kits
- 9.3 MTL647 / MTL646 Programming Guide.

10. Index

The MTL647 is CE marked to show compliance with the European Explosive Atmospheres Directive 94/9/EC, the European EMC Directive 89/336/EEC and the European Low Voltage Directive 73/23/EEC

This page is left intentionally blank

MTL647

IS FIELD MOUNTING SERIAL TEXT DISPLAY

1. DESCRIPTION

The MTL647 is an intrinsically safe instrument, which can display text and simple graphics in a hazardous area. Incorporating four operator switches, two solid state outputs and a backlit graphical display, it forms a simple operator interface for machine or process control applications.

The MTL647 text display has been certified intrinsically safe by European Notified Body Intertek Testing Services (ITS) to the ATEX Directive 2014/34/EU.

Safety approvals from authorities outside Europe are being obtained, please contact Eaton associates for the latest information.

Housed in a robust IP66 glass reinforced polyester (GRP) enclosure with an armoured glass window, the MTL647 is surface mounting, or may be pipe mounted using one of the accessory kits.

2. OPERATION

Fig 1 shows a simplified block diagram of a MTL647 serial text display. The instrument is connected to a serial data galvanic isolator in the safe area via two, three or four wires that carry both power and bi-directional communication. The switch outputs may be controlled and the operator switches interrogated from the safe area via the serial communication link.

The MTL647 serial text display has been designed to operate with a certified galvanic isolator that has an RS232 or RS422 safe area port. This enables the MTL647 to be controlled and interrogated by a process computer or a dedicated instrument such as a PLC.

Installation and commissioning are simple. A MTL647 serial text display may be operated on a simple two-wire system that provides both power and bi-directional communications. Two MTL647 displays with separate addresses may be multi-dropped from a two-wire system and up to four displays from a three-wire system. Up to 14 serial text displays may be addressed from one RS232 or 422 port.

Section 7 of this manual includes a summary of the MTL programming protocol and instruction set. Detailed information is contained in the Programming Guide which may be downloaded from the MTL website www.mtl-inst.com

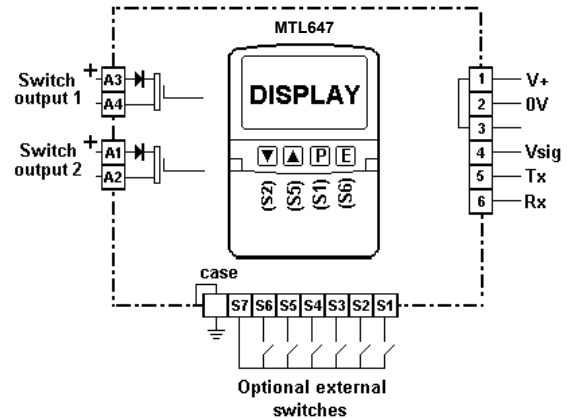


Fig 1 Simplified block diagram of MTL647

2.1 MTL protocol

MTL protocol enables text to be written anywhere on the screen in five different font sizes, together with lines, boxes and bargraphs. Simple bit map graphics may also be downloaded to the display and all characters can be reversed or flashed. Information may also be written to a hidden screen that may be displayed when required.

The protocol enables each of the four front panel push-buttons to be interrogated so they may be used for operator controls. If larger industrial size push-buttons are required, six may be connected to the MTL647 terminals. When external switches are used the instrument front panel push-buttons are disabled.

Two single pole solid state outputs may be used to switch certified hazardous area loads such as sounders, beacons and valves.

2.2 Legacy protocol

The legacy protocol contained in the MTL647 allows the instrument to replace an MTL643 IS text display. All the functions of an MTL643 are replicated, but with the advantage of a backlit display and certification to the ATEX Directive.

Legacy protocol only allows three external switches S1, S2 & S3, not the front panel push-buttons, to be used for operator inputs. Similarly, there is only one output control, so the two switch outputs operate in parallel.

When using the legacy protocol, the configuration menus are only operational between power being applied to the MTL647 and the first message being received.

3. INTRINSIC SAFETY CERTIFICATION

3.1 ATEX certificate

The MTL647 has been issued with EC-Type Examination Certificate ITS03ATEX21173 by Intertek Testing Services (ITS) confirming compliance with the European ATEX Directive 2014/34/EU for Group II, Category 1, gas atmospheres, EEx ia IIC T5. The instrument bears the Community Mark and, subject to local codes of practice, may be installed in any of the European Economic Area (EEA) member countries, which currently comprise: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom. Certificates to the ATEX Directive are also accepted in Switzerland and the Czech Republic. This instruction manual describes installations that conform with BS EN 60079-14:2003 Electrical Installation in Hazardous Areas. When designing systems for installation outside the UK, the local Code of Practice should be consulted.

3.2 System certificates

In addition to the EC-Examination Certificate, ITS have issued three system certificates of conformity.

Ex03E21194	2 wire system	SCI-976
Ex03E21195	3 wire system	SCI-977
Ex03E21196	4 wire system	SCI-978

3.3 Zones, groups and T rating

The MTL647 has been issued with EC Type Examination certificate ITS03ATEX21173 confirming that it complies with the requirements for Group II Category 1 G EEx ia IIC T5 (Tamb -40°C to $+60^{\circ}\text{C}$) specified in the ATEX Directive. When connected to a suitable system the MTL647 may be installed in:

Zone 0	explosive gas air mixture continuously present.
Zone 1	explosive gas air mixture likely to occur in normal operation.
Zone 2	explosive gas air mixture not likely to occur, and if it does will only exist for a short time.

for use with gases in groups:

Group A	propane
Group B	ethylene
Group C	hydrogen

and having a temperature classification of:

T1	450 $^{\circ}\text{C}$
T2	300 $^{\circ}\text{C}$
T3	200 $^{\circ}\text{C}$
T4	135 $^{\circ}\text{C}$
T5	100 $^{\circ}\text{C}$

at an ambient temperature between -40°C and $+60^{\circ}\text{C}$.

Note: the guaranteed operating temperature range of the text display is -20°C to $+60^{\circ}\text{C}$

This allows the MTL647 to be installed in all Zones and to be used with most common industrial gases.

3.4 Power supply

When installed in a hazardous area the MTL647 must be powered from an MTL5051 serial data galvanic isolator, or from an MTL 5051 plus an MTL5025 solenoid driver.

Although there are other certified barriers, or galvanic isolators, with IS parameters compatible with the MTL646, the MTL5051 must be used because it is the only one, currently, providing the required data conversion.

The maximum permitted cable parameters are shown on the system certificates.

3.5 External switches

For applications requiring operator inputs to be made by large industrial push-buttons, terminals S1 to S7 allow external switches to be connected to the text display. When the external push-buttons are enabled in the configuration menu, the front panel push-buttons are automatically disabled.

