Jameco Part Number 150957

LCD2041
Technical Manual

Revision: 2.0

Contents

1   Getting Started

Figure 1: LCD2041-WB

The LCD2041 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^{2}C protocols, the versatile LCD2041 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 charaters such as character sets for bar graphs, medium and large numbers may be stored in the non-volitile memory to be easily recalled and displayed at any time.

1.1   Display Options Available

The LCD2041 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.
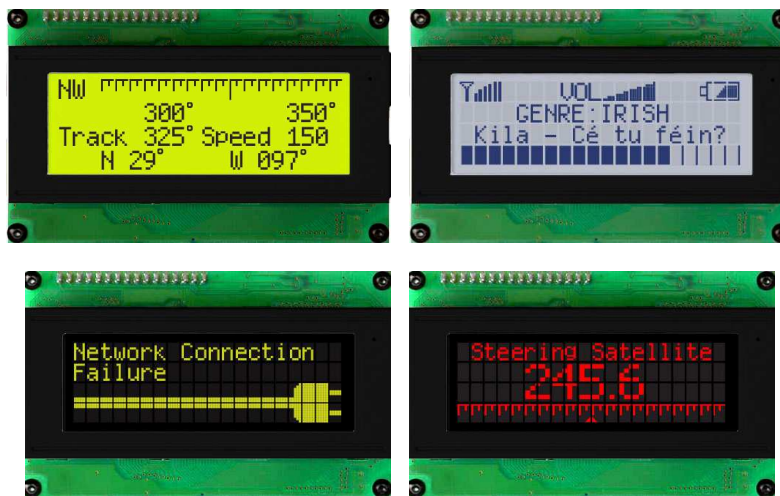
Figure 2: LCD2041 Options

1.2 Accessories

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 12.5 on page 49 for contact information.

Figure 3: 5V Power Cable Adapter

Figure 4: 12V Power Cable Adapter (V/VPT Models)

Figure 5: Breadboard Cable
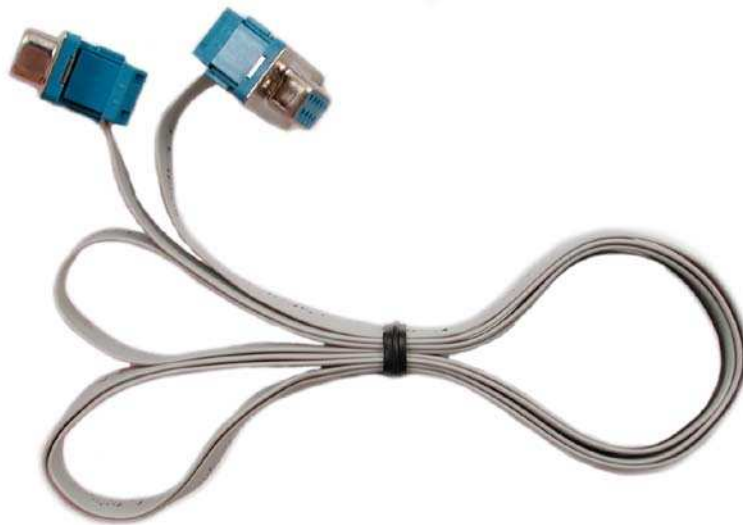
Figure 6: Serial Cable 4FT
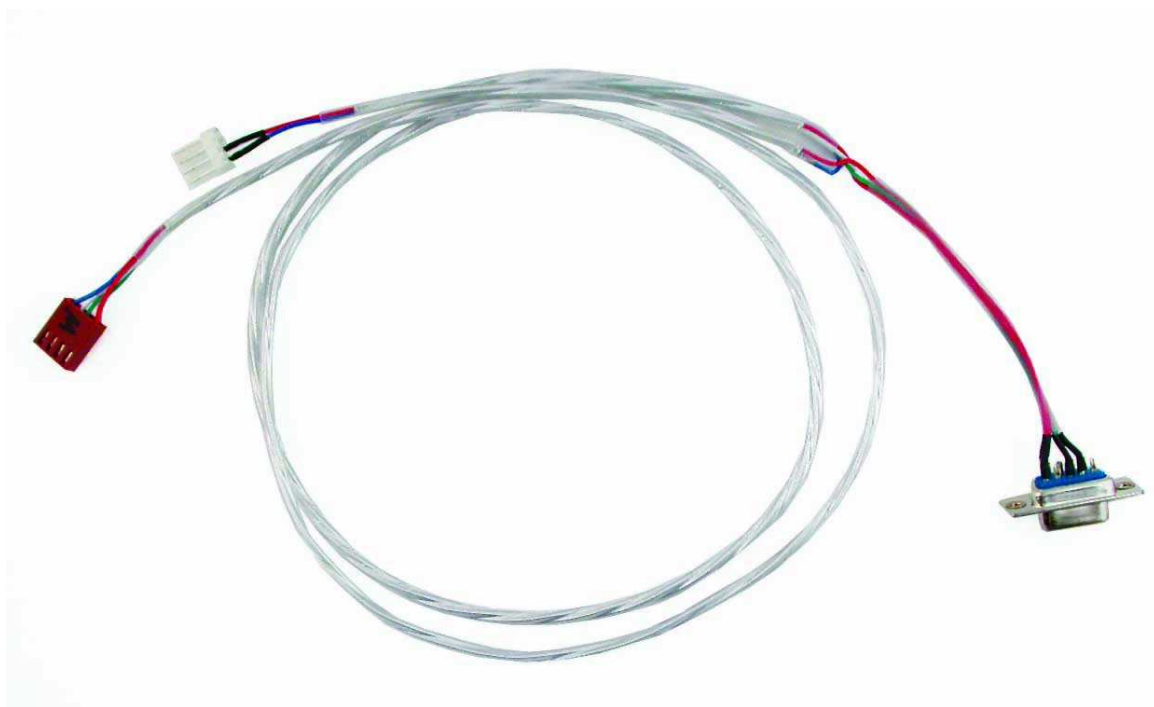
Figure 7: Communication and 5V Power Cable

1.3 Features

- 20 column by 4 line alphanumeric liquid crystal display
- Selectable communication protocol, RS-232 or I^2C
- One-wire interface that is capable of communicating with up to 32 devices over a single bus
- Three, 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^2C
- 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^2C interface
- 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
- Horizontal or vertical bar graphs
- Extended temperature option
- Fits Matrix Orbital's mountings without any modifications

1.4 Connecting to a PC

The LCD2041 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 6 on page 3*, as well as a modified 5V power adapter such as the one pictured in *figure 3 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.
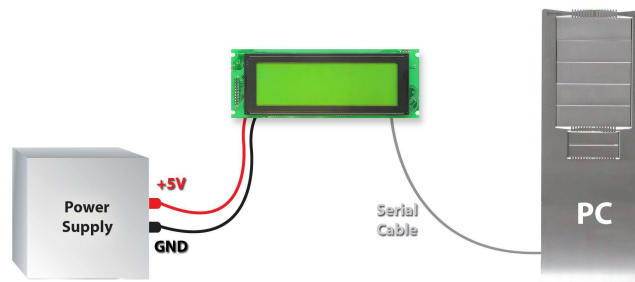
WARNING   DO NOT use the standard floppy drive power connector, as this will not provide you with the correct voltage and will damage the display module.
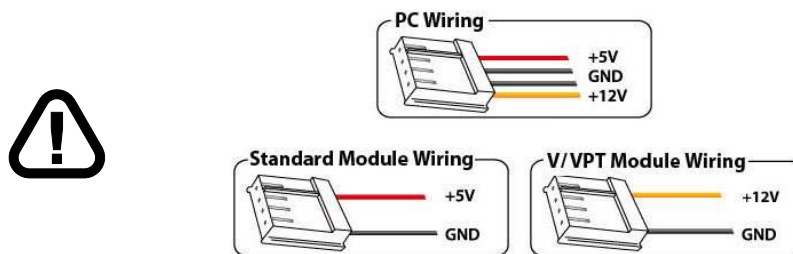
Figure 8: PC vs Matrix Orbital Display Module Wiring

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.

