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GLK24064-25 / GLT24064

Including GLK24064-25-422, GLK24064-25-USB, GLT24064-422, and GLT24064-USB

Technical Manual

Revision 2.2

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Firmware Revision: 8.1 or Higher

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2.1	January 27, 2011	Filesystem Command Updates for Firmware Revision 8.1	Clark
2.0	November 3, 2010	Initial Release	Clark

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1 Introduction

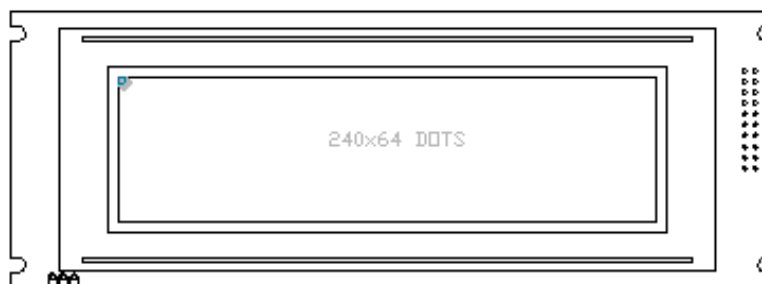


Figure 1: GLK24064-25/GLT24064 Display

The GLK24064-25/GLT24064 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 GLK24064-25/GLT24064 to be connected to a wide variety of host controllers. Communication speeds of up to 115.2kbps for serial protocols and 100kbps for I²C 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 thirty-two kilobytes of customizable fonts and bitmaps to enhance the graphical user experience.

User input on the GLK24064-25 is available through a five by five matrix style keypad or a resistive touch overlay on the GLT24064. Six general purpose outputs provide simple switchable five volt sources on each model. In addition, a versatile Dallas One-Wire header provides a communication interface for up to thirty-two devices.

The versatile GLK24064-25/GLT24064, 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

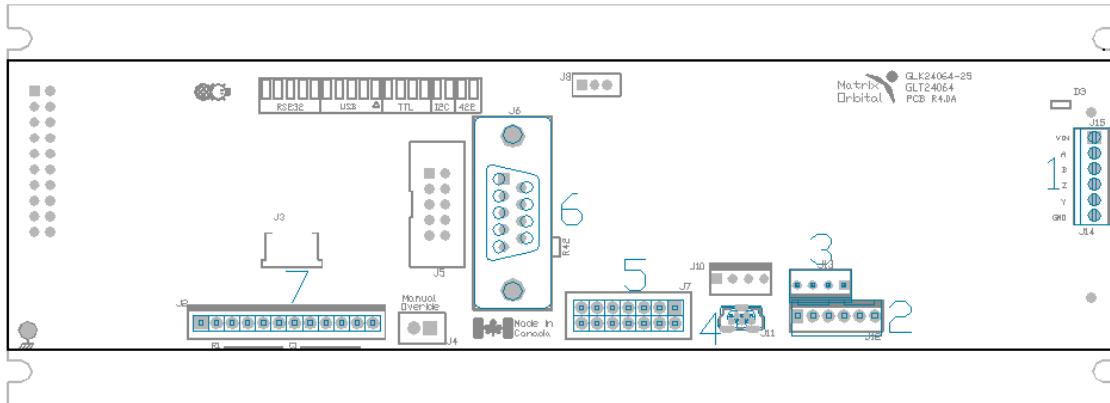


Figure 2: GLK24064-25/GLT24064 Header Locations

Table 1: List of Available Headers

#	Header	Mate	Population
1	RS422 Terminal Block	16-30 AWG Wire	422 Model Only
2	Extended Communication/Power Connector	ESCCPC5V/BBC	Standard Model Only
3	Alternate Power Connector	PCS	422 and USB Models Only
4	Mini USB Connector	EXTMUSB3FT/INTMUSB3FT	USB Model Only
5	GPO Header	None Offered	All Models
6	DB9 Serial Header	CSS1FT/CSS4FT	Standard Model Only
7	Keypad/Touchpad	KPP4x4/Touch Panel	GLK/GLT Model Only

2.2 Standard Module

The standard version of the GLK24064-25/GLT24064 allows for user configuration of three 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 I²C protocol. Connections for each protocol can be accessed through the four pin Communication/Power Header as outlined in the Serial Connections and I²C Connections sections below.

Recommended Parts



Figure 3: 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 4: Breadboard Cable (BBC)

For a more flexible interface to the GLK24064-25/GLT24064, 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.

