# Matrix Orbital Corporation

# LCD2021
## User Manual

Software controlled
Backlight & Contrast

**Important:  Read pages 2 and 3 before applying power.**

**Connecting LCD2021**

**Regular Voltage**

Power is applied to the white or brown four pin SIP connector as follows:

Pin 1:  + 5V DC
Pin 2:  = SCL  (I²C Clock)
Pin 3:  = SDA  (I²C Data)
Pin 4:  Gnd
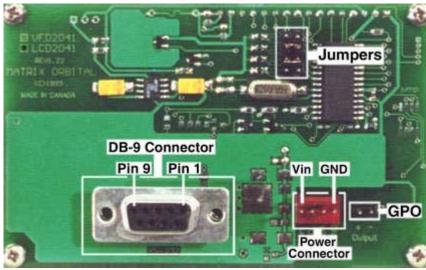
If the sole data source is via the RS-232, the data input is via the DB-9 connector. Pins 2 and 3 are not used.

**Wide Voltage Option**

Power is applied to the white or brown four pin SIP as follows:

Pin 1:  + 8-15V DC
Pin 2:  = SCL  (I²C Clock)
Pin 3:  = SDA  (I²C Data)
Pin 4:  Gnd

If the sole data source is via the RS-232, the data input is via the DB-9 connector. Pins 2 and 3 are not used.



(LCD2041)

**WARNING:**

**DO NOT APPLY ANY POWER WITH REVERSED POLARITY.**
**DO NOT APPLY ANY VOLTAGE OTHER THAN THE SPECIFIED VOLTAGE.**
**DO NOT USE ANY CABLES OTHER THAN THE CABLES SUPPLIED BY MATRIX ORBITAL CORPORATION UNLESS YOU ARE AWARE OF THE MODIFICATIONS REQUIRED.**
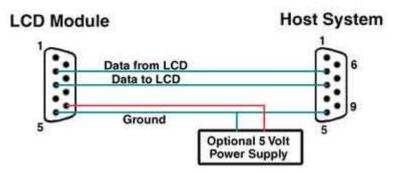**DO NOT UNDER ANY CIRCUMSTANCES USE AN UNMODIFIED FLOPPY DRIVE POWER CABLE.**

**DB-9 Connector Pin Out**

RS-232 port: This connector is wired so that a standard "straight through" 9 pin D-sub cable may be used to connect the modules on a standard serial port such as comm ports on PCs. Note that this device complies to the EIA232 standard in that it uses signal levels from +/- 3V to +/- 12V. It will not operate correctly at TTL (0 to +5V) levels.

| Pin Number | Description |
| --- | --- |
| 2 | Data Out |
| 3 | Data In |
| 5 | Ground |
| 9 | +5Vdc |

Note: Signals are shown as interpreted by the Liquid Crystal Display module.



Power may be provided to the module by pin 9 of the DB-9 connector instead of through the 4-pin SIP. If power is to be applied using the DB-9, it must be a regulated +5Vdc supply. If the user intends to use pin 9 as the power source, the user must solder the 5 volt jumper point beside the DB-9 connector. If you have any further questions or concerns please don't hesitate to contact Matrix Orbital.
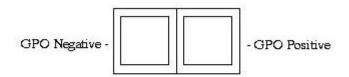
WARNING: USE THIS METHOD OF POWER UP AT YOUR OWN RISK. APPLICATION OF A VOLTAGE TO PIN 9 GREATER THAN 5.5VOLTS WILL CAUSE IMMEDIATE DESTRUCTION OF UNIT AND VOID THE WARRANTY.

Note: This applies to wide voltage units (V extensions) as well as to standard 5 volt units.

**General Purpose Output (GPO)**

The GPO is meant to be used as a pair. The positive side of the GPO is connected to a power source of +5Vdc supplied by the module at 20mA. The negative side of the GPO is capable of finding a path to ground through a 240 ohm resistor. This resistor will limit the current flow through a GPO to approximately 20mA in the event of a short circuit. 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 it's own greater than 250 ohms, then the 240 ohm resistor may be shorted. You will find this resistor directly below the negative pin of the general purpose output.

Note: This operation requires soldering. The GPO does not have any over current or over/under voltage protection so care must be taken if the user decides to connect the negative side differently. For instance if the external device is a relay it must be fully clamped to absorb any generated back electromotive force (EMF).