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

Figure 9: uProject Settings

NOTES

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

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2   Hardware Information

Refer to the following diagram for this chapter:
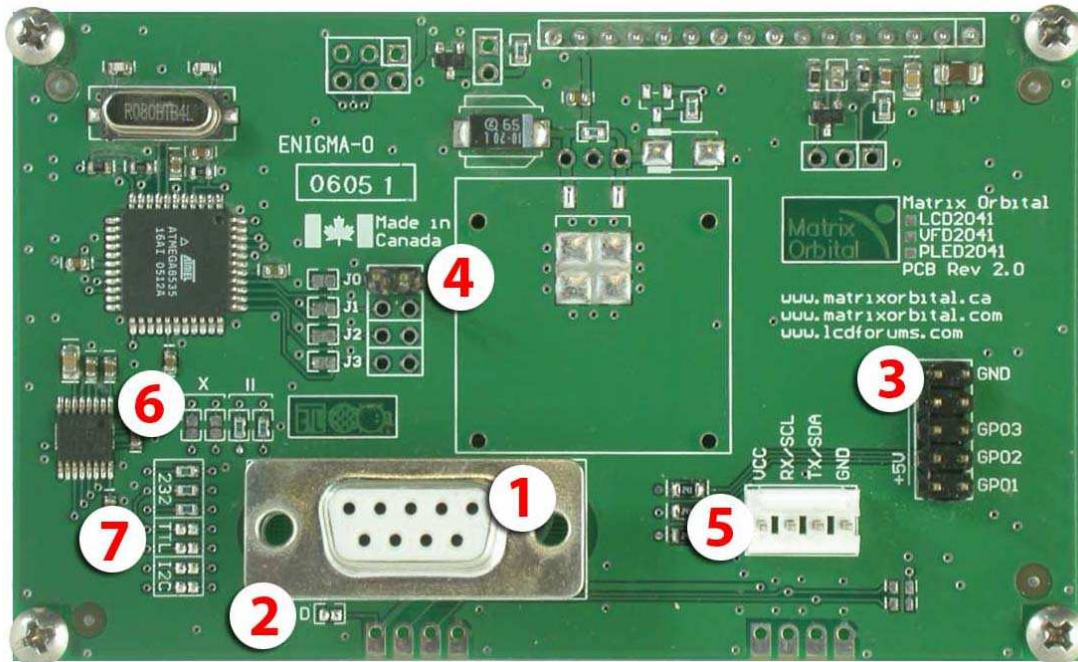
1 DB-9 Connector	**5** Power / Data Connector
2 Power Through DB9 Jumper	**6** Legacy Connector Jumper
3 GPOs	**7** Protocol Select Jumpers
4 Manual Override	

Figure 10: LCD2041

2.1   DB-9 Connector

The LCD2041 provides a *DB-9 Connector* to readily interface with serial devices which use the EIA232 standard signal levels of ±12V to ±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*.
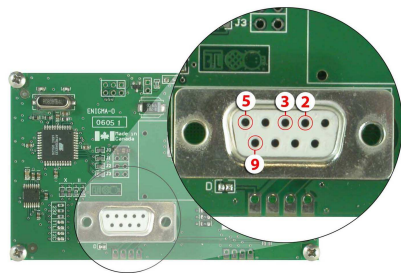
Pin 2	Rx \ SCL (I^{2}C clock)
Pin 3	Tx \ SDA (I^{2}C data)
Pin 5	GND
Pin 9	PWR *(Must solder Power Through DB-9 Jumper. See table 1 on the next page for power requirements.)*

Figure 11: 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 12* below. The LCD2041 allows all voltage models to use the power through DB-9 option, see table 1 on the following page for display module voltage requirements.
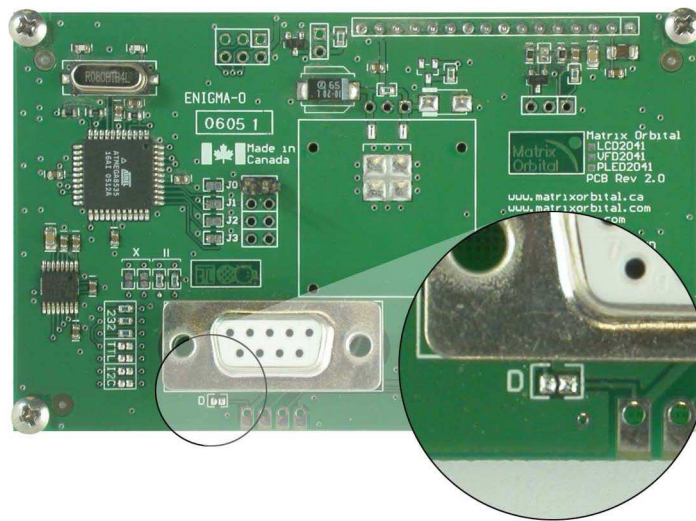
Figure 12: Power Through DB-9 Jumper

⚠ **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 LCD2041 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^{2}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.
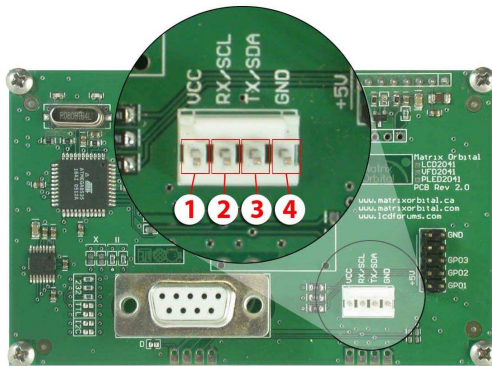
Pin 1   PWR *(See table 1)*
Pin 2   Rx \ SCL (I^{2}C clock)
Pin 3   Tx \ SDA (I^{2}C data)
Pin 4   GND

Figure 13: Power Connector and Pin out

Table 1: Power Requirements

	Standard	**-V**	**-VPT**
Supply Voltage	+5Vdc $\pm$0.25V	+9V to +15V	+9V to +35V
Supply Current	11 mA typical		
Supply Backlight Current	160 mA typical		

WARNINGS

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

2.2.1 Legacy Data Connector Jumpers

To reverse pins two and three of the *Power/Data Connector* remove the zero ohm resistors from the *Legacy Data Connector Jumpers*, labeled with the **=** symbol and place them on the jumpers labeled with the

X symbol. This will allow you to transmit on pin two, and receive data on pin three instead of the default of receiving on pin two and transmitting on pin three of the *Power/Data Connector*.