2.3 Serial Connections

Serial protocol provides a classic connection to the GLK24064-25/GLT24064. 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 GLK24064-25/GLT24064.
 - b. Insert the male end of your serial cable to the corresponding DB9 header of the Extended Communication/Power Cable and 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 Extended Communication/Power Cable.
3. Create.
 - MOGD# or hyperterminal will serve to get you started, and then you can move on with your own development. Instructions for these programs can be found below and a variety of application notes are available at www.matrixorbital.ca/appnotes.

I²C Connections

A more advanced connection to the GLK24064-25/GLT24064 is provided by the I²C 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 GLK24064-25/GLT24064 in I²C mode, get started with the guidelines below.

1. Set the Protocol Select switches.
 - I²C: Ensure that the two I²C 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 GLK24064-25/GLT24064 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.

2.4 USB Module

The GLK24064-25-USB/GLT24064-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 5: Mini USB Cable
(EXTMUSB3FT)

The External Mini USB cable is recommended for the GLK24064-25-USB/GLT24064-USB display. It will connect to the mini-B 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 GLK24064-25-USB/GLT24064-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 GLK24064-25-USB/GLT24064-USB, please follow the steps below.

1. Set the Protocol Select jumpers.
 - USB: The GLK24064-25-USB/GLT24064-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 the USB protocol. 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 GLK24064-25-USB/GLT24064-USB and the regular USB header into your computer USB jack. Additional power may be required, especially for YG displays, and can be supplied to the Alternate Power Connector.
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 hyperterminal to get started, and then move on with your own development. Instructions for these programs can be found below and a number of application notes are available at www.matrixorbital.ca/appnotes.

2.5 RS422 Module

The GLK24064-25-422/GLT24064-422 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 each of 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 unit. RS422 signals are available in a six pin connector as described in the RS422 Connections section.

RS422 Connections

The GLK24064-25-422/GLT24064-422 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 unit. To connect to your GLK24064-25-422/GLT24064-422, adhere to the steps laid out below.

1. Set the Protocol Select jumpers.
 - RS422: The GLK24064-25-422/GLT24064-422 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 in Table 62.
 - 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.
 - In a PC environment, MOGD# or hyperterminal 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 GLK24064-25/GLT24064 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	
10	Line feed / New line

Once the correct communication port is identified, the following communication settings can be applied to communicate correctly with the GLK24064-25/GLT24064.

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 monotone 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.

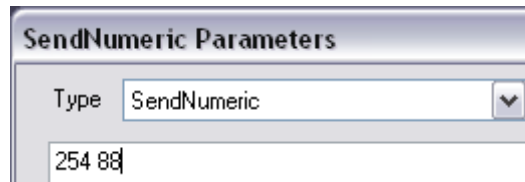


Figure 6: MOGD# Command Example

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.

3.1 Firmware Upgrade

Beginning with revision 8.1, the firmware of the GLK24064-25/GLT24064 can be upgraded in the field. Alternatively, the changes to the filesystem and subsequent commands can also be reverted by downgrading the firmware to revision 8.0 using the same process.

All firmware revisions of the GLK24064-25/GLT24064 can be downloaded from www.matrixorbital.ca/software/GLTSeries and installed using MOGD#.

3.2 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

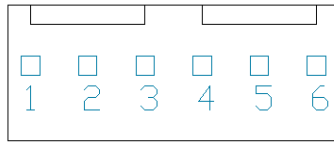


Figure 7: Extended Communication/Power Header

Table 4: Extended Communication/Power Pinout

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

The Extended Communication/Power Header provides a standard connector for interfacing to the GLK24064-25/GLT24064. 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 the electrical specifications in Table 62 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.

Serial DB9 Connector

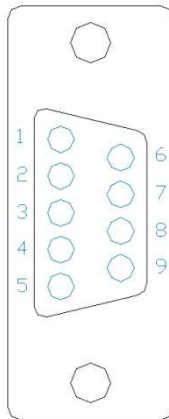


Figure 8: Serial DB9 Connector

Table 5: Serial DB9 Pinout

Pin	Function
2	Tx
3	Rx
5	Gnd
9	NC/Vcc*

The GLK24064-25/GLT24064 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 R42, as illustrated below. This connection can be made using a zero ohm resistor, recommended size 0603, or a solder bridge. The GLK24064-25/GLT24064 allows all voltage models to use the power through DB-9 option, see the specifications in Table 62 for voltage requirements.