**Configuring LCD 2021**

Default configuration is J1 and J2 installed. This configures the RS-232 to 19 200 baud and I²C to slave address 0x5C - depending on which connector is used. Please refer to the Appendix of this manual for programming notes.

RS-232 port: J0, J1, J2 - control baud rate
RS-232 format is 8N1 (8 characters, no parity, one stop bit)
I²C port: J0, J1, J2, J3 - sets slave peripheral address

| Baud Rate | Slave Address | J3 | J2 | J1 | J0 |
|-----------|---------------|-----|-----|-----|-----|
| 1200 | 50H | Off | Off | Off | Off |
| | 52H | Off | Off | Off | On |
| 2400 | 54H | Off | Off | On | Off |
| | 56H | Off | Off | On | On |
| 9600 | 58H | Off | On | Off | Off |
| | 5AH | Off | On | Off | On |
| 19200 | 5CH | Off | On | On | Off |
| | 5EH | Off | On | On | On |
| 1200 | 60H | On | Off | Off | Off |
| | 62H | On | Off | Off | On |
| 2400 | 64H | On | Off | On | Off |
| | 66H | On | Off | On | On |
| 9600 | 68H | On | On | Off | Off |
| | 6AH | On | On | Off | On |
| 19200 | 6CH | On | On | On | Off |
| | 6EH | On | On | On | On |

**Write Text**

This section of the manual allows the user to send commands to the LCD to alter the appearance or behavior of the display. To utilize a command, the user must send a command prefix followed by the command in the format described in this portion of the manual. Any characters sent without a command prefix will be interpreted as text and will be displayed on the module at the current cursor position. The current cursor position will be incremented for each character received. Please note that unless line wrap is turned on, the text will follow the memory map of the module.

The command set discusses in detail what the LCD's capabilities of and how to execute each command. The basic format of all the commands listed in this segment that do not require parameters is:
< command prefix> < command>

For commands that do require parameters however the format is as follows:
< command prefix> < command> [< parameter> < parameter> .....]

**Auto Line Wrap On**
ASCII 'C', Hex 43, Decimal 67
Syntax 0xFE 0x43

This command enables the automatic line wrap function. Transmitted characters which overrun the width of the display will automatically wrap to the next line. The bottom line wraps to line 1 of the display. To carry out this command the user must send a command prefix followed the character 'C'.

**Auto Line Wrap Off**
ASCII 'D', Hex 44, Decimal 68
Syntax 0xFE 0x44

This command disables the automatic line wrapping function. To turn off the auto line wrapping, send a command prefix followed by the character 'D'.

**Auto Scroll On**
ASCII 'Q', Hex 51, Decimal 81
Syntax 0xFE 0x51

To turn the automatic line scrolling on, send a command prefix followed by the character 'Q'. In combination with the "Auto Line Wrap" command the text will automatically wrap and scroll up.

Note: "Auto Line Wrap" must be enabled for "Auto Scroll" to work properly.

**Auto Scroll Off**
ASCII 'R', Hex 52, Decimal 82
Syntax 0xFE 0x82

To turn the automatic line scrolling off, send a command prefix followed by the character 'R'.

**Backlight On**
ASCII 'B', Hex 42, Decimal 66
Syntax 0xFE 0x42< number of minutes>

To turn the backlight on, send a command prefix followed by the character 'B' as well as the number of minutes for the backlight to be activated. If < minutes> is sent as zero then the backlight will remain on indefinitely. The maximum value for < minutes> is 100.

**Backlight Off**
ASCII 'F', Hex 46, Decimal 70
Syntax 0xFE 0x46

To turn the backlight off, send a command prefix followed by the character 'F'.

**Clear Display**
ASCII 'X', Hex 58, Decimal 88
Syntax 0xFE 0x58

This command clears any text and graphics off the display. To clear the display, send a command prefix followed the character 'X'.