Power/Data Connector	
Pin 2	Rx \ SCL (I^{2}C clock)
Pin 3	Tx \ SDA (I^{2}C data)
Pin 2	Tx \ SDA (I^{2}C data)
Pin 3	Rx \ SCL (I^{2}C clock)
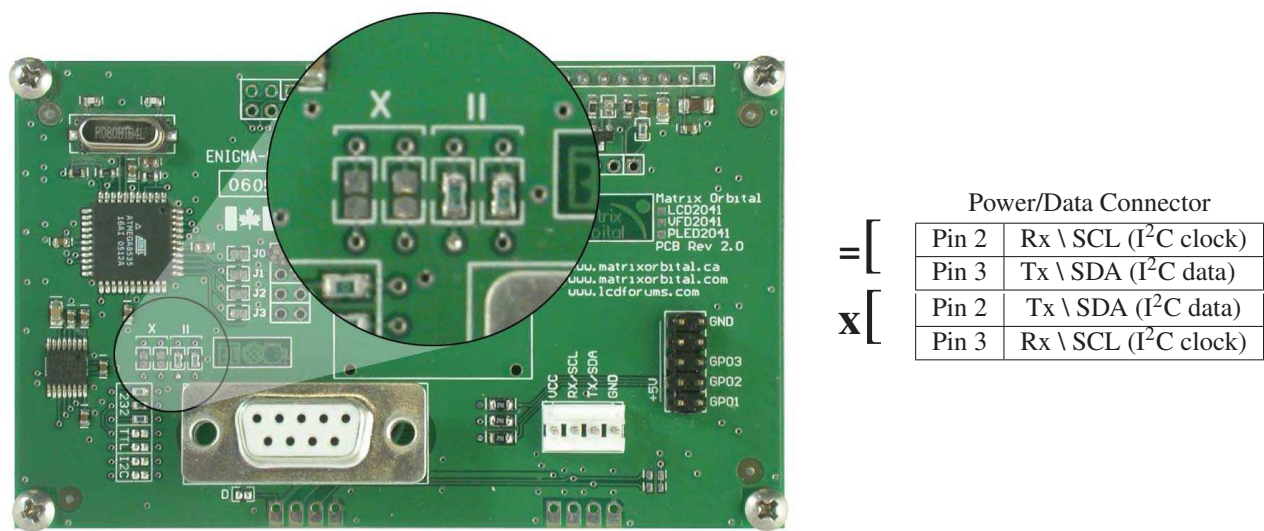
Figure 14: Legacy Data Connector Jumpers

2.3 Protocol Select Jumpers

The *Protocol Select Jumpers*, pictured below in *figure 15*, provide the means necessary to toggle the display module between RS-232, TTL and I^{2}C protocols. As a default, the jumpers are set to RS-232 mode with zero ohm resistors on the 232 jumpers. In order to place the display module in I^{2}C mode you must first remove the zero ohm resistors from the 232 jumpers and then solder the resistors on to the I2C jumpers. The display will now be in I^{2}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^{2}C jumpers and solder them to the TTL jumpers.
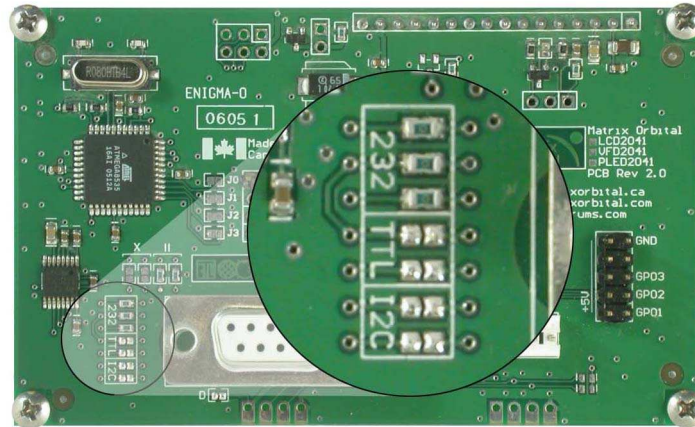
Figure 15: Protocol Select Jumpers

2.4 General Purpose Outputs

A unique feature of the LCD2041 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. 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, which is associated with the GPO may be removed and replaced with a Jumper.

-   GND
+   MAX: 20 mA, +5Vdc
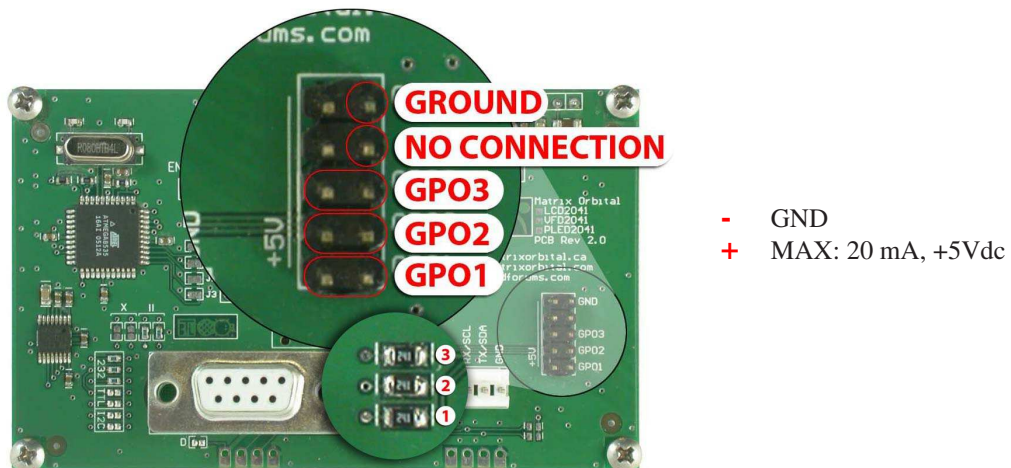
Figure 16: General Purpose Output

⚠	**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.
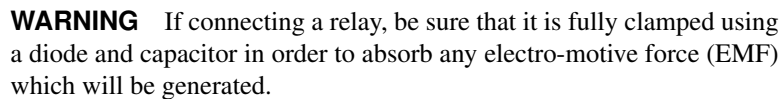
2.5   Manual Override

The *Manual Override* is provided to allow the LCD2041 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^2C 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 17: Manual Override Jumper

Table 2: Default Values

Contrast	128
Backlight	255
Baud Rate	19.2 kbps
I²C Slave Address	0x50
Data Lock	False
RS232AutoTransmitData	True

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

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 8 on page 5*. 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 LCD2041. If the *Power / Data Connector* has become loose, or you are unable to resolve the issue, please contact Matrix Orbital, see *12.5 on page 49* 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 10*.
- 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 I²C please ensure that the data is being sent to the correct address. The default slave address for the display module is 0x50.

NOTE I²C 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 2.5 on page 12*.