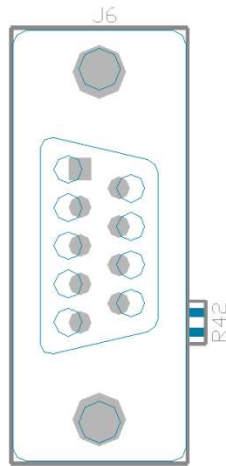


Figure 9: Power Through DB9 Jumper

Alternate Serial Header

Some advanced applications may prefer the straight two by five pin connection offered through the optional Alternate Serial Header. This header offers power and communication access in a simple interface package. The Alternate Serial Header may be added to the GLK24064-25/GLT24064 Standard model for an added charge as part of a custom order. Please Contact sales for details.

Protocol Select Jumpers

The Protocol Select Jumpers provide the means necessary to toggle the standard GLK24064-25/GLT24064 model 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 I²C 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 as R13, 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

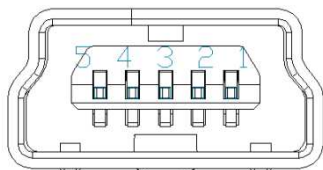


Figure 10: Mini USB Connector

Table 6: Mini USB Pinout

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

The GLK24064-25-USB/GLT24064-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 GLK24064-25-USB/GLT24064-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

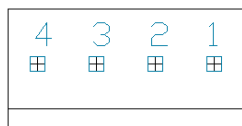


Figure 11: Alternate Power Connector

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 GLK24064-25-USB/GLT24064-USB using a second cable. The Tyco 171825-4 style header is particularly useful for connecting to an unmodified floppy power cable from a PC power supply for a simple bench power solution.

4.3 RS422 Model

RS422 Header

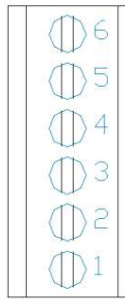


Figure 12: RS422 Header

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 GLK24064-25-422/GLT24064-422 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 variant 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

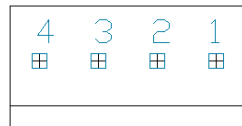


Figure 13: Alternate Power Connector

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 GLK24064-25-422/GLT24064-422 using a second cable. This is particularly useful for the regular module that is to be powered locally. The Tyco 171825-4 style header will fit a floppy power cable from a PC power supply for a simple bench power solution.

4.4 GLK Model

Keypad Header

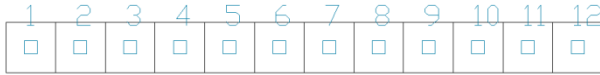


Figure 14: Keypad Header

Table 10: Keypad Pinout

Pin	Function	Pin	Function
1	Gnd	7	Column 1
2	Row 1	8	Column 2
3	Row 2	9	Column 3
4	Row 3	10	Column 4
5	Row 4	11	Column 5
6	Row 5	12	Gnd/Vcc*

To facilitate user input, the GLK24064-25 provides a Keypad Interface Connector which allows a matrix style keypad of up to twenty-five keys to be directly connected to the display module. Key presses are generated when a short is detected between a row and a column. When a key press is generated, a character specific to that key press is automatically sent on the Tx communication line. If the display module is running in I²C mode, the “Auto Transmit Keypress” function may be turned off to allow the key presses to remain in the buffer so that they may be polled. The character that is associated with each key press may also be altered using the “Assign Key Codes” command. The straight twelve pin header of the Keypad Interface Connector will interface to a variety of different devices including the Matrix Orbital KPP4x4 keypad.

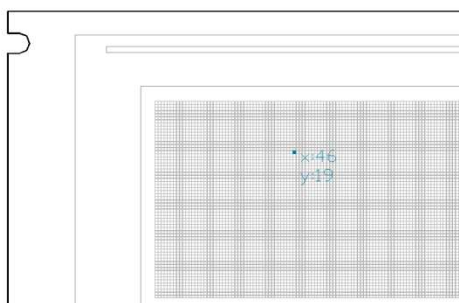
***Note:** The Ground / +5V pin is toggled by the jumper to the right of the keypad connector. Jump pads 1 & 2 for +5V or 2 & 3 for GND.

4.5 GLT Model

Touch Screen

The GLT24064 facilitates user touch input in one of two distinct ways. Coordinate mode will report events by supplying their exact position on the screen. Region mode will report events within defined boundaries on the screen. Both modes are outlined below.