**Contrast**
ASCII 'P', Hex 50, Decimal 80
Syntax 0xFE 0x80< hex value defining contrast>

This command allows you to set the display contrast to a level between 0(light) and 256(dark). To execute this command, send a command prefix followed by the character 'P' and a hex value between 0x00 and 0xFF. Different displays and lighting conditions will affect the actual value used. Different modules have different power up contrast settings. Example:

| | |
|---|---|
| < command prefix> | 0xFE |
| < command> | 0x50 |
| < hex value> | 0x00 to 0xFF (level of contrast) |

**Cursor On**
ASCII 'J', Hex 4A, Decimal 74
Syntax 0xFE 0x4A

To turn the cursor on at the current position, send a command prefix followed by the character 'J'. Note cursor is on by default at power up.

**Cursor Off**
ASCII 'K', Hex 4B, Decimal 75
Syntax 0xFE 0x4B

To turn the cursor off at the current position , send a command prefix followed by the character 'K'.

**Cursor Left**
ASCII 'L', Hex 4C, Decimal 76
Syntax 0xFE 0x4C

To move the cursor one space to the left of current position, send a command prefix followed by the character 'L'.

**Cursor Right**
ASCII 'M', Hex 4D, Decimal 77
Syntax 0xFE 0x4D

To move the cursor one space to the right of the current position, send a command prefix followed by the character 'M'.

**Cursor Blink On**
ASCII 'S', Hex 53, Decimal 83
Syntax 0xFE 0x53

To turn on the blinking cursor at the current position, send a command prefix followed by the character 'S'. Please note that the blinking cursor is on by default at power up.

**Cursor Blink Off**
ASCII 'T', Hex 54, Decimal 84
Syntax 0xFE  0x54

To turn off the blinking cursor at the current position send a command prefix followed by the character 'T'.

**Create Custom Character**
ASCII 'N', Hex 4E, Decimal 78
Syntax 0xFE 0x4E< character between 0x00 and 0x07> < 8 bytes>

This command creates a custom character. For the LCD2021 the user can have up to eight custom characters. To execute this command, send a command prefix followed by the character 'N'. The display will now await the number which identifies the custom character. This number must be between 0x00 and 0x07. When the module determines what character it's working on, then the user must send 8 bytes. This defines the display character. See Diagram A below for and explanation of the display character structure.

Diagram A

| MSB | | | | | | | LSB | |
|---|---|---|---|---|---|---|---|---|
| * | * | * | 1 | 2 | 3 | 4 | 5 | Data Byte 1 |
| * | * | * | 6 | 7 | 8 | 9 | 10 | Data Byte 2 |
| * | * | * | 11 | 12 | 13 | 14 | 15 | Data Byte 3 |
| * | * | * | 16 | 17 | 18 | 19 | 20 | Data Byte 4 |
| * | * | * | 21 | 22 | 23 | 24 | 25 | Data Byte 5 |
| * | * | * | 26 | 27 | 28 | 29 | 30 | Data Byte 6 |
| * | * | * | 31 | 32 | 33 | 34 | 35 | Data Byte 7 |
| * | * | * | 36 | 37 | 38 | 39 | 40 | Data Byte 8 |

Pixel Layout of Display Characters

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 |
| 36 | 37 | 38 | 39 | 40 |
| Cursor Line | | | | |

**General Purpose Output On**
ASCII 'V', Hex 56, Decimal 86
Syntax 0xFE 0x56< hex number corresponding to output>

To turn on the general purpose output, send a command prefix followed by the character 'V'. Please note that the output is a current sink. (Max 20mA)

**General Purpose Output Off**
ASCII 'W', Hex 57, Decimal 87
Syntax 0xFE 0x57< hex number corresponding to output>

To turn off the general purpose output, send a command prefix followed by the character 'W'.

**Go To Position**
ASCII 'G', Hex 47, Decimal 71
Syntax 0xFE 0x47< column number> < row number>

To set the current cursor position, send a command prefix followed by the character 'G' and two values defining the column and row of the desired cursor position. Example:

| | |
|---|---|
| < command prefix> | 0xFE |
| < command> | 0x47 |
| < column number> | 0x01 to 0x14 for a twenty column display |
| < row number> | 0x01 to 0x02 for a two line display |

**Go To Top Left**
ASCII 'H', Hex 48, Decimal 72
Syntax 0xFE 0x48

This command resets the current cursor position to the top left of the LCD screen. To execute this command send a command prefix followed by character 'H'.