Terminals S1 to S7 have the following combined output safety parameters:

Uo	=	14.7V dc
Io	=	99mA dc
Po	=	0.6W

The switches and associated wiring connected to the terminals must comply with the requirements for simple apparatus. i.e. they must have IP20. Most industrial push-buttons satisfy these requirements

The total maximum permitted cable parameters for all the cables connected to terminals S1 to S7 in Group IIC must be less than:

$$\begin{aligned} C_o &= 0.22\mu\text{F} \\ L_o &= 0.26\text{mH} \end{aligned}$$

Although these are the lowest figures specified by any of the three system certificates, they are not restrictive and allow a significant distance between the switches and the instrument. See system certificates for maximum limits for each of the three configurations.

3.6 Switch outputs

Each of the two switch outputs is a separate galvanically isolated solid state switch. The EC-Type Examination Certificate specifies that under fault conditions the voltage, current and power at each switch output will not exceed those specified for *simple apparatus* in Clause 5.4 of EN50020:2002. This allows each of the MTL647 switch outputs to be connected to any intrinsically safe circuit protected by a certified zener barrier or galvanic isolator providing that the output parameters of each circuit are less than:

$$\begin{aligned} U_o &28\text{V dc} \\ I_o &200\text{mA} \\ P_o &0.85\text{W} \end{aligned}$$

The two switch outputs are not shown on the MTL647 system certificates because they will be covered by the certificate for the system to which the contacts are connected.

The maximum equivalent capacitance and inductance of each MTL647 switch output is:

$$\begin{aligned} C_i &= 40\text{nF} \\ L_i &= 20\mu\text{H} \end{aligned}$$

To determine the maximum permissible cable parameters, C_i and L_i must be subtracted from the maximum cable capacitance and inductance specified by the system certificate of the circuit connected to the switch.

3.7 Certification Label Information

The certification label (see below) is fitted in a recess on the top outer surface of the enclosure. It shows the certification information plus the MTL name and location. Other non-European certification information may also appear on the label. The instrument serial number and year of manufacture are recorded on a separate label inside the terminal compartment.



4. SYSTEM DESIGN FOR HAZARDOUS AREAS

There are three configurations that may be used for hazardous area installations. The choice depends upon how many text displays are required, the backlight brilliance and the communication speed required. The following table summarises the performance.

	2 wire system		3 wire system				4 wire system
Number of text displays	1	2	1	2	3	4	1
Backlight brilliance	Bright	Dim	Bright	Bright	Dim	Dim	Bright
Communication speed kbaud	1.2 to 9.6		1.2 to 9.6				0.3 to 19.2

4.1 Cable length

The dc loop resistance of the cable between the MTL647 and the associated galvanic isolator in the safe area must not exceed 20Ω. This applies for 2, 3 and 4 wire systems irrespective of the number of text displays connected to the loop. Most instrument cables have a loop resistance of between 50 and 200mΩ per meter, thus limiting the maximum cable length to between 100 and 400 meters.

The maximum permitted intrinsic safety cable parameters specified on the system certificates must also not be exceeded. However, in practice only the capacitive limit in IIC gases is likely to be restrictive.

Communication speed will also limit the transmission distance. At 9.2k baud a screened twisted pair should provide reliable communication up to 100 metres. If data corruption occurs the communication speed should be reduced.

4.2 Two wire system

This is the simplest and probably the most frequently used system. One or two MTL647 serial text displays are connected to a MTL5051 in the safe area via two wires that provide both power and bi-directional communication.

Fig 2 shows the wiring diagram, which is defined by ITS System Certificate Ex03E21194. With this configuration data may

be transmitted and received at 1.2, 2.4, 4.8 or 9.6kbaud. When two MTL647 text displays are multidropped from a common galvanic isolator the brilliance of both display backlights will be significantly reduced.

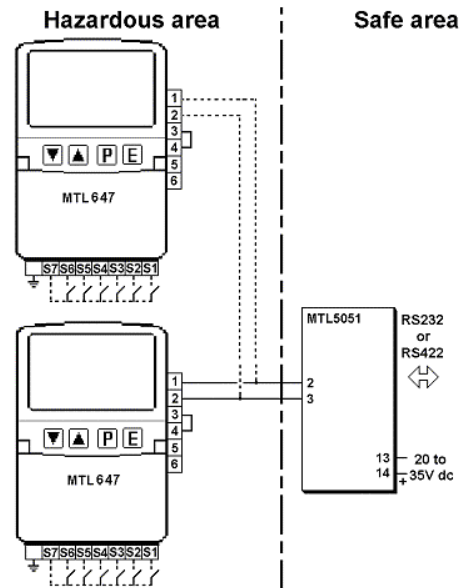


Fig 2 Two wire system

4.3 Three wire system

The three wire system illustrated in Fig 3 can be used for multidrop applications. Up to four MTL647 serial text displays may be powered and addressed, but if more than two are used, the backlight brilliance of all the displays will be significantly reduced.

With this configuration data may be transmitted and received at 1.2, 2.4, 4.8 or 9.6kbaud.

ITS System Certificate Ex03E21195 defines this system.

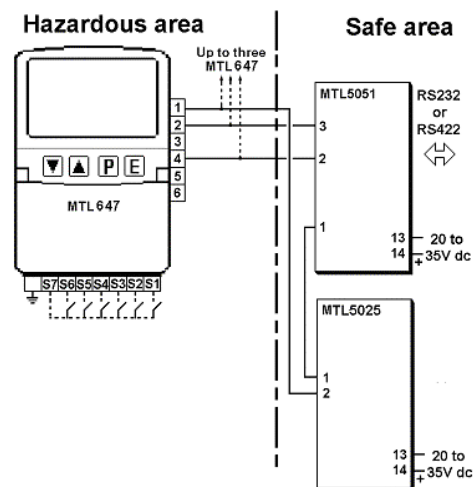


Fig 3 Three wire system

4.4 Four wire system

The four wire system which is defined by ITS System Certificate Ex03E21196 allows communication at higher and lower rates than the other two configurations. It should be used for applications requiring fast display updates, or with slow data rates when long cable runs are required. The four wire system does not support multidrop operation.

Data may be transmitted and received at 0.3, 0.6, 1.2, 2.4, 4.8, 9.6 and 19.2kbaud.

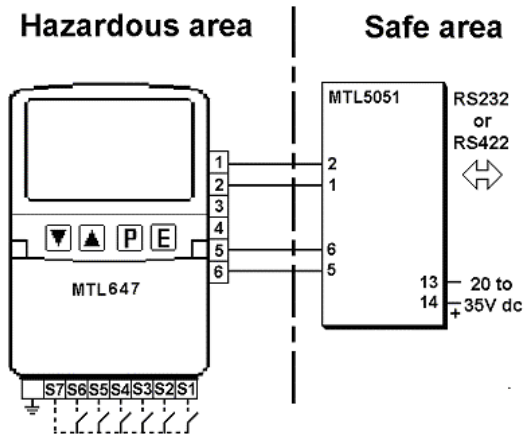


Fig 4 Four wire system

4.5 Switch outputs

Each switch output is a galvanically isolated single pole solid state switch output as shown in Fig 5.