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 *12.5 on page 49* for contact information.

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4   Communications

4.1   Introduction

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

4.1.1 I^2C Communication

The LCD2041 is capable of communicating at 400 Kbps in I^2C mode, with 127 units addressable on a single I^2C communication line. However, in order to communicate via I^2C 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 LCD2041 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^2C address see section 8.2.1.

When communicating in I^2C the LCD2041 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^2C 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^{2}C the LCD2041 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. Furthmore the LCD2041 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^{2}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^{2}C write address (0x00 - 0xFF).

Description
: This command sets the I^{2}C write address of the module between 0x00 and 0xFF. The I^{2}C write address must be an even number and the read address is automatically set to one higher. For example if the I^{2}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 corrisponding 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]

Parameters	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

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

$$speed = 74.07 - 1 \qquad\qquad speed = 73.07$$

- **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 acurate 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.

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5   Text

5.1   Introduction

The LCD2041 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

Figure 18: 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.

Remembered | Yes

Factory Default | On

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.

Remembered | Yes

5.4 Clear Screen

Syntax | Hexadecimal | 0xFE 0x58
| Decimal | 254 88
| ASCII | 254 "X"

Description | This command will immediately clear all of the contents of the display.

Remembered | No

5.5   Changing the Startup Screen

Syntax	Hexadecimal	0xFE 0x40 [chars]
	Decimal	254 64 [chars]
	ASCII	254 "@" [chars]

Parameters	Parameter	Length	Description
	chars	80	Characters to display for the startup screen.

Description   In order to change the text that is displayed by the LCD2041 when it starts up simply send the command bytes 254 64 followed by the characters that you wish to display, starting from the top left. This command will automatically line wrap the characters that are sent to it.

Remembered   Yes

5.6   Set Auto Line Wrap On

Syntax	Hexadecimal	0xFE 0x43
	Decimal	254 67
	ASCII	254 "C"

Description   Enabling Auto Line Wrap will allow the cursor to automatically wrap over to the next line when the current line is full.

NOTE   Line wraps may occur in the middle of a word.

Remembered   Yes

5.7   Set Auto Line Wrap Off

Syntax	Hexadecimal	0xFE 0x44
	Decimal	254 68
	ASCII	254 "D"

Description   Disabling Auto Line Wrap will allow you to have full control over the
                 cursor position. This means that once the cursor has advanced to the
                 end of a line, it will not wrap over to the next line, unless given the 'Set
                 Cursor Position' Command.

NOTE   All characters written to the display past the end of a line will be lost.

Remembered   Yes

5.8 Set Cursor Position

Syntax   Hexadecimal   0xFE 0x47 [col] [row]
                 Decimal   254 71 [col] [row]
                 ASCII   254 "G" [col] [row]

Parameters

Parameter	Length	Description
col	1	Column
row	1	Row

Description   This command will allow you to manually set the cursor position, which
                 controls the text insertion point, by specifying the [col] and [row] of the
                 new proposed cursor position.

NOTE   If the cursor position is set past the end of a line it will wrap to the beginning of
the next line.

Remembered   No

5.9 Go Home

Syntax   Hexadecimal   0xFE 0x48
                 Decimal   254 72
                 ASCII   254 "H"

Description   This command will return the cursor to the top left corner of the display
                 area, identified as row one, column one.

Remembered   No

5.10 Move Cursor Back

Syntax   Hexadecimal   0xFE 0x4C
                    Decimal   254 76
                    ASCII   254 "L"

Description   This command will move the cursor back one space. If this command is
                    sent when the cursor is at the home position the cursor will wrap to the
                    last row / column position if line wrap is on. Sending this command will
                    not effect the text displayed on the module, however any characters that
                    are sent will over write the current characters that are being displayed.

Remembered   No

5.11 Move Cursor Forward

Syntax   Hexadecimal   0xFE 0x4D
                    Decimal   254 77
                    ASCII   254 "M"

Description   This command will move the cursor forward one space. If this command
                    is sent when the cursor is at the bottom right position the cursor will wrap
                    back to the home position if line wrap is on. Sending this command will
                    not effect the text displayed on the module, however any characters that
                    are sent will over write the current characters that are being displayed.

Remembered   No

5.12 Underline Cursor On

Syntax   Hexadecimal   0xFE 0x4A
                    Decimal   254 74
                    ASCII   254 "J"

Description   This command will cause the LCD2041 to display an underline cursor at
                     the current text insertion point.

Remembered   Yes

5.13   Underline Cursor Off

Syntax   Hexadecimal   0xFE 0x4B
                           Decimal   254 75
                           ASCII   254 "K"

Description   This command will turn the the underline cursor off.

Remembered   Yes

5.14   Blinking Block Cursor On

Syntax   Hexadecimal   0xFE 0x53
                           Decimal   254 83
                           ASCII   254 "S"

Description   This command will cause the LCD2041 to display an underline cursor at
                     the current text insertion point.

Remembered   Yes

5.15   Blinking Block Cursor Off

Syntax   Hexadecimal   0xFE 0x54
                           Decimal   254 84
                           ASCII   254 "T"

Description   This command will turn the block cursor off.

Remembered   Yes

6   Special Characters

6.1   Introduction

6.2   Creating a Custom Character

Syntax	Hexadecimal	0xFE 0x4E [refID] [data]
	Decimal	254 78 [refID] [data]
	ASCII	254 "N" [refID] [data]

Parameters	Parameter	Length	Description
	refID	1	Character reference ID (0-7).
	data	8	Character data.

Description   The LCD2041 allows for up to eight custom defined characters to be
                     added onto the the character set. A custom character is a five by eight
                     pixel matrix with each row represented by a byte value. For example:

Custom Character 'h'					Decimal	Hex
1	*0*	*0*	*0*	*0*	16	0x10
1	*0*	*0*	*0*	*0*	16	0x10
1	*0*	*0*	*0*	*0*	16	0x10
1	*0*	*0*	*0*	*0*	16	0x10
1	*0*	**1**	**1**	*0*	22	0x16
1	**1**	*0*	*0*	**1**	25	0x19
1	*0*	*0*	*0*	**1**	17	0x11
1	*0*	*0*	*0*	**1**	17	0x11

                     Each bit value of one, in the table, represents an on pixel, whereas a value
                     of zero represents a pixel that is turned off. Therefore in order to define
                     custom character 'h' you would send the command byte prefix 254 fol-
                     lowed by the command 78. Next, you will have to select the memory
                     location in which you wish to save the character in. The available mem-
                     ory locations for this command are zero through to seven. After sending
                     the memory location, or [refID], you may then send the eight byte custom
                     character data in sequence from the top to the bottom.
                     Once you have defined a custom character you may display it by sending
                     the display module the [refID]. For example if a custom character was
                     saved in position one, the command to display the custom character, at
                     the current cursor position, would be simply to send the number one to
                     the display module without quotes.