**Initialize Horizontal Bar Graph**
ASCII 'h', Hex 68, Decimal 104
Syntax 0xFE 0x68

Before any horizontal bar graphs may be created, this command must be executed. It only needs to be sent once to initialize the custom characters for bar graph creation. Due to the fact bar graphs use custom characters, no user custom characters may be displayed or created while bar graphs are in use.

**Make Horizontal Bar Graph**
ASCII '|', Hex 7C, Decimal 124
Syntax 0xFE 0x7C< column number> < row number> < direction> < bar length>

This command places a horizontal bar graph at the specified column and row with the specified width. The format of the command is as follows:

| | |
|---|---|
| < command prefix > | 0xFE |
| < command> | 0x7C |
| < column number> | 0x01 to 0x14 for a twenty column display |
| < row number> | 0x01 to 0x02 for a two line display |
| < direction> | 0 for left to right, 1 for right to left |
| < bar length> | 0x00 to 0x64 (0 to100) for a twenty column display |

Bar length is in pixel widths. On a twenty column display the maximum bar graph width is one hundred pixels (if the bar graph starts at the edge). This is due to the fact that each of the twenty columns on the display are five pixels wide. The width of the space between columns is not taken into account.

**Initialize Thick Vertical Bar Graph**
ASCII 'v', Hex 76, Decimal 118
Syntax 0xFE 0x76

Before any thick vertical bar graphs may be created, this command must be executed. It only needs to be sent once to initialize the custom characters required for bar graph creation. Bar graphs use custom characters, therefore no user custom characters may be displayed or created while bar graphs are in use.

**Initialize Thin Bar Vertical Graph**
ASCII 's', Hex 73, Decimal 115
Syntax 0xFE 0x73

This command is executed in exactly the same manner as the 'Initialize Thick Bar Graph' command.

**Make Vertical Bar Graph**
ASCII '= ', Hex 3D, Decimal 61
Syntax 0xFE 0x3D< column number> < bar length>

This command places a bar graph at the specified column with the specified height. The style of the vertical bar graph whether it be thick or thin is selected by the initialize vertical bar graph command. If thick bar graphs are preferred, the 'v' command should be send to initialize the bar graph. If a thin vertical bar graph is desired, the 's' command should be sent. The format for the command is as follows:

| | |
|---|---|
| < command prefix> | 0xFE |
| < command> | 0x3D |
| < column number> | 0x01 to 0x14 for an twenty column display |
| < bar length> | 0x00 to 0x16 for a two line display. |

Bar height is in pixel widths. On a two line display the maximum bar graph height is sixteen, this is because each of the lines in the display are eight pixels high. The width of the space between the lines is not taken into account.

**Note: Vertical bar graphs may not be used with horizontal bar graphs, and thick bar graphs may not be used with thin bar graphs. This is because all these functions make use of the same "custom character" spaces. As a result, custom characters are also unavailable while any of these functions are in use.**

# LCD Character Font Chart

| D7 D6 D5 D4 | | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **D3 D2 D1 D0** | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **A** | **B** | **C** | **D** | **E** | **F** |
| 0 0 0 0 | 0 | | | | 0 | @ | P | ` | p | | | | ― | タ | ミ | ﾜ | ρ |
| 0 0 0 1 | 1 | | | ! | 1 | A | Q | a | q | | | 。 | ア | チ | ム | ﾞ | q |
| 0 0 1 0 | 2 | | | " | 2 | B | R | b | r | | | ｢ | イ | ツ | メ | β | θ |
| 0 0 1 1 | 3 | | | # | 3 | C | S | c | s | | | ｣ | ウ | テ | モ | ε | ∞ |
| 0 1 0 0 | 4 | | | $ | 4 | D | T | d | t | | | 、 | エ | ト | ヤ | μ | Ω |
| 0 1 0 1 | 5 | | | % | 5 | E | U | e | u | | | ・ | オ | ナ | ユ | σ | ü |
| 0 1 1 0 | 6 | | | & | 6 | F | V | f | v | | | ヲ | カ | ニ | ヨ | ρ | Σ |
| 0 1 1 1 | 7 | | | ' | 7 | G | W | g | w | | | ァ | キ | ヌ | ラ | g | π |
| 1 0 0 0 | 8 | | | ( | 8 | H | X | h | x | | | ィ | ク | ネ | リ | ∫ | x̄ |
| 1 0 0 1 | 9 | | | ) | 9 | I | Y | i | y | | | ゥ | ケ | ノ | ル | ⁻¹ | у |
| 1 0 1 0 | A | | | * | : | J | Z | j | z | | | ェ | コ | ハ | レ | j | 千 |
| 1 0 1 1 | B | | | + | ; | K | [ | k | { | | | ォ | サ | ヒ | ロ | x | 万 |
| 1 1 0 0 | C | | | , | < | L | ¥ | l | | | | | ャ | シ | フ | ワ | ¢ | 円 |
| 1 1 0 1 | D | | | - | = | M | ] | m | } | | | ュ | ス | ヘ | ン | ½ | ÷ |
| 1 1 1 0 | E | | | . | > | N | ^ | n | → | | | ョ | セ | ホ | ゛ | ñ | ▓ |
| 1 1 1 1 | F | | | / | ? | O | _ | o | ← | | | ッ | ソ | マ | ゜ | ö | █ |

