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**LK204-25**  
**Technical Manual**

**Revision: 2.0**

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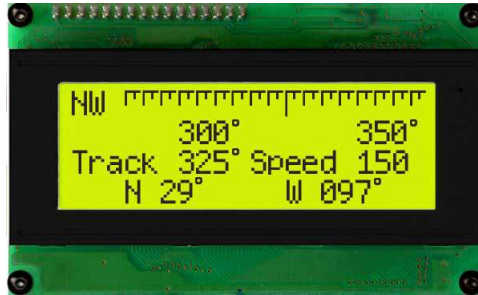
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# 1 Getting Started



The LK204-25 is an intelligent LCD display designed to decrease development time by providing an instant solution to any project. With the ability to communicate via serial RS-232/TTL and I<sup>2</sup>C protocols, the versatile LK204-25 can be used with virtually any controller. The ease of use is further enhanced by an intuitive command structure to allow display settings such as backlight brightness, contrast and baud rate to be software controlled. Additionally, up to thirty-two custom characters such as character sets for bar graphs, medium and large numbers may be stored in the non-volatile memory to be easily recalled and displayed at any time.

## 1.1 Display Options Available

The LK204-25 comes in a wide variety of colors including the standard yellow/green or inverse yellow, the popular blue/white and the crisp white/grey as well as inverse red which is excellent for viewing at night. Extended voltage, and temperature options are also available, to allow you to select the display which will best fit your project needs.

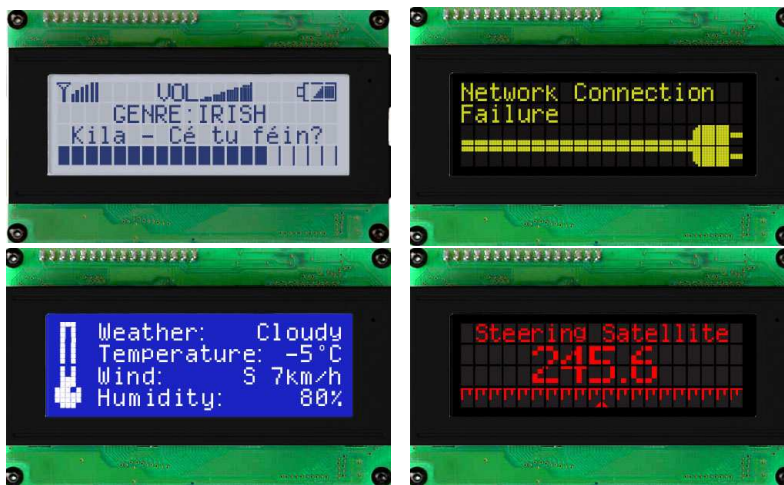


Figure 1: LK204-25 Options

## 1.2 Accessories

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**NOTE** Matrix Orbital provides all the interface accessories needed to get your display up and running. You will find these accessories and others on our e-commerce website at <http://www.matrixorbital.com>. To contact a sales associate see Section 14.5 on page 60 for contact information.

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Figure 2: 5V Power Cable Adapter



Figure 3: 12V Power Cable Adapter (V/VPT Models)