Remembered   No

6.3 Saving Custom Characters

Syntax   Hexadecimal   0xFE 0xC1 [Bank] [ID] [Data]
                     Decimal   254 193 [Bank] [ID] [Data]

Parameters

Parameter	Length	Description
Bank	1	Memory bank to save to (0-4).
ID	1	Character ID (0-7)
Data	8	Character Definition

Description	New to the LCD2041 has added five non-volatile memory banks for custom character storage. This is intended to allow you to create your own custom bar graphs, medium/large numbers and startup screen. However, each memory bank may be used to store a set of any eight custom characters; with the only provision being that memory bank zero contains the characters that will be used in the startup screen. By default the memory banks will be loaded as follows:

[Bank]	Description
0	Startup screen characters.
1	Horizontal bars
2	Vertical bars
3	Medium numbers
4	Large numbers

In order to save new custom characters into a memory bank, follow the same process as you would for creating a custom character, see Section 6.2 on page 24, only use 254 193 [Bank Number] before sending the [ID] and character [Data].

Remembered	Yes

6.4 Loading Custom Characters

Syntax	Hexadecimal	0xFE 0xC0 [Bank]
	Decimal	254 192 [Bank]

Parameters	Parameter	Length	Description
	Bank	1	Memory bank to save to (0-4).

Description	This command is used to load the custom characters into the volatile memory so that they may be used. If custom bar graph or number characters are stored in the memory banks, this command may be used instead of initializing the bar graph / number. To use this command send the command bytes followed by the [Bank] that contains the custom character data that you want to retrieve.

Remembered	No

6.5 Save Startup Screen Custom Characters

Syntax	Hexadecimal	0xFE 0xC2 [refID] [data]
	Decimal	254 194 [refID] [data]

Parameters

Parameter	Length	Description
refID	1	Character reference ID (0-7).
data	8	Character data.

Description   Using this command you may create the custom characters. that will be stored in memory bank zero, which will be used in the startup screen. For more information about creating custom characters see *Section 6.2 on page 24*.

NOTES

- Changes only take place once the power has been cycled.
- This command is the same as sending CMD 254 / 193 / 0 / [ID] / [DATA]

Remembered   Yes

6.6 Initialize Medium Number

Syntax	Hexadecimal	0xFE 0x6D
	Decimal	254 109
	ASCII	254 "m"

Description   This command will load the default medium number characters into the volatile memory. If you have stored your own custom medium numbers, use the 'Load Custom Characters' command to load your custom character data into the volatile memory. This command will allow you to use the 'Place Medium Numbers' command.

Remembered   No

6.7 Place Medium Numbers

Syntax		
	Hexadecimal	0xFE 0x6F [Row] [Col] [Digit]
	Decimal	254 111 [Row] [Col] [Digit]
	ASCII	254 "o" [Row] [Col] [Digit]

Parameters	Parameter	Length	Description
	Row	1	The row number.
	Col	1	The column number.
	Digit	1	Medium number to place (0-9).

Description   This command will place a medium number (two columns high) at the [row] and [col] specified.

Remembered   No

6.8   Initialize Large Numbers

Syntax		
	Hexadecimal	0xFE 0x6E
	Decimal	254 110
	ASCII	254 "n"

Description   This command will load the default large number characters into the volatile memory. If you have stored your own custom large numbers, use the 'Load Custom Characters' command instead to load your custom character data into the volatile memory. This command will allow you to use the 'Place Large Numbers' command.

Remembered   No

6.9   Place Large Number

Syntax		
	Hexadecimal	0xFE 0x23 [Col] [Digit]
	Decimal	254 35 [Col] [Digit]
	ASCII	254 "#" [Col] [Digit]

Parameters	Parameter	Length	Description
	Col	1	The column number.
	Digit	1	Large number to place (0-9).

Description	This command will place a large number (four columns high) at the [row] and [col] specified.

Remembered	No

6.10 Initialize Horizontal Bar

Syntax	Hexadecimal	0xFE 0x68
	Decimal	254 104
	ASCII	254 "h"

Description	This command will load the default horizontal bar characters into the volatile memory. If you have stored your own custom horizontal bar data, use the 'Load Custom Characters' command instead to load your custom bar data into the volatile memory. This command will allow you to use the 'Place Horizontal Bar' command.

Remembered	No

6.11 Place Horizontal Bar Graph

Syntax	Hexadecimal	0xFE 0x7C [Col] [Row] [Dir] [Length]
	Decimal	254 124 [Col] [Row] [Dir] [Length]
	ASCII	254 "l" [Col] [Row] [Dir] [Length]

Parameters	Parameter	Length	Description
	Col	1	The column number.
	Row	1	The row number.
	Dir	1	The direction of the bar data (0 or 1).
	Length	1	The length of the bar data.

Description	This command will place a bar graph at [row], [column]. A [Dir] value of zero will cause the bar to go right, and one will cause the bar to go left. The [Length] is the size in pixels of the bar graph.

Remembered	No

6.12 Initialize Narrow Vertical Bar

Syntax   Hexadecimal   0xFE 0x73
                                    Decimal   254 115
                                    ASCII   254 "s"

Description   This command will load the narrow vertical bar characters into the volatile memory. If you have stored your own custom vertical bar data, use the 'Load Custom Characters' command instead to load your custom bar data into the volatile memory. This command will allow you to use the 'Place Vertical Bar' command.

NOTE   Narrow bars have a width of two pixels.

Remembered   No

6.13 Initialize Wide Vertical Bar

Syntax   Hexadecimal   0xFE 0x76
                                    Decimal   254 118
                                    ASCII   254 "v"

Description   This command will load the wide vertical bar characters into the volatile memory. If you have stored your own custom vertical bar data, use the 'Load Custom Characters' command instead to load your custom bar data into the volatile memory. This command will allow you to use the 'Place Vertical Bar' command.

NOTE   Wide bars have a width of five pixels.

Remembered   No

6.14 Place Vertical Bar

Syntax	Hexadecimal	0xFE 0x3D [Column] [Length]
	Decimal	254 61 [Column] [Length]
	ASCII	254 "=" [Column] [Length]

Parameters	Parameter	Length	Description
	Column	1	The column number.
	Length	1	The length of the bar data.

Description   This command will place a bar graph at the specified [Column] with the specified [Length]. The [Length] is the size in pixels of the bar graph.

Remembered   No

7   General Purpose Output

7.1   Introduction

General purpose outputs allow you to connect devices, such as temperature probes, to the LCD2041 and supply them with up to 20mA of current at 5V. The LCD2041 has 3 GPOs which are software controlled, with functions to turn them on/off and set the power state for the next startup.

7.2   General Purpose Output Off

Syntax	Hexadecimal	0xFE 0x56 [Num]
	Decimal	254 86 [Num]
	ASCII	254 "V" [Num]

Parameters	Parameter	Length	Description
	Num	1	GPO number.

Description   This command turns OFF general purpose output [num].

NOTE   OFF means that the output is ground.

Remembered   Yes

7.3 General Purpose Output On

Syntax

Hexadecimal	0xFE 0x57 [Num]
Decimal	254 87 [Num]
ASCII	254 "W" [Num]

Parameters

Parameter	Length	Description
Num	1	GPO number.

Description

This command turns ON general purpose output [num]. The standard GPO's on the LCD2041 output 20mA of current at 5V.

NOTE   The output is pulled high.