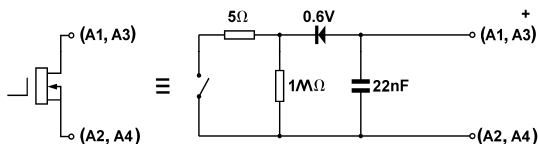


Fig 5 Equivalent circuit of each switch output

The outputs are polarised and current will only flow in one direction. Terminals A1 and A3 should be connected to the positive side of the supply.

$$R_{on} = 5\Omega + 0.6V$$

$$R_{off} = \text{greater than } 1M\Omega$$

Note: Because of the series protection diode, some test meters may not detect a closed alarm output

WARNING

These switch outputs should not be used for critical safety applications such as an emergency shut down system.

When the MTL647 power supply is turned off or disconnected, both MTL647 switch outputs will open irrespective of how they have been programmed.

5. INSTALLATION

5.1 Location

The MTL647 serial text display is housed in a robust IP66 glass reinforced polyester (GRP) enclosure incorporating armoured glass window and stainless steel fittings. It is suitable for exterior mounting in most industrial environments, including off-shore and waste water treatment installations. Please consult Eaton's MTL product line if high vibration is anticipated.

The MTL647 enclosure is surface mounting. Accessory kits described in sections 9.2 of this manual enable the instrument to be mounted onto a vertical or horizontal pipe.

The field terminals and the two mounting holes are located in a separate compartment with a sealed cover allowing the instrument to be installed without exposing the display assembly.

The MTL647 earth terminal is connected to the internal EMC filters. For maximum radio frequency interference rejection this terminal should be connected to a local earth, or to a cable screen which is earthed in the safe area. The MTL647 enclosure is supplied with a bonding plate to ensure electrical continuity between the three conduit / cable entries.

5.2 Installation Procedure

Fig 6 illustrates the instrument installation procedure.

- Remove the instrument terminal cover by unscrewing the two captive 'A' screws.
- Mount the instrument on a flat surface and secure with two M6 screws through the 'B' holes. Alternatively use one of the mounting kits described in section 9.2
- Remove the temporary dust seals from the three cable entries and install the required glands, conduit fittings or blanking plugs.

Note: The temporary dust seals fitted for transit do not maintain the IP66 protection of the MTL647 enclosure.
- Connect the field wiring to the terminals as shown in Fig 7.
- Replace the instrument terminal cover and evenly tighten the two 'A' screws.

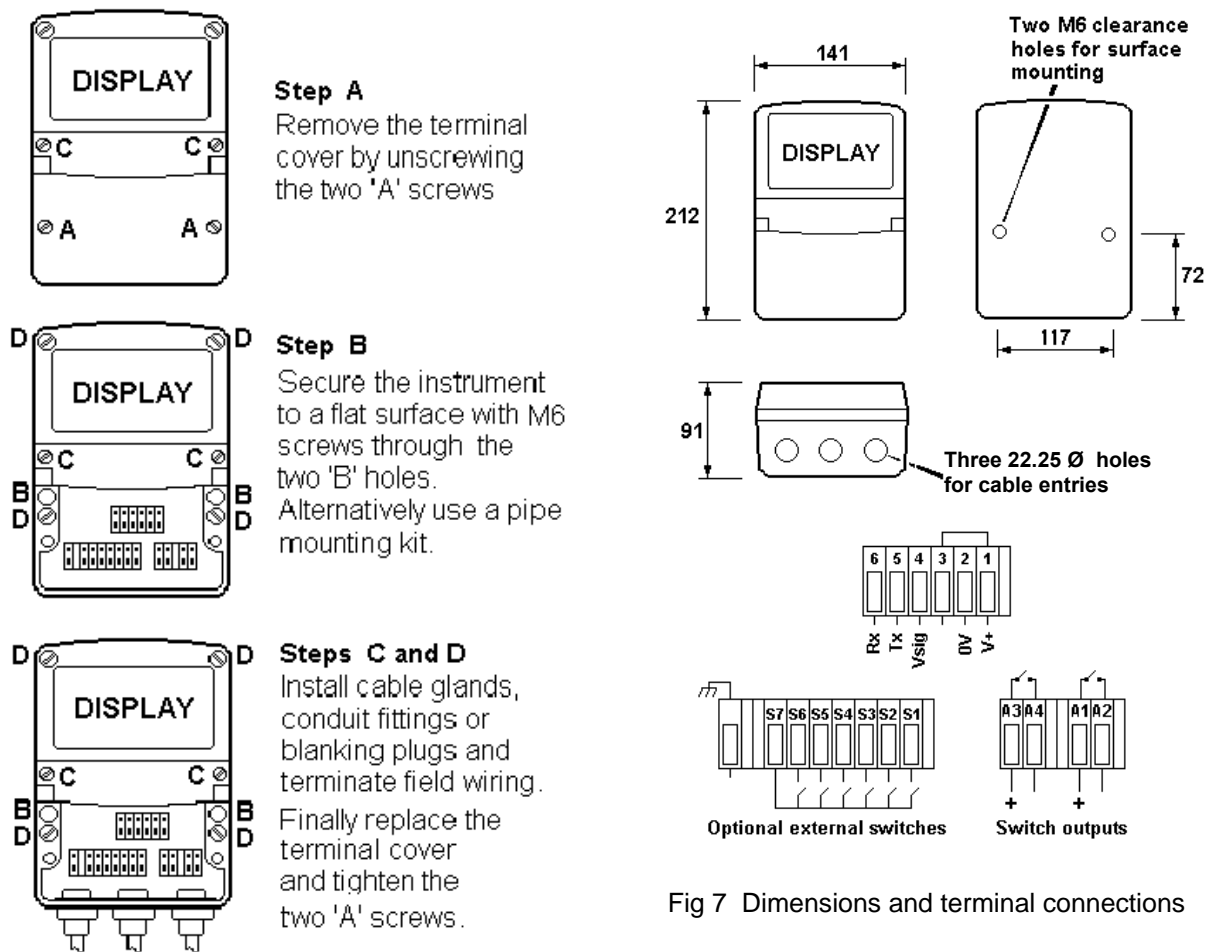


Fig 7 Dimensions and terminal connections

Fig 6 MTL647 installation procedure

5.3 EMC

The MTL647 complies with the requirements of the European EMC Directive 89/336/EEC. For specified immunity all wiring should be in screened twisted pairs and the MTL647 earth terminal should be locally earthed or connected to a cable screen which is earthed in the safe area.

To prevent circulating currents, cable screens should only be earthed at one point in the safe area.

6. CONFIGURATION

Before the MTL647 can be commissioned it must be configured to be compatible with the host's communications format and to have the required functions enabled.

