
# LK402-25

Including LK402-25-422 and LK402-25-USB

## Technical Manual

Revision 1.5

**PCB Revision: 3.0 or Higher**

**Firmware Revision: 7.3 or Higher**

## Revision History

| Revision | Description | Author |
|---|---|---|
| 1.5 | Correction to Set Non-Standard Baud Rate command | Divino |
| 1.4 | Revision to Commands for Firmware Version 7.3 | Divino |
| 1.3 | Added Power Directions for the RS422 Model | Clark |
| 1.2 | Added Command Summary Addition | Clark |
| 1.1 | Grammatical and Ease of Reading Enhancements | Clark |
| 1.0 | Initial Release | Clark |

# Contents

# Introduction

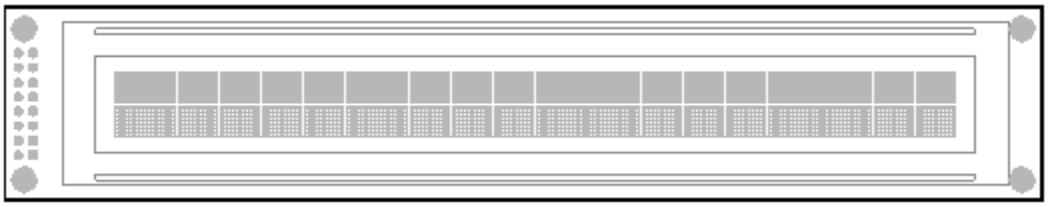


*Figure 1: LK402-25 Display*

The LK402-25 is an intelligent alphanumeric liquid crystal display designed to decrease development time by providing an instant solution to any project. In addition to the RS232, TTL and $I^2C$ protocols available in the standard model, USB and RS422 communication models allow the LK402-25 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 data display.

The simple command structure provided permits easy software control of many settings including backlight brightness, screen contrast, and baud rate. On board memory provides up to thirty-two custom characters which can be saved and recalled for start screens, bar graphs or larger numbers.

User input is available through a five by five matrix style keypad, and six general purpose outputs provide simple switchable five volt sources. In addition, a Dallas One-Wire header provides a convenient communication interface for up to thirty-two devices.

The versatile LK402-25, with all the features mentioned above, is available in a variety of colour, voltage, and temperature options to suit almost any application.

# Quick Connect Guide

## Standard Module

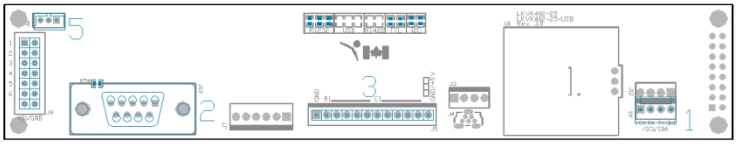


*Figure 2: Standard Connections*

*Table 1: Standard Headers*

| # | Header | Mate |
|---|---|---|
| 1 | Communication/ Power | SCCPC5V/ BBC |
| 2 | DB9 | CSS1FT/CSS4FT |
| 3 | Keypad | KPP4x4 |
| 4 | GPO | None Offered |
| 5 | Dallas One-Wire | Temperature Probe |

The standard version of the LK402-25 allows for user configuration of three common communication protocols. First, the unit can communicate using serial protocol at either RS232 or TTL voltage levels. Second, it can communicate using the Inter-Integrated Circuit, or $I^2C$ protocol. Connections for each protocol can be accessed through the four pin Communication/Power Header as outlined in Serial Connections the and $I^2C$ Connections sections below.

### Recommended Parts

*Figure 3: Communication/Power Cable (SCCPC5V)*

The most common cable choice for any standard Matrix Orbital display, the 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 LK402-25, 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

The serial interface provides a classic connection to the LK402-25. The Communication/Power Cable is most commonly used for this setup 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 three jumpers* in the 232 protocol box with the zero ohm jumper resistors provided or an alternate wire or solder solution.
   - TTL: Connect the two 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 four pin female header of the Communication/Power Cable to the Communication/Power Header of your LK402-25.
   b. Insert the male end of your serial cable to the corresponding DB9 header of the 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.
   - uProject or hyperterminal will serve to get you started, and then 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.

### I²C Connections

A more advanced connection to the LK402-25 is provided by the I²C protocol setting. It requires a connection directly to your project. 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 LK402-25 in I²C mode, get started with the guidelines below.

1. Set the Protocol Select Jumpers.
   - 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 LK402-25 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.

## USB Module

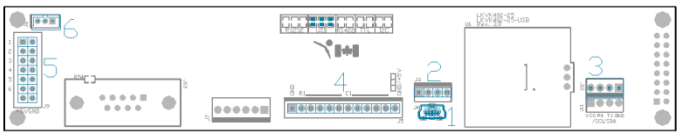



*Figure 5: USB Connections*

*Table 2: Standard Headers*

| # | Header | Mate |
|---|---|---|
| 1 | Mini USB | EXTMUSB3FT/ INTMUSB3FT |
| 2 | Alternate USB | None Offered |
| 3 | Alternate Power | PCS |
| 4 | Keypad | KPP4x4 |
| 5 | GPO | None Offered |
| 6 | Dallas One-Wire | Temperature Probe |

The LK402-25-USB offers a single USB interface supplying an 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: External Mini USB Cable (EXTMUSB3FT)*

The External Mini USB Cable is recommended for the LK402-25-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 LK402-25-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 LK402-25-USB, please follow the steps below.

1. Set the Protocol Select Jumpers.
   - USB: The LK402-25-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 LK402-25-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 uProject or hyperterminal 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.

## RS422 Module

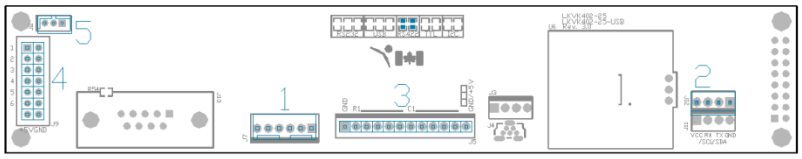



*Figure 7: RS422 Connections*

*Table 3: Standard Headers*

| # | Header | Mate |
|---|---|---|
| 1 | RS422 | 16-30 AWG Wire |
| 2 | Alternate Power | PCS |
| 3 | Keypad | KPP4x4 |
| 4 | GPO | None Offered |
| 5 | Dallas One-Wire | Temperature Probe |

The LK402-25-422 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 or -V unit. RS422 signals are available in a six pin connector as described in the RS422 Connections section.

### RS422 Connections

The LK402-25-422 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 -V unit. To connect to your LK402-25-422, follow the steps below.

1. Set the Protocol Select Jumpers.
   - RS422: The LK402-25-422 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 42.
   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, uProject or hyperterminal will serve to get you started. In addition, a variety of application notes are also available in a number of different languages to aid in development. Instructions for the former can be found below and the simple C# example at www.matrixorbital.ca/appnotes is a great first reference for the latter.

## Software

The multiple communication protocols available and simple command structure of the LK402-25 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 number of control characters are also activated. Commands are merely values prefixed with a special command byte, 254 in decimal. While many software programs are available to communicate with the LK402-25, a number of more common samples are detailed in depth below.