Remembered   Yes

7.4 Set Startup GPO state

Syntax

Hexadecimal	0xFE 0xC3 [Num] [state]
Decimal	254 195 [Num] [state]

Parameters

Parameter	Length	Description
Num	1	GPO number.
state	1	Startup state (0: Off, 1: On)

Description

This command will set the startup state for the GPO on the next power up. A value of one will cause the GPO to be off on the next startup while a value of one will cause the GPO to be on.

NOTE   This command does not affect the current state of the GPO.

Remembered   Always

8 Display Functions

8.1 Introduction

The LCD2041 employs software controlled display settings, which allow for control over, clearing the screen, changing the brightness and contrast or setting timers for turning it on or off. The combination of these allow you complete software control over your display's appearance.

8.2 Display On

Syntax	Hexadecimal	0xFE 0x42 [min]
	Decimal	254 66 [min]
	ASCII	254 "B" [min]

Parameters	Parameter	Length	Description
	min	1	Minutes before turning the display on (0 to 100).

Description	This command turns the display on after the [minutes] timer has expired , with a one-hundred minute maximum timer. A time of 0 specifies that the display should turn on immediately and stay on. When this command is sent while the remember function is on, the timer will reset and begin after power up.
Remembered	Yes
Factory Default	0

8.3 Display Off

Syntax	Hexadecimal	0xFE 0x46
	Decimal	254 70
	ASCII	254 "F"

Description	This command turns the display off immediately. The display will remain off until a 'Display On' command has been received.

Remembered   Yes

8.4 Set Brightness

Syntax	Hexadecimal	0xFE 0x99 [brightness]
	Decimal	254 153 [brightness]

Parameters	Parameter	Length	Description
	brightness	1	Display brightness setting (0 to 255).

Description   This command sets the display [brightness]. If the remember function is on, this command acts the same as 'Set and Save Brightness'.

Remembered   Yes

Factory Default   255

8.5 Set and Save Brightness

Syntax	Hexadecimal	0xFE 0x98 [brightness]
	Decimal	254 152 [brightness]

Parameters	Parameter	Length	Description
	brightness	1	Backlight setting (0 to 255).

Description   This command sets and saves the display [brightness] as default.

Remembered   Always

8.6 Set Contrast

Syntax	Hexadecimal	0xFE 0x50 [contrast]
	Decimal	254 80 [contrast]
	ASCII	254 "P" [contrast]

Parameters	Parameter	Length	Description
	contrast	1	Contrast value (0 to 255).

Description   This command sets the display's contrast to [contrast], where [contrast] is a value between 0x00 and 0xFF (between 0 to 255). Lower values cause 'on' elements in the display area to appear lighter, while higher values cause 'on' elements to appear darker. Lighting and temperature conditions will affect the actual value used for optimal viewing. Individual display modules will also differ slightly from each other in appearance. In addition, values for optimal viewing while the display backlight is on may differ from values used when backlight is off.
This command does not save the [contrast] value, and is lost after power down; but this command has the option of remembering the settings when issued with the Remember function 'on' . When this is the case, this command is the same as the Set and Save Contrast command.

Remembered   Yes

Factory Default   128

8.7 Set and Save Contrast

Syntax	Hexadecimal	0xFE 0x91 [contrast]
	Decimal	254 145 [contrast]

Parameters	Parameter	Length	Description
	contrast	1	Contrast value (0 to 255).

Description	This command sets the display's contrast to [contrast], where [contrast] is a value between 0x00 and 0xFF (between 0 to 255). Lower values cause 'on' elements in the display area to appear lighter, while higher values cause 'on' elements to appear darker. Lighting conditions will affect the actual value used for optimal viewing. Individual display modules will also differ slightly from each other in appearance. In addition, values for optimal viewing while the display backlight is on may differ from values used when backlight is off.

NOTE   This command saves the [contrast] value so that it is not lost after power down.

Remembered	Yes

Factory Default	128

9   Data Security

9.1   Introduction

Ensuring that your LCD2041 display's exactly what you want it to can be the difference between a projects success and failure. This is why we incorporate features such as Data Lock into the LCD2041 With this new feature you now are in control over of how and when settings will be changed so there is no need to worry about the module acting exactly like you expected it to because all the settings may be locked and remembered for the next power up.

9.2   Set Remember

Syntax	Hexadecimal	0xFE 0x93 [switch]
	Decimal	254 147 [switch]

Parameters	Parameter	Length	Description
	switch	1	0: Do not remember, 1: Remember

Description	This command allows you to switch the remember function on and off. To use the remember function, set remember to on, then set all of the settings that you wish to save, settings that are listed as 'Remember: Yes' support being saved into the non-volatile memory. After you have set all of the commands that you wish to save, you may then cycle the power and check the display settings to ensure that all the settings have been saved. If you wish to use remember again after cycling the power, you must set it to on again.

NOTES

- Writing to non-volatile memory is time consuming and slows down the operation of the display.
- Non-volatile memory has a 'write limit' and may only be changed approximately 100,000 times.

Remembered	No

Factory Default	Do not remember

9.3 Data Lock

Syntax	Hexadecimal	0xFE 0xCA 0xF5 0xA0 [level]
	Decimal	254 202 245 160 [level]

Parameters	Parameter	Length	Description
	level	1	Sets the data lock level

Description   Data lock, originally known as paranoia, allows you to lock the module
from displaying information, as well as enables the protection of the
filesystem and module settings. Each bit corresponds corresponds to a
different lock level, while sending a zero will unlock your display as the
following tables explains:

Bit	Data Lock Level	Description
0	Unlock	Sending a zero will cause the display to unlock. (0)
1-4	Reserved	These bits are used as place holders and should not be omitted. (0000)
5	Setting Lock	Locks the display settings such as backlight, contrast and GPO settings. (10000)
6	Reserved for graphical displays. (000000)	
7	Command Lock	Locks all commands but the data lock command. (1000000)
8	Display Lock	Locks the module from displaying any new information. (10000000)

NOTES

- Sending a new data lock level will override the previous data lock level.
- Data lock levels may be combined.

Remembered   Always

Factory Default   0

Examples

Hex	Dec	Binary	Description
0x00	0	0	Unlock
0x50	80	01010000	Setting and Command Lock

9.4 Set and Save Data Lock

Syntax	Hexadecimal	0xFE 0xCB 0xF5 0xA0 [level]
	Decimal	254 203 245 160 [level]

Parameters	Parameter	Length	Description
	level	1	Sets the data lock level

Description   This command will set and save the data lock level. See the Data Lock section for more information.

Remembered   Always

Factory Default   0

10   Miscellaneous

10.1   Introduction

This chapter covers the 'Report Version Number' and 'Read Module Type' commands. These commands can be particularly useful to find out more information about the display module before contacting technical support.