The MTL647 is configured via the four front panel push-buttons. All the configuration functions are contained in an easy to use menu shown in Fig 8. Where necessary the sub-menus contain on-screen prompts to guide the user through each adjustment.

When navigating through the configuration menu, the push-button(s) should be held until the required screen is displayed.

6.1 Default configuration

Unless otherwise requested at time of ordering, MTL647 text displays will be supplied configured as follows:

Baud rate	9.6k
Data bits	8
Stop bit	1
Parity	None
Protocol	MTL
Units	Single
Address	0
Operational mode	1
Keypad	Internal
Display brightness	50%
Display contrast	50%
Limit backlight	On
Quick access menu	On
Quick access menu code	0000
Configuration menu access code.	0000

6.2 Accessing the configuration menus

Throughout this manual push-buttons are shown in italics e.g. *P* or *Up* push-button, and legends displayed by the instrument are shown within inverted commas e.g. 'Please enter code'.

The configuration menu is accessed by operating the *P* and *E* push-buttons simultaneously. If the MTL647 is not protected by an access code the main menu will be displayed. If an access code other than the default code 0000 has already been entered, the MTL647 will request that the access code be entered.

Using the *Up* or *Down* button set the first digit of the code which will be flashing. Pressing *P* will transfer control to the next digit which should be adjusted in the same way. When all four digits have been set, pressing the *E* button

will enter the access code. If the code is correct the main menu will be displayed, if the code is incorrect 'Invalid access code' will be displayed.

When entering an access code, timeout will occur and the instrument will automatically return to the operating mode ten seconds after the push-buttons were last operated. In all other menus timeout occurs after thirty seconds.

When the main menu is displayed the required sub-menu can be highlighted by scrolling through the menu using the *Up* or *Down* push-button. Operating the *P* push-button will display the highlighted sub-menu from which a further selection may be made. After a configuration parameter has been adjusted, pressing the *E* button will enter the selection and move the display up one level.

After the instrument configuration has been completed, operating the *E* push-button repeatedly will return the instrument display to the main menu. One more operation of the *E* button will then return the MTL647 to the operating mode.

6.3 Summary of configurable functions

This section provides a brief explanation of each configurable function and should be read in conjunction with Fig 8.

View settings

Displays the instruments main communication settings.

Baud rate

Data rate may be set to seven speeds between 0.3 and 19.2kbaud. Allowable rates depend upon the system in which the MTL647 is used.

Data bits

7 or 8 data bits may be selected. 8 bit data is required in MTL mode for graphics and error checked modes.

Stop bits

1 or 2 stop bits may be selected

Parity

An even, odd or no parity bit may be selected.

Protocol

MTL or legacy protocol may be selected. The Legacy protocol is compatible with the MTL643.

Units

Selects single or multiple MTL647 connected to a single MTL5051.

Address

For multidrop applications each text display must be allocated a unique non-zero address. Addresses may be set between 1 and 15. For single text display applications the MTL647 address should be set to 0.

Operational mode

Five levels of communications security may be selected, ranging from immediate execution of a command with no acknowledgement, to a requirement for a 16 bit cyclic redundancy check. See section 7 and the programming guide for a detailed explanation.

This function is not available when Legacy protocol is selected.

Keypad

This function allows the instrument front panel push-buttons or external push-buttons to be used for operator inputs. Whichever are selected, the instrument front panel push-buttons are used for configuration.

This function is not available when Legacy protocol is selected.

Display settings

Allows the backlight brightness and contrast of the MTL647 display to be adjusted.

Limit backlight

When 'On' is selected the maximum backlight brightness will be automatically set depending upon whether a 'Single Unit' or 'Multiple Unit' has been selected in the configuration menu.

When 'Off' is selected the automatic brilliance limit is overridden for special applications. e.g. Two text displays on a three wire system.

Quick access menu

This function enables the quick access menu described in section 6.4. When 'On' is selected an operator can adjust the screen brilliance and contrast without having access to other conditioning parameters.

Access code for the Quick Access Menu

Defines a four digit alphanumeric code that must be entered to gain access to the instrument's quick access menu. Alpha characters are case sensitive. Default code 0000 allows direct access without a code.

Access code for the Configuration Menu

Defines the four digit alphanumeric code that must be entered to gain access to the instrument configuration menus. Alpha characters are case sensitive. Default code 0000 allows direct access without a code.

Unit information

Displays the instrument model number and the software version.

Configuration defaults

This function allows the configuration default defined in section 6.1 to be globally set.

6.4 Quick Access Menu

The quick access menu allows an operator to adjust the backlight brilliance and the display contrast without having access to the other configuration parameters.

The quick access menu is accessed by operating the *P* and *Up* push-buttons simultaneously. If the quick access menu is not protected by an access code the brilliance and contrast controls will be displayed immediately. If an access code other than the default code 0000 has already been entered, the MTL647 will request that the access code be entered. Section 6.2 explains how an access code should be entered.

The backlight brilliance is adjusted using the *Up* and *Down* push-buttons. Operating the *P* push-button will transfer control to the display contrast adjustment. When both are set as required operating the *E* button will store both settings and return the instrument to the operating mode.