*Table 4: Reserved Control Characters*

| Control Characters | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | Backspace | 10 | Line feed / New line | 12 | Clear screen / New page | 13 | Carriage return |

### Hyperterminal

Installed on most Windows computers, hyperterminal can be run by selecting run and typing 'hypertrm' in the command line. This basic program will allow communication between a PC and your display.

When starting up, a name must be given to your connection, and an icon may be chosen, neither is consequential. Next, it's important to select the appropriate communication port to which your display is connected. Finally, the settings below must be entered to complete the port setup.

*Table 5: Hyperterminal Settings*

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

Once a port is successfully set up, data can be sent to an attached display by typing on the keyboard. At this point, it may be helpful to echo keys to the monitor by selecting properties from the file menu and opening the ASCII settings from settings tab.

Commands can be sent to an attached display by issuing decimal commands using the number pad. While the ALT key is held down, four digit decimal values can be sent as a single ASCII character. For example, to clear the screen, try the following sequence.

**ALT +0254 ALT +0088**

*Figure 8: Hyperterminal Command*

Any commands or text desired can be sent to the communication port using this method to provide total control of any Matrix Orbital display.

## uProject

The Matrix Orbital alphanumeric display tuner, or uProject, is offered as a free download from the www.matrixorbital.ca support site. It allows the basic functionality of any display* to be tested using a simple graphical user interface system.

While basic functionality can be tested using the GUI portion of the program, more advanced users will enjoy the scripting capability found in the uploader tab. Here commands can be stacked, run, and saved for later use. Although many commands are available to be dragged into the script dialog, perhaps the most powerful is the raw data command found in the other branch.

This command allows raw bytes to be sent to the display, permitting many different formats for entry and displaying in decimal notation. Any command from this manual may be entered in decimal notation separated by slashes.

**/254/ /88/**

*Figure 9: uProject Command*

Again, the clear screen command is sent to a connected display, this time using uProject raw data command style. Scripts can be run as a whole using the execute command from the script menu, or as single commands by selecting execute once. Before issuing commands, it is a good idea to ensure communication with a display is successful using some of the more basic GUI functions in the main window.

This program provides scratch pad upon which a tome of display projects and ideas can be assembled.

***Note:** The uProject AutoDetect function will not perform correctly when a USB display is connected. Please manually configure any USB display.

## Application Notes

Full demonstration programs and code are available for Matrix Orbital displays in the C# language from Simple C# AppNote Pack in the Matrix Orbital 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.

# Hardware

## Standard Model

### Communication/Power Header


*Figure 10: Communication/Power Header*

*Table 6: Communication/Power Pinout*

| Pin | Function |
|---|---|
| 1 | Vcc |
| 2 | Rx (SCL) |
| 3 | Tx (SDA) |
| 4 | Gnd |

The Communication/Power Header provides a standard connector for interfacing to the LK402-25. 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 42 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. The versatile Tyco 640456-4-LF style header employed here can be mated to a wide array of female connectors for a perfect fit in any project.

### Serial DB9 Connector

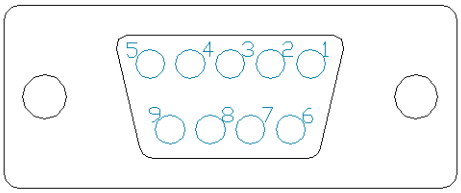



*Figure 11: Serial DB9 Connector*

*Table 7: Serial DB9 Pinout*

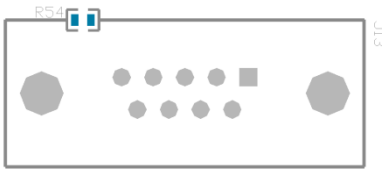
| Pin | Function |
|---|---|
| 5 | Gnd |
| 3 | Rx |
| 2 | Tx |
| 9 | NC/Vcc* |

The LK402-25 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 R54, as illustrated below. This connection can be made using a zero ohm resistor, recommended size 0603, or a solder bridge. The LK402-25 allows all voltage models to use the power through DB-9 option, see the electrical specifications in Table 42 for voltage requirements.




*Power Through DB9 Jumper*

### Protocol Select Jumpers

The Protocol Select Jumpers provide the means necessary to toggle the LK402-25 between RS-232, TTL and I²C protocols. As a default, the jumpers are set to RS-232 mode with solder jumps on the 232 jumpers. In order to place the display module in I²C mode you must first remove the solder jumps from the 232 jumpers and then place them on the I²C jumpers. The display will now be in I²C mode and have a default slave address of 0x50, unless it has been changed. Similarly, in order to change the display to TTL mode, simply remove the zero ohm resistors from the 232 or I²C jumpers and solder them to the TTL jumpers. Protocol tables are shown below where an `X` designates a connected jump while an 'O' signifies an open connection.

*Table 8: RS232 Protocol Settings*

| RS232 | | | TTL | | I²C | |
|---|---|---|---|---|---|---|
| X | X | X | 0 | 0 | 0 | 0 |

*Table 9: TTL Protocol Settings*

| RS232 | | | TTL | | I²C | |
|---|---|---|---|---|---|---|
| O | O | O | X | X | O | O |

*Table 10: I²C Protocol Settings*

| RS232 | | | TTL | | I²C | |
|---|---|---|---|---|---|---|
| O | O | O | O | O | X | X |

## USB Model

### Mini USB Connector

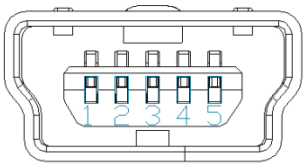



*Figure 12: Mini USB Connector*

*Table 11: Mini USB Pinout*

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

The LK402-25-USB comes with a familiar Mini USB Connector to fulfill both communication and power needs. The standard MiniB 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

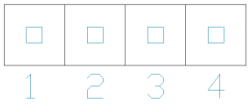



*Figure 13: Alternate USB Header*

*Table 12: Alternate USB Pinout*

| Pin | Function |
|---|---|
| 1 | Gnd |
| 2 | D+ |
| 3 | D- |
| 4 | Vcc |

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 LK402-25-USB for an added charge as part of a custom order. Please use the Contact section to request for more information from the friendly Matrix Orbital sales team.

### Alternate Power Connector

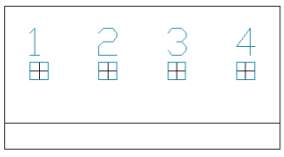



*Figure 14: Alternate Power Connector*

*Table 13: Alternate Power Pinout*

| Pin | Function |
|---|---|
| 1 | NC |
| 2 | Gnd |
| 3 | Gnd |
| 4 | Vcc |

The Alternate Power Connector provides the ability to power the LK402-25-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.

## RS422 Model

### RS422 Header

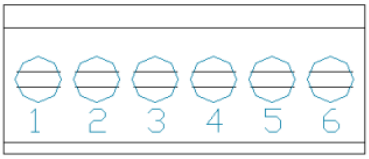



*Figure 15: RS422 Header*

*Table 14: 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 LK402-25-422 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 –V 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

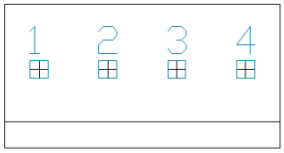



*Figure 16: Alternate Power Connector*

*Table 15: Alternate Power Pinout*

| Pin | Function |
|---|---|
| 1 | NC |
| 2 | Gnd |
| 3 | Gnd |
| 4 | Vcc |

The Alternate Power Connector provides the ability to power the LK402-25-422 using a second cable. This is particularly useful for the regular or -V modules that are 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.

## Common Features

### General Purpose Outputs

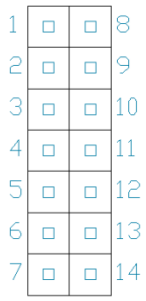



*Figure 17: GPO Header*

*Table 16: GPO Pinout*

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

A unique feature of the LK402-25 is the ability to control relays* and other external devices using one of six General Purpose Outputs. Each can source up to 20mA of current at five volts when on or sink 10mA 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

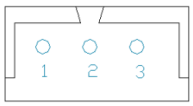



*Figure 18: Dallas One-Wire Connector*

*Table 17: Dallas One-Wire Pinout*

| Pin | Function |
|---|---|
| 1 | Vcc |
| 2 | D |
| 3 | Gnd |

In addition to the six general purpose outputs the LK402-25 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 for more information from the Matrix Orbital sales team.

## Keypad Header


*Figure 19: Keypad Header*

*Table 18: Keypad Pinout*

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

To facilitate user input, the LK402-25 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 $I^2C$ 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.

# Troubleshooting

## Power

In order for your Matrix Orbital display to function correctly, it must be supplied with the appropriate power. If the D2 power LED near the top right corner of the board is not illuminated, power is not applied correctly. Try following the tips below.

- First, make sure that you are using the correct power connector. Standard floppy drive power cables from your PC power supply may fit on the Communication/Power Header; however they do not have the correct pin out to provide power. Matrix Orbital supplies power cable adapters for connecting to a PC, which can be found in the accessories section.
- Next, 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 power 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.

## 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.

## 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 LK204-25 to the transmitting pin from your host and the Tx pin to the receiving pin.
- If you are communicating to the display via $I^2C$***** please ensure that the data is being sent to the correct address. The default slave address for the display module is 80.
- In $I^2C$ mode, connect Rx to the data 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:** $I^2C$ communication will always require pull up resistors on SCL and SDA of one to ten kilohms.

## 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 middle two pins of the keypad header, R5 and C1.
3. Reconnect power to your unit, and wait for the start screen before removing the override jumper.
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 |
| $I^2C$ Address | 80 |

*Table 19: Manual Override Settings*

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

# Commands

## 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. Default is 19200. | | | |
| Speed | 1 byte, valid settings shown below | | |

*Table 20: Accepted Baud Rate Values*

| Rate | 1200 | 2400 | 4800 | 9600 | 19200 | 28800 | 38400 | 57600 | 115200 |
|---|---|---|---|---|---|---|---|---|---|
| Speed | 83 | 41 | 207 | 103 | 51 | 34 | 25 | 16 | 8 |

| 1.3. Set a Non-Standard Baud Rate | Dec | 254 164 | Speed |
|---|---|---|---|
| | Hex | FE A4 | Speed |
| | ASCII | ■ ñ | Speed |
| Immediately changes the baud rate to a non-standard value. Baud 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 | 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*

| 1.4. 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 | | |

## 2. Text

| 2.1. Auto Scroll On | | | |
|---|---|---|---|
| | Dec | 254 81 | |
| | Hex | FE 51 | |
| | ASCII | ■ Q | |
| The entire contents of screen are shifted up one line when the end of the screen is reached. Default is on. | | | |

| 2.2. Auto Scroll Off | | | |
|---|---|---|---|
| | Dec | 254 82 | |
| | Hex | FE 52 | |
| | ASCII | ■ R | |
| New text is written over the top line when the end of the screen is reached. Default is Auto Scroll on. | | | |

| 2.3. Clear Screen | | | |
|---|---|---|---|
| | Dec | 254 88 | |
| | Hex | FE 58 | |
| | ASCII | ■X | |
| Clears the contents of the screen. | | | |

| 2.4. Changing the Start Up Screen | | | |
|---|---|---|---|
| | Dec | 254 64 | Characters |
| | Hex | FE 40 | Characters |
| | ASCII | ■ @ | Characters |
| Changes the message displayed on start up. Custom characters can be included by adding their decimal value (0-7). Characters will automatically wrap on the display. | | | |
| Characters | 80 bytes, space characters can be added as needed | | |

| 2.5. Set Cursor Position | | | |
|---|---|---|---|
| | Dec | 254 71 | Column Row |
| | Hex | FE 47 | Column Row |
| | ASCII | ■ G | Column Row |
| Sets the cursor to a specific position where the next transmitted character is printed. | | | |
| Column | 1 byte, value between 1 and 40 | | |
| Row | 1 byte, value between 1 and 2 | | |

| 2.6. Go Home | | | |
|---|---|---|---|
| | Dec | 254 72 | |
| | Hex | FE 48 | |
| | ASCII | ■ H | |
| Returns the cursor to the top left of the screen. | | | |

| 2.7. Move Cursor Back | Dec | 254 76 |
|---|---|---|
| | Hex | FE 4C |
| | ASCII | ■ L |

Moves cursor one position to the left. Cursor will obey wrap settings.

| 2.8. Move Cursor Forward | Dec | 254 77 |
|---|---|---|
| | Hex | FE 4D |
| | ASCII | ■ M |

Moves cursor one position to the right. Cursor will obey wrap settings.

| 2.9. Underline Cursor On | Dec | 254 74 |
|---|---|---|
| | Hex | FE 4A |
| | ASCII | ■ J |

Displays a line under the current cursor position. Can be used with block cursor.

| 2.10. Underline Cursor Off | Dec | 254 75 |
|---|---|---|
| | Hex | FE 4B |
| | ASCII | ■ K |

Removes line under current cursor position. Setting is only saved when remember is set on.

| 2.11. Blinking Block Cursor On | Dec | 254 83 |
|---|---|---|
| | Hex | FE 53 |
| | ASCII | ■ S |

Displays a blinking block over the current cursor position. Can be used with underline.

| 2.12. Blinking Block Cursor Off | Dec | 254 84 |
|---|---|---|
| | Hex | FE 54 |
| | ASCII | ■ T |

Removes blinking block over current cursor position.

## 3. Special Characters

| 3.1. Creating a Custom Character | Dec | 254 78 | ID Data |
|---|---|---|---|
| | Hex | FE 4E | ID Data |
| | ASCII | ■ N | ID Data |

Creates a custom character. Each character is divided into 8 rows of 5 pixels; each data byte represents one row. Each byte is padded by three zero bits followed by five bits representing each pixel state. A one represents an on condition while a zero is off. Characters are lost when a new memory bank is loaded, unless they are saved.

| | |
|---|---|
| ID | 1 byte, character ID, value between 0 and 7 |
| Data | 8 bytes, character pixel data as shown below |

*Table 21: Custom Degree Character*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Data1 | 000 | p1 | **p2** | p3 | p4 | p5 | 0000**1**000 | 8 |
| Data2 | 000 | **p1** | p2 | **p3** | p4 | p5 | 000**1**0**1**00 | 20 |
| Data3 | 000 | p1 | **p2** | p3 | p4 | p5 | 0000**1**000 | 8 |
| Data4 | 000 | p1 | p2 | p3 | **p4** | **p5** | 00000**11** | 3 |
| Data5 | 000 | p1 | p2 | **p3** | p4 | p5 | 00000**1**00 | 4 |
| Data6 | 000 | p1 | p2 | **p3** | p4 | p5 | 00000**1**00 | 4 |
| Data7 | 000 | p1 | p2 | p3 | **p4** | **p5** | 00000**11** | 3 |
| Data8 | 000 | p1 | p2 | p3 | p4 | p5 | 00000000 | 0 |

| 3.2. Saving Custom Characters | Dec | 254 193 | Bank ID Data |
|---|---|---|---|
| | Hex | FE C1 | Bank ID Data |

Provides access to all memory banks to create and save custom characters, graph bars, and large digits. Any new characters saved will overwrite the old, so care should be taken when writing to any bar or digit memory bank. Bank structure is shown below.

| | |
|---|---|
| Bank | 1 byte, memory bank ID, value between 0 and 4 |
| ID | 1 byte, character ID, value between 0 and 7 |
| Data | 8 bytes, character pixel data as above |

*Table 22: Custom Character Banks*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **0** | Start-up Characters | **1** | Horizontal Bars | **2** | Vertical Bars | **3** | Medium Digits | **4** | Large Digits |

| 3.3. Loading Custom Characters | Dec | 254 192 | Bank |
|---|---|---|---|
| | Hex | FE C0 | Bank |

Loads a bank of custom characters into memory for use. Must be issued before using a bank of characters. Alternatively, an appropriate initialize command can be used.

| | |
|---|---|
| Bank | 1 byte, memory bank ID, value between 0 and 4 |

| 3.4. Save Start Up Screen Custom Characters | Dec 254 194 ID Data<br>Hex FE C2 ID Data |
|---|---|
| Saves a custom character to memory for the start up screen or repeated use. Start up characters are displayed by sending their ID to the screen. | |
| ID | 1 byte, character ID, value between 0 and 7 |
| Data | 8 bytes, character pixel data, see custom character example |

| 3.5. Initialize Medium Number | Dec 254 109<br>Hex FE 6D<br>ASCII ■ m |
|---|---|
| Loads the medium number custom character bank into memory. Medium numbers must be initialized before use. | |

| 3.6. Place Medium Numbers | Dec 254 111 Row Column Digit<br>Hex FE 6F Row Column Digit<br>ASCII ■ o Row Column Digit |
|---|---|
| Places a single medium decimal digit of 2 row height and 1 column width on the display at the position specified. Medium numbers must be initialized before being placed. | |
| Row | 1 byte, value between 1 and 40 |
| Column | 1 byte, value between 1 and 2 |
| Digit | 1 byte, single decimal digit to display |

| 3.7. Initialize Horizontal Bar | Dec 254 104<br>Hex FE 68<br>ASCII ■ h |
|---|---|
| Loads the horizontal bar graph custom character bank into memory. Horizontal bar characters must be initialized before a graph is displayed. | |

| 3.8. Place Horizontal Bar Graph | Dec 254 124 Column Row Direction Length<br>Hex FE 7C Column Row Direction Length |
|---|---|
| Places a horizontal bar graph on the screen beginning at the column and row specified. The bar extends either right or left to the length indicated. New bars will overwrite old. | |
| Column | 1 byte, value between 1 and 40 |
| Row | 1 byte, value between 1 and 2 |
| Direction | 1 byte, 0 for right and 1 for left |
| Length | 1 byte, length in pixels of the graph, value between 0 and 100 |

| 3.9. Initialize Narrow Vertical Bar | Dec 254 115<br>Hex FE 73<br>ASCII ■ s |
|---|---|
| Loads the narrow horizontal bar graph custom character bank into memory. A narrow bar is 2 pixels wide. Horizontal bar characters must be initialized before a graph is displayed. | |

| 3.10. Initialize Wide Vertical Bar | Dec | 254 118 |
|---|---|---|
| | Hex | FE 76 |
| | ASCII | ■ v |

Loads the wide horizontal bar graph custom character bank into memory. A wide bar is 5 pixels wide. Horizontal bar characters must be initialized before a graph is displayed.

| 3.11. Place Vertical Bar | Dec | 254 61 | Column Length |
|---|---|---|---|
| | Hex | FE 3D | Column Length |
| | ASCII | ■ = | Column Length |

Places a vertical bar graph on the screen extending from the first row of the column specified. The bar extends upwards to the length indicated. A new bar will over write the old.

| | |
|---|---|
| Column | 1 byte, value between 1 and 40 |
| Length | 1 byte, height in pixels of the graph, value between 0 and 16 |

## 4. General Purpose Output

| 4.1. General Purpose Output Off | | | |
|---|---|---|---|
| | Dec | **254 86** | Number |
| | Hex | **FE 56** | Number |
| | ASCII | **■ V** | Number |
| Turns the specified GPO off, sinking current to an output of zero volts. | | | |
| Number | 1 byte, GPO to be turned off, value between 1 and 6 | | |

| 4.2. General Purpose Output On | | | |
|---|---|---|---|
| | Dec | **254 87** | Number |
| | Hex | **FE 57** | Number |
| | ASCII | **■ W** | Number |
| Turns the specified GPO on, sourcing current from an output of five volts. | | | |
| Number | 1 byte, GPO to be turned on, value between 1 and 6 | | |

| 4.3. Set Start Up GPO State | | | |
|---|---|---|---|
| | Dec | **254 195** | Number State |
| | Hex | **FE C3** | Number State |
| Sets and saves the start up state of the specified GPO in non volatile memory. Changes will be seen on start up. | | | |
| Number | 1 byte, GPO to be controlled, value between 1 and 6 | | |
| State | 1 byte, 1 for on or 0 for off | | |

# 5. Dallas One-Wire

| 5.1. Search for a One-Wire Device | Dec | 254 200 2 |
|---|---|---|
| | Hex | FE C8 02 |
| Sends a search query to each of the up to 32 devices on the one wire bus. Any connected device will respond with an identification packet. | | |
| Response | 14 bytes, identification packet as shown below | |

*Table 23: Dallas One-Wire Packet Information*

| Offset | Length | Value | Description |
|---|---|---|---|
| 0 | 2 | 9002 | Preamble |
| 2 | 1 | 138 | Another device packet will follow OR |
| | | 10 | Last device packet |
| 3 | 1 | 49 | Packet Type |
| 4 | 1 | 0 | Error Code (0 indicates success) |
| 5 | 8 | | Device Address |
| 13 | 1 | 0 | CRC8 address check (0 indicates validity) |

| 5.2. Dallas One-Wire Transaction | Dec | 254 200 1 | Flags Send Bits Receive Bits Data |
|---|---|---|---|
| | Hex | FE C8 01 | Flags Send Bits Receive Bits Data |
| Performs a single Dallas 1-Wire transaction. Consult your device documentation for information regarding device specific protocols. If an error is encountered, a corresponding value will be returned by the device. | | | |
| Flags | 1 byte, flags for transaction, see below | | |
| Send Bits | 1 byte, number of bytes to be sent to the device | | |
| Receive Bits | 1 byte, number of bytes expected to be received from the device | | |
| Data | Variable, data to be transmitted LSB to MSB | | |

*Table 24: Dallas One-Wire Flag Table*

| Bit | Flag Description |
|---|---|
| 7 | |
| 6 | Unused |
| 5 | |
| 4 | 0 (Future Compatibility) |
| 3 | Add CRC8 to transaction |
| 2 | 0 (Future Compatibility) |
| 1 | Read CRC8 from transaction |
| 0 | Reset Bus prior to transaction |

*Table 25: Dallas One-Wire Error Table*

| Code | Error Description |
|---|---|
| 0 | Success |
| 1 | Unknown Command |
| 2 | No Devices Found |
| 3 | Fatal Search Error |

## 6. Keypad

| 6.1. Auto Transmit Key Presses On | Dec | 254 65 |
|---|---|---|
| | Hex | FE 41 |
| | ASCII | ■ A |

Key presses are automatically sent to the host when received by the display. Default is Auto Transmit on.

| 6.2. Auto Transmit Key Presses Off | Dec | 254 79 |
|---|---|---|
| | Hex | FE 4F |
| | ASCII | ■ O |

Key presses are held in the 10 key buffer to be polled by the host using the Poll Key Press command. Use this mode for I2C transactions. Default is Auto Transmit on.

| 6.3. Poll Key Press | Dec | 254 38 |
|---|---|---|
| | Hex | FE 26 |
| | ASCII | ■ & |

Reads the last unread key press from the 10 key display buffer. If another key is stored in the buffer the MSB will be 1, the MSB will be 0 when the last key press is read. If there are no stored key presses a value of 0 will be returned. Auto transmit key presses must be turned off for this command to be successful.

| Response | 1 byte, value of key pressed (MSB determines additional keys to be read) |
|---|---|

| 6.4. Clear Key Buffer | Dec | 254 69 |
|---|---|---|
| | Hex | FE 45 |
| | ASCII | ■ E |

Clears all key presses from the key buffer.

| 6.5. Set Debounce Time | Dec | 254 85 | Time |
|---|---|---|---|
| | Hex | FE 55 | Time |
| | ASCII | ■ U | Time |

Sets the time between a key press and a key read by the display. Most switches will bounce when pressed; the debounce time allows the switch to settle for an accurate read. Default is 8 representing a debounce time of approximately 52ms.

| Time | 1 byte, debounce increment (debounce time = Time * 6.554ms) |
|---|---|

| 6.6. Set Auto Repeat Mode | Dec | 254 126 | Mode |
|---|---|---|---|
| | Hex | FE 7E | Mode |

Sets key press repeat mode to typematic or hold. In typematic mode if a key press is held, the key value is transmitted immediately, then 5 times a second after a 1 second delay. In hold mode, the key down value is transmitted once when pressed, and then the key up value is sent when the key is released. Default is typematic.

| Mode | 1 byte, 1 for hold mode or 0 for typematic |
|---|---|

| 6.7. Auto Repeat Mode Off | Dec | 254 96 |
|---|---|---|
| | Hex | FE 60 |

Turns auto repeat mode off. Default is on (typematic).

| 6.8. Assign Keypad Codes | Dec | 254 213 | Key Down Key Up |
|---|---|---|---|
| | Hex | FE D5 | Key Down Key Up |
| Assigns the key down and key up values sent to the host when a key press is detected. A key up and key down value must be sent for every key, a value of 255 will leave the key unaltered. Defaults are shown below. | | | |
| Key Down | 25 bytes, key down values | | |
| Key Up | 25 bytes, key up values | | |

*Table 26: Default Key Down Values*

| Key Down | | | | |
|---|---|---|---|---|
| A(65) | B(66) | C(67) | D(68) | E(69) |
| F(70) | G(71) | H(72) | I(73) | J(74) |
| K(75) | L(76) | M(77) | N(78) | O(79) |
| P(80) | Q(81) | R(82) | S(83) | T(84) |
| U(85) | V(86) | W(87) | X(88) | Y(89) |

*Table 27: Default Key Up Values*

| Key Up | | | | |
|---|---|---|---|---|
| a(97) | b(98) | c(99) | d(100) | e(101) |
| f(102) | g(103) | h(104) | i(105) | j(106) |
| k(107) | l(108) | m(109) | n(110) | o(111) |
| p(112) | q(113) | r(114) | s(115) | t(116) |
| u(117) | v(118) | w(119) | x(120) | y(121) |

| 6.9. Set Typematic Delay | Dec | 254 159 | Delay |
|---|---|---|---|
| | Hex | FE 9F | Delay |
| | ASCII | ■ ƒ | Delay |
| Sets the delay between the first key press and first typematic report when a key is held in typematic mode. | | | |
| Delay | Byte | Time key must be held to trigger typematic reports, specified in 100ms, default is 10 (1s). | |

| 6.10. Set Typematic Interval | Dec | 254 158 | Interval |
|---|---|---|---|
| | Hex | FE 9E | Interval |
| | ASCII | ■ Pts | Interval |
| Sets the interval between reported key presses when a key is held and the display is in typematic mode. | | | |
| Interval | Byte | Time between key reports, specified in 100ms increments, default is 2 (200ms). | |

## 7. Display Functions

| 7.1. Display On | Dec | 254 66 | Minutes |
|---|---|---|---|
| | Hex | FE 42 | Minutes |
| | ASCII | ■ B | Minutes |

Turns the display backlight on for a specified length of time. If an inverse display color is used this command will essentially turn on the text.

| Minutes | 1 byte, number of minutes to leave backlight on, a value of 0 leaves the display on indefinitely |
|---|---|

| 7.2. Display Off | Dec | 254 70 |
|---|---|---|
| | Hex | FE 46 |
| | ASCII | ■ F |

Turns the display backlight off. If an inverse display colour is used this command will turn off the text.

| 7.3. Set Brightness | Dec | 254 153 | Brightness |
|---|---|---|---|
| | Hex | FE 99 | Brightness |

Immediately sets the backlight brightness. If an inverse display color is used this represents the text colour intensity instead. Default is 255.

| Brightness | 1 byte, brightness level from 0(Dim) to 255(Bright) |
|---|---|

| 7.4. Set and Save Brightness | Dec | 254 152 | Brightness |
|---|---|---|---|
| | Hex | FE 98 | Brightness |

Immediately sets and saves the backlight brightness. Although brightness can be changed using the set command, it is reset to this saved value on start up. Default is 255.

| Brightness | 1 byte, brightness level from 0(Dim) to 255(Bright) |
|---|---|

| 7.5. Set Contrast | Dec | 254 80 | Contrast |
|---|---|---|---|
| | Hex | FE 50 | Contrast |
| | ASCII | ■ P | Contrast |

Immediately sets the contrast between background and text. If an inverse display color is used this also represents the text brightness. Default is 128.

| Contrast | 1 byte, contrast level from 0(Light) to 255(Dark) |
|---|---|

| 7.6. Set and Save Contrast | Dec | 254 145 | Contrast |
|---|---|---|---|
| | Hex | FE 91 | Contrast |

Immediately sets and saves the contrast between background and text. Although contrast can be changed using the set command, it is reset to this saved value on start up. Default is 128.

| Contrast | 1 byte, contrast level from 0(Light) to 255(Dark) |
|---|---|

## 8. Data Security

| 8.1. Set Remember | Dec | 254 147 | Switch |
|---|---|---|---|
| | Hex | FE 93 | Switch |

Allows changes to specific settings to be saved to the display memory. Writing to non-volatile memory can be slow and each change consumes 1 write of approximately 100,000 available. The Command Summary outlines which commands are saved always, never, and when this command is on only. Remember is off by default.

| Switch | 1 byte, 1 for on or 0 for off |
|---|---|

| 8.2. Set Data Lock | Dec | 254 202 245 160 | Level |
|---|---|---|---|
| | Hex | FE CA F5 A0 | Level |

Temporarily locks certain aspects of the display to ensure no inadvertent changes are made. The lock is released after a power cycle. A new level overrides the old, and levels can be combined. Default is 0.

| Level | 1 byte, each bit representing a level, see Table 28 |
|---|---|

*Table 28: Data Lock Bits*

| Display | Command | Reserved | Setting | Address | Reserved | Reserved | Reserved |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

*Table 29: Lock Parameters*

| | |
|---|---|
| Reserved | Place holders only, should be 0 |
| Address | Locks the Baud Rate and $I^2C$ address |
| Setting | Locks all settings from being saved |
| Command | Locks all commands, text can still be written |
| Display | Locks entire display, no new text can be displayed |

| 8.3. Set and Save Data Lock | Dec | 254 203 245 160 | Level |
|---|---|---|---|
| | Hex | FE CB F5 A0 | Level |

Locks certain aspects of the display to ensure no inadvertent changes are made. The lock is not affected by a power cycle. A new level overrides the old, and levels can be combined. Default is 0.

| Level | 1 byte, see data lock table |
|---|---|

## 9. Miscellaneous

| 9.1. Write Customer Data | Dec | 254 52 | Data |
|---|---|---|---|
| | Hex | FE 34 | Data |
| | ASCII | ■ 4 | Data |
| Saves a user defined block of data to non-volatile memory. Useful for storing display information for later use. | | | |
| Data | 16 bytes, user defined data | | |

| 9.2. Read Customer Data | Dec | 254 53 |
|---|---|---|
| | Hex | FE 35 |
| | ASCII | ■ 5 |
| Reads data previously written to non-volatile memory. Data is only changed when written, surviving power cycles. | | |
| Response | 16 bytes, previously saved user defined data | |

| 9.3. Read Version Number | Dec | 254 54 |
|---|---|---|
| | Hex | FE 36 |
| | ASCII | ■ 6 |
| Causes display to respond with its firmware version number. | | |
| Response | 1 byte, convert to hexadecimal to view major and minor revision numbers | |

| 9.4. Read Module Type | Dec | 254 55 |
|---|---|---|
| | Hex | FE 37 |
| | ASCII | ■ 7 |
| Causes display to respond with its module number. | | |
| Response | 1 byte, module number, see partial list below | |

*Table 30: Sample Module Type Responses*

| 8 | LK202-25 | 9 | LK204-25 | 75 | LK402-25 |
|---|---|---|---|---|---|

# Appendix

## Command Summary

Available commands below include identifying number, required parameters, the returned response and an indication of whether the setting is remembered always, never, or with remember set to on.

*Table 31: Communication* Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Changing the I2C Slave Address | 51 | 33 | 3 | Address | None | Always |
| Changing the Baud Rate | 57 | 39 | 9 | BaudRate | None | Always |
| Set a Non-Standard Baud Rate | 164 | A4 | ñ | Speed | None | Always |
| Transmission Protocol Select | 160 | A0 | á | Protocol | None | Remember On |

*Table 32: Text* Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Auto Scroll On | 81 | 51 | Q | None | None | Remember On |
| Auto Scroll Off | 82 | 52 | R | None | None | Remember On |
| Clear Screen | 88 | 58 | X | None | None | Never |
| Changing the Start Up Screen | 64 | 40 | @ | Characters [80] | None | Always |
| Set Cursor Position | 71 | 47 | G | Col, Row | None | Never |
| Go Home | 72 | 48 | H | None | None | Never |
| Move Cursor Back | 76 | 4C | L | None | None | Never |
| Move Cursor Forward | 77 | 4D | M | None | None | Never |
| Underline Cursor On | 74 | 4A | J | None | None | Remember On |
| Underline Cursor Off | 75 | 4B | K | None | None | Remember On |
| Blinking Block Cursor On | 83 | 53 | S | None | None | Remember On |
| Blinking Block Cursor Off | 84 | 54 | T | None | None | Remember On |

*Table 33: Special Character* Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Creating a Custom Character | 78 | 4E | N | ID, Data [8] | None | Remember On |
| Saving Custom Characters | 193 | C1 | ┴ | Bank, ID, Data [8] | None | Always |
| Loading Custom Characters | 192 | C0 | └ | Bank | None | Never |
| Save Start Up Screen Custom Characters | 194 | C2 | ┬ | ID, Data [8] | None | Always |
| Initialize Medium Number | 109 | 6D | m | None | None | Never |
| Place Medium Numbers | 111 | 6F | o | Row, Col, Digit | None | Never |
| Initialize Horizontal Bar | 104 | 68 | h | None | None | Never |
| Place Horizontal Bar Graph | 124 | 7C | \| | Col, Row, Dir, Length | None | Never |
| Initialize Narrow Vertical Bar | 115 | 73 | s | None | None | Never |
| Initialize Wide Vertical Bar | 118 | 76 | v | None | None | Never |
| Place Vertical Bar | 61 | 3D | = | Col, Length | None | Never |

*Table 34: General Purpose Output* Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| General Purpose Output Off | 86 | 56 | V | Number | None | Never |
| General Purpose Output On | 87 | 57 | W | Number | None | Never |
| Set Start Up GPO State | 195 | C3 | ├ | Number, State | None | Always |

*Table 35: Dallas One-Wire* Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Search for a One-Wire Device | 200, 2 | C8, 02 | └, ☻ | None | Data [14] | Never |
| Dallas One-Wire Transaction | 200, 1 | C8, 01 | └, ☺ | Flags, Send, Receive, Data [] | Data [] | Never |

*Table 36: Keypad* Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Auto Transmit Key Presses On | 65 | 41 | A | None | None | Remember On |
| Auto Transmit Key Presses Off | 79 | 4F | O | None | None | Remember On |
| Poll Key Press | 38 | 26 | & | None | KeyPress | Never |
| Clear Key Buffer | 69 | 45 | E | None | None | Never |
| Set Debounce Time | 85 | 55 | U | Time | None | Remember On |
| Set Auto Repeat Mode | 126 | 7E | ~ | Mode | None | Remember On |
| Auto Repeat Mode Off | 96 | 60 | ` | None | None | Remember On |
| Assign Keypad Codes | 213 | D5 | ╒ | KeyUp [25], KeyDown [25] | None | Always |
| Set Typematic Delay | 159 | 9F | ƒ | Delay | None | Remember On |
| Set Typematic Interval | 158 | 9E | ₧ | Delay | None | Remember On |

Table 37: Display Functions Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Display On | 66 | 42 | B | Minutes | None | Remember On |
| Display Off | 70 | 46 | F | None | None | Remember On |
| Set Brightness | 153 | 99 | Ö | Brightness | None | Remember On |
| Set and Save Brightness | 152 | 98 | ÿ | Brightness | None | Always |
| Set Contrast | 80 | 50 | P | Contrast | None | Remember On |
| Set and Save Contrast | 145 | 91 | æ | Contrast | None | Always |

Table 38: Data Security Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Set Remember | 147 | 93 | ô | Switch | None | Always |
| Set Data Lock | 202, 245, 160 | CA, F5, A0 | ╩, ⌡, á | Level | None | Remember On |
| Set and Save Data Lock | 203, 245, 160 | CB, F5, A0 | ╦, ⌡, á | Level | None | Always |

Table 39: Miscellaneous Command Summary

| Name | Dec | Hex | ASCII | Parameters | Response | Remembered |
|---|---|---|---|---|---|---|
| Write Customer Data | 52 | 34 | 4 | Data [16] | None | Always |
| Read Customer Data | 53 | 35 | 5 | None | Data [16] | Never |
| Read Version Number | 54 | 36 | 6 | None | Version | Never |
| Read Module Type | 55 | 37 | 7 | None | Module | Never |

## Character Set

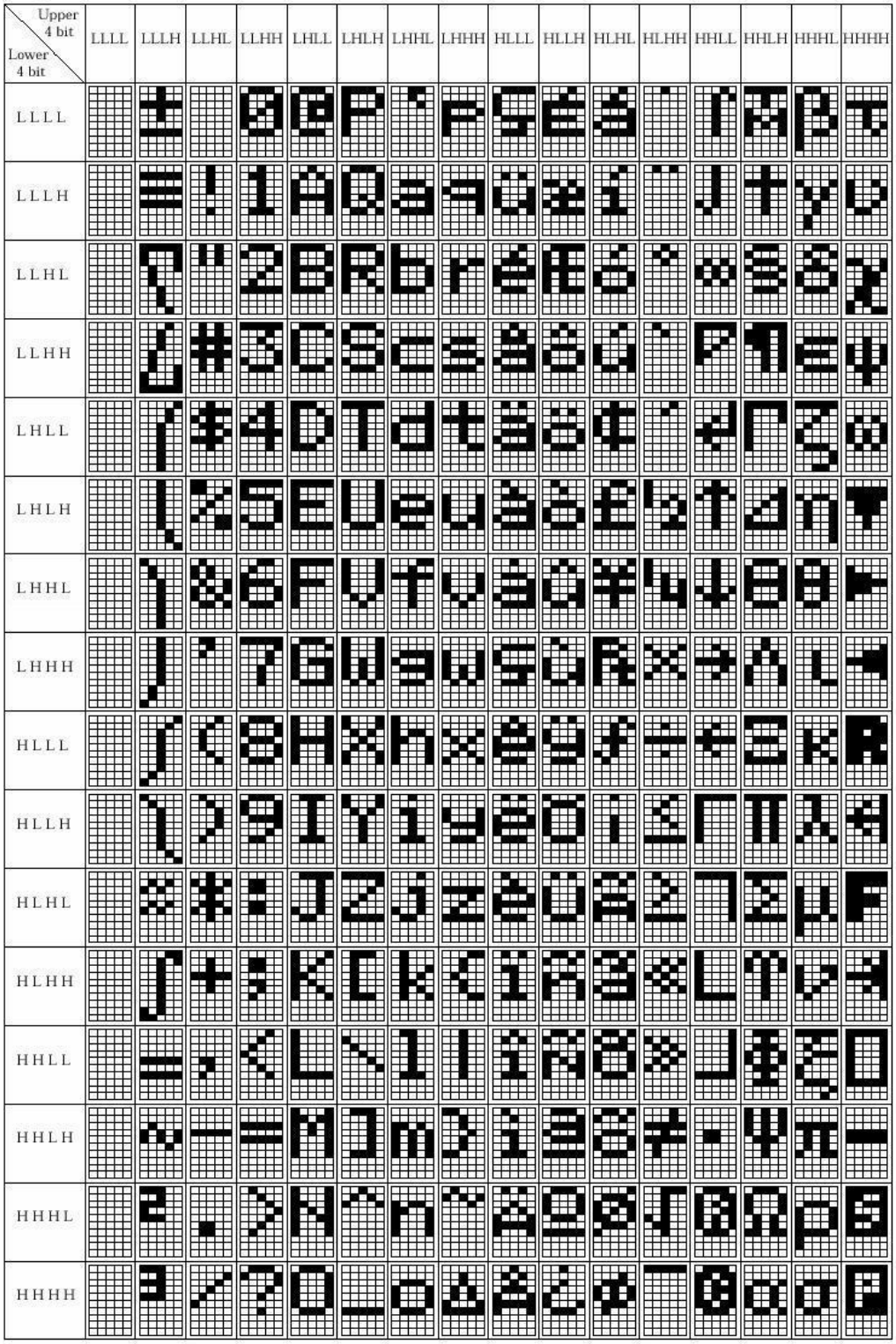



*Figure 20: LK402-25 European Character Set*

## Environmental Specifications

*Table 40: Environmental Limits*

| | Standard | Extended (-E) |
|---|---|---|
| Operating Temperature | 0°C to +50°C | -20°C to +70°C |
| Storage Temperature | -10°C to +60°C | -30°C to +80°C |
| Operating Relative Humidity | Maximum 90% non-condensing | |

## Electrical Tolerances

### Current Consumption

*Table 41: Current Consumption*

| Board | | Backlight | | GPOs |
|---|---|---|---|---|
| 40mA | + | 210mA | + | 20mA each maximum |

### Input Voltage Specifications

*Table 42: Voltage Specifications*

| Standard* | Wide Voltage (-V)* | Extended Wide Voltage (-VPT) |
|---|---|---|
| 4.75-5.25V | 9.0-15.0V | 9.0-35.0V |

***Note:** Standard and Wide Voltage variants of the RS422 model should be powered from a local source only.

## Optical Characteristics

*Table 43: Display Optics*

| | | |
|---|---|---|
| Module Size | 182.00 x 33.50 x 30.5 | mm |
| Viewing Area | 154.5 x 17.0 | mm |
| Active Area | 147.5 x 11.5 | mm |
| Character Size | 3.20 x 5.55 | mm |
| Character Pitch | 3.70 x 5.95 | mm |
| Pixel Size | 0.60 x 0.65 | mm |
| Pixel Pitch | 0.65 x 0.70 | mm |
| Viewing Direction | 12 | O'clock |
| Viewing Angle | -30 to +30 | ° |
| Contrast Ratio | 3 | |
| Backlight Half-Life | 100,000 | Hours |

## Dimensional Drawing

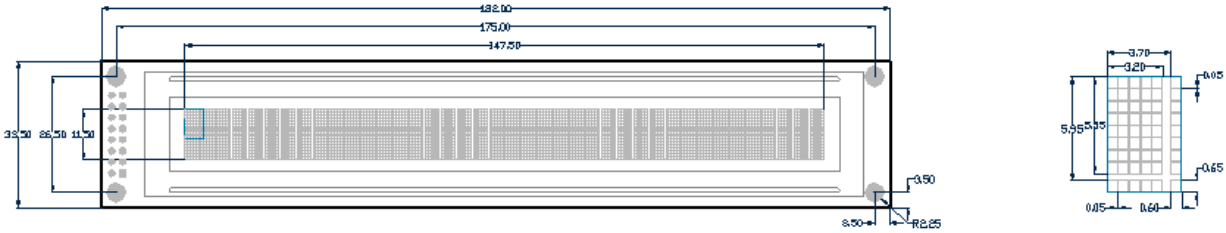



*Figure 21: Display Dimensional Drawing*

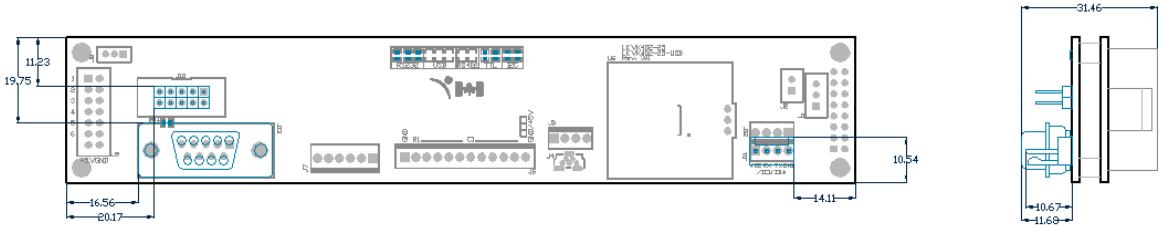



*Figure 22: Standard Model Dimensional Drawing*

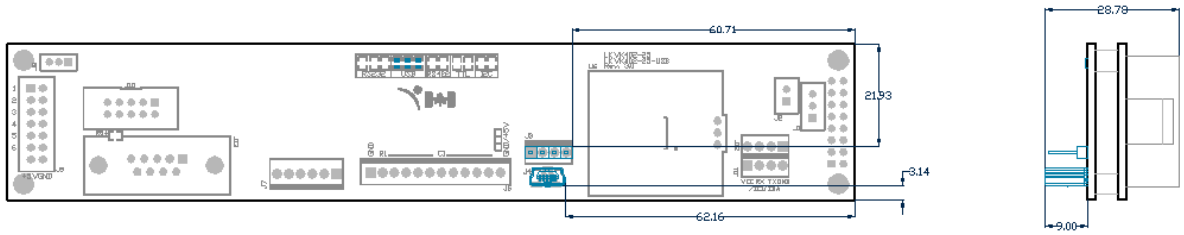



*Figure 23: USB Model Dimensional Drawing*

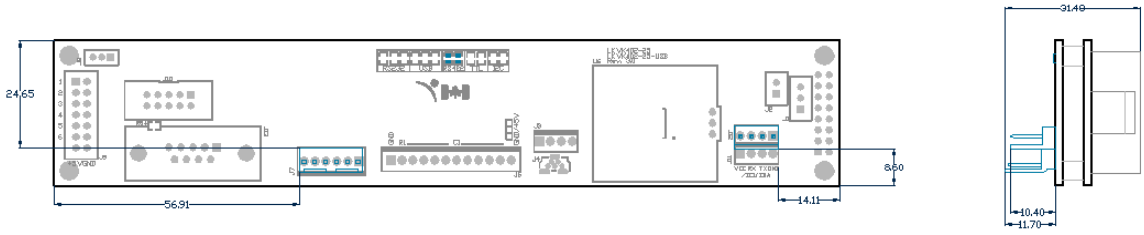



*Figure 24: RS422 Model Dimensional Drawing*

# Ordering

## Part Numbering Scheme

*Table 44: Part Numbering Scheme*

| LK | -402 | -25 | -V | -422 | -E |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |

## Options

*Table 45: Display Options*

| # | Designator | Options |
|---|---|---|
| 1 | Product Type | LK: Liquid Crystal Display with Keypad Input |
| 2 | Display Size | -402: 40 columns by 2 rows |
| 3 | Keypad Size | -25: 25 key maximum |
| 4 | Voltage | NP: Standard Voltage<br>-V: Wide Voltage<br>-VPT: Wide Voltage with Efficient Switching Power Supply |
| 5 | Protocol | NP: Standard Model<br>-USB: USB Only Model<br>-422: RS422 Only Model* |
| 6 | Temperature | NP: Standard<br>-E: Extended Temperature |

***Note:** The RS422 model should only be powered from a local source, unless the –VPT variant is used.

## Accessories

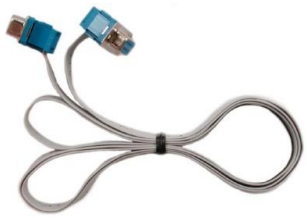
### Power

*Table 46: Power Accessories*

| | | |
|---|---|---|
| **PCS** | Standard Power Cable |  |

### Communication

*Table 47: Communication Accessories*

| | | |
|---|---|---|
| **CSS4FT** | 4 ft. Serial Cable |  |
| **EXTMUSB3FT** | Mini-USB Cable |  |
| **INTMUSB3FT** | Internal Mini-USB Cable |  |
| **SCCPC5V** | Serial Communication/5V Power Cable |  |
| **BBC** | Breadboard Cable |  |

## Peripherals

*Table 48: Peripheral Accessories*

| | | |
|---|---|---|
| **KPP4x4** | 16 Button Keypad |  |
| **Temperature Probe** | Dallas One-Wire Temperature Probe |  |

## Definitions

ASCII: American standard code for information interchange used to give standardized numeric codes to alphanumeric characters.

BPS: Bits per second, a measure of transmission speed.

DOW: Dallas One-Wire protocol, similar to $I^2C$, provides reduced data rates at a greater distance. One wire carries data, while two others supply power and ground. Matrix Orbital tests non-parasitic devices only, those that do not draw power from the data line; however, some parasitic devices may work.

FFSTN: Double film super-twisted nematic in reference to an LCD. The addition of two layers of film between the STN display and polarizer improves contrast.

GPO: General purpose output, used to control peripheral devices from a display.

GUI: Graphical user interface.

Hexadecimal: A base 16 number system utilizing symbols 0 through F to represent the values 0-15.

$I^2C$: Inter-integrated circuit protocol uses clock and data lines to communicate short distances at slow speeds from a master to up to 128 addressable slave devices. A display is a slave device.

LSB: Least significant bit or byte in a transmission, the rightmost when read.

MSB: Most significant bit or byte in a transmission, the leftmost when read.

RS232: Recommended standard 232, a common serial protocol. A low level is -30V, a high is +30V.

RS422: Recommended standard 422, a more robust differential pair serial protocol.

SDA: Serial data line used to transfer data in $I^2C$ protocol. This open drain line should be pulled high through a resistor. Nominal values are between 1K and 10K Ω.

SCL: Serial clock line used to designate data bits in $I^2C$ protocol. This open drain line should be pulled high through a resistor. Nominal values are between 1K and 10K Ω.

STN: Super-twisted nematic in reference to an LCD. In a relaxed or nematic state, crystals orientate themselves in the same direction and pass light. In an excited state these crystals align to block light. Super-twisted crystals move from 180 to 270 degrees between to increase contrast over TN models.

TTL: Transistor-transistor logic applied to serial protocol. Low level is 0V while high logic is 5V.

## Contact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### Online
Purchasing: www.matrixorbital.com
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