10.2   Read Version Number

Syntax	Hexadecimal	0xFE 0x36
	Decimal	254 54
	ASCII	254 "6"

Description   This command will return a byte representing the version of the module, see the following table as an example:

Hex Value	Version Number
0x10	Version 1.0
0x20	Version 2.0
0x42	Version 4.2

Remembered   No

10.3 Read Module Type

Syntax

Hexadecimal	0xFE 0x37
Decimal	254 55
ASCII	254 "7"

Description
This command will return a hex value corresponding to the the model number of the module see the following table:

Hex	Product ID	Hex	Product ID
1	LCD0821	36	LK202-24-USB
2	LCD2021	37	VK202-24-USB
5	VK202-25	38	LK204-24-USB
6	LCD4021	39	VK204-24-USB
7	LCD4041	3A	PK162-12
8	LK202-25	3B	VK162-12
9	LK204-25	3C	MOS-AP-162A
A	LK404-55	3D	PK202-25
B	VFD2021	3E	MOS-AL-162A
C	VFD2041	40	MOS-AV-202A
D	VFD4021	41	MOS-AP-202A
E	VK202-25	42	PK202-24-USB
F	VK204-25	43	MOS-AL-082
10	GLC12232	44	MOS-AL-204
13	GLC24064	45	MOS-AV-204
15	GLK24064-25	46	MOS-AL-402
22	GLK12232-25-WBL	47	MOS-AV-402
24	GLK12232-25-SM	48	LK082-12
31	LK404-AT	49	VK402-12
32	MOS-AV-162A	4A	VK404-55
33	LK402-12	4B	LK402-25
34	LK162-12	4C	VK402-25
35	LK204-25PC		

Remembered   No

11   Command Summary

11.1   Communications

Description	Syntax		Page
Changing the I²C Slave Address	Hexadecimal	0xFE 0x33 [adr]	15
	Decimal	254 51 [adr]	
	ASCII	254 "3" [adr]	
Changing the Baud Rate	Hexadecimal	0xFE 0x39 [speed]	15
	Decimal	254 57 [speed]	
	ASCII	254 "9" [speed]	
Setting a Non-Standard Baud Rate	Hexadecimal	0xFE 0xA4 [speed]	16
	Decimal	254 164 [speed]	

11.2 Text

Description	Syntax		Page
Auto Scroll On	Hexadecimal	0xFE 0x51	19
	Decimal	254 81	
	ASCII	254 "Q"	
Auto Scroll Off	Hexadecimal	0xFE 0x52	19
	Decimal	254 82	
	ASCII	254 "R"	
Clear Screen	Hexadecimal	0xFE 0x58	19
	Decimal	254 88	
	ASCII	254 "X"	
Changing the Startup Screen	Hexadecimal	0xFE 0x40 [chars]	20
	Decimal	254 64 [chars]	
	ASCII	254 "@" [chars]	
Set Auto Line Wrap On	Hexadecimal	0xFE 0x43	20
	Decimal	254 67	
	ASCII	254 "C"	
Set Auto Line Wrap Off	Hexadecimal	0xFE 0x44	20
	Decimal	254 68	
	ASCII	254 "D"	
Set Cursor Position	Hexadecimal	0xFE 0x47 [col] [row]	21
	Decimal	254 71 [col] [row]	
	ASCII	254 "G" [col] [row]	

Description	Syntax		Page
Go Home	Hexadecimal	0xFE 0x48	21
	Decimal	254 72	
	ASCII	254 "H"	
Move Cursor Back	Hexadecimal	0xFE 0x4C	22
	Decimal	254 76	
	ASCII	254 "L"	
Move Cursor Forward	Hexadecimal	0xFE 0x4D	22
	Decimal	254 77	
	ASCII	254 "M"	
Underline Cursor On	Hexadecimal	0xFE 0x4A	22
	Decimal	254 74	
	ASCII	254 "J"	
Underline Cursor Off	Hexadecimal	0xFE 0x4B	23
	Decimal	254 75	
	ASCII	254 "K"	
Blinking Block Cursor On	Hexadecimal	0xFE 0x53	23
	Decimal	254 83	
	ASCII	254 "S"	
Blinking Block Cursor Off	Hexadecimal	0xFE 0x54	23
	Decimal	254 84	
	ASCII	254 "T"	

11.3 Special Characters

Description	Syntax		Page
Creating a Custom Character	Hexadecimal	0xFE 0x4E [refID] [data]	24
	Decimal	254 78 [refID] [data]	
	ASCII	254 "N" [refID] [data]	
Saving Custom Characters	Hexadecimal	0xFE 0xC1 [Bank] [ID] [Data]	25
	Decimal	254 193 [Bank] [ID] [Data]	
Loading Custom Characters	Hexadecimal	0xFE 0xC0 [Bank]	26
	Decimal	254 192 [Bank]	

Description	Syntax		Page
Save Startup Screen Custom Characters	Hexadecimal	0xFE 0xC2 [refID] [data]	26
	Decimal	254 194 [refID] [data]	
Initialize Medium Number	Hexadecimal	0xFE 0x6D	27
	Decimal	254 109	
	ASCII	254 "m"	
Place Medium Numbers	Hexadecimal	0xFE 0x6F [Row] [Col] [Digit]	27
	Decimal	254 111 [Row] [Col] [Digit]	
	ASCII	254 "o" [Row] [Col] [Digit]	
Initialize Large Numbers	Hexadecimal	0xFE 0x6E	28
	Decimal	254 110	
	ASCII	254 "n"	
Place Large Number	Hexadecimal	0xFE 0x23 [Col] [Digit]	28
	Decimal	254 35 [Col] [Digit]	
	ASCII	254 "#" [Col] [Digit]	
Initialize Horizontal Bar	Hexadecimal	0xFE 0x68	29
	Decimal	254 104	
	ASCII	254 "h"	
Place Horizontal Bar Graph	Hexadecimal	0xFE 0x7C [Col] [Row] [Dir] [Length]	29
	Decimal	254 124 [Col] [Row] [Dir] [Length]	
	ASCII	254 "|" [Col] [Row] [Dir] [Length]	
Initialize Narrow Vertical Bar	Hexadecimal	0xFE 0x73	30
	Decimal	254 115	
	ASCII	254 "s"	
Initialize Wide Vertical Bar	Hexadecimal	0xFE 0x76	30
	Decimal	254 118	
	ASCII	254 "v"	
Place Vertical Bar	Hexadecimal	0xFE 0x3D [Column] [Length]	30
	Decimal	254 61 [Column] [Length]	
	ASCII	254 "=" [Column] [Length]	

11.4 General Purpose Output

Description	Syntax		Page
General Purpose Output Off	Hexadecimal	0xFE 0x56 [Num]	31
	Decimal	254 86 [Num]	
	ASCII	254 "V" [Num]	
General Purpose Output On	Hexadecimal	0xFE 0x57 [Num]	32
	Decimal	254 87 [Num]	
	ASCII	254 "W" [Num]	
Set Startup GPO state	Hexadecimal	0xFE 0xC3 [Num] [state]	32
	Decimal	254 195 [Num] [state]	