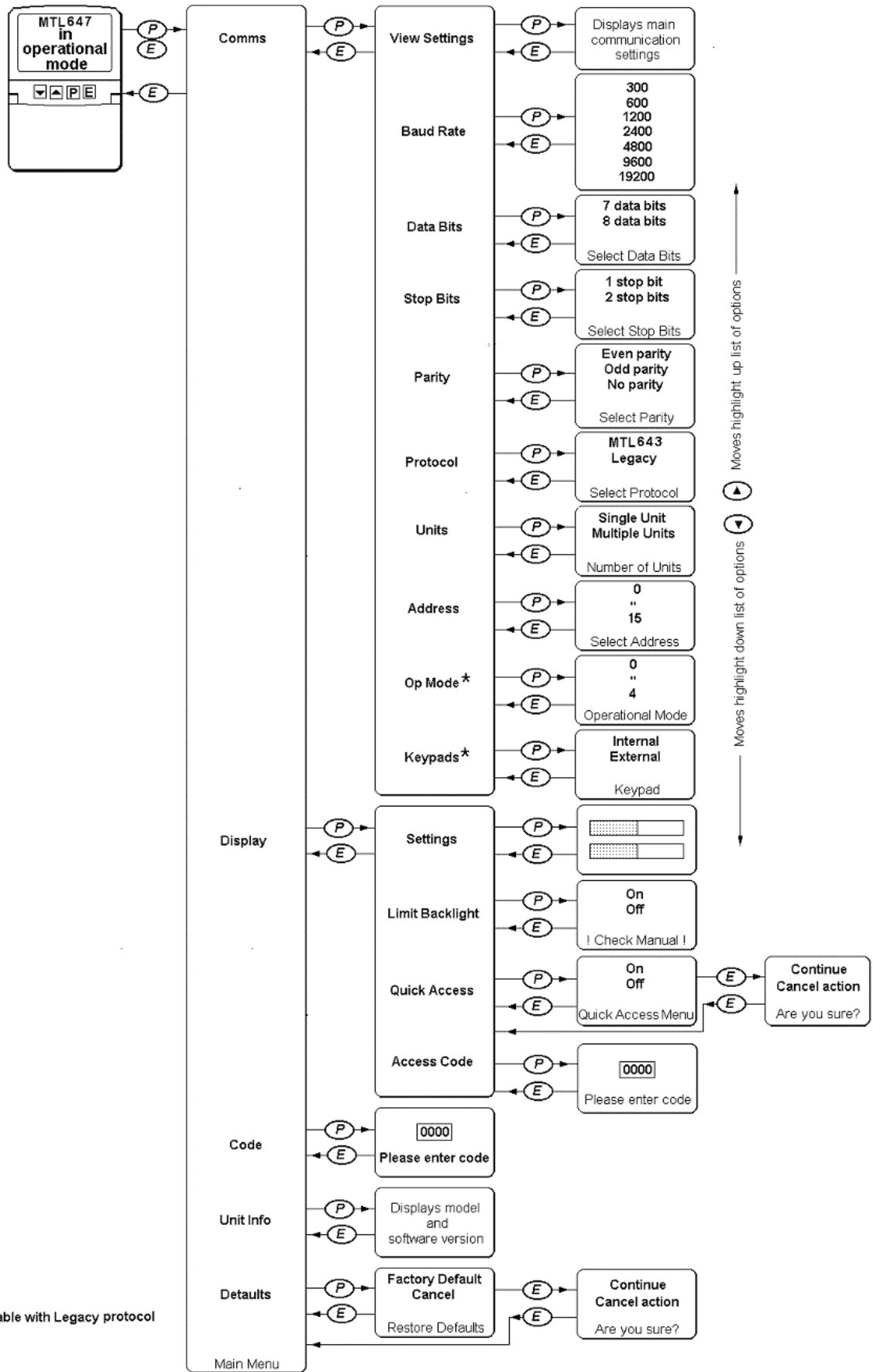


Fig 8 Structure of Configuration Menu

7. PROGRAMMING

A detailed description of the MTL programming protocol, together with examples of all the instructions, are contained in the MTL647 & MTL646 Programming Guide which may be downloaded from the MTL web site at www.mtl-inst.com. This manual only includes a summary of the MTL protocol and instruction set.

7.1 Summary of MTL protocol

- Pure ASCII protocol except for graphics downloads, checksums and CRCs.
- Commands are two characters, case insensitive, enclosed in angled brackets.
- Some commands require parameters. Parameters follow the command directly. Multiple parameters are separated by commas. A command and its parameters are enclosed within a single set of angled brackets.
- All attribute commands are active until overridden by another command.
- No spaces are allowed in commands/parameter strings. (except in the WT write text command)
- Any characters not enclosed in angled brackets are written directly to the screen at the current cursor position (operational mode < 2). If angle brackets are required in text, two consecutive brackets may need to be sent depending upon the operational mode.
- Any detected parameter error causes the command to be ignored.
- The instrument's response to received messages is programmable. Modes are:
 - No response.
 - Response to every correctly formatted command.
 - Response to a set of correctly formatted commands.

- Status of operator switches is encoded into the returned message, or can be explicitly requested.
- Communications error checking is programmable. Modes are:
 - No error checking
 - Simple checksum
 - 16bit Cyclic Redundancy Check.

7.2 Command format

<AB[param1],[param2]>

where:

AB is the command.

[..] indicates optional parameters separated by commas.

examples:

<CM4,90> Cursor Move to Row 4
 Column 90

<CS> Clear Screen

7.3 Response format

Ka or Ea or ?a or P0

where:

K indicates that the previous command/command set has been accepted.

E indicates an error has been detected in the previous command string.

? indicates that command is unrecognised.

P indicates that a message has been received but NOT actioned because the instrument is in the conditioning mode.

a returns the key status

0=no key pressed
1=key1
2=key2
3=key3
4=key4
5=key5
6=key6 pressed

examples:

K0	Command accepted, no keys pressed.
E1	Command error detected, key 1 pressed.
?6	Command unrecognised, key 6 pressed.
P0	Command rejected, instrument in conditioning mode.

7.4 Operational Modes

The operational mode is defined in the conditioning menu, see section 6.3

Mode 0:

Commands are executed immediately, no reply message. Plain text is written directly to the screen, no reply message.

Mode 1:

Commands are executed immediately, a response is returned to each command. Plain text is written directly to the screen, no reply message.

Mode 2:

Multiple commands can be sent, but these are not executed until a "Command Implement" <CI> command is sent. One reply is returned for each set of commands. An error in any of the commands will result in a Command Error response. Plain text is ignored.

Mode 3:

As Mode 2 but the <CI> command is replaced by a <CCn> command where n is a single byte simple checksum of all characters sent (including spaces) up to, but not including the <CCn> command. The response has a similar single byte checksum appended to the end of the response. The command string is not actioned if the checksum of the data received does not match the parameter of the <CCn> command. Plain text is ignored.

Mode 4:

As Mode 3 but the <CCn> is replaced by <CRnn> where nn is a 16-bit CRC code.

7.5 Multidrop Operation

Multidrop operation is possible. Unique unit addresses > 0 need to be set on each instrument.

Command <MCn> (Make Connection) is used to define the address (n) to which subsequent commands are directed.

Command <RC> disconnects the currently 'connected' unit.

7.6 Summary of Commands

Commands are listed in functional groups. Detailed descriptions of each command including examples of how they should be used are included in the MTL646 & MTL647 Programming Guide which may be downloaded from www.mtl-inst.com

7.6.1 Screen handling and text

Command	Meaning	Description
<CLn>	Clear Line	Erases all text on line n. For parameter ranges see CM command. Row Mode only.
<CMy,x>	Cursor Move	Cursor moved to Row y Column x. Row values are 0-7 (Row Mode), 0-63 (Pixel Mode) Column values are 0 – 119.
<CS>	Clear Screen	All pixels off, cursor homed
<CW>	Clear Window	All pixels set to off in the defined window area. Cursor homed in the windowed area. Row Mode only
<EL>	Erase Line	Erases text from current cursor position to end of line. Row Mode only.
<FS>	Fill Screen	All pixels on, cursor homed
<FW>	Fill Window	Sets all pixels in the defined window 'on'. Cursor Homed in the windowed area. Row Mode only
<HC>	Home Cursor	Returns the cursor to the top left of the screen for the current font. This command is window aware in Row Mode
<LN>	Line New	Sends a carriage return and line feed to the display so that following text is written on the next line down. Row Mode only.
<RS>	Request Status	Returns switch status when operating in Mode 0. Works in any mode.
<SD>	Screen Defaults	Returns the instrument screen to default state. See definition at the end of this table.
<WSn>	Write Soft character	Write Soft character n. n=0-3. This command displays the previously downloaded soft character at the current cursor position. It will assume all of the currently active attributes, just as any normal character. Command is active in both Row Mode <RM> and Pixel Mode <PM>. Soft fonts are lost when power is removed. Soft fonts F1 to F4 can be saved to eeprom. and restored. See <KF> and <FR> commands.
<WTthis is a message>	Write Text	Sends text and ensures a response from the instrument Operational Mode OM>0.