Coordinate Mode

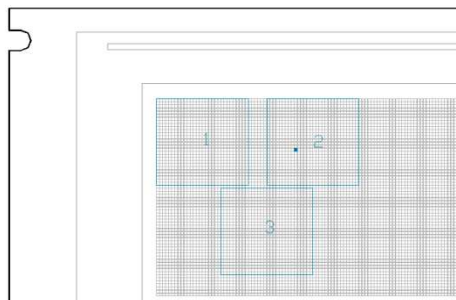


In coordinate mode all touch events are reported using three single byte values. First, the type of event is transmitted, followed by the x and y coordinates of its position. Pressure and drag thresholds must be exceeded for an event to be registered. A low drag threshold will result in greater tracking accuracy but transmits much more data to the host. Care should be taken to find balance. This mode offers a great degree of flexibility and creativity.

Table 11: Coordinate Mode Event Prefixes

Return Value	1	2	4
Touch Event	Press	Release	Drag

Region Mode



A simpler, keypad style alternative to coordinate mode, region mode offers only a single byte for each touch event. Unique regions are created by specifying a position, size, and return values. A value corresponding to a specific region is returned when an event occurs within its bounds. Events outside of regions result in transmission of the value 255. Regions can be deleted individually or collectively when no longer needed. This mode allows quick and easy set up.

Table 12: Region Mode Event Responses

Return Value	Key Down	Key Up	Key Down	255
Touch Event	Press	Release	Drag	Out of Region

4.6 Common Features

General Purpose Outputs

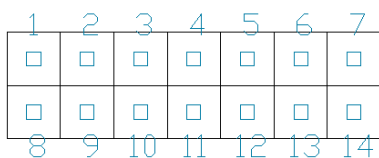


Figure 15: GPO Header

Table 13: 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 GLK24064-25/GLT24064 is the ability to control relays* and other external devices using one of six General Purpose Outputs. Each can source up to 19mA of current at 4.6V when on or sink 19mA at 0V 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

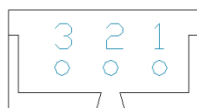


Figure 16: Dallas One-Wire Connector

Table 14: Dallas One-Wire Pinout

Pin	Function
1	Vcc
2	D
3	Gnd

In addition to the six general purpose outputs the GLK24064-25/GLT24064 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 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 protocol, ensure that the host system and display module are both communicating on the same baud rate. The default baud rate for the display module is 19200 bps.
- Match Rx from the GLK24064-25/GLT24064 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.

***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. Place a jumper on the two manual override pins, for the GLK model these are the middle two keypad pins, for the GLT these are the two pins near the keypad header.
3. Reconnect power to your unit, and wait for the start screen before removing the jumper. Please note the jumper will adversely affect GLT performance if left in place during use.
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
I ² C Address	80

Table 15: 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 Communications

1.1 Changing the I2C Slave Address	Dec	254 51	Address
	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	1 byte, even value		

1.2 Changing the Baud Rate	Dec	254 57	Speed
	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	1 byte, valid settings shown below		

Table 16: Accepted Baud Rate Values

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

1.3 Transmission Protocol Select	Dec	254 160	Protocol
	Hex	FE A0	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	1 byte, 1 for Serial (RS232/RS422/TTL/USB) or 0 for I2C		

1.4 Turn Software Flow Control On	Dec	254 58	Full Empty
	Hex	FE 3A	Full Empty
	ASCII	■ :	Full 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 128 bytes. Not available in I ² C. Default off.			
Full	1 byte, number of bytes remaining before buffer is completely full, 0 < Full < Empty < 128		
Empty	1 byte, number of bytes remaining before buffer can be considered empty enough to accept more data		

1.5 Turn Software Flow Control Off	Dec	254 59
	Hex	FE 3B
	ASCII	■ ;
Disables flow control. Bytes sent to the display may be permitted to overflow the buffer resulting in data loss.		

1.6 Set Software Flow Control Response	Dec	254 60	Xon Xoff
	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	1 byte, value returned when display buffer is almost empty, permitting transmission to resume		
Xoff	1 byte, value returned when display buffer is almost full, signaling transmission to halt		

1.7 Set Hardware Flow Control Trigger Level	Dec	254 62	Level
	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	1 byte, trigger level as below		

Table 17: Hardware Flow Control Trigger Levels

Bytes	1	4	8	14
Level	0	1	2	3

Table 18: Flow Control Settings

Flow Control	None	Software	Hardware
Mode	0	1	2

1.8 Set Flow Control Mode	Dec	254 63	Mode
	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 Hardware, or 2.			
Mode	1 byte, flow control setting as above		