11.5   Display Functions

Description	Syntax		Page
Display On	Hexadecimal	0xFE 0x42 [min]	33
	Decimal	254 66 [min]	
	ASCII	254 "B" [min]	
Display Off	Hexadecimal	0xFE 0x46	33
	Decimal	254 70	
	ASCII	254 "F"	
Set Brightness	Hexadecimal	0xFE 0x99 [brightness]	34
	Decimal	254 153 [brightness]	
Set and Save Brightness	Hexadecimal	0xFE 0x98 [brightness]	34
	Decimal	254 152 [brightness]	
Set Contrast	Hexadecimal	0xFE 0x50 [contrast]	34
	Decimal	254 80 [contrast]	
	ASCII	254 "P" [contrast]	
Set and Save Contrast	Hexadecimal	0xFE 0x91 [contrast]	35
	Decimal	254 145 [contrast]	

11.6   Data Security

Description	Syntax		Page
Set Remember	Hexadecimal	0xFE 0x93 [switch]	36
	Decimal	254 147 [switch]	
Data Lock	Hexadecimal	0xFE 0xCA 0xF5 0xA0 [level]	37
	Decimal	254 202 245 160 [level]	
Set and Save Data Lock	Hexadecimal	0xFE 0xCB 0xF5 0xA0 [level]	38
	Decimal	254 203 245 160 [level]	

11.7 Miscellaneous

Description	Syntax		Page
Read Version Number	Hexadecimal	0xFE 0x36	39
	Decimal	254 54	
	ASCII	254 "6"	
Read Module Type	Hexadecimal	0xFE 0x37	40
	Decimal	254 55	
	ASCII	254 "7"	

11.8 Command By Number

Command			Description	Page
Hex	Dec	ASCII		
0x23	35	"#"	Place Large Number	28
0x33	51	"3"	Changing the I^2C Slave Address	15
0x36	54	"6"	Read Version Number	39
0x37	55	"7"	Read Module Type	40
0x39	57	"9"	Changing the Baud Rate	15
0x3D	61	"="	Place Vertical Bar	30
0x40	64	"@"	Changing the Startup Screen	20
0x42	66	"B"	Display On	33
0x43	67	"C"	Set Auto Line Wrap On	20
0x44	68	"D"	Set Auto Line Wrap Off	20
0x46	70	"F"	Display Off	33
0x47	71	"G"	Set Cursor Position	21
0x48	72	"H"	Go Home	21
0x4A	74	"J"	Underline Cursor On	22
0x4B	75	"K"	Underline Cursor Off	23
0x4C	76	"L"	Move Cursor Back	22

Command			Description	Page
Hex	Dec	ASCII		
0x4D	77	"M"	Move Cursor Forward	22
0x4E	78	"N"	Creating a Custom Character	24
0x50	80	"P"	Set Contrast	34
0x51	81	"Q"	Auto Scroll On	19
0x52	82	"R"	Auto Scroll Off	19
0x53	83	"S"	Blinking Block Cursor On	23
0x54	84	"T"	Blinking Block Cursor Off	23
0x56	86	"V"	General Purpose Output Off	31
0x57	87	"W"	General Purpose Output On	32
0x58	88	"X"	Clear Screen	19
0x68	104	"h"	Initialize Horizontal Bar	29
0x6D	109	"m"	Initialize Medium Number	27
0x6E	110	"n"	Initialize Large Numbers	28
0x6F	111	"o"	Place Medium Numbers	27
0x73	115	"s"	Initialize Narrow Vertical Bar	30
0x76	118	"v"	Initialize Wide Vertical Bar	30
0x7C	124	"|"	Place Horizontal Bar Graph	29
0x91	145		Set and Save Contrast	35
0x93	147		Set Remember	36
0x98	152		Set and Save Brightness	34
0x99	153		Set Brightness	34
0xA4	164		Setting a Non-Standard Baud Rate	16
0xC0	192		Loading Custom Characters	26
0xC1	193		Saving Custom Characters	25
0xC2	194		Save Startup Screen Custom Characters	26
0xC3	195		Set Startup GPO state	32

12   Appendix

12.1   Specifications

12.1.1   Environmental

Table 55: Environmental Specifications

	Standard Temperature	Extended Temperature
Operating Temperature	0°C to +50°C	-20°C to +70°C
Storage Temperature	-20°C to +70°C	-30°C to +80°C
Operating Relative Humidity	90% max non-condensing	
Vibration (Operating)	4.9 m/s^2 XYZ directions	
Vibration (Non-Operating)	19.6 m/s^2 XYZ directions	
Shock (Operating)	29.4 m/s^2 XYZ directions	
Shock (Non-Operating)	490 m/s^2 XYZ directions	

12.1.2   Electrical

Table 56: Electrical Specifications

	Standard	-V	-VPT
Supply Voltage	+5Vdc ±0.25V	+9V to +15V	+9V to +35V
Supply Current	11 mA typical		
Supply Backlight Current	160 mA typical		

12.2   Optical Characteristics

Table 57: Optical Characteristics

Character x Lines	20 columns x 4 rows
Module Size	98.00 mm x 60.00 mm x 27.50 mm
Character Size	2.95 mm x 4.75 mm
Display Size	76.30 mm x 25.00 mm
LED Backlight Life	100, 000 hours typical

12.3   Physical Layout

Figure 19: Physical Diagram
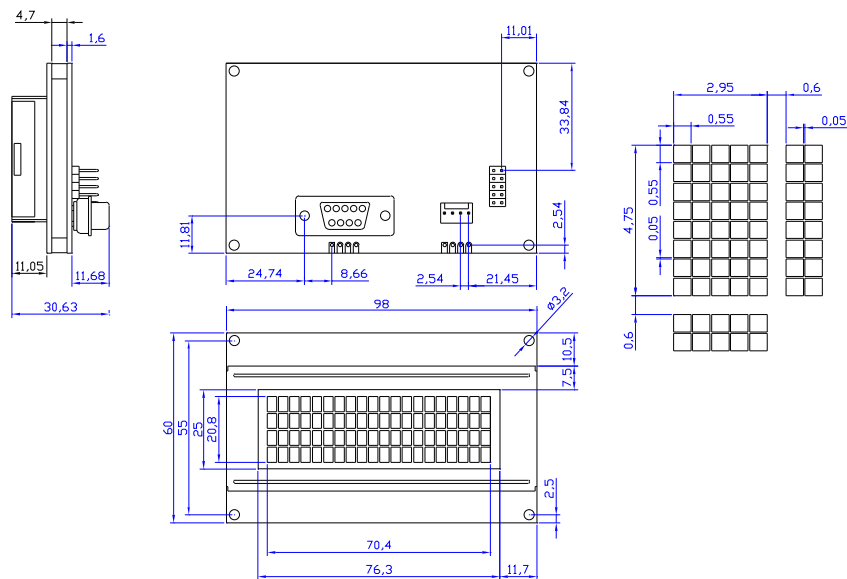
12.4   Definitions

E Extended Temperature (-20C to 70C)

VPT Wide Voltage with Efficient Switching Power Supply (+9 to +35Vdc)

V Wide Voltage (+9 to +15Vdc)

GW Grey Text / White Background

WB White Text / Blue Background

R Inverse Red

IY Inverse Yellow

MSB Most Significant Byte

LSB Least Significant Byte

12.5   Contacting Matrix Orbital

Telephone

Sales and Support: 1(403)229-2737

On The Web

Sales: http://www.MatrixOrbital.com

Support: http://www.MatrixOrbital.ca

Forums: http://www.lcdforums.com