Note: The Screen Defaults <SD> command returns the display and its attributes to a known state listed below.

Display scroll off	Visible frame = 0
Key press data cleared	Active frame = 0
Window definition cleared	Small font 8 x 6 Pixels
<VF0>	Clear Screen
<AF0>	Cursor homed
<F1>	Normal text
<CS>	Row Mode
<HC>	Inhibit Flashing
<WM0>	Text Steady attribute
<RM>	No text Alignment
<IF>	Background Mode = 0
<ST>	No Underline
<NA>	
<BM0>	
<NU>	

7.6.2 Attributes

Command	Meaning	Description
<BMn>	Background Mode	If n=0, flash background is pixels off If n=1, flash background is pixels on If n=2, flash background is the inverse of the character or graphic being written. Default state is <BM0>. To use this command, the flashing attribute <FL> must be set. To enable screen flash the Enable flash <EF> command must be sent.
<CA>	Centre Align	Text is centred (x-direction). Use with <WT> command. Window aware in Row Mode only.
<DWyt,yb,xl,xr>	Define Window	Creates a sub-window for text . yt=top row, yb=bottom row, xl=left column, xr=right column. Row Mode only
<EF>	Enable Flashing	Enables flashing for characters written with the flashing attribute set
<F1>	Font 1	6 mm high 8 x 6 pixels. Cursor is homed.
<F2>	Font 2	11 mm high 16 x 10 pixels. Cursor is homed.
<F3>	Font 3	17 mm high 24 x 15 pixels. Cursor is homed.
<F4>	Font 4	23 mm high 32 x 19 pixels. Cursor is homed.
<F5>	Font 5	34 mm high 48 x 29 pixels. Partial Character set only (0-9, A-Z, space, comma, full-stop, plus, minus). Undefined characters not trapped. Cursor is homed.
<FL>	Flash	Following text flashing
<IF>	Inhibit Flashing	Stops flashing on the whole display. Overrides attributes

Command	Meaning	Description
<LA>	Left Align	Text is left justified . Use with <WT> command. Window aware in Row Mode only.
<LF>	Line Feed	Line feed added after carriage return. Row Mode only
<NA>	No Align	Text is written at the current cursor position by the <wt> command. This is the default setting.
<NL>	No Linefeed	Carriage return and line feed are independent actions. Row Mode only
<NU>	No Underline	Cancels the command above
<RA>	Right Align	Text is right justified. Use with <WT> command. Window aware in Row Mode only.
<ST>	Steady	Following text non-flashing
<SW>	Smart Wrap	Wraps text onto next line, does not break words. Use with WT command. Row Mode only. Cancelled by any subsequent text alignment command.
<TW>	Text Wrap	Characters are wrapped on to the next line at the end of the line in the current window. Row Mode only. Cancelled by any subsequent text alignment command.
	UnderLine	Text in fonts F2 to F5 is underlined in the descender area of the current font. Underlining can be used in both row and pixel modes.
<WMn>	Write Mode	0=Normal, 1=OR, 2=XOR, 3=Inverse

7.6.3 System commands

Command	Meaning	Description
<AFn>	Active Frame	Subsequent writes to the instrument are written to page frame n. n=0 or 1. Default is 0.
<CCn>	Check Code	Specifies a simple checksum (n) of a previously sent command string. Operational Mode 3.
<CI>	Command Implement	Signal to execute previously sent commands. Operational Mode 2.
<CE>	Configuration Enable	Entry to the menu structure by the dual P-E keypress is enabled. This is the default state.
<CP>	Configuration Prohibit	Entry to the menu structure by the dual P-E keypress is inhibited.
<CRnn>	Cyclic redundancy check	Specifies a 16-bit CRC (nn) of a previously sent command string. Operational Mode 4.
<DFn>	Download Font	Download soft character n for the currently active font. (n=0-3) After this command has been issued a binary download of a .BPM file is expected. This file must be an image exactly the same size (in pixels) as the currently active font. An image of any other size will cause an error response. The mechanism and .BMP file requirements for this command is exactly the same as that for the Download Graphic <DG> and Download Logo <DL> commands.
<FR>	Font Restore	Soft fonts F1 to F4 are recovered from eeprom. This will overwrite any downloaded fonts that have not been saved using the <KF> command above.
<HSmnrstuv>	Horizontal Scroll	m= 0 scroll is Right to Left, m=1 scroll is Left to Right. n=Start row of block to scroll r=Last row of block to scroll A line of length t pixels starting at Pixel=s above the bottom of row r and a line of length v pixels starting at Pixel=u above the bottom of row r is inserted For Left to Right scroll, the line is inserted at the left of the screen, for Right to Left scroll at the right of the screen. This is a row mode command that can be used in a window. If it is used in a window, then the parameters are relative to the defined window.
<KF>	Keep Fonts	Soft fonts F1 to F4 are saved to Eeprom.

Command	Meaning	Description
<MCn>	Make Connection	Subsequent commands are addressed to the stated node. n=1 to n=15.
<ODn>	Switch Output De-energised	Output n open circuit. n=1 or n=2.
<OEn>	Switch Output Energised	Output n short circuit. n=1 or n=2.
<PM>	Pixel Mode	Text is pixel aligned. Any defined windows are cleared.
<RB>	ReBoot	Hardware restart activated by deliberate watchdog timeout.
<RC>	Release Connection	Releases the connection made with the <MC> command above. After this command, no instruments will respond until a further <MCn> command is issued.
<RFm>	Restore Frame	Restores the frame saved with <SF> to the current active frame. Attributes are not restored
<RLx>	Restore Logo	User defined logo is written to the current visible frame. x=0 gives a static display, x=1 enables scrolling of the logo as at power-up. If there is no user logo saved, the Eaton logo is displayed.
<RM>	Row Mode	Text is row aligned.
<SBn>	Set Backlight	Backlight set to intensity n=0 to n=40.
<SFnm>	Save Frame	Saves frame 'm' to memory area 'n'.
<SL>	Save Logo	The visible frame is saved to eeprom and used as a power-up logo to replace the Eaton logo. Command takes about 2 seconds to complete. Saving a blank screen re-enables the Eaton logo. Intended to be used in conjunction with the <DL> command, but any screen image can be saved.
<TO n>	Time Out	Flashes a warning message on the screen when no communication is received for n x 10 seconds. n=0 disables the timeout function. Default is disabled.
<VF n>	Visible Frame	Page frame n is made visible. n=0 or 1. Default is 0. Cursor positions are not saved or restored with frames.