Figure 4: Breadboard Cable

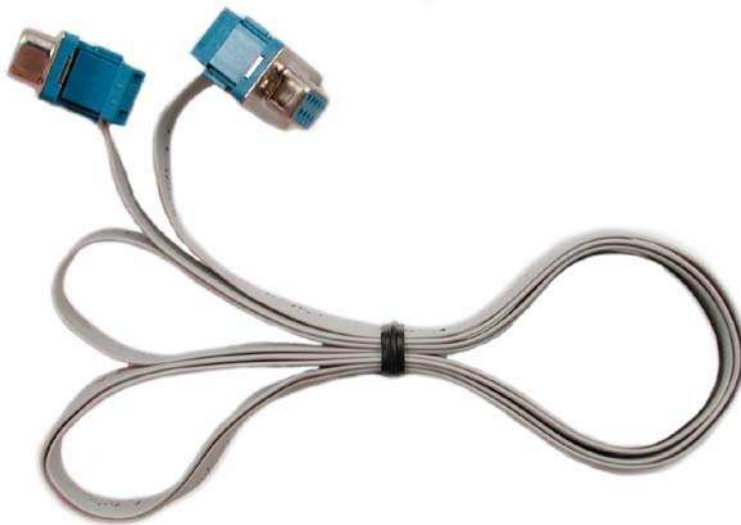


Figure 5: Serial Cable 4FT



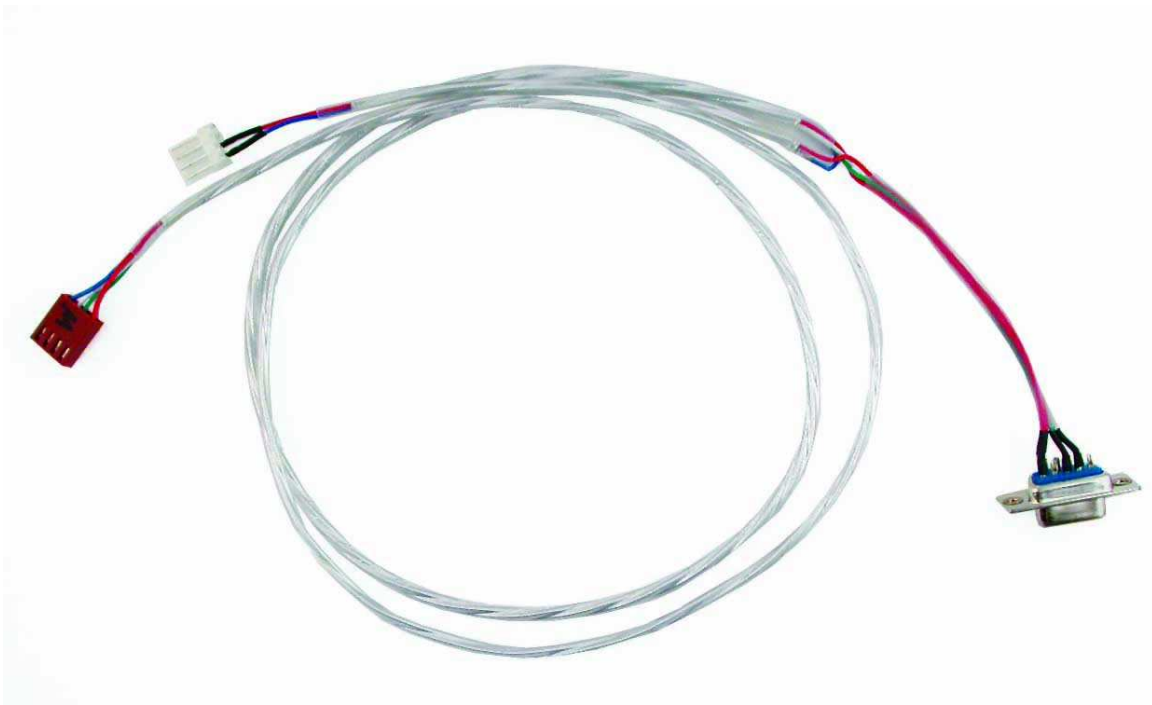


Figure 6: Communication and 5V Power Cable

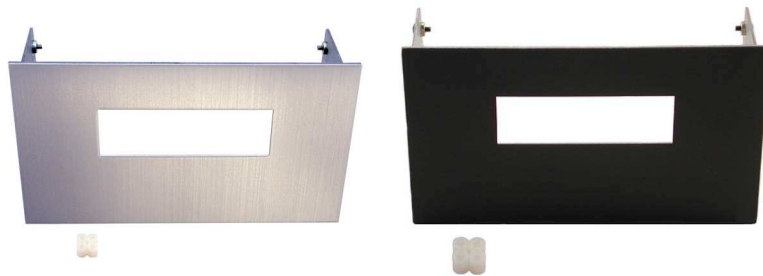


Figure 7: Aluminum Mountings

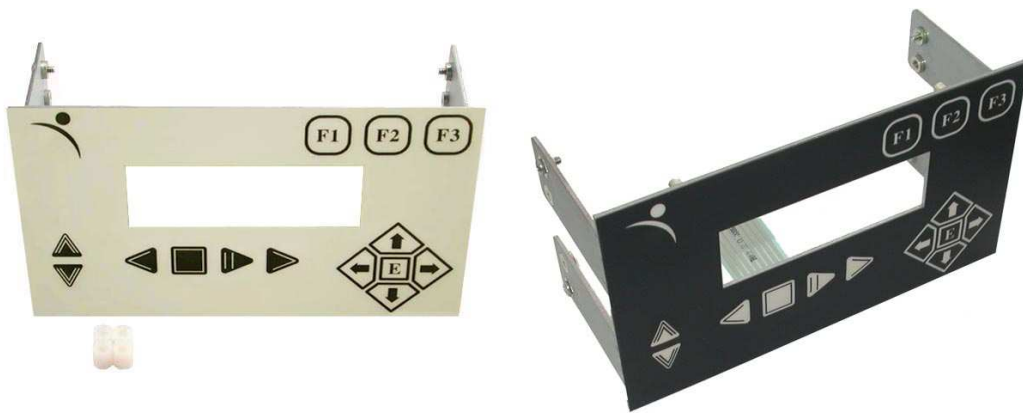


Figure 8: Keypad Mountings

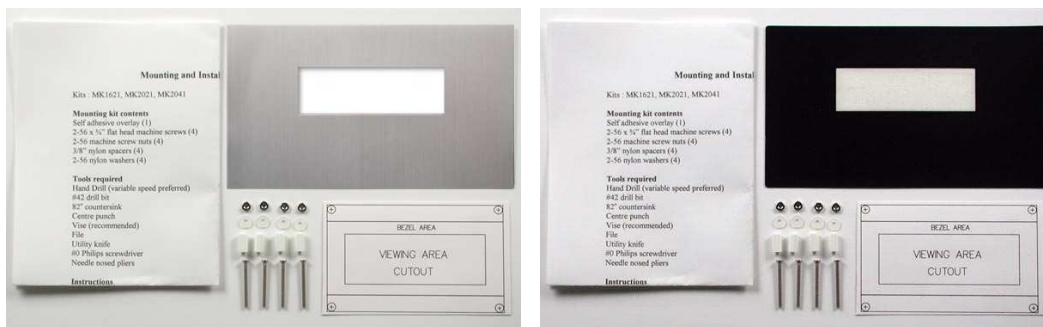


Figure 9: Mounting Kits



Figure 10: 4X4 Keypad

## 1.3 Features

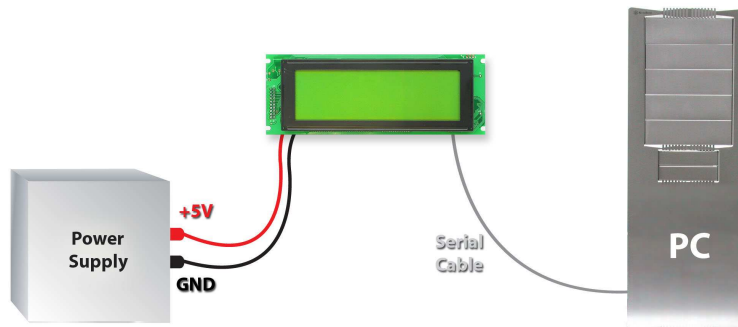
- 20 column by 4 line alphanumeric liquid crystal display
- Selectable communication protocol, RS-232 or I<sup>2</sup>C
- One-wire interface
- Six, 5V -20mA, general purpose outputs for a variety of applications
- Lightning fast communication speeds, up to 57.6 kbps for RS-232 and 400 kbps for I<sup>2</sup>C
- Default 19.2 kbps serial communication speed
- Extended temperature available for extreme environments of -20C to 70C
- Extended voltage and efficient power supply available
- Built in font with provision for up to 8 user defined characters
- Use of up to 127 modules on the same 2 wire I<sup>2</sup>C interface
- 1-wire bus that is capable of communicating with up to 32 devices over a single bus
- Fully buffered so that no delays in transmission are ever necessary
- Ability to add a customized splash / startup screen
- Software controlled contrast and brightness with configurable time-out setting up to 90 minutes
- Use of up to a 25 key keypad with a 10 key buffer
- Horizontal or vertical bar graphs
- Extended temperature option
- Fits Matrix Orbital's mountings without any modifications