# Specifications

## Environmental Specifications

|  | Standard Temp. | Extended Temp. |
|---|---|---|
| Operating Temperature | 0º to + 50º C | -20º to + 70º C |
| Storage Temperature | -20º to + 70º C | -40º to + 85º C |
| Operating Relative Humidity | 90% max non-condensing ||

## Electrical Specifications

| Supply Voltage | 4.75 - 5.25 Vdc (optional 7 - 15Vdc) |
|---|---|
| Supply Current | 9mA typical |
| Backlight Supply Current | 115mA typical |

## Optical Specifications

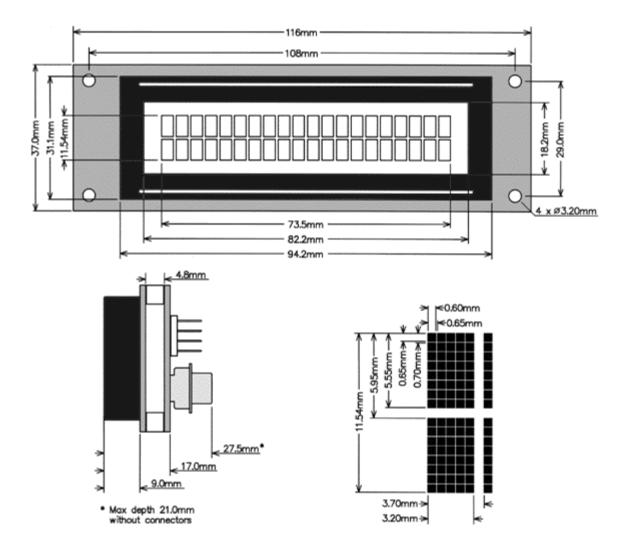| Number of characters | 40 (20 Characters x 2 Lines) |
|---|---|
| Matrix format | 5 x 7 with underline |
| Display area | 82.20 x 18.20 mm (XxY) |
| Character size | 3.20  x 5.55 mm (XxY), not including underline |
| Character pitch | 3.70 mm |
| Line pitch | 5.95 mm |
| Dot size | 0.60 x 0.65 mm (XxY) |
| Dot pitch | 0.65 x 0.70 mm (XxY) |
| LED Backlight life | 100,000 hours typical |
| Color of illumination | Yellow green |

## Appendix

Hex numbers are specified in C language convention as 0xUL - where U is the upper nibble and L is the lower nibble. For instance, 0xFE is 1111 1110 in binary. This is equivalent to ULH or ULh as in the binary number:

|  |  |
|---|---|
| 1111 | 1110 |
| UpperNibble | Lower Nibble |

This would be FEH or FEh.

# LCD2021

116mm

108mm

37.0mm

31.1mm

11.54mm

18.2mm

29.0mm

4 x Ø3.20mm

73.5mm

82.2mm

94.2mm

4.8mm

27.5mm*

17.0mm

9.0mm

* Max depth 21.0mm
  without connectors

0.60mm

0.65mm

5.95mm

5.55mm

0.65mm

0.70mm

11.54mm

3.70mm

3.20mm

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**Note**: Currently only carries LCD2041, LK204-25

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