Line graphics

Command	Meaning	Description
<BDylength,xlength,lwidth>	Box Draw	Draws a box y length pixels high, x length pixels wide, and with a line width of l width pixels, from the current cursor position (up and to the right). Parameters can be any value that will keep the box being drawn on screen. Pixel Mode only.
<HBnm>	Horizontal Bargraph	Draw a horizontal bargraph from the current cursor position. n=length, m=fill both in pixels. Row Mode only
<LHxlength, lwidth>	Line Horizontal	Draws a horizontal line x length pixels long, l width pixels wide from the current cursor position (up and to the right). The line length and line width can be any value that will keep the line being drawn on screen. Pixel Mode only
<LVylength, lwidth>	Line Vertical	Draws a vertical line ylength pixels long, lwidth pixels wide from the current cursor position (up and to the right). The line length and line width can be any value that will keep the line being drawn on screen. Pixel Mode only
<VBnm>	Vertical Bargraph	Draw a vertical bargraph from the current cursor position. n=length, m=fill both in pixels. Row Mode only

7.6.5 Pixel graphics

Command	Meaning	Description
<DG>	Download Graphic	Command is followed by a .BMP file download. See Graphics Download section. Pixel Mode only.
<DS>	Download Screen	Command is followed by a .BMP file download. See Graphics Download section.
<UE>	Upload Enable	Enables the screen dump command above. Needs to be sent immediately prior to the <US> command.
<US>	Upload Screen	Sends a screen image back to the user as a .bmp file. The <US> command is acknowledged in the normal way. After a short gap (25ms), a 1086 byte block of data is sent. A command acknowledge is then sent with the check bytes as per the current operational mode. The check bytes include the data block bytes and the acknowledgement, but not the check bytes themselves. The data block, saved to file is a graphics image of the screen.

7.7 Graphics Downloads.

The protocol is extended as follows to cover the two simple graphics download commands <DG> and <DS>

7.7.1 <DS> command

- Command <DL> is issued with any additional bytes (checksum, CRC etc) as required by the current operational mode.
- Command is acknowledged if correctly received.
- A binary download of the .BMP file is then expected. After the file has been downloaded, the <CI>, <CCn> or <CRnn> command must be sent as per the current operational mode. "n" represents the simple checksum of all the bytes in the .BMP file, "nm" represents the 16-bit CRC of all the bytes in the .BMP file
- The download is acknowledged if correctly received (including checksum or CRC checks).

- There is a 2 second timeout for the download operation. If no bytes are received in this time, the download is aborted and an error response is returned.
- The downloaded logo is then displayed. The image must be exactly 120x64 pixels and two colour (black and white) in standard Windows (OS2) format. An error response is returned if these requirements are not satisfied.

7.7.2 <DG> command

- Command <DG> follows exactly the same mechanism as the <DS> command above, but any size of image can be sent up to 120x64. Files in excess of this size will cause an error response.
- The display must be in Pixel Mode <PM> and the downloaded image is displayed at the current cursor position.
- The image dimensions are computed from the .BMP file sent.

- The image is drawn upwards from and to the right of the current cursor position. If any part of the image exceeds the display bounds the image is NOT displayed and an error response is returned.
- The .BMP format must still be two colour, standard Windows (OS2) format. An error response is returned if these requirements are not satisfied
- The downloaded image adopts the display attributes currently in force (Normal, OR, XOR, Inverse, Flashing, Steady)

Note:

1. The <DS> command is just a special case of the <DG> command but because of its fixed size is executed much more quickly.
2. Graphics can be downloaded to a hidden frame using the <VF> and <AF> commands and then made visible when complete.

7.8 Cyclic Redundancy Check

The 16-bit CRC used in the protocol is the same as used for the well-known Modbus Protocol. Details are as follows:

The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive eight-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.

During generation of the CRC, each eight-bit character is exclusive ORed with the register contents. The result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive ORed with a preset, fixed value (A001 hex). If the LSB was a 0, no exclusive OR takes place.

This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next eight-bit character is exclusive ORed with the register's current value, and the process repeats for eight more shifts as described above. Finally, the contents of the register, after all the characters of the message have been applied, is the CRC value.

7.8.1 Procedure for generating a CRC

- Step 1 Load a 16-bit register with FFFF hex (all 1's). Call this the CRC register.
- Step 2 Exclusive OR the first eight-bit byte of the message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.
- Step 3 Shift the CRC register one bit to the right (toward the LSB), zerofilling the MSB. Extract and examine the LSB.
- Step 4 If the LSB is 0, repeat Step 3 (another shift). If the LSB is 1, Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
- Step 5 Repeat Steps 3 and 4 until eight shifts have been performed. When this is done, a complete eight-bit byte will have been processed.
- Step 6 Repeat Steps 2 to 5 for the next eight-bit byte of the message. Continue doing this until all bytes have been processed.
- Step 7 The final contents of the CRC register is the CRC value.

This CRC value is then appended to the message. The LSB of the CRC is sent first followed by the MSB.

8. MAINTENANCE

8.1 Fault finding during commissioning

If a MTL647 fails to function during commissioning the following procedure should be followed:

Symptom	Cause	Check:
No Display	No Power Incorrect wiring	That there is 10 to 14 volts between terminals 1 and 2 of the six way terminal block. Terminal 1 should be positive.
No Communication	Communications parameters incorrectly set	Baud rate, data bits, stop bits and parity settings match those of the host. Configuration switches on the communications isolator.
	Incorrect Protocol	Protocol settings in "Comms" Menu
	Incorrect wiring	Wiring is as per diagrams for the chosen configuration
	Address Incorrect in Multidrop Mode	Address setting in "Comms" menu
Poor Communication	Too many MTL647 displays on the line. Lines too long. Communication speed too fast.	Configuration settings. Installation guidelines
Dark Display	Contrast too high	Contrast level in "Display Settings" menu
No Backlight or Backlight dim	Backlight off or set low or Multidrop mode in use	Brightness level in "Display Settings" menu Units setting in "Comms" menu
Cannot enter configuration menu	Keys not held for long enough (up to 2 seconds required) Menu inhibited	Send "Program Enable" command (MTL mode) Restart unit (Legacy mode)

8.2 Fault finding after commissioning

ENSURE PLANT SAFETY BEFORE STARTING MAINTENANCE

Live maintenance is permitted on intrinsically safe equipment installed in a hazardous area, but only certified test equipment should be used unless a gas clearance certificate is available.

If a MTL647 fails after it has been functioning correctly, the table shown in section 8.1 may help to identify the cause of the failure.

If this procedure does not reveal the cause of the fault, it is recommended that the instrument is replaced.

8.3 Servicing

We recommend that faulty MTL647 serial text displays are returned to Eaton's MTL product line or to our local agent for repair.