## 1.4 Connecting to a PC

The LK204-25 connects seamlessly to a PC and it is an excellent means of testing the functionality. To connect your display to a PC, you will require a standard RS-232 9-pin serial cable such as the one pictured in *figure 5 on page 3*, as well as a modified 5V power adapter such as the one pictured in *figure 2 on page 2*.

In order to connect your display to a personal computer follow these easy instructions:

1. Plug the serial cable into the com port you wish to use.
2. Connect the modified 5V power adapter to a power lead from your PC power supply (you will have to open your computer case).
3. Connect the serial cable to the DB-9 connector on the back of the display.
4. Connect the 5V power adapter to the 4-pin connector on the back of the display.



---

**WARNING** DO NOT use the standard floppy drive power connector, as this will not provide you with the correct voltage and will damage the display module.

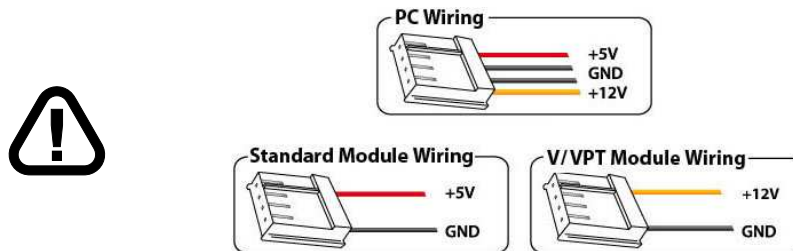


Figure 11: PC vs Matrix Orbital Display Module Wiring

## 1.5 Installing the Software

### 1.5.1 uProject

uProject was designed by Matrix Orbital to provide a simple and easy to use interface that will allow you to test all of the features of our alpha numeric displays.

To install uProject from the Matrix Orbital CD, follow the following steps:

1. Insert the Matrix Orbital CD-ROM into the CD drive
2. Locate the file, *uProject.exe*, which should be in the “CD-drive:\Download” directory.
3. Copy *uProject.exe* to a directory that you wish to run it from.
4. Double click on "uProject.exe"

Be sure to check the information selected in the COM Setup the first time uProject is run. Once this information is entered correctly the program can be used to control all functions of the graphic display.



