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GLK19264A-7T-1U

Including the GLK19264A-7T-1U-USB, and GLK19264A-7T-1U-422

Technical Manual

Revision 2.5

PCB Revision: 2.0 or Higher

Firmware Revision: 8.4 or Higher

Revision History

Revision	Date	Description	Author
2.5	October 27, 2015	Correction to Hardware Lock	Divino
2.4	October 19, 2015	Revision to Commands for Firmware Revision 8.6	Clark
2.3	May 21, 2014	Revision to Commands for Firmware Revision 8.5	Martino
2.2	March 5, 2014	Correction to Current Draw of Backlights	Martino
2.1	September 9, 2013	Corrected Scripted Key and Keypad Brightness Commands	Clark
2.0	July 10, 2013	Initial Release	Clark

Contents

1 Introduction

Figure 1: GLK19264A-7T-1U Display

The GLK19264A-7T-1U is an intelligent graphic liquid crystal display engineered to quickly and easily add an elegant creativity to any application. In addition to the RS232, TTL and I2C protocols available in the standard model, USB and RS422 communication models allow the GLK19264A-7T-1U to be connected to a wide variety of host controllers. Communication speeds of up to 115.2kbps for serial protocols and 100kbps for I^2C ensure lightning fast text and graphic display.

The simple command structure permits easy software control of many settings including backlight brightness, screen contrast, and baud rate. On board memory provides a whopping 256KB of customizable fonts and bitmaps to enhance the graphical user experience.

User input on the GLK19264A-7T-1U is available through a built-in seven key tactile keypad. Three bi-colour LEDs provide visual outputs and six general purpose outputs provide simple switchable five volt sources on each model. In addition, an optional Dallas One-Wire header provides a communication interface for up to thirty-two devices.

The versatile GLK19264A-7T-1U, with all the features mentioned above, is available in a variety of colour, voltage, and temperature options to suit almost any application.

2 Quick Connect Guide

2.1 Available Headers

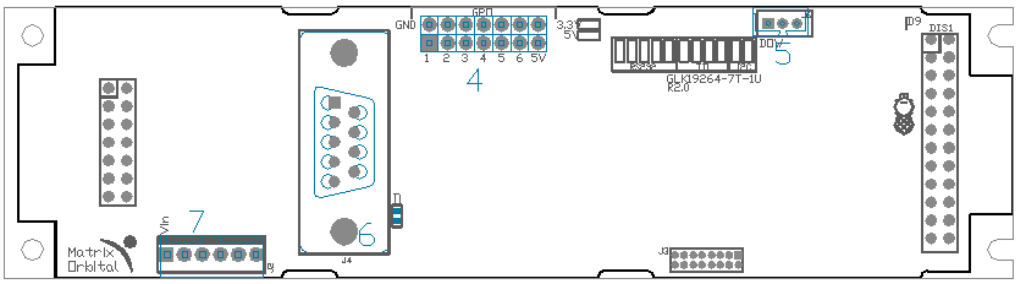

Figure 2: GLK19264A-7T-1U Standard Module Header Locations

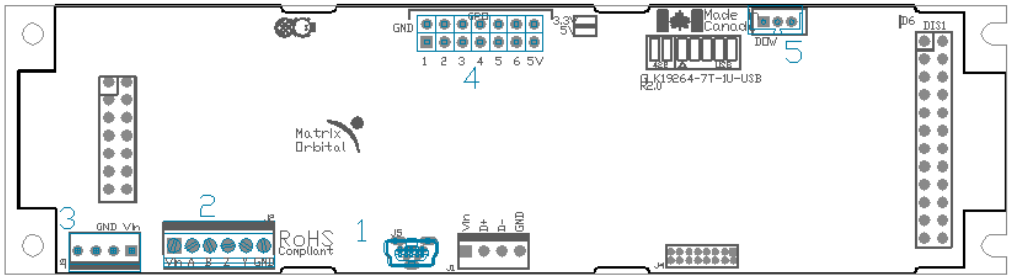

Figure 3: GLK19264A-7T-1U USB and RS422 Model Header Locations

Table 1: List of Available Headers

#	Header	Mate	Population
1	Mini USB Connector	EXTMUSB3FT/INTMUSB3FT	USB Model Only
2	RS422 Terminal Block	16-30 AWG Wire	422 Model Only
3	Alternate Power Connector	PCS	422 and USB Models Only
4	GPO Header	None Offered	All Models
5	Optional Dallas One-Wire Header	Temperature Probe	USB Model Only
6	DB9 Serial Header	CSS1FT/CSS4FT	Standard Model Only
7	Extended Communication/Power Connector	ESCCPC5V/BBC	Standard Model Only

2.2 Standard Module

The standard version of the GLK19264A-7T-1U allows for user configuration of two common communication protocols. First, the unit can communicate using serial protocol at either RS323 or TTL voltage levels. Second, it can communicate using the Inter-Integrated Circuit connect, or I^2C protocol. Connections for each protocol can be accessed through the four pin Communication/Power Header as outlined in the Serial Connections and I^2C Connections sections below.

Recommended Parts

Figure 4: Extended Communication/Power Cable (ESCCPC5V)

The most common cable choice for any standard Matrix Orbital display, the Extended Communication/ Power Cable offers a simple connection to the unit with familiar interfaces. DB9 and floppy power headers provide all necessary input to drive your display.

Figure 5: Breadboard Cable (BBC)

For a more flexible interface to the GLK19264A-7T-1U, a Breadboard Cable may be used. This provides a simple four wire connection that is popular among developers for its ease of use in a breadboard environment.

Serial Connections

Serial protocol provides a classic connection to the GLK19264A-7T-1U. The Extended Communication/Power Cable is most commonly used for this set up as it provides connections for DB9 serial and floppy power cables. To place your board in Serial mode, adhere to the steps laid out below.

1. Set the Protocol Select jumpers.
   - RS232: Connect the five jumpers* in the 232 protocol box with the zero ohm jumper resistors provided or an alternate wire or solder solution.
   - TTL: Connect the four jumpers* in the TTL protocol box.

***Note:** Jumpers must be removed from all protocol boxes save for the one in use.

2. Make the connections.
    a. Connect the six pin female header of the Extended Communication/Power Cable to the Communication/Power Header of your GLK19264A-7T-1U.
    b. Insert the male end of your serial cable to the corresponding DB9 header of the Extended Communication/Power Cable and the mate the female connector with the desired communication port of your computer.
    c. Select an unmodified floppy cable from a PC power supply and connect it to the power header of the Communication/Power Cable.
3. Create.
    - MOGD# or a terminal program will serve to get you started, and then you can move on with your own development. Instructions for the former can be found below and a variety of application notes are available for the latter at www.matrixorbital.ca/appnotes.

I^2C Connections

A more advanced connection to the GLK19264A-7T-1U is provided by the I^2C protocol setting. This is best accomplished using a breadboard and the Breadboard Cable. Power must be supplied from your breadboard or another external source. To dive right into your application and use the GLK19264A-7T-1U in I^2C mode, get started with the guidelines below.

1. Set the Protocol Select switches.
    - I^2C: Ensure that the two I^2C jumpers in the corresponding protocol box are connected while all others are open.
2. Make the connections.
    a. Connect the Breadboard Cable to the Communication/Power Header on your GLK19264A-7T-1U and plug the four leads into your breadboard. The red lead will require power, while the black should be connected to ground, and the green and yellow should be connected to your controller clock and data lines respectively.
    b. Pull up the clock and data lines to five volts using a resistance between one and ten kilohms on your breadboard.
3. Create.
    - This time you're on your own. While there are many examples within the Matrix Orbital AppNote section, www.matrixorbital.ca/appnotes, too many controllers and languages exist to cover them all. If you get stuck in development, it is possible to switch over to another protocol on the standard board, and fellow developers are always on our forums for additional support.

2.3 USB Module

The GLK19264A-7T-1U-USB offers a single USB protocol for easy connection to a host computer. The simple and widely available protocol can be accessed using the on board mini B style USB connector as outlined in the USB Connections section.

Recommended Parts

Figure 6: Mini USB Cable (EXTMUSB3FT)

The External Mini USB cable is recommended for the GLK19264A-7T-1U-USB display. It will connect to the miniB style header on the unit and provide a connection to a regular A style USB connector, commonly found on a PC.

USB Connections

The USB connection is the quickest, easiest solution for PC development. After driver installation, the GLK19264A-7T-1U-USB will be accessible through a virtual serial port, providing the same result as a serial setup without the cable hassle. To connect to your GLK19264A-7T-1U-USB please follow the steps below.

1. Set the Protocol Select jumpers.
   - USB: The GLK19264A-7T-1U-USB offers USB protocol only. Model specific hardware prevents this unit from operating in any other protocol, and does not allow other models to operate in USB. Protocol Select jumpers on the USB model cannot be moved.
2. Make the connections.
   - Plug the mini-B header of your External Mini USB cable into your GLK19264A-7T-1U-USB and the regular USB header into your computer USB jack.
3. Install the drivers.
   a. Download the latest drivers at www.matrixorbital.ca/drivers, and save them to a known location.
   b. When prompted, install the USB bus controller driver automatically
   c. If asked, continue anyway, even though the driver is not signed
   d. When the driver install is complete, your display will turn on, but communication will not yet be possible.
   e. At the second driver prompt, install the serial port driver automatically
   f. Again, if asked, continue anyway
4. Create.
   - Use MOGD# or a terminal program to get started, and then move on with your own development. Instructions for the former can be found below and a number of application notes are available for the latter at www.matrixorbital.ca/appnotes.

2.4 RS422 Module

The GLK19264A-7T-1U-422 provides an industrial alternative to the standard RS232 communication protocol. Rather than single receive and transmit lines, the RS422 model uses a differential pair for the receive and transmit signals to reduce degradation and increase transmission lengths. Power can be transmitted at distance to a -VPT module or supplied from the immediate vicinity to a regular or –LV unit. RS422 signals are available in a six pin connector as described in the RS422 Connections section.

RS422 Connections

The GLK19264A-7T-1U-422 provides a robust RS422 interface to the display line. For this interface, a series of six wires are usually screwed into the RS422 terminal block provided. An alternate header is also available to provide local power to a regular or –LV unit. To connect to your GLK19264A-7T-1U-422, adhere to the steps laid out below.

1. Set the Protocol Select jumpers.
   - RS422: The GLK19264A-7T-1U-422 offers only RS422 protocol and does not require any jumper changes.
2. Make the connections.
   a. Screw one wire; sized 16 to 30 on the American Wire Gauge, into each of the six terminal block positions. When local power is supplied, a floppy cable may link to the alternate power header.
   b. Connect the Vcc wire to the positive terminal of your power supply and the GND terminal to the negative or ground lead to provide appropriate power as per Voltage Specifications.
   c. Secure the A and B wires to your non-inverting and inverting output signals respectively, while attaching the Z and Y wires to your inverting and non-inverting inputs.
3. Create.
   a. In a PC environment, MOGD# or a terminal program will serve to get you started. In addition, a variety of application notes are available online in a number of different languages to aid in the development of a host controller. Instructions for these programs can be found below and the simple C# example at www.matrixorbital.ca/appnotes is a great first programming reference.

3 Software

The multiple communication protocols available and simple command structure of the GLK19264A-7T-1U means that a variety of applications can be used to communicate with the display. Text is sent to the display as a character string, for example, sending the decimal value 41 will result in an 'A' appearing on the screen. A single control character is also available. Commands are merely values prefixed with a special command byte, 254 in decimal.

Table 2: Reserved Control Characters

Control Characters			
7	Bell / Sound Buzzer	10	Line feed / New line

Once the correct communication port is identified, the following communication settings can be applied to communicate correctly with the GLK19264A-7T-1U.

Table 3: Communication Settings

BPS	Data Bits	Parity	Stop Bits	Flow Control
19200	8	None	1	None

Finally, with a communication port identified and correctly setup simple text strings or even command bytes can easily be transmitted to control your display.

3.1 MOGD#

The Matrix Orbital Graphic Display interface, MOGD#, is offered as a free download from www.matrixorbital.ca/software/software_graphic. It provides a simple graphical interface that allows settings, fonts, and bitmaps to be easily customised for any application.

While monochromatic bitmaps can easily be created in virtually any image editing program, MOGD# provides an extensive font generation suite to stylize your display to any project design. In addition to standard font wide modifications, character ranges can be specified by start and end values to eliminate unused symbols, and individual glyphs can be modified with a double click. Finally, text spacing can be tailored and a complete font library built with your Matrix Orbital graphic display.

Like uProject, MOGD# offers a scripting capability that provides the ability to stack, run, and save a series of commands. The most basic function is the Send Numeric tool which is used to transmit a string of values to the display to write text or execute a command.

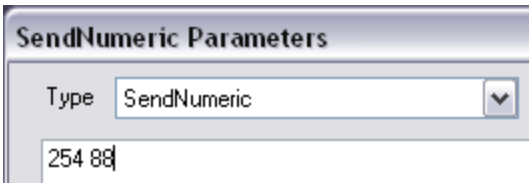

Figure 7: MOGD# Command Example

Again, the clear screen command is sent to a connected display, this time using the MOGD# Send Numeric function command style. Scripts can be run as a whole using the Play button from the toolbar or as single commands by selecting Step; once executed it must be Reset. Before issuing commands, it is a good idea to ensure communication with a display is successful using the autodetect button.

This program provides both a staging areas for your graphics display and a proving ground that will prepare it for any application environment.

3.2 Firmware Upgrade

Beginning with revision 8.1, the firmware of the GLK19264A-7T-1U can be upgraded in the field. All firmware revisions can be installed using software found at www.matrixorbital.ca/software/GLT Series.

If it is necessary to forgo all current and future upgrades to the filesystem and subsequent commands, firmware revision 8.0 may be ordered as a part of a custom order. Please use the Contact section to request more information from the Matrix Orbital sales team.

3.3 Application Notes

Full demonstration programs and code are available for Matrix Orbital displays in the C# language from Simple C# AppNote Pack in the Application Note section at www.matrixorbital.ca/appnotes. Difficulty increases from beginner, with the Hello World program, to advanced with the Dallas One-Wire temperature reading application.

Many additional applications are available in a number of different programming languages. These programs are meant to showcase the capability of the display and are not intended to be integrated into a final design. For additional information regarding code, please read the On Code document also found on the support site.

4 Hardware

4.1 Standard Model

Extended Communication/Power Header

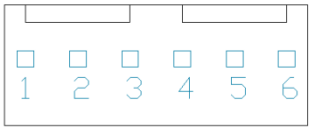

Figure 8: Extended Communication/Power Header

Table 4: Extended Communication/Power Pinout

Pin	Function
1	Vcc
2	Rx (SCL)
3	Tx (SDA)
4	Gnd
5	CTS
6	RTS

The Extended Communication/Power Header provides a standard connector for interfacing to the GLK19264A-7T-1U. Voltage is applied through pins one and four of the four pin Communication/Power Header. Please ensure the correct voltage input for your display by referencing Voltage Specifications before connecting power. Pins two and three are reserved for serial transmission, using either the RS-232/TTL or clocking data through the I²C protocol, depending on what has been selected by the Protocol Select Jumpers. Pins five and six can be used for serial transmission hardware flow control, and are ignored for I²C communications. The Molex 22-04-1061 style header used can be mated to a number of connectors, a 22-01-1062 for example.

Serial DB9 Connector

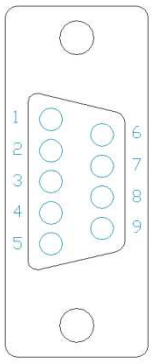

Figure 9: Serial DB9 Connector

Table 5: Serial DB9 Pinout

Pin	Function
2	Tx
3	Rx
5	Gnd
7	CTS
8	RTS
9	NC/Vcc*

The GLK19264A-7T-1U provides a DB-9 Connector to readily interface with serial devices using EIA232 standard signal levels. It is also possible to communicate at TTL levels of 0 to +5V by setting the Protocol Select Jumpers to TTL. As an added feature it is also possible to apply power through pin 9 of the DB-9 Connector in order to reduce cable clutter. A standard male DB9 header will provide the perfect mate for this connector.

***Note:** Do not apply voltage through pin 9 of the DB-9 Connector AND through the Communication/Power Header at the same time.

Power Through DB9 Jumper

In order to provide power through pin 9 of the DB-9 Connector you must connect the Power Through DB-9 Jumper labelled D, as illustrated below. This connection can be made using a zero ohm resistor, recommended size 0603, or a solder bridge. The GLK19264A-7T-1U allows all voltage models to use the power through DB-9 option, see the Voltage Specifications for power requirements.

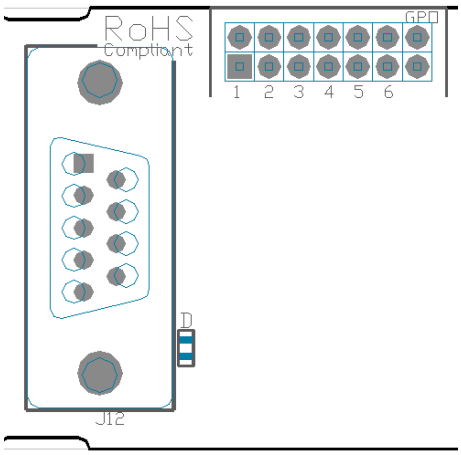

Figure 10: Power Through DB9 Jumper

Protocol Select Jumpers

The Protocol Select Jumpers provide the means necessary to toggle the GLK19264A-7T-1U between RS-232, TTL and I²C protocols. As a default, the jumpers are set to RS-232 mode with solder jumps on the RS232 jumpers. In order to place the display module in I²C mode you must first remove the solder jumps from the RS232 jumpers and then place them on the I^2C jumpers. The display will now be in I²C mode and have a default slave address of 80, unless changed with the appropriate command. Similarly, in order to change the display to TTL mode, simply remove the zero ohm resistors from the RS232 or I²C jumpers and solder them to the TTL jumpers.

Hardware Lock

The Hardware Lock allows fonts, bitmaps, and settings to be saved, unaltered by any commands. By connecting the two pads near the memory chip, designated R74, with a zero ohm resistor, the display will be locked. This supersedes the data lock command and cannot be circumvented by any software means. To unlock the display and make changes simply remove the jumper.

4.2 USB Model

Mini USB Connector

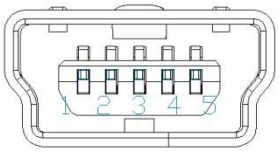

Figure 11: Mini USB Connector

Table 6: Mini USB Pinout

Pin	Function
1	Vcc
2	D-
3	D+
5	Gnd

The GLK19264A-7T-1U-USB comes with a familiar Mini USB Connector to fulfill both communication and power needs. The standard Mini-B style header can be connected to any other USB style using the appropriate cable. Most commonly used with a PC, this connection creates a virtual com port that offers a simple power solution with a familiar communication scheme.

Alternate USB Header

Some advanced applications may prefer the straight four pin connection offered through the Optional Alternate USB Header. This header offers power and communication access in a simple interface package. The Optional Alternate USB Header may be added to the GLK19264A-7T-1U-USB for an added charge as part of a custom order. Please use the Contact section to request more information from the friendly Matrix Orbital sales team.

Alternate Power Connector

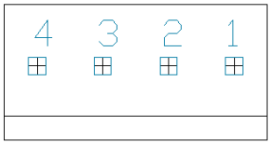

Figure 12: Alternate Power Connector

Table 7: Alternate Power Pinout

Pin	Function
1	Vcc
2	Gnd
3	Gnd
4	NC

The Alternate Power Connector provides the ability to power the GLK19264A-7T-1U-USB using a second cable. The Tyco 171825-4 style header is particularly useful for connecting to an unmodified floppy power cable, a 171822-4 for example, from a PC power supply for a simple bench power solution.

4.3 RS422 Model

RS422 Header

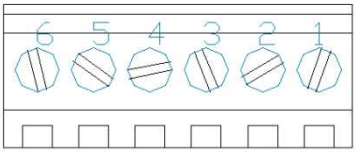

Figure 13: RS422 Header

Table 8: RS422 Pinout

Pin	Function
1	Gnd
2	Rx (Y)
3	Inv Rx (Z)
4	Inv Tx (B)
5	Tx (A)
6	Vcc

The six pin RS422 interface header of the GLK19264A-7T-1U-422 offers power and ground connections as well as two differential pair communication lines. Regular and inverted lines are provided for both receive and transmit signals. Power is supplied locally to the regular or –LV variants while the –VPT can receive power over a distance. The Tyco 282834-6 style header is most suited to a simple wire connection.

Alternate Power Connector

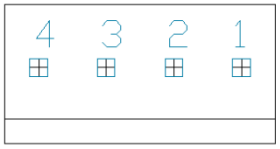

Figure 14: Alternate Power Connector

Table 9: Alternate Power Pinout

Pin	Function
1	Vcc
2	Gnd
3	Gnd
4	NC

The Alternate Power Connector provides the ability to power the GLK19264A-7T-1U-USB using a second cable. The Tyco 171825-4 style header is particularly useful for connecting to an unmodified floppy power cable, a 171822-4 for example, from a PC power supply for a simple bench power solution.

4.4 Common Features

General Purpose Outputs

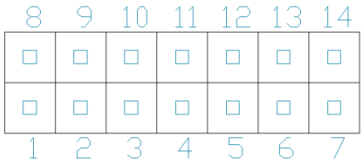

Figure 15: GPO Header

Table 10: GPO Pinout

Pin	Function	Pin	Function
1	GPO 1	8	Gnd
2	GPO 2	9	Gnd
3	GPO 3	10	Gnd
4	GPO 4	11	Gnd
5	GPO 5	12	Gnd
6	GPO 6	13	Gnd
7	Vcc	14	Gnd

A unique feature of the GLK19264A-7T-1U is the ability to control relays* and other external devices using either one or six General Purpose Outputs. Each can source up to 10mA of current at five volts when on or sink 20mA at zero volts when off. The two row, fourteen pin header can be interfaced to a number of female connectors to provide control to any peripheral devices required.

***Note:** If connecting a relay, be sure that it is fully clamped using a diode and capacitor in order to absorb any electro-motive force (EMF) which will be generated.

Dallas One-Wire Connector

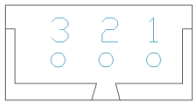

Figure 16: Dallas One-Wire Connector

Table 11: Dallas One-Wire Pinout

Pin	Function
1	Vcc
2	D
3	Gnd

In addition to the six general purpose outputs the GLK19264A-7T-1U offers an Optional Dallas One-Wire bridge, to allow for an additional thirty two one-wire devices to be connected to the display. This header can be populated with a Tyco 173979 connector at an added cost by custom order only. Please use the Contact section to request more information from the Matrix Orbital sales team.

5 Troubleshooting

5.1 Power

In order for your Matrix Orbital display to function correctly, it must be supplied with the appropriate power. If the power LED near the top right corner of the board is not illuminated, power is not applied correctly. Try following the tips below.

- First, check the power cable which you are using for continuity. If you don't have an ohm meter, try using a different power cable, if this does not help try using a different power supply.
- If power is applied through the DB9 connector, ensure that the Power Through DB9 Jumper is connected.
- If changes have been made to the protocol select block, ensure all the appropriate protocol select jumpers are connected and all unused protocol jumpers are disconnected.
- The last step will be to check the interface connector in use on your display. If the power connections have become loose, or you are unable to resolve the issue, please Contact Matrix Orbital for more information.

5.2 Display

If your display is powered successfully, the Matrix Orbital logo, or user created screen should display on start up. If this is not the case, check out these tips.

- Ensure the contrast is not too high or too low. This can result in a darkened or blank screen respectively. See the Manual Override section to reset to default.
- Make sure that the start screen is not blank. It is possible to overwrite the Matrix Orbital logo start screen, if this happens the screen may be blank. Try writing to the display to ensure it is functional, after checking the contrast above.

5.3 Communication

When communication of either text or commands is interrupted, try the steps below.

- First, check the communication cable for continuity. If you don't have an ohm meter, try using a different communication cable. If you are using a PC try using a different Com/USB Port.
- Next, please ensure that the display module is set to communicate on the protocol that you are using, by checking the Protocol Select Jumpers.
- In serial and USB protocols, ensure that the host system and display module are both communicating on the same baud rate. The default rate for the display module is 19200 bps.
- Match Rx from your display to the transmitting pin from your host and the Tx pin to the receiving pin.
- If you are communicating to the display via I²C* please ensure that the data is being sent to the correct address. The default slave address for the display module is 80.
- In I²C mode, connect Rx to the clock line of your controller and Tx to the data output.
- Unlock the display. See the Set and Save Data Lock command for more info.
- Finally, you may reset the display to its default settings using the Manual Override procedure outlined below.

***Note:** I²C communication will always require pull up resistors on SCL and SDA of one to ten kilohms.

5.4 Manual Override

Should the settings of your display become altered in a way that dramatically impacts usability, the default settings can be temporarily restored. To override the display, please follow the steps below.

1. Disconnect power from your display.
2. Hold down the bottom left dot key.
3. Reconnect power to your unit, and wait for the start screen before releasing the key.
4. Settings will be temporarily** overridden to the defaults listed in the Manual Override Settings table. At this point any important settings, such as contrast, backlight, or baud rate, should not only be set but saved so they remain when the override is removed.

Parameter	Value
Backlight	255
Contrast	128
Baud Rate	19200
I²C Address	80

Table 12: Manual Override Settings

****Note:** The display module will revert back to the old settings once turned off, unless desired settings are saved.

6 Commands

6.1 Communication

1.1 Change Baud Rate	Dec	254 57	Speed	v8.0
	Hex	FE 39	Speed	
	ASCII	■ 9	Speed	
Immediately changes the baud rate. Not available in I2C. Baud rate can be temporarily forced to 19200 by a manual override.				
Speed	Byte	Valid settings shown below.		

Table 13: Accepted Baud Rate Values

Rate	9600	14400	19200	28800	38400	57600	76800	115200
Speed	207	138	103	68	51	34	25	16

1.2 Change I2C Slave Address	Dec	254 51	Address	v8.0
	Hex	FE 33	Address	
	ASCII	■ 3	Address	
Immediately changes the I2C write address. Only even values are permitted as the next odd address will become the read address. Default is 80.				
Address	Byte	Even value.		

1.3 Transmission Protocol Select	Dec	254 160	Protocol	v8.0
	Hex	FE A0	Protocol	
		■ á	Protocol	
Selects the protocol used for data transmission from the display. Data transmission to the display is not affected. Must be set to the protocol in use to receive data correctly.				
Protocol	Byte	1 for Serial (RS232/RS422/TTL/USB) or 0 for I2C.		

1.4 Set a Non-Standard Baud Rate	Dec	254 164	Speed	v5.0
	Hex	FE A4	Speed	
	ASCII	■ ñ	Speed	
Immediately changes the baud rate to a non-standard value. Speed must be a whole number between 977 and 153800. Due to rounding, error increases with baud rate, actual baud must be within 3% of desired baud to ensure accurate communication. Not available in I2C. Can be temporarily forced to 19200 by a manual override.				
Speed	Short	Calculations shown below, standard crystal speed is 16MHz.		

$$Speed = \frac{CrystalSpeed}{(8 \times DesiredBaud)} - 1$$

Equation 1: Speed Byte Calculation

$$ActualBaud = \frac{CrystalSpeed}{(8 \times (Speed + 1))}$$

Equation 2: Actual Baud Rate Calculation

$$\frac{|DesiredBaud - ActualBaud|}{DesiredBaud} < 0.03$$

Equation 3: Baud Rate Error Calculation

1.5 Set Flow Control Mode	Dec	254 63	Mode	v8.0
	Hex	FE 3F	Mode	
	ASCII	■ ?	Mode	

Toggles flow control between hardware, software and off settings. Software and Hardware control can be further tuned using the settings above. Default is Off, or 0.

Mode	Byte	Flow control setting as below.

Table 14: Hardware Flow Control Trigger Levels

Bytes	1	4	8	14
Level	0	1	2	3

Table 15: Flow Control Settings

Flow Control	None	Software	Hardware
Mode	0	1	2

1.6 Set Hardware Flow Control Trigger Level	Dec	254 62	Level	v8.0
	Hex	FE 3E	Level	
	ASCII	■ >	Level	

Sets the hardware flow control trigger level. The Clear To Send signal will be deactivated once the number of characters in the display buffer reaches the level set; it will be reactivated once all data in the buffer is handled.

Level	Byte	Trigger level as above.

1.7 Turn Software Flow Control On	Dec	254 58	Almost Full	Almost Empty	v8.0
	Hex	FE 3A	Almost Full	Almost Empty	
	ASCII	■ :	Almost Full	Almost Empty	

Enables simple flow control. The display will return a single, Xoff, byte to the host when the display buffer is almost full and a different, Xon, byte when the buffer is almost empty. Full value should provide enough room for the largest data packet to be received without buffer overflow. No data should be sent to the display between full and empty responses to permit processing. Buffer size is 256* bytes. Not available in I^2C. Default off.

Almost Full	Byte	Number of bytes remaining before buffer is completely full, 0 < Full < Empty < 256*.
Almost Empty	Byte	Number of bytes before buffer can be considered empty enough to accept data.

***Note:** Buffer size was increased to 256 bytes from 128 bytes at firmware revision 8.3.

1.8 Turn Software Flow Control Off	Dec	254 59	v8.0
	Hex	FE 3B	
	ASCII	■ ;	

Disables flow control. Bytes sent to the display may be permitted to overflow the buffer resulting in data loss.

1.9 Set Software Flow Control Response	Dec	254 60	Xon	Xoff	v8.0
	Hex	FE 3C	Xon	Xoff	
	ASCII	■ <	Xon	Xoff	

Sets the values returned for almost full and almost empty messages when in flow control mode. This command permits the display to utilize standard flow control values of 0x11 and 0x13, note that defaults are 0xFF and 0xFE.

Xon	Byte	Value returned when display buffer is almost empty, permitting transmission to resume.
Xoff	Byte	Value returned when display buffer is almost full, signaling transmission to halt.

1.10 Echo	Dec	254 255	Length	Data	v8.3
	Hex	FE FF	Length	Data	
	ASCII	■	Length	Data	

Send data to the display that it will echo. Useful to confirm communication or return information from scripts.

Length	Short	Length of data array to be echoed.
Data	Byte(s)	An arbitrary array of data that the module will return.
Response	Byte(s)	The same arbitrary array of data originally sent.

1.11 Delay	Dec	254 251	Time	v8.3
	Hex	FE FB	Time	
	ASCII	■ √	Time	

Pause command execution to and responses from the display for the specified length of time.

Time	Short	Length of delay in ms, maximum 2000.

1.12 Software Reset	Dec	254 253 77 79 117 110	v8.4
	Hex	FE FD 4D 4F 75 6E	
	ASCII	■ ² M O u n	

Reset the display as if power had been cycled via a software command. No commands should be sent while the unit is in the process of resetting; a response will be returned to indicate the unit has successfully been reset.

Response	Short	Successful reset response, 254 212.

6.2 Text

2.1 Clear Screen	Dec	254 88	v8.0
	Hex	FE 58	
	ASCII	■ X	

Clears the contents of the screen.

2.2 Go Home	Dec	254 72	v8.0
	Hex	FE 48	
	ASCII	■ H	

Returns the cursor to the top left of the screen.

2.3 Set Cursor Position	Dec	254 71	Column	Row	v8.0
	Hex	FE 47	Column	Row	
	ASCII	■ G	Column	Row	

Sets the cursor to a specific cursor position where the next transmitted character is printed.

Column	Byte	Value between 1 and number of character columns.
Row	Byte	Value between 1 and number of character rows.

2.4 Set Cursor Coordinate	Dec	254 121	X Y	v8.0
	Hex	FE 79	X Y	
	ASCII	■ y	X Y	

Sets the cursor to an exact pixel position where the next transmitted character is printed.

X	Byte	Value between 1 and screen width, represents leftmost character position.
Y	Byte	Value between 1 and screen height, represents topmost character position.

2.5 Get String Extents	Dec	254 41	Text	v8.6
	Hex	FE 29	Text	
	ASCII	■)	Text	

Read the size of the rectangle that the specified string would occupy if it was rendered with the current font.

Text	String	String on which to preform extents calculation. A single line of text is assumed.
Response	Byte(s)	Width and height of the string in pixels. A width greater than the screen will return 0.

2.6 Initialize Text Window	Dec	254 43	ID X1 Y1 X2 Y2 Font CharSpace LineSpace Scroll	v8.3
	Hex	FE 2B	ID X1 Y1 X2 Y2 Font CharSpace LineSpace Scroll	
	ASCII	■ +	ID X1 Y1 X2 Y2 Font CharSpace LineSpace Scroll	

Designates a portion of the screen to which text can be confined. Font commands affect only the current window, default (entire screen) is window 0.

ID	Byte	Unique text window identification number, value between 0 and 15.
X1	Byte	Leftmost coordinate.
Y1	Byte	Topmost coordinate.
X2	Byte	Rightmost coordinate.
Y2	Byte	Bottommost coordinate.
Font*	Short	Unique font ID to use for this window, value between 0 and 1023.
CharSpace	Byte	Spacing between characters to use for this window.
LineSpace	Byte	Spacing between lines to use for this window.
Scroll	Byte	Number of pixel rows to write to before scrolling text.

***Note:** Font was changed from a Byte length at firmware revision 8.5

2.7 Set Text Window	Dec	254 42	ID	v8.3
	Hex	FE 2A	ID	
	ASCII	■ *	ID	

Sets the text window to which subsequent text and commands will apply. Default (entire screen) is window 0.

ID	Byte	Unique text window to use.

2.8 Clear Text Window	Dec	254 44	ID	v8.3
	Hex	FE 2C	ID	
	ASCII	■ ,	ID	

Clear the contents of a specific text window, similar to the clear screen command.

ID	Byte	Unique text window to clear.

2.9 Initialize Label	Dec	254 45	ID X1 Y1 X2 Y2 Vert Hor Font Background CharSpace	v8.3
	Hex	FE 2D	ID X1 Y1 X2 Y2 Vert Hor Font Background CharSpace	
	ASCII	■ -	ID X1 Y1 X2 Y2 Vert Hor Font Background CharSpace	

Designates a portion of the screen that can be easily updated with one line of text, often used to display variables.

ID	Byte	Unique label identification number, value between 0 and 15.
X1	Byte	Leftmost coordinate.
Y1	Byte	Topmost coordinate.
X2	Byte	Rightmost coordinate.
Y2	Byte	Bottommost coordinate.
Vert	Byte	Vertical justification of the label text; 0 for top, 1 for middle, or 2 for bottom.
Hor	Byte	Horizontal justification of the label text; 0 for left, 1 for centre, or 2 for right.
Font*	Short	Unique font ID to use for this label, value between 0 and 1023.
Background	Byte	State of the pixels in the label region that is not occupied by text; 0 for off or 1 for on.
CharSpace	Byte	Spacing between characters to use for this label.

***Note:** Font was changed from a Byte length at firmware revision 8.5

2.10 Initialize Scrolling Label	Dec	254 47	ID X1 Y1 X2 Y2 Vert Dir Font Background CharSpace Delay	v8.6
	Hex	FE 2F	ID X1 Y1 X2 Y2 Vert Dir Font Background CharSpace Delay	
	ASCII	■ /	ID X1 Y1 X2 Y2 Vert Dir Font Background CharSpace Delay	

Designates a portion of the screen that can be easily updated with one line of text, often used to display variables.

ID	Byte	Unique label identification number, value between 0 and 15.
X1	Byte	Leftmost coordinate.
Y1	Byte	Topmost coordinate.
X2	Byte	Rightmost coordinate.
Y2	Byte	Bottommost coordinate.
Vert	Byte	Vertical justification of the label text; 0 for top, 1 for middle, or 2 for bottom.
Dir	Byte	Direction of the scrolling behavior; 0 for left, 1 for right, or 2 for bounce.
Font	Short	Unique font ID to use for this label, value between 0 and 1023.
Background	Byte	State of the pixels in the label region that is not occupied by text; 0 for off or 1 for on.
CharSpace	Byte	Spacing between characters to use for this label.
Delay	Short	Time in milliseconds to elapse between characters printed.

2.11 Update Label	Dec	254 46	ID Data	v8.3
	Hex	FE 2E	ID Data	
	ASCII	■ .	ID Data	

Update a previously created label or scrolling label with new text. Send a null character (empty string) to clear.

ID	Byte	Unique label to update, value between 0 and 15.
Data	String	Information to display in the label, must be terminated with a null (value of zero) byte.

2.12 Auto Scroll On	Dec	254 81	v8.0
	Hex	FE 51	
	ASCII	■ Q	

The entire contents of screen are shifted up one line when the end of the screen is reached. Display default is on.