8.4 Routine maintenance

The mechanical and electrical condition of the instrument should be regularly checked. Initially annual inspections are recommended, although the inspection frequency should be adjusted to suit the environmental conditions.

8.5 Guarantee

Instruments that fail within the guarantee period should be returned to Eaton's MTL product line or our local agent. It is helpful if a brief description of the fault symptoms is provided.

8.6 Customer comments

Eaton is always pleased to receive comments from customers about our products and services. All communications are acknowledged and whenever possible, suggestions are implemented.

9. ACCESSORIES

9.1 Tag number

The MTL647 can be supplied with a blank or custom engraved stainless steel plate secured by two screws to the side of the instrument enclosure. This plate can accommodate:

1 row of 9 alphanumeric characters 10mm high

or 1 row of 11 alphanumeric characters 7mm high

or 2 rows of 18 alphanumeric characters 5mm high

9.2 Pipe mounting kits

A pipe mounting kit is available for securing the MTL647 to a horizontal or vertical pipe.

PIP647 Stainless steel bracket secured by two worm drive hose clips for 60 to 80mm outside diameter pipes.

9.3 MTL647 & MTL646 Programming Guide

A detailed guide to programming the MTL647 and MTL646 serial text displays may be downloaded from the MTL website at www.mtl-inst.com

10. INDEX

Subject	Section	Subject	Section
Address	6.3	Notified Body	1
ATEX Directive	3.1; 3.7	MTL644 display	2.2
Backlight	4, 4.2, 4.3, 6.1, 6.4	MTL5051 galvanic isolator	3.4, 4.2, 6.3
MTL protocol	2.1	Power supply	3.4
Cable		Programming	7.
Length	4.1	Commands	
Parameters	3.5, 3.6, 4.1	Attributes	7.6.2
Certificates		Line graphics	7.6.4
EC-Type Examination	3.1	Pixel graphics	7.6.5
Label	3.7	Screen handling	7.6.1
system	3.2	System	7.6.3
Communication speed	4.	Command format	7.2
Configuration	6.	Cyclic Redundancy	
Access	6.2	check.	7.8, 7.8.1
Default settings	6.1	Guide	2., 9.3
Structure	Fig 8	Operating modes	7.4
Quick access menu	6.4	Response format	7.3
EMC	5.3	Summary of MTL	
External switches	3.5	protocol.	7.1
Fault finding		Servicing	8.3
During commissioning	8.1	Switch outputs	3.6
After commissioning	8.2	Systems	
Galvanic isolators	3.4	2-wire	4.2
Gas groups	3.3	3-wire	4.3
Guarantee	8.5	4-wire	4.4
Installation	5.2	Certificates	3.2
Intrinsic safety	1; 3; 4	T rating	3.3
Legacy protocol	2.2	Terminal numbers	Fig 7
Location	5.1	Zones	3.3
Maintenance	8.		
Routine	8.4		
Multidrop	2. 4.2, 4.3, 4.4, 7.5		

This page is left intentionally blank

AUSTRALIA

MTL Instruments Pty Ltd,
10 Kent Road, Mascot, New South Wales, 2020, Australia
Tel: +61 1300 308 374 Fax: +61 1300 308 463
E-mail: mtl-salesanz@eaton.com

BeNeLux

MTL Instruments BV
Ambacht 6, 5301 KW Zaltbommel
The Netherlands
Tel: +31 (0)418 570290 Fax: +31 (0)418 541044
E-mail: mtl.benelux@eaton.com

CHINA

Cooper Electric (Shanghai) Co. Ltd
955 Shengli Road, Heqing Industrial Park
Pudong New Area, Shanghai 201201
Tel: +86 21 2899 3817 Fax: +86 21 2899 3992
E-mail: mtl-cn@eaton.com

FRANCE

MTL Instruments sarl,
7 rue des Rosiéristes, 69410 Champagne au Mont d'Or
France
Tel: +33 (0)4 37 46 16 53 Fax: +33 (0)4 37 46 17 20
E-mail: mtlfrance@eaton.com

GERMANY

MTL Instruments GmbH,
Heinrich-Hertz-Str. 12, 50170 Kerpen, Germany
Tel: +49 (0)22 73 98 12-0 Fax: +49 (0)22 73 98 12-2 00
E-mail: csckerpen@eaton.com

INDIA

MTL India,
No.36, Nehru Street, Off Old Mahabalipuram Road
Sholinganallur, Chennai- 600 119, India
Tel: +91 (0) 44 24501660 /24501857 Fax: +91 (0) 44 24501463
E-mail: mtlindiasales@eaton.com

ITALY

MTL Italia srl,
Via San Bovio, 3, 20090 Segrate, Milano, Italy
Tel: +39 02 959501 Fax: +39 02 95950759
E-mail: chmninfo@eaton.com

JAPAN

Cooper Crouse-Hinds Japan KK,
MT Building 3F, 2-7-5 Shiba Daimon, Minato-ku,
Tokyo, Japan 105-0012
Tel: +81 (0)3 6430 3128 Fax: +81 (0)3 6430 3129
E-mail: mtl-jp@eaton.com

NORWAY

Norex AS
Fekjan 7c, Postboks 147,
N-1378 Nesbru, Norway
Tel: +47 66 77 43 80 Fax: +47 66 84 55 33
E-mail: info@norex.no

RUSSIA

Cooper Industries Russia LLC
Elektrozavodskaya Str 33
Building 4
Moscow 107076, Russia
Tel: +7 (495) 981 3770 Fax: +7 (495) 981 3771
E-mail: mtlrussia@eaton.com

SINGAPORE

Cooper Crouse-Hinds Pte Ltd
No 2 Serangoon North Avenue 5, #06-01 Fu Yu Building
Singapore 554911
Tel: +65 6 645 9888 Fax: +65 6 487 7997
E-mail: sales.mtlsing@eaton.com

SOUTH KOREA

Cooper Crouse-Hinds Korea
7F, Parkland Building 237-11 Nonhyun-dong Gangnam-gu,
Seoul 135-546, South Korea.
Tel: +82 6380 4805 Fax: +82 6380 4839
E-mail: mtl-korea@eaton.com

UNITED ARAB EMIRATES

Cooper Industries/Eaton Corporation
Office 205/206, 2nd Floor SJ Towers, off. Old Airport Road,
Abu Dhabi, United Arab Emirates
Tel: +971 2 44 66 840 Fax: +971 2 44 66 841
E-mail: mtlgulf@eaton.com

UNITED KINGDOM

Eaton Electric Ltd,
Great Marlings, Butterfield, Luton
Beds LU2 8DL
Tel: +44 (0)1582 723633 Fax: +44 (0)1582 422283
E-mail: mtlenquiry@eaton.com

AMERICAS

Cooper Crouse-Hinds MTL Inc.
3413 N. Sam Houston Parkway W.
Suite 200, Houston TX 77086, USA
Tel: +1 281-571-8065 Fax: +1 281-571-8069
E-mail: mtl-us-info@eaton.com