<b>Comport</b>	The serial port the display is plugged in to.
<b>Baudrate</b>	The communication speed the display module is set to. (Default 19,200)

Figure 12: uProject Settings

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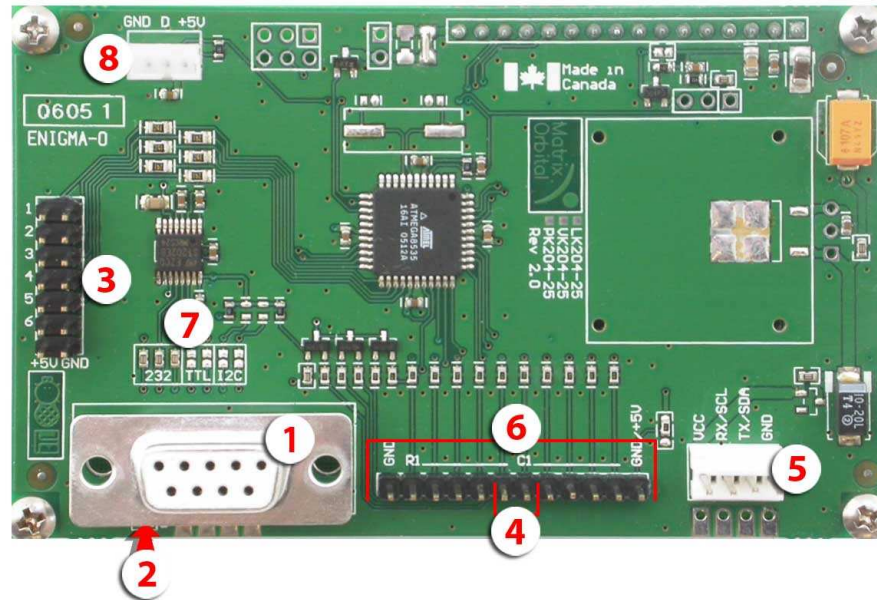
#### NOTES

- uProject and other alphanumeric software may also be downloaded from Matrix Orbital's support site at [http://www.matrixorbital.ca/software/software\\_alpha/](http://www.matrixorbital.ca/software/software_alpha/)
-



## 2 Hardware Information

Refer to the following diagram for this chapter:

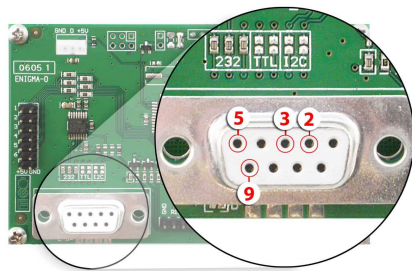


- |                            |                           |
|----------------------------|---------------------------|
| 1 DB-9 Connector           | 5 Power / Data Connector  |
| 2 Power Through DB9 Jumper | 6 Keypad Interface        |
| 3 GPOs                     | 7 Protocol Select Jumpers |
| 4 Manual Override          | 8 Dallas 1-Wire Bridge    |

Figure 13: LK204-25

### 2.1 DB-9 Connector

The LK204-25 provides a *DB-9 Connector* to readily interface with serial devices which use the EIA232 standard signal levels of  $\pm 12V$  to  $\pm 12V$ . 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. However, in order to accomplish this you must set the *Power Through DB-9 Jumper*.



- Pin 2** Rx \ SCL (I<sup>2</sup>C clock)
- Pin 3** Tx \ SDA (I<sup>2</sup>C data)
- Pin 5** GND
- Pin 9** PWR (*Must solder Power Through DB-9 Jumper. See table 1 on the next page for power requirements.*)

Figure 14: RS-232 Pin out

### 2.1.1 Power Through DB-9 Jumper

In order to provide power through pin 9 of the *DB-9 Connector* you must place a solder jumper on the *Power through DB-9 Jumper* pictured in **figure 15** below. The LK204-25 allows all voltage models to use the power through DB-9 option, see table 1 on the following page for display module voltage requirements.

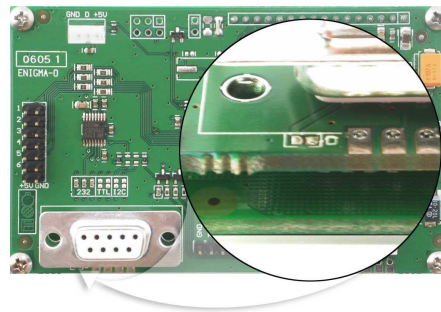


Figure 15: Power Through DB-9 Jumper



**WARNING** Do not apply voltage through pin 9 of the DB-9 connector AND through the Power/Data Connector at the same time.

## 2.2 Power/Data Connector

The *Power/Data Connector* provides a standard connector for powering the display module. The LK204-25 requires five volts for the standard display module, between nine to fifteen for the wide voltage (V) and between nine to thirty-five volts for the wide voltage with efficient power supply module (VPT). The voltage is applied through pins one and four of the four pin *Power/Data connector*. Pins two and three are reserved for serial transmission, using either the RS-232/TTL or the I<sup>2</sup>C protocol, depending on what has been selected by the *Protocol Select Jumpers*. Pins two and three may be reversed by changing the *Legacy*

Connector Jumpers in order to be compatible with previous PCB revisions.

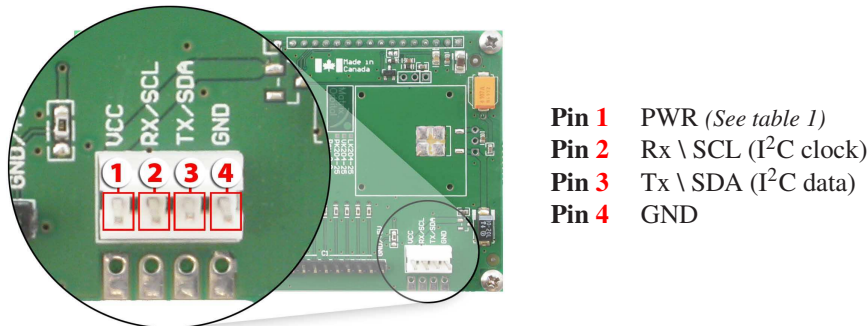


Figure 16: Power Connector and Pin out

Table 1: Power Requirements

	Standard	-V	-VPT
Supply Voltage	+5Vdc $\pm$ 0.25V	+9V to +15V	+9V to +35V
Backlight On	110 mA typical		
Backlight Off Supply	40 mA		



#### WARNINGS

- Do not apply any power with reversed polarization.
- Do not apply any voltage other than the specified voltage.

## 2.3 Protocol Select Jumpers

The *Protocol Select Jumpers*, pictured below in *figure 17*, provide the means necessary to toggle the display module between RS-232, TTL and I<sup>2</sup>C 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 I<sup>2</sup>C mode you must first remove the solder jumps from the 232 jumpers and then place them on the I<sup>2</sup>C jumpers. The display will now be in I<sup>2</sup>C 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 I<sup>2</sup>C jumpers and solder them to the TTL jumpers.

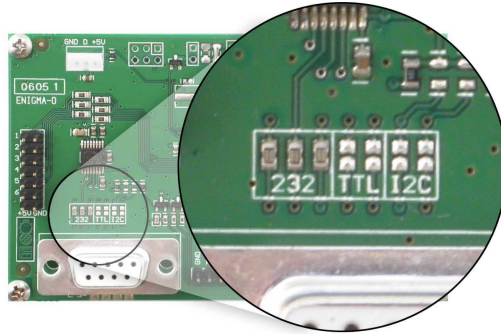


Figure 17: Protocol Select Jumpers

## 2.4 General Purpose Outputs

A unique feature of the LK204-25 is the ability to control relays and other external devices using a *General Purpose Output*, which can provide up to 20 mA of current and +5Vdc from the positive side of the GPO. This is limited by a 240 ohm resistor which is located to the above right of the GPOs as pictured below in *figure 21*. If the device, which is being driven by a GPO, requires a relatively high current (such as a relay) and has an internal resistance of its own greater than 250 ohms, then the 240 ohm resistor may be removed and replaced with a Jumper.

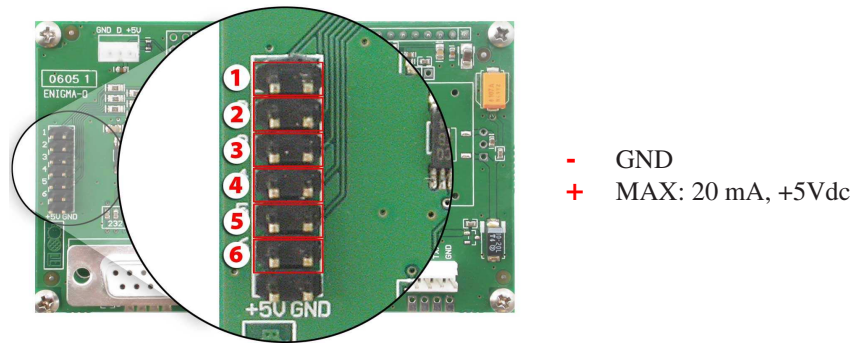


Figure 18: General Purpose Output



**WARNING** 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.

## 2.5 Dallas 1-Wire Bridge

In addition to the six general purpose outputs the LK204-25 offers a Dallas 1-wire bridge, to allow for an additional thirty two 1-wire devices to be connected to the display. See *Section 8.1 on page 35*.

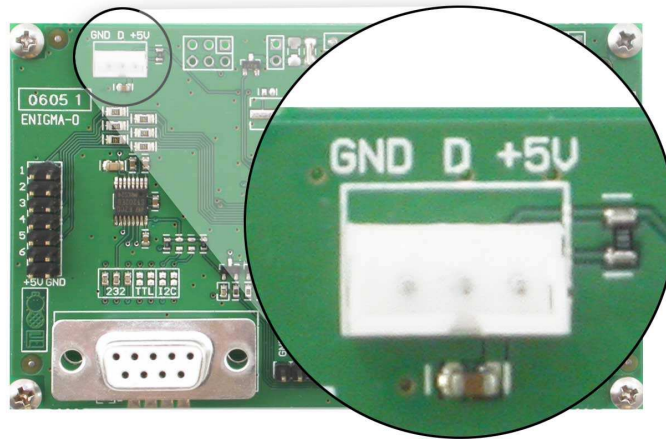


Figure 19: Dallas 1-Wire Bridge

## 2.6 Manual Override

The *Manual Override* is provided to allow the LK204-25 to be reset to factory defaults. This can be particularly helpful if the display module has been set to an unknown baud rate or I<sup>2</sup>C Slave Address and you are no longer able to communicate with it. If you wish to return the module to its default settings you must:

1. Power off the display module.
2. Place a Jumper on the *Manual Override* pins.
3. Power up the display module.
4. The display module is now set to its default values listed below in *table 2*.
5. Edit and save settings.



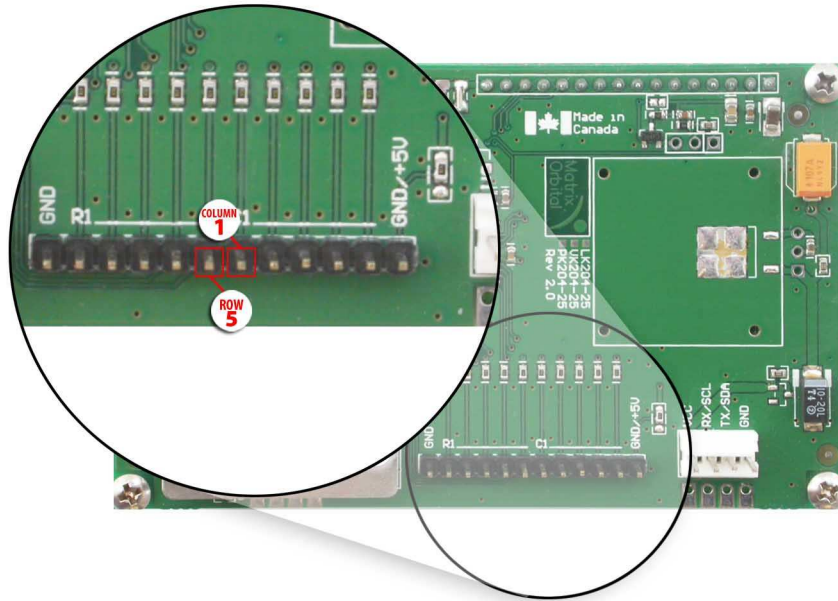


Figure 20: Manual Override Jumper

Table 2: Default Values

<b>Brightness</b>	255
<b>Baud Rate</b>	19.2 kbps
<b>I<sup>2</sup>C Slave Address</b>	0x50
<b>Data Lock</b>	False
<b>RS232AutoTransmitData</b>	True

---

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

---

## 2.7 Keypad Interface Connector

The LK204-25 provides a *Keypad Interface Connector* which allows for up to a five by five matrix style keypad 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, which is associated with the particular key press, is automatically sent on the Tx communication line. If the display module is running in I<sup>2</sup>C 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, for more detailed information see the *Keypad Section, on page 37*.

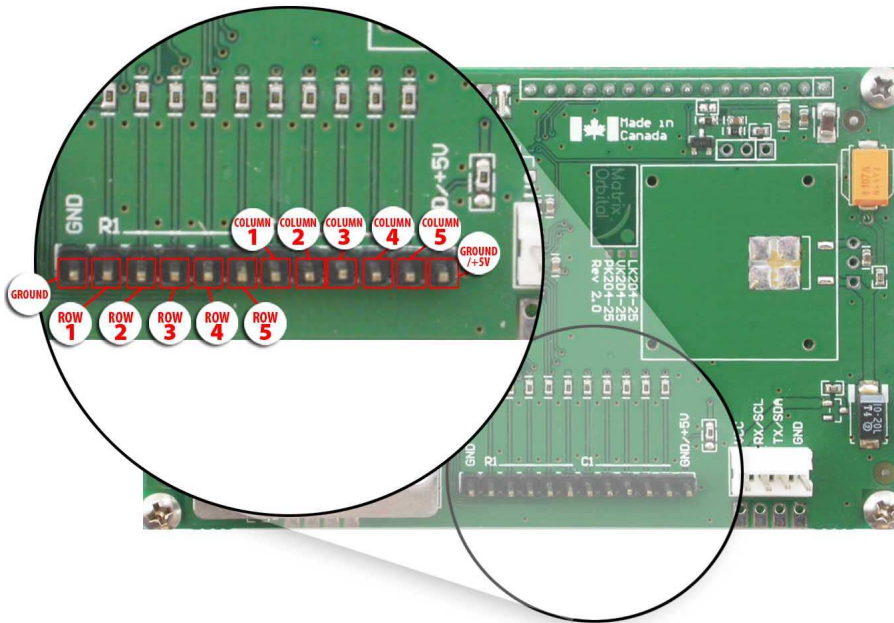


Figure 21: Keypad Interface Connector

---

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

---

## 3 Troubleshooting

### 3.1 The display does not turn on when power is applied.

- First, you will want to make sure that you are using the correct power connector. Standard floppy drive power cables from your PC power supply may fit on the Power/Data Connector however they do not have the correct pin out as can be seen in *figure 11 on page 7*. Matrix Orbital supplies power cable adapters for connecting to a PC, which can be found in the *Accessories Section on page 2*.
- The next step is to 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.
- The last step will be to check the *Power / Data Connector* on the LK204-25. If the *Power / Data Connector* has become loose, or you are unable to resolve the issue, please contact Matrix Orbital,

see *14.5 on page 60* for contact information.

## 3.2 The display module is not communicating.

- 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.
- Second, please ensure that the display module is set to communicate on the protocol that you are using, by checking the *Protocol Select Jumpers*. To change the protocol used by the display module see *Section 2.3 on page 11*.
- Third, 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.
- If you are communicating to the display via I<sup>2</sup>C please ensure that the data is being sent to the correct address. The default slave address for the display module is 0x50.

---

**NOTE** I<sup>2</sup>C communication will always require pull up resistors.

---

- Finally, you may reset the display to it's default settings using the *Manual Override Jumper*, see *Section 2.6 on page 13*.

## 3.3 The display module is communicating, however text cannot be displayed.

- A common cause may be that the contrast settings have been set to low. The solution to this problem is to adjust the contrast settings. The default setting that will work in most environments is 128.

---

**NOTE** Optimal contrast settings may vary according to factors such as temperature, viewing angle and lighting conditions.

If you are unable to resolve any issue please contact Matrix Orbital. See *14.5 on page 60* for contact information.

---

# 4 Communications

## 4.1 Introduction

The commands listed in this chapter describe how to configure data flow on the RS232/TTL and I<sup>2</sup>C port.

### 4.1.1 I<sup>2</sup>C Communication

The LK204-25 is capable of communicating at 400 Kbps in I<sup>2</sup>C mode, with 127 units addressable on a single I<sup>2</sup>C communication line. However, in order to communicate via I<sup>2</sup>C you must first set the Protocol

Select Jumpers as can be seen in **Section 2.3** and ensure that pull up resistors, with a nominal value of 1K to 10K, are placed on the SCL SDA communication lines coming from pins two and three of the Data / Power Connector respectively. The LK204-25 uses 8-bit addressing, with the 8th bit designated as the read write bit, a 0 designates a write address and a 1 designates a read address. The default read address of the display module will be 0x51, whereas the write address is 0x50 by default, to change the I<sup>2</sup>C address see section 8.2.1.

When communicating in I<sup>2</sup>C the LK204-25 will send an ACK on the 9th clock cycle when addressed. When writing to the display module, the display will respond with a ACK when the write has successfully been completed. However if the buffer has been filled, or the module is too busy processing data it will respond with a NAK. When performing a multiple byte read within one I<sup>2</sup>C transaction, each byte read from the slave should be followed by an ACK to indicate that the master still needs data, and a NAK to indicate that the transmission is over.

### 4.1.2 Serial Communication

In addition to being able to communicate via I<sup>2</sup>C the LK204-25 communicates natively through the RS-232 protocol at a default baud rate of 19,200 bps and is capable of standard baud rates from 1200 to 57600 bps. Furthermore the LK204-25 is also capable of reproducing any non-standard baud rate in between using values entered into our baud rate generation algorithm and set through command 164 (0xA4). The display module communicates at standard voltage levels of ±12V to ±12V or at TTL levels of 0 to +5V by setting the *Protocol Select Jumpers* to TTL.

## 4.2 Changing the I<sup>2</sup>C Slave Address

Syntax	Hexadecimal	0xFE 0x33 [adr]
	Decimal	254 51 [adr]
	ASCII	254 “3” [adr]

Parameters	Parameter	Length	Description
	adr	1	The new I <sup>2</sup> C write address (0x00 - 0xFF).

Description This command sets the I<sup>2</sup>C write address of the module between 0x00 and 0xFF. The I<sup>2</sup>C write address must be an even number and the read address is automatically set to one higher. For example if the I<sup>2</sup>C write address is set to 0x50, then the read address is 0x51.

---

**NOTE** The change in address is immediate.

---

Remembered	Always
------------	--------

Factory Default    0x50

### 4.3 Changing the Baud Rate

Syntax            Hexadecimal    0xFE 0x39 [speed]  
                      Decimal        254 57 [speed]  
                      ASCII         254 "9" [speed]

Parameters	Parameter	Length	Description
	speed	1	Hex value corresponding to a baud rate.

Description        This command sets the RS-232 port to the specified [speed]. The change takes place immediately. [speed] is a single byte specifying the desired port speed. Valid speeds are shown in the table below. The display module can be manually reset to 19,200 baud in the event of an error during transmission, including transmitting a value not listed below, by setting the manual override jumper during power up. However, it should be noted that this command will be ignored until the manual override jumper is removed again.

Hex Value	Baud Rate
53	1200
29	2400
CF	4800
67	9600
33	19200
22	28800
19	38400
10	57600

Remembered       Always

Factory Default    19,200 bps

### 4.4 Setting a Non-Standard Baud Rate



Syntax            Hexadecimal    0xFE 0xA4 [speed]  
                       Decimal            254 164 [speed]

Parameter	Parameter	Length	Description
	speed	2	Inputed LSB MSB from baud rate formula (12-2047).

Description        This command sets the RS-232 port to a non-standard baud rate. The command accepts a two byte parameter that goes directly into the modules baud generator. Use the formula,  $speed = \frac{CrystalSpeed}{8 \times DesiredBaud} - 1$  to calculate the [speed] for any baud rate setting. The speed can be anywhere from 12 to 2047 which corresponds to a baud range of 977 to 153,800 baud. Setting the baud rate out of this range could cause the display to stop working properly and require the Manual Override jumper to be set.

Remembered       Always

Examples

**Crystal Speed 8 Mhz**

$$speed = \frac{crystalspeed}{8 * DesiredBaud} - 1 \qquad speed = \frac{8,000,000}{8 * 13,500} - 1$$

$$speed = 74.07 - 1$$

$$speed = 73.07$$

- **LSB** = 0x4A (rounded)
- **MSB** = 0x00
- Inteded Baud Rate: 13,500 baud      Actual Baud Rate:  
 $\frac{8,000,000}{8(73+1)} = 13,675$       Percent Difference: 1.8%

---

**NOTES**

- Results from the formula are rounded down to the nearest whole number (73.07 = 73).
  - This formula becomes less accurate as baud rates increase, due to rounding.
  - Place the speed result backwards into the formula to receive the actual baud rate. ( $Baud = \frac{CrystalSpeed}{8(speed+1)}$ )
  - The actual baud rate must be within 3% of the intended baud rate for the device to communicate.
-

# 5 Text

## 5.1 Introduction

The LK204-25 is an intelligent display module, designed to reduce the amount of code necessary to begin displaying data. This means that it is able to display all characters and strings that are sent to it, which are defined in the current character set. The display module will begin displaying text at the top left corner of the display area, known as home, and continue to print to the display as if it was a page on a typewriter. When the text reaches the bottom right row, it is able to automatically scroll all of the lines up and continue to display text, with the auto scroll option set to on.

### 5.1.1 Character Set

		Higher 4-bit (D4 to D7) of Character Code (Hexadecimal)																
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
Lower 4-bit (D0 to D3) of Character Code (Hexadecimal)	0	CG RAM (1)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	
	1	CG RAM (2)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	2	CG RAM (3)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	3	CG RAM (4)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	4	CG RAM (5)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	5	CG RAM (6)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	6	CG RAM (7)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	7	CG RAM (8)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	8	CG RAM (1)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	9	CG RAM (2)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	A	CG RAM (3)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	B	CG RAM (4)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	C	CG RAM (5)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	D	CG RAM (6)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	E	CG RAM (7)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣
	F	CG RAM (8)	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣	␣

Figure 22: Character Set

## 5.1.2 Control Characters

**0x08** Backspace

**0x0C** Clear screen / New page

**0x0D** Carriage return

**0x0A** Line feed / New line

## 5.2 Auto Scroll On

Syntax	Hexadecimal	0xFE 0x51
	Decimal	254 81
	ASCII	254 “Q”

Description	When auto scrolling is on, it causes the display to shift the entire display’s contents up to make room for a new line of text when the text reaches the end of the last row.
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Remembered	Yes
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Factory Default	On
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## 5.3 Auto Scroll Off

Syntax	Hexadecimal	0xFE 0x52
	Decimal	254 82
	ASCII	254 “R”

Description	When auto scrolling is disabled the text will wrap to the top left corner of the display area when the text reaches the end of last row.
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Remembered	Yes
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## 5.4 